

Evaluation of the Nottingham Park Serpentine Barrens
Chester County, Pennsylvania

For its Merit in Meeting National Significance Criteria as a National Natural Landmark in
Representing Serpentine Barrens as a Natural Feature in the Mid-Atlantic Piedmont Region

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Fameflower (*Talinum teretifolium*)
photo by Katharina AM Engelhardt

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Table of Contents

Executive Summary	1
Introduction.....	2
Source of Site Proposal.....	2
Evaluators	2
Scope of Evaluation	2
Characterization of the Primary Natural Features	3
Description.....	3
<i>Primary Geological Features</i>	3
<i>Primary Biological Features</i>	4
Distribution and Context.....	4
Regional Variation	5
Significance.....	5
Nottingham Park Serpentine Barrens Site Description.....	6
Primary Natural Features	6
<i>Primary Biological Features</i>	6
<i>Primary Geological Features</i>	7
Natural History Themes Represented	7
Secondary Natural Features	7
Physical Setting.....	7
Location and Access	8
Ownership.....	8
Land Use and Condition	8
<i>Historic Land Use</i>	8
<i>Current Land Use and Present Condition</i>	9
Sensitive or Hazardous Resources	9
Comparative Assessment	10
Regional Site Inventory	10
Site Descriptions	10
<i>Highest Quality Sites</i>	10
<i>Other Sites</i>	12
Comparative Analysis & Discussion	14
Evaluation Recommendations	17
Proposed Landmark Boundary	17
Literature Cited	18
Figures.....	21
Appendix A: Flora and Fauna Lists	29
Appendix B: Representative Site Photographs	44
Appendix C: Consideration of the Addition of Goat Hill Serpentine Barrens for Inclusion in the Proposed NNL Boundary.....	53

Executive Summary

The National Natural Landmark (NNL) Program encourages the preservation of the Nation's biological and geological features. To qualify for NNL designation, a site must be one of the best examples of a geological or biological feature within a biophysigraphic province. A portion of Nottingham County Park in Chester County, Pennsylvania has been identified as a potentially outstanding example of a Serpentine Barren natural history sub-theme in the Piedmont biophysigraphic province of the Mid-Atlantic United States. The owners of the park have consented to allow the site to be evaluated as a Potential National Natural Landmark (PNNL). This evaluation considers whether the resources at Nottingham Park Serpentine Barrens are intact, nationally significant, and deserving of NNL designation. It includes a characterization of Serpentine Barren Ecosystems as they occur within the Piedmont, a site description of Nottingham Park Serpentine Barrens PNNL, a comparative assessment of other serpentine sites in the region, a final recommendation for designation, and a map of the recommended boundary.

Serpentine soils are unique geologically because they contain high concentrations of iron, chromium, nickel and cobalt that are toxic to many plant species. This toxicity, in combination with low nutrient concentrations and shallow soils, contributes to the development of unique vegetation communities containing many rare and endemic plant species. These serpentine communities are unusual in the Piedmont province of the Mid-Atlantic and therefore contribute significantly to the natural history of the province. As such, consideration of a serpentine barren in the Mid-Atlantic region is warranted to encourage the preservation of the region's unique natural features.

*It is our recommendation that Nottingham PNNL meets the national significance criteria required for the NNL Program. The proposed site supports shallow serpentine rock outcrops and unique vegetation communities, especially serpentine grassland and open savanna communities. Historic mine sites provide glimpses of the underlying geology, illustrate the history of human use of the area, and also serve as good habitat for rare species. Prescribed burns and mechanical removal will need to be continued on an annual basis to maintain open grasslands and prevent invasion by invasive species, especially greenbriar (*Smilax rotundifolia*). Nottingham PNNL supports several rare and endemic species, maintains a well-designed trail system to provide access to the site, and is actively engaged in research and education. A comparison with other serpentine barrens in the region identified Soldiers Delight Serpentine Barrens in Maryland as equal in many significance criteria. Soldiers Delight is larger than Nottingham PNNL and is in the midst of an ambitious restoration program. However, Nottingham supports an intact pitch pine (*Pinus rigida*) population, which is uniquely illustrative and occurs on few other barrens in the region. Nottingham is also centrally located with regards to other Mid-Atlantic serpentine sites.*

After considerable research, discourse with experts, and site visits we have come to the conclusion that Nottingham PNNL contains the required biological and geologic feature to be listed as a National Natural Landmark. We include a map of the proposed landmark boundary, which delineates a total of 179 hectares.

Introduction

Source of Site Proposal

The Nottingham Park Serpentine Barrens were originally recommended as a Potential National Natural Landmark (PNNL) in the Potential Ecological Landmarks Study Piedmont Region commissioned by the National Park Service (Radford & Martin 1975). The barrens are representative of the crossroads between the eastern deciduous forest (Theme 24) and grassland (Theme 25) natural history themes. Radford & Martin (1975) describe Nottingham Park Serpentine Barrens as one of the five most outstanding sites for National Natural Landmark (NNL) consideration. The site has been previously evaluated for NNL status, and Erdman (1977) and Smith & Wilkinson (1989) both recommended the Nottingham Park Serpentine Barrens for NNL designation.

Evaluators

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Scope of Evaluation

The study area used in this evaluation was the Piedmont Region of the Mid-Atlantic United States (Figure 1). The sites selected for the comparative assessment lie within a similar climatic zone as the Nottingham Park Serpentine Barrens. Serpentine sites in the northeast, southeast, and west coast of the United States were not considered, as these were judged to be substantially different climatically and floristically.

The evaluation of the Nottingham Park Serpentine Barrens is based upon scientific literature, site visits, and conversations with scientific experts. Site visits were conducted in July 2006 to Nottingham Park Serpentine Barrens, Chrome Serpentine Barrens, Soldiers Delight Serpentine Barrens, Goat Hill Serpentine Barrens, Pilot Serpentine Barrens, Rock Springs Serpentine Barrens, and Travilah Serpentine Barrens. Experts conferred with during the course of this evaluation include: Wayne Tyndall, Maryland Department of Natural Resources; Roger Latham, Continental Conservation; Mark Mattie, Chester County Parks and Recreation GIS/Mapping Analyst; Kate Mrakovich, Chester County Parks and Recreation; Kerry Horner, Chester County Parks and Recreation; Nels Johnson, The Nature Conservancy, Pennsylvania; Doug Samson, The Nature Conservancy, Maryland; Daniel Gustafson, Department of Biology, The Citadel; Matthew Wallenstein, Natural Resources Ecology Laboratory, Colorado State; Bill DeCarme, former Nottingham Park Superintendent; Mike Bertram, volunteer, The Nature Conservancy, Pennsylvania. The report has been externally reviewed by three peer-reviewers.

Characterization of the Primary Natural Features

Description

Primary Geological Features

Serpentinite is one of the most rare and unusual bedrock materials in the United States. The term “serpentine” is derived from the greenish color and pattern of the rock, which resembles that of a snake’s skin. The serpentine group of minerals have the general formula $Mg_3Si_2O_5(OH)_4$ and are important constituents of weathered ultramafic rocks (Brooks 1987). These minerals, mainly chrysotile and lizardite, are formed at sea floor fracture zones due to seawater intrusion. The seawater reacts with the minerals olivine and pyroxene to create the hydrated ultramafic rocks of serpentine. They are then pushed upward through tectonic activity inland of coastal regions, and soils are formed as the rocks are exposed to chemical and physical weathering.

Serpentine rocks include economically important minerals such as chromium, talc, asbestos, and corundum (Dann 1988). Serpentine is also used as a building stone. In the late nineteenth century, Pennsylvania and Maryland were the world leaders of chromium mining because of the high concentration of serpentine found there.

Serpentine soils have been extensively studied in the United States. They are unusual in the Piedmont province of the Mid-Atlantic and therefore contribute significantly to the natural history of the province. Common characteristics include (Kruckeberg 1985, Brooks 1987):

1. High concentrations of siderophile elements such as iron, chromium, nickel, and cobalt;
2. Low concentrations of plant nutrients such as nitrogen, phosphorus, and potassium;
3. Low calcium/magnesium quotient, compared to non-serpentine soils; and
4. Low clay content, relative to non-serpentine soils.

Owing to these characteristics, referred to collectively as the “serpentine syndrome”, serpentine soils are considered relatively infertile (Kruckeberg 1985). The main reasons for this infertility are: the toxic effects of nickel, chromium, cobalt, and excess magnesium; infertility due to the low content of calcium and other plant nutrients; and the adverse effects on vegetation of the calcium/magnesium quotient in the substrate (Brooks 1987). This relative infertility has important implications for the biota, as it greatly limits the vegetation community that can develop (Whittaker 1954, Brady 2005). The term “barrens” derives from the unsuccessful attempts of early settlers to cultivate these infertile savannas. The inability of crops or other common vegetation to thrive on these soils has permitted an anomalous and rare flora to flourish.

Primary Biological Features

Only a small fraction of serpentine outcrops bear the distinctive serpentine barren vegetation: a diverse native grassland with scattered pines and oaks, sclerophyllous shrubs, and exposed rock (Whittaker 1954, Proctor 1971). In aerial view, these serpentine barrens look like islands surrounded by forest and farmland rather than water (Natural Heritage Data Center 1993). When compared to non-serpentine vegetation, serpentine plants generally display a greater tolerance of high magnesium and low calcium levels, have higher magnesium requirements for growth, have lower magnesium adsorption and greater calcium absorption, and show magnesium exclusion from leaves (Tyndall & Farr 1989).

Serpentine barrens serve as specialized habitats for many rare, disjunct, and endemic plant species including: moss pink (*Phlox subulata*), wood lily (*Lilium philadelphicum*), annual fimbry (*Fimbristylis annua*), plain ragwort (*Senecio anonymus*), few-flowered nutrush (*Scleria pauciflora*), fame flower (*Talinum teretifolium*), serpentine aster (*Aster depauperatus*), long-haired barrens chickweed (*Cerastium velutinum* var. *villosissimum*), serpentine maidenhair (*Adiantum pedatum*), sandplain gerardia (*Agalinus acuta*), and glade spurge (*Euphoria purpurea*) (Latham 1993, Gustafson et al. 2003, Gustafson and Latham 2005). The barrens are also the primary home to rare insect species such as the buckmoth (*Hemileuca maia*) (Fergus 2002).

The rare communities that inhabit serpentine barrens are fire dependent. Increased fire suppression beginning in the early 1900's has allowed fire intolerant species such as Virginia pine (*Pinus virginiana*) and eastern redcedar (*Juniperus virginiana*) to increase in abundance on the serpentine grasslands (Tyndall & Farr 1989). In addition, the number of large-scale fires in many of the barrens has inadvertently decreased owing to the fragmentation of the landscape by trails, roads, and other firebreaks (Latham 1993). This has caused succession from the typical oak savanna to pine savannas, or even pine forests. These pine species are susceptible to intense fires, which are believed to return the serpentine areas to an oak savanna state (Miller 1981). Many organizations are now studying and promoting prescribed burning within these ecosystems in order to maintain the rare habitats (e.g., Samson and Kramme 1993).

Distribution and Context

The rarity of the underlying geologic substrate combined with the need for frequent disturbance provide an uncommon set of circumstances for the development of serpentine ecosystems. Light green serpentine bedrock is found throughout the world. Every continent has a few outcrops of serpentine; however, serpentine occupies less than 1 percent of any continent's surface (Brooks 1987). In North America, serpentine is found in four clusters: Georgia to Newfoundland, Quebec to Manitoba, Guatemala to Cuba, and central California to Alaska (Irwin & Coleman 1972).

The region of serpentine that is the focus of this evaluation stretches from Alabama in the southeast United States through the Appalachians and into northern Quebec (Figure 2). Brooks (1987) describes the most important portion of this eastern belt of serpentine as the portion passing through Maryland, Pennsylvania, and Delaware where the belt of ultramafic rocks is 250 kilometers (km) long and up to 80 km wide (Figure 3). We use this Piedmont Upland region as the geographic extent for this evaluation.

Regional Variation

The State-line Barrens in Pennsylvania and Maryland make up more than 90% of the eastern serpentine outcrops. A string of seven sites comprise these barrens along 20 km of the Pennsylvania/Maryland border (Latham 1993). Two additional serpentine belts exist in Maryland, the Laurel belt and the Belair belt (Tyndall & Farr 1989). The Laurel belt extends from western Baltimore City southwest to Laurel, Maryland. The Belair belt extends from eastern Baltimore City northeast through the town of Bel Air and into Cecil County, Pennsylvania. Historically, grasslands, shrublands, and open woodlands covered over 100,000 hectares of this region of Pennsylvania and adjacent northeastern Maryland due to Native American management of the land through burning (Marye 1955). However, serpentine grasslands probably comprised no more than 2,000 hectares in Pennsylvania and Maryland, of which less than 1,000 hectares remain today owing to fire suppression and development (Tyndall 2005).

Significance

The conditions necessary for serpentine communities to develop are globally and nationally uncommon, including serpentine soils and frequent disturbances. When present, however, these conditions support a unique collection of vegetation. Approximately 1,200 plant species, including 140 lichens, 200 bryophytes, 35 ferns, and 1,000 phanerogams, have been found on the serpentine barrens of the Piedmont Upland in Maryland, Pennsylvania, and Delaware (Brooks 1989). Many of these species are listed as federally or state rare and are more or less restricted to serpentine barrens. These include annulus panic grass (*Dichanthelium annulum*), annual fimbry (*Fimbristyllis annua*), and prairie dropseed (*Sporobolus heterolepsis*). An even larger group of plants, while not restricted to the barrens, are found much more frequently in these habitats. The two true endemic plant taxa to eastern serpentine barrens are serpentine aster (*Aster depauperatus*) and long-haired barrens chickweed (*Cerastium velutinum* var. *villosissimum*).

In California, islands of serpentine vegetation have been used to illustrate the ecological concept of metapopulations for butterflies (Harrison 1997). Although little evidence is available to support the notion that moths and butterflies of eastern serpentine barrens exhibit behavior consistent with metapopulations, it is possible. Many invertebrate species rely upon the vegetation of this unique ecosystem and may disperse long distances. Wind dispersal may also allow some plant species to colonize distant habitats. However, residential areas, roads and agricultural fields, which exist within the matrix of the fragmented serpentine landscape, are dispersal barriers for most species that prefer or are restricted to serpentine barrens. Even the short distance between Nottingham Serpentine Barrens and Goat Hill Serpentine Barrens should restrict dispersal to only those species that are capable of long-distance dispersal.

