Ecological site R149BY001NY
Serpentine Till Uplands

Last updated: 1/13/2020
Accessed: 05/10/2024

General information

Approved. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 149B–Long Island-Cape Cod Coastal Lowland

The glaciated, Serpentine Till Upland ecological site occupies the southwestern portion of major land resource area (MLRA) 149B–Long Island-Cape Cod Coastal Lowland. This coincides with the anomalous serpentine highland that interrupts the adjacent Cretaceous sediments and glacial overburden that typifies the MLRA.

This MLRA is in the embayed section of the Coastal Plain Province of the Atlantic Plain Division (Fenneman & Johnson, 1946). It is part of the partially submerged coastal plain of New England. It is mostly an area of nearly level to rolling plains, but it has some steeper hills (glacial moraines). Ridges border the lower plains. Elevation generally ranges from sea level to 80 feet (0 to 25 meters), but it is as much as 410 feet (125 meters) in a few areas.

The site was sampled in Staten Island (Richmond County), New York.

Classification relationships

A. Phytotaxonomically, from a floristic perspective:

1. The Serpentine Till Uplands reference state: little bluestem – Indiangrass (*Schizachyrium scoparium – Sorghastrum nutans*) phase; and the excavated barrens state: little bluestem –white heath aster (*Schizachyrium scoparium – Symphyotrichum ericoides*) approximate the Serpentine Barrens description page 81 in Edinger, G.J., D.J. Evans, S. Gebauer, T.G. Howard, D.M. Hunt, and A.M. Olivero (editors). 2002. Ecological Communities of New York State. Second Edition. A revised and expanded edition of Carol Reschkes Ecological Communities of New York State. (Draft for review). New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY. http://www.dec.ny.gov/animals/29392.html.

2. The Serpentine Till Uplands reference state: little bluestem – Indiangrass (*Schizachyrium scoparium – Sorghastrum nutans*) phase and the oak(s) – tuliptree (Quercus spp. – *Liriodendron tulipifera*) phase also resemble the CEGL006441 *Sorghastrum nutans* - *Schizachyrium scoparium* Serpentine Herbaceous Vegetation, and the CEGL006438 *Acer rubrum* - Quercus spp. / Smilax spp. Serpentine Forest, respectively, of the Federal Geographic Data Committee 2008. National Vegetation Classification, version 2. FGDC-STD-005-2008 (Version 2). http://usnvc.org/.

B. Cartographically, the Serpentine Till Uplands are mapped by:

1. EPA, as a segment of the glaciated Triassic lowlands (64e); in Bryce, S.A., G.E. Griffith, J.M. Omernik, G. Edinger, S. Indrick, O. Vargas, and D. Carlson. 2010. Ecoregions of New York (2 sided color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, VA. Scale 1:1,250,000.

2. U.S. Forest Service, as 232Aa - Long Island Coastal Lowland and Moraine; in Keys, J. A. et al. 1995. Ecological Units of the Eastern United States - First Approximation (Map 1:3,500,00 + Booklet) US Department of Agriculture Forest Service, Atlanta, GA.

Ecological site concept

Site concept:
Landform: Ridges
Elevation (feet): 24-410
Slope (percent): 0-60
Water Table Depth (inches): n/a
Flooding-Frequency: None
Ponding-Frequency: None
Aspect: n/a
Mean annual precipitation (inches): 39.8-50.5
Primary precipitation: relatively even throughout the year
Mean annual temperature (degrees Fahrenheit): 54.2
Restrictive Layer: Bedrock
Temperature Regime: Mesic
Moisture Regime: Udic
Parent Materials: Till over serpentinite bedrock
Surface Texture: Loam
Surface Fragments <=3" percent cover): 0
Surface Fragments > 3" (percent cover): 0
Soil Depth (inches): 10-40
Vegetation: The reference state is a mosaic of different community types ranging from grasslands characterized by little bluestem – Indiangrass (*Schizachyrium scoparium – Sorghastrum nutans*), to shrublands characterized by winged sumac – northern bayberry (*Rhus copallinum* var. latifolia – *Morella pensylvanica*), and to woodlands/forests characterized by oak(s) – tuliptree (Quercus spp. – *Liriodendron tulipifera*). An additional state may be produced by the introduction of invasive plants, again typified by dominant strata: grasslands characterized by common wormwood (*Artemisia vulgaris*), to shrublands characterized by honeysuckle(s) - Oriental bittersweet (Lonicera spp. – *Celastrus orbiculatus*), and to woodlands/forest characterized by black locust - tree of heaven (*Robinia pseudoacacia* - *Ailanthus altissima*). Another, albeit, uncommon state may be produced by excavating the topsoil creating artificial barrens that are sparsely vegetated and characterized by little bluestem – white heath aster (*Schizachyrium scoparium – Symphyotrichum ericoides*).
Notes: This site is found on summits, shoulders, and backslopes of glacially scoured ridges associated with the

Staten Island serpentinite exposure.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium* (2) *Sorghastrum nutans*

Physiographic features

This ecological site occupies the highest portions of the Staten Island landscape. A distinct ridge primarily composed of serpentinite abruptly rises above the neighboring glacial sediments overlying Cretaceous and Triassic deposits. Local relief is 25 to 245 feet (8 to 75 meters). These sites are on summits, shoulders, and backslopes of ridges, with slopes ranging from 0 to 60 percent (mean slope of 25 percent).

No water table is found within the unconsolidated soil material overlying the serpentinite bedrock. The depth of soil over bedrock naturally represents the limit of field observation of water table and other properties. However, due to the geomorphic position of this site, it is with confidence that no water table is found within 60 inches (1.5 meters). The reported water table depth of 60 inches represents the maximum depth reported for ecological site descriptions and should be interpreted as greater than 60 inches.

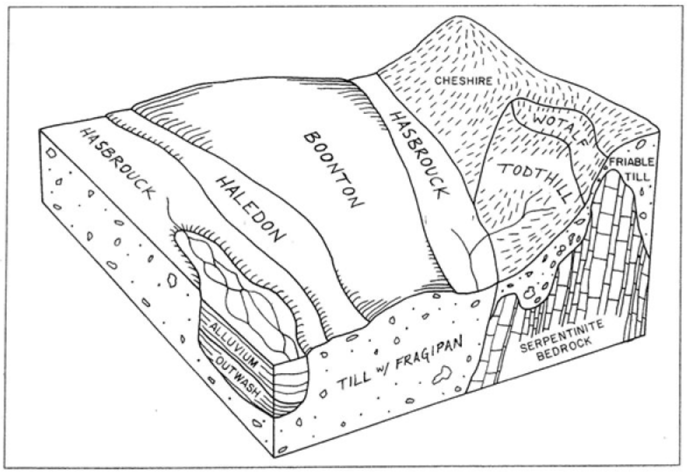


Figure 2. Block diagram of Serpentine and surrounding areas

Table 2. Representative physiographic features

Landforms	(1) Ridge
Flooding frequency	None
Ponding frequency	None
Elevation	7–125 m
Slope	0–60%
Water table depth	152 cm
Aspect	Aspect is not a significant factor

Climatic features

In winter, the average temperature is 34.2 degrees F and the average daily minimum temperature is 27.4 degrees. The lowest temperature on record, which occurred on January 18, 1982, is -13 degrees. In summer, the average temperature is 68.0 degrees and the average daily maximum temperature is 81.9 degrees. The highest temperature, which occurred on July 3, 1966, is 105 degrees.

The average annual total precipitation is about 46 inches. Of this, about 33 inches, or 72 percent, usually falls in April through November. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 7.80 inches on August 14, 2011. Thunderstorms occur on about 15 days each year, and most occur in July.

Monthly precipitation in Staten Island is fairly uniform throughout the year (DeGaetano, 1999). However, on average, potential evapotranspiration exceeds precipitation during summer by 1.5 to 4.7 inches (4 to 12 cm). Occasional drought is a normal, recurrent feature of virtually every climate in the United States. However, even with a temperate moist climate, normal fluctuations in regional weather patterns can lead to periods of dry weather. The last severe droughts in New York State occurred in the mid-1960s and again in the early and mid-1980s (New York City Office of Emergency Management, 2009). Weather that brings 62 percent of normal precipitation or less occurs only one year out of 50 in New York City (Willeke, Hosking, & Guttman, 1994).

The average seasonal snowfall is 25.0 inches. The greatest snow depth at any one time during the period of record was 28 inches recorded on February 18, 2003 and February 4, 1961. On an average, 42 days per year have at least 1 inch of snow on the ground. The heaviest 1-day snowfall on record was 21.6 inches recorded on February 17, 2003.

The Atlantic hurricane season runs from June through November. The estimated return period for hurricanes passing within 50 nautical miles of Staten Island is 19 years (NOAA NWS, 2013). The return period for major (i.e. category 3 or greater) hurricanes is 74 years. Staten Island has no recorded direct or indirect hurricane strikes from 1900-2005, however the nearby New York and Kings counties each have category 3 hurricane indirect strikes recorded in 1938 and 1944 (Jarrell, Hebert, & Mayfield, 2010).

Future projections indicate that greenhouse warming will cause the globally averaged intensity of tropical cyclones to shift towards stronger storms, with intensity increases of 2 to11 percent by 2100 (Knutson et al., 2010).

Table 3. Representative climatic features

Frost-free period (average)	221 days
Freeze-free period (average)	244 days
Precipitation total (average)	1,143 mm

Influencing water features

There are no water features influencing this site.

Soil features

This ecological site is represented by soils in the Inceptisols soil order. Major soil series for this ecological site are Todthill and Wotalf. Map units having these soils as major components make up approximately 85 percent of the ecological site. The remaining 15 percent include serpentinite rock outcrop miscellaneous areas with inclusions of Wotalf and Todthill soils.

These soils have a mesic soil temperature regime, an udic soil moisture regime, and mixed mineralogy (Soil Survey Staff, Official Series Descriptions, 2013). They are shallow or moderately deep to a lithic contact (serpentinite bedrock) and have a loamy-skeletal particle size class.

A seasonal high water table is generally not observed in the soil above the bedrock contact (within 40 inches). The soil series associated with this ecological site are interpreted to be well drained according to New York drainage class standards. Saturated hydraulic conductivity in the soil material is moderately high and high (Soil Survey Staff, 2013).

Soils associated with this ecological site formed in a loamy till mantle overlying consolidated serpentinite bedrock. The till mantle is of mixed origin (serpentinite, red acid sandstone, siltstone, and shale), due to the flow direction of the glacial lobe that deposited material upon the serpentine ridge. Though this mantle is not formed of weathered serpentinite alone, these shallow to moderately deep soils express chemical properties associated with residual serpentine soils. The chemical properties include elevated levels of certain trace metals (e.g. chromium, nickel, and cobalt), low calcium-magnesium ratios, high pH, and elevated base saturation (Rabenhorst, Foss, and Fanning, 1982). This serpentine chemical signature provides an environmental stress allowing for the unique ecological states associated with this site. However, these unique chemical properties are less well expressed than their residual analogs that are found south of the terminal extent of the Wisconsinan glaciation (i.e. Maryland and Pennsylvania).

Where the till mantle thickens to greater than 40 inches (1 meter), the serpentine chemical properties are not well expressed or are absent. This ecological site is not correlated to these deep till components (Cheshire and similar soils).

The available water capacity values have a wide range due to the variable depth to bedrock contact. Expressed in total inches, the available water capacity range covers soils as shallow as 10 inches with high fragment content to soils as deep as 40 inches with relatively lower fragment content.

Figure 7. (Soil profile at Old Mill Road site; units are cm)

Table 4. Representative soil features

Parent material	(1) Ablation till–sandstone and siltstone
Surface texture	(1) Loam (2) Gravelly loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderately slow to rapid
Soil depth	25–102 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	2.29–16.76 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	5.6–7.8

Subsurface fragment volume <=3" (Depth not specified)	5–85%
Subsurface fragment volume >3" (Depth not specified)	0–15%

Ecological dynamics

The vegetation of serpentine sites is often visually distinct and set apart from the surrounding vegetation. The boundaries between such isolated serpentine sites and neighboring non-serpentine sites are most pronounced in sites known locally as "barrens". The term barrens, referring to the poor soils, narrowly refers to sparsely-vegetated sites, yet today, the term more commonly refers collectively to open sites, ranging structurally from grasslands to open shrublands/savannas and to even somewhat open woodlands of trees with short stature. While these more open serpentine sites are of the greatest historical and conservation significance, the reference state described here also includes a moderately-closed canopy woodland/forest vegetation-form.

