MAINTAINING THE INTEGRITY OF THE LOW-ELEVATION GRANITIC-DOME COMMUNITIES OF CARL SANDBURG NATIONAL HISTORIC SITE

A Thesis
by
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ABSTRACT

MAINTAINING THE INTEGRITY OF THE LOW-ELEVATION GRANITIC-DOME COMMUNITIES OF CARL SANDBURG NATIONAL HISTORIC SITE

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A vegetational survey was conducted for the granitic rock-outcrop communities at Carl Sandburg National Historic Site (CARL). Low-elevation granitic domes within the boundaries of CARL have been recognized as a critical resource within the Park (Hart 1993, Johnson 2003, White 2003). This project was concerned with characterizing the plant communities that occur on the granitic domes at CARL, with an emphasis on their floristic composition, present and potential threats to community structure, and the age and structure of the encroaching forest matrix. This study was conducted to provide the baseline data needed to assist CARL management personnel in identifying damaged granitic domes, mitigating resource degradation associated with visitor use, preserving valuable outcrop resources, and directing the future management of this fragile community type.

A total of 21 low-elevation granitic domes were identified in the Park. Low-elevation granitic domes supported substantial floristic diversity. A large portion of this flora was not known to exist in the Park and 24 of these species were new reports for CARL. A GIS database was created to link spatial data with information about the species located at each outcrop. Major threats to the integrity of granitic-dome

communities that were identified during the course of this study were impacts from visitor use, the spread of invasive exotic plant species, and fire suppression activities. Accessible and frequently visited outcrops exhibited loss of vegetation, a change in species composition, and damage to soils. Invasive, exotic species were located on all granitic dome sites. I used an assessment model to rank the potential impact of invasive species and prioritize management actions. I analyzed the history and current age structure of trees associated with granitic-dome communities using dendrochronology. This approach provided baseline information on their current successional status and the communities' past relationship with fire. Low-elevation granitic-dome communities and their environs are of interest both because of their global rarity, and because they harbor a unique flora, which is often restricted wholly or essentially to granitic outcrop community types. The granitic domes of CARL contribute substantially to biodiversity both within the Park and regionally.

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INTRODUCTION

Granitic domes in the Southeastern United States have fascinated botanists over the past 200 years. Early botanists recognized that granitic domes in the Appalachians supported an anomalous flora (Burbank and Phillips 1983). There are few community types in the southern Appalachians that have so many rare or otherwise uncommon species growing together (White 2003). Outcrop-restricted species are adapted to the extreme environmental conditions that are common on exposed bedrock. As a consequence of the disjunct distribution of these extreme microenvironments, low-elevation granitic domes support a high level of rare and often endemic xerophytic vegetation in a region of abundant rainfall and high primary productivity (Shure 1999). In addition, many of the globally stable species that occur on the low-elevation granitic domes of Carl Sandburg National Historic Site (CARL) are uncommon in the local landscape. Occurrence of these abrupt and azonal communities contributes substantially to regional floristic diversity and is extremely valuable to the scientific community as well as the general public. The National Vegetation Classification System (Grossman et al. 1998) describes these special areas with a rarity rating of G-2. Low-elevation granitic dome communities are at a high risk of elimination due to their very restricted range and intrinsic vulnerability.

This paper examines the ecological significance of low-elevation granitic dome communities located at Carl Sandburg National Historic Site in relation to current information on granitic-rock outcrops scattered throughout the southern Appalachians. This information is used to (a) interpret the quality of these communities; (b) infer the potential future impacts of increased visitor use; (c) monitor the spread of invasive exotic species; and (d) determine the impact of fire suppression activities on the structure and integrity of low-elevation granitic-dome communities in the Park.

Granitic domes occur sporadically through the Blue Ridge and Piedmont provinces of Virginia, North Carolina, Georgia and Alabama. In the southern Appalachians the distribution of granitic-rock outcrops, and the communities that inhabit them, is determined by the distribution of erosion-resistant bedrock, the extent of geomorphic processes, and natural disturbances that maintain them as open habitats (Wiser et al. 1996). Fire, drought, windthrow, and spalling of vegetative mats have been described as important sources of natural disturbance (Whitehouse 1933, Oosting and Anderson 1939, Burbank and Phillips 1983, Houle 1990).

Granitic-dome communities are separated from other outcrop community types by occurring on massive, exfoliating rock with few crevices or irregularities containing soil. Granitic-dome ecogroups are distinguished by differences in vegetation and elevation. However, some overlap does occur. The elevational boundary that separates high-elevation granitic domes from low-elevation granitic domes occurs around 915 m (3000 ft). Higher temperatures, lower rainfall, and less frequent fog make low-elevation granitic domes and flatrock communities much drier than high-elevation granitic domes (Schafale and Weakley 1990). Granitic domes are similar to granitic-flatrock communities and share many features of ecology, structure, and characteristic vegetation. Low-elevation granitic domes communities are supported on the “flat rock” of CARL for which the town is named (White 2003). However, granitic-flatrock communities are restricted to relatively flat terrain and occur more frequently in the Piedmont.

The flora of granitic domes of CARL has evolved and persisted for millennia despite constant drought, erosion, and infertility. In addition to vascular diversity the role of lichen and moss species richness is high. Conservative morphological and physical traits of plants on rock outcrops can be interpreted as adaptations for survival. The morphology of component species and the ecology of individual vascular plant species of rock outcrops are described as short-lived and desiccation tolerant (Matthews and Murdy 1969, Sharitz and McCormick 1973, Wyatt 1983). Compositional differences in vegetation have been strongly associated with sources of environmental stress common to these community types, including shallow, poorly-developed soils, extreme temperatures, a high temperature differential, and drought (Ware and Pinion 1990, Wiser et al. 1996). Some rock-outcrop communities in the Southeast have been described as "micro-environmental deserts" with life forms more similar to those found in Death Valley as compared to those within the relatively mesic macro-climatic area (Phillips 1982).

A major goal of ecology has been to understand the factors that influence the structure and diversity of natural communities. There is an extensive body of literature dealing with various aspects of granitic-outcrop community structure (Fry 1927, Oosting and Anderson 1939, McVaugh 1943, Burbank and Platt 1964, Johnson 1989, Wiser et al. 1996). Outcrops may vary locally with temperature-steepness gradients, micro-topography, geology, and fracture indices (Wiser et al. 1998). Differences in vegetation between rock faces with northerly and southerly aspects have been described (Oosting and Anderson 1937, Wiser et al. 1996, Smith 1998). In addition, vegetation within outcrop communities of a single bedrock type may correlate with site-scale characteristics of elevation and solar radiation (Wiser et al. 1996). Compositional differences in rock-outcrop community distributions have been associated with regional gradients of temperature and precipitation (Wiser et al. 1998, Ware and Pinion 1990, Schafale and Weakley 1990).

Soil and edaphic properties within these habitats are poorly understood. In general soils are xeric and shallow. Erosion potential is high and the soils of granitic domes are highly sensitive to disturbance. Narrow soil belts surrounding granitic dome edges and similarly structured soil islands support the majority of the vascular flora. McVaugh (1943) described a flora of roughly 100 rock-outcrop-restricted species on granitic outcrops throughout the piedmont of North Carolina, South Carolina, and Georgia. Nearly half of McVaugh's (1943) endemic indicator species were found in the narrow transitional zone of vegetation that formed the border between the outcrops and the surrounding forest matrix. Burbank and Platt (1964) concentrated on soil-island communities that occupied depressions within granitic flatrocks. Floral composition was relatively diverse and even and comprised nearly 50% of the total outcrop flora. However, they reported a substantially lower level of outcrop-restricted species.

Because granite is generally massive, the hydrology of granitic domes is highly variable both spatially and temporally. Deep crevices and seepage zones do occur. A striking contrast within the herb layer surrounding these microsites is the juxtaposition of both xerophytic and mesophytic species. It is not uncommon to find highly drought-tolerant species like *Hypericum gentianoides* and *Talinum teretifolium* growing near obligate wetland species such as *Sphagnum inundatum* or *Spiranthes cernua.* Seepage zones often occur at the forested edges of rock outcrops or at the base of soil islands where soil water emerges onto the rock. They rarely occupy large portions of rock outcrops.

Park History

The Carl Sandburg National Historic Site is situated in the southern Blue Ridge Mountains in Henderson County, North Carolina, within the town of Flat Rock. Originally called Rock Hill by the estate's founder, Charles G. Memminger (1803-1888), the estate is centered in a famous pre-Civil War resort community in Western North Carolina. The Flat Rock area served as a summer refuge for many of the community's residents of Charleston who migrated there, to escape the "fever months" of June through October (Jones 2005).

In 1945 Carl Sandburg (1878-1967) and his wife Lillian (1883-1977) purchased the estate, which was then referred to as Connemara. Mr. and Mrs. Sandburg lived there from 1945 to 1969 along with their three daughters, Margaret, Janet, and Helga, as well as Helga's two children, John Carl and Karlen Paula. The Sandburgs immediately recognized the historical significance of the estate and maintained the estate's title as Connemara, a gesture that the community's residents appreciated (Hart 1993). The subsequent owner, Ellison Smyth, had renamed the estate Connemara in honor of the rugged pastoral landscape of quartzite and schist terrain on the West Coast of Ireland. For the Smyths the house was still mainly a place of retreat during summer months. However, like Rock Hill, Connemara was also a working farm. In addition, the Smyth's were responsible for several improvements on the property including the addition of Side Lake and the establishment of a trail to the open granitic dome at the summit of Big Glassy Mountain (Jones 2005).

The Sandburgs drew inspiration from the natural setting of Connemara. The 22 years that Carl Sandburg spent on the property represents one of his most influential periods as a poet, writer, historian, biographer, and musician. It was his home when he won the Pulitzer Prize in 1951 for his *Complete Poems*, and where nearly a third of his life's works were completed. For Lillian the open pastures and loamy soils on the lower hillside provided excellent browse and exercise for her champion Chikaming goat herd (Jones 2005).

After his death in October 1967, Lillian deeded the estate to the National Park Service (NPS). President Lyndon B. Johnson approved a congressional act making the home a historic site on October 18, 1968. After Lillian, Margaret, and Janet departed from the house in 1969 the estate was acquired by the Department of the Interior. The property was opened to the public by 1974 (Hart 1993, Jones 2005). Today the Carl Sandburg Home National Historic Site is dedicated to preserving the legacy of Carl Sandburg and communicating the significance of his storied life and work as a writer, historian, and social activist (NPS 2005). Several recent studies, however, emphasize the biological resources that the Park contains (Blaha et al. 1999, Johnson 2003, White 2003). Low-elevation granitic domes within the boundaries of CARL have been recognized as critical resources within the Park (Hart 1993, Johnson 2003, White 2003). The NPS operates under a dual mandate. In addition to maintaining the historic character of the Connemara Estate, protecting natural communities and maintaining biodiversity are primary management objectives (Johnson 2003).

Land History

Granitic rock is widely distributed throughout the continental crust of the Earth and is the most abundant basement rock that underlies the relatively thin sedimentary veneer of the continents (Turekian and Wedepohl 1961). Because granite is common and highly resistant to erosion the distribution of granitic-rock outcrops is cosmopolitan. However, despite being fairly common throughout the world, there are specific regions that have an abundance of granitic-rock outcroppings. Within the Appalachians their distribution is concentrated between North Carolina and eastern Alabama (McVaugh 1943, Houle and Phillips 1989).

The relatively high degree of endemism on low-elevation granitic domes suggests an extremely long-term habitation by plants that have been subject to speciation processes (McVaugh 1943, Murdy 1966). Mountain ranges, particularly those with high precipitation, were important in maintaining floristic communities through periods of changing climatic conditions associated with glacial cycles. Granitic-rock outcrops in the southern Appalachians played an important historical role as refugia for many species during paleo-climatic changes (McVaugh 1943, Dey 1978, Wiser et al. 1998). At the peak of the Wisconsin glaciations, the northern extent of many plant species in eastern North America was restricted to granitic-rock outcrops in the southern Appalachians (McVaugh 1943, Dey 1978, Wiser et al. 1998). The onset of the Holocene was characterized by accelerated warming across the region, as southern evergreen forests expanded northward and southward (Delcourt and Delcourt 1987). Northern migrations of plant species occurred rapidly as ice masses retreated, leaving distributions of woody plants similar to contemporary forests by the beginning of the Holocene epoch.

The endemic species that occupy present-day granitic-outcrop communities in the Southeastern United States occur either as Arcto-tertiary relicts or as emergences of new taxa from ancestors over these periods of isolation (Galloway 1996). Murdy (1968) stresses that most of the present endemic plant taxa evolved through adaptations to outcrop habitats rather than representing remnants of more widespread species that evolved elsewhere. In light of accepted theories about dispersal, genetic isolation, and speciation it is not surprising that these exceedingly insular communities support substantial levels of endemism (Shure 1999).

The evolution of plant communities in the Southeastern United States was greatly influenced by the arrival of aboriginal man to North America (Noss 1985, Delcourt and Delcourt 1987). Recent evidence from the Saltville archeological site in southwest Virginia suggests that humans were living in the southern Appalachians as early as 14,000 years ago (Davis 2006). These early Native Americans were hunter-gatherers who migrated from site to site, collecting and hunting food sources (Waldrop et al. 1992). Permanent Native American communities were established in the region around 10,000 years ago (Delcourt and Delcourt 1987). By this time the region supported a temperate climate rather than the previously boreal climate.

Recent research indicates that southeastern Indian populations were much larger than previously estimated (Waldrop et al. 1992). By the early 1700s the southern Appalachians supported a population of about 21,000 Native Americans from the Cherokee Nation, the largest aboriginal clan in the Southeast (Oswalt 1988). Granitic domes within the vicinity of Flat Rock are reported to have been important hunting grounds for the Cherokee (Johnson 2003), because of their high visibility and concentration of edge habitat. Research indicates that interactions of southeastern Native American populations with the ecosystem were more important than previously estimated, suggesting widespread use of fire for land clearing (DeVivo 1991, Waldrop et al. 1992, Williams 1994, Yarnell 1998). Primary and secondary accounts relate purposeful burning toward maintaining resource diversity, maximizing edge habitat, and maintenance of ecotone boundaries (Lewis 1985). This anthropogenic fire regime created variable patterns of fire frequency across the landscape, producing a mosaic of vegetation types and stand-ages (Buckner 1989). Granitic domes contributed naturally to this landscape heterogeneity. Although there is limited available evidence on specific land management activities of Native Americans, as a result of an accelerated fire regime granitic domes would have been maintained towards their maximum extent (Johnson 2003).

The Blue Ridge of North Carolina remained largely free of European settlement until 1800 (Yarnell 1998). European settlers began moving into the southern Appalachian region by the mid-1700s; however, the first settlements in the Flat Rock region were not established until the 1790s (Yarnell 1998, Jones 2005). The Cherokee were increasingly encouraged to move westward and in 1785 ceded the territory under the terms of the Treaty of Hopewell. Land grants began soon after with the earliest in the vicinity of Flat Rock coming in 1790 (Jones 2005).

Early European settlers practiced agricultural methods similar to those of the Native Americans. However, they introduced another practice that dramatically altered the landscape: livestock grazing (Pierce 2000). Fire was also used by European settlers but their practice differed in that fire was used to create a uniformity of habitats (Williams 1994). It was an important tool for improving livestock pasture on slopes and ridges, a practice referred to regionally as “greening the grass.” This process encouraged the growth of grasses and shoots for livestock consumption, while removing the underbrush that restricted livestock movement (Pierce 2000).

In 1800, the second Federal census enumerated nearly 11,000 people in what is now primarily Henderson and Buncombe County, many of them small farmers of Scotch-Irish descent (Jones 2005). The population of Henderson County, North Carolina continues to increase at a steady rate. U.S. Census Bureau (2008) statistics indicate approximately 28% growth between 1990 (69,285 residents) and 2000 (89,173). In the 2006 census the area’s population of 99,005 had already exceeded the population projection for the year 2015 (Hendersonville Chamber of Commerce 2000). Residential home development and land subdivision are associated with this growth. These present land-use changes are causing the landscape surrounding CARL to become suburban in nature. As a result of land-use impacts to rock outcrops outside the Park, the low-elevation granitic domes of CARL are becoming increasingly insular, rare, and unique.

Visitor Use Patterns

Along with regional population growth the number of visitors to the Park is increasing. Between January 1999 and December 1999, the National Park Service recorded over 50,000 visitors who participated in ranger or volunteer-led interpretive programs at CARL (NPS 2005). Two types of visitors generally use Park facilities: non-local visitors and local visitors. Non-local visitors typically focus their visits on the historic character of the Park and, in particular, on the main house, its historic furnishings, and the surrounding grounds. Local visitors appear to be Henderson County residents who use the trails for hiking (NPS 2003). Visitation estimates do not include local visitors using the trail system within the Park. While no formal data have been collected on the actual number of local visitors, unofficial estimates based on staff observations suggest that the number could well exceed 100,000 visitor days per year (NPS 2003).

The granitic domes of CARL are an attractive feature for hikers, with several providing access to excellent views. Natural views are an important aesthetic feature at CARL. Visitor's use of the granitic domes of CARL is generally limited to hiking and many outcrops are used to access these viewsheds. Important among these are the many outcrops that can be found along Glassy Trail. Big Glassy Overlook, at the trail's summit, is the most-visited feature of CARL after the main house. In addition to the Park's designated trail system many of the rock outcrops at CARL are now accessed by a series of informal "community trails". As visitation increases the use of low-elevation granitic domes for recreational purposes is expected to grow.

Sensitivity of Granitic-Dome Communities

Land managers have become increasingly concerned about the effect recreational use is having on rock-outcrop communities. Trampling by hikers stresses rock-outcrop plant communities. For example, individual plants may be crushed underfoot, and outcrop soils may be compacted, or blown or washed away once vegetation is removed or destroyed. Vegetation types on rock outcrops and cliff faces that serve recreational purposes have been found to differ significantly from vegetation types and percent coverage on those that are un-impacted by visitor use (Nuzzo 1995, Smith 1998, McMillan and Larson 2002). The inherent growing conditions sustained on rock outcrops are tenuous and extreme. As a result of these harsh environmental factors, rock-outcrop plants and lichens grow slowly. Due to the extreme growing conditions, once damaged, or destroyed, the recovery of rock-outcrop communities, if possible at all, may take decades (Farris 1998, Larson et al. 2000).

Not only are rock outcrop communities sensitive to the impacts of increased visitor use but they are also subject to legacy effects caused by landscape-level impacts related principally to the disruption of the fire regime. Fire has played a major role in structuring natural communities for centuries. Fire maintains open, early-successional types of vegetation. There has been no record of fire on the estate for the last 150 years. Although the faces of rock-outcrop systems typically function as refugia from fire, the ecotonal boundaries support many fire-dependent species. These transitional boundaries are an integral portion of vascular diversity in rock-outcrop communities and support a high proportion of the indicator species of low-elevation granitic domes (McVaugh 1943, Burbank and Platt 1964). Many of these species thrive only in high-light conditions and are poor competitors in shaded situations (Cotter and Platt 1959). Through successional processes and the legacy effects of fire suppression the boundaries of low-elevation granitic domes are moving towards dense closed-canopy forests with little to no regeneration of fire-dependent species.

A number of studies have shown that when non-indigenous species colonize natural communities they may disrupt ecosystem processes and alter biological diversity (Braithwaite et al. 1989, Hobbs and Mooney 1991, Davis 2000). Invasion by an exotic species is influenced by three factors: ecosystem properties, which could be related to the type and frequency of disturbance, the number of propagules entering a new environment, and the properties of the invading species (Lonsdale 1999). Community types that are the most susceptible to exotic invasions are those that are impacted by chronic low-intensity disturbances. Disturbance to soil substrates initiates a pulse of seed germination (Rosburg et al. 1994). Frequent disturbance to rock outcrops has been shown to make them highly susceptible to exotic invasion (Porembski and Barthlott 2000). Soil disturbances of all sorts including compaction from trampling, tree fall, and erosion provide opportunities for exotic colonization.

Over the last decade the Hendersonville and Flat Rock Area has experienced unprecedented growth. Given the interest in landscape-scale models for conservation and restoration, it is imperative that rock outcrops are included in any efforts to protect biodiversity in the southern Appalachians. Conserving the granitic domes of CARL has been listed as a priority by Park staff and fits into a series of previously-stated objectives by Park administration including: restoring native habitats, reducing the environmental impact of visitor use, reducing the effect of exotic species, and maintaining and enhancing biodiversity (Hart 1993, Johnson 2003, NPS 2003, NPS 2005). In addition to these stated objectives, The National Park Service Organic Act (39 Stat. 535, 16 USC 1) of 1916, mandates a fundamental purpose of conserving the scenery, wildlife and historical and natural objects therein, of all National Parks in a manner that will leave them unimpaired for the enjoyment of future generations (NPS 2009). In compliance and with furtherance of the NPS Organic Act, the National Park Omnibus Management Act (39 Stat. 402, 16 USC. 1 et seq.), finds that the preservation and conservation of Park resources and values requires that visitation will not unduly impair these resources and values (NPS 2009). Because of the importance of multiple-resource use at CARL these impacts should be evaluated upon the historical and natural context of each outcrop. However, it is clear that the impacts to the natural integrity of isolated and high-quality granitic-dome communities at CARL are to be mitigated.