Nottingham Park Serpentine Barrens Site Description

The Nottingham Park Serpentine Barrens have been proposed for this evaluation because they contain some of the greatest numbers of endemic, rare, characteristic, and disjunct species found on serpentine soils within the Piedmont (Radford and Martin 1975). The following sections describe these barrens in detail.

Primary Natural Features

The Nottingham Park Serpentine Barrens cover 179 hectares in Chester County, Pennsylvania. It is owned by Chester County and operated as a public park (Figure 4). The site consists of areas of mixed and deciduous forest with substantial areas of coniferous forest and open grassland, which are indicative of serpentine habitats. The site is bounded on one side by the headwaters of Black Run, which runs from east to west into Octoraro Creek, a tributary to the Susquehanna River. There is also a recreational lake (McPherson Lake) in the northwestern section of the park that is just outside the delineated NNL area.

Primary Biological Features

The Nottingham Park Serpentine Barrens provide an illustrative example of the biological and geological features of an eastern serpentine barren ecosystem. The barrens are a patchy mosaic of serpentine communities in an agricultural yet suburbanizing landscape matrix (Arabas 2000). Ecological communities that occupy the site include: bedrock outcrops, prairie, fen, pine savanna, and oak-pine woodlands.

The pine savanna and prairie ecosystems are especially species rich, supporting diverse warm-season grasses including: big bluestem (*Andropogon gerardii*), little bluestem beardgrass (*Andropogon scoparius*), Indian grass (*Sorghastrum nutans*), and prairie dropseed (*Sporobolus heterolepis*). Other unique plants found on site include: the northernmost occurrence of fame flower (*Talinum teretifolium*), as well as moss pink (*Phlox subulata*), whorled milkweed (*Asclepias verticillata*), and lyre-leaved rockcress (*Arabis lyrata*). Recent surveys have confirmed the presence of at least 21 globally or state-rare plant species including one of the largest population in the world of serpentine aster (*Aster depauperatus*), which is one of the only two recognized serpentine endemics of eastern North America (Appendix A). The area also contains a mixed mesophytic forest consisting of black oak (*Quercus velutina*), white oak (*Quercus alba*), red maple (*Acer rubrum*), black cherry (*Prunus serotina*), sassafras (*Sassafras albidum*), bigtooth aspen (*Populus grandidentata*), and blackgum (*Nyssa sylvatica*) (Arabas 2000).

Invasive coniferous trees and shrubs, especially Virginia pine (*Pinus virginiana*), are perhaps the major threat to remaining serpentine vegetation in the region (Hochman 2001). As a result of past grazing prior to park establishment and fires of human origin in the 19th and 20th centuries, Nottingham Park Serpentine Barrens is still relatively free of Virginia pine and maintains one of the largest extents of pitch pine forest in the state of Pennsylvania. A mixture of pitch pines, grasses and shrubs is a characteristic and regionally rare serpentine community found at the site. Typical species in these serpentine pitch pine communities include: pitch pine (*Pinus rigida*), post oak (*Quercus stellata*), and blackjack oak (*Quercus marilandica*) (Brooks 1987).

The site is host to a wide variety of birds, mammals, moths, butterflies, amphibians and reptiles including at least 33 that are globally or state rare (Appendix A). It is included within an Important Bird Area, a designation given by Audubon Pennsylvania because of the early successional forests and grasslands that support northern bobwhites (*Colinus virginianus*), prairie warblers (*Dendroica discolor*), white-eyed vireos (*Vireo griseus*), common yellowthroats (*Geothlypis trichas*), brown thrashers (*Toxostoma rufum*), and gray catbirds (*Dumetella carolinensis*). The pitch pines also provide valuable nesting habitat for locally rare and declining birds such as the pine warbler (*Dendroica pinus*), yellow-billed cuckoo (*Coccyzus americanus*), and yellow-breasted chat (*Icteria virens*).

Primary Geological Features

Nottingham Park Serpentine Barrens has one of the broadest ranges of geologic features in the region (Smith and Barnes 1998). Soils at Nottingham Park Serpentine Barrens are part of the Neshaminy-Chrome-Conowingo association: moderately-deep and deep silty soils derived from serpentine bedrock. At Nottingham, soil depths range from 15 to 75 centimeters. The soils are characterized by low permeability and are severely eroded on ridgetops and steep areas. Exposed areas including mine sites and roadways within the proposed NNL demonstrate the serpentine geology, which typically shows a glassy texture and a dull dark green color.

Natural History Themes Represented

The Nottingham Park Serpentine Barrens are representative of the serpentine barren ecosystem sub-theme. This sub-theme shares characteristics with the eastern deciduous forest (Theme 24) and grassland (Theme 25) natural history themes as identified by the NNL program.

Secondary Natural Features

Certain species are present at Nottingham Park Serpentine Barrens as a result of the Wisconsin glacial advance and retreat (Brooks 1987). For example, the southernmost extent of the Wisconsin ice sheet was just north of the site, allowing new species to establish themselves in the region during the tundra-like climatic conditions. When the ice sheet retreated, these species remained in the serpentine barrens where they likely had far fewer competitors. Small's ragwort (*Senecio smallii*) has a similar, but contrasting history. This plant is not found north of Virginia, except on serpentine barrens. The plant established itself in the north during the warmest part of the present interglacial period, but as temperatures cooled around 5,000 years ago, Small's ragwort persisted only in the serpentine barrens, presumably because of its tolerance of serpentine soils and intolerance of competition (Brooks 1987). Many seeps and small streams also drain the barrens, and the site contains groundwater seep communities dominated by wavy hairgrass (*Deschampsia caespitosa*) that are uncommon to the area (Podniesinski pers. comm.).

Physical Setting

The Nottingham Park Serpentine Barrens are located on gently rolling hills in southeastern Pennsylvania. The terrain consists of slopes between 3 and 40 percent with an average elevation of 400 meters and a range of approximately 50 meters (Arabas 2000). Climate is humid temperate with an average temperature of 11°C and annual precipitation of 1200 millimeters distributed evenly throughout the year (U.S. Department of Agriculture 1963 as cited in Arabas 2000). The generally southern exposure of the park results in favorable climatic conditions for southern plants relative to the rest of Chester County (Vanderwerff 1993).

Location and Access

The delineated National Natural Landmark boundary is entirely within Nottingham County Park. Nottingham County Park is near the towns of Rising Sun, Maryland and Oxford, Pennsylvania. It is accessible from Interstate 95 (Figure 5) and also from the Pennsylvania Turnpike. The address is 150 Park Road, Nottingham, PA 19362. From the south, follow I-95 North to Rt. 272, and proceed 11 miles on Rt. 272 North to the Village of Nottingham. Proceed through the main village intersection to Herr Drive. After taking a left onto Herr Drive, turn right onto Old Baltimore Pike, and then right onto Park Road. From there, follow signs to the entrance on the left. From the north, take the Turnpike to the exit for Valley Forge (and go via Rt. 202) or Morgantown (and go via Rt. 10) to Rt. 1 South. Turn left onto Rt. 272 South and proceed 0.25 miles to Herr Drive. Turn right onto Herr Drive, and follow directions above. The Park is completely within the 1: 24,000 scale topographic map quadrangle “Rising Sun, MD-PA” (39076-F1-TF-024) 1992 (Figure 6).

Ownership

Historically, the Nottingham Park Serpentine Barrens site has been privately owned and managed primarily for mining activities. In 1977, Chester County designated the site as the county’s first public park and Natural Area, a designation that recognizes the area’s unique scenic, historic, geologic, and ecological attributes. The entire park is owned by Chester County with no privately owned inholdings. The proposed landmark boundary is wholly within the park (Figure 7). Surrounding lands are predominantly in private ownership with a small holding of The Nature Conservancy adjacent to the northeast boundary of the park.

Land Use and Condition

Historic Land Use

The Nottingham Park Serpentine Barrens have a long history of mining including the extraction of chromium, sodium feldspar, and building stone. By 1850, the State-line serpentine district was the world’s leading source of chromite (Pearre & Heyl 1960). These operations were later replaced by feldspar mines at the turn of the 20th century. Old mining sites can still be found throughout the park, and these sites provide an excellent opportunity for visitors to view serpentine outcrops. In all cases, mine pits are fenced for the protection of park visitors (DeCarme, pers. comm.). The mining sites were not large and therefore resulted in minimal damage to any surrounding savanna vegetation (Arabas 2000). The total area mined in the delineated NNL area is 0.57 hectares.

Based on an absence of records and infertility of the soil, it is assumed that farming never took place on the serpentine barrens areas, nor is there direct evidence of Native American burning or related activities on the site (Arabas 2000). However, disturbance is critically important to maintaining serpentine barrens, and the fire-suppression activities implemented by early European settlers had a substantial impact on serpentine areas surrounding the proposed NNL. The persistence of pitch pines at the site is unusual and indicates that fire continued to burn parts of the Nottingham landscape throughout this historical period of fire suppression.

Current Land Use and Present Condition

The Nottingham Park Serpentine Barrens have remained one large parcel since the mid 1800's (Arabas 2000). Since Nottingham Park was established as a County Park, only a small part of the park has been modified for recreational purposes. These portions are not included in this evaluation because they are not in the proposed NNL area. All land south of Black Run is designated by the park as a protected Natural Area, which prevents any major development but allows management that is thought to be beneficial. Recreation within the proposed area consists primarily of hiking, biking and horseback riding, and the overall condition of the area is very much intact.

We conducted an evaluation of the land cover present within the proposed NNL area using unpublished GIS data from Chester County Parks. These data indicate that 81 percent of the NNL area is forested (Figure 8). Fields comprise nearly 1 percent of the park's area and brush or serpentine savanna comprises roughly 18 percent. This evaluation likely underestimates the amount of brush and savanna and overestimates the amount of forested area due to a thinning of approximately 32 hectares that was done in the eastern section of the park subsequent to map creation (Mark Mattie and Bill DeCarme pers. comm.). Without active management, including prescribed burning, the savanna vegetation is likely to shift from an open to closed canopy forest (Arabas 2000).

Currently, The Nature Conservancy assists with the park's prescribed fire management. The burns provide an excellent opportunity to educate the public on the role of fire in natural ecosystem processes. The Conservancy implements an active program of spring and fall annual burns as outlined in their five-year management plans. The current management plan is set to expire in 2007 (Bill DeCarme pers. comm.), but it is expected to be renewed for another five years and planning is currently underway for both spring and fall burns in 2007 (Kerry Horner pers. comm.). Future development outside the park may result in the need for a greater effort to inform the public about prescribed burns and for a closer watch on wind conditions, but should not significantly inhibit the burning regime.

Sensitive or Hazardous Resources

A major threat to the eastern temperate serpentine barrens is increased development. According to Latham (1993), northern Chester County and central Delaware County in Pennsylvania are "littered with more than a dozen small...serpentine barrens, eaten away by housing developments...golf courses, and other types of intensive land use." At Nottingham Park Serpentine Barrens specifically, a large farm is located to the north of the park, and the character of the park could be greatly influenced if this land were to be developed (DeCarme pers. comm.). Conservation easements are one way of limiting encroaching development and The Nature Conservancy actively pursues these types of agreements in the area. Additional pressures to serpentine barrens of the eastern United States include mining, illegal dumping, and invasive plant species. Nottingham County Park is protected from future mining. Park management policy also specifies clean up of dumping sites and invasive plant removal.

Comparative Assessment

Regional Site Inventory

The Regional Site Inventory was compiled through a literature search and conversations with scientific experts. The following sites were identified for potential inclusion in the comparative assessment (listed in alphabetical order):

Brinton's Quarry Serpentine Barren, Pennsylvania
Cherry Hill, Pennsylvania
Chrome Serpentine Barren, Pennsylvania
Fern Hill Serpentine Barren, Pennsylvania
Goat Hill Serpentine Barren, Pennsylvania / Maryland
Goshen Serpentine Barren, Maryland
New Texas Serpentine Barren, Pennsylvania
Pilot Serpentine Barren, Maryland
Pink Hill Serpentine Barren, Pennsylvania
Robert E. Lee Park, Maryland
Rock Springs Serpentine Barren, Pennsylvania
Soldiers Delight Serpentine Barren, Maryland
Sugartown Serpentine Barren, Pennsylvania
Travilah Serpentine Barren, Maryland
Unionville Serpentine Barren, Pennsylvania

Site Descriptions

The first four sites described in this section are those of highest quality. Three of the four sites are located within the State-line serpentine district (Figure 4). The fourth, Soldiers Delight, is located approximately 77 km from Nottingham Park Serpentine Barrens in Baltimore County (Figure 3). Additional sites are described in alphabetical order where pertinent information was available.

Highest Quality Sites

Soldiers Delight Serpentine Barrens

Soldiers Delight Serpentine Barrens is located in northeastern Maryland, 15 km from Baltimore. At 730 hectares, it is the largest single serpentine barrens site in the eastern United States (Tyndall 1994). Elevation ranges from approximately 31 to 88 meters, and the climate is typical of the Maryland Piedmont (Hull & Wood 1984). The site is designated as a Natural Environmental Area and is part of Maryland's Patapsco Valley State Park.

There are three main plant associations within the Soldiers Delight Serpentine Barrens: a serpentine association and *Andropogon* and *Andropogon*-oak associations (Worthley 1984). The serpentine association is comprised of a group of seven species found on barren ground, including villose field chickweed (*Cerastium arvense* f. *villosissimum*) and pleatleaf knotweed (*Polygonum tenue*). The presence of the endemic serpentine aster (*Aster depauperatus*) has also been recorded at the site (Flanagan-Brown 2001). Other rare wildflower species found at Soldiers Delight include: sandplain gerardia (*Agalanis acuta*), fame flower (*Talinum*

teretifolium), and fringed gentian (*Gentianopsis crinita*). Grassland species found at Soldiers Delight include Indian grass (*Sorghastrum nutans*) and little bluestem (*Schizachyrium scoparium*) (Flanagan-Brown 2001).

Major tree species at Soldiers Delight include Virginia pine (*Pinus virginiana*), blackjack oak (*Quercus marilandica*), post oak (*Quercus stellata*), black oak (*Quercus velutina*), and sassafras (*Sassafras albidum*) (Knox 1984). Notably absent at the site are pitch pines (*Pinus rigida*), a species illustrative of serpentine barrens. The invasion of Virginia pine at Soldiers Delight has been well documented, as has the effects of this invasion on the physical and chemical properties of the serpentine soils (Hochman 2001, Kelly & Cumming 2003). The bedrock at Soldiers Delight consists of serpentinite with dunite, peridotite, pyroxene, and soapstone. Soils are classified under the Chrome series, specifically as Chrome chanery silt loams (Hull & Wood 1984).