The ecological dynamics of the glacial serpentine uplands are featured by a variety of different vegetation-forms. Differences among the various serpentine plant community-types (and non-serpentine vegetation in general) are due primarily to: (1) the nature and extreme edaphic conditions of the serpentine site, (2) the physiologically adaptive nature of the plants, which make up the unusual and interesting plant biodiversity, and (3) the disturbance history of the site, notably fire, soil disturbance, and infrequent wind events of significant magnitude.

The serpentine nature of the soils is derived from the weathering of ultramafic rock outcrops, namely, serpentinite rocks. The geologic origin of serpentinite in eastern North America is explained by Alexander (2009) and Rajakaruna et al. (2009), who describe how serpentinite was derived from the earth's mantle and produced in oceanic or magmatic-arc settings and accreted onto the proto-North American continent during deformational or mountain building episodes called orogenies. Serpentine soils occur in a discontinuous band along the eastern edge of the Appalachian mountain system from Newfoundland and Quebec, Canada, through New England, USA, to Staten Island, NY, and again from northern New Jersey to Alabama along the piedmont (Brooks 1987).

About a third of Staten Island is underlain by serpentinite bedrock, forming a pronounced northeast-southwest trending ridge that reaches an extraordinary 135 m (410 feet) above sea level at Todt Hill. This is the highest natural feature of NYC and, in fact, the highest point on the eastern seaboard south of Maine (USGS 2003). "Todt" comes from the Dutch language meaning "dead". It is presumed that the name was chosen in keeping with the generally impoverished appearance of the exposed, scrubby, rocky, serpentine barren nature of the terrain. Although presently much of the ridge is developed and residential, a large area of contiguous parks and natural areas, known as the "Staten Island Greenbelt" is protected, amounting to 1133 hectares (2800 acres).

Serpentine soils create a novel and harsh environment for plant growth (Brady et al. 2005). The "serpentine syndrome" was coined by Hans Jenny (1980) to describe the cumulative suite of limiting soil conditions to which a plant must adapt (as cited in Brady et al. 2005). Serpentine soils are high in first transition metals such as nickel, cobalt, and chromium, which can be toxic or limiting to some plants. Serpentine soils have low levels of available calcium and high levels of magnesium, which contribute to a low Ca:Mg ratio (less than one), which is considered unfavorable for plant growth. Serpentine soils are also deficient in many essential plant nutrients such as phosphorus, potassium, and molybdenum. Physical stresses such as drought, wind, and erosion are additional factors that plants must tolerate, because serpentine outcrops are often associated with open, steep landscapes with thin, rocky soils. In serpentine soils, water availability as determined by soil depth does affect the distribution and dynamics of the vegetation. In general, serpentine grasslands are more common on shallow rocky soils, while serpentine forests occur in deeper soils (Tyndall and Hull 1999, Arabas 2000).

The influence of the Pleistocene glaciation upon the degree and character of soil formation is another important factor at Staten Island, NY, and serpentine areas to the north (Alexander 2009). Much of the serpentinite bedrock on Staten Island is covered by a mantle of glacial till/moraine (Soren 1988 as cited in USGS 2003), forming soils that are definitively non-serpentine and that lack typical serpentine vegetation. Where serpentine soils are expressed on Staten Island, they occur in the landscape mostly on higher upper slope positions, on steep to moderately steep slopes, mostly with a southerly aspect; hence the serpentine soils are thin and tend toward droughtiness. These landscape conditions occur at several locations mostly within or near the Staten Island Greenbelt: at South LaTourette Park, above Bloodroot Valley (near the haunted Seaview Hospital), and elsewhere at Grymes Hill, also known as the Serpentine Art and Nature Commons, and along the eastern reaches of the Long Island Expressway.

In addition to edaphic factors, natural and human-caused disturbances are considered important factors influencing the character and dynamics of serpentine vegetation.

Fire clearly plays an important role in maintaining the open character of serpentine sites that support many unusual and rare serpentine plants (Arabas 2000, Rajakaruna et al 2009, Miller 1981, Tyndall and Hull 1999, Tyndall 1994, Latham 1993, Marye 1955). The plant community-types that inhabit serpentine barrens, grasslands, savannas, and open woodlands are considered fire-dependent. Fire also removes the surface organic matter and delays soil development. Historically, fire deliberately set by Native Americans largely for hunting and land management was responsible for maintaining open conditions of the vegetation, a practice that was not readily continued at the same magnitude by later European colonists (Day 1953, Marye 1955). Long-term direct fire suppression and indirect fire cessation through inadvertent fire breaks (e.g., roads, fragmentation), has led to succession from grasslands/savannas and open woodlands to closed-canopied forest. Over time, afforestation can lead to organic matter accumulation and enhanced soil development that could eventually shift the plant community away from a serpentine system (Latham 1993). It is generally accepted that fire played a role in keeping serpentine sites open on Staten Island, given the history of its occupation by Native Americans and its legacy as a former agricultural and fishing community. Today, in spite of the policy of fire protection in the developed areas, occasional fires break out in the parks, either by accidental means or by arson.

Wind events can have an effect on woodland and forest sites, especially on more exposed sites with thin soils. Windthrows are occasionally evident on the steeper slopes with thin soils where canopy trees may have established, such as the south face of Egbertsville Ravine in the Greenbelt.

Mining and other construction activities, including building and road development, have had a drastic detrimental impact upon serpentine vegetation. Mining and construction activities typically remove the serpentine topsoil down to bedrock, exposing barren landscapes (O'Dell and Claasen 2009). Three such sites on Staten Island are worth noting: the Road-to-Nowhere, Moses' Mountain, and Grymes Hill. The Road-to-Nowhere is along the eastern side of the Staten Island Expressway at a vast road cut for an abandoned highway interchange, revealing a large exposure of serpentinite. During its construction, an enormous volume of serpentinite rubble was relocated to a site near Bloodroot Valley and heaped into a steep hill known as Moses' Mountain. The steep roadcut exposures are still relatively barren and sparsely vegetated. Moses"""" Mountain is vegetated predominately by woody invasive plants. Grymes Hill, also known as the Serpentine Arts and Nature Commons, is a steep slope left barren after a contractor removed all topsoil. Grymes Hill is only sparsely re-vegetated. A framework for the restoration of disturbed serpentine landscape is proposed by O'Dell and Claasen (2009) including physical site stabilization to prevent collapse and soil erosion, substrate amendments with local serpentine parent materials to replicate original conditions, and careful plant materials selection to recreate a dynamic plant species mix characteristic of the desired serpentine nature. It is worth noting that the Greenbelt Native Plant Center is engaged in localized seed collection and banking of conservation worthy plant species in order to preserve and sustain the unique serpentine plant diversity of Staten Island.

Plants inhabiting serpentine areas are widely recognized for their biological diversity. Serpentine areas are specialized habitats for many rare, disjunct, and endemic plant species that are of considerable conservation interest (Rajakaruna et al 2009, Young 2010). Serpentine floras of glaciated areas of eastern North America, such as Staten Island, NY, tend to be somewhat impoverished compared to non-glaciated areas because the Pleistocene ice removed all vegetation. Furthermore, those plants that have colonized such young soils after the last glaciation may not have not had adequate time to diverge and specialize (Rajakaruna et al 2009). In addition, the diluting effects of non-serpentine glacial till would ameliorate the ecological and evolutionary effects of the serpentine soil syndrome.

A systematic inventory of the serpentine flora of eastern North America was conducted by C.F.Reed, (1986) including several trips to Staten Island in the late 1960s. Of the 44 species he listed, Cerastium velutinum var. villosissimum (longhaired serpentine chickweed) [= *Cerastium arvense* L. ssp. velutinum var. villosum – field chickweed (NRCS PLANTS Database)] was the only endemic encountered. Reed noted that by 1986 all of the floras native to the serpentine areas of Staten Island have been extirpated (as cited in Levine & Greller 2004, Tyndall & Hull 1999). To put these loses into context, the native species losses for all habitats across Staten Island were over forty per cent (53% of regionally rare and endangered species) spanning the last 60 years of the 20th century during an accelerating period of suburbanization and land use change. At the same time, the proportion of non-native species has increased from 19% to > 33% of the flora (Robinson et al. 1994). The pervasiveness of invasive plant species remains a threat to the conservation integrity of Staten Island serpentine sites. Nonetheless, a recent compilation of published local floristic inventories of serpentine areas in eastern North America has been summarized by Rajakaruna et al. (2009). All vascular plant species recorded from serpentine are listed by state occurrence along with protection status and literature sources.

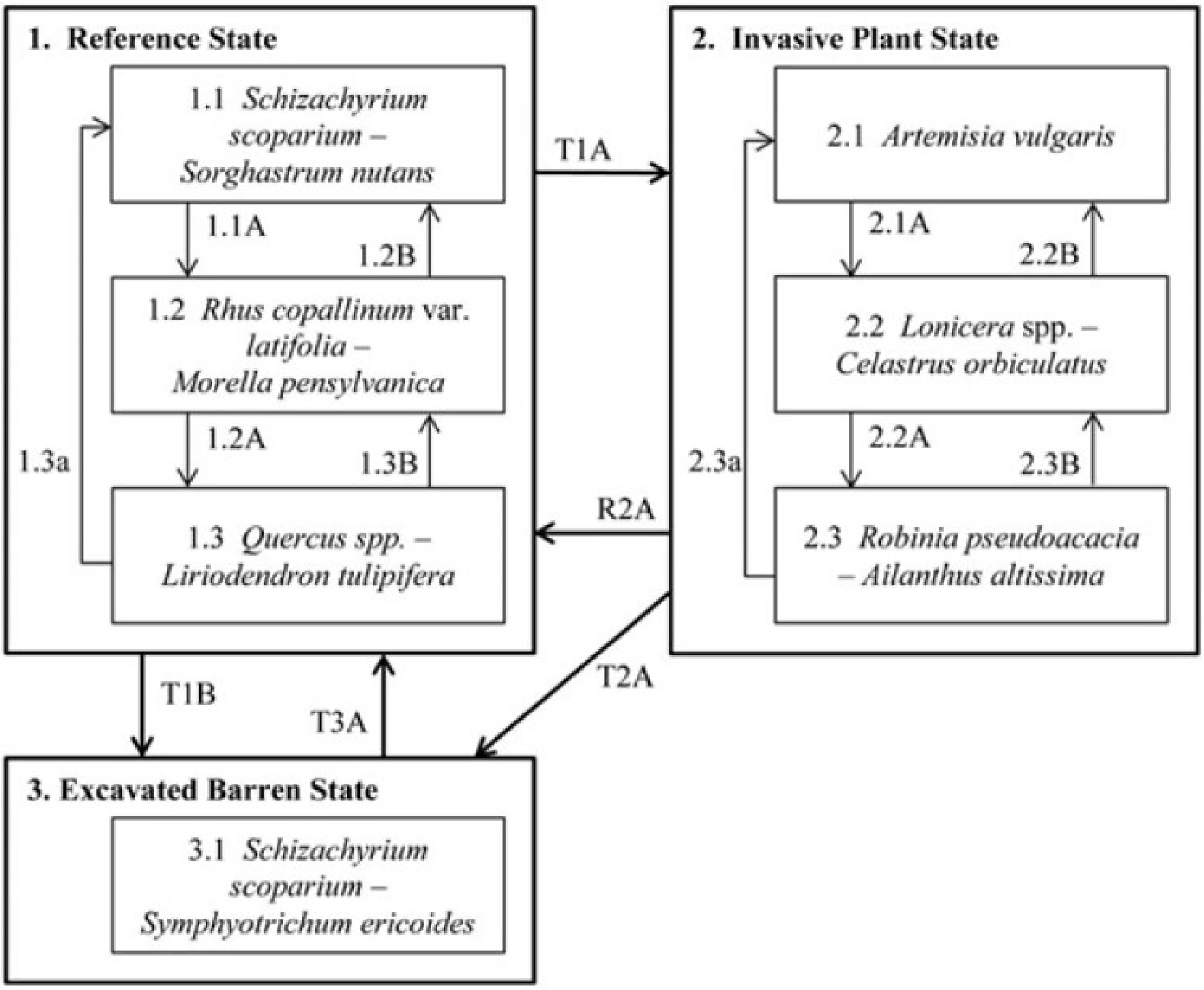
The vegetation of the glaciated, serpentine till uplands are characterized by 3 different states:
a "Reference State", recognizing dominance by native plants, subdivided into three physiognomically different phases identified by strata differences in lifeform (i.e., grassland, shrubland, forest); a second "Invasive Plant State", recognizing dominance by invasive species, again with three physiognomically different phases (i.e., grassland, shrubland, forest); and a third "Excavated Barren State" representing a highly-modified, sparsely vegetated barrens.