Table 1. Potentially critical components and processes in granitic-dome communities; their key roles and major threats associated with them.

Component	Key Roles	Associated threats
Xeric Soils	Severe conditions support xeric plant species that contribute to site diversity.	Disturbance, erosion and sedimentation from trails, and compaction from visitors, disturb soil resources.
Seeps	Seeps support mesophytic and wetland species, moss, and lichen communities.	Disturbance, erosion sedimentation from trails, and vegetative spalling affect frequency and species composition.
Lichen and Moss Communities	Lichen and moss colonies affect seedling recruitment, water, and nutrient relations. Relict communities are reported on many outcrop systems.	Trampling from visitors, and atmospheric deposition can impact abundance and composition.
Vascular Plant Community	A unique suite of habitat specific and regionally uncommon species. They contribute substantially to regional biodiversity.	Trampling from visitors, exotic invasions, disturbance to soil substrates, and over-collection.
Disturbance	Maintains granitic domes as open. Disturbance controls vegetation structure and determines spatial heterogeneity and species abundances.	Frequency, response lag, and legacy effects from anthropogenic throughputs, particularly disruption of the fire regime.
Landscape pattern	Affects meta-population dynamics and gene flow.	Increasing regional development and associated impacts. Greater insularity of outcrop communities.

STUDY SITE

CARL comprises 108 ha and lies entirely within the French Broad River drainage. The Park is dissected by two perennial water sources and several intermittent drainages. Drainage areas and soil types are oriented in relation to Big Glassy and Little Glassy Mountains. Small streams originating on Big Glassy and Little Glassy unite to form Memminger Creek, which exits the Park under Little River Road. The regional climate is mild, with 180 frost-free days, and a mean temperature of 12.8^{o} C (55.1^{o} F). Mean average precipitation is 1.42 m (56.6 in), falling mostly as rain and distributed fairly evenly throughout the year (State Climate Office of North Carolina 2008). Elevations at CARL range from 658 m (2,160 ft) along the northern boundary to 848 m (2,783 ft) at a large granitic dome at the top of Big Glassy Mountain, the Park's highest point and most popular natural feature.

Henderson County is composed primarily of igneous and metamorphic rocks. Within CARL, the underlying substrate of gneiss is often exposed and forms scattered granitic-rock outcrops throughout the Park (King 1980, White 2003). Because the average annual rainfall in Henderson County is relatively high it has had the general effect of leaching soluble bases out of the soils, causing them to be less fertile and more acidic. Four primary soil series are contained within the boundaries of CARL: Ashe stony sandy loam, Cordorous loam, Edneyville fine sandy loam, and Tate fine sandy loam (King 1980). Low-elevation granitic domes occur most frequently within the Ashe stony sandy loam. The Ashe soil is represented by a thin layer of sandy loamy soil overlying igneous and metamorphic bedrock. It occurs predominantly in the southern portion of the Park (Johnson 2003). Additional granitic-dome communities occur sporadically along lower elevations within the Edneyville, Tate, and Cordorous soils, all of which are deeper sandy loams. The topography of the Park is relatively steep and rugged, particularly along the flanks of the Little Glassy and Big Glassy Mountain area where slopes sometimes exceed 65%. Slopes throughout the remainder of the Park vary between 5% and 25% (Hart 1993).

Approximately 80 ha of the Park is covered by mixed-pine and hardwood forests, 15 ha are in fenced pasture land, 3.5 ha in ponds, and the remainder in residential-style landscapes (NPS 2003). A total of 14 distinct ecological-plant communities have been delineated within the Park, representing an impressive amount of diversity (White 2003). Important among these are low-elevation granitic-dome communities that support a vegetation association that is rare globally. CARL contains several excellent examples of this plant community.

The historic landscape of the Park is managed primarily as a cultural resource in which natural resources play an integral role. Minor vegetation removal associated with normal maintenance activities occurs on a regular basis including the removal of exotic species (Irene Van Hoff, NPS Forestry Technician, pers. communication).

MATERIALS AND METHODS

Botanical Inventory

A systematic survey of all known granitic-dome communities within the boundaries of CARL was completed over the 2006 and 2007 growing seasons. Each of the outcrops were visited at least three times each year, in early spring to identify spring ephemerals (those species that complete their life cycle in April and May), in mid-summer, and in the fall. I identified and recorded all vascular-plant species that occurred across the outcrop surface, on soil islands and within 3 m of each outcrop edge. Botanical nomenclature follows Weakley (2005) and otherwise Kartesz (1994). A systematic inventory of the macro-lichen flora occurring on each outcrop was also conducted over the two-year period. Lichen samples were collected where possible. Samples were collected, dated, and the location recorded. Lichens samples were then sent to Dr. Coleman McCleneghan for identification using the nomenclature from Lichens of North America (Brodo et al. 2001). When sampling foliose and crustose lichens, it was often necessary to use a cold chisel to remove a small portion of the rock substrate. Care was taken to minimize scarring to the rock face during collection. Bryophytes were also inventoried for each site. Because bryophyte identification was also not possible in the field, samples were collected, placed in paper bags, and labeled with the date of collection and outcrop number. Bryophyte samples were transported to the Appalachian State University herbarium and identified by Justin Wynns, a bryologist, using the nomenclature of Stotler and Crandall-Stotler (Stotler and Crandall-Stotler 1977). Macro-lichen and bryophyte voucher specimens were deposited in the CARL Herbarium. A cataloged collection of bryophytes and lichens were then used in the field to aid in identification during additional fieldwork throughout the project.

GIS Database

Prior to this project, there were not any spatial data describing the locations of the granitic-rock outcrops at CARL in digital format, or more specifically, GIS format (i.e. shapefile, Geodatabase). The GIS model for this project was developed using the Environmental Systems Research Institute's (ESRI) latest version of ArcGIS Desktop software (i.e. ArcMap 9.1). Spatial data for the GIS was collected using a Trimble GeoXT GPS locator unit to survey the boundaries all of all outcrops at the site. Pathfinder Office software was used for post-processing the GPS data that was collected in the field. In addition to ancillary data acquired from the Park Service, other ancillary data were collected as well, including ortho-imagery from the National Agriculture Imagery and Mapping Program and the United States Geological Survey.

Site Conditions

Community structure and the distribution and abundance of plant species within granitic-dome communities was sampled using interrupted single-line belt transects (Figure 1). Survey metrics included quantitative sampling, stratified by vegetation type, climatic variables, and soil features. A main transect extended along the longest axis of each dome. Sampling coordinates were randomly chosen (using a random numbers table applied to transect meters) as distance from the beginning of the main transect. Using the main transect as a center point, 1 m^2 plots were placed along the perpendicular axis at 3 m intervals to the right of the main transect and continued to the edge of each granitic dome. Delineation of the outcrop edge was determined by an abrupt change in available soil substrates. Edge has a strong influence on community dynamics and has been described as a boundary line (Clements 1907, Thomas et al. 1979) or narrow transition between community types (Wales 1972). Boundary plots were labeled as A and B and were located within the first 2 m of the outcrop boundary. The A-plot was established first and was located on the first point of the belt transect that contacted a solid boundary of soil substrates or detritus. B-plots were located adjacent to A-plots, 1 m further along the belt transect. A-plots and B-plots were also recorded on the opposite boundary, to the left of the main transect. One m^2 quadrats were constructed using 2.5 cm PVC pipe. PVC piping was cut to length and coupled using 1.25 cm diameter 90° elbows to create the quadrat frame. To increase sampling accuracy the quadrat frame was further divided into 25 sub-plots of 4% each by wrapping the frames at evenly-spaced intervals with electrical tape to create a grid. Coverage of less than 1% was recorded as such. The area of an open hand from the wrist to first knuckles was considered to be equivalent to 1% cover. Coverage estimates were recorded as the total area within the quadrat frame. Individuals that originated outside of the quadrat frame were included if part of that individual was contained within the quadrat.

Quadrats were evaluated by the cover of the main vegetation layers, climatic variables, soil features and litter composition. Aspect, position, slope, soil depth, and overhead cover were recorded. Slope was measured using a Suunto inclinometer, Suunto

Tandem-360PC/360, Suunto, Vantaa, Finland. For plots in which the rock surface was uneven, the slope was measured using the frame of the quadrat. Plot aspect was recorded using a magnetic compass, unadjusted for declination. As with slope, aspect was measured using the quadrat frame when the rock surface was uneven. Overhead cover was estimated using a densiometer held 1 m above the center of each quadrat.

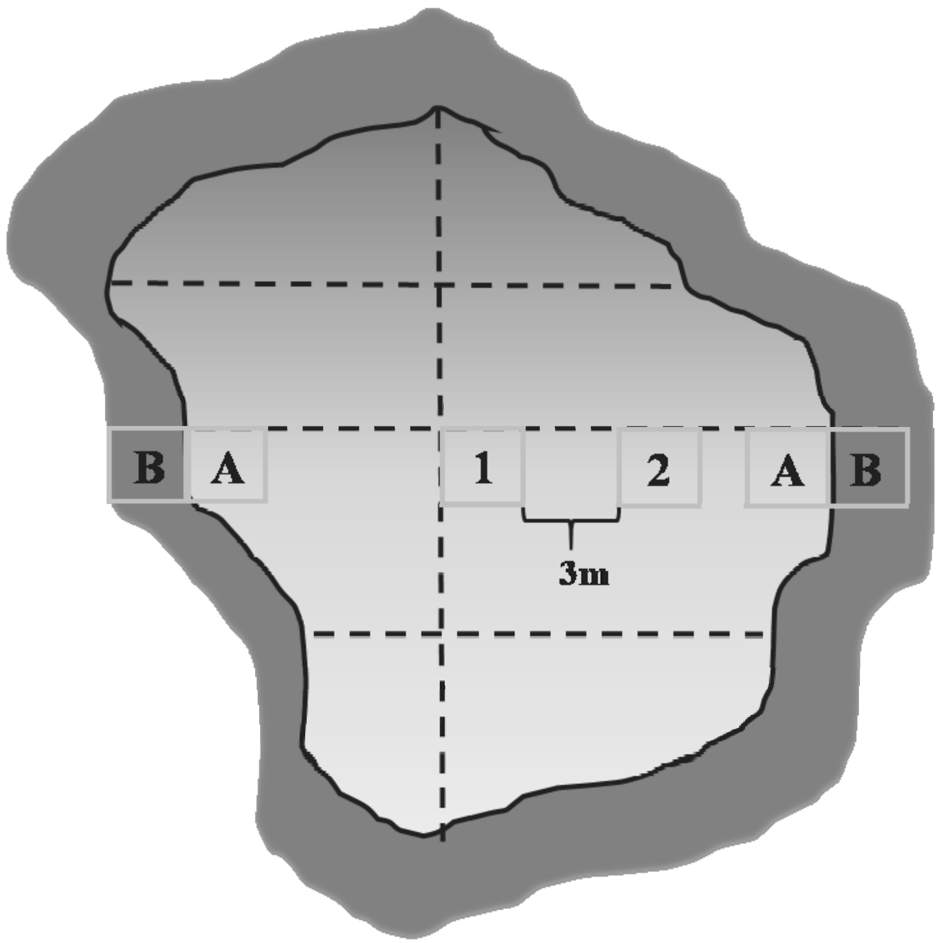

Figure 1. Diagram of single-line belt transect placement across low-elevation granitic domes.

Soil depth was measured when available. Measurements of soil depth were determined by calculating the average of three separate soil depth measurements, placed in the plot center and the upper left and lower right-hand corners of the quadrat frame. Measurements of soil depth were recorded on a scale of 0-5, with 0 indicating the absence of soil substrates and 5 totaling more than 25 cm soil. The dominant microfeature was also recorded for each quadrat. Microfeatures were defined according to 10 different classes, and included features such as crevices, depression, ledges, and protrusions. The main vegetation layers were characterized by visual estimation of the coverage on surface stratum only. Percent cover for all vascular plants was recorded for each plot, as well as the percent cover by each vascular species. Bryophyte coverage included total cover of all moss species. Cover of each individual species was included, when possible, by comparing bryophytes to a collection of previously collected and identified specimens that were carried in the field. Lichen cover included total cover of all lichen species. Lichen species identification was not possible in the field, however lichens were recorded to genus when possible and lichen morphotype percent cover (crustose, fruticose, foliose, squamulose and leprose) was determined.

Visitor Impacts

The cover of the main vegetation layers was compared between outcrops that were located on designated trails, those that were accessed by non-designated trails, and those that remained completely off-trail. Sites accessed by non-designated trails had clear and apparent evidence of human footpaths that were not included on any Park maps. Data were analyzed using traditional parametric regression methods using SAS software, Version 9.1 of the SAS/STAT® software System (SAS Institute Inc. 2003). Confidence intervals were determined at 95%. Tests for homeoscedasticity were performed using Levene's test for homogeneity of variance. Multiple comparison tests were performed using Tukey's test. Reported probabilities of multiple comparisons are from Tukey.

Invasive Plant Species

Non-indigenous plant species occurrence data from 2006-2007 were used to generate a predictive model for 10 of the most frequently-observed non-native species on the granitic domes at CARL. Coverage data and life-history information were entered into the Alien Plant Ranking System (APRS) developed for the USDA by the APRS Implementation Team (2000). The APRS is an analytical tool which prioritizes exotic species management objectives by separating innocuous exotic species from those that are invasive. In addition to identifying those species that currently impact a site, the APRS also highlights those species that have a high potential to affect natural communities in the future (APRS Implementation Team 2000). The system uses a query method to amass information about species characteristics as well as features of the invaded community. Twenty-three multiple-choice questions are assembled into three sections: 1) Significance of Threat or Impact, 2) Innate Ability to Become a Pest, and 3) Difficulty of Control. These queries were answered based on field surveys which were conducted during the 2006 growing season. Field surveys were conducted to estimate the distribution and abundance of each species on each granitic dome site. Areal extents and numerical dominance were determined by estimating the proportion of each site occupied by each species. The threats, impacts, and effects of each species on management goals were determined based on field observations of the density and distribution of each species at each site, conversations with Park personnel, and reviews of the literature. Information on fecundity, dispersal mechanisms, habitat requirements, and growth rates of individual species was provided through reviews of primary literature.

Succession of Outcrop Borders

To determine population age-structures of trees associated with granitic domes, increment cores and stem cross-sections were taken from a small subsample over a range of tree sizes and species. To assure maximum accuracy in age determination, each core was sampled at a height of approximately 40 cm from the base of each tree. Increment cores were collected for trees > 6 cm in diameter. To provide accurate models for trees in all age classes, a cross section was collected for several trees < 6 cm in diameter. The sample included trees within this range up to 10 m from the outcrop edges. In selecting trees for increment boring, those with decay were avoided, which may have eliminated some older or less vigorous (slower-growing) trees from the sample. Position, average soil depth, and distance from the edge of each outcrop were recorded for each sample. In the laboratory, cores were mounted into 6 cm wide dadoes cut into wooden holders and sanded to expose the annual growth rings. Stem cross sections were also sanded. Tree age was determined by counting growth rings under 10x-magnification on the cleanly-cut face of each sample. Age was recorded for sample trees and regressed over tree diameter for each species. These regressions were later used to estimate the relative age of trees whose diameter only had been measured.

Increment core data was mapped in relation to two outcrops located near the Main House to illustrate the rate of encroachment along outcrop borders. The location of each core collected on Outcrop 18 and Outcrop 19 is included in Appendix B. The area of Outcrop 18 was defined along a transect beginning at the exposed rock along the trail entering from the west and traveled 70 m to the base of the outcrop at approximately 70^0. The area of Outcrop 19 was mapped along a 57 m long transect that began at the top edge of the outcrop and continued at approximately 63^0 to the bottom edge.

To examine the structure of the forest community a series of 100 m^2 fixed-area plots were established in three primary outcrop complexes during the winter of 2007. The origin of each plot was randomly selected by applying a random-numbers table to transects drawn through the longest axis of each outcrop. Within each fixed-area plot all tree species were accounted by size category: overstory-trees, understory-trees, and regenerating-tree-species. Because the plots were surveyed after leaf fall, *Qurecus sp.* (oaks) were identified only to genus and were recorded as such, however *Quercus prinus* and *Quercus coccinea* appeared to be the most common. *Carya sp.* (hickories) were also identified only to genus. On each plot trees greater than 12.7 cm at diameter breast height (dbh) represented overstory-trees. The species, diameter, and soil depth at the base of each overstory-tree was recorded. Diameter was also recorded at 40 cm in height from the base of each tree so that these measurements could be compared to diameter and age regression models that were developed previously for each species.

Within the same plot all trees between 2.54 cm and 12.7 cm were recorded as understory-trees. Understory-trees were also recorded by species, and diameter. Soil depth was measured at the base of each understory-tree. All tree species with a dbh below 2.54 cm were recorded as the regeneration stratum. Measurements for regeneration followed the same protocol as the other two vertical strata. These counts and measurements allowed for a full account of all tree species within each plot. Size categories were chosen to correspond with previous studies of forest structure conducted within the Park (Johnson 2003). For each stratum, basal-area per hectare, density per hectare, and frequency were calculated. From these data relative frequency, relative density, and relative dominance were calculated to derive importance values for each species for overstory, understory, and regenerating-tree-species where:

$$IV = (\text{relative density} + \text{relative frequency} + \text{relative basal area}) \div 3.$$

Relative density, relative frequency and relative basal area are expressed as percentages of all species present. Importance values capture the structural role of each species within the community, with equal weight given to all three variables: basal area, density, and frequency.

Soils

Soil development on granitic domes was examined by systematically sampling soil depth on soil-islands of varying ages. Because the actual age of each island could not be determined, the estimated age of vegetation was used to differentiate the ages of each soil-island. The soil-island that was determined to be the oldest was occupied by a red cedar that was estimated to be at least 250 years old. An intermediate-age soil-island was occupied by a red cedar that was estimated to be 90 years old and the youngest and least developed soil-island contained only annual and perennial forb species. A series of line transects was established from the center point of each soil island and extended to the interface with bare rock (Figure 2). A total of 10 transects were established for each soil-island and were drawn at 36^0 intervals. Maximum soil depth was then measured at 0.5 m intervals along each transect using a metal probe. Maps of soil depths were constructed for each island and are included in Appendix B.

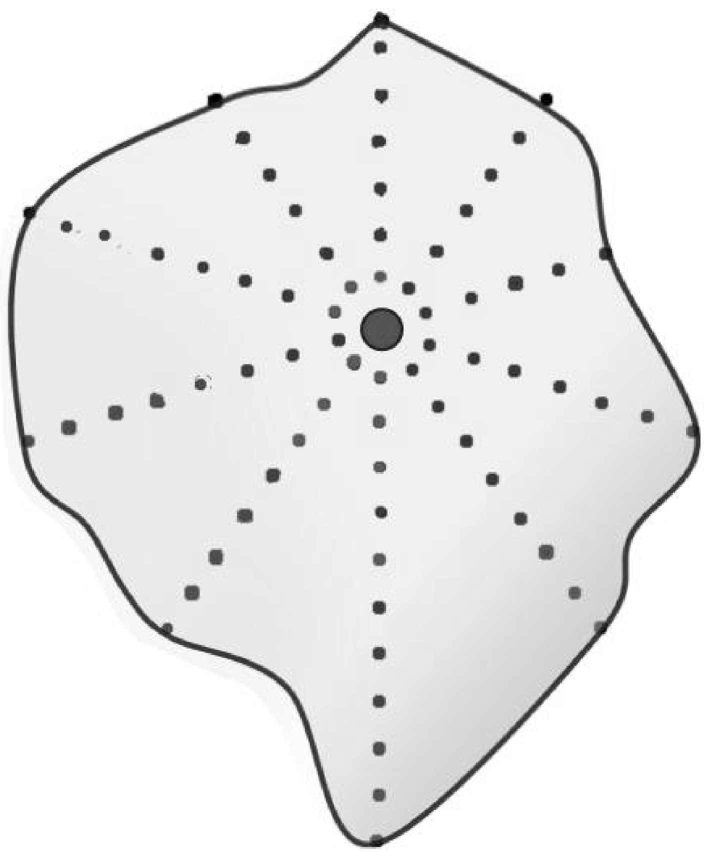

Figure 2. Diagram of transect placement and sampling points across soil-islands.

RESULTS

Botanical Inventory

During this study a total of 21 granitic domes were identified in the Park (Figure 3). They range from heavily-impacted to high-quality examples of this community type. Granitic domes are distributed throughout the Park and can be found from about 658 m in elevation (2,160 ft) at Side Lake to 848 m (2,783 ft) at the top of Big Glassy Mountain. Species lists were completed for 19 of 21 granitic domes. A total of 196 native vascular-plant taxa representing 61 families were identified. Forb and herb species diversity was the greatest (40%), followed by trees (23%), and graminoid species (16%). A vascular-plant inventory recently completed by NatureServe (White 2003) documented 519 vascular species within the Park boundaries. Accordingly, about 38% of all known vascular species at CARL were located on low-elevation granitic domes during my inventory. I collected and identified a total of 33 lichens species on the granitic domes of CARL. 18 of these species were new reports for the Park. A total of 16 moss species were found on granitic domes. Of these moss species six were new records for the Park.