Parts of Soldiers Delight were mined for chromium in the mid-1800s (Knox 1984), and abandoned mines are visible throughout the site. A 400-hectare ecosystem restoration program at Soldiers Delight is underway. The purpose of this program is recovery of the serpentine grasslands and oak savanna habitats through the clearing of the invasive Virginia pine (*Pinus virginiana*) and eastern redcedar (*Juniperus virginiana*) forests (Flanagan-Brown 2001; Tyndall 2005). Another aspect of this ecosystem restoration is the removal of invasive greenbriar (*Smilax rotundifolia*), which has been observed to increase with increased Virginia pine coverage (Tyndall 2005). Management activities, including annual prescribed burning, has decreased the extent of greenbriar and invasive tree species in the restoration areas and could eradicate the species from the cleared areas, if continued (Flanagan-Brown 2001; Tyndall 2005).

New Texas Serpentine Barren

The New Texas Serpentine Barrens is located in Fulton Township, Lancaster County, Pennsylvania, approximately 3 km south of Wakefield and 11 km from Nottingham Park Serpentine Barrens. The 150-hectare site is privately owned and access is limited. It is composed of open savanna areas and forest stands of varying ages. The forest patches are rectangular in shape, and almost certainly reflect old fence lines (Wallenstein pers. comm.). The barrens have been historically maintained by grazing, which limits the encroachment of shrubs and trees. Fires have been largely excluded since the late 1800's. With the absence of disturbance from grazing and fire, the barrens began succeeding to forest in the 1940's (Barton and Wallenstein 1997). The Nature Conservancy has been managing the site since 1997, and the barrens now appear to be in stable and good condition following the removal of invasive Virginia pines (Roger Latham personal communication).

The site contains some of the highest quality serpentine grasslands in the eastern United States, but is surrounded by agriculture and residences. Soils are silty alfisols of the Chrome association (Barton and Wallenstein 1997). These support a savanna habitat dominated by prairie grasses such as little bluestem (*Schizachyrium scoparium*) and prairie dropseed (*Sporobolus heterolepis*). Upland scrub and forest habitat is dominated by Virginia pine (*Pinus virginiana*), eastern redcedar (*Juniperus virginiana*), and various oaks (*Quercus marilandica*, *Q. ilicifolia*, and *Q. velutina*). Riparian areas contain soils of the Conowingo association, which support oak,

red maple (*Acer rubrum*), sassafras (*Sassafras albidum*), tulip poplar (*Liriodendron tulipifera*), and dogwood (*Cornus florida*) (Barton and Wallenstein 1997).

Pilot Serpentine Barren

Pilot Serpentine Barrens, located in northern Cecil County ~13 km from Nottingham Park Serpentine Barrens, is the only site within the State-line Barrens complex that is located in Maryland. The Nature Conservancy has owned and managed 13 hectares since 1985 with 24 additional hectares under a management agreement with a neighbor. Aerial photographs of the Pilot Serpentine Barrens show that since 1938, Virginia pine has been invading the typical serpentine savanna ecosystem such that most of the open barren grasslands have become Virginia pine forests (Latham 1993). The site is dominated by invasive species, such as Japanese stiltgrass (*Microstegium vimineum*) and greenbriar (*Smilax rotundifolia*). The Nature Conservancy occasionally burns a few hectares in an effort to restore the serpentine grassland, and a prescribed fire is scheduled for 2007. Several typical serpentine species exist at the restored site, including the fameflower (*Talinum teretifolium*) and the lyre-leaved rockcress (*Arabidopsis lyrata*).

Goat Hill Serpentine Barren

The Goat Hill Serpentine Barrens is located in West Nottingham Township, Chester County, Pennsylvania, approximately 4 km from Nottingham Park. The site is owned and managed by the State of Pennsylvania Bureau of Forestry with assistance from The Nature Conservancy. The main access route into the 140 hectare serpentine barrens is a power line right-of-way. The Goat Hill Serpentine Barrens also include the site known as the Octoraro Creek Red Oak Slope. The Slope was identified as a PNNL by Radford & Martin in 1975 (see Smith & Wilkinson 1979).

Goat Hill contains several important taxa that are absent at Nottingham: 7 additional rare animal species and 6 additional rare plant species, including the endemic long-haired barrens chickweed (*Cerastium velutinum* var. *villosissimum*). The site also supports several species that are at the northernmost extent of their range and contains a prime example of a mature northern red oak forest. In the early 1980's, Goat Hill Serpentine Barrens was protected as a rare plant preserve, largely in response to a proposal made to strip mine the site for economically important minerals (Latham pers. comm.). In addition to mining threats, Goat Hill Serpentine Barrens are also threatened by invasive exotic plant species. Around the edges of the barrens, the once dominant pitch pine (*Pinus rigida*) is now replaced by young red maple (*Acer rubrum*), black cherry (*Prunus serotina*), black locust (*Robinia pseudoacacia*), and tree-of-heaven (*Ailanthus altissima*) (Latham 1993). Aerial views of the once open barrens show that the pine canopies are closing over the warm-grass prairie, overtaking the typical serpentine vegetation (Latham 1993). Recent restoration efforts have had some success in scraping off excess soil and restoring the soil profile needed for serpentine meadows to redevelop (Bertam pers. comm.).

Other Sites

Brinton's Quarry Serpentine Barren

Located in West Chester, Pennsylvania, this serpentine barren includes an active quarry and is heavily mined. One small study has been conducted with seeds collected from the site (Hart 1980), but it is generally in poor condition with black locust heavily invading the barrens (*Robinia pseudoacacia*).

Chrome Serpentine Barren

Chrome Barrens is located in Chester County, Pennsylvania. It is 137 hectares in size and is part of the State-line Serpentine Barrens. The serpentine aster (*Aster depauperatus*) is one of the many rare plants found here. Chrome Barrens has numerous owners, the largest of which is Elk Township. Most of the grassland has succeeded to forest (Latham pers. comm.), but The Nature Conservancy has initiated some small management efforts under agreement with the Township including prescribed fire and scraping.

Cherry Hill

The serpentine area is located in Hartford County, Pennsylvania, about 1.5 km east of Cherry Hill. Most of this serpentine soil is occupied by a forested community dominated by Virginia pine (*Pinus virginiana*) and greenbriar (*Smilax rotundifolia*). The small and scattered pine-cedar savanna is confined almost completely to steep, south-facing slopes (Tyndall and Farr 1989).

Fern Hill Serpentine Barren

Located in West Chester County, Pennsylvania, the site has intact grasslands in fair condition but is not currently managed (Natural Heritage Data Center 1993, Latham, pers. comm).

Pink Hill Serpentine Barren

Pink Hill Serpentine Barren is part of the Tyler Arboretum in Delaware County, Pennsylvania. Typical plants of this serpentine barren include: blackjack oak (*Quercus marilandica*), slender mountain mint (*Pycnanthemum tenuifolium*), whorled milkweed (*Asclepias verticillata*), serpentine aster (*Aster depauperatus*), and moss pink (*Phlox subulata*) (Brooks 1987; Latham 1993).

Rock Springs Serpentine Barren

These barrens are part of the Rock Springs Nature Preserve in Fulton Township, Lancaster County, Pennsylvania, but were previously owned by The Nature Conservancy. The property is in different stages of restoration, and large brush piles dot the landscape. The site is indicative of a degraded serpentine site in the process of being restored.

Sugartown Serpentine Barren

The 44-hectare site south of Willistown, in Chester County, Pennsylvania, is a grassy serpentine barren with little rock exposure (Lendemer, 2004). It is protected as part of a partnership between the Willistown Conservation Trust, Natural Lands Trust, Williston Township, Greater Chester Valley Soccer Association, Chester County, PADCNR, and Main Line Health Systems. The agreement includes a parcel of 25 hectares that is serpentine habitat and farm fields.

Travilah Serpentine Barren

Access is limited at this site in Montgomery County, Maryland. It has a locked gate and fenced perimeter. It has reportedly been newly preserved as an example of a forested serpentinite community rather than a serpentine barren.

Unionville Serpentine Barren

This site has been historically maintained by Native American burning dating back thousands of years and remains in excellent condition. It is slightly smaller than some of the other sites in the region, but has a large portion of its area in grassland and despite its small size is one of the most species-rich of the eastern serpentine barrens (Latham pers. comm.). Ownership is by at least three entities, the largest of which is the Brandywine Conservancy.

Comparative Analysis & Discussion

We compare the Nottingham Park Serpentine Barrens to the four other potential sites in the region deemed to be of highest quality (Soldiers Delight, New Texas, Pilot, and Goat Hill). The sites represent examples of serpentine soils that support, in part, characteristic serpentine barren vegetation. Other sites that feature serpentine soils exist in the region as well, but these sites do not currently support the characteristic vegetation and/or are significantly disturbed. These secondary sites are therefore not particularly illustrative of a serpentine barren and are not considered in comparison with Nottingham Park Serpentine Barrens.

1. Comparison of PNNL with Soldiers Delight

Nottingham Park Serpentine Barrens is most closely matched in primary features with Soldiers Delight. We therefore consider secondary features to further illustrate similarities and differences.

- A) *Illustrative Character:* Both areas are characteristic of serpentine grasslands, showing areas of serpentine rock outcrops and characteristic serpentine vegetation. Nottingham Park Serpentine Barrens is one of only a few sites in the region that support pitch pine, a species that is illustrative of serpentine barrens. In contrast, Soldiers Delight supports the invasive Virginia pine, which can destroy serpentine barren systems by altering the soil properties in drastic ways (Barton and Wallenstein 1997, Hochman 2001, Cumming & Kelly 2007). Virginia pine is being removed from 400 hectares of Soldiers Delight in an extensive 5-year restoration effort. Nevertheless, pitch pines are not currently present at the site. We suggest that the presence of pitch pine at Nottingham PNNL is an important and unique illustrative characteristic of the PNNL. We therefore rank Nottingham PNNL higher than Soldiers Delight even though the two sites are otherwise similar in illustrative character.
- B) *Present Condition:* Both sites are closely matched in their present condition. They have both been mined historically, and old mine sites can still be found at both locations. These mined areas are small and do not distract from the illustrative character of either site. In fact, they provide a way to study the geology of the sites. Invasive species dominate areas at both sites such that mechanical removal and prescribed burning is used at both sites to varying degrees to control the problem. Soldiers Delight, designated as a Natural Environmental Area, supports a relatively extensive (400 hectare) and intensive (prescribed burning and tree girdling) restoration program, whereas Nottingham PNNL, being part of a county park with fewer resources, actively manages 25 hectares but also uses mechanical removal and prescribed burning on a regular basis. While restoration activities are more noticeable

at Soldiers Delight owing to its larger size and resources, both sites control invasive species annually as part of their management plan. Thus, we rank both sites as equal in present condition.

- C) *Diversity*: Both sites support characteristic serpentine rock outcrops and serpentine vegetation. Both sites are therefore ranked as equal.
- D) *Rarity*: In addition to supporting rare and endemic plant species, such as the rare and endemic Serpentine aster, both areas report the presence of several endangered butterflies and moths. Serpentine soils have been used to classically illustrate the concept of metapopulations for butterflies inhabiting constellations of habitat patches in California (Harrison 1997). While Soldiers Delight exists largely in isolation within urban Baltimore County, Nottingham sits in close proximity to a number of other barrens sites within the State-line serpentine district. Whether a single large or several small areas in close proximity is better for the persistence of species has been a long standing and unresolved debate in conservation biology (Diamond 1975, Burkey 1989) and cannot be used here to rank one site over the other. Thus, while Soldiers Delight is a bigger area, Nottingham's small size is offset by its location within a network of other serpentine areas. We therefore rank both sites as equal.
- E) *Value for Science and Education*: Both sites are actively engaged in education through staffed visitor centers that focus on the features of a serpentine barren grassland. Both sites have also strongly supported scientific research in the past as evidenced by the number of publications and student theses and dissertations focusing on the locations. The two sites are therefore ranked as equal.

In sum, we found few differences in the primary and secondary characteristics of Nottingham Park Serpentine Barrens and Soldiers Delight. However, we do suggest that Nottingham Park Serpentine Barrens is ranked higher in illustrative character than Soldiers Delight owing to the relative lack of Virginia pines and the presence of pitch pines, a unique and important characteristic that indicates a high quality serpentine area. Nottingham Park Serpentine Barrens may be an important component of a potential State-line invertebrate metapopulations; however, how the State-line Barrens are connected through movement of organisms is not clear at this time. Both sites support characteristic geologies and vegetation, they are both impacted by the same stressors (past mining and invasive species), they both support rare and endemic species, and they both are actively engaged in science and education.

2. Comparison of PNNL with New Texas

Nottingham Park Serpentine Barrens and New Texas are matched reasonably well in illustrative character and present condition. However, Nottingham Park Serpentine Barrens surpasses New Texas in secondary characteristics associated with education, outreach and research.

- A) *Illustrative Character*: Both sites are illustrative of a serpentine barren grassland, supporting characteristic geologies and vegetation. Nottingham PNNL supports pitch pine, whereas New Texas was invaded by Virginia pine.

- B) *Present Condition:* Invasive species are a problem at both sites that requires continued active management. The grassland at New Texas appears to be stable after cutting invasive Virginia pines and reintroducing active grazing (Latham pers. comm.).
- E) *Value for Science and Education:* The privately-owned New Texas site has less opportunity for public education than Nottingham PNNL. In addition to the limitations placed on access, New Texas does not engage in the type of outreach activities (newsletters, etc.) that Nottingham does as a part of the Chester County Parks system.

3. Comparison of PNNL with Pilot

Nottingham Park Serpentine Barrens surpasses Pilot in primary features such that secondary features are not considered here.

- A) *Illustrative Character:* Pilot shows signs of serpentine rock outcrops and characteristic vegetation after a successful prescribed fire. However, these characteristics are only apparent in a small area that was recently burned. Pitch pines are not present at Pilot.
- B) *Present Condition:* Both sites are heavily invaded and both sites engage in invasive species management. However, prescribed burns to maintain the grassland at Pilot are infrequent. Fire is used as a tool at Nottingham Park Serpentine Barrens, on the other hand, on an almost annual basis.