The highly-modified excavated barrens state is the direct result of land excavation and top soil removal, as well as the limited deposition of excavated serpentine spoils. Lacking appreciable soil and a more natural landscape context distinguishes these highly modified Staten Island barrens from other typical, more naturally occurring barrens. Furthermore, these man-made barrens are small and localized in extent. Nonetheless, the excavated barrens are no less true in character than other more natural serpentine barrens as described elsewhere (Tyndall and Hull 1999). However, where man-made barrens exist (Grymes Hill, Long Island Expressway, and Moses' Mountain), because of their unusual origin and small size, they are typically regarded only as rocky features and mapped accordingly on the soils map. Therefore, in this context, the highly modified and localized excavated barrens, as described here, do not warrant describing a separate Ecological Site.

The floristic and structural distinctions among vegetation types described follow accepted standards for the classification and description of vegetation (Jennings et al 2009, USNVC 2008).

The state-and-transition model for the Serpentine Till Uplands 149BS001 follows, along with descriptions for each state, transition, plant community, and pathway depicted in the model. The source of information is based on original field observations and relevé plots sampled within the Staten Island Greenbelt and on Grymes Hill. The field work was conducted by NRCS with assistance from the Greenbelt Native Plant Society. Additional relevé plots were provided courtesy of the NY Natural Heritage Program. Additional information was also obtained from literature sources, as cited.

State and transition model



Code	*Practice*
1.1A, 1.2A, 2.1A, 2.2A	Lack of fire, lack of management, vegetation development [succession]
1.2B, 1.3A, 1.3B, 2.2B, 2.3A, 2.3B	Disturbance to site (*e.g.,* wind, fire, cutting, herbicide) woody overstory removal
T1A	Major disturbance to site (*e.g.,*wind, drought, fire), Invasive species establishment
T1B, T2A	Topsoil removal, excavation and dumping
R2A	Selective removal (cutting, herbicide, prescribed burn), appropriate new plantings
T3A	Physical "topsoil" establishment and stabilization, substrate amendments, and appropriate new plantings.

Figure 8. Serpentine Till Uplands - 149BS001NY

State 1
Reference State

The reference state for the glaciated serpentine uplands is a mosaic of physiognomically different phases, consisting of grasslands and or meadow dominated by little bluestem (*Schizachyrium scoparium*) and Indiangrass

(*Sorghastrum nutans*), to predominately shrublands supporting a mix of winged sumac (*Rhus copallinum* var. latifolia), and northern bayberry (*Morella pensylvanica*), to serpentine woodlands dominated by a mix of oaks (Quercus spp.), tuliptree (*Liriodendron tulipifera*), and sweetgum (*Liquidambar styraciflua*). What ties these vegetation forms together in the reference state is, that given time and lacking management, natural processes alone, such as wildfire or lack of wildfire, ice storms, and wind storms can, potentially, effect the development of the transitions between all of the three structural phases described and any intermediate stages. The defining characteristic of the reference state is the dominance of native plants, at least in the uppermost defining stratum, and the presence of serpentine soil development. These criteria separate the reference state from the invasive plant state and the excavated barren state. Historically, a similar mosaic of these types was also likely, a mosaic that was reinforced by the patchy occurrences of serpentine soils on Staten Island. Serpentine grasslands may have dominated as the modal plant community resulting from Native American fires that occurred at least every few years as has been reported (Day, 1953) and resulting from clearing and pasturing practices by early colonists (Leng and Davis, 1930 as cited in Robinson et al., 1994). Currently, the serpentine grassland plant community-type phase is a conservation focus for the management of rare and endangered plant species (NY Natural Heritage Program, 2013). Collecting biomass, tree cores, or vouchers was not allowed on these conservation lands.

Community 1.1
Little bluestem – Indiangrass (Schizachyrium scoparium – Sorghastrum nutans)

Figure 9. Serpentine Grasslands, on Wotalf-Todthill loams, 15 to 35 percent slopes, very rocky at Seaview, Staten Island

Figure 10. Asclepias viridiflora, green comet milkweed

This serpentine grassland community phase is characterized by a dominance of warm-season grasses with admixtures of other herbaceous plants forming a dense to nearly continuous cover. The dominant grass is little bluestem (*Schizachyrium scoparium*), as well as Indiangrass (*Sorghastrum nutans*) (New York Natural Heritage Program, 2013). Other characteristic species may include western yarrow (*Achillea millefolium* ssp. lanulosa), switchgrass (*Panicum virgatum*), roundhead lezpedeza (*Lespedeza capitata*), white heath aster (*Symphyotrichum ericoides*), common mullein (*Verbascum thapsus*), Queen Anne's lace (*Daucus carota*), green comet milkweed (*Asclepias viridiflora*), globose flatsedge (*Cyperus echinatus*), panicledleaf ticktrefoil (*Desmodium paniculatum*), as well as calico aster (*Symphyotrichum lateriflorum*), white oldfield aster (*Symphyotrichum pilosum*), poverty oatgrass (*Danthonia spicata*), tufted hairgrass (Deschampsia caespitosa), Small's ragwort (*Packera anonyma*), narrowleaf evening primrose (*Oenothera fruticosa* ssp. glauca), marsh bristlegrass/bristly foxtail (*Setaria parviflora*), lesser snakeroot, (*Ageratina aromatica*), and common cinquefoil (*Potentilla simplex*) (New York Natural Heritage Program, 2013). In the serpentine meadow on Staten Island, sparsely scattered shrubs may be present but contribute no more than 25 percent cover. Shrub species may include winged sumac (*Rhus copallinum* var. latifolia) and northern bayberry, (Morella penslyvanica). Additionally, non-native, invasive plants are found (NYS-DEC), such as common wormwood (*Artemisia vulgaris*), which, when dominant, are treated separately as a different state. Historically, these sites were maintained as grasslands by Native American fires and clearing by early colonists frequently enough to eradicate or control woody incursives. The integrity of these sites can be maintained similarly. However, prescribed burning may be difficult to do in areas too close to residences. Fires do occur either by accident or by arson. With fire suppression or lack of management, the serpentine grasslands can expect to succeed to shrublands and woodland phases. The open serpentine grassland phase is more persistent on droughty sites. These open serpentine grassland phases (as well as barrens) are the principal focus of conservation efforts to protect rare species, most notably green comet milkweed (*Asclepias viridiflora*), purple milkweed (*Asclepias purpurascens*), globose flatsedge (*Cyperus echinatus*), and velvet panicum (*Dichanthelium scoparium*) (New York Natural Heritage Program, 2013). Collecting biomass, tree cores, or vouchers was not allowed on conservation lands. Main photo: Serpentine Grasslands, on Wotalf-Todthill loams, 15 to 35 percent slopes, very rocky at Seaview, near reference condition. (Nels Barrett, 7/25/2013)

Forest overstory. absent

Forest understory. Predominately a grassland characterized by little bluestem (Schizachyrium scoparium), and Indiangrass (Sorghastrum nutans).

Table 5. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	1%
Grass/grasslike basal cover	5-10%
Forb basal cover	1-2%
Non-vascular plants	0%
Biological crusts	0%
Litter	83-88%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	5%

Table 6. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	–	–
>0.15 <= 0.3	–	–	1-1%	1-2%
>0.3 <= 0.6	0-1%	4-8%	87-100%	6-87%
>0.6 <= 1.4	0-9%	19-54%	–	–
>1.4 <= 4	0-4%	0-18%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 1.2
Winged sumac – Northern bayberry (Rhus copallinum var. latifolia – Morella pensylvanica)

Figure 11. Serpentine Grasslands, at Seaview, Todthill-Wotalf loams

Serpentine shrublands are characterized by a predominance of shrubs than can be mixed with young short trees and scattered grasses and wildflowers. Serpentine shrublands result as a shift from the grassland phase 1.1 if fire is suppressed and/or if no manner of woody plant control is done. A shift may also occur from woodland or forest if woody tree cover is removed manually or by heavy winds. The shrub cover typically exceeds 25 percent cover, ranging from open shrublands to dense thickets. Shrub heights will vary with species, but are typically 2 to 3 meters in height. The dominant shrubs include winged sumac (*Rhus copallinum* var. latifolia and northern bayberry (*Morella pensylvanica*). Other common shrubs may include smooth sumac (*Rhus glabra*), Allegheny blackberry (*Rubus allegheniensis*), Japanese angelica tree (*Aralia elata*), and even highbush blueberry (*Vaccinium corymbosum*). Occasional young trees (less than 5 m in height) can include gray birch (*Betula populifolia*), quaking aspen (*Populus tremuloides*), and black cherry (*Prunus serotina*). Similar to the serpentine grassland or herbland community phase 1.1, patches of grasses such as little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*) are mixed with several wildflowers including western yarrow (*Achillea millefolium* ssp. lanulosa), roundleaf thoroughwort, (*Eupatorium rotundifolium* var. ovatum), flat-top goldentop/goldenrod, (*Euthamia graminifolia*), panicledleaf ticktrefoil (*Desmodium paniculatum*), and western brackenfern (*Pteridium aquilinum*). Additionally, non-native, invasive plants are found, such as honeysuckles (Lonicera spp., barberry (*Berberis thunbergii*), and Oriental bittersweet (*Celastrus orbiculatus*), which when dominant are treated as separately as a different state. Collecting biomass, tree cores, or vouchers was not allowed on conservation lands. Main photo: Serpentine Shrublands, on Wotalf-Todthill loams, 15 to 35 percent slopes, very rocky at Seaview , Staten Island. (Nels Barrett, 7/25/2013) Unless management steps are taken to eradicate or control woody plants, the serpentine shrublands phase 1.2 will most likely proceed to the closed canopy serpentine forest phase 1.3.

Forest overstory. Young early successional trees, gray birch (Betula populifolia), quaking aspen (Populus tremuloides), and black cherry (Prunus serotina).

Forest understory. The dominant shrubs include winged sumac (Rhus copallinum var. latifolia and northern bayberry (Morella pensylvanica.

Table 7. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	1-2%
Grass/grasslike basal cover	1%
Forb basal cover	1-2%
Non-vascular plants	0%
Biological crusts	0%
Litter	83-88%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	5-10%

Table 8. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	–	–
>0.15 <= 0.3	–	–	1-4%	1-7%
>0.3 <= 0.6	–	–	38-74%	7-52%
>0.6 <= 1.4	0-7%	5-14%	–	–
>1.4 <= 4	0-70%	0-18%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 1.3
Oak(s) – Tuliptree (Quercus spp. – Liriodendron tulipifera)

Figure 12. Serpentine forest, South LaTourette Park

Figure 13. Overstory canopy, South LaTourette Park

Figure 14. Serpentine forest, South LaTourette Park

Establishment of trees into an open serpentine site with appreciable soil is almost inevitable given the small patchy nature of serpentine sites at Staten Island surrounded by potential seed sources. Woodland, by definition, has a more open character, with a canopy coverage between 25 to 60 percent, whereas forests exhibit canopy cover exceeding 60 percent. The dominant trees are oaks, which in order of prevalence are scarlet oak (*Quercus coccinea*), chestnut oak (*Q. montana*), black oak (*Q. velutina*), less commonly white oak (*Q. alba*) and uncommonly, willow oak, (*Q. phellos*) and the hybrid oak (Q.x filailis = *Q. phellos* x *Q. velutina*). Other common canopy trees include tuliptree (*Liriodendron tulipifera*) and sweetgum (*Liquidambar styraciflua*). Other trees may include sassafras (Sassafrass albidum), gray birch (Betula populiflolia), as well as red maple (*Acer rubrum*) and quaking aspen (*Populus tremuloides*) (New York Natural Heritage Program, 2013). Younger tree seedlings (less than 5 m in height) of the same canopy species may be present. Shrubs may include northern spicebush (*Lindera benzoin*), winged sumac (*Rhus copallinum* ssp. latifolia), northern arrowood (*Viburnum dentatum* var. lucidum) and highbush blueberry (*Vaccinium corymbosum*). Understory herbs may include white wood aster (*Eurybia divaricata*), Canada mayflower (*Maianthemum canadense*), Virginia creeper (*Parthenocissus quinquefolia*), eastern hayscented fern (*Dennstaedtia punctilobula*), and patches of little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). Other spring herbs, including smooth-forked nailwort or chickweed (*Paronychia canadensis*), are listed by Levine et al. 2004. Collecting biomass, tree cores, or vouchers was not allowed on conservation lands. Photo credit: Nels Barrett, 7/25/2013

Forest overstory. Forest overstory is closed but not typically dense. The predominant trees are scarlet oak (Quercus coccinea), tuliptree (Liriodendron tulipifera) and sweetgum (Liquidambar styraciflua).

Forest understory. The understory is a variable mix of ferns, herb, and grasses. Due to the relative openness of the canopy, vines like poison ivy (Toxicodendron radicans), Virginia creeper (Parthenocissus quinquefolia), and Allegheny blackberry (Rubus allegheniensis)are often more abundant.