The floristics of the low-elevation granitic domes of CARL sites were similar to granitic-dome communities found in the southeast (Schafale and Weakley 2001). *Schizachirium scoparium, Deschampsia flexuosa,* and *Dichanthelium spp.* were the most common and abundant native graminoids and *Danthonia spicata* is important on a few sites. *Saxifraga michauxii*, *Coreopsis major*, *Hypericum gentianoides, Talinum teretifolium*, *Croton wildenowii*, *Rhexia mariana, Scutellaria integrifolia, Pycnanthemum flexuosum* and *Senecio anonymus* are common forbs. These species can be considered as indicator species for this community type. The most common woody species that occur are *Pinus strobus*, *Quercus coccinea*, *Pinus virginiana*, *Chionanthus virginica*, and *Juniperus virginiana*.

The conservation status rank, developed by NatureServe and the Natural Heritage Network, was recorded for each species. A complete plant list for each outcrop is included in Appendix A. Numerous plants of concern were identified including: Michaux's saxifrage (*Saxifraga michauxii*), rough panic grass (*Dicanthelium leucothrix*), and Small's ragwort (*Packera anonyma*), two-fruit rushfoil (*Croton willdenowii*) and quill fameflower *(Phemeranthus teretifolius*). Fourteen of these 23 species were found on only one or two granitic outcrops within the Park. The critically imperiled and globally-rare Piedmont ragwort (*Packera millefolia)* was identified in 2001 on a single granitic dome (Outcrop 14). However, it has not been relocated since that report and was not identified during my inventory. A singular occurrence of one State-imperiled species (S2) (*Spiranthes odorata*) was located during this study.

GIS database

A total of 26 outcrops were located. A GIS map and data base was constructed and they show the locations of the 26 rock outcrops, 21 of which were classified as low-elevation granitic-dome communities. The GIS database links the spatial locations of all outcrops with the botanical inventory. The coordinate system of the created shapefile is: NAD_1983_StatePlane_North_Carolina _FIPS_3200_Feet. The shapefile was also converted into a Feature Class and stored in a Geodatabase. Both formats contain essentially the same data and are compatible with the ESRI ArcGIS Desktop version 9.2.

The shapefile/feature class contains information about each outcrop, thus a total of 19 features (individual polygons) are contained within each shapefile/feature class. The attribute tables for the newly-created spatial data contain information about the species located at each outcrop. Specifically, the user is able to click on an individual outcrop (feature), using ArcGIS Desktop software, and determine the total number of species identified for each outcrop, as well as a breakdown of the total number of vascular, moss and lichen species. Additionally, the total number of natives and non-natives are listed.

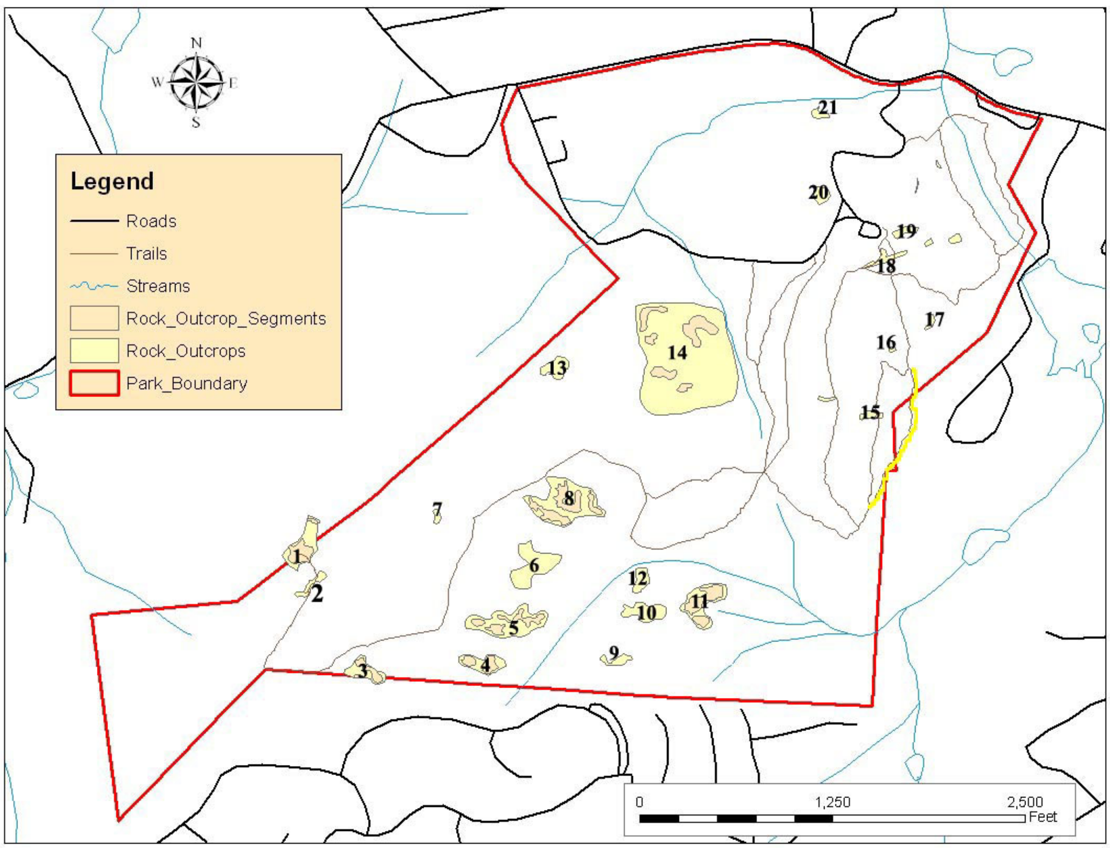

Figure 3. Map identifying rock outcrop locations at Carl Sandburg National Historic Site.

Site Conditions

A survey of existing conditions showed that the vegetation occupying outcrop faces was dominated by lichens and bryophytes (Table 2). Outcrop faces were generally devoid of overhead cover and had little to no available soil substrates. Lichen cover on outcrop faces was composed primarily of foliose species from the genera *Xanthoparmelia* ($\bar{x}$=8.7 ± 1.5%) and squamulose *Cladonia spp.* (5.1 ± 0.8%). Leprose species of *Lepraria* were also important (2.6 ± 0.7%). Bryophyte cover on outcrop faces was dominated by *Dicranum scoparium* (1.4 ± 0.6%) and *Polytrichum ohioense* (0.9 ± 0.4%), often forming mixed species mats. *Grimmia laevigata* (1.2 ± 0.5%) was also important. Vascular cover was low, as expected, and was limited to small soil-filled depressions or cracks. *S. michauxii* was the most common vascular species (0.7 ± 0.3%) on outcrop faces.

Outcrop-edge (A-plot) vegetation was similarly structured to outcrop face plots and was dominated by lichens and mosses. Foliose and fruticose lichens were common. Fruticose lichen cover (7.1 ± 1.4%) was composed primarily of *Cladina spp.*, more commonly known as reindeer lichens. *Dicranum scoparium* (7.0 ± 1.6%) and *P. ohioense* (1.4 ± 0.6%) continued to dominate the bryophyte cover. *Adreaea rothii* was also common (1.1 ± 0.8%). Outcrop edges had substantial debris and leaf-litter coverage (45.0 ± 4.8%), which occurred more frequently than soil substrates. Most litter was cast by pines and oaks. Accumulations of coarse woody debris often functioned as traps where needles and leaves were concentrated by surface runoff. Overstory cover was frequent (*f* =0.59) and averaged 25.4 ± 3.7%.

On adjacent outcrop transition plots (B-plots) bryophyte cover increased significantly (p=0.014). Species of *Sphagnum* were common (4.3 ± 1.6%) and formed large mats along seepage zones. The density of vascular cover also increased significantly ($p=<0.0001$). Vascular coverage was composed mostly of grasses (6.4 ± 1.8%) and ericaceous shrubs (2.6 ± 1.0%). Lichen cover appeared to decrease along outcrop transition plots. Fruticose *Cladina spp.* (9.3 ± 1.8%) remained principally important. Overstory cover (57.0 ± 4.6%) and soil were present on all plots. Soil depths ranged from 1 cm to greater than 27 cm.

Table 2. Mean percent cover of species of various life forms and frequencies (per m^2) on the granitic domes at Carl Sandburg National Historic Site.

Variable	All Plots	Outcrop Face	Outcrop Edge (A-plots)	Outcrop Transition (B-plots)
N	454	204	125	124
Bryophyte cover	12.51 (0.59)	4.93 (0.34)	13.91 (0.74)	22.08 (0.79)
Macrolichen cover	18.98 (0.87)	21.19 (0.91)	22.58 (0.93)	12.68 (0.76)
Vascular cover	4.91 (0.32)	2.60 (0.14)	1.01 (0.23)	12.65 (0.69)
Graminoid species	2.28 (0.14)	0.78 (0.05)	0.57 (0.06)	6.40 (0.35)
Annual forbs	0.07 (0.03)	0.02 (0.01)	0.00 (0.00)	0.32 (0.06)
Biennial forbs	0.01 (0.01)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Perennial forbs	0.68 (0.13)	0.73 (0.10)	0.31 (0.12)	1.00 (0.17)
Subshrubs	0.05 (0.02)	0.00 (0.00)	0.01 (0.01)	0.17 (0.06)
Vines	0.09 (0.03)	0.05 (0.01)	0.07 (0.04)	0.15 (0.05)
Shrub Species	1.05 (0.06)	0.33 (0.02)	0.00 (0.00)	3.28 (0.19)
Tree species	0.75 (0.10)	0.69 (0.04)	0.04 (0.03)	1.30 (0.27)

Visitor Impacts

Trail-designation had no effect on vascular or bryophyte cover for rock outcrops. There was a highly significant (p=<0.0001) decrease of lichen cover on outcrop faces that were located directly on the Parks designated-trail sysytem ($\bar{x}$=5.4 ± 3.0%) as compared to off-trail sites (24.1 ± 3.4%). Total lichen cover also appeared to decrease on sites accessed by informal trails however it was not statistically significant (19.1 ± 2.0%, p=0.28). The impact of informal-trail development affects sites differently, with some outcrops receiving higher incidences of visitor use. Lower segments of Outcrop 8 and Outcrop 12 appeared to be the most highly accessed. Both formal and informal-trail use correlated to reduced densites of specific lichen morphotypes Percent cover of squamulose species was highest on granitic domes that were located off-trail (4.7 ± 1.0%). Squamulose lichen cover decreased on sites that were located on the Park's designated-trail system (0.35 ± 0.51%) and on sites accessed by informal trails (1.9 ± 1.8%). Foliose species decreased on sites that were located on designated trails and those that were off-trail (3.9 ± 1.5% and 9.6 ± 0.9%, respectively, p=0.003) however it was statistically significant for formal-trail sites only. Leprose lichen cover had no correlation to trail designation. Although leprose species were important on outcrop faces they were restricted to different surface features upon the rock surface. Consequently their distribution was highly aggregate. Fruticose species were nearly absent on the borders of granitic-dome sites that were located on designated trails (0.1 ± 0.2%, p=0.001) and were also impacted by the use of non-designated trails (3.3 ± 1.8%, p=0.006) as compared to those that were off trail (8.4 ± 0.9%). Crustose lichens were resistant to trampling and species densities were very similar among all sites (p=0.83).

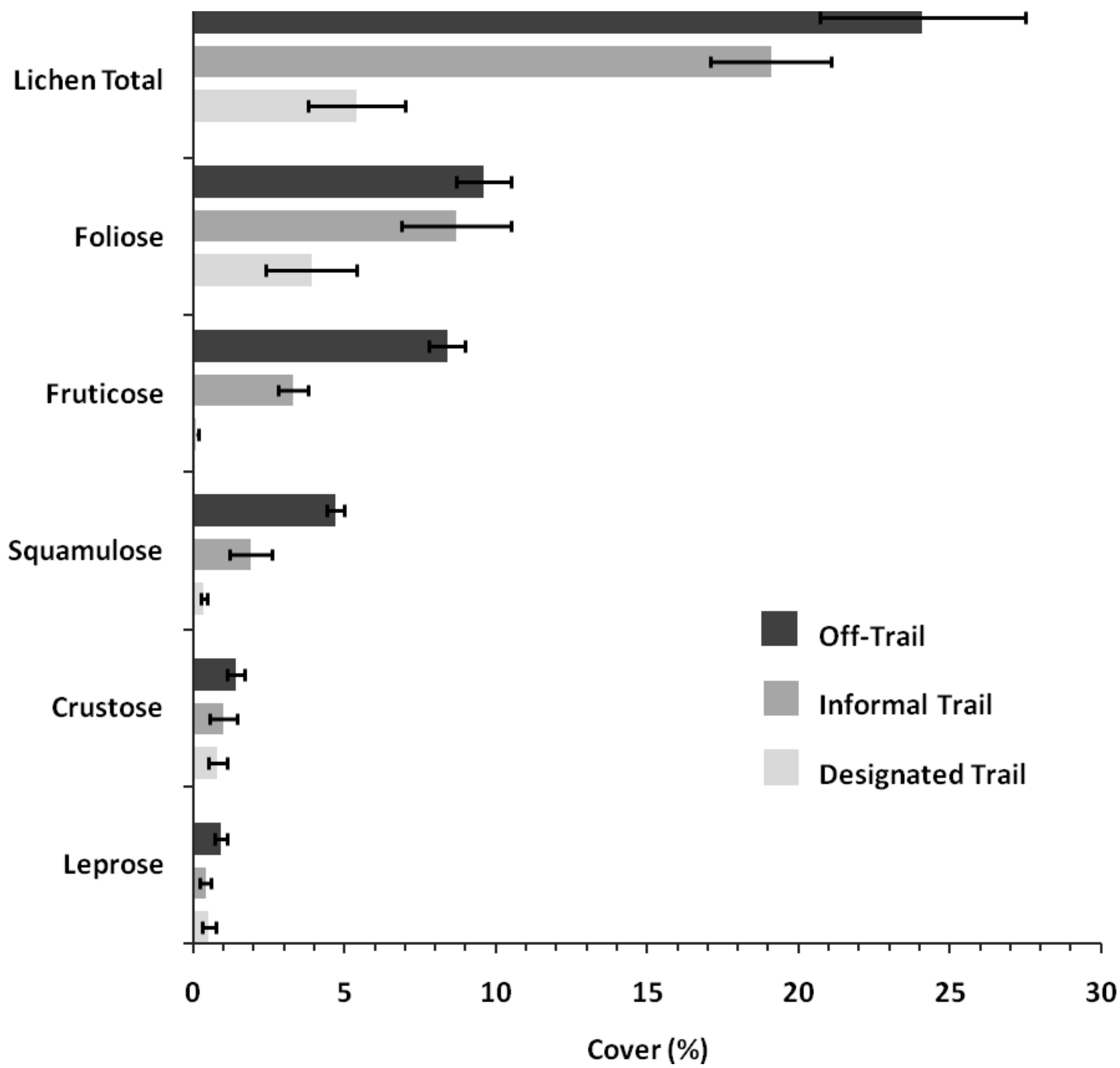

Figure 4. Mean percentages of lichen cover in response to available access at the granitic-rock outcrops of Carl Sandburg National Historic Site (bars indicate standard error).

Invasive Plant Species

A total of 20 exotic plant species were identified during the botanical inventory. Exotic species were present on all granitic domes. Seven of the exotic species which scored highest in the APRS are categorized as Rank 1 invasive exotics in the State of North Carolina.

Chinese privet, *Ligustrum sinense*, ranked highest in the APRS. Chinese privet is a semi-evergreen shrub or small tree that grows to 6 m. When Chinese privet colonizes rock outcrops it often forms thick, impenetrable stands that shade out the understory. Chinese privet can colonize by root sprouts but its greatest potential for dispersal comes from its abundant seed production which is often spread by birds. Landscape plantings provided seed sources for establishment. Long-distance dispersal from birds has allowed Chinese privet to establish satellite populations distant from human mediated habitats and privet is abundant on some of the more-isolated outcrops of CARL. Soil disturbances of all sorts including compaction, tree fall, and erosion provide opportunities for colonization.

Japanese honeysuckle, *Lonicera japonica*, ranked as the second-most problematic species in the APRS, and is another Rank 1 invasive that is often dispersed by birds. This aggressive vine climbs and drapes over native vegetation. Monotypic stands seriously altered the understory and herbaceous layers of the rock-outcrop communities it invaded. Japanese honeysuckle recived high scores for potential impact and difficulty of control. In addition to its colonial habit, the semi-evergreen condition of Japanese honeysuckle allows for growth both prior to and after dormancy of other deciduous plants. Flowering and seed development are heaviest in open-sun areas (Nyboer 1990).

Ranking third as most problematic was English Ivy, *Hedera helix.* The impacts of English Ivy are evident throughout the Flatrock community. It typically colonizes by vegetative means and several large colonies that originated as residential plantings cover substantial portions of the surrounding woodlands. Within the Park, English Ivy spread from either the Lily Garden or from a former planting when Ellison Smyth owned the estate. English ivy now covers large areas to west and south of the Main House.

Multi-flora rose, *Rosa multiflora*, was ranked as the fourth-most problematic species by the APRS. The State of North Carolina has designated Multi-flora rose as a Rank 1 invasive exotic. Multiflora rose reproduces by seed, root sprouts, and layering. Seeds are eaten and spread by birds and other animals. Multi-flora rose had a major impact on Outcrop 7. However, chemical and manual control efforts initiated by the NPS were effective at reducing the population. In addition there are several naturally occurring biological control agents that are expected to impact the spread of multi-flora rose in the future. These include rose rosette disease, a virus spread by the eriophyid mite (*Phyllocoptes fructiphilus)* and the rose seed chalcid (*Megastigmus aculeatus* var. *nigroflavus)*, a wasp that was introduced with multi-flora rose and deposits its eggs into the developing ovules.

Asiatic dayflower, *Commelina communis* and Japanese stilt grass (*Microstegium vimineum*) also ranked high in the APRS. As its common name suggests *C. communis* was introduced from Asia and bears ephemeral flowers that disintegrate rapidly. A related species, the native *Commelina virginica*, can be distinguished from Asiatic dayflower by the united margin of its spathe. The spathe of Asiatic dayflower is free basally. Although Asiatic dayflower and Japanese stilt grass are more abundant in mesic-community types, both species were found within seepage zones found at the base of soil islands and along rock-outcrop edges. These seepage zones rarely occupy large portions of rock outcrops and provide the only microhabitat available for these species. Because both species are restricted to these small seepage zones their potential to spread is limited. However, because these sites provide for a unique suite of native mesophytic species, they pose a substantial potential threat to native-site diversity within rock-outcrop communities.

Tree of heaven, *Ailanthus altissima* ranked as the seventh most problematic species. Only three inviduals of tree of heaven were located on two sites. Because, tree-of heaven currently occurs at low densities and frequency it received a low APRS score. However, all three individuals that were located appeared to be recently established. The spread of *A. alitissima* should be closely monitored in the future. It can form monotypic stands and is a prolific seed producer with the potential for long-distance dispersal from wind.

Anthoxanthum odoratum was the most frequently observed exotic species. *A. odoratum* is not known to be a colonial species and was typically observed as single individuals. Because *A. odoratum* never occurred at high densities it received a low potential impact score and a lower score from the APRS model (Table 3). *Rumex acetosella* and *Polygonum caespitosum* were also not considered to pose a major threat to rock-outcrop communities due to low densities and a limited potential to form large colonies

Table 3. APRS ranks for the ten most common exotic species identified on the granitic domes at Carl Sandburg National Historic Site.

APRS Rank	Code	Scientific Name	Common Name	State Rank	Outcrops
1	LS	*Ligustrum sinense*	Chinese privet	Rank 1	#5, #6, #7, #8, #14, #15, #16, #17, #18,
2	LJ	*Lonicera japonica*	Japanese honeysuckle	Rank 1	#7, #16, #17
3	HH	*Hedera helix*	English ivy	Rank 1	#17, #18, #19
4	RM	*Rosa multiflora*	Multi-flora rose	Rank 1	#2, #7, #14
5	MV	*Microstegium vimineum*	Japanese stilt grass	Rank 1	#14, #15, #17, #18
6	CC	*Commelina communis*	Asiatic dayflower	SNR	#2, #3, #7, #8, #14, #15, #17, #18, #19
7	AA	*Ailanthus altissima*	Tree-of heaven	Rank 1	#8, #16
8	RA	*Rumex acetosella*	Sheep sorrel	SNR	#1, #14, #15
9	AO	*Anthoxanthum odoratum*	Sweet vernal grass	SNR	#3, #4 #5, #8, #9, #10, #11, #13, #15, #16
10	PC	*Polygonum caespitosum*	Oriental smartweed	SNR	#2, #8, #15

Soils

Total surface area was similar among all three sites. Soil depth for all soil islands showed a concentric pattern, gradually decreasing from the center of the island toward the island edge. The oldest soil island observed had deeper soil and greater species-richness. Soil depths on the oldest soil island were also more complex, with several deep pockets of soil located across the island. Maximum soil depth was 48.6 cm on the oldest soil island. Maximum soil depths for the intermediate-island and the annual-perennial-island were 33.2 cm and 18.4 cm respectively. Shallow soils lacked a classic profile and consisted of weathered rock fragments and humus material. The development of soil horizons was evident on the deeper sections of soils located on the two oldest soil islands. Maximum soil depths for all three sites were located near the center of the soil islands, indicating that they were centered above depressions in the rock surface. Maximum soil depths for the two oldest soil islands were located at the base of trees occupying each island.