4. Comparison of PNNL with Goat Hill

Few serpentine rock outcrops are apparent at Goat Hill and there is less evidence of mining (e.g., exposed quarry pits) at the site. Goat Hill contains a handful of populations of rare species that are not found at Nottingham, including the long-haired barrens chickweed and glade spurge (*Euphorbia purpurea*). However, Nottingham contains nearly double the total number of globally and state-rare plant and animal species (54 known at Nottingham compared to 32 at Goat Hill). In addition, Goat Hill historically has not undergone the type of management required to prevent loss of grasslands and invasion by invasive plants. As a result, the site is currently in a degraded state relative to Nottingham. Pitch pines, however, are present at Goat Hill, and the Pennsylvania Department of Conservation in collaboration with The Nature Conservancy have recently introduced efforts to restore this site to its potential condition. An argument could be made for including Goat Hill in the final designation due to the close proximity of this potentially high-quality site to Nottingham (see Appendix C). However, considered separately, Nottingham surpasses Goat Hill in illustrative character and in present condition.

Evaluation Recommendations

After careful evaluation of both primary and secondary features of the serpentine barrens found at Nottingham Park Serpentine Barrens, we recommend the site for designation as a National Natural Landmark. In our opinion, the site offers one of the best examples of the serpentine barren natural feature in the Piedmont Upland region of the eastern United States. The site contains illustrative serpentine soils that support characteristic serpentine barren vegetation. The ecosystem supports both rare and endemic species, and the park is actively engaged in science and education. Also taken into consideration in our evaluation is the placement of the park in a regional context at the center of the State-line Barrens network of serpentine sites, and the potential that this may provide for exchange of organisms and genetic material to and from the park.

In comparing the Nottingham Park Serpentine Barrens to other potential sites in the Piedmont Uplands, we rank it only slightly above the Soldiers Delight Barrens. This prioritization is based primarily on the presence of pitch pines at Nottingham, but the sites both provide excellent representative samples of serpentine barren natural features within the biophysiological province. In summary, we recommend either of these two sites as meeting the national significance criteria for designation as an NNL. Of the five sites reviewed in depth in the comparative analysis, we rank them from best to worst as determined by the NNL significance criteria as follows: Nottingham Park Serpentine Barrens, Soldiers Delight, New Texas, Pilot, Goat Hill.

Proposed Landmark Boundary

The proposed landmark boundary was limited to areas within Nottingham County Park. The political boundary of Nottingham County Park largely encapsulates the contiguous undeveloped serpentine habitat in this part of the State-line Barrens. We used a combination of vector layers and aerial photography to delineate the boundary. The Nature Conservancy provided a serpentine soils layer that was compared to a timber typing layer that was provided courtesy of Chester County Parks. The timber typing coverage was derived from a ground survey conducted by County Park staff and Nottingham's superintendent in 2002. One of the classes in the layer represented pitch pine dominated vegetation on serpentine soils. Where the timber layer and TNC soils layer disagreed, we resolved differences using aerial photographs (Color Infrared Digital Orthoimagery Quarter Quadrangles). The resulting map (Figure 5) is coarsely bound by the park boundary to the south, east, and west and Black Run to the north.

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Figure 1. Map of physiographic provinces.

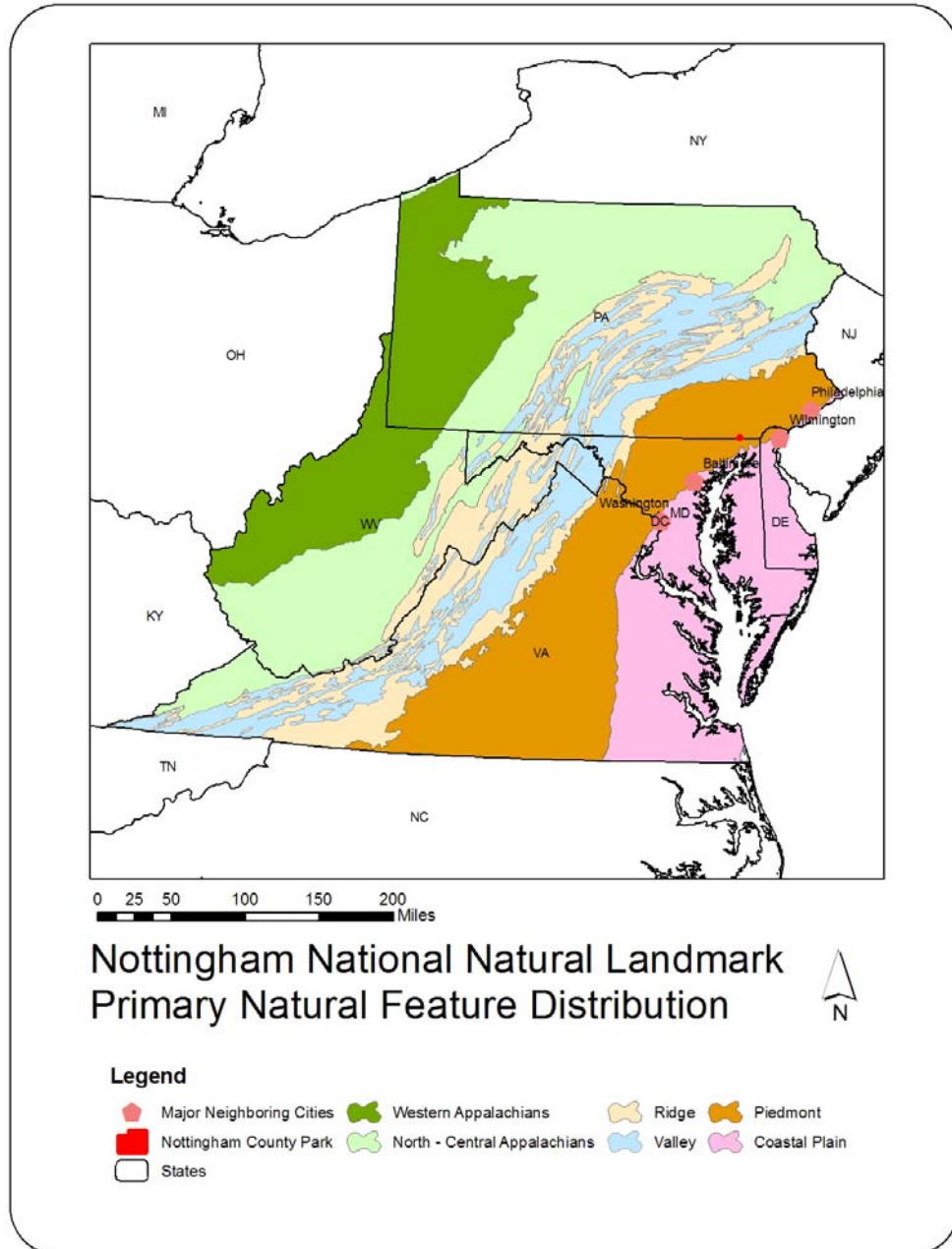


Figure 2. Ultramafic rock outcrops (solid areas) of the eastern United States. Reprinted from Brooks, 1987 (Figure 11.6).

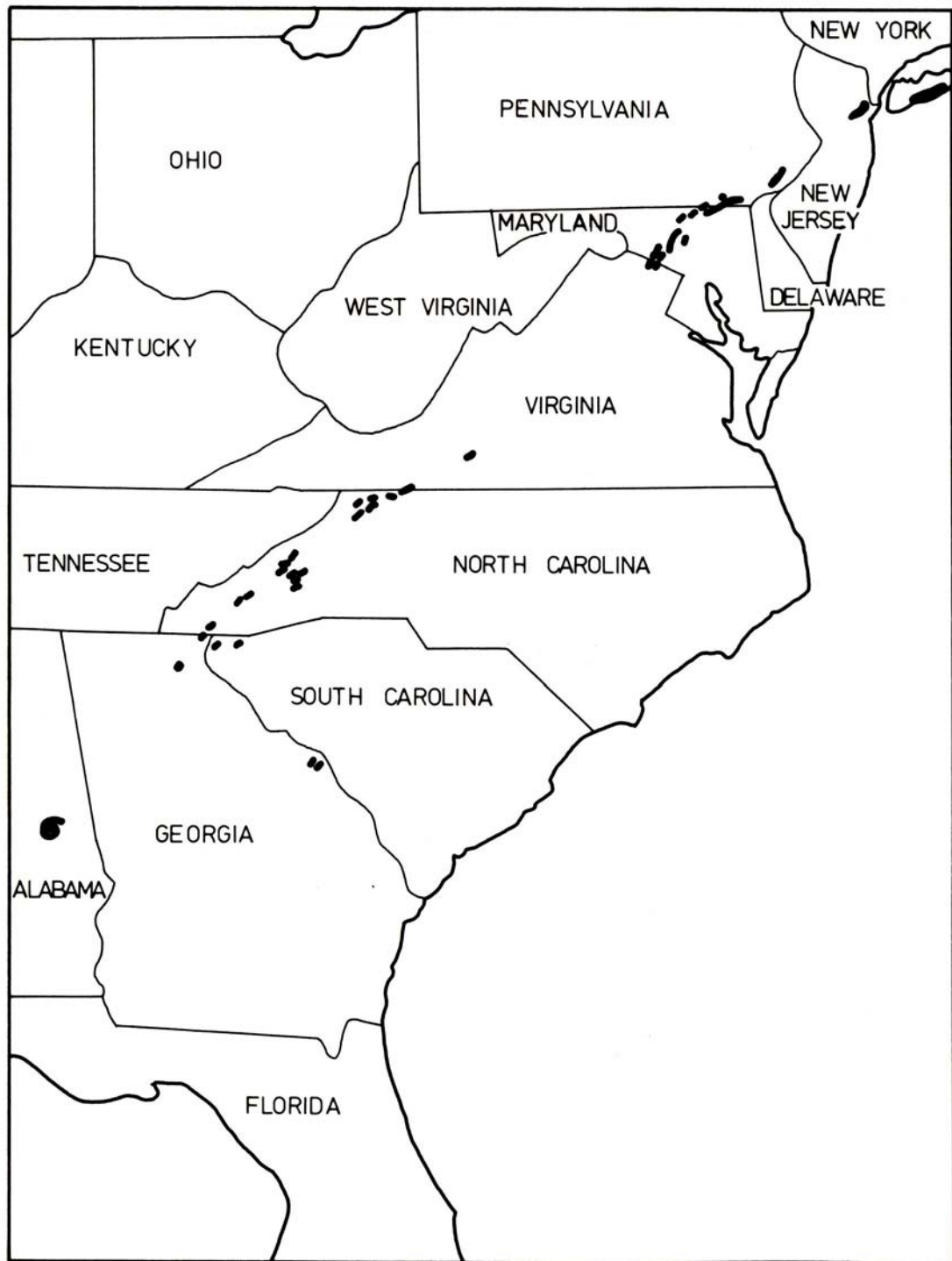


Figure 3. Serpentine sites of the Piedmont Upland of the eastern United States reprinted from Brooks, 1987 (Figure 11.5). The red color represents the State-line Barrens system.

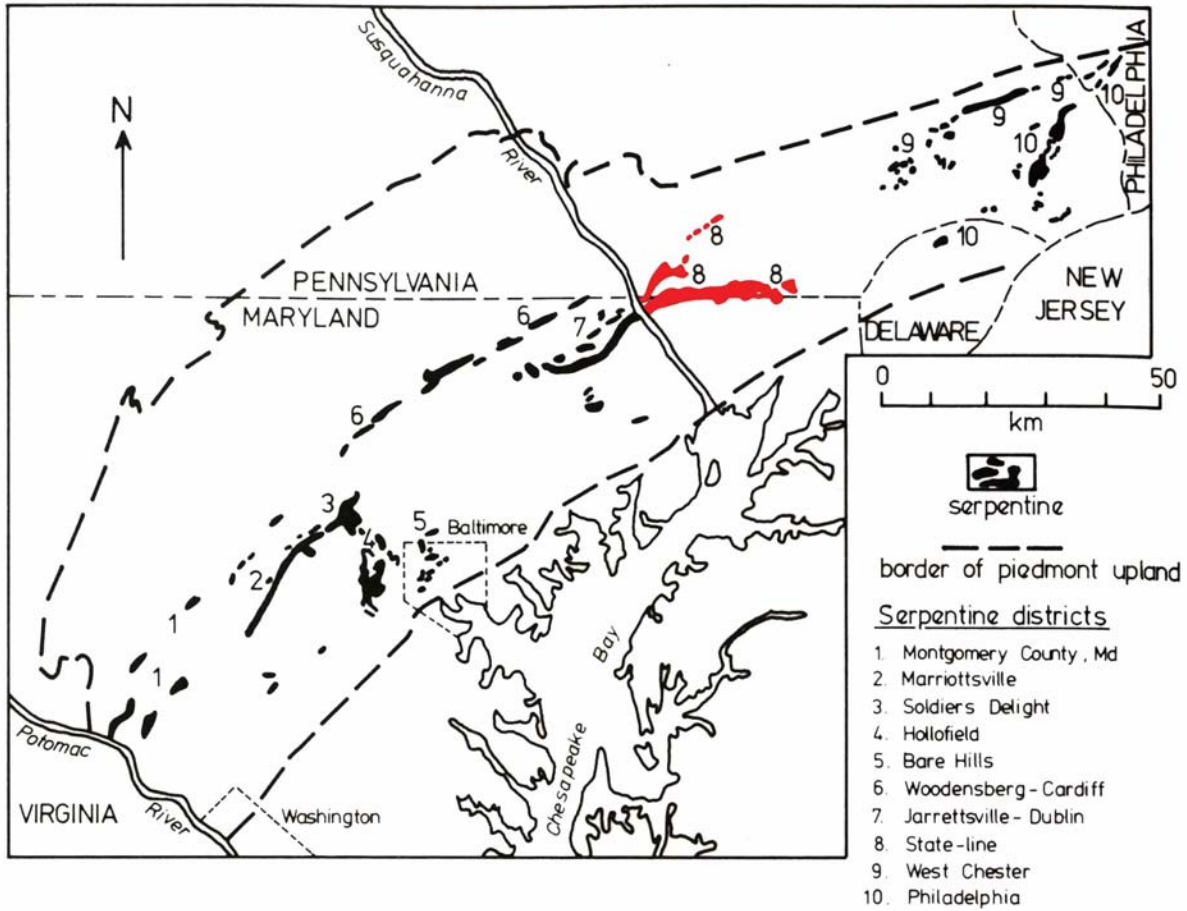


Figure 4. Distribution of State-line serpentine barren sites close to the Nottingham Park Serpentine Barrens.