Table 9. Soil surface cover

Tree basal cover	2-3%
Shrub/vine/liana basal cover	1%
Grass/grasslike basal cover	1%
Forb basal cover	1-2%
Non-vascular plants	0%
Biological crusts	0%
Litter	92-94%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-30%
Bedrock	0%
Water	0%
Bare ground	1%

Table 10. Woody ground cover

Downed wood, fine-small (<0.40" diameter; 1-hour fuels)	–
Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels)	2-4%
Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels)	5-7%
Downed wood, coarse-small (3.00-8.99" diameter; 1,000-hour fuels)	2-3%
Downed wood, coarse-large (>9.00" diameter; 10,000-hour fuels)	0%
Tree snags** (hard***)	–
Tree snags** (soft***)	–
Tree snag count** (hard***)	0-10 per hectare
Tree snag count** (hard***)	0-25 per hectare

*** Decomposition Classes: N - no or little integration with the soil surface; I - partial to nearly full integration with the soil surface.**

**** >10.16cm diameter at 1.3716m above ground and >1.8288m height--if less diameter OR height use applicable down wood type; for pinyon and juniper, use 0.3048m above ground.**

***** Hard - tree is dead with most or all of bark intact; Soft - most of bark has sloughed off.**

Table 11. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	5-10%	0-1%	0-5%
>0.15 <= 0.3	–	20-24%	0-2%	1-5%
>0.3 <= 0.6	–	5-20%	–	0-2%
>0.6 <= 1.4	0-30%	4-25%	–	–
>1.4 <= 4	4-86%	0-21%	–	–
>4 <= 12	2-15%	–	–	–
>12 <= 24	50-95%	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 1.1A
Community 1.1 to 1.2

Little bluestem – Indiangrass (Schizachyrium scoparium – Sorghastrum nutans)

Winged sumac – Northern bayberry (Rhus copallinum var. latifolia – Morella pensylvanica)

Lack of fire, fire suppression or management enables woody plant invasion and eventual conversion or succession to shrubland or forest phases. The length of time for vegetation development is decadal or longer.

Pathway 1.2B
Community 1.2 to 1.1

Winged sumac – Northern bayberry (Rhus copallinum var. latifolia – Morella pensylvanica)

Little bluestem – Indiangrass (Schizachyrium scoparium – Sorghastrum nutans)

Loss, removal, or control of woody plants with wildfire, prescribed burn, and selective herbicides and cutting can maintain the integrity of the desired serpentine grassland or meadow phase. In addition, serpentine appropriate native planting can accelerate the development of the serpentine grassland.

Conservation practices

Clearing and Snagging
Upland Wildlife Habitat Management
Early Successional Habitat Development/Management

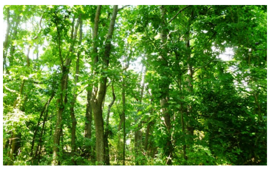
Pathway 1.2A
Community 1.2 to 1.3

Winged sumac – Northern bayberry (Rhus copallinum var. latifolia – Morella pensylvanica)

Oak(s) – Tuliptree (Quercus spp. – Liriodendron tulipifera)

Fire suppression or lack of woody plant control may lead to further woody plant development and subsequent loss of open grassland and herbland plants over time during an eventual conversion to a closed canopy forest phase. The length of time for vegetation development is decadal or longer.

Pathway 1.3A
Community 1.3 to 1.1



Oak(s) – Tuliptree (Quercus spp. – Liriodendron tulipifera)

Little bluestem – Indiangrass (Schizachyrium scoparium – Sorghastrum nutans)

Total removal and control of all woody plants and other invasive or incursive plants using wildfire, prescribed burning, and selective herbicides and cutting can maintain the integrity of the desired serpentine grassland phase. However, recovery from forest to serpentine grassland from the seed bank alone may require additional seed sowing and/or native planting to achieve the desired serpentine grassland phase.

Conservation practices

Brush Management
Prescribed Burning
Restoration and Management of Rare and Declining Habitats
Upland Wildlife Habitat Management
Native Plant Community Restoration and Management

Invasive Plant Species Control
Herbaceous Weed Control

Pathway 1.3B
Community 1.3 to 1.2

Oak(s) – Tuliptree (Quercus spp. – Liriodendron tulipifera)

Winged sumac – Northern bayberry (Rhus copallinum var. latifolia – Morella pensylvanica)

Removal or control of the tree canopy by natural means such as windstorms or wildfire or active management using prescribed burning, cutting, and selective herbiciding can revert the site back to a predominately shrubland phase.

Conservation practices

Brush Management
Restoration and Management of Rare and Declining Habitats
Upland Wildlife Habitat Management
Record Keeping

State 2
Invasive Plants State

The presence and dominance of non-native, invasive plant species can be pervasive in certain serpentine areas on Staten Island (Robinson et al., 1994), thereby warranting separate states, especially if active management is necessary to restore the native serpentine vegetation. Invasive species are a potential problem given the small isolated nature of the serpentine uplands and the close proximity to sources of invasive plant seeds and propagules from nearby urban and residential areas. The Invasive Plants State for the glaciated serpentine uplands is a mosaic of physiognomically different phases, ranging from grasslands or meadows dominated by common wormwood (*Artemisia vulgaris*) to predominately shrublands supporting a mix of honeysuckles (Lonicera spp.), Oriental bittersweet (Celastrus occidentalis) and common wormwood (*Artemisia vulgaris*) and woodlands or forest dominated by black locust (*Robinia pseudoacacia*) and tree of heaven (*Ailanthus altissima*). Successful invasive plant control at any physiognomic phase can restore the serpentine site back to the native flora of the reference state. Given time and the lack of disturbance or active management, grasslands or meadows can succeed to woody phases as shrubland and woodland or forest phases. Natural processes alone, such as wildfire or lack of wildfire, ice storms, and windstorms, can reduce the dominating overstory structure, driving the vegetation development back to more open phases.

Community 2.1
Common wormwood (Artemisia vulgaris)

Figure 15. South Latourette Park, Todthill-Wotalf complex

The serpentine invasive shrubland is dominated sometimes exclusively by common wormwood (*Artemisia vulgaris*). Common wormwood has a reputation for its weediness and it also occurs in mixures with other forbs and grasses. Without management, succession can proceed to woody vegetation phases. Collecting biomass, tree cores, or vouchers was not allowed on conservation lands. Main photo: Invasive, serpentine grasslands, on Todthill-Wotalf complex, 35 to 60 percent slopes, very rocky at South LaTourette Park (Nels Barrett, 7/25/2013)

Forest overstory. absent

Forest understory. Common wormwood (Artemisia vulgaris) commonly dominates.

Table 12. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	–	–
>0.15 <= 0.3	–	–	–	–
>0.3 <= 0.6	–	–	1-1%	99-99%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.2
Honeysuckle(s) - Oriental bittersweet (Lonicera spp. - Celastris orbiculatis)

Figure 16. Invasive shrublands, Moses Mountain

Figure 17. Serpentinite, Moses Mountain

The serpentine invasive shrubland is characterized by the dominance of any one or mix of: Japanese honeysuckle (*Lonicera japonica*), Morrow's honeysuckle (*Lonicera morrowii*), Oriental bittersweet (*Celastrus orbiculatus*), sweet autumn virginsbower (*Clematis terniflora*), multiflora rose (*Rosa multiflora*), and wine raspberry (*Rubus phoenicolasius*), occasionally mixed with natives such as patches of little bluestem (*Schizachyrium scoparium*) switchgrass (*Panicum virgatum*), and common milkweed (*Asclepias syriaca*). Small young trees, if present, would include black locust (*Robinia pseudoacacia*), and tree of heaven (*Ailanthus altissima*), mixed with natives such as quaking aspen (*Populus tremuloides*) and black cherry (*Prunus serotina*). Collecting biomass, tree cores, or vouchers was not allowed on conservation lands. Main photo: Invasive shrublands on serpentinite bedrock/rubble features at Moses Mountain (Jacob Isleib, 7/27/2012). Unless management steps are taken to eradicate or control woody plants, the serpentine invasive shrublands phase 2.2 can possibly form relatively stable shrublands resisting further vegetation development or can proceed to the closed canopy serpentine forest phase 1.3.

Forest overstory. If present, small young trees of black locust (Robina pseuodacacia).

Forest understory. The most common invasive shrubs include, honeysuckles (Lonicera spp.), Oriental bittersweet (Celatrus orbiculatus), and multiflora rose (Rosa multiflora).

Table 13. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	–	–
>0.15 <= 0.3	–	–	–	1-1%
>0.3 <= 0.6	–	3-11%	3-11%	1-1%
>0.6 <= 1.4	–	1-4%	–	1-12%
>1.4 <= 4	3-6%	4-4%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.3
Black locust - Tree of heaven (Robinia pseudoacacia - Ailanthus altissima)

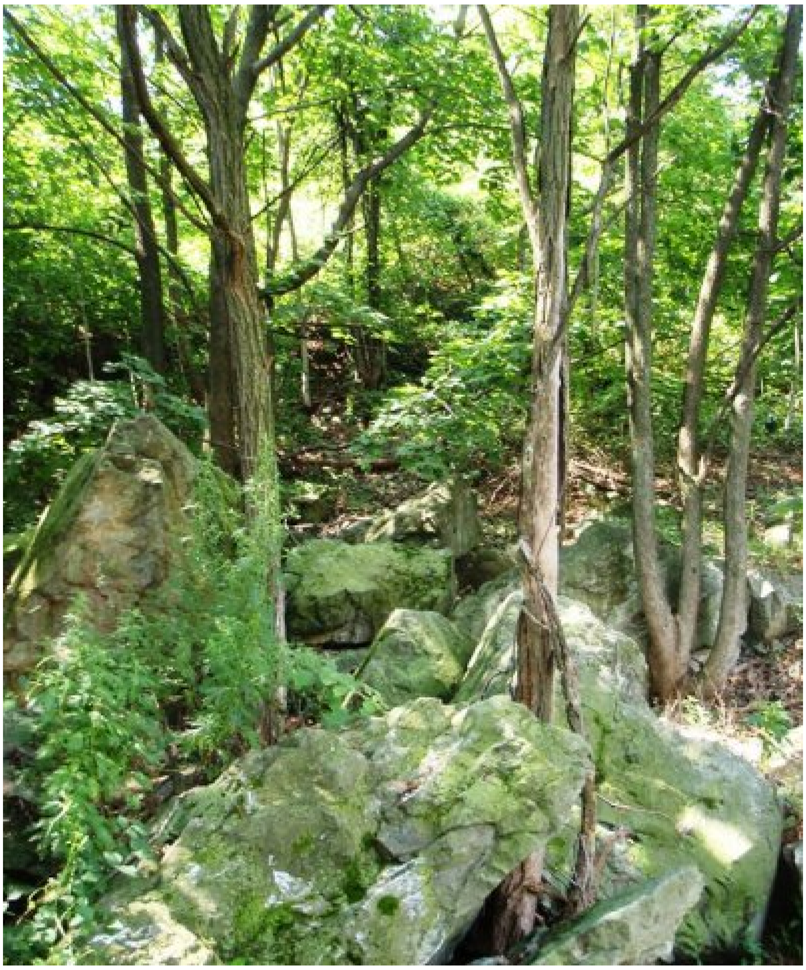


Figure 18. Invasive Woodlands, VanDuzer/Grymes Hill

The serpentine invasive woodland/forest community phase is warranted based on the ubiquity of invasive plants on Staten Island (Robinson et al., 1994). The dominant invasive trees are black locust (Robina pseuodacacia) and tree of heaven (*Ailanthus altissima*). Other non-native trees include silk tree or mimosa (*Albizia julibrissin*) and princesstree (*Paulownia tomentosa*). Often, due to the disturbance history of these sites, other native trees are more commonly early successional species such as gray birch (*Betula populifolia*), quaking aspen (*Populus tremuloides*), and sassafras (*Sassafras albidum*) albeit, oaks (Quercus spp.) also occur. Other non-natives include multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), Oriental bittersweet (*Celastrus orbiculatus*), Japanese honeysuckle (*Lonicera japonica*), and common wormwood/mugwort (*Artemisia vulgaris*). Collecting biomass, tree cores, or vouchers was not allowed on conservation lands. Main Photo: Invasive Woodlands on serpentinite bedrock/rubble feature at VanDuzer/Grymes Hill (Jacob Isleib, 7/27/2012).

Forest overstory. The forest canopy trees are typically black locust (Robina pseuodacacia), or tree of heaven (Ailanthus altissima).