During the course of this study the most apparent causes of damage to the structure and composition of soils that I observed was the introduction of sediment from trail runoff. Increasing sediment loads were particularly apparent on Outcrop #8 along the Big Glassy Trail and Outcrop #15 on the slopes of Little Glassy Mountain. In addition to limiting the extent of bare rock surface, soil deposition zones were occupied by a variety of exotic species.

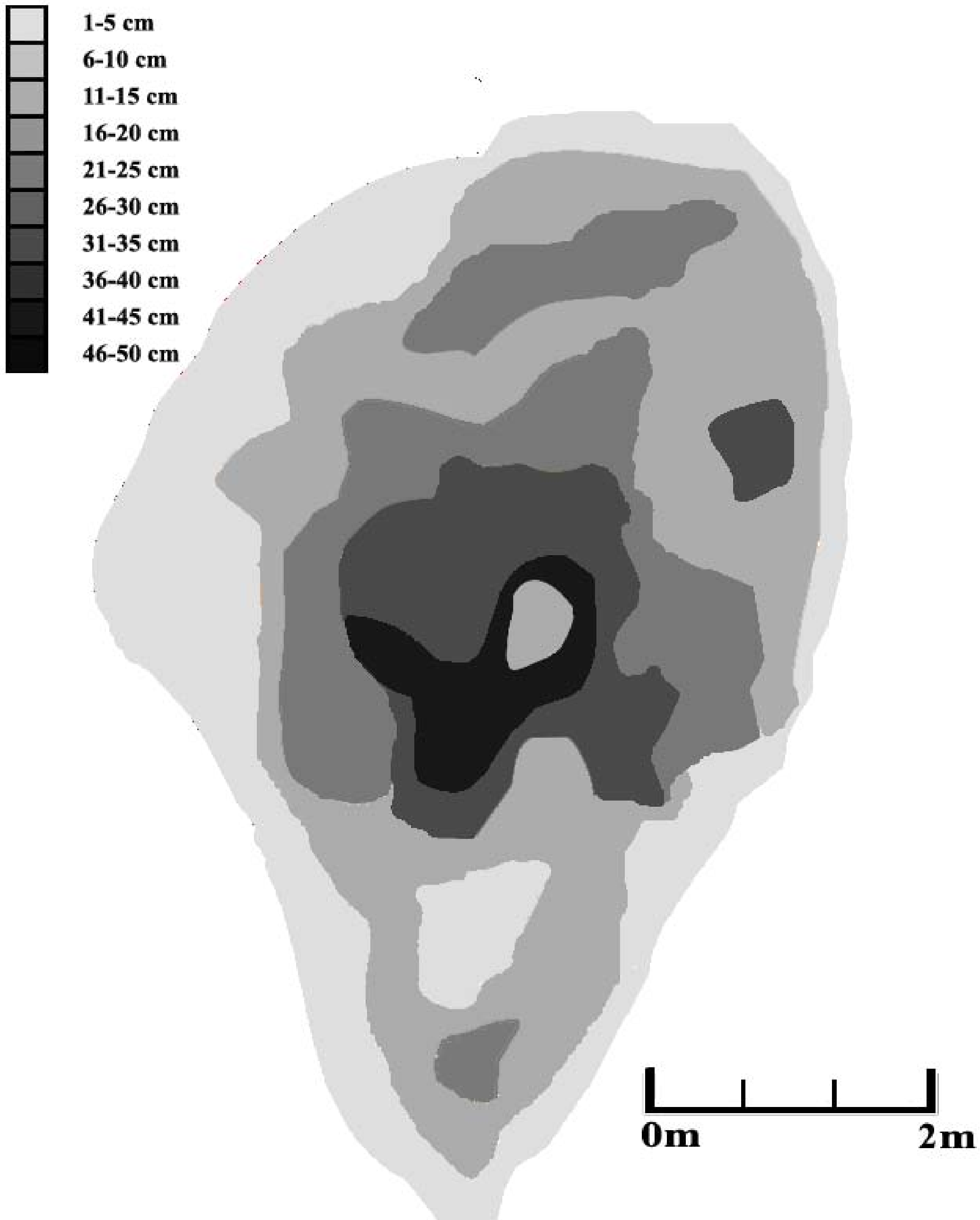

Figure 5. A map depicting soil depths on a soil island on Outcrop #11. The oldest tree located at the center of the island was estimated to be at least 250 years old.

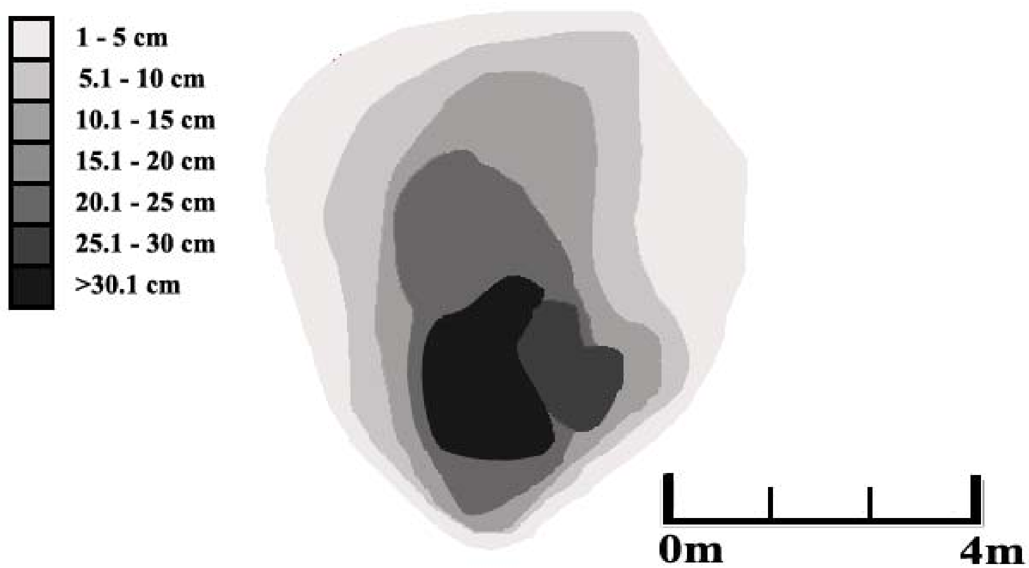

Figure 6. A map depicting soil depths on a soil island on Outcrop #14. The oldest tree located at the center of the island was estimated to be 90 years old.

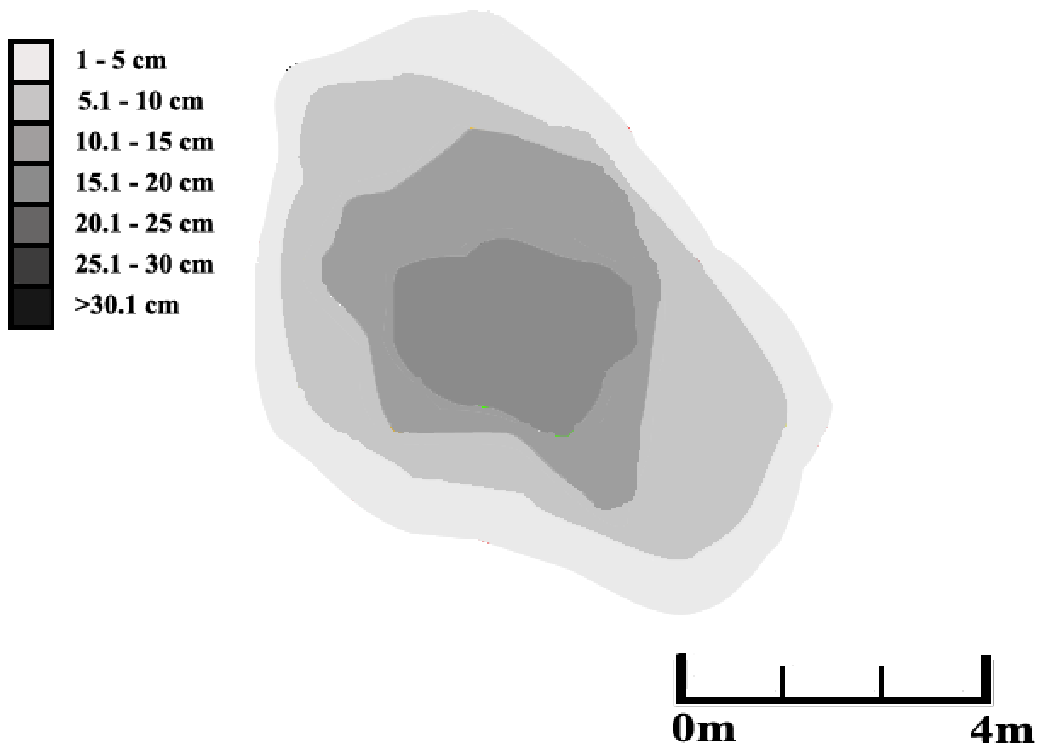

Figure 7. A map depicing maximum soil depths for a soil island occupied by perrenial and annual species on Outcrop #10.

Succession of Outcrop Borders

The role of forest encroachment has been widely discussed in many Park documents. I attempted to define the historical extent of the granitic outcrops of CARL through an archival review. In defining the historical extent of these outcrops there were several challenges. I was unable to acquire suitable aerial photographs in an appropriate format. Many of the photos provided quality resolution but lacked an appropriate geographic scale and listed flight numbers but no dates. Because I could not identify a precise photo-control, I was unable to perform an archival review of the historical extent of the outcrops. However, there were several useful aerial photos within the Park archives. From these photos it appeared that many of the granitic domes of CARL were more open historically. I was able to provide detailed information on the historical extent of two granitic dome sites by mapping the actual age of trees along the outcrop borders. These maps are included in Appendix B.

Suitable models of tree size and tree age were established for: *Pinus rigida, P. strobus, J. virginiana,* and *Quercus spp*. These models were intended to be descriptive for site-specific conditions and, they were established to provide baseline data about tree-age structure for trees occupying the granitic outcrops of CARL. The total number of samples (all species) was 157. Growth models were less effective for estimating the age of understory trees. Many of the present saplings were established under the canopy and remain in suppression, particularly understory white pines. As a result, several small white pines (5 cm in dbh and under) approached 30 to 35 years in age. The regressions used to estimate age are summarized in Table 4. For graphs of each regression see Appendix B.

Oaks and red cedar (*Quercus spp.* and *J. virginiana*) were the slowest-growing species that were recorded. Although no ancient cedars were located, several very old cedars exist on the outcrops of CARL, with some that predate the establishment of Rock Hill. One tree of note was a cedar that measured over 80 cm in diameter. It was likely the oldest tree observed during the inventory and was estimated to be over 250 years old. However the trunk of the tree was largely decayed and it may have been much older than that. Because of their slow growth small red cedars on rock outcrops are often deceptively old. White pine was the fastest growing tree that was measured. I recorded a mean diameter of over 32 cm for white pine trees that were established by the mid-1940s.

Table 4. Linear regressions of tree diameter (cm) against actual age for tree species of the forest matrix bordering granitic domes at Carl Sandburg National Historic Site.

Species	N	Equation of the Model	p	R^2 value	Est. Mean Diam. (cm) at 60 Years
Juniperus virginiana	25	Diam. = -3.50+0.31*Years	0.01	0.683	15.1
Pinus rigida	13	Diam. = 6.73+0.29*Years	< 0.0001	0.811	24.13
Pinus strobus	43	Diam. = -7.88+0.67*Years	< 0.0001	0.775	32.32
Quercus sp.	32	Diam. = 6.90+0.26*Years	< 0.0001	0.764	22.5

Forests occupying the edge of the granitic domes of CARL were primarily associated with the Appalachian Highlands Pitch and Table Mountain Pine Woodlands

Ecogroup and Appalachian Highlands Upland White Pine Forests (Schafale and Weakley 1990). These associations are generally uncommon within the Park and typically occupy sites that are exposed, dry, and nutrient poor. Forest edges of granitic domes were mature and vertically diverse. Forest structure was uneven-aged. Uneven-aged-forest structure indicates the lack of wide-scale disturbance. The understory was heavily dominated by fire intolerant species such as white pine and red maple (*Acer rubrum*). Stand basal area was relatively high (G=47.7 m^2/ha) but within the common range for hardwood forests. Stand density was higher than values reported for other cover types within the Park (Johnson 2003).

The dominant-overstory species were clearly white pine and oaks, which accounted for over 67% of the importance values. Both white pine and oak occurred at the same relative frequency. White pines and oaks were the largest trees in the overstory with average diameters of 24.52 cm and 29.28 respectively. Pitch pine (*Pinus rigida*) was also important in the overstory, but declined in the understory and regeneration layers. There was an inverse relationship between the importance and relative density of pitch pine and red maple across vegetation layers. Pitch pine declined in importance below the overstory and was nearly absent in the regeneration layer. By contrast red maple had a negative distribution, where the density and importance of red maple increased sharply within the understory and regeneration layers.

There were observable differences in the age and size-class distributions of species groups (Figure 8). White pines in the overstory were, on average, younger than oaks. The estimated average age for white pine was 45 years and was lower than values reported for white pine in other forest types (Johnson 2003). White pine density was similar across vegetation layers, but the relative dominance of white pine peaked between the 15 cm and 40 cm dbh size range (Figure 9). These size classes correspond to white pines between 15 years and 62 years of age. Oaks were, on average, of similar age to oaks in interior forests (Johnson 2003). Oaks were dominant among larger size classes, and the relative-dominance of oaks peaked above the 40 cm dbh class. This corresponds to oaks that were over 150 years old.

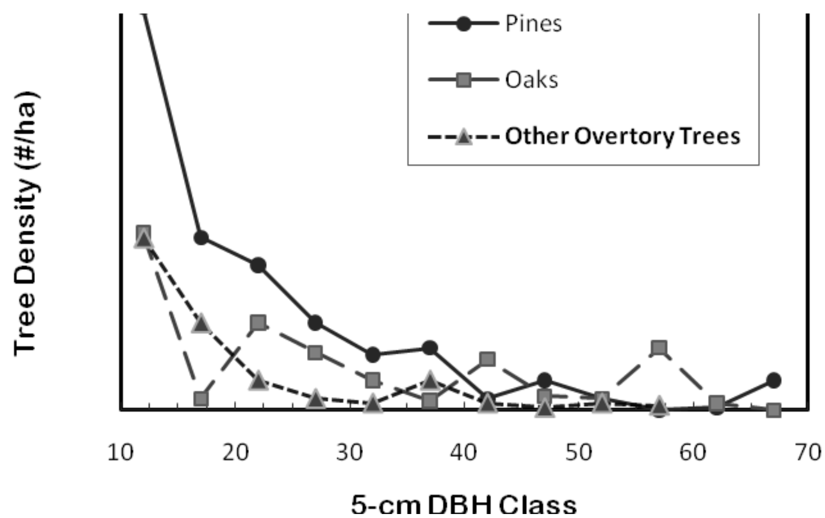

Figure 8. Diameter class distribution by species group for forest edges surrounding the granitic domes at Carl Sandburg National Historic Site.

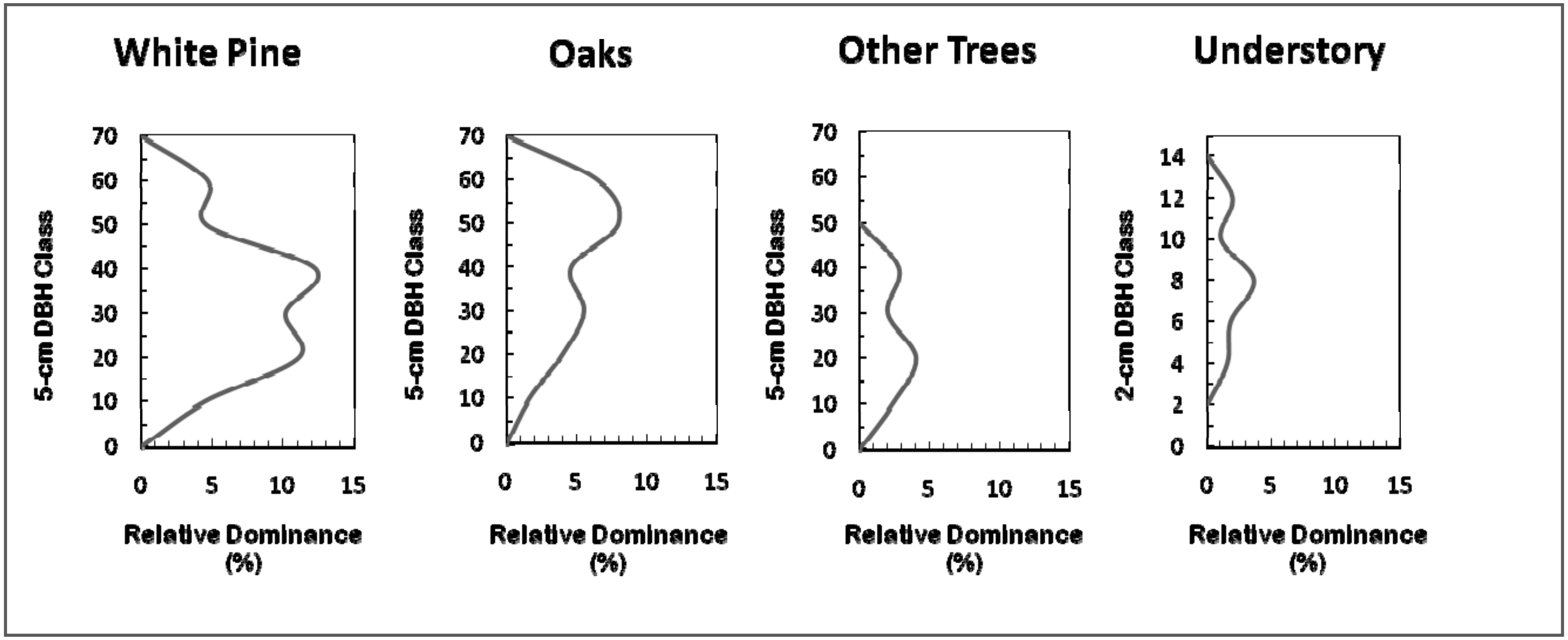

Figure 9. Relative dominance by tree groups and dbh class for forest edges surrounding the granitic domes at Carl Sandburg National Historic Site.

Table 5. Forest overstory characteristics for forest edges surrounding the granitic-rock outcrops at Carl Sandburg National Historic Site.

Species	Diameter (cm)	Basal Area/ha (m^2)	Density Trees/ha	Relative Density (%)	Relative Frequency (%)	Importance Value (%)
Pinus strobus	24.52	17.39	313	41.67	26.92	36.63
Quercus spp.	29.28	16.40	200	26.67	26.92	30.85
Pinus rigida	23.13	3.75	75	10	19.2	12.7
Acer rubrum	21.83	2.15	55	6.67	7.79	6.49
Carya spp.	18.53	1.32	44	6.46	7.59	5.82
Juniperus virginiana	16.02	0.48	50	3.33	3.85	2.78
Pinus virginiana	14.8	0.86	38	3.53	3.85	2.72
Nyssa sylvatica	14.6	0.20	13	1.67	3.85	2.00
Total	**20.34**	**42.55**	**788**	**100**	**100**	**100**

Table 6. Forest understory characteristics for forest edges surrounding the granitic-rock outcrops at Carl Sandburg National Historic Site

Species	Diameter (cm)	Basal Area/ha (m^2)	Density Trees/ha	Relative Density (%)	Relative Frequency (%)	Importance Value (%)
Pinus strobus	5.74	1.81	325	29.62	20.51	28.14
Quercus spp.	5.29	1.53	300	26.07	20.51	25.15
Acer rubrum	4.11	0.29	163	15.40	15.38	13.13
Pinus rigida	5.07	0.38	137	7.70	12.82	9.22
Pinus virginiana	7.30	0.32	88	4.74	5.13	6.22
Chionanthus virginicus	3.82	0.28	250	4.74	5.13	3.99
Prunus serotina	3.05	0.03	38	2.96	7.69	3.83
Juniperus virginiana	7.90	0.25	38	2.37	2.56	3.24
Cornus florida	7.86	0.12	25	1.18	5.13	2.84
Nyssa sylvatica	3.15	0.08	75	4.15	2.56	2.75
Amelanchier spp.	4.82	0.05	25	1.18	2.56	1.54
Total	**5.28**	**5.14**	**1464**	**100**	**100**	**100**

Table 7. Forest regeneration characteristics for forest edges surrounding the granitic-rock outcrops at Carl Sandburg National Historic Site.