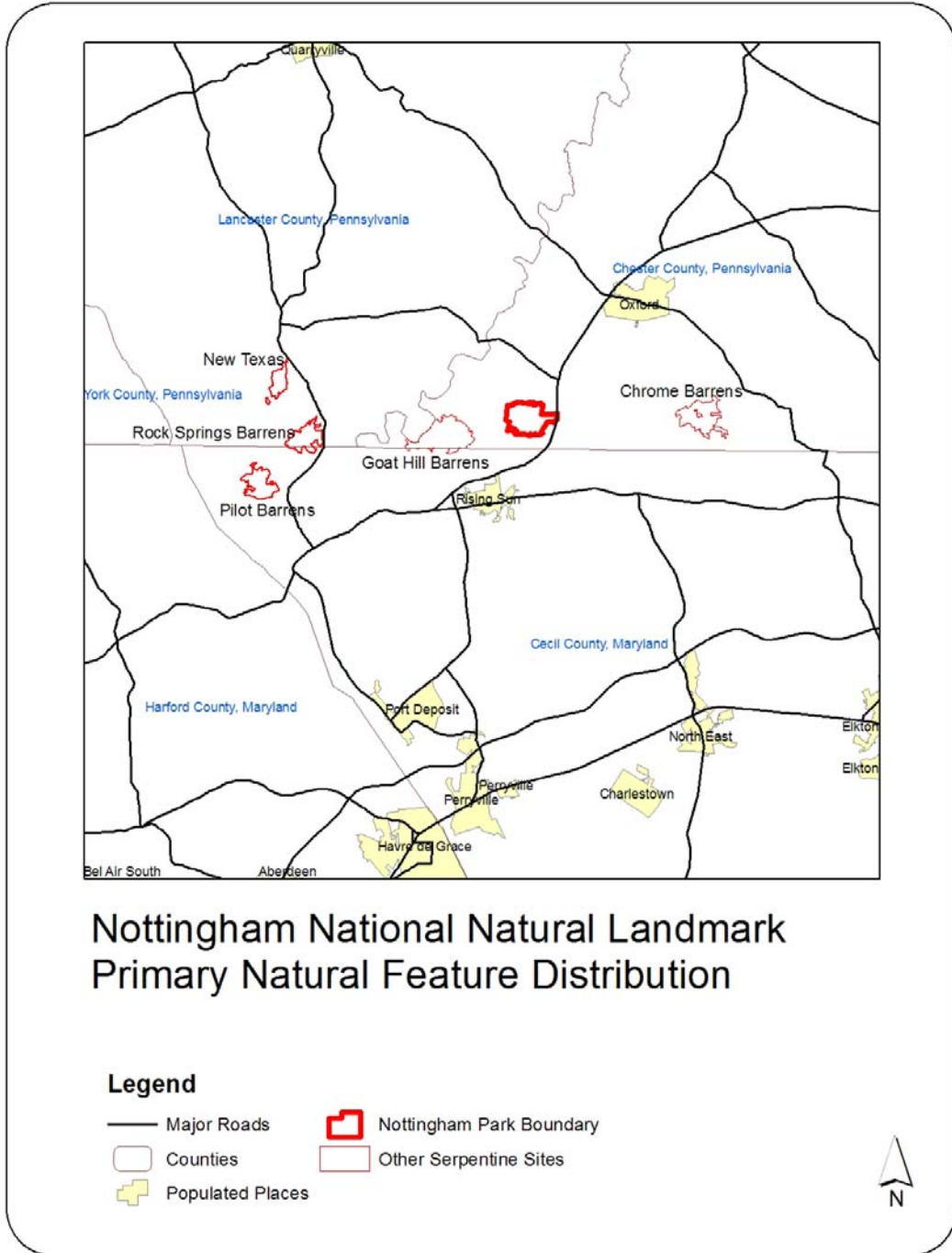


Figure 5. Nottingham Park Serpentine Barrens proposed National Natural Landmark boundary.

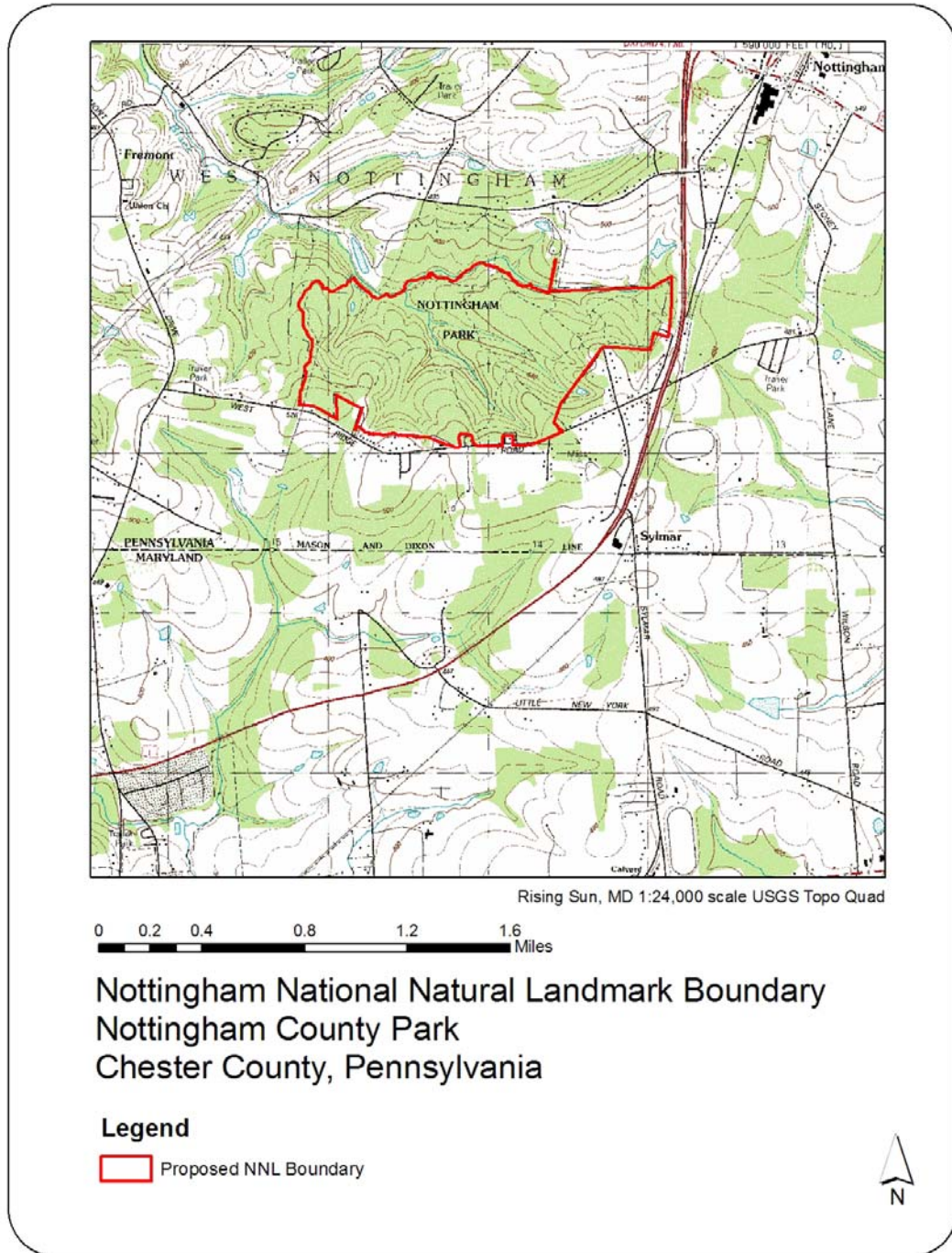


Figure 6. Topographic quadrangle index map.

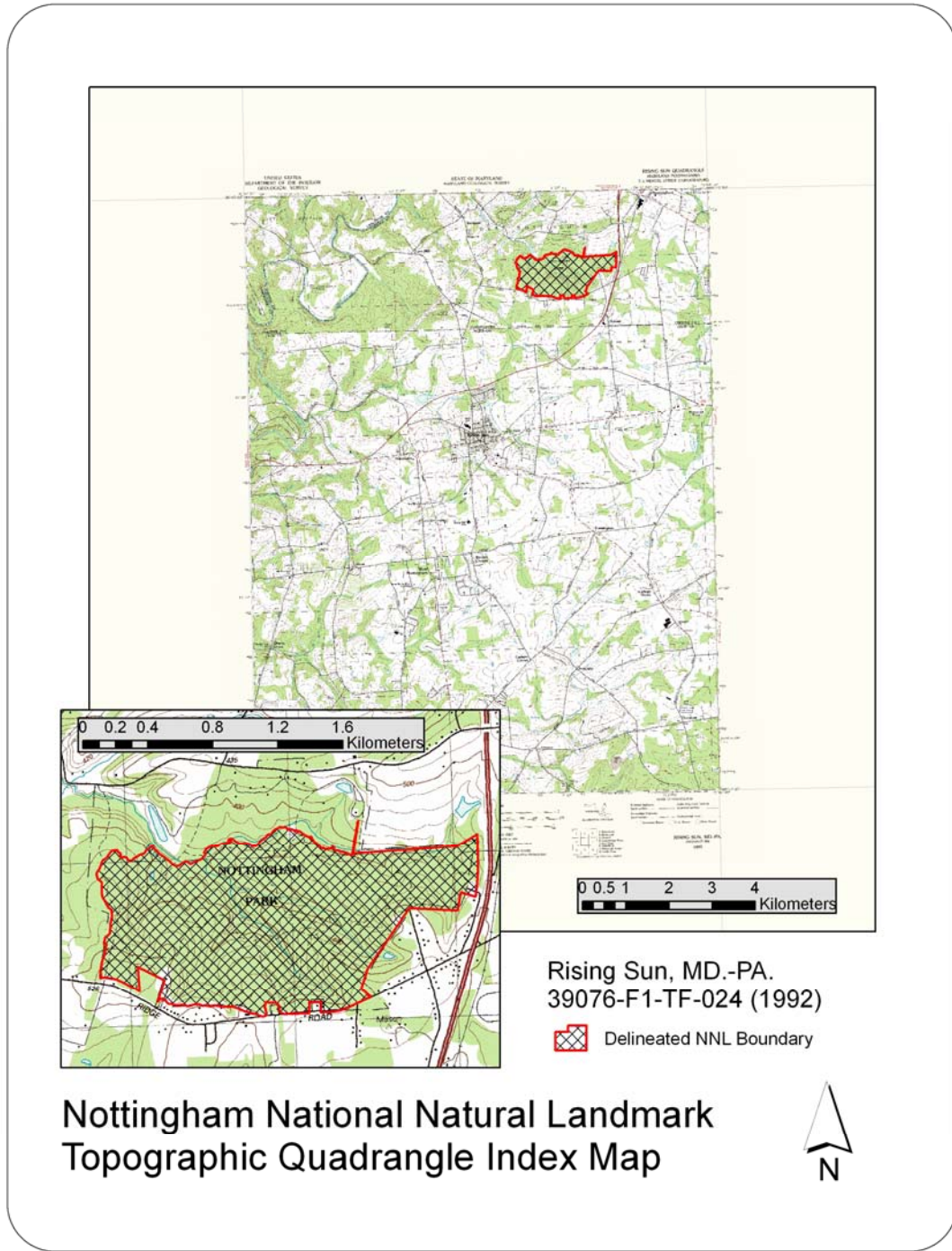


Figure 7. Ownership map for Nottingham Park Serpentine Barrens and surrounding lands.