Forest understory. Understory is often dominated by low shrubs such as the invasive honeysuckles (Lonicera spp.) and Oriental bitterseet (Celatrus orbiculatus), but may include coccasional herbs and grases, found im the serpentine woods.

Table 14. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	–	–
>0.15 <= 0.3	–	–	–	–
>0.3 <= 0.6	–	1-5%	2-2%	39-39%
>0.6 <= 1.4	1-2%	2-5%	1-1%	–
>1.4 <= 4	1-5%	–	–	–
>4 <= 12	80-80%	–	–	–
>12 <= 24	5-5%	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 2.1A
Community 2.1 to 2.2

Common wormwood (Artemisia vulgaris)

Honeysuckle(s) - Oriental bittersweet (Lonicera spp. - Celastris orbiculatis)

Lack of fire, fire suppression or management enables woody plant invasion and eventual conversion to shrubland or forest phases.

Pathway 2.2B
Community 2.2 to 2.1

Honeysuckle(s) - Oriental bittersweet (Lonicera spp. - Celastris orbiculatis)

Common wormwood (Artemisia vulgaris)

Loss, removal, or control of woody plants can permit the establishment of an invasive grassland phase.

Pathway 2.2A
Community 2.2 to 2.3

Honeysuckle(s) - Oriental bittersweet (Lonicera spp. - Celastris orbiculatis)

Black locust - Tree of heaven (Robinia pseudoacacia - Ailanthus altissima)

Fire suppression and lack of woody plant control can lead to further invasive woody plant development and conversion to a closed-canopy forest phase.

Pathway 2.3A
Community 2.3 to 2.1

Black locust - Tree of heaven (Robinia pseudoacacia - Ailanthus altissima)

Common wormwood (Artemisia vulgaris)

Total loss, removal, and control of all woody plants by wildfire, prescribed burn, and selective herbicides can revert the vegetation type to an invasive grassland phase.

Conservation practices

Prescribed Burning
Wetland Wildlife Habitat Management
Record Keeping
Invasive Plant Species Control
Herbaceous Weed Control

Pathway 2.3B
Community 2.3 to 2.2

Black locust - Tree of heaven (Robinia pseudoacacia - Ailanthus altissima)

Honeysuckle(s) - Oriental bittersweet (Lonicera spp. - Celastris orbiculatis)

Removal or control of the tree canopy by natural means such as windstorms or wildfire or active management using prescribed burning, cutting, and selective herbiciding can revert the site back to a predominately shrubland phase dominated by invasive plants.

Conservation practices

Prescribed Burning
Restoration and Management of Rare and Declining Habitats
Upland Wildlife Habitat Management
Record Keeping
Invasive Plant Species Control

State 3
Excavated Barrens State

The serpentine barrens at Staten Island exist only as localized, highly modified sites created by excavation and topsoil removal or deposition of excavated spoils. However, due to the strong serpentine influence, open barrens sites are also of significant conservation focus by efforts to protect rare species (NYNHP 2013). Furthermore, the poor nature of the soils may limit the incidence of invasive species.

Community 3.1
Little bluestem – White heath aster (Schizachyrium scoparium – Symphyotrichum ericoides)

Figure 19. Excavated serpentine barrens, VanDuzer and Grymes Hill

Figure 20. Serpentinite bedrock, stones, and cobble, VanDuzer/Grymes Hill

Figure 21. Dedicated conservation lands, VanDuzer/Grymes Hill

Serpentine barrens occur exclusively on areas of serpentine rubble or bedrock lacking any appreciable developed soil. These sites are very open, less than 25 percent vegetated, and exhibit generally xeromorphic conditions. Characteristic plant species of the serpentine barren, including some of the plants already common to serpentine grasslands, include scattered patches of little bluestem (*Schizachyrium scoparium*), roundhead bushclover (*Lespedeza capitata*), white heath aster (*Symphyotrichum ericoides*), calico aster (*Symphyotrichum lateriflorum*), white old-field aster (*Symphyotrichum pilosum*), smooth blue aster (Symphyotrichum leave), common mullein (*Verbascum thapsus*), Queen Anne’s lace (*Daucus carota*), green comet milkweed (*Asclepias viridiflora*), as well as, lace grass (*Eragrostis capillaris*), late thoroughwort (*Eupatorium serotinum*), Scribner's rosette grass (*Dichanthelium oligosanthes* ssp. scribnerianum), and butter and eggs (*Linaria vulgaris*). Additionally, scattered and isolated woody plants, such as Virginia creeper (Parthenicissus quinquefolia), northern bayberry (*Morella pensylvanica*), winged sumac (*Rhus copallinum* var. latifolia), fragrant sumac (Rhus aromatic), black cherry (*Prunus serotina*), and sassafras (*Sassafras albidum*) are included. Occasionally, non-native, invasive plants are found, such as young trees (less than 5 m in height) of black locust (*Robinia pseudoacacia*), tree of heaven (Alianthus altissima) and silk tree or mimosa (*Albizia julibrissin*) as well as infrequently herbs including common wormwod (*Artemisia vulgaris*), sweet autumn virginsbower (*Clematis terniflora*), meadow hawkweed (*Hieracium caespitosum*), and moth mullein (*Verbascum blattaria*). Collecting biomass, tree cores, or vouchers was not allowed on these conservation lands. Excavated serpentine barrens on serpentinite bedrock and rubble at VanDuzer and Grymes Hill (Jacob Isleib, 7/27/2012) .

Forest overstory. Asbent.

Forest understory. the excavated "barrens" state is sparsely vegetated.

Table 15. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	1%
Grass/grasslike basal cover	1%
Forb basal cover	1%

Non-vascular plants	0%
Biological crusts	0%
Litter	2%
Surface fragments >0.25" and <=3"	15%
Surface fragments >3"	30%
Bedrock	0%
Water	0%
Bare ground	50%

Table 16. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	1-1%	–
>0.15 <= 0.3	–	1-1%	1-1%	1-9%
>0.3 <= 0.6	–	2-3%	39-81%	3-13%
>0.6 <= 1.4	0-1%	2-8%	–	–
>1.4 <= 4	0-11%	0-2%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Transition T1A
State 1 to 2

Invasive species can eventually dominate and displace many native species. Due to the close proximity of urban and dense residential environments, the serpentine sites on Staten Island are subject to many disturbances like excessive trampling and dumping that would facilitate the invasion and establishment of invasive species.

Transition T1B
State 1 to 3

Land clearing on a localized scale removes all vegetation and topsoil and creates an artificial “barrens ” of exposed serpentinite bedrock and rubble. Localized deposition of excavated serpentine spoils similarly creates an artificial “barrens .” With the resident serpentine seed bank striped away or at least severely diminished, few plants get established and are typically scattered. (This situation is not common).

Restoration pathway R2A
State 2 to 1

All invasive plants are selectively removed by any single or combination of management practices such as cutting, pulling, and selective herbicide. Additional seed sowing or native planting is done to achieve the desired serpentine grassland phase.

Conservation practices

Brush Management
Prescribed Burning
Restoration and Management of Rare and Declining Habitats
Upland Wildlife Habitat Management

Record Keeping
Invasive Plant Species Control
Herbaceous Weed Control

Transition T2A
State 2 to 3

Land clearing on a localized scale removes all vegetation and topsoil and creates an artificial “barrens” of exposed serpentinite bedrock and rubble. Localized deposition of excavated serpentine spoils similarly creates an artificial “barrens.” With the resident serpentine seedbank stripped away or at least severely diminished, few plants get established and are typically scattered. (This situation is not common).

Transition T3A
State 3 to 1

If desired, physical soil establishment can be achieved with serpentine parent material and soil amendments (O’Dell and claassen 2009). Additional seed sowing and/or native planting is done to achieve the desired species composition. (This situation is rare.)

Additional community tables

Table 17. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	0.3–0.9	63–85
switchgrass	PAVI2	*Panicum virgatum*	Native	0.6–1.2	2–38
sweet vernalgrass	ANOD	*Anthoxanthum odoratum*	Introduced	0.3–0.6	1
Lindheimer panicgrass	DIACL	*Dichanthelium acuminatum var. lindheimeri*	Native	0.2–0.3	1
flat-top goldentop	EUGR5	*Euthamia graminifolia*	Native	0.3–0.6	1
rabbit-tobacco	PSOBO	*Pseudognaphalium obtusifolium ssp. obtusifolium*	Native	0.2–0.3	1
purple lovegrass	ERSP	*Eragrostis spectabilis*	Native	0.3–0.6	0.5
globe flatsedge	CYEC2	*Cyperus echinatus*	Native	0.3–0.6	0.5
Forb/Herb					
American pokeweed	PHAMA3	*Phytolacca americana var. americana*	Native	0.9–1.8	0–85
wrinkleleaf goldenrod	SORU2	*Solidago rugosa*	Native	0.6–1.2	1–18
common wormwood	ARVU	*Artemisia vulgaris*	Introduced	0.3–0.9	1–2
common mullein	VETH	*Verbascum thapsus*	Introduced	0.9–1.5	1–2
Queen Anne's lace	DACA6	*Daucus carota*	Introduced	0.3–0.6	1–2
Canada goldenrod	SOCA6	*Solidago canadensis*	Native	0.6–0.9	0.5–1
green comet milkweed	ASVI	*Asclepias viridiflora*	Native	0.3–0.6	1
annual ragweed	AMAR2	*Ambrosia artemisiifolia*	Native	0.3–0.6	1
white heath aster	SYERE	*Symphyotrichum ericoides var. ericoides*	Native	0.2–0.3	1
roundleaf thoroughwort	EUROO	*Eupatorium rotundifolium var. ovatum*	Native	0.3–0.6	1
roundhead lespedeza	LECA8	*Lespedeza capitata*	Native	0.3–0.6	1
sleepy silene	SIAN2	*Silene antirrhina*	Native	–	0.5
Shrub/Subshrub					
southern bayberry	MOCA7	*Morella caroliniensis*	Native	0.6–1.4	8–18
winged sumac	RHCOL2	*Rhus copallinum var. latifolia*	Native	1.4–4	7–18
winged sumac	RHCOL2	*Rhus copallinum var. latifolia*	Native	1.2–2.4	2–8
black locust	ROPS	*Robinia pseudoacacia*	Introduced	0.6–1.4	1–8
Japanese honeysuckle	LOJA	*Lonicera japonica*	Introduced	0.9–1.8	1–2
Japanese angelica tree	AREL8	*Aralia elata*	Introduced	–	0.5
Tree					
black locust	ROPS	*Robinia pseudoacacia*	Introduced	1.4–4	38
sassafras	SAAL5	*Sassafras albidum*	Native	1.2–4	1–2
black cherry	PRSES	*Prunus serotina var. serotina*	Native	0.6–1.4	1–2
hybrid oak	QUFI	*Quercus ×filialis*	Unknown	1.4–4	1
Vine/Liana					
Oriental bittersweet	CEOR7	*Celastrus orbiculatus*	Introduced	0.3–1.8	0.5

Table 18. Community 1.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	0.3–0.9	38–63
switchgrass	PAVI2	*Panicum virgatum*	Native	0.6–1.2	2–8
cypress panicgrass	DIDID	*Dichanthelium dichotomum var. dichotomum*	Native	0.2–0.3	4
flat-top goldentop	EUGR5	*Euthamia graminifolia*	Native	0.3–0.6	1–2
sweet vernalgrass	ANOD	*Anthoxanthum odoratum*	Introduced	0.3–0.6	1–2
rosette grass	DICHA2	*Dichanthelium*	Native	0.2–0.3	1
Indiangrass	SONU2	*Sorghastrum nutans*	Native	0.3–0.9	1
Forb/Herb					
panicledleaf ticktrefoil	DEPA6	*Desmodium paniculatum*	Native	0.2–0.3	1–7
gray goldenrod	SONE	*Solidago nemoralis*	Native	0.3–0.9	4
green comet milkweed	ASVI	*Asclepias viridiflora*	Native	0.3–0.6	4
roundleaf thoroughwort	EUROO	*Eupatorium rotundifolium var. ovatum*	Native	0.3–0.6	1–3
moth mullein	VEBL	*Verbascum blattaria*	Introduced	0.3–0.6	1–2
early goldenrod	SOJU	*Solidago juncea*	Native	0.3–1.2	1–2
annual ragweed	AMAR2	*Ambrosia artemisiifolia*	Native	0.3–0.6	1–2
Allegheny blackberry	RUAL	*Rubus allegheniensis*	Native	–	1–2
northern bayberry	MOPE6	*Morella pensylvanica*	Native	0.6–1.4	1–2
rabbit-tobacco	PSOBO	*Pseudognaphalium obtusifolium ssp. obtusifolium*	Native	–	1–2
dwarf cinquefoil	POCA17	*Potentilla canadensis*	Native	–	1
Canada goldenrod	SOCA6	*Solidago canadensis*	Native	–	1
Queen Anne's lace	DACA6	*Daucus carota*	Introduced	0.3–0.6	1
common mullein	VETH	*Verbascum thapsus*	Introduced	0.3–0.9	1
common wormwood	ARVU	*Artemisia vulgaris*	Introduced	0.3–0.9	0.5
Shrub/Subshrub					
gray birch	BEPO	*Betula populifolia*	Native	1.4–4	8–38
smooth sumac	RHGL	*Rhus glabra*	Native	1.4–4	18
winged sumac	RHCOL2	*Rhus copallinum var. latifolia*	Native	0.6–1.4	1–8
Japanese honeysuckle	LOJA	*Lonicera japonica*	Introduced	0.6–1.4	4
Tree					
bigtooth aspen	POGR4	*Populus grandidentata*	Native	1.4–4	1–38
tree of heaven	AIAL	*Ailanthus altissima*	Introduced	0.6–1.4	4
gray birch	BEPO	*Betula populifolia*	Native	0.6–1.4	4
sassafras	SAAL5	*Sassafras albidum*	Native	0.6–1.4	1