Species	Diameter (cm)	Basal Area/ha (m^2)	Density Trees/ha	Relative Density (%)	Relative Frequency (%)	Importance Value (%)
Pinus strobus	2.06	0.11	338	32.53	16.67	27.80
Quercus spp.	1.98	0.24	238	21.69	29.17	24.08
Acer rubrum	2.14	0.07	188	18.07	25	21.29
Amelanchier spp.	1.63	0.04	175	16.87	8.33	12.18
Pinus rigida	2.32	0.01	20	2.41	8.33	4.65
Nyssa sylvatica	2.08	0.02	50	3.61	4.17	3.88
Chionanthus virginicus	2.02	0.01	38	3.61	4.17	3.87
Ligustrum sinense	3.05	0.02	38	12.05	4.17	2.25
Total	**2.16**	**0.52**	**1040**	**100**	**100**	**100**

DISCUSSION

Botanical Inventory

The goal of this portion of the project was to document the flora on the granitic domes of CARL. The effort from this project added over 24 new species to a list of 375 species already present within the current boundaries of the Park. The results of the botanical survey indicate that the low-elevation granitic domes of CARL are occupied by a flora characteristic of the granitic outcrops of the southern Appalachian region rather than a flora peculiar to the Park or any one outcrop.

Characterization of the plant species composition of the low-elevation granitic domes of CARL is essential if the NPS intends to preserve these communities within the Park. Since no historical documents elaborate on the floristics of these communities, the only way to access this information was to conduct comprehensive floristic inventories of extant outcrop communities. This methodology likely omits some important taxa that were present historically that may have been extirpated from these communities and likely adds taxa that are currently present on low-elevation granitic domes but may not have occurred on these sites in the past. However, ecological community information such as that gathered for this project and described in the Appendix provides baseline information that can be very useful as a management and monitoring tool for the Park. It is also important to note that both the growing season of 2006 and 2007 were marked by severe drought. Variation in weather and climate influences the annual production of plant biomass and short- and long-term changes in species composition (Passey and Hugie 1962). Below normal precipitation during this inventory could have significantly affected plant production. This may explain why *Packera millefolia* was not located during this inventory. The severe drought also made species identification difficult, due to stunted specimens and a lack of reproductive features. Future interpretation of either short- or long-term changes in the community composition of the low-elevation granitic domes of CARL must also consider climate and weather.

The highest species diversity among sites was observed at Oucrop 14. This granitic-dome complex is a high-quality example of the community type. Although the outcrop is highly visible in the Park landscape it remains largely inaccessible due to various landscape features and the steep slopes that surround the outcrop perimeter. Outcrop #14 is also the largest granitic-dome complex in the Park. Because of its large size the outcrop supports a wide range of micro-habitats. The species-area relationship of granitic-outcrop communities is supported by the specific requirements of outcrop plant secies and greater heterogeneity among microsites (Houle 1990, Rosenzweig 1995). Outcrop #14 and other high-quality granitic domes identified during this study provide an important reference for management activities directed at granitic-dome conservation in the Park. The condition of these high-quality outcrops should be closely monitored in the future.

Community Structure

The composition of low-elevation granitic domes has been well-described and has a definite floristic composition, uniform habitat condition, and uniform physiognomy (McVaugh 1943, Burbank and Platt 1964, Murdy 1968, Phillips 1982, Schafale and Weakley 1990, Shure 1999). The striking xeric character of the low-elevation granitic dome communities of CARL is due to the combination of higher rates of solar radiation and limited soil and water availability. However, direct comparison of plant cover and composition data from my study with those studies that are outlined above is difficult. The following evidence from the botanical inventory suggest that most of the rock-outcrop communities in the Park depart little from similar vegetation that has been considered “natural” in other areas:

1) The rock outcrops of CARL support a high proportion of outcrop-restricted species.
2) With the exception of those outcrops that are heavily accessed by visitors, outcrop vegetation is largely a zoned collection of lichens, mosses and herbs.
3) Where soil substrates are available the relative importance of graminoids such as *Schizachirium scoparium, Deschampsia flexuosa,* and *Dichanthelium spp*. and of major forb species such as *Saxifraga michauxii*, *Coreopsis major*, *Hypericum gentianoides, Talinum teretifolium*, and *Croton wildenowii* dominate.

Visitor Impacts

The objective of this study was to establish a clear reference for evaluating the impact of visitor use on granitic-dome communities. The results of this study indicate that lichen coverage can provide an effective monitoring tool for assessing visitor use on granitic-dome communities. Granitic domes are an important recreational feature in the natural landscape of CARL. Many of these sites offer panoramic views of the landscape in and around the Park and are a popular destination for hikers. An important result of the visitor-impact study was that visitor impacts to the granitic domes of CARL were not contained to the outcrop face. Trail acess was correlated to reductions in fruticose lichen density on outcrop borders. This indicates that visitors not only access granitic domes for the potential views that they offer, but also explore the perimeter of the community.

Because visitor use of the granitic domes of CARL is diffuse across the community there are additional community-level impacts that can be inferred from a high incidence of visitor use. In particular, the soil belts that surround low-elevation granitic domes may be particularly sensitive to issues related to compaction. Several researchers have shown that the effects of soil compaction are compounded in environments where nutrients and moisture are scarce (Gouvenain 1996, Saravi et al. 2005). Compacted soils have lower soil volume and greater bulk density. Both soil density and soil volume have important affects on soil moisture, nutrient availability, and thermal conductivity (Wills and Raney 1971, Kemper et al. 1971, Gouvenain 1996). In addition to compaction, one of the most apparent causes of damage to the structure and composition of soils on the rock outcrops of CARL is ersosion and the introduction of sediment from trail runoff. Erosion and sediment deposition from nearby trails were particularly apparent on Outcrop #8 along the Big Glassy Trail and Outcrop #15 on the slopes of Little Glassy Mountain. Trampling along the edges of granitic domes also has greater potential to impact vascular and bryophyte communities. There were no observable differences in vascular or bryophyte cover during this study. The resiliency of vascular and bryophyte communities on the low-elevation granitic dome communities of CARL may be due in part to the morphology and growth characteristics of component species and to environmental factors that are specific to the community type.

Lichens are more sensitive to trampling on granitic domes because of site-specific factors. A study by the USFS on Hurricaine Island, Maine indicated that *Cladina sp.*

were largely un-impacted from trail use as compared to bryophyte and vascular species (Leonard et al. 1985a). Although the island was composed largely of granitic substrates, site conditions were substantially different than those found on the granitic-dome communities of CARL. Leonard et al. (1985a) linked the resiliency of lichens to the the lack of slope and the per-humid climate of Hurricane Island combined with relatively low levels of visitor use. Lichens have a unique ability to regenerate from fragments that are crushed under foot (Törn et al. 2006). Under low-intensities of trampling these fragments lead to a rapid recovery of lichen cover (Leonard et al. 1985a, Törn et al. 2006). Steeper slopes that are associated with low-elevation granitic domes may prevent the regeneration of lichens by increasesing runoff-rates. Higher rates of runoff on low-elevation granitic domes can transport these fragments away from the area of incidence to other areas within the community that may have substantially different micro-climatic conditions. Törn et al. (2006) attributed the influence of slope to a six-fold decrease in lichen densities as compared to sites located on flat terrain in recreation areas of the North Cascades. The resiliency of vascular and bryophyte species on low-elevation grantic domes might also be attributed to changes in competive interactions due to the loss of lichen cover. Many lichen species are alleopathic and antimicrobial as a result of secondary compounds (Gardner and Mueller 1981, Hobbs 1985). Several authors have suggested that reductions in lichen cover encourage the germination of trees and forbs (Zamfir 2000, Asselin et al. 2006, Sedia and Ehrenfeld 2003).

Lichen groupings, similar to the ones used in this study, showed the greatest resolution of recreation-related impacts among vegetation types across all portions a cliff system of the Niagara Escarpment (McMillan and Larson 2002). Grouping vascular and bryophyte plant species according to their ability to resist mechanical damage could provide greater sensitivity in evaluating visitor impacts. However, this approach would be less straightforward than groupings of lichen morphotypes.

Research indicates that impacts from visitor use follow a natural progression (Cole 1982, Leonard et al. 1985b, McMillan and Larson 2002). Initial and very light trampling may only damage particularly fragile vegetation. However, with additional trampling, the majority of vegetation cover is lost and surface organic litter is pulverized. As trampling continues all but the most resistant plant species are lost and the lack of vegetation on a site greatly increases the potential for soil erosion. The rate of erosion continues to increase once organic soil layers are removed and mineral soils are exposed. The deposition of eroded soil has the potential to affect other areas of vegetation. These resource related impacts occur in a curvilinear fashion (Leonard et al. 1985b). For example, a study of soil compaction in Northern Minnesota found that only 12 nights of campsite use per year caused substantial biophysical changes, while further increases in use caused significantly less additional change for most forms of impact (Cole 1982). A USFS study that examined trail use in granitic communities of New Hampshire showed that in as few as 25 passes there was visible damage to plant communities (Leonard et al. 1985b). An important implication of this curvilinear relationship is that comparatively low levels of visitor use must be eliminated to achieve significant reductions in visitor-use impacts. The magnitude of impact from low levels of visitor use is an important consideration in mitigating community trail development at CARL.

The rate at which a plant community can sustain recreational use is a combination of its ability to resist trampling and its capacity to regenerate (Törn et al. 2006). Research has shown that recovery rates on trails are considerably lower than initial impact rates (Leonard et al. 1985a). There is a lack of information regarding resistance and resiliency in rock outcrop communities. However, it is apparent that trampling damage can occur at very low levels of visitor use and that recovery periods are often slower than initial impact rates. The National Park System operates under a dual legal mandate: to provide both high-quality recreation experiences and to protect natural resources and processes. Recreationial use of rock outcrops unintentionally tramples vegetation, compacts soils, and increases erosion rates. Such recreation-related biophysical changes present a dilemma for managers charged with the dual objectives of providing recreational opportunities and preserving natural communities. Management of the low-elevation granitic domes of CARL will require actions that balance these conflicting objectives.

The primary management objective for the conservation of granitic dome communities is to prevent deterioration of high-quality sites. The ecological value of individual granitic domes within the Park is influenced by site size, site complexity and species diversity. The Conservation Status for each of the granitic domes at CARL is defined by their ecological value and the level of human impact currently present at each site (Table 8). High Conservation Status sites are larger, more species diverse, and relatively un-impacted by visitor use. Moderate Conservation Status refers to sites that contain relatively high amounts of plant diversity and moderate levels of human impact. None of these sites are accessible from the Park's designated-trail system, but many are visible or immediately adjacent to these trails. Low Conservation Status sites are accessible by formal trails and have moderate to high levels of human-caused degradation to soil and vegetation cover.

The success of designating granitic domes specifically for conservation is dependent on the Park's ability to establish and maintain sites that are off-limits to visitors. The granitic domes of CARL are a focal point in the natural landscape of CARL and the community of Flatrock. However, few members of the community know of the sensitivity or rarity of this community type. Public awareness and understanding of the sensitivity of rock outcrop resources is critical to the success of any proposed effort towards conservation. Public awareness can be generated through a variety of methods. The most unobtrusive methods include the use of interpretive brochures and presentations to educate the public about the value of granitic-dome communities. Interpretive brochures could be distributed at one of the Park’s current trail kiosks. Installing interpretive signs would provide a more permanent and visible means for expository media. Two excellent sites for the use of permanent interpretive materials include Outcrop #8 and Outcrop #15. The use of interpretive materials could enhance public appreciation of granitic-dome resources and support and achieve wider objectives by enhancing the visitor experience. In addition, if the public places a high value on the conservation of granitic-dome communities, it improves sentiment to support additional protective measures for rock-outcrop communites located outside of the Park. Establishing a long-term visitor impact monitoring program offers significant benefits to the natural resource managers of CARL. The methods used to measure visitor impacts in this study may be impractical, given the labor intensity of data collection and the limited resources and personnel at the Park. The use of photography would be an efficient and effective way to establish a measurable reference point to which future conditions can be compared. Simple photogrammetric methods have been employed in the past to measure lichen growth over certain time periods (Brink 1973, Hooker and Brown 1977). If permanent quadrats could be placed and photographed on an annual basis, evidence could be collected to provide a direct indication of increased visitor impacts over time. A long-term photographic monitoring project on the outcrops of CARL has many potential benefits. Deteriorating conditions can be detected before severe or irreversible impacts occur, allowing time for implementing corrective actions. Photographic monitoring data also permits an evaluation of the success or failure of implemented resource protection measures. Not only could the data add to information regarding visitor impacts but it could also provide information on disturbance, extent, and successional change. In addition, a photographic monitoring program provides an objective record of resource conditions, even though individual managers may come and go.

Table 8. Conservation status of the granitic domes at Carl Sandburg National Historic Site.

Conservation Status	Criteria for Designation	Outcrop Sites
High	Large sites that remain relatively un-impacted are structurally complex and have high species diversity	#4, #5, #6, #9, #10, #11, #13, #14,
Moderate	Moderately to heavily impacted rock outcrops that are generally smaller and/or support lower species diversity	#3, #7, #8, #12, #15, #16, #17,
Low	Rock outcrop sites that are heavily impacted and/or serve primarily for recreational and cultural uses	#1, #2, #18, #19, #20, #21

Invasive Plant Species

The goal of the invasive species assessment was to determine the relative importance of the most abundant and widespread invasive plant species on the low-elevation granitic domes of CARL. Although the APRS was originally developed for grassland systems in the Midwest, its efficacy has been evaluated regionally. Results in the Southeastern United Sates have been shown to be consistent with species-ranking designations from other organizations, such as the Tennessee Exotic Pest Plant Council (Drake et al. 2003).

The relative rank of invasive plant species in the APRS mirrored the observed density patterns of invasive exotic species on low-elevation granitic domes as a whole. Invasive species that ranked the highest in the APRS shared three important characteristics. The most problematic species were colonial woody shrubs and vines with endozoochorous dispersal mechanisms. Endozoochorous dispores have the potential to travel long distances – as long as they are in the digestive tract of a moving disperser. Long- distance dispersal has allowed these species to occupy many of the isolated outcrops of CARL. These species influence the diversity and structure of the low-elevation granitic domes of CARL in two main ways. First, by forming large monocultures on soil islands and along outcrop edges invasive exotic species crowd out native species and reduce the diversity and complexity of these communities. Second, when invasive woody shrubs and vines occupy upper vegetative strata they seriously alter or destroy the understory and herbaceous layers of the community by affecting available sunlight. Many endemic rock-outcrop species have high light requirements (McVaugh 1943, Cotter and Platt 1959, Shure 1999). Granitic domes are particularly sensitive to endozoochorous dispersal, specifically from birds. Birds provide a common mechanism of endozoochory among many invasive plants. Recruitment of bird-dispersed seeds is highest below perching structures (Holl 1998). The small size and azonal structure of granitic dome communities creates a high proportion of edge and provides substantial perching territories. The influence of seed-rain has not been investigated in these communities. Future studies on propagules pressure could provide valuable insight into the immigration potential of both native and non-native species.

The APRS model is an important first step in illustrating and prioritizing invasive species management needs on the outcrops of CARL. However, there are several limitations in the predictive power of risk-assessment models. Despite the considerable attention that invasive species have received the majority of scientific evaluations of invasive species impacts remain qualitative (Parker et al. 1999). It became apparent while reviewing the literature that even basic ecological information on many invasive species is not readily available. The lack of quantitative data directed at the effects of exotic invasions on natural communities makes overall assessments of the magnitude of impact of invasive species difficult (Drake et al. 2003). Even for many widespread Rank 1 invasive species there are large information gaps on reproductive and dispersal characteristics, the viability and longevity of propagules in the soil seedbank, relative growth rates, and community characteristics of exotic species within their native ranges. Additional information on these topics would improve the ability to rank these species, provide more precise predictions of their impacts, and more efficient targeting of resources in restoring damaged community types. Because of these limitations the APRS model for the rock-outcrops of CARL may serve more as a point in time reference than as a predictive model.

Two species that were not ranked to be problematic in the APRS that raised particular concern were *P. tomentosa* and *M. sinensis*. Recently, the State of Tennessee upgraded the classification of *P. tomentosa* to a Rank 1 Invasive plant—one that poses a severe threat. It has Rank 2 classification—significant threat status, in Kentucky and Virginia, but bears no designation in North Carolina. *P. tomentosa* has been documented to be particularly aggressive on cliffs and rock-outcrop communities (Langdon and Johnson 1994). The threat of *M. sinensis* has only been classified in the State of Michigan, where it has Rank 1 status, and has received very little attention from the scientific community. *P. tomentosa* and *M. sinensis* are widely cultivated as ornamentals and can be found in residential landscapes that surround CARL. Both species have escaped cultivation and have become widespread throughout the Asheville Basin. They are highly fecund and produce wind-dispersed diaspores that have the potential for long-distance dispersal. The interface of residential and natural landscapes provides a means for propagules of these species to enter rock-outcrop communities and allows these species to establish satellite populations on new or potentially un-impacted rock outcrops. Immediate attempts should be made to control known populations of these species within the Park and their impact to granitic-dome communities should be carefully monitored in the future.

The control of exotic species at CARL is a primary management goal. The results of the APRS indicate that low-elevation granitic domes face a growing threat from aggressive exotic plants. Without continued effort to control the invasive exotic plants the low-elevation granitic domes of CARL will sustain major negative impacts. Management strategies for the control of invasive species in order of priority are prevention, eradication, containment, and large-scale population reduction (Wooten and Renwyck 2001). Invasive species management should focus on all priority species that were identified in the APRS assessment and should prioritize the protection of intact areas, remove the pressure that invasive plants place on native plants, and encourage the natural recruitment and spread of native plants into degraded areas by means of seeds.

Managing the rock-outcrops of CARL for invasive species will require significant effort and a long-term commitment. Invasive species are persistent, and success may require repeated treatments over several years. Invasive plants can be controlled by a variety of means and include physical, chemical, and biological alternatives. Wooten and Renwyck (2001) provide a thorough description of each of these methods. They all have costs, benefits, and risks associated with their application, that vary in magnitude with each individual invasive species and site. Because of the fragile nature of low-elevation granitic dome communities, direct or secondary effects of invasive plant control should be minimized to the greatest extent possible.

The prevention of new species introductions should also be a concept incorporated into this management plan. Annual surveys targeting non-native invasive species are an important component in maintaining current successful efforts towards invasive-species control. Early detection of non-natives is the most cost-effective management action for controling exotic-invasive species (Hobbs and Humphries 1995). In instances where invasive-plant concentrations on adjacent private land threaten granitic-dome communities and if the adjacent land owners agree to participate, invasive-plant identification, mapping, and control should be extended to adjacent properties when feasible.

Soils

Spatial patterns in soil-island depth appear to be good analogs of patterns in species composition. Soil depth increased with the progression of seral stages as did vertical diversity. Trees occurred at maximum soil depths of ≥ 32 cm. Although site conditions are very different among rock-outcrop types this value is strikingly similar to values reported by Houle and Phillips (1989). As in other studies, trees that occupy soil-islands on the granitic domes of CARL are often solitary and centered within the soil-island (Houle and Phillips 1989, Phillips 1981). The presence of solitary trees is interesting because these trees are expected to increase propagule pressure. The lack of apparent regeneration may be due to limited available resources, limited available microsites for establishment, or inhibitory effects of the established trees. It is doubtful that these trees all established at the center of soil-islands. It is more likely that the position of these trees is related to their effect on soil retention. The presence of a deep soil pocket at the base of these trees is likely facilitated by the exudation of organic acids by tree roots.

Because this study was limited to singular observations no attempt can be made to determine the rate of succesional development on the granitic domes of CARL. However it was apparent that rock-outcrop soil development was, (1) slow, (2) highly-localized, and (3) heavily- dependent on environmental conditions. I used the estimated age of trees to rank the relative age of soil-islands. These rankings may be inaccurate for several reasons. Because of temporal and spatial varability in site specific factors, soil-island development may have more to do with position on the rock surface than on relative age. For example the position and scale of micro-features (crevices, cracks, and shallow bedrock depressions) on the rock surface has a major effect on soil accumulation.

Studies of soil island development focus on changes in community structure towards a predictable end point dominated by trees and shrubs (Burbank and Platt 1964, Rogers 1971, Shure and Ragsdale 1977). Evidence from this study supports the hypothesis that succession and soil development are a unified process (Moravec 1969). However, soil island development on the granitc domes of CARL is not strictly facilitative as proposed by Hart (1993). Although facilitative processes are important in soil island development, Hart (1993) provides little explanation for the long-continued existence of rock outcrops. The extent of soil islands on the granitic domes of CARL may have changed very little since the Sandburgs purchased the estate. For example, Phillips (1981) did not observe any major increases in the area of soil-islands over 22 years of observation on granitic domes of Panola Mountain, Georgia. Some authors have refuted simple models of relay floristics and have proposed models of succession that are less deterministic (Connell and Slatyer 1977, Sedia and Ehrenfeld 2003, Jasinski and Payette 2005). It is possible that soil-islands are spatially stable for long periods of time. Temporal and compositional stability can be caused by physical and biotic factors and discrete processes in community dynamics. Discrete processes include the occurrence of steep environmental gradients, chronic natural disturbances, and negative feedbacks from species interactions (Walker and del Moral 2008). During this study I saw substantial evidence of drought induced mortality. Rather than being a stabilized ecosystem as described by Oosting and Anderson (1939) the development of soil islands may be cyclic in response to moisture stress (Phillips 1981). Several authors have suggested that inhibition caused by species interactions can promote stable-state community dynamics on rock outcrops (Snyder 1971, Sedia and Ehrenfeld 2003, Asselin et al. 2006). The use of long-term data is necessary to improve our understanding of the role of disturbance and inhibition in these systems. Information provided in this study should be used to monitor the rate of soil-island development in the future. Because soil is formed so slowly on rock outcrops, anthropogenic impacts to soil resources can have a major and direct effect on community dynamics. Damage to granitic-dome soils in the form of soil accumulation from trail runoff, accelerated soil loss, and compaction are primary management concerns.