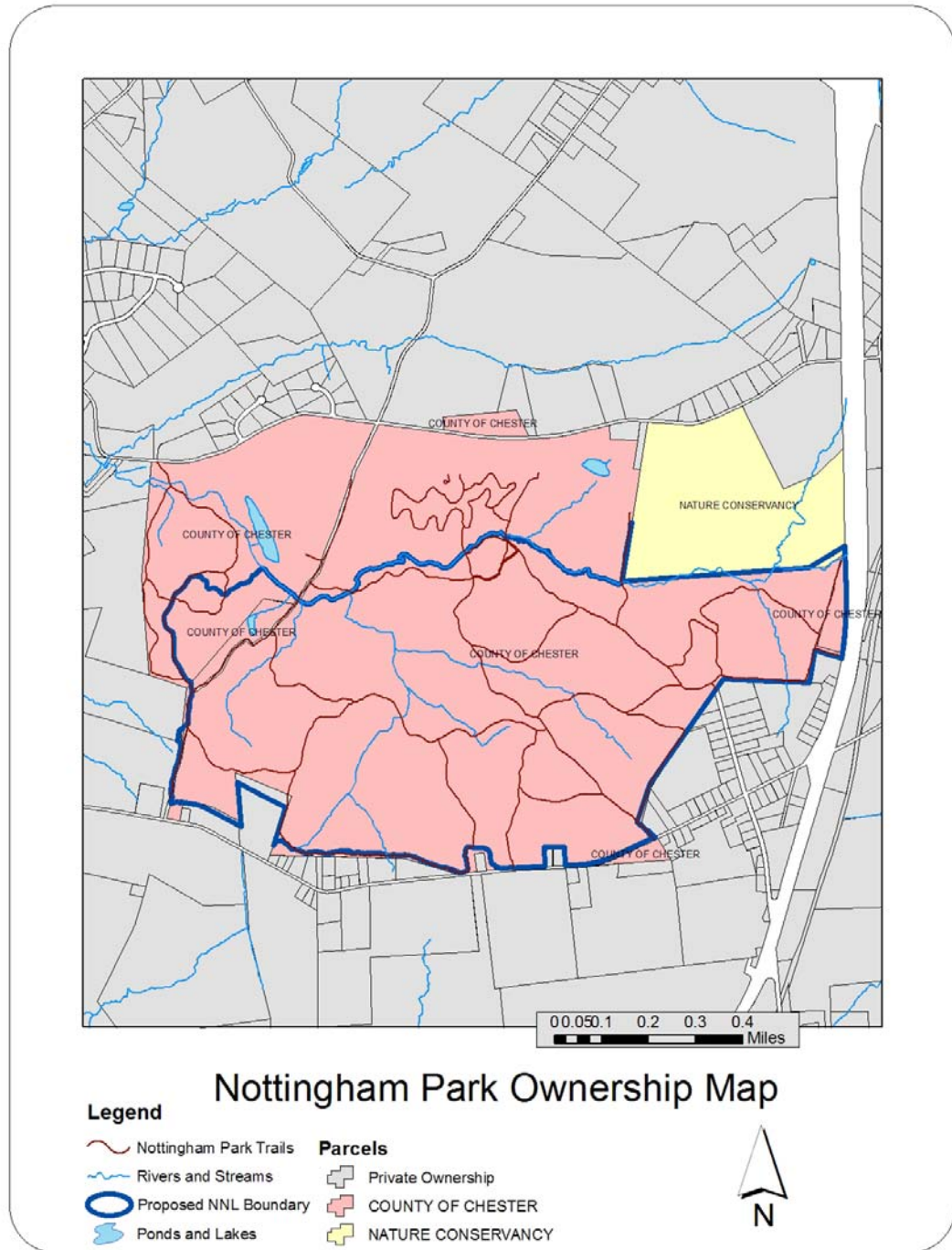
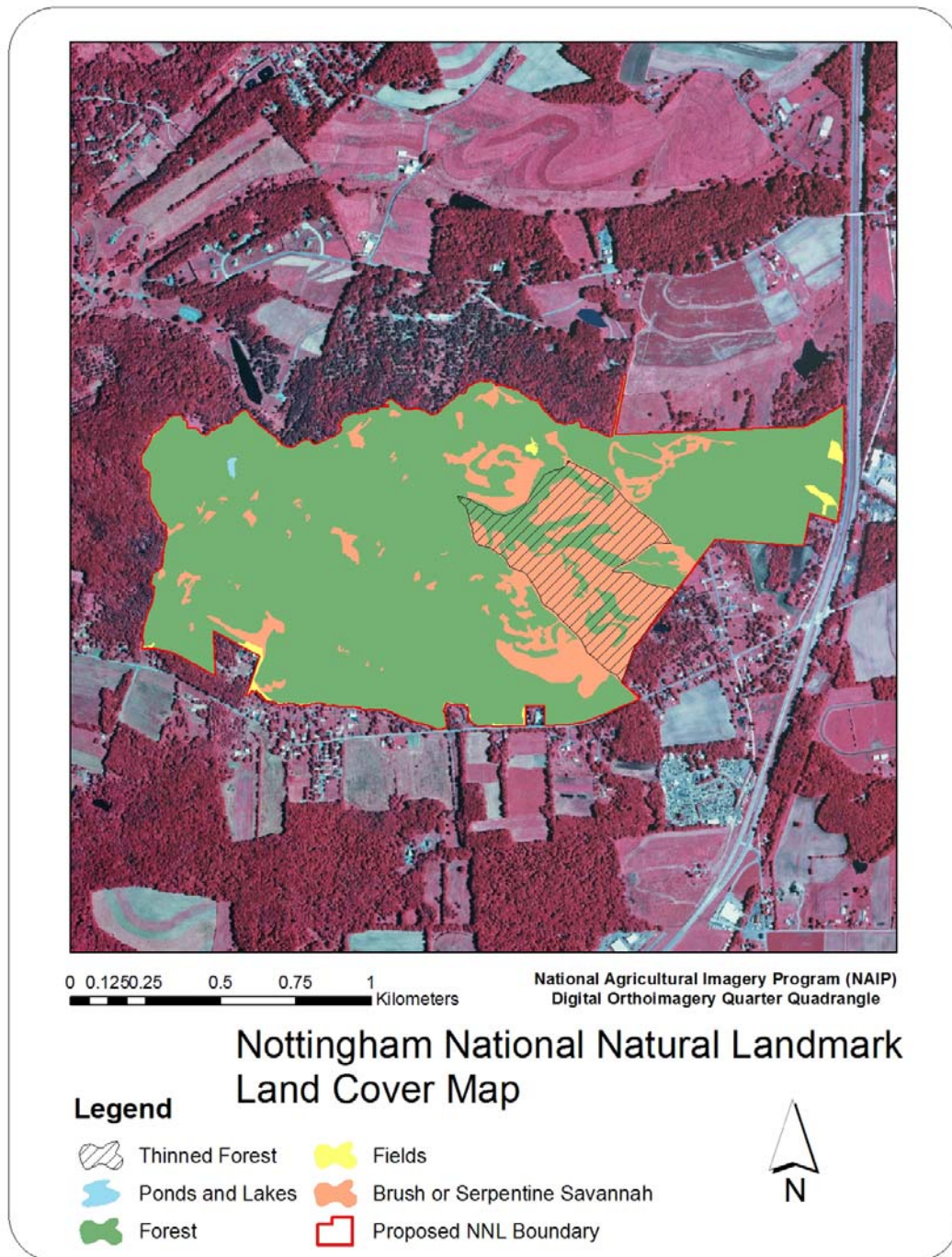


Figure 8. Land cover map for Nottingham Park Serpentine Barrens and surrounding lands.



Appendix A: Flora and Fauna Lists

This comprehensive list of plant species found within Nottingham Park is adapted from Vanderwerff's (1993) *The Flora of Nottingham County Park* with supplementation from Roger Latham (pers. comm). The lists of moths, butterflies, birds and mammals are largely from internal park documents and communications with park personnel. The list of herpetofauna are from Bauer and Witwer (1995). Globally or state-rare (MD or PA) species are marked with an asterisk (*):

Part 1. Plants

Ferns – 21 species and varieties

- Asplenium platyneuron* (ebony spleenwort)
- Athyrium angustum* var. *rubellum* (reddish lady fern)
- Athyrium asplenoides* (southern lady fern)
- Athyrium thelypteroides* (silvery spleenwort)
- Botrychium dissectum* (cut-leaved grape fern)
- Botrychium obliquum* (ternate grape fern)
- Botrychium virginianum* (rattlesnake fern)
- Dennstaedtia punctilobula* (hayscented fern)
- Dryopteris intermedia* (evergreen wood fern)
- Dryopteris marginalis* (marginal wood fern)
- Lycopodium flabelliforme* (crows foot)
- Lycopodium lucidulum* (shining clubmoss)
- Lycopodium obscurum* (ground pine)
- Onoclea sensibilis* (sensitive fern)
- Osmunda cinnamomea* (cinnamon fern)
- Osmunda claytoniana* (interrupted fern)
- Osmunda regalis* (royal fern)
- Polypodium virginianum* (common polypody)
- Polystichum acrostichoides* (Christmas fern)
- Polystichum acrostichoides* forma *incisum* (incised Christmas fern)
- Pteridium aquilinum* (bracken)

Gymnosperms – 3 species and varieties

- Juniperus virginiana* (red cedar)
- Pinus rigida* (pitch pine)
- Pinus virginiana* (Jersey pine)

Angiosperms Monocots – 102 species and varieties

Grasses – 56 species and varieties

- Agrostis alba* (redtop)
- Agrostis perennans* (autumn bentgrass)
- Agrostis scabra* (rough hairgrass)
- Andropogon gerardii* (big bluestem)
- Andropogon scoparius* (little bluestem)
- Andropogon virginicus* (broomsedge)
- Anthoxanthum odoratum* (sweet vernal grass)

- Aristida dichotoma* (poverty grass)
- * *Aristida purpurecens* (arrowfeather)
- Arthraxon hispidus* (hairy arthraxon)
- Bromus japonicus* (Japanese chess)
- Bromus racemosus* (upright chess)
- Dactylis glomerata* (orchard grass)
- Danthonia spicata* (poverty oatgrass)
- * *Dichanthelium annulum* (annulus panic-grass)
- * *Dichanthelium oligosanthes* (Heller's witch-grass)
- Digitaria sanguinalis* (crabgrass)
- Echinochloa cruegalli* (barnyard grass)
- Echinochloa pungens* (barnyard grass)
- Eleusine indica* (goosegrass)
- Eragrostis spectabilis* (purple lovegrass)
- * *Festuca paradoxa* (nodding fescue)
- Festuca pratensis* (meadow fescue)
- Glycaria striata* (fowl mannagrass)
- Learsia oryzoides* (rice cutgrass)
- Learsia virginica* (white grass)
- Microstegium vimineum* (eulalia)
- Miscanthus sinensis* (Japanese plumegrass)
- Muhlenbergis mexicana* (satin grass)
- Muhlenbergis schreberi* (nimblewill)
- Panicum agroetoides* (redtop panic grass)
- Panicum ancepe* (beaked panic grass)
- Panicum capillare* (witchgrass)
- Panicum clandestinum* (deertongue)
- Panicum depauperatum* (starved panic grass)
- Panicum depauperatum* ver. *Psilophyllum* (smooth-leaved starved panic)
- Panicum dichotomiflorum* var. *geniculatum* (bent fall panicum)
- Panicum lanuginosum* (wooly panic grass)
- Panicum linearifolium* (low white-haired panic grass)
- Panicum meridionale* (matting panic grass)
- Panicum microcarpon* (barbed panic grass)
- Panicum polyanthes* (small-fruited panic grass)
- Panicum scribnerianum* (Scribner's panic grass)
- Panicum tennesseense* (Tennessee panic grass)
- Paspalum leave* (field paepalum)
- Phragmites australis* (common reed)
- Poa compressa* (Canada bluegrass)
- Setaria faberi* (giant foxtail)
- Setaria geniculata* (knotroot bristlegrass)
- Setaria glauca* (yellow bristlegrass)
- Setaria viridis* (green bristlegrass)
- Sorghastrum nutane* (Indian grass)
- Sphenopholis obtuesta* (prairie wedgegrass)

- * *Sporobolus heterolepsis* (prairie dropseed)
- Sporobolus vaginiflorus* (sheathed dropseed)
- Tridens flavus* (purpletop)
- Sedges – 24 species and varieties
- Carex artitecta* (closely-covered sedge)
- Carex bushii* (Bush's sedge)
- Carex conjuncta* (soft fox sedge)
- Carex interior* (inland sedge)
- Carex leptoneura* (fine-nerved sedge)
- Carex lurida* (sallow sedge)
- * *Carex meadii* (Mead's sedge)
- Carex normalis* (larger straw sedge)
- Carex rosea* (stellate sedge)
- * *Carex richardsonii* (Richardson's sedge)
- Carex stipata* (awl-fruited sedge)
- Carex stricta* (tussock sedge)
- Carex swanii* (Swan's sedge)
- Cyperus flavescens* (yellow cyperus)
- Cyperus ovularis* (globose cyperus)
- Cyperus strigosus* (straw-colored cyperus)
- Eleocharis tenuis* (slender spike rush)
- * *Fimbristylis annua* (annual fimbry)
- Rhynchospora capitellata* (clustered beak rush)
- Scirpus atrovirens* (dark-green bulrush)
- Scirpus cyperinus* (wool grass)
- Scirpus rubricosus* (red wool grass)
- Scirpus validus* (great bulrush)
- * *Scleria pauciflora* (few-flowered nutrush)
- Other Monocots – 22 species and varieties
- Allium vineale* (field garlic)
- Asparagus officinalis* (asparagus)
- Chamaelirium luteum* (blazing star)
- Goodyera pubescens* (rattlesnake plantain)
- Hypoxis hirsuta* (yellow star grass)
- Juncus effusus* var. *solutus* (loose soft rush)
- Juncus secundus* (secund rush)
- Juncus tenuis* (path rush)
- Maianthemum canadense* (wild lily-of-the-valley)
- Medeola virginiana* (Indian cucumber root)
- Polygonatum biflorum* (smooth Solomon's seal)
- Sisyrinchium angustifolium* (stout blue-eyed grass)
- Sisyrinchium mucronatum* (slender blue-eyed grass)
- Smilax glauca* (cat brier)
- Smilax herbacea* (carrion flower)
- Smilax hispida* (bristly greenbrier)
- Smilax rotundifolia* (common greenbrier)

- Spiranthes gracilis* (slender ladies' tresses)
- * *Spiranthes vernalis* (spring ladies' tresses)
- Symplocarpus foetidus* (skunk cabbage)
- Typha angustifolia* (narrow-leaved cattail)
- Uvularia sessilifolia* (sessile-leaved bellwort)

Angiosperms Dicots – 223 species and varieties

Trees and shrubs – 48 species and varieties

- Ailanthus altissima* (tree of heaven)
- Albizia julibrissin* (mimosa)
- Alnus serrulata* (smooth alder)
- Amelanchier arborea* (downy juneberry)
- Betula lenta* (cherry birch)
- Carpinus caroliniana* (ironwood)
- Carya glabra* (pignut hickory)
- Carya tomentosa* (mockernut hickory)
- Castanea dentata* (chestnut)
- Ceanothus americanus* (New Jersey tea)
- Celtis occidentalis* (American hackberry)
- Cornus florida* (flowering dogwood)
- Diospyros virginiana* (persimmon)
- Gleditsia triacanthos* (honey locust)
- * *Ilex opaca* (American holly)
- Juglans nigra* (black walnut)
- Lindera benzoin* (spice bush)
- Liriodendron tulipifera* (tulip poplar)
- Lonicera morrowi* (Morrow honeysuckle)
- * *Lyonia mariana* (staggerbush)
- * *Magnolia tripetala* (umbrella tree)
- Malus domestica* (apple)
- Nyssa sylvatica* (sour gum)
- Paulownia tomentosa* (empress tree)
- Populus grandidentata* (bigtooth aspen)
- Prunus avium* (sweet cherry)
- * *Quercus falcata* (southern red oak)
- Quercus ilicifolia* (bear oak)
- Quercus marilandica* (blackjack oak)
- Quercus prinoides* (dwarf chestnut oak)
- Quercus rubra* (northern red oak)
- Quercus stellata* (post oak)
- Quercus velutina* (black oak)
- Rhododendron periclymenoides* var. *eglandulosum* (pinxter flower)
- Rhus copalina* var. *latifolia* (broad-leaved winged sumac)
- Rhus typhina* (staghorn sumac)
- Robinia pseudo-acacia* (black locust)
- Rosa Carolina* (low pasture rose)

Salix fragilis (crack willow)
Salix nigra (black willow)
Salix tristis (dwarf gray willow)
Sambucus canadensis (common elder)
Sassafras albidum (sassafras)
Sassafras albidum var. molle (red sassafras)
Vaccinium stamineum (deerberry)
Viburnum acerifolium (mapleleaf viburnum)
Viburnum dentatum (southern arrowwood)
Viburnum prunifolium (black haw)