Table 19. Community 1.3 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
tuliptree	LITU	*Liriodendron tulipifera*	Native	9.1–15.2	7–85	25.4–29.2	–
sweetgum	LIST2	*Liquidambar styraciflua*	Native	4.6–15.2	1–85	17.8–61	–
black cherry	PRSES	*Prunus serotina var. serotina*	Native	7.6–12.8	40	25.4	–
sassafras	SAAL5	*Sassafras albidum*	Native	5.2–15.2	25–34	12.7–22.9	–
tree of heaven	AIAL	*Ailanthus altissima*	Introduced	6.1–15.2	1–8	43.2	–
sweetgum	LIST2	*Liquidambar styraciflua*	Native	4–7.6	1–8	10.2	–
scarlet oak	QUCO2	*Quercus coccinea*	Native	4.6–10.7	8	10.2	–
white oak	QUAL	*Quercus alba*	Native	3–4.9	1–8	–	–
scarlet oak	QUCO2	*Quercus coccinea*	Native	6.1–15.2	4–8	66	–
black oak	QUVE	*Quercus velutina*	Native	4.6–8.2	1–4	7.6–15.2	–
chestnut oak	QUMO4	*Quercus montana*	Native	3–4.9	1–4	–	–
tree of heaven	AIAL	*Ailanthus altissima*	Introduced	4–6.1	4	10.2	–
black cherry	PRSES	*Prunus serotina var. serotina*	Native	4–7.6	1–4	8.9–15.2	–
black oak	QUVE	*Quercus velutina*	Native	6.7–15.2	2	20.3	–

Table 20. Community 1.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
Indiangrass	SONU2	*Sorghastrum nutans*	Native	0.3–0.9	18
little bluestem	SCSC	*Schizachyrium scoparium*	Native	0.3–0.9	8
switchgrass	PAVI2	*Panicum virgatum*	Native	0.3–0.9	4
sweet vernalgrass	ANOD	*Anthoxanthum odoratum*	Introduced	0.3–0.6	4
Pennsylvania sedge	CAPE6	*Carex pensylvanica*	Native	0.2–0.3	1–2
Nepalese browntop	MIVI	*Microstegium vimineum*	Introduced	0–0.3	1
Lindheimer panicgrass	DIACL	*Dichanthelium acuminatum var. lindheimeri*	Native	0–0.3	1
deertongue	DICL	*Dichanthelium clandestinum*	Native	0.3–0.6	0.5
Forb/Herb					
feathery false lily of the valley	MARAR	*Maianthemum racemosum ssp. racemosum*	Native	0.2–0.3	1–8
Allegheny blackberry	RUAL	*Rubus allegheniensis*	Native	0.3–0.9	1–4
wine raspberry	RUPH	*Rubus phoenicolasius*	Introduced	–	1–4
common wormwood	ARVU	*Artemisia vulgaris*	Introduced	0.3–0.9	1
white wood aster	EUDI16	*Eurybia divaricata*	Native	0.2–0.3	1
roundleaf thoroughwort	EUROO	*Eupatorium rotundifolium var. ovatum*	Native	0.3–0.6	1
Shrub/Subshrub					
Japanese angelica tree	AREL8	*Aralia elata*	Introduced	0.6–1.4	7–40
northern spicebush	LIBE3	*Lindera benzoin*	Native	0.6–4	8–18
multiflora rose	ROMU	*Rosa multiflora*	Introduced	0.6–4	1–8
southern bayberry	MOCA7	*Morella caroliniensis*	Native	0.6–4	4
black huckleberry	GABA	*Gaylussacia baccata*	Native	0.6–1.4	1–2
Blue Ridge blueberry	VAPA4	*Vaccinium pallidum*	Native	0.2–0.3	1–2
Tree					
gray birch	BEPO	*Betula populifolia*	Native	0.6–4	3–18
black locust	ROPS	*Robinia pseudoacacia*	Introduced	1.4–4	1–8
black cherry	PRSES	*Prunus serotina var. serotina*	Native	0.6–4	1–8
willow oak	QUPH	*Quercus phellos*	Native	1.4–4	1
willow oak	QUPH	*Quercus phellos*	Native	1.4–4	1
Vine/Liana					
eastern poison ivy	TORA2	*Toxicodendron radicans*	Native	0–0.6	1–8
Oriental bittersweet	CEOR7	*Celastrus orbiculatus*	Introduced	0–4	1–8
Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	Native	0.2–0.6	2–5
eastern poison ivy	TORA2	*Toxicodendron radicans*	Native	0.6–4	1–4
Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	Native	0.6–1.4	1–2

Table 21. Community 2.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Forb/Herb					
common wormwood	ARVU	*Artemisia vulgaris*	Introduced	0.3–0.9	62
American pokeweed	PHAMA3	*Phytolacca americana var. americana*	Native	0.3–0.9	12
common mullein	VETH	*Verbascum thapsus*	Introduced	0.3–0.9	1

Table 22. Community 2.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	0.3–0.9	8
switchgrass	PAVI2	*Panicum virgatum*	Native	0.3–0.9	3
Forb/Herb					
common wormwood	ARVU	*Artemisia vulgaris*	Introduced	0.3–0.9	12
horseflyweed	BATI	*Baptisia tinctoria*	Native	0.3–0.6	1
Shrub/Subshrub					
smooth sumac	RHGL	*Rhus glabra*	Native	0.9–1.8	3
Morrow's honeysuckle	LOMO2	*Lonicera morrowii*	Introduced	0.9–1.8	1
Tree					
silktree	ALJU	*Albizia julibrissin*	Introduced	0.9–1.8	1
Vine/Liana					
Oriental bittersweet	CEOR7	*Celastrus orbiculatus*	Introduced	0.3–0.9	8
eastern poison ivy	TORA2	*Toxicodendron radicans*	Introduced	0.3–0.9	3

Table 23. Community 2.3 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
black locust	ROPS	*Robinia pseudoacacia*	Introduced	3.7–7.6	70	–	–
black cherry	PRSES	*Prunus serotina var. serotina*	Native	3.7–5.5	5	–	–
sassafras	SAAL5	*Sassafras albidum*	Native	3.7–7.6	3	–	–
princesstree	PATO2	*Paulownia tomentosa*	Introduced	10.7–15.2	2	–	–
tree of heaven	AIAL	*Ailanthus altissima*	Introduced	4.6–9.1	1	–	–
willow oak	QUPH	*Quercus phellos*	Native	2.4–4.9	1	–	–

Table 24. Community 2.3 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
common reed	PHAU7	*Phragmites australis*	Introduced	0.9–1.8	1
Forb/Herb					
common wormwood	ARVU	*Artemisia vulgaris*	Introduced	0.3–0.9	37
Shrub/Subshrub					
multiflora rose	ROMU	*Rosa multiflora*	Introduced	0.9–1.8	2
Japanese honeysuckle	LOJA	*Lonicera japonica*	Introduced	0.3–0.9	2
Japanese barberry	BETH	*Berberis thunbergii*	Introduced	0.3–0.9	1
Tree					
silktree	ALJU	*Albizia julibrissin*	Introduced	0.9–1.8	1
black cherry	PRSES	*Prunus serotina var. serotina*	Native	0.9–1.8	1
Vine/Liana					
roundleaf greenbrier	SMRO	*Smilax rotundifolia*	Introduced	0.3–1.8	2
eastern poison ivy	TORA2	*Toxicodendron radicans*	Introduced	0.3–0.9	1
Oriental bittersweet	CEOR7	*Celastrus orbiculatus*	Introduced	0.3–0.9	1

Table 25. Community 3.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	0.3–0.6	38–63
switchgrass	PAVI2	*Panicum virgatum*	Native	0.3–0.6	18
common reed	PHAU7	*Phragmites australis*	Introduced	0.9–2.1	0.5–1
lace grass	ERCA	*Eragrostis capillaris*	Native	0.2–0.3	0.5
Forb/Herb					
meadow hawkweed	HICA10	*Hieracium caespitosum*	Introduced	0.2–0.3	1–2
common wormwood	ARVU	*Artemisia vulgaris*	Introduced	0.2–0.3	1–2
lateflowering thoroughwort	EUSE2	*Eupatorium serotinum*	Native	0.3–0.6	1–2
sweet autumn virginsbower	CLTE4	*Clematis terniflora*	Introduced	0.3–1.2	1
Queen Anne's lace	DACA6	*Daucus carota*	Introduced	0.2–0.3	1
butter and eggs	LIVU2	*Linaria vulgaris*	Introduced	0.2–0.3	1
smooth blue aster	SYLA3	*Symphyotrichum laeve*	Native	0.2–0.3	1
white heath aster	SYERE	*Symphyotrichum ericoides var. ericoides*	Native	0.2–0.3	1
moth mullein	VEBL	*Verbascum blattaria*	Introduced	0.3–0.6	0.5
sleepy silene	SIAN2	*Silene antirrhina*	Native	0.2–0.3	0.5
goldenrod	SOLID	*Solidago*	Native	0.3–0.6	0.5
green comet milkweed	ASVI	*Asclepias viridiflora*	Native	0.3–0.6	0.5
roundhead lespedeza	LECA8	*Lespedeza capitata*	Native	0.3–0.6	0.5
Shrub/Subshrub					
winged sumac	RHCOL2	*Rhus copallinum var. latifolia*	Native	0.6–1.4	1–8
southern bayberry	MOCA7	*Morella caroliniensis*	Native	0.6–1.4	1–4
fragrant sumac	RHAR4	*Rhus aromatica*	Native	0.6–1.4	1–2
winged sumac	RHCOL2	*Rhus copallinum var. latifolia*	Native	0.3–0.6	1
Tree					
black locust	ROPS	*Robinia pseudoacacia*	Introduced	1.5–2.4	38
tree of heaven	AIAL	*Ailanthus altissima*	Introduced	1.4–4	4–8
silktree	ALJU	*Albizia julibrissin*	Introduced	1.4–4	1–2
common hackberry	CEOC	*Celtis occidentalis*	Native	1.4–4	1–2
black cherry	PRSES	*Prunus serotina var. serotina*	Native	0.6–1.4	1–2
sassafras	SAAL5	*Sassafras albidum*	Native	1.4–4	1
black locust	ROPS	*Robinia pseudoacacia*	Introduced	1.4–4	1
sassafras	SAAL5	*Sassafras albidum*	Native	0.3–0.6	1
Vine/Liana					
eastern poison ivy	TORA2	*Toxicodendron radicans*	Native	0.3–0.6	1–2
Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	Native	0.2–0.3	1

Animal community

Serpentine sites on Staten Island are typically small and isolated. A few sites are embedded in a larger area of natural areas and parklands known as the “The Greenbelt.” Wildlife habitat of serpentine sites, when viewed in context with the larger setting of “The Greenbelt,” provides for a variety of common suburban wildlife, including mammals, birds, reptiles, amphibians, arthropods as well as a rich variety of plants. (http://www.nycgovparks.org/greening/wildlife). In fact, “The Greenbelt” at Staten Island is considered one of the most biologically diverse places in New York City.

Wildlife habitat specifically limited to the more open serpentine habitats, such as the grasslands and barrens have been identified as important habitat for Lepidoptera e.g., the Arogos skipper (Atrytone arogos) (Matteson and Roberts, 2010). Recommendations to conserve butterfly and moth species include maintaining the open sites free from human disturbance, assessing the status of host plants, and increase monitoring and management of Lepidoptera and associated habitats.

Hydrological functions

Serpentine Till Uplands are mapped well drained but tending to excessively drained in stony barren sites. Surface runoff is medium or high in most areas. Coarse-textured soils with high percolation may have lower surface runoff rates. The severity of runoff increases directly with slope, and shallowness to bedrock.