Succession of Outcrop Borders

Past influences together with current micro-climatic conditions allow rock-outcrop communities to persist among forested community types within the Park. The encroachment of forests on the granitic outcrops of CARL has been discussed in several Park documents (Hart 1993, Johnson 2003, White 2003). The results of dendrochronological evidence collected in this study indicate that forested encroachment is not occurring as rapidly as previously reported (Hart 1993). The position of trees in older-age classes along the forested borders of granitic domes indicate that the extent of the granitic domes of CARL have remained fairly constant for at least the last 150 years. However, the structure and composition of these stands have changed dramatically over this time period.

I found a bimodal composite age structure for trees occupying the forest overstory. This indicates that two major disturbances led to the two major recruitment events at these study sites. Oaks exhibited a unimodal distribution in age-structure. The resulting peak indicates a major recruitment event of oak stands occurred in the 110 - 150 year age-classes or from 1859 to 1900. This peak in age-structure corresponds to the period following the Civil War, when wide-scale changes in land-use patterns drastically altered forest composition in the southern Appalachians (Davis 1978, Williams 1989, Yarnell 1998). The presence of older oaks in the overstory suggests that the original forests that occupied the edges of granitic domes of CARL contained a major oak component. Existing *P. strobus* are younger than the oaks in the overstory. *Pinus strobus* has established continuously since the early 1940s, near the time the Sandburgs occupied the estate. There is no evidence of fire or catastrophic stand-altering disturbances during this period other than the chestnut blight (Carlson 1995, Scott and Shelburne 2003). As is widely reported, chestnut blight may have constituted over 40% of stand density in the southern Appalchians. It is possible that canopy openings caused by chestnut blight facilitated the initial establishment of *P. strobus* in these forests. Chestnut blight was first reported in North Carolina near Stokes and Surry counties in 1913 (Buttrick 1925). By 1925 one in five trees was affected by blight in neighboring Buncombe County (Silver 2003), and by 1940 there was scarcely a tree left throughout the entire Appalachian region (Exum 1992, Davis 2000). This period of white pine recruitment is exhibited in other forested communities of the southern Appalachians. Scott and Shelburne (2003) reported that over 96% of overstory white pine recruitment in the nearby Ellicott Wilderness of South Carolina occurred in the 1950s. There was a small cohort of older-age white pines sampled during this study (>70 yrs), which could have provided propagules during the last major recruitment phase. However, this cohort was substantially smaller than oak. This raises important questions about the structure of forests prior to the last recruitment phase and about the dispersal potential and competitive ability of *P. strobus*. Although, this study provided accurate estimates of age-structures, further dendrochronological evidence is needed to interperet whether the recruitment of white pine was caused by a release of suppressed saplings or from the direct establishment of seed.

Results of this study support the hypothesis that *P. strobus* has undergone a change from its presettlement distribution (White and Lloyd 1998, Blankenship and Arthur 1999). White and Lloyd (1998) and Blankenship and Arthur (1999) hypothesized that *P. strobus* was confined in the presettlement southern Appalachian forest to mesic sites protected from fire, but is shifting or expanding into xeric-community types following fire suppression activities initiated in the early 1900s. The importance of *A. rubrum* in regeneration and understory strata provides additional evidence of fire suppression activities (Lafon et al. 2007). Without fire, slow structural and compositional changes occur in low-elevation granitic dome vegetation. Further changes in forest structure should be expected as more fire-intolerant species reach the canopy. Although the density of oaks was represented evenly across forest layers the relative-dominance of middle-aged white pines will likely result in general oak decline in the forested edges of rock outcrops in the future (Lafon et al. 2007).

Fire has been a major ecological force in the evolution and distribution of community types in the Southeast. Fire creates open woodland conditions on xeric sites, rather than continuous closed-canopy forest (White and Lloyd 1998). Although the faces of rock outcrops function as fire breaks (Porembski and Barthlott 2000, Clarke 2002), low-elevation granitic domes support conditions that can promote frequent and intense fires. In addition to being highly xeric, granitic domes collect substantial debris in the form of litter and duff. The accumulation of these fuels increases the likelihood of high-severity fires. Fire intensity has important effects on the structure and response of vegetative communities (Lafon et al. 2007). Barden (2000) suggests that xeric forests in the southern Appalachians burned historically at 5- to 7-year intervals in "understory shrub fires" and less frequently, every 75 years, in "catastrophic" stand-replacing fires. These conditions would have expanded the ecotonal boundaries of granitic domes substantially. Anderson and Bowles (1999) provide evidence that xeric and azonal communities created large savanna-type ecotones. These conditions would support a number of rock-outcrop restricted species (Johnson 1989, Johnson et al. 1989, Schafale and Weakley 1990, Anderson and Bowles 1999).

A report by NatureServe suggested that mechanical thinning could be used to enhance plant diversity within the granitic-dome communities of CARL (White 2003). Restoration practitioners frequently remove woody plants with chainsaws to mimic fire to promote the growth of herbs and grasses and to expand communities such as in prairie systems (Rosburg et al. 1994). However, there are important fire effects that are not addressed by mechanical reductions of overhead cover (Brown et al. 2004, Albrect and McCarthy 2006). In addition, mechanical treatments would be highly labor intensive and pose a greater risk of compaction to soils from the secondary effects of plant removal. Because of the small size of CARL and the importance of historical and residential features it is impossible to initiate landscape-level fires. A legacy of fire suppression creates conditions that alter the characteristics of fire regimes such as spread patterns and intensity (Keeling et al. 2006). An uncontrolled fire at CARL would likely reach high intensity. In this study, average duff depths varied from plot to plot, but were overall very thick. Additionally, the presence of a thick understory acts as a fire ladder that can carry fire from the forest floor into the canopy (Johnson 2003). The use of prescribed burns can provide the most cost-effective and efficient land management tool for mimicking the role of fire on the natural communities of CARL. However, fire management within the residential landscape that surrounds CARL will require new and refined approaches as well as active dialogue with the surrounding community. Controlled burns are currently being used in Great Smoky Mountains National Park to sustain similar community types there (Brose and Waldrop 2006). Between 2003 and 2006, Cowpens National Battlefield used prescribed fire inside the Loop Road to restore native grasses and to allow sunlight to reach the forest floor (NPS 2003). Active management strategies that mimic disturbances caused by the historic fire regime will be an essential component in maintaining the diversity of the low-elevation granitic domes of CARL. Although unrestrained fire represents a hazard to public safety and property, the benefits of carefully prescribed and controlled fires can be realized.

Any attempt to manage the disturbance regime of granitic-dome communities should acknowledge that a great deal of uncertainty exists about the nature of ecosystems and the organisms and processes that define them. Compensating for the loss of fire in the landscape is complex for several reasons, and any attempt to interpret the historical fire regime is inherently subjective. While it is well established that fires were more frequent in dry southern Appalachian forests than at present, the relative importance of the historical-fire regime is still debated and may have varied greatly within the southern Appalachian region (Delcourt and Delcourt 1987, Yarnell 1998). Delcourt and Delcourt (1987), for example, reported low frequencies of lightning fires, and concluded that Native American burning largely maintained presettlement fire-tolerant vegetation. In the first half of the century livestock pastures were maintained in ways similar to the native Americans where pastures were cleared at repeated intervals using slash and burn methods (Yarnell 1998). The impacts of the historic anthropogenic fire regime, however, were not uniform across the southern Appalachians, and it is unclear how frequently, if at all, an area would be burned (Yarnell 1998). Likewise, lightning-caused fires may have been relatively rare, but it is unclear how the size of areas burned by lightning fires compared to that of Native American fires. It is possible that the current structure of forests observed at CARL represents a vegetation type that would have historically occurred more extensively had anthropogenic burning not increased fire frequencies above those typical of lightning ignitions.

In implementing management strategies that mimic the historic fire regime the Park should move forward cautiously by targeting a small number of sites. Exposed ground surfaces, a flush of nutrients, and high light may favor regrowth and expansion of invasive plants in burned areas. A preliminary study of the soil seed bank is an informative first step before implementing any level of disturbance, because it is important to know which desirable and undesirable species are present in the soil. Brown (1998) used the seed bank prior to restoration activities to illuminate which invasive species were present in the soil “waiting” for the appropriate conditions to proliferate.

Johnson et al. (2006) evaluated nonnative plant establishment, spread, and persistence following wildfire in natural areas. Though conventional wisdom is that many invasive plant species will dramatically increase following fire, the authors concluded that invasive species may either increase or decrease depending on type of habitat and departure from natural fire regimes. In lieu of prescribed burning the efficacy of mechanical treatments should also be evaluated. Successive treatments should continually build on knowledge obtained at the target sites, and continue to help tailor the management approach.

Conclusion

The NPS is a leader in developing facilities that are sensitive to the environment and retain a sense of heritage. The purpose of this project was to coordinate efforts to achieve a resource-preservation vision for the granitic-dome communities at CARL. In addition to providing for a valuable visitor experience granitic domes have clear ecological value. They support a significant proportion of plant diversity within the Park and are of high priority for maintaining the natural integrity of CARL. Several conservation and recreation-related issues concerning the present condition of granitic domes were identified in the initial assessment. It may seem logical that designating natural areas within the Park is enough to assure the preservation of rock outcrop communities and that they are best left alone to take care of themselves. However, the natural communities of CARL are undergoing constant change. Not only are rock outcrop communities sensitive to the impacts of increased visitor use but they are also subject to legacy effects caused by landscape-level impacts including: the introduction of invasive, exotic species, regional habitat fragmentation, and disruption of the fire regime. Maintenance of the granitic dome communities of CARL will require active management to retain their functions and values into the future. Important management considerations for these communities include strategies to maintain species diversity and community function, to mitigate the impacts of visitor use, and to compensate for the disruption of natural processes. In order to define the most appropriate range of resource conditions and visitor use experiences that should be provided for rock outcrop resources three alternative concepts and a No-action Alternative are presented for the management of low-elevation-granitic domes at CARL. Creating a full range of management alternatives helps define a framework that examines different prescriptive management strategies and potential actions. In addition to the No-action Alternative, potential management alternatives range from enhancing opportunities for visitor use to managing strictly for natural resource integrity.

No-Action Alternative

A No-Action Alternative, consists of maintaining existing visitor access to outcrop sites that are located directly on the Park's designated trail system and to outcrops that are accessed by informal "community" trails. Informal trails are tolerated and allowed to increase in the future. Outcrops that serve as historical features will be maintained through a "hands-off" policy. Viewsheds are not maintained. Monitoring of natural resources will continue in order to satisfy NPS mandates by identifying moderate to adverse effects to the natural resources of rock outcrops.

This alternative would cause increased degradation to granitic dome resources in the future. The impact of the No-Action Alternative will be a management policy that can only function reactively to specific site impacts. Likely natural resource impacts include the proliferation of non-native species, changes in community structure, and trampling of isolated high-quality sites. In addition the visitor experience is affected through the loss of historical integrity and the obstruction of views.

Emphasis on Visitor Use Alternative

Visitor access and opportunities for enjoyment of rock outcrop resources is of primary importance in this alternative. As a public green space CARL is an integral part of the Flat Rock community and provides residents with an important source of recreation. As the regional population increases and the character of the surrounding community becomes more suburban, fewer opportunities for solitude and contemplative experiences may exist outside Park boundaries. Isolated rock outcrops provide access to many underappreciated views within the Park and provide an opportunity for enhanced visitor experiences. In this alternative the Park's trail system will be modified to support high visitor use including establishing formally designated trails to access additional rock outcrops. In addition the use of informal trails will be tolerated. Trail facilities at outcrop sites will be enhanced to provide visitor enjoyment and will include the maintenance of views and benches. Cultural outcrop resources will be maintained and preserved to closely reflect the historic character of the Sandburg residency. Selective invasive species control will continue in order to maintain the aesthetic nature of rock outcrops. Natural resource monitoring of rock outcrops will continue, but no management action will be placed on outcrops with high conservation value.

This alternative fails to meet the Park's multiple-use objectives by failing to preserve the natural integrity of the property. The effect of managing primarily for visitor use will likely impact granitic domes through greater proliferation of non-native species, changes in community structure, trampling of sensitive plant species, and soil compaction. These impacts will extend to sites that are of high conservation value.

Emphasis on Natural Communities Alternative

This management alternative prioritizes the protection and restoration of natural communities within the Park. The prevention of human impacts to granitic domes is of primary importance. Heavily-restrictive visitor management practices are used to mitigate adverse impacts. An assessment of visitor use and impacts will be completed at regular intervals. Conflicts from visitor use will be contained by the use of barriers, platforms, boardwalks, and interpretive materials.

Although rock outcrops are an important natural feature of CARL, strict preservation of natural communities fails to meet the Park's multiple-use objectives. This alternative impacts the visitor experience by reducing opportunities for recreation and degrades the interpretive potential of the landscape by affecting its historical accuracy.

Balance Between Resource Conservation and Visitor Use Alternative

A balance between resource conservation and visitor use attempts to balance visitor access and resource protection needs. Given that Park management personnel are mandated to protect rock outcrop resources while still providing opportunities for visitor enjoyment this is clearly the preferred alternative for the management of rock outcrop resources at CARL. This alternative seeks to conserve natural resources on isolated and high-quality granitic domes, and provide for visitor use and enjoyment of rock outcrop areas that are currently accessed by the Park's designated trail system. Viewsheds are maintained where appropriate. Cultural outcrop sites are maintained at their current extent. Visitor use of rock outcrops located on Park trails is encouraged and views are maintained. However, visitor access to sites of high conservation value is limited through regulations or the use of interpretive materials. Long-term management strategies are implemented to maintain the composition and diversity of granitic dome communities. Invasive species control measures continue and appropriate monitoring criteria are implemented.

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APPENDIX A

SPECIES ASSOCIATED WITH THE GRANITIC ROCK OUTCROPS OF CARL

CARL – Vascular Species – Outcrop 1

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Carya alba (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Carya pallida (Ashe) Engl. & Graebn.	sand hickory	Native	G5, S4
Chionanthus virginicus L.	fringetree	Native	G5, S5
Clethra acuminata Michx.	sweet pepperbush	Native	G4, S4
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Crataegus flava Ait.	yellowleaf hawthorn	Native	G5, SNR
Croton willdenowii Webster	two-fruit rushfoil	Native	G5, S3
Deschampsia flexuosa (L.) Trin.	wavy hairgrass	Native	G5, S3
Dichanthelium sp. (Hitchc. & Chase) Gould	a panic grass	Native	N/A
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark	tapered rosette grass	Native	G5, SNR
Hypericum hypericoides (L.) Crantz	St. Andrew's cross	Native	G5, S5
Hypericum sp. L.	St. John's-wort	Native	G5, S4
Iris verna L.	dwarf Iris	Native	G5, S4
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Lysimachia quadrifolia L.	whorled yellow loosestrife	Native	G5, S5
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Photinia melanocarpa (Michx.) Robertson & Phipps	black chokeberry	Native	G5, S3S4
Phytolacca americana L.	pokeweed	Native	G5, S5
Pinus rigida P. Mill.	pitch pine	Native	G5, S4
Pinus strobus L.	white pine	Native	G5, S5
Pinus virginiana P. Mill.	Virginia pine	Native	G5, S5

Potentilla canadensis L.	dwarf cinquefoil	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus coccinea Muenchh.	scarlet oak	Native	G5, S5
Quercus marilandica Muenchh.	blackjack oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus flagellaris Willd.	northern dewberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Rumex acetosella L.	sheep sorrel	Alien	GNR, SNA
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Solidago canadensis L.	Canada goldenrod	Native	G5, SNR
Solidago roanensis Porter	Roan Mountain goldenrod	Native	G4G5, S4
Symphyotrichum sp. Nees	an aster	Native	N/A
Uvularia sessilifolia L.	sessile-leaf bellwort	Native	G5, S4
Vaccinium sp. L.	blueberry	Native	N/A
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium pallidum Aiton	hillside blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 1

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR

Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Leskea gracilescens Hedw.	leskea moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Pohlia nutans (Hedw.) Lindb.	nodding-thread moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR
Scapania nemorosa (L.) Grolle.	scapania moss	Native	G5, SNR
Lichen			
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia arbuscula (Wallr.) Hale & Culb.	reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Cladonia macilenta var. *bacillaris*	cladonia lichen	Native	G5, SNR
Dimelaena oreina (Ach.) Norman	mountain lichen	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidea lapicida (Ach.) Ach.	lecidea lichen	Native	G5, SNR
Lecidea tessellate Flörke	lecidea lichen	Native	GNR, SNR
Lecidella carpathica Korber	disk lichen	Native	G5?, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Micarea erratica (Korber) Hertel, Rambold & Pietschmann	erratic dot lichen	Native	GNR, SNR
Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR
Xanthoparmelia tasmanica (J.D. Hook. & Taylor) Hale	Tasmanian xanthoparmelia lichen	Native	G5, SNR

CARL – Vascular Species – Outcrop 2

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Ambrosia artemisiifolia L.	annual ragweed	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke	dense-tuft hairsedge	Native	G5, S4
Carya alba (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Carya pallida (Ashe) Engl. & Graebn.	sand hickory	Native	G5, S4
Chionanthus virginicus L.	fringetree	Native	G5, S5
Commelina communis L.	Asiatic dayflower	Alien	G5, SNA
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Corydalis sempervirens (L.) Pers.	pale corydalis	Native	G4G5, S3
Croton willdenowii Webster	two-fruit rushfoil	Native	G5, S3
Cypripedium acaule Ait.	moccasin flower	Native	G5, S5
Dryopteris marginalis (L.) Gray	marginal woodfern	Native	G5, S5
Erigeron sp. L.	fleabane	Native	N/A
Eupatorium rotundifolium L.	roundleaf thoroughwort	Native	G5, S5
Hypericum hypericoides (L.) Crantz	sharp-leaved loosestrife	Native	G4, S4
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Photinia melanocarpa (Michx.) Robertson & Phipps	black chokeberry	Native	G5, S3S4
Pinus strobus L.	white pine	Native	G5, S5
Polygonum cespitosum Blume var. *longisetum* (Bruijn) A.N. Steward	oriental smartweed	Alien	GNR, SNA
Potentilla canadensis L.	dwarf cinquefoil	Native	G5, S5

Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus alba L.	white oak	Native	G5, S5
Quercus coccinea Muenchh.	scarlet oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	northern red oak	Native	G5, S5
Quercus stellata Wangenh.	post oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rhododendron maximum L.	great laurel	Native	G5, S5
Rhododendron periclymenoides (Michx.) Shinners	pink azalea	Native	G5, S5
Rosa multiflora Thunb. ex Murr.	multi-flora rose	Alien	GNR, SNA
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus flagellaris Willd.	northern dewberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Toxicodendron radicans (L.) Kuntze	poison ivy	Native	G5, S5
Uvularia sessilifolia L.	sessile-leaf bellwort	Native	G5, S4
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5
Vitis rotundifolia Michx.	muscadine grape	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 2

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR

Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Pohlia nutans (Hedw.) Lindb.	nodding-thread moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR
Lichen			
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Diploschistes scruposus (Schreber) Norman	crater lichen	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidea lapicida (Ach.) Ach.	lecidea lichen	Native	G5, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR
Xanthoparmelia tasmanica (J.D. Hook. & Taylor) Hale	Tasmanian xanthoparmelia lichen	Native	G5, SNR

CARL – Vascular Species – Outcrop 3

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Agrostis perennans (Walter) Tuck.	autumn bentgrass	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	GNR, SNA
Aralia spinosa L.	devils walking-stick	Native	G5, S5
Bidens frondosa L.	devil's beggartick	Native	G5, S5
Bulbostylis capillaris (L.) Kunth ex C.B.	dense-tuft hairsedge	Native	G5, S4

Carya alba - (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra - (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Carya ovalis (Wangenh.) Sarg.	red hickory	Native	G5, S4
Chionanthus virginicus L.	fringetree	Native	G5, S5
Clethra acuminata Michx.	sweet pepperbush	Native	G4, S4
Commelina communis L.	Asiatic dayflower	Alien	G5, SNA
Croton willdenowii Webster	two-fruit rushfoil	Native	G5, S3
Cypripedium acaule Ait.	moccasin flower	Native	G5, S5
Dichanthelium (cf.) dichotomum (L.) Gould	cypress panic grass	Native	G5, SNR
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark	tapered rosette grass	Native	G5, SNR
Eupatorium rotundifolium L.	round-leaf thoroughwort	Native	G5, S5
Heuchera americana L.	American alumroot	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrew's cross	Native	G5, S5
Hypericum punctatum Lam.	spotted St. John's-wort	Native	G5, S5
Juniperus virginiana L.	red cedar	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Liriodendron tulipifera L.	tulip poplar	Native	G5, S5
Lysimachia quadrifolia L.	whorled loosestrife	Native	G5, S5
Maianthemum racemosum (L.) Link ssp. *racemosum*	false Solomon's seal	Native	G5, SNR
Nyssa sylvatica Marsh.	black gum	Native	G5, S5