Other Dicots – 175 species and varieties

Abutilon theophrasti (velvet leaf)
Achillea millefolium (yarrow)
Achillea millefolium form rosea (pink yarrow)
Agalinis purpurea (purple gerardia)
Agrimonia parviflora (many-flowered agrimony)
Ambrosia artemisiifolia (common ragweed)
Anemone quinquefolia (wood anemone)
Anemonella thalictroides (rue anemone)
Angelica venenosa (hairy angelica)
Antennaria neodioica (mouse-ear cudweed)
Arabidopsis thaliana (mouse-ear cress)
Arabis lyrata (lyre-leaved rock cress)
Aralia nudicaulis (wild sarsaparilla)
Arenaria stricta (rock sandwort)
Asclepias incarnata (swamp milkweed)
Asclepias verticillata (whorled milkweed)
Asclepias viridiflora (green milkweed)
Ascyrum hypericoides (St. Andrew's cross)
Aster cordifolius (heart-leaved aster)
* *Aster depauperatus* (serpentine aster)
* *Aster dumosum* (bushy aster)
Aster laevis (smooth aster)
Aster lateriflorus (calico aster)
Aster patens (late purple aster)
Aster pilosus (heath aster)
Aster prenanthoides (crooked-stem aster)
* *Aster solidaginus* (narrow-leaved white-topped aster)
Aster undulates (wavy-leaf aster)
Baptisia tinctoria (wild indigo)
Barberis vulgaris (common winter cress)
Barberis vulgaris var. arcuata (bow-like winter cress)
Bidens connata var. petiolata (petioled swamp beggar ticks)
Boehmeria cylindrical (false nettle)
Boehmeria cylindrical var. drummondiana (Drummond's variety)
Capsella bursa-pastoris (shepherd's purse)

Cardamine bulbosa (spring cress)
Cardamine hirsute (hairy bitter cress)
Cassia fasciculata (partridge pea)
Cassia nictitans (wild sensitive plant)
Centaurea jacea (brown knapweed)
Cerastium glomeratum (lesser mouse-ear chickweed)
Cerastium holosteoides (larger mouse-ear chickweed)
Chimaphila maculata (spotted wintergreen)
Cicuta maculata (spotted water hemlock)
Cirsium arvense (Canada thistle)
Cirsium muticum (swamp thistle)
Cirsium pumilum (pasture thistle)
Claytonia virginica (spring beauty)
Coronilla varia (crown vetch)
Cuscuta cephalanthi (button-bush dodder)
Cuscuta gronovii (common dodder)
Desmodium canadense (showy tick trefoil)
Dianthus armeria (Deptford pink)
Draba verna (Whitlow grass)
Duchesnia indica (Indian strawberry)
Erechites hieracifolia (fireweed)
Erigeron philadelphicus (common fleabane)
Erigeron strigosus (lesser daisy fleabane)
Eupatorium aromaticum (aromatic boneset)
Eupatorium fistulosum (hollow Joe Pye weed)
Eupatorium perfoliatum (common boneset)
Galium boreale (northern bedstraw)
Galium circaezans var. *hypomalacrum* (hairy wild licorice)
Galium triflorum (sweet-scented bedstraw)
* *Gentiana villosa* (striped gentian)
Geranium maculatum (wild geranium)
Hedyotis caerulea (bluets)
Helianthus decapetalus (thin-leaved sunflower)
Helianthus giganteus (tall sunflower)
Helianthus laetiflorus (showy sunflower)
Hieracium flagellare (green mouse-ear hawkweed)
Hieracium scabrum (rough hawkweed)
Hypericum mutilum (dwarf St. Johnswort)
Hypericum punctatum (spotted St. Johnswort)
Impatiens capensis (spotted jewelweed)
Ipomea hederacea (ivy-leaved morning glory)
Lactuca canadensis (wild lettuce)
Lactuca canadensis var. *latifolia* (broad-leaved wild lettuce)
Lactuca canadensis var. *longifolia* (long-leaved wild lettuce)
Lamium purpureum (purple deadnettle)
Lespedeza procumbens (trailing bush clover)

- * *Linum intercursum* (sandplain wild flax)
- Linum virginianum* (slender yellow flax)
- Lobelia inflata* (Indian tobacco)
- Lobelia siphilitica* (great blue lobelia)
- Lobelia spicata* (spiked lobelia)
- Lycopus uniflorus* (northern bugleweed)
- Lysimachia ciliata* (ciliate loosestrife)
- Melilotus alba* (white sweet clover)
- Mimulus ringens* (square stemmed monkey flower)
- Mitchella repens* (partridge berry)
- Myosoton aquaticum* (giant chickweed)
- Myriophyllum spicatum* (Eurasian water-milfoil)
- Oenothera fruticosa* (narrow-leaved sundrops)
- Oenothera perennis* (small sundrops)
- Oenothera tetragonia* (common sundrops)
- Oenothera tetragonia var. longistipata* (long-stalked variety)
- Osmorhiza claytoni* (sweet cicily)
- Oxalis europaea* (tall yellow wood sorrel)
- Parthenocissus quinquefolia* (Virginia creeper)
- Phlox subulata* (moss pink)
- Phytolacca americana* (pokeweed)
- Plantago lanceolata* (English plantain)
- Plantago major* (common plantain)
- Polygala verticillata* (whorled milkwort)
- Polygonum aviculare* (prostrate knotweed)
- Polygonum caespitosum* (creeping smartweed)
- Polygonum erectum* (erect smartweed)
- Polygonum hydropiperoides* (mild water pepper)
- Polygonum pensylvanicum var. laevigatum* (smooth pinkweed)
- Polygonum persicaria* (lady's thumb)
- Polygonum sagittatum* (arrow-leaved tearthumb)
- Polygonum scandens* (climbing false buckwheat)
- Polygonum tenue* (slender knotweed)
- Portulaca oleracea* (purslane)
- Potentilla canadensis* (dwarf cinquefoil)
- Potentilla simplex* (common cinquefoil)
- Prunella vulgaris var. lanceolata* (lance-leaved heal-all)
- Prunella vulgaris forma candida* (white heal-all)
- Pycnanthemum tenuifolium* (narrow-leaved mountain mint)
- Ranunculus abortivus* (small-flowered crowfoot)
- Ranunculus bulbosus* (bulbous buttercup)
- Rubus allegheniensis* (mountain blackberry)
- Rubus frondosus* (leafy-flowered blackberry)
- Rubus occidentalis* (black raspberry)
- Rubus pensylvanicus* (blackberry)
- Rubus phoenicolasius* (wineberry)

- Rudbeckia hirta* var. *pulcherrima* (black-eyed Susan)
Rumex acetosella (sheep sorrel)
Sabatia angularis (rose pink)
Sanguinaria canadensis (bloodroot)
* *Sanguisorba canadensis* (Canadian burnet)
Satureja vulgaris (wild basil)
Saxifraga virginiana (early saxifrage)
Scutellaria integrifolia (hyssop skullcap)
* *Senecio anonymus* (plain ragwort)
Senecio smallii (Small's ragwort)
Silene stellata (starry campion)
Solidago altissima (tall goldenrod)
Solidago bicolor (silverrod)
Solidago gigantea var. *leiophylla* (smooth-leaved late goldenrod)
Solidago graminifolia var. *nuttalli* (Nuttall's lance-leaved goldenrod)
Solidago juncea (early goldenrod)
Solidago nemoralis (gray goldenrod)
Solidago rugosa (rough-stemmed goldenrod)
Stellaria media (common chickweed)
Strophostyles umbellata (pink wild bean)
* *Talinum teretifolium* (round-leaved fameflower)
Taraxicum officinale (common dandelion)
Thalictrum pubescens (tall meadow rue)
Thlaspi arvense (field pennycress)
Tovara virginiana (Virginia knotweed)
Trifolium campeatre (low hop clover)
Trifolium repens (white clover)
Triodanis perfoliata (Venus' looking glass)
Urtica procera (slender nettle)
Verbascum blattaria (moth mullein)
Verbascum thapsus (wooly mullein)
Verbena urticifolia (white vervain)
Vernonia noveboracensis (New York ironweed)
Veronica arvensis (corn speedwell)
Veronica persica (birdseye)
Veronica serpyllifolia (thyme-leaved speedwell)
Viola affinis (Le Conte's violet)
Viola cucullata (marsh blue violet)
Viola fimbriatula (northern downy violet)
Viola pallens (northern white violet)
Viola rafinesquii (field pansy)
Viola sororia (wooly blue violet)
Viola sororia – glabrescent form (common blue violet)
Viola triloba (three-lobed violet)
Vitis labrusca (fox grape)
Zizia aurea (golden alexanders)

Part 2. Moths and Butterflies

- Amblyscirtes vialis* (Roadskip Skipper)
- * *Anomogyna elimata* (Southern Variable Dart)
- * *Anthocharis midea* (Falcate Orangetip)
- Ancyloxypha numitor* (Least Skipper)
- * *Apodrepanulatrix libraria* (a Geometrid Moth)
- * *Artace cribraria* (a Lasiocampid Moth; Dot-lined White Moth)
- * *Atrytonopsis hianna* (Dusted Skipper)
- Battus philenor* (Pipevine Swallowtail)
- Boloria bellona* (Meadow Fritillary)
- Callophrys grysneus* (Olive Hairstreak)
- Callophrys niphon* (Eastern Pine Elfin)
- * *Calycopis cecrops* (Red-banded Hairstreak)
- * *Caripeta aretaria* (a Geometrid Moth; Southern Pine Looper Moth)
- * *Catopyrrha coloraria* (a Geometrid Moth)
- Celastrina ladon* (Spring Azure)
- Cercyonis pegala* (Common Wood-nymph)
- Chlosyne nycteis* (Silvery Checkerspot)
- * *Cisthene packardii* (Packard's Lichen Moth)
- * *Citheronia sepulchralis* (Pine Devil Moth)
- Colias eurytheme* (Orange Sulphur)
- Colias philodice* (Clouded Sulphur)
- Danaus plexippus* (Monarch)
- Epargyreus clarus* (Silver-spotted Skipper)
- * *Erastria coloraria* (Broad-lined Erastria Moth)
- Erynnis baptisiae* (Wild Indigo Duskywing)
- Erynnis brizo* (Sleepy Duskywing)
- Erynnis horatius* (Horace's Duskywing)
- Erynnis icelus* (Dreamy Duskywing)
- Erynnis juvenalis* (Juvenal's Duskywing)
- * *Erynnis martialis* (Mottled Duskywing)
- Euptoieta claudia* (Variegated Fritillary)
- Everes comyntas* (Eastern Tailed-blue)
- * *Hemileuca maia* (Barrens Buckmoth)
- * *Hesperia leonardus* (Leonard's Skipper)
- * *Hesperia metea* (Cobweb Skipper)
- * *Holomelina laeta* (Joyful Holomelina)
- * *Hypagyrtis esther* (Esther Moth)
- * *Incisalia irus* (Frosted Elfin)
- Junonia coenia* (Common Buckeye)
- * *Lagoa crispata* (Black-Waved Flannel Moth)
- Limentitis arthemis astayanax* (Red-spotted Purple)
- Lycaena phlaeas* (American Cooper)
- * *Macrochilo hypocriticalis* (Moth)
- Megisto cymela* (Little Wood-satyr)
- * *Metaxaglaea semitaria* (Footpath Sallow)

- Nastra iherminier* (Swarthy Skipper)
- Nymphalis antiopa* (Mourning Cloak)
- * *Panthea* sp novum (Moth)
- * *Papaipema marginidens* (a Borer Moth)
- Papilio glaucus* (Eastern Tiger Swallowtail)
- Papilio troilus* (Spicebush Swallowtail)
- Phycodes tharos* (Pearl Crescent)
- Pieris papae* (Cabbage White)
- Poanes hobomok* (Hobomok Skipper)
- Poanes zabulon* (Zabulon Skipper)
- Polites origenes* (Crossline Skipper)
- Polites peckius* (Peck's Skipper)
- Polites themistocles* (Tawny-edged Skipper)
- Pyrgus communis* (Common Checkered-skipper)
- * *Renia nemoralis* (Moth)
- * *Renia* sp. novum (Moth)
- Rytonopsis hianna* (Dusted Skipper)
- Satyrium titus* (Coral Hairstreak)
- Speyeria cybele* (Great Spangled Fritillary)
- * *Sutyna privata teltowa* (Moth)
- Thorybes bathyllus* (Southern Cloudywing)
- Thorybes pylades* (Northern Cloudywing)
- * *Tolype minta* (a Lasiocampid Moth; Southern Tolype Moth)
- Vanessa virginiensis* (American Lady)
- * *Xylotype capax* (Broad Swallow Moth)
- * *Zale curema* (a Noctuid Moth)
- * *Zale oblique* (Oblique Zale Moth)
- * *Zale squamularis* (Gray-banded Zale Moth)
- * *Zanaclognatha martha* (a Noctuid Moth)

Part 3. Birds

Gavia immer (Common Loon)
Phalacrocorax auritus (Double-Crested Cormorant)
Ardea herodias (Great Blue Heron)
Egretta thula (Snowy Egret)
Butorides virescens (Green Heron)
Chen caerulescens (Snow Goose)
Branta canadensis (Canada Goose)
Aix sponsa (Wood Duck)
Anas platyrhynchos (Mallard)
Mergus merganser (Common Merganser)
Coragyps atratus (Black Vulture)
Cathartes aura (Turkey Vulture)
Pandion haliaetus (Osprey)
Haliaeetus leucocephalus (Bald Eagle)
Circus cyaneus (Northern Harrier)
Accipiter striatus (Sharp-shinned Hawk)
Accipiter cooperii (Cooper's Hawk)
Buteo lineatus (Red-shouldered Hawk)
Buteo platypterus (Broad-winged Hawk)
Buteo jamaicensis (Red-tailed Hawk)
Falco sparverius (American Kestrel)
Phasianus colchicus (Ring-necked Pheasant)
Colinus virginianus (Northern Bobwhite)
Charadrius vociferus (Killdeer)
Scolopax minor (American Woodcock)
Actitis macularia (Spotted Sandpiper)
Larus delawarensis (Ring-billed Gull)
Columba livia (Rock Pigeon)
Zenaida macroura (Mourning Dove)
Coccyzus americanus (Yellow-billed Cuckoo)
Tyto alba (Barn Owl)
Otus asio (Eastern Screech Owl)
Bubo virginianus (Great Horned Owl)
Strix varia (Barred Owl)
Caprimulgus vociferus (Whip-poor-will)
Chaetura pelagica (Chimney Swift)
Archilochus colubris (Ruby-throated Hummingbird)
Ceryle alcyon (Belted Kingfisher)
Melanerpes carolinus (Red-bellied Woodpecker)
Sphyrapicus varius (Yellow-bellied Sapsucker)
Picoides pubescens (Downy Woodpecker)
Picoides villosus (Hairy Woodpecker)
Colaptes auratus (Northern Flicker)
Dryocopus pileatus (Pileated Woodpecker)
Contopus virens (Eastern Wood Peewee)