Recreational uses

Due to the conservation significance of serpentine sites, recreational uses are limited. Most of the exposed serpentine on Staten Island is located within the The Greenbelt. The Greenbelt consists of 2800 acres of natural areas and traditional parklands, most of which is available for passive recreation. An extensive system of six major hiking trails exist which traverse through the serpentine areas. Centrally located, the Greenbelt Nature Center is a hub for a wide variety of activities and programs relating to The Greenbelt history, geography, flora, and fauna. Serpentine Art and Nature Commons manages an 11.5 acre serpentine site as a natural area on the slopes of Gryme Hill: open to hiking, schools, and interested groups.

Wood products

None.

Other products

None.

Other information

Conservation Measures

The serpentine till upland ecological sites on Staten Island are a small part of a limited and narrow, discontinuous band of a few disjoint serpentine sites located along the eastern edge of the Appalachian mountain system (Brooks, 1987). Due to the unusual nature of serpentine soils, the “serpentine syndrome” (Jenny, 1980), the associated flora and fauna include a large number of unique and uncommon species, which for several decades have become imperiled as a result of human disturbance. Consequently, conservation measures are necessary to sustain these serpentine ecosystems as follows: (1) desired conditions, (2) threats, (3) conservation management and strategies, and (4) inventory and monitoring.

(1) Desired conditions:
Desired conditions are attributes considered essential to maintaining the ecological character of an ecological site.

(i) Protect and conserve (restore, maintain, and enhance) serpentine sites and landscape context. Protect existing and potential serpentine sites from further loss or degradation of habitat due to development, or habitat conversion due to lack of management. Follow conservation goals to sustain a suite of serpentine habitats, including the plant communities of high stewardship value and the imperiled flora and fauna.

(ii) Conserve serpentine plant communities of highest stewardship value and component species (New York Natural Heritage Program, 2013). Plant community conservation priorities are the more open vegetation forms: (i) the reference phase serpentine grassland: little bluestem–Indiangrass (*Schizachyrium scoparium–Sorghastrum nutans*), and (ii) the [excavated] serpentine barrens state: little bluestem –white heath aster (*Schizachyrium scoparium – Symphyotrichum ericoides*. Secure serpentine species composition and richness, and address “focal”

species issues of conservation status as well as invasive species. Secure populations of serpentine species of conservation status known to be present:
o green comet milkweed (*Asclepias viridiflora*) [threatened],
o purple milkweed (*Asclepias purpurascens*) [listed and ranked but unprotected],
o globose flatsedge (*Cyperus echinatus*) [endangered],
o velvet panic grass (*Dichanthelium scoparium*) [endangered].
Also, consider securing populations of serpentine species of conservation interest formerly present and consider translocation of populations of species at peril from similar serpentine sites, in consideration of future climate change scenarios.

(iii) Maintain or emulate ecosystem processes and patch dynamics. Historically, periodic, almost regular disturbances, such as fire and drought were necessary to maintain the mosaic of open and nutrient-poor character of serpentine sites as dynamic patches of habitat. Because a certain level of fire suppression is needed to provide for the safety of persons and property in the surrounding human settlements, the lack of fire has somewhat disrupted the cycle of serpentine patch dynamics. Without disturbance, the metapopulations of serpentine flora and associated fauna (especially lepidoptera) are extirpated without opportunities to return. Consequently, adaptive management practices are recommended to find alternatives to recreate the patchwork of open grasslands and barrens.

(2) Threats:
Threats to the upland till serpentine ecological sites are related to, and amplified by, the surrounding dense urban and suburban settlement of Staten Island (New York Natural Heritage Program, 2013). Principal threats include:

(i) Fire suppression and succession to woody overgrowth. Fire was the most important agent to maintain open, serpentine grassland habitats and to reduce organic matter accumulation at the soil surface. Hence, fire suppression has facilitated the succession of grasslands to woodlands at many locales. Large scale prescribed burns are unfeasible due to reasonable concerns over the safety of persons and property. Whether small, localized prescribed burns are effective or practical remains to be determined. Alternatives to fire may be tree cutting, land clearing, and removing biomass. Lack of fire also allows the accumulation of surface organic matter that increases the available water-holding capacity of the surface soils and nutrient availability and water-holding capacity to some degree.

(ii) Invasive and incursive species displacing native species. Invasive non-native plants and weedy incursive native plants displace native species and hasten succession to woody vegetation. The list is much longer, but the most problematic invasive species are: black locust (*Robinia pseudoacacia*), tree of heaven (*Ailanthus altissima*), multiflora rose (*Rosa multiflora*), Oriental bittersweet (*Celastrus orbiculatus*), *Aralia elata* (Japanese angelica tree), honeysuckles (Lonicera spp.), and common wormwood (*Artemisia vulgaris*).

(iii) Human disturbances, human-transported material, and off-trail impacts. Surrounded by dense urban and suburban settlements, the natural areas surrounding the serpentine sites are, unfortunately, used as dumping grounds. Much of the natural areas, especially The Greenbelt, are heavily used recreation areas, subject to human disturbances, such as off-trail biking and hiking that negatively impact the serpentine habitat.

(iv) Critically low or lost populations of conservation species associated with habitat decline. Habitat loss or decline is especially serious for the small isolated patches of open serpentine sites on Staten Island. The risk of extirpation (localized extinction) increases with shrinking available habitat. Extirpation of much of the serpentine flora has already happened (Reed, 1986). Large numbers of extirpated flora and precariously small numbers of remaining species warrant a comprehensive plant species reintroduction plan.

(v) Climate change scenario. Climate change in New England is trending toward extremes. Even with higher temperatures, greater droughtiness, and more severe and frequent precipitation events, the open, grassland and barren serpentine sites are expected to be somewhat resilient. Higher temperatures may lead to greater decomposition and hence less net organic matter accumulation. With more frequent droughts to stress woody plants, and less stress-tolerant invasives, serpentine grasslands and barrens would be better able to resist forest invasion. Also, with more frequent and severe precipitation, greater localized soil erosion will keep sites more open as desired.

(3) Conservation management strategies:
Improve the ecological conditions conducive to serpentine sites:

(i) Limit or control human access to sensitive areas. Much of the serpentine areas such as The Greenbelt and Serpentine Arts and Nature Commons are already enclosed with fencing, so additional fencing may be locally limited, if warranted. Due to maintenance and aesthetic issues, structural enclosures are, at best, considered as a last resort. Clearly designating and marking approved trails and closing unwanted social trails can effectively reduce human disturbances. Redirecting trails to avoid crossing sensitive areas or at least limiting trails to the periphery is desirable. Outreach opportunities exist through local conservation organizations, such as The Greenbelt Nature Center and the Serpentine Arts and Nature Commons, to foster a cult of responsibility aspired to protect and conserve serpentine sites.

(ii) Control invasive and incursive species (New York Natural Heritage Program, 2013). Because of the close proximity of serpentine sites to urban and suburban settlement as sources of plant propagules, the issue of aggressive non-native invasive plants and incursive native plants will always be a chronic problem. An invasive species management plan should address species-specific treatments. For example, root-sprouting woody plants such as black locust (*Robinia pseudoacacia*) and tree of heaven (*Ailanthus altissima*) are typically left intact and treated with a basal bark herbicide application to prevent suckering. Broadcast herbiciding is not recommended to avoid non-target, and sensitive plant species.

(iii) Mechanically remove soil surface organic matter or add serpentine parent material. Invasive or incursive plants are especially problematic in sites with better fertility and water-holding capacity because of appreciable surface organic matter accumulation. This also holds true for sites where the serpentine residuum is mixed with overlying till that dilutes the serpentine nature of the soil. Removal of the top few centimeters of organic matter accumulation and soil will not only expose the serpentine substrate desired for restoration, but may also expose the buried the seed bank, a potential source of serpentine plants. It may also open the site up to plant invasion. Likewise, adding serpentine parent material to the topsoil will restore the serpentine character of the soils, desirable for restoration. It may also introduce additions to the seed bank with plants more characteristic of serpentine sites and invasive plants as well. Invasive plants and, more typical serpentine plants alike, will germinate in the first flush, but usually the characteristic serpentine plants are more likely to persist under the restored serpentine and droughty soil conditions. Seeding and planting desirable species is a further enhancement.

(iv) Conduct localized, low-intensity prescribed burns. Large scale prescribed burns are presently considered unfeasible on Staten Island due to concerns over the safety of persons and property. Localized low intensity burns using a propane torch wand such as a weed dragon can focus the burn on woody invasives and emerging woody shoots. Historically, wildfires were most likely during the growing season; the timing of localized burns should suit the management objectives. The frequency of torching and smoldering the organic matter or topsoil remains to be tested, but it may reduce organic matter and the surface seedbank where a flush of invasives is anticipated.

(v) Reintroduce and augment characteristic serpentine plant species (including host plants for Lepidoptera). Small, isolated, patchy habitats of serpentine grasslands and barrens of Staten Island have long suffered extirpations because of small metapopulations. Many of the serpentine plant species that were once present may be suitable for reintroduction. This mimics nature's reestablishment, except on a shorter time scale. Seed collection and banking conducted by the Greenbelt Native Plant Center can provide local genotypes as source materials. Seed sources may include other ex-situ conservation plant centers. Local genotypes may also be "rescued' from nearby serpentine patches on Staten Island or from nearby Pennsylvania. Furthermore, in light of pending climate change, and the disjointed nature of serpentine areas throughout the east coast, it follows that serpentine plants with more southern affinities may be transplanted to augment the existing serpentine flora of Staten Island and as a conservation measure to sustain the regional serpentine flora.

(vi) Establish and maintain native buffers. In designated natural areas, natural buffers are typically recommended to insulate more sensitive areas from human disturbance. Fortunately, much of the serpentine areas embedded in The Greenbelt are sufficiently buffered with vegetation, which must be managed to exclude invasive or incursive plant species.

4. Inventory, monitoring, and research are needed (New York Natural Heritage Program, 2013).
Determine the nature, status, and identity of entities associated with serpentine under conservation management:

e.g., soils, flora and fauna, vegetation.

The type and scope of inventory, monitoring, and research will be determined by the individual specific project objectives. The objectives may be, for example, a simple tally of plants or butterflies, or determining the effects of a specific management. Inventory, monitoring, and research designs and protocols are varied in scope and durations, and range from description to quantification using a wide range of technologies including GIS.

Inventory data references

The data contained in this document is derived from the analysis of field inventories (relevé plots and reconnaissance notes collected by MLRA Soil Survey Office 12-TOL with assistance from the NYC Greenbelt Native Plant Center, supplemented by plots data from NYSDEC-Natural Heritage Program), and literature interpretations (by MLRA Soil Survey Office 12-TOL), and communication with partners:
NYSDEC - New York Natural Heritage Program and
NYC Greenbelt Native Plant Center
New Jersey NRCS

Type locality

Location 1: Richmond County, NY	
Latitude	40° 35′ 18″
Longitude	-74° 7′ 50″
General legal description	Bloodroot/Seaview, near former Seaview Hospital in SI Greenbelt. Approx. one mile NNE from trailhead at Manor Rd. x Rockland Ave. Mosaic of vegetation phases ranging from grasslands, shrublands, woodlands.

Location 2: Richmond County, NY	
Latitude	40° 34′ 25″
Longitude	-74° 8′ 59″
General legal description	South LaTourette Park near golf course in SI Greenbelt. Aong southfacing slope approx. on-half mile east from trailhead at St. Andrews Church, Old Mill Rd. Mosaic of vegetation phases ranging from grasslands, shrublands, woodlands.

Other references

Alexander, E. 2009. Serpentine Geoecology of the Eastern and Southeastern Margins of North America. Northeast Naturalist, 16(Special Issue 5): 223–252. doi:http://dx.doi.org/10.1656/045.016.0518.

Arabas, K. B. 2000. Spatial and Temporal Relationships Among Fire Frequency, Vegetation, and Soil Depth in an Eastern North American Serpentine Barren. Journal of the Torrey Botanical Society, 127(1): 51–65.

Brady, K. U., Kruckeberg, A. R., & Bradshaw Jr., H. D. 2005. Evolutionary Ecology of Plant Adaptation to Serpentine Soils. Annual Review of Ecology, Evolution, and Systematics, 36(1): 243–266. doi:10.1146/annurev.ecolsys.35.021103.105730.

Bryce, S.A., G.E. Griffith, J.M. Omernik, G. Edinger, S. Indrick, O. Vargas, and D. Carlson. 2010. Ecoregions of New York (2-sided color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, VA. Scale 1:1,250,000.