Oxydendrum arboreum (L.) DC.	sourwood	Native	G5, S5
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Paspalum laeve Michx.	field paspalum	Native	G5, S5
Phemeranthus teretifolius (Pursh) Raf.	quill fameflower	Native	G4, S3
Pinus strobus L.	white pine	Native	*G5, S5*
Pinus virginiana P. Mill.	Virginia pine	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Pteridium aquilinum (L.) Kuhn	bracken fern	Native	G5, S5
Pycnanthemum flexuosum (Walt.) B.S.P.	Appalachian mountain mint	Native	G5, S5
Quercus alba L.	white oak	Native	G5, S5
Quercus marilandica Muenchh.	black-jack oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	northern red oak	Native	G5, S5
Quercus stellata Wangenh.	post oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rhexia mariana L. var. *mariana*	Maryland meadowbeauty	Native	G5, S5
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S5
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Smilax glauca Walt.	cat greenbrier	Native	G5, S5

Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Spiranthes cernua (L.) L.C. Rich.	nodding ladies'-tresses	Native	G5, S4
Symphyotrichum dumosum (L.) Nesom	bushy aster	Native	G5, S5
Toxicodendron radicans (L.) Kuntze	poison ivy	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium sp. L.	Blueberry	Native	G5, S5
Vaccinium stamineum L.	Deerberry	Native	G5, S5
Viburnum acerifolium L.	maple leaf viburnum	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 3

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR
Lichen			
Cladina mitis (Sandst.) Hustich	green reindeer lichen	Native	G5, SNR
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR

Cladonia arbuscula (Wallr.) Hale & Culb.	reindeer lichen	Native	G5, SNR
Cladonia pleurota (Flörke) Schaerer	red-fruited pixie-cup	Native	G3G5, SNR
Lecidea lapicida (Ach.) Ach.	lecidea lichen	Native	G5, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR

CARL – Vascular Species – Outcrop 4

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	GNR, SNA
Apocynum cannabinum L.	Indian-hemp	Native	G5, S5
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke	dense-tuft hairsedge	Native	G5, S4
Carya alba - (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra - (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Chionanthus virginicus L.	fringetree	Native	G5, S5
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Cypripedium acaule Ait.	moccassinflower	Native	G5, S5
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark	tapered rosette grass	Native	G5, SNR
Eupatorium rotundifolium L.	roundleaf thoroughwort	Native	G5, S5

Hypericum hypericoides (L.) Crantz	St. Andrew's cross	Native	G5, S5
Hypericum punctatum Lam.	spotted St. John's-wort	Native	G5, S5
Pinus rigida P. Mill.	pitch pine	Native	G5, S4
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Pinus strobus L.	white pine	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus marilandica Muenchh.	black-jack oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rhus copallinum L. var. *latifolia* Engl.	winged sumac	Native	G5, SNR
Robinia pseudoacacia L.	black locust	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S5
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Smilax biltmoreana (Small) J.B.S. Norton ex Pennell	Biltmore's carrionflower	Native	G4?, S3
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Symphyotrichum dumosum (L.) Nesom	bushy aster	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5
Vitis aestivalis Michx.	summer grape	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 4

Species Name	**Common Name**	**Native/ Alien**	**Conservation Status**
Moss			
Cephaloziella divaricata (Sm.) Schiffn.	cephaloziella moss	Native	G5, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Pohlia nutans (Hedw.) Lindb.	nodding-thread moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR
Racomitrium heterostichum (Hedw.) Brid.	racomitrium moss	Native	G5, SNR
Lichen			
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladina mitis (Sandst.) Hustich.	green reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Collema sp. Wigg	collema lichen	Native	N/A
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidea tessellata Flörke	lecidea lichen	Native	GNR, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Umbilicaria mammulata (Ach.) Tuck.	common rock tripe	Native	G4G5, SNR
Xanthoparmelia sp. (Vain.) Hale	xanthoparmelia lichen	Native	N/A

CARL – Vascular Species – Outcrop 5

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	GNR, SNA
Aralia spinosa L.	Devil's club	Native	G5, S5
Calamagrostis coarctata (Torr.) Eaton	Nuttall's reedgrass	Native	G5, SNR
Carya alba - (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra - (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Croton willdenowii Webster	two-fruit rushfoil	Native	G5, S3
Deschampsia flexuosa (L.) Trin.	wavy hairgrass	Native	G5, S3
Eupatorium rotundifolium L.	round-leaf thoroughwort	Native	G5, S5
Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry	Native	G5, S5
Hypericum gentianoides (L.) B.S.P.	pineweed	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrews cross	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Ligustrum sinense Lour.	Chinese privet	Alien	GNR, SNA
Maianthemum racemosum (L.) Link ssp. *racemosum*	false Solomon's-seal	Native	G5, S5
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Oxydendrum arboreum (L.) DC.	sourwood	Native	G5, S5

Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Paspalum laeve Michx.	field paspalum	Native	G4G5, SNR
Photinia melanocarpa (Michx.) Robertson & Phipps	black chokeberry	Native	G5, S3S4
Pinus echinata P. Mill.	shortleaf pine	Native	G5, S5
Pinus rigida P. Mill.	pitch pine	Native	G5, S4
Pinus strobus L.	white pine	Native	G5, S5
Pinus virginiana P. Mill.	Virginia Pine	Native	G5, S5
Polygala curtissii Gray	Curtiss' milkwort	Native	G5, S5
Polygonatum biflorum (Walt.) Ell.	Solomon's seal	Native	G5, S5
Polystichum acrostichoides	Christmas fern	Native	G5, S5
Pycnanthemum flexuosum (Walt.) B.S.P.	narrowleaf mountainmint	Native	G5, S5
Quercus alba L.	white oak	Native	G5, S5
Quercus coccinea Muenchh.	scarlet oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	northern red oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rhexia mariana L. var. *mariana*	Maryland meadowbeauty	Native	G5, S5
Rhododendron calendulaceum (Michx.) Torr.	flame azalea	Native	G5, S5
Rhus copallinum L. var. *latifolia* Engl.	winged sumac	Native	G5, SNR
Rhynchospora recognita (Gale) Kral	globe beaksedge	Native	G5?, S4
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Smilax tamnoides L.	bristly greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf catbrier	Native	G5, S5
Solidago sp. L.	a goldenrod	Native	N/A

Symphyotrichum dumosum (L.) Nesom	bushy aster	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5
Xyris torta Sm.	twisted yellow-eyed grass	Native	G5, S3

CARL – Moss and Macrolichen Species – Outcrop 5

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR
Racomitrium heterostichum (Hedw.) Brid.	racomitrium moss	Native	G5, SNR
Sphagnum inundatum Russ.	water sphagnum	Native	G4, SNR
Lichen			
Cladina arbuscula (Wallr.) Hale & Culb.	reindeer lichen	Native	G5, SNR
Cladina stellaris (Opiz) Brodo	star-tipped reindeer lichen	Native	G5, SNR
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR

Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Pycnothelia papillaria Dufour	nipple lichen	Native	G3G5, SNR
Xanthoparmelia sp. (Vain.) Hale	xanthoparmelia lichen	Native	N/A

CARL - Vascular Species Outcrop 6

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Agrostis perennans (Walter) Tuck.	autumn bentgrass	Native	G5, S5
Amelanchier arborea - (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Carya alba - (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra - (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Carya pallida - (Ashe) Engl. & Graebn.	Sand hickory	Native	G5, S4
Chionanthus virginicus L.	fringetree	Native	G5, S5
Coreopsis major Walter var. rigida (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Croton willdenowii Webster	two-fruit rushfoil	Native	G5, S3
Deschampsia flexuosa (L.) Trin.	wavy hairgrass	Native	G5, S3
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. lindheimeri (Nash) Gould & C.A. Clark	tapered rosette grass	Native	G5, SNR
Diospyros virginiana L.	persimmon	Native	G5, S5
Euonymus americanus L.	strawberry bush	Native	G5, S5
Eupatorium rotundifolium L.	roundleaf thoroughwort	Native	G5, S5
Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry	Native	G5, S5

Houstonia purpurea L.	purple bluets	Native	G5, S5
Hypericum gentianoides (L.) B.S.P.	pineweed	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrew's cross	Native	G5, S5
Hypericum punctatum Lam.	spotted St. John's-wort	Native	G5, S5
Ilex opaca Ait.	American holly	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Lechea racemulosa Michx.	Illinois pinweed	Native	G5, S5
Ligustrum sinense Lour.	Chinese privet	Alien	GNR, SNA
Liriodendron tulipifera L.	tulip poplar	Native	G5, S5
Lyonia ligustrina (L.) DC.	maleberry	Native	G5, S5
Lysimachia quadrifolia L.	whorled loosestrife	Native	G5, S5
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Oxydendrum arboreum (L.) DC.	Sourwood	Native	G5, S5
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Paspalum laeve Michx.	Field paspalum		G4G5, SNR
Photinia melanocarpa (Michx.) Robertson & Phipps	black chokeberry	Native	G5, S3S4
Pinus rigida P. Mill.	pitch pine	Native	G5, S4
Pinus strobus L.	white pine	Native	G5, S5
Polygala curtissii Gray	Curtiss' milkwort	Native	G5, S5
Polystichum acrostichoides	Christmas fern	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Pycnanthemum flexuosum (Walt.) B.S.P.	Appalachian mountain mint	Native	G5, S5
Quercus alba L.	white oak	Native	G5, S5
Quercus coccinea Muenchh.	scarlet oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	northern red oak	Native	G5, S5

Rhexia mariana L. var. mariana	Maryland meadowbeauty	Native	G5, S5
Rhododendron calendulaceum (Michx.) Torr.	flame azalea	Native	G5, S5
Rhynchospora recognita (Gale) Kral	globe beaksedge	Native	G5?, S4
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus flagellaris Willd.	northern dewberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Schizachyrium scoparium (Michx.) Nash	little blue-stem	Native	G5, S5
Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Sericocarpus linifolius (L.) B.S.P.	narrow-leaf whitetop aster	Native	G5, S5
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Symphyotrichum dumosum (L.) Nesom	bushy aster	Native	G5, S5
Toxicodendron radicans (L.) Kuntze	poison ivy	Native	G5, S5
Uvularia sessilifolia L.	sessile-leaf bellwort	Native	G5, S4
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 6

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Leucobryum glaucum	pincushion moss	Native	G5, SNR

(Hedw.) Angstr. in Fries			
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR
Sphagnum inundatum Russ.	water sphagnum	Native	G4, SNR
Lichen			
Cladonia arbuscula (Wallr.) Hale & Culb.	reindeer lichen	Native	G5, SNR
Cladina stellaris (Opiz) Brodo	star-tipped reindeer lichen	Native	G5, SNR
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Collema sp. F.H. Wigg	collema sp.	Native	N/A
Dimalaena oreina (Ach.) Norman	mountain lichen	Native	G5, SNR
Diploschistes scruposus (Schreber) Norman	crater lichen	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidea tessellata Flörke	lecidea lichen	Native	G5, SNR
Lecidella carpathica Korber	disk lichen	Native	G5?, SNR
Lepraria lobificans Nyl.	dust lichen	Native	GNR, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Xanthoparmelia conspersa (Ehrh. ex Ach.)	peppered rock shield	Native	G5, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR

CARL – Vascular Species – Outcrop 7

Species Name	Common Name	Native/ Alien	Conservation Status
Ageratina altissima (L.) King & H. Rob. var. *altissima*	white snakeroot	Native	G5, S5
Ambrosia artemisiifolia L.	annual ragweed	Native	G5, S5
Amelanchier arborea - (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Carya alba - (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Commelina communis L.	Asiatic dayflower	Alien	G5, SNA
Corydalis sempervirens (L.) Pers.	pale corydalis	Native	G4G5, S3
Croton willdenowii Webster	two-fruit rushfoil	Native	G5, S3
Dryopteris marginalis (L.) Gray	marginal woodfern	Native	G5, S5
Euonymus americanus L.	strawberry bush	Native	G5, S5
Geum canadense Jacq.	white avens	Native	G5, S5
Heuchera americana L.	alumroot	Native	G5, S5
Ipomoea pandurata (L.) G.F.W. Mey.	man-of-the-earth	Native	G5, S5
Juniperus virginiana L.	red cedar	Native	G5, S5
Ligustrum sinense Lour.	Chinese privet	Alien	GNR, SNA
Lonicera japonica Thunb.	Japanese honeysuckle	Alien	GNR, SNA
Magnolia fraseri Walt.	Fraser magnolia	Native	G5, S5
Maianthemum racemosum (L.) Link ssp. *racemosum*	false Solomon's seal	Native	G5, S5
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Phytolacca Americana L.	pokeweed	Native	G5, S5
Polystichum acrostichoides (Michx.) Schott	Christmas fern	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus coccinea Muenchh.	scarlet oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5

Rosa multiflora Thunb. ex Murr.	multi-flora rose	Alien	GNR, SNA
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Smilax biltmoreana (Small) J.B.S. Norton ex Pennell	Biltmore's greenbrier	Native	G4?, S3
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5
Verbascum thapsus L.	common mullein	Alien	GNR, SNA
Vitis aestivalis Michx.	summer grape	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 7

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Hypnum imponens Hedw.	hypnum moss	Native	G5, SNR
Lichen			
Xanthoparmelia sp.	xanthoparmelia lichen	Native	N/A

CARL – Vascular Species – Outcrop 8

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Ageratina altissima (L.) King & H. Rob. var. *altissima*	white snakeroot	Native	G5, S5
Agrostis perennans (Walter) Tuck.	autumn bentgrass	Native	G5, S5
Ailanthus altissima (P. Mill.) Swingle	tree-of-heaven	Alien	GNR, SNA

Ambrosia artemisiifolia L.	annual ragweed	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	GNR, SNA
Aralia spinosa L.	devil's club	Native	G5, S5
Arenaria serpyllifolia L.	thymeleaf sandwort	Alien	GNR, SNA
Aristida dichotoma Michx.	churchmouse three-awn	Native	G5, S5
Asplenium platyneuron (L.) B.S.P.	ebony spleenwort	Native	G5, S5
Betula lenta L.	sweet birch	Native	G5, S5
Bidens bipinnata L.	Spanish needles	Native	G5, S5
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke	dense-tuft hairsedge	Native	G5, S4
Carex laevivaginata (Kukenth.) Mackenzie	smooth-sheath sedge	Native	G5, S4
Carya alba (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Carya pallida (Ashe) Engl. & Graebn.	sand hickory	Native	G5
Commelina communis L.	Asiatic dayflower	Alien	G5, SNR
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Corydalis sempervirens (L.) Pers.	pale corydalis	Native	G4G5, S3
Crataegus flava Ait.	yellowleaf hawthorn	Native	G5, SNR
Croton willdenowii Webster	two-fruit rushfoil	Native	G5, S3
Cyperus retrorsus Chapman	retrorse flat-sedge	Native	G5, S5
Cypripedium acaule Ait.	moccasin flower	Native	G5, S5
Deschampsia flexuosa (L.) Trin.	wavy hairgrass	Native	G5, S3
Dichanthelium sp. (Hitchc. & Chase) Gould	a panic grass	Native	N/A
Dichanthelium acuminatum (Sw.) Gould	tapered rosette grass	Native	G5, SNR

& C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark			
Dichanthelium depauperatum (Muhl.) Gould	starved witchgrass	Native	G5, S4
Dichanthelium sphaerocarpon (Elliot) Gould var. *sphaerocarpon*	roundseed panicum	Native	G5, S5
Eupatorium rotundifolium L.	roundleaf thoroughwort	Native	G5, S5
Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry	Native	G4, S5
Heuchera americana L.	American alumroot	Native	G5, S5
Hypericum gentianoides (L.) B.S.P.	pineweed	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrew’s cross	Native	G5, S5
Hypericum punctatum Lam.	spotted St. John ‘s-wort	Native	G5, S5
Ilex opaca Ait.	American holly	Native	G5, S5
Ipomoea pandurata (L.) G.F.W. Mey.	man-of-the-earth	Native	G5, S5
Juncus dichotomus Ell.	forked rush	Native	G5, S3S4
Juncus tenuis Willd.	path rush	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Lechea racemulosa Michx.	Illinois pineweed	Native	G5, S5
Ligustrum sinense Lour.	Chinese privet	Alien	GNR, SNA
Liriodendron tulipifera L.	tulip poplar	Native	G5, S5
Lyonia ligustrina (L.) DC	maleberry	Native	G5, S5
Maianthemum racemosum (L.) Link ssp. *racemosum*	false Solomon’s seal	Native	G5, S5
*Malus sp***.** Mill.	an apple	N/A	N/A
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Oxydendrum arboreum	sourwood	Native	G5, S5

(L.) DC.			
Packera anonyma (Wood) W.A. Weber & A. Love	Small's ragwort	Native	G5, S5
Panicum virgatum L.	switch grass	Native	G5, S5
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Phemeranthus teretifolius (Pursh) Raf.	quill fameflower	Native	G4, S3
Physalis longifolia Nutt. var. *subglabrata* (Mack. & Bush) Cronquist	longleaf groundcherry	*Native*	*G5, S3*
Phytolacca americana L.	pokeweed	Native	G5, S5
Pinus echinata P. Mill.	shortleaf pine	Native	G5, S5
Pinus rigida P. Mill.	pitch pine	Native	G5, S4
Pinus strobus L.	white pine	Native	G5, S5
Pinus virginiana P. Mill.	Virginia pine	Native	G5, S5
Polygonum cespitosum Blume var. *longisetum* (Bruijn) A.N. Steward	oriental smartweed	Alien	GNR, SNA
Prenanthes altissima L.	tall rattlesnake-root	Native	G5?, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus alba L.	white oak	Native	G5, S5
Quercus marilandica Muenchh.	black jack oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus stellata Wangenh.	post oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rhexia mariana L. var. *mariana*	Maryland meadowbeauty	Native	G5, S5
Rhus copallinum L. var. *latifolia* Engl.	winged sumac	Native	G5, SNR
Rosa carolina L.	Carolina rose	Native	G5, S4
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus flagellaris Willd.	northern dewberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4

Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Sericocarpus linifolius (L.) B.S.P.	narrow-leaf whitetop aster	Native	G5, S5
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Solidago arguta Ait.	Atlantic goldenrod	Native	G5, S5?
Solidago juncea Ait.	early goldenrod	Native	G5, S3?
Solidago odora Ait.	sweet goldenrod	Native	G5, S5
Solidago roanensis Porter	Roan Mountain goldenrod	Native	G4G5, S4
Spiranthes odorata (Nutt.) Lindl.	sweet-scent ladies'-tresses	Native	G5, S2
Symphyotrichum dumosum (L.) Nesom	bushy aster	Native	G5, S5
Symphyotrichum patens (Ait.) Nesom	late purple aster	Native	G5, SNR
Symphyotrichum undulatum (L.) Nesom	wavy-leaf aster	Native	G5, S5
Uvularia sessilifolia L.	sessile-leaf bellwort	Native	G5, S4
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5
Vitis aestivalis Michx.	summer grape	Native	G5, S5
Xanthorhiza simplicissima Marsh.	shrub yellowroot	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 8

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR

Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR
Lichen			
Cladina stellaris (Opiz) Brodo	star-tipped reindeer lichen	Native	G5, SNR
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	Cup lichen	Native	G3G5, SNR
Cladonia cylindrica (A. Evans) A. Evans	cylinder cup lichen	Native	G3G5, SNR
Cladonia digitata (L.) Hoffman	finger pixie-cup	Native	G3G5, SNR
Cladonia pleurota (Flörke) Schaerer	red-fruited pixie-cup	Native	G3G5, SNR
Cladonia subradiata (Vain.) Sandst.	powdery peg lichen	Native	G4G5, SNR
Collema sp. Wigg	collema lichen	Native	N/A
Dimelaena oreina (Ach.) Norman	mountain lichen	Native	G5, SNR
Diploschistes scruposus (Schreber) Norman	crater lichen	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidea tessellata Flörke	lecidea lichen	Native	G5, SNR
Lecidella carpathica Korber	disk lichen	Native	G5?, SNR
Lepraria lobificans Nyl.	dust lichen	Native	GNR, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR

Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Pycnothelia papillaria Dufour	nipple lichen	Native	G3G5, SNR
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR

CARL – Vascular Species – Outcrop 9

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Agrostis perennans (Walter) Tuck.	autumn bentgrass	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	GNR, SNA
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke	dense-tuft sedge	Native	G5, S4
Calamagrostis coarctata (Torr.) Eaton	Nuttall's reedgrass	Native	G5, SNR
Chionanthus virginicus L.	fringe tree	Native	G5, S5
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Deschampsia flexuosa (L.) Trin.	wavy hairgrass	Native	G5, S3
Dichanthelium sp. (Hitchc. & Chase) Gould	a panic grass	Native	N/A
Goodyera pubescens (Willd.) R. Br. ex Ait. f.	rattlesnake plantain	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrews cross	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Oxydendrum arboreum (L.) DC.	sourwood	Native	G5, S5
Phemeranthus teretifolius	quill fameflower	Native	G4, S3