Empidonax virescens (Acadian Flycatcher)
Empidonax minimus (Least Flycatcher)
Sayornis phoebe (Eastern Phoebe)
Myiarchus crinitus (Great Crested Flycatcher)
Tyrannus tyrannus (Eastern Kingbird)
Tachycineta bicolor (Tree Swallow)
Stelgidopteryx serripennis (Northern Rough-winged Swallow)
Hirundo rustica (Barn Swallow)
Cyanocitta cristata (Blue Jay)
Corvus brachyrhynchos (American Crow)
Corvus ossifragus (Fish Crow)
Poecile atricapilla (Black-capped Chickadee)
Poecile carolinensis (Carolina Chickadee)
Baeolophus bicolor (Tufted Titmouse)
Sitta canadensis (Red-breasted Nuthatch)
Sitta carolinensis (White-breasted Nuthatch)
Certhia americana (Brown Creeper)
Thryothorus ludovicianus (Carolina Wren)
Troglodytes aedon (House Wren)
Troglodytes troglodytes (Winter Wren)
Regulus satrapa (Golden-crowned Kinglet)
Regulus calendula (Ruby-crowned Kinglet)
Polioptila caerulea (Blue-gray Gnatcatcher)
Sialia sialis (Eastern Bluebird)
Catharus fuscescens (Veery)
Catharus guttatus (Hermit Thrush)
Hylocichla mustelina (Wood Thrush)
Turdus migratorius (American Robin)
Dumetella carolinensis (Gray Catbird)
Mimus polyglottos (Northern Mockingbird)
Toxostoma rufum (Brown Thrasher)
Sturnus vulgaris (European Starling)
Bombycilla cedrorum (Cedar Waxwing)
Vireo griseus (White-eyed Vireo)
Vireo solitarius (Blue-headed Vireo)
Vireo flavifrons (Yellow-throated Vireo)
Vireo olivaceus (Red-eyed Vireo)
Vermivora pinus (Blue-winged Warbler)
Parula americana (Northern Parula)
Parula pitiayumi (Yellow Warbler)
Dendroica pensylvanica (Chestnut-sided Warbler)
Dendroica magnolia (Magnolia Warbler)
Dendroica caerulescens (Black-throated Blue Warbler)
Dendroica fusca (Blackburnian Warbler)
Dendroica castanea (Bay-breasted Warbler)
Dendroica pinus (Pine Warbler)

Dendroica discolor (Prairie Warbler)
Dendroica palmarum (Palm Warbler)
Dendroica cerulea (Cerulean Warbler)
Mniotilta varia (Black and White Warbler)
Setophaga ruticilla (American Redstart)
Helmitheros vermivorus (Worm-eating Warbler)
Seiurus aurocapillus (Ovenbird)
Seiurus motacilla (Louisiana Waterthrush)
Oporornis formosus (Kentucky Warbler)
Geothlypis trichas (Common Yellowthroat)
Wilsonia citrina (Hooded Warbler)
Wilsonia canadensis (Canada Warbler)
Icteria virens (Yellow-breasted Chat)
Piranga olivacea (Scarlet Tanager)
Cardinalis cardinalis (Northern Cardinal)
Peucaea ludoviciana (Rose-breasted Grosbeak)
Passerina cyanea (Indigo Bunting)
Pipilo erythrophthalmus (Eastern Towhee)
Spizella arborea (American Tree Sparrow)
Spizella passerina (Chipping Sparrow)
Spizella pusilla (Field Sparrow)
Passerella iliaca (Fox Sparrow)
Melospiza melodia (Song Sparrow)
Melospiza georgiana (Swamp Sparrow)
Zonotrichia albicollis (White-throated Sparrow)
Zonotrichia leucophrys (White-crowned Sparrow)
Junco hyemalis (Dark-eyed Junco)
Agelaius phoeniceus (Red-winged Blackbird)
Sturnella magna (Eastern Meadowlark)
Quiscalus quiscula (Common Grackle)
Molothrus ater (Brown-headed Cowbird)
Icterus spurius (Orchard Oriole)
Icterus galbula (Baltimore Oriole)
Carpodacus purpureus (Purple Finch)
Carpodacus mexicanus (House Finch)
Carduelis tristis (American Goldfinch)
Passer domesticus (House Sparrow)

Accidentals

Accipiter gentilis (Northern Goshawk)
Tyrannus verticalis (Western Kingbird)
Lanius ludovicianus (Loggerhead Shrike)
Loxia curvirostra (Red Crossbill)
Coccothraustes vespertinus (Evening Grosbeak)
Carduelis pinus (Pine Siskin)

Part 4. Mammals

Didelphia virginiana (Opossum)
Blarina brevicauda (Short-tailed Shrew)
Cryptotis parva (Least Shrew)
Sorex cinereus (Masked Shrew)
Scalopus aquaticus (Eastern mole)
Condylura cristata (Star-nosed mole)
Parascalops breweri (Hairy-tailed mole)
Eptesicus fuscus (Big brown bat)
Myotis lucifugus (Little brown bat)
Nycticeius humeralis (Evening bat)
Sylvilagus floridanus (Eastern cottontail)
Marmota monax (Woodchuck or groundhog)
Sciurus carolinensis (Gray squirrel)
Tamias striatus (Eastern chipmunk)
Tamiasciurus hudsonicus (Red squirrel)
Glaucomys volans (Southern flying squirrel)
Castor canadensis (Beaver)
Peromyscus leucopus (White-footed mouse)
Clethrionomys gapperi (Red-backed vole)
Microtus pennsylvanicus (Meadow vole)
Microtus pinetorum (Pine or woodland vole)
Ondatra zibethicus (Muskrat)
Mus musculus (House mouse)
Rattus norvegicus (Norway Rat)
Zapus hudsonius (Meadow jumping mouse)
Canis latrans (Coyote)
Urocyon cinereoargenteus (Gray fox)
Vulpes vulpes (Red fox)
Procyon lotor (Raccoon)
Mustela frenata (Long-tailed weasel)
Mustela erminea (Ermine or short-tailed weasel)
Mustela vison (Mink)
Lutra canadensis (River otter)
Mephitis mephitis (Striped skunk)
Odocoileus virginianus (White-tailed deer)

Part 5. Herpetofauna

Amphibia

Caudata

- Desmognathus fuscus fuscus* (Northern Dusky Salamander)
- Eurycea bislineata* (Northern Two-lined Salamander)
- Eurycea longicauda longicauda* (Longtail Salamander)
- Plethodon cinereus* (Redback Salamander)
- Pseudotriton ruber ruber* (Northern Red Salamander)

Anura

- Bufo americanus americanus* (Eastern American Toad)
- Pseudacris crucifer crucifer* (Northern Spring Peeper)
- Rana catesbeiana* (Bullfrog)
- Rana clamitans melanota* (Green Frog)
- Rana palustris* (Pickerel Frog)
- Rana sylvatica* (Wood Frog)

Reptilia

Testudines

- Chelydra serpentina serpentina* (Common Snapping Turtle)
- Sternotherus odoratus* (Common Musk Turtle)
- Chrysemys picta marginata x C.p. picta* (Painted Turtle)
- Clemmys guttata* (Spotted Turtle)
- Terrapene Carolina Carolina* (Eastern Box Turtle)

Serpentes

- Carphophis amoenus amoenus* (Eastern Worm Snake)
- Coluber constrictor constrictor* (Northern Black Racer)
- Diadophis punctatus edwardsii* (Northern Ringneck Snake)
- Elaphe obsoleta obsoleta* (Black Rat Snake)
- Lampropeltis triangulum triangulum* (Eastern Milk Snake)
- Nerodia sipedon sipedon* (Northern Water Snake)
- Thamnophis sauritus sauritus* (Eastern Ribbon Snake)
- Thamnophis sirtalis sirtalis* (Eastern Garter Snake)
- Virginia valeriae valeriae* (Eastern Earth Snake)

Appendix B: Representative Site Photographs



Outreach and education at Nottingham Park

Photos by Katharina AM Engelhardt



The Nature Conservancy Next door neighbor (NE corner)

Photo by Katharina AM Engelhardt

Natural history features (geology and vegetation)



Exposed ultramafic bedrock at the old mine.



Exposed serpentine rock showing classic veined patterning.



Close up view of serpentine rock.
Photos by Katharina AM Engelhardt



Serpentine grassland area with pitch pine forest.
Photo by Katharina AM Engelhardt



Serpentine barren ecosystem containing pitch pine and grasslands.
Photo by Katharina AM Engelhardt

Pitch pines (*Pinus rigida*)



A view of pitch pines at Nottingham Park Serpentine Barrens.



Pitch pine with greenbriar (*Smilax rotundifolia*).
Photos by Katharina AM Engelhardt

Flowering plants



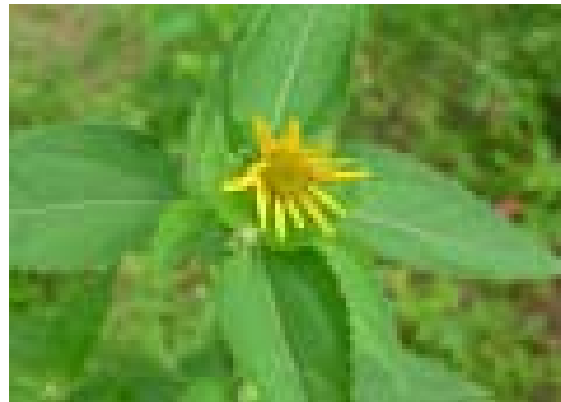
Nottingham's Serpentine Endemic:
Serpentine Aster (*Aster depauperatus*)



Fameflower (*Talinum teretifolium*)

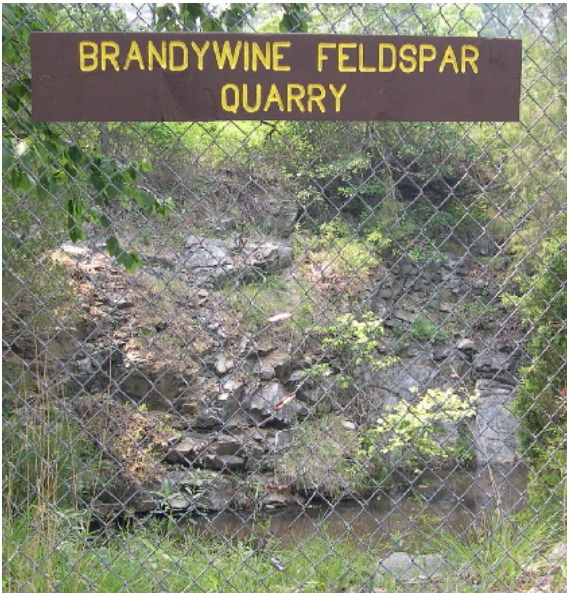


Moss phlox (*Phlox subulata*)
Photos by Kate Mrakovich



Additional representative flowering plants observed at the site including species of *Oenothera*, *Scirpus*, *Asclepias*, *Asplenium* and *Helianthus* (from top to bottom).
Photos by Katharina AM Engelhardt

Disturbances (current and historical)



Old mines



Greenbriar (*Smilax rotundifolia*) invasion

Photos by Katherina AM Engelhardt

Sample photographs of other sites evaluated



Rock Springs Barrens



Travilah Barrens



Soldiers Delight Barrens

Photos by Katherina AM Engelhardt

Appendix C: Consideration of the Addition of Goat Hill Serpentine Barrens for Inclusion in the Proposed NNL Boundary

We greatly appreciate the external reviewers' valuable comments on our evaluation of Nottingham Serpentine Barrens for inclusion in the National Park Service's listing of National Natural Landmarks (NNL). The reviews were generally in support of our recommendation to list Nottingham Serpentine Barrens as a NNL. We have revised the evaluation in cases that required simple corrections or additions of fact. One comment questioned the recommended boundary of the proposed NNL; we address this comment here to clarify and justify our recommendation.

One of the reviewers, Dr. Roger Latham, supported the recommendation to list Nottingham Serpentine Barrens ("Nottingham") as a NNL but suggested that a nearby site, Goat Hill Serpentine Barrens ("Goat Hill"), should be listed within the NNL designation. Dr. Latham argues that Goat Hill supports several important taxa that are absent at Nottingham (7 additional rare animal species and 6 additional rare plant species), contains a more dramatic topography with frontage of a river-sized stream, and supports a prime example of a mature northern red oak forest. Funds were just recently allocated for a full-scale restoration and management program that includes a burn and a public education program. It should be emphasized, however, that Dr. Latham does not recommend designation of Goat Hill as a NNL, rather he recommends the two serpentine barrens be considered jointly in one designation.

We agree with Dr. Latham that the addition of Goat Hill would add features to the NNL that Nottingham alone would not have. This is to be expected if for no other reason than species-area relationships – adding area increases the variety of habitats and, hence, species richness and the presence of additional rare species. By this reasoning, adding all serpentine barrens within the State-line barren system or all serpentine barrens within the Mid-Atlantic region would increase the number of features even more. The question thus becomes not about whether Nottingham Serpentine Barren should be designated as a NNL, but what other sites and how many, if any, to include.

We stress that this is partly a programmatic question and not one that we originally addressed. Therefore, we have not undertaken an intensive review of this option. Nevertheless, we stand behind our recommendation that Nottingham, in isolation, meets the criteria necessary for NNL designation for several reasons:

1. Nottingham Serpentine Barrens is the best representation of an eastern serpentine barren. It remains representative even without the addition of other areas to the NNL boundary. *Nottingham Serpentine Barrens can stand alone to represent the unique serpentine barren ecosystem.*
2. The future plans for the restoration and management of Goat Hill are very promising. However, the current state of Goat Hill is degraded and it will require a considerable and consistent effort to restore the serpentine barrens at the site. We are basing our recommendation on what is rather than what might be. At this point in time, *Goat Hill has undergone less active management, and therefore supports less grassland, than Nottingham.*

3. Adding Goat Hill or other sites to the NNL designation would increase the number of owners within the NNL boundary. *Multiple owners, while not necessarily prohibitive, could substantially complicate the designation and oversight of the NNL.*

Considering multiple sites in the NNL designation is an intriguing idea. If sites were to be combined, Goat Hill and Nottingham would be the logical first choice. They are the closest two sites; second and third largest sites (after Soldiers Delight); the two sites containing pitch pine dominated communities; and together would provide examples of the only two eastern serpentine endemic plant species (serpentine aster and long-haired barrens chickweed). However, we do not believe that additional sites are necessary to increase the value of the proposed NNL. We recommend the originally proposed boundary that includes only Nottingham Serpentine Barrens as this area is the single, best representation of eastern serpentine barrens and is owned by one entity that is committed to its stewardship and public education. From a management perspective, we encourage Nottingham and Goat Hill managers to communicate in their efforts to manage and restore their serpentine barrens. Their close proximity is conducive to such collaborative efforts and could only benefit conservation efforts of this important and unique ecosystem.