Casper, B. B., & Castelli, J. P. 2007. Evaluating Plant–Soil Feedback Together with Competition in a Serpentine Grassland. Ecology Letters, 10: 394–400.

Crosby, W. O. 1914. Physiographic Relations of Serpentine, with Special Reference to the Serpentine Stock of Staten Island NY. Journal of Geology, 22(6): 582–593.

Day, G. M. 1953. The Indian as an Ecological Factor in the Northeastern Forest. Ecology, 34(2): 329–346.

doi:10.2307/1930900.

Dearden, P. 1979. Some Factors Influencing the Composition and Location of Plant Communities on a Serpentine. Journal of Biogeography, 6(1): 93–104.

DeGaetano, Arthur T. 1999. A Temporal Comparison of Drought Impacts and Responses in the New York City Metropolitan Area. Climatic Change 42.3: 539-560.

Federal Geographic Data Committee. 2008. National Vegetation Classification, version 2. FGDC-STD-005-2008 (Version 2).
http://usnvc.org/.

Fenneman, N. M., & Johnson, D. W. 1946. Physical divisions of the United States: US Geological Survey map prepared in cooperation with the Physiographic Commission. US Geological Survey, scale, 1(700,000).

Haegele, E., & Willig, S. 2011. Unionville Serpentine Barrens: Analyzing the Relationship Between Soil Profiles and Forest Succession Rate. University of Pennsylvania, Department of Earth and Environmental Science, Philadelphia. http://repository.upenn.edu/mes_capstones/42

Harrison, S. 1999. Local and Regional Diversity in a Patchy Landscape: Native, Alien, and Endemic Herbs on Serpentine. Ecology, 80(1): 70–80.

Harshberger, J. W. 1903. The Flora of the Serpentine Barrens of Southeast Pennsylvania. Science, 18(454): 339–343.

Hart, R. 1980. The Coexistence of Weeds and Restricted Native Plants on Serpentine Barrens in Southeastern Pennsylvania. Ecology: 61(3): 688–701.

Jarrell, J. D., Hebert, P. J., & Mayfield, M. 2010. Hurricane Experience Levels of Coastal County Populations from Texas to Maine [data file, updated February 4, 2010] (NWS NHC 46). Retrieved from http://www.nhc.noaa.gov/ms-excel/HurricaneStrikes_20100204.xls

Jennings, M. D., Faber-Langendoen, D., Loucks, O. L., Peet, R. K., & Roberts, D. 2009. Standards for Associations and Alliances of the U.S. National Vegetation Classification. Ecological Monographs, 79(2): 173–199.

Jenny, H. 1980. The Soils Resource: Origin and Behavior. Ecological Studies, 37: (256-259).

Knox, R. G. 1984. Age Structure of Forests on Soldier’s Delight, a Maryland Serpentine Area. Bulletin of the Torrey Botanical Club, 111(4): 498–501.

Knutson, Thomas R. et al. 2010. “Tropical Cyclones and Climate Change.” Nature Geosci 3.3. (pp. 157-163.

Latham, R. 1993. The Serpentine Barrens of Temperate Eastern North America: Critical Issues in the Management of Rare Species and Communities. Bartonia, 57(Symposium on Rare Plants of Pennsylvania and Adjacent States): pp. 61–74.

Latham, R. 2005. Protecting the Unionville Barrens - Biological, Historical and Value Considerations, 30.

Latham, R., & Thorne, J. F. 2010. Understanding Successional Pathways to Conserve Serpentine Grasslands. Retrieved from www.continentalconservation.us

Leng, C. W., & Davis, W. T. 1933. Staten Island and Its History, 1609-1929. (Vol. 5). Lewis historical Publishing Company.

Levine, M. E., & Greller, A. M. 2004. Ecological and Floristic Analyses of Vascular Plants Along a Gradient on Disturbed Serpentinite on Opposing Slopes in Staten Island, NY. Journal of the Torrey Botanical Society, 131(1): 69–92.

Lookingbill, T. R., Engelhardt, K. A., Florkowski, L. N., Churchill, J. B., & Ashley, L. J. 2007. Evaluation of the Nottingham Park Serpentine Barrens, Chester County, PA, 54.

Mansberg, L., & Wentworth, T. 1984. Vegetation and Soils of a Serpentine Barren in Western North Carolina. Bulletin of the Torrey Botanical Club, 111(3): pp. 272–286.

Marx, E. (2007). Vegetation Dynamics of the Buck Creek Serpentine Barrens, Clay County, North Carolina. University of North Carolina at Chapel Hill.

Marye, W. B. 1955a. The Great Maryland Barrens I. Maryland Historical Magazine, 50(1): 11–23.

Marye, W. B. 1955b. The Great Maryland Barrens II. Maryland Historical Magazine, 50(2): 120–142.

Marye, W. B. 1955c. The Great Maryland Barrens III. Maryland Historical Magazine, 50(3): 234–253.

Matteson, K.C. and N. Roberts. 2010. Diversity and conservation of butterflies in the New York City metropolitan area. Cities and the Environment. 3(1):poster 18. http://escholarship.bc.edu/cate/vol3/iss1/18.

Miller, G. L. 1981. Secondary Succession Following Fire on a Serpentine Barren. Proceedings of the Pennsylvania Academy of Science, 55: 62–64.

New York City Office of Emergency Management). 2009. New York City Natural Hazard Mitigation Plan. Retrieved from http://www.nyc.gov/html/oem/downloads/pdf/hazard_mitigation/section_3g_drought_hazard_analysis.pdf.

New York Natural Heritage Program. 2013. Online Conservation Guide to Serpentine Barrens. Retrieved November 28, 2012, from http://http://www.acris.nynhp.org/guide.php?id=9950.

NOAA National Weather Service. May 31, 2013.). Tropical Cyclone Climatology. Retrieved August 7, 2013, from http://www.nhc.noaa.gov/climo/#returns.

O'Dell, R. E., & Claassen, V. P. 2009. Serpentine Re-vegetation: a Review. Northeastern Naturalist:16(5): 253–271.

Pennell, F. W. 1910. Flora of the Conowingo Barrens of Southeastern Pennsylvania. Proceedings of the Academy of Natural Sciences of Philadelphia Academy of Natural Sciences, 62(3): 541–584.

Pennell, F. W. 1912. Further Notes on the Flora of the Conowingo or Serpentine Barrens of Southeastern Pennsylvania. Proceedings of the Academy of Natural Sciences of Philadelphia Academy of Natural Sciences, 64(3): 520–539.

Rabenhorst, M. C., & Foss, J. E. 1981. Soil and Geologic Mapping Over Mafic and Ultramafic Parent Materials in Maryland. Soil Science Society of America Journal, 45: 1157–1160.

Rabenhorst, M. C., Foss, J. E., & Fanning, D. S. 1982. Genesis of Maryland Soils Formed from Serpentinite. Soil Science Society of American Journal: 46, 607–616.

Rajakaruna, N., Harris, T. B., & Alexander, E. B. 2009. Serpentine Geoecology of Eastern North America: A Review. Rhodora, 111(945): 21–108.

Reed, C. F. 1986. Floras of Serpentinite Formations in Eastern North America, with descriptions of geomorphology and minerology of the formations. Baltimore, MD: Reed Herbarium.

Robinson, G. R., Yurlina, M. E., & Handel, S. N. 1994. A Century of Change in the Staten Island Flora: Ecological Correlates of Species Losses and Invasions. Bulletin of the Torrey Botanical Club, 121(2): 119–129.

Soren, J. 1988. Geologic and Geohydrologic Reconnaissance of Staten Island, New York (Water Resources Investigation Report No. ; scale 1:41700). United States Geological Survey.

Tyndall, R. Wayne. 1992a. Herbaceous Layer Vegetation on Maryland Serpentine. Castanea, 57(4): 264-272.

Tyndall, R. Wayne. 1992b. Historical Considerations of Conifer Expansion in Maryland Serpentine “Barrens.” Castanea, 57(2): 123-131.

Tyndall, R. Wayne. 2005. Twelve Years of Herbaceous Vegetation Change in Oak Savanna Habitat on a Maryland Serpentine Barren after Virginia Pine Removal. Castanea, 70(4): 287-297.

Tyndall, R.W., & Farr, P. M. 1989. Vegetation Structure and Flora of a Serpentine Pine-Cedar Savanna in Maryland. Castanea, 54(3): 191-199.

Tyndall, R.W., & Farr, P. M. 1990. Vegetation and Flora of the Pilot Serpentine Area in Maryland. Castanea, 55(4): 259-265.

Tyndall, R.W., & Hull, J. C. 1999. 4. Vegetation, Flora, and Plant Physiological Ecology of Serpentine Barrens of Eastern North America. In R. C. Anderson, J. S. Fralish, & J. M. Baskin (Eds.), Savannas, Barrens, and Rock Outcrop Plant Communities of North America (pp. 67–82). Cambridge University Press.

Tyndall, R.Wayne. 1994. Conifer Clearing and Prescribed Burning Effects to Herbaceous Layer Vegetation on a Maryland Serpentine “Barren.” Castanea, 59(3): 255 273.

Tyndall, W. R. 2012. Soil Differences Between Extant Serpentine Oak Savanna and Grassland in Soldiers Delight Natural Environment Area, Maryland. Castanea, 77(3): 224–230.

US Federal Geographic Data Committee. 2008. National Vegetation Classification Standard, Version 2. FGDC Document number FGDC-STD-005-2008. Washington, DC.

Wherry, E. T. 1963. Some Pennsylvania Barrens and their Flora. I. Serpentine. Bartonia, 33: 7–11.

Whittaker, R. H. 1954. The Ecology of Serpentine Soils. Ecology, 35(2): 258–288.

Willeke, G., J. R. M. Hosking, J. R. Wallis, and N. B. Guttman. 1994. The National Drought Atlas. Institute for Water Resources [CD ROM]. Rep. 94-NDS-4, U. S. Army Corps of Engineers.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Official Soil Series Descriptions. Available online at http://soils.usda.gov/technical/classification/osd/index.html. Accessed [06/26/2013].

Approval

Nels Barrett, 1/13/2020

Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	Nels Barrett, Ph.D.
Contact for lead author	Nels Barrett, Ph.D.
Date	08/13/2013
Approved by	Nels Barrett
Approval date	

Composition (Indicators 10 and 12) based on	Foliar Cover

Indicators

1. **Number and extent of rills:** Rills are uncommon due to the rocky nature of the site.

2. **Presence of water flow patterns:** Water infiltrates rapidly due to the rocky nature of the site.

3. **Number and height of erosional pedestals or terracettes:** n/a

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Large areas of bare ground exist in the sparsely vegetated, excavated barrens and also to a limited extent under the dense canopy of woody shrubs of low stature.

5. **Number of gullies and erosion associated with gullies:** n/a

6. **Extent of wind scoured, blowouts and/or depositional areas:** n/a

7. **Amount of litter movement (describe size and distance expected to travel):** minimal where litter is sparse otherwise litter movement unknown.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Resistance high due to the rocky nature of the soil surface; lower resistance in areas of steeper slopes.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** A horizon weak to medium granular structure; 10YR3/2; SOM 9 -12 % in A Horizon; thickness 4 to 18 cm.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Variable effects - directly related to plant densities and slopes. However, low effects due to the rocky nature of the soil

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** none.

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

Dominant: SCSC *Schizachyrium scoparium* little bluestem

Sub-dominant: SONU2 *Sorghastrum nutans* Indiangrass

Other: PAVI *Panicum virgatum* switchgrass

Additional:

---

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** unknown.

---

14. **Average percent litter cover (%) and depth (in):** unknown

---

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** unknown; destructive sampling prohibited on conservation lands

---

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** ACPL Acer platanoides Norway maple
AIAL *Ailanthus altissima* tree of heaven
ALJU *Albizia julibrissin* silktree / mimosa
BETH *Berberis thunbergii* Japanese barberry
CEOR7 *Celastrus orbiculatus* Oriental bitterwseet
ROPS *Robinia pseudoacacia* black locust
AREL8 *Aralia elata* Japanese angelica tree
ROMU *Rosa multiflora* multiflora rose
EUAL13 Euonymus alatus winged spindletree
FAJA2 Fallopia japonica Japanese knotweed
FRAL4 Frangula alnus glossy buckthorn
LOJA *Lonicera japonica* Japanese honeysuckle
LOMO2 *Lonicera morrowii* Morrow""s honeysuckle
RUAL *Rubus allegheniensis* Allegheny blackberry
ARVU *Artemisia vulgaris* mugwort, common wormwood
MIVI Microstegium vimineum Japanese stiltgrass
PHAU7 Phragmites australis var. australis common reed

---

17. **Perennial plant reproductive capability:** Variable. Reproduction limited in barren sites.