(Pursh) Raf.			
Phytolacca americana L.	pokeweed	Native	G5, S5
Pinus rigida P. Mill.	pitch pine	Native	G5, S4
Pinus strobus L.	white pine	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	northern red oak	Native	G5, S5
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Selaginella rupestris (L.) Spring	ledge spikemoss	Native	G5, S3
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 9

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Andreaea rothii Web. & Mohr	Roth's andreaea moss	Native	G5, SNR
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Pohlia nutans (Hedw.) Lindb.	nodding-thread moss	Native	G5, SNR
Racomitrium heterostichum (Hedw.) Brid.	racomitrium moss	Native	G5, SNR
Lichen			
Cladina stygia (Fr.) Ahti	black footed- reindeer lichen	Native	G5, SNR

Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Cladonia arbuscula (Wallr.) Hale & Culb.	reindeer lichen	Native	G5, SNR
Cladonia cylindrica (A. Evans) A. Evans	cylinder cup lichen	Native	G3G5, SNR
Cladina mitis (Sandst.) Hustich.	green reindeer lichen	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidella carpathica Korber	disk lichen	Native	G5, SNR
Umbilicaria mammulata (Ach.) Tuck.	common rock tripe	Native	G4G5, SNR
Usnea amblyoclada (Müll. Arg.) Zahlbr.	rock beard lichen	Native	N/A
Xanthoparmelia sp. (Vain.) Hale	xanthoparmelia lichen	Native	N/A

CARL – Vascular Species – Outcrop 10

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Agrostis perennans (Walter) Tuck.	autumn bentgrass	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common service berry	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	GNR, SNA
Aristida dichotoma Michx.	churchmouse three-awn	Native	G5, S5
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke	dense-tuft sedge	Native	G5, S4
Calamagrostis coarctata (Torr.) Eaton	Nutall’s reedgrass	Native	G4, SNR
Carya alba (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra (P. Mill.) Sweet	pignut hickory	Native	G5, S5

Chionanthus virginicus L.	fringe tree	Native	G5, S5
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Croton willdenowii Webster	two-fruit rushfoil	Native	G5, S3
Cypripedium acaule Ait.	moccasin flower	Native	G5, S5
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes	poverty oatgrass	Native	G5, S5
Deschampsia flexuosa (L.) Trin.	wavy hairgrass	Native	G5, S3
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark	tapered rosette grass	Native	G5, SNR
Eupatorium rotundifolium L.	roundleaf thoroughwort	Native	G5, S5
Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry	Native	G5, S3?
Hypericum gentianoides (L.) B.S.P.	pineweed	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrew’s cross	Native	G5, S5
Juniperus virginiana L.	red cedar	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Lyonia ligustrina (L.) DC	maleberry	Native	G5, S5
Maianthemum racemosum (L.) Link ssp. *racemosum*	false Solomon’s seal	Native	G5, S5
Oxydendrum arboreum (L.) DC.	sourwood	Native	G5, S5
Photinia melanocarpa (Michx.) Robertson & Phipps	black chokeberry	Native	G5, S3S4
Pinus rigida P. Mill.	pitch pine	Native	G5, S4
Pinus strobus L.	white pine	Native	G5, S5
Pinus virginiana P. Mill.	Virginia pine	Native	G5, S5
Quercus alba L.	white pine	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5

Quercus rubra L.	northern red oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rhynchospora recognita (Gale) Kral	globe beaksedge	Native	G5?, S4
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Uvularia sessilifolia L.	sessile-leaf bellwort	Native	G5, S4
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium pallidum Aiton	hillside blueberry	Native	G5, S5
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 10

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Andreaea rothii Web. & Mohr	Roth's andreaea moss	Native	G5, SNR
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranella heteromalla (Hedw.) Schimp.	dicranella moss	Native	G5?, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR

Racomitrium heterostichum (Hedw.) Brid.	racomitrium moss	Native	G5, SNR
Scapania nemorosa (L.) Grolle.	scapania moss	Native	G5, SNR
Sphagnum inundatum Russ.	water sphagnum	Native	G4, SNR
Lichen			
Cladina arbuscula (Wallr.) Hale & Culb.	reindeer lichen	Native	G5, SNR
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Cladonia chlorophaea (Flörke ex Sommerf.) Sprengle	mealy pixie-cup	Native	G5, SNR
Diploschistes scruposus (Schreber) Norman	crater lichen	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidea lapicida (Ach.) Ach.	lecidea lichen	Native	G5, SNR
Lecidea tessellata Flörke	lecidea lichen	Native	GNR, SNR
Lecidella carpathica Korber	disk lichen	Native	G5, SNR
Lepraria lobificans Nyl.	dust lichen	Native	GNR, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Micarea erratica (Korber) Hertel, Rambold & Pietschmann	erratic dot lichen	Native	GNR, SNR
Polysporina simplex (Davies) Vezda	polysporina lichen	Native	G5?, SNR
Pycnothelia papillaria Dufour	nipple lichen	Native	G3G5, SNR
Usnea amblyoclada (Müll. Arg.) Zahlbr.	rock beard lichen	Native	N/A

Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR

CARL – Vascular Species – Outcrop 11

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Agrostis perennans (Walter) Tuck.	autumn bentgrass	Native	G5, S5
Deschampsia flexuosa (L.) Trin.	wavy hairgrass	Native	G5, S3
Aristida dichotoma Michx.	churchmouse three awn	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	GNR, SNA
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke	dense-tuft sedge	Native	G5, S4
Calamagrostis coarctata (Torr.) Eaton	Nuttall's reedgrass	Native	G5, SNR
Carya alba (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Carya pallida (Ashe) Engl. & Graebn.	sand hickory	Native	G5
Chionanthus virginicus L.	fringe tree	Native	G5, S5
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes	poverty oatgrass	Native	G5, S5
Danthonia compressa Austin ex Peck	flattened out grass	Native	G5, S3
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould	tapered rosette grass	Native	G5, SNR

& C.A. Clark			
Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry	Native	G5, S5
Gaylussacia ursina (M.A. Curtis) Torr. & Gray ex Gray	bear huckleberry	Native	G5, S3?
Gentiana saponaria L.	soapwort gentian	Native	G5, S3
Hypericum gentianoides (L.) B.S.P.	pineweed	Native	G5, S5
Hypericum punctatum Lam.	spotted St. John's-wort	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrews-cross	Native	G5, S5
Hypericum virgatum Lam.	sharpleaf St. John's-wort	Native	G4, S4
Juniperus virginiana L.	red cedar	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Liriodendron tulipifera L.	tulip polar	Native	G5, S5
Lysimachia quadrifolia L.	whorled loosestrife	Native	G5, S5
Lyonia ligustrina (L.) DC	maleberry	Native	G5, S5
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Oxydendrum arboreum (L.) DC.	sourwood	Native	G5, S5
Pinus rigida P. Mill.	pitch pine	Native	G5, S4
Pinus strobus L.	white pine	Native	G5, S5
Pinus virginiana P. Mill.	Virginia pine	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus marilandica Muenchh.	blackjack oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	northern red oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rhus copallinum L. var. *latifolia* Engl.	winged sumac	Native	G5, SNR
Rubus argutus Link	sawtooth blackberry	Native	G5, S5

Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Smilax glauca Walt.	Cat greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Solidago rugosa P. Mill.	wrinkleleaf goldenrod	Native	G5, S5
Solidago juncea Ait.	early goldenrod	Native	G5, S3?
Solidago roanensis Porter	Roan Mountain goldenrod	Native	G4G5, S4
Symphyotrichum dumosum (L.) Nesom	bushy aster	Native	G5, S5
Symphyotrichum undulatum (L.) Nesom	wavy-leaf aster	Native	G5, S5
Uvularia sessilifolia L.	sessile-leaf bellwort	Native	G5, S4
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium pallidum Aiton	hillside blueberry	Native	G5, S5
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 11

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Andreaea rothii Web. & Mohr	Roth's andreaea moss	Native	G5, SNR
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranella heteromalla (Hedw.) Schimp.	dicranella moss	Native	G5?, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Leucobryum glaucum	pincushion moss	Native	G5, SNR

(Hedw.) Angstr. in Fries			
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR
Racomitrium heterostichum (Hedw.) Brid.	racomitrium moss	Native	G5, SNR
Scapania nemorosa (L.) Grolle.	scapania moss	Native	G5, SNR
Sphagnum inundatum Russ.	water sphagnum	Native	G4, SNR
Lichen			
Cladonia arbuscula (Wallr.) Hale & Culb.	reindeer lichen	Native	G5, SNR
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Cladonia chlorophaea (Flörke ex Sommerf.) Sprengle	mealy pixie-cup	Native	G5, SNR
Diploschistes scruposus (Schreber) Norman	crater lichen	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidea lapicida (Ach.) Ach.	lecidea lichen	Native	G5, SNR
Lecidea tessellata Flörke	lecidea lichen	Native	GNR, SNR
Lecidella carpathica Korber	disk lichen	Native	G5, SNR
Lepraria lobificans Nyl.	dust lichen	Native	GNR, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Micarea erratica (Korber) Hertel, Rambold & Pietschmann	erratic dot lichen	Native	GNR, SNR
Pycnothelia papillaria Dufour	nipple lichen	Native	G3G5, SNR

Usnea amblyoclada (Müll. Arg.) Zahlbr.	rock beard lichen	Native	N/A
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR

CARL – Vascular Species – Outcrop 12

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Aristida dichotoma Michx.	churchmouse three-awn	Native	G5, S5
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke	dense-tuft sedge	Native	G5, S4
Clethra acuminata Michx.	sweet pepperbush	Native	S4, G4
Cypripedium acaule Ait.	moccasin flower	Native	G5, S5
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes	poverty oatgrass	Native	G5, S5
Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry	Native	G5, S5
Hamamelis virginiana L.	witch hazel	Native	G5, S5
Hypericum gentianoides (L.) B.S.P.	pineweed	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Lyonia ligustrina (L.) DC	maleberry	Native	G5, S5
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Oxydendrum arboreum (L.) DC.	sourwood	Native	G5, S5
Photinia melanocarpa (Michx.) Robertson & Phipps	black chokeberry	Native	G5, S3S4
Pinus rigida P. Mill.	pitch pine	Native	G5, S4

Pinus strobus L.	white pine	Native	G5, S5
Pinus virginiana P. Mill.	Virginia pine	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus marilandica Muenchh.	blackjack oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium pallidum Aiton	hillside blueberry	Native	G5, S5
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 12

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Andreaea rothii Web. & Mohr	Roth's andreaea moss	Native	G5, SNR
Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranella heteromalla (Hedw.) Schimp.	dicranella moss	Native	G5?, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio haircap moss	Native	G5, SNR

Racomitrium heterostichum (Hedw.) Brid.	racomitrium moss	Native	G5, SNR
Lichen			
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Cladonia chlorophaea (Flörke ex Sommerf.) Sprengle	mealy pixie-cup	Native	G5, SNR
Cladonia cristatella Tuck.	British soldiers	Native	G5?, SNR
Cladonia pleurota (Flörke) Schaerer	red-fruited pixie-cup	Native	G3G5, SNR
Cladonia sp. P. Browne	cladonia lichen	Native	N/A
Cladonia squamosa (Scop.) Hoffm.	dragon cladonia	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidea tessellata Flörke	lecidea lichen	Native	GNR, SNR
Lecidella carpathica Korber	disk lichen	Native	G5, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Micarea erratica (Korber) Hertel, Rambold & Pietschmann	erratic dot lichen	Native	GNR, SNA
Physcia halei Thomson	Hale’s rosette lichen	Native	G3, SNR
Physcia subtilis Degel.	rosette lichen	Native	G4, SNR
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR

CARL – Vascular Species – Outcrop 13

Species	Common	Native/	Conservation

Name	Name	Alien	Status
Acer rubrum L.	red maple	Native	G5, S5
Agrostis perennans (Walter) Tuck.	autumn bentgrass	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	G5, S5
Calamagrostis coarctata (Torr.) Eaton	Nuttall's reedgrass	Native	G5, SNR
Chimaphila maculata (L.) Pursh	striped prince's pine	Native	G5, S5
Chionanthus virginicus L.	fringe tree	Native	G5, S5
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Cypripedium acaule Ait.	moccasin flower	Native	G5, S5
Deschampsia flexuosa (L.) Trin.	wavy hairgrass	Native	G5, S3
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark	tapered rosette grass	Native	G5, SNR
Dichanthelium sp. (Hitchc. & Chase) Gould	a panic grass	Native	N/A
Galax urceolata (Poir.) Brummitt	galax	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Liatris spicata (L.) Willd	gayfeather	Native	G5, S3?
Liriodendron tulipifera L.	tulip poplar	Native	G5, S5
Lysimachia lanceolata Walt.	lanceleaf loosestrife	Native	G5, S3
Maianthemum racemosum (L.) Link ssp. *racemosum*	false Solomon's seal	Native	G5, S5
Oxydendrum arboreum (L.) DC.	sourwood	Native	G5, S5

Photinia melanocarpa (Michx.) Robertson & Phipps	black chokeberry	Native	G5, S3S4
Pinus rigida P. Mill.	pitch pine	Native	G5, S4
Pinus strobus L.	white pine	Native	G5, S5
Quercus alba L.	white oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	northern red oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rhododendron maximum L.	great laurel	Native	G5, S5
Rhynchospora recognita (Gale) Kral	globe beaksedge	Native	G5?, S4
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Solidago juncea Ait.	early goldenrod	Native	G5, S3?
Solidago roanensis Porter	Roan Mountain goldenrod	Native	G4G5, S4
Toxicodendron radicans (L.) Kuntze	poison ivy	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium pallidum Aiton	hillside blueberry	Native	G5, S5
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 13

Species Name	Common Name	Native/ Alien	Conservation Status

Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Hypnum imponens Hedw.	hypnum moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio pincushion moss	Native	G5, SNR
Racomitrium heterostichum (Hedw.) Brid.	racomitrium moss	Native	G5, SNR
Sphagnum inundatum Russ.	water sphagnum	Native	G4, SNR
Lichen			
Cladina stellaris (Opiz) Brodo	star-tipped reindeer lichen	Native	G5, SNR
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Cladina mitis (Sandst.) Hustich.	green reindeer lichen	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecidea tessellata Flörke	lecidea lichen	Native	G5, SNR
Lepraria lobificans Nyl.	dust lichen	Native	GNR, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Micarea erratica (Korber) Hertel, Rambold & Pietschmann	erratic dot lichen	Native	GNR, SNR
Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Polysporina simplex	polysporina lichen	Native	G5?, SNR

(Davies) Vezda			
Xanthoparmelia sp. (Vain.) Hale	xanthoparmelia lichen	Native	N/A

CARL – Vascular Species – Outcrop 14

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Agrostis perennans (Walter) Tuck.	autumn bentgrass	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Aristida dichotoma Michx.	churchmouse three-awn	Native	G5, S5
Asplenium platyneuron (L.) B.S.P.	ebony spleenwort	Native	G5, S5
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke	dense-tuft sedge	Native	G5, S4
Carya alba (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Carya ovalis (Wangenh.) Sarg.	red hickory	Native	G5, S4
Carya pallida (Ashe) Engl. & Graebn.	sand hickory	Native	G5, S5
Chimaphila maculata (L.) Pursh	striped prince’s pine	Native	G5, S5
Chionanthus virginicus L.	fringe tree	Native	G5, S5
Commelina communis L.	Asiatic dayflower	Alien	G5, SNR
Coreopsis major Walter var. *rigida* (Nutt.) Boynt.	greater tickseed	Native	G5, S5
Crataegus flava Ait.	yellowleaf hawthorn	Native	G5, SNR
Croton willdenowii Webster	two-fruit rushfoil	Native	G5, S3
Cypripedium acaule Ait.	moccasin flower	Native	G5, S5
Deschampsia flexuosa	wavy hairgrass	Native	G5, S3

(L.) Trin.			
Desmodium nudiflorum (L.) DC.	naked-flower ticktrefoil	Native	G5, S5
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark	tapered rosette grass	Native	G5, SNR
Dichanthelium dichotomum (cf.) var. *dichotomum* (L.) Gould	forked witch grass	Native	G5, SNR
Diospyros virginiana L.	persimmon	Native	G5, S5
Dryopteris marginalis (L.) Gray	marginal woodfern	Native	G5, S5
Eupatorium purpureum L.	joe-pye-weed	Native	G5, S5
Eupatorium rotundifolium L.	roundleaf thoroughwort	Native	G5, S5
Galax urceolata (Poir.) Brummitt	galax	Native	G5, S5
Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry	Native	G5, S5
Gaylussacia ursina (M.A. Curtis) Torr. & Gray ex Gray	bear huckleberry	Native	G5, S3?
Gentiana saponaria L.	soapwort gentian	Native	G5, S3
Goodyera pubescens (Willd.) R. Br. ex Ait. f.	rattlesnake plantain	Native	G5, S5
Heuchera americana L.	alumroot	Native	G5, S5
Hypericum gentianoides (L.) B.S.P.	pineweed	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrews Cross	Native	G5, S5
Hypericum prolificum L.	shrubby St. Johnswort	Native	G5, S4
Hypericum punctatum Lam.	spotted St. Johnswort	Native	G5, S5
Hypericum virgatum Lam.	sharp-leaf St. John’s wort	Native	G4?, S4
Juncus dichotomus Ell.	forked rush	Native	G5, S3S4
Juncus tenuis Willd.	path rush	Native	G5, S5

Juniperus virginiana L.	red cedar	Native	G5, S5
Kalmia latifolia L.	mountain laurel	Native	G5, S5
Liatris spicata (L.) Willd	gayfeather	Native	G5, S3?
Ligustrum sinense Lour.	Chinese privet	Alien	GNR, SNA
Liriodendron tulipifera L.	tulip poplar	Native	G5, S5
Lobelia nuttallii J.A. Schultes	Nutall's lobelia	Native	G4G5, S5
Lonicera flava Sims	yellow honeysuckle	Native	G5, S3
Lyonia ligustrina (L.) DC.	maleberry	Native	G5, S5
Lysimachia quadrifolia L.	whorled loosestrife	Native	G5, S5
Maianthemum racemosum (L.) Link ssp. *racemosum*	false Solomon's seal	Native	G5, S5
Microstegium vimineum (Trin.) A. Camus	Japanese stiltgrass	Alien	GNR, SNA
Miscanthus sinensis Anderss.	Chinese silvergrass	Alien	GNR, SNA
Mitchella repens L.	partridge berry	Native	G5, S5
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Oxydendrum arboreum (L.) DC.	sourwood	Native	G5, S5
Packera anonyma (Wood) W.A. Weber & A. Love	Small's ragwort	Native	G5, S5
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Paulownia tomentosa (Thunb.) Sieb. & Zucc. ex Steud.	princess tree	Alien	GNR, SNA
Phemeranthus teretifolius (Pursh) Raf.	quill fameflower	Native	G4, S3
Photinia melanocarpa (Michx.) Robertson & Phipps	black chokeberry	Native	G5, S3S4
Phytolacca americana L.	pokeweed	Native	G5, S5
Pinus rigida P. Mill.	pitch pine	Native	G5, S4

Pinus strobus L.	white pine	Native	G5, S5
Pityopsis graminifolia (Michx.) Nutt. var. *graminifolia*	narrowleaf silk-grass	Native	G5, S3
Polygala curtissii Gray	Curtiss' milkwort	Native	G5, S5
Polygonatum biflorum (Walt.) Ell.	Solomon's seal	Native	G5, S5
Polypodium virginianum L.	rock polypody	Native	G5, S5
Polystichum acrostichoides (Michx.) Schott	Christmas fern	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Pycnanthemum flexuosum (Walt.) B.S.P.	Appalachian mountain mint	Native	G5, S5
Pycnanthemum verticillatum (Michx.) Pers.	whorled mountain mint	Native	G5, S3
Quercus alba L.	white pine	Native	G5, S5
Quercus phellos	willow oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	northern red oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rhexia mariana L. var. *mariana*	Maryland meadowbeauty	Native	G5, S5
Rhododendron maximum L.	great laurel	Native	G5, S5
Rhynchospora recognita (Gale) Kral	globe beaksedge	Native	G5?, S4
Rosa carolina L.	Carolina rose	Native	G5, S4
Rosa multiflora Thunb. ex Murr.	multi-flora rose	Alien	GNR, SNA
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rumex acetosella L.	sheep sorrel	Alien	GNR, SNA
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S5
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5

Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Selaginella rupestris (L.) Spring	ledge spikemoss	Native	G5, S3
Sericocarpus linifolius (L.) B.S.P.	narrowleaf whitetop aster	Native	G5, S5
Smilax biltmoreana (Small) J.B.S. Norton ex Pennell	Biltmore's carrionflower	Native	G4?, S3
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Solidago arguta Ait.	Atlantic goldenrod	Native	G5, S5?
Solidago canadensis L.	Canada goldenrod	Native	G5, SNR
Solidago juncea Ait.	early goldenrod	Native	G5, S3?
Solidago roanensis Porter	Roan Mountain goldenrod	Native	G4G5, S4
Solidago rugosa P. Mill.	rough stemmed goldenrod	Native	G5, S5
Symphyotrichum dumosum (L.) Nesom	bushy aster	Native	G5, S5
Symphyotrichum patens (Ait.) Nesom	late purple aster	Native	G5, SNR
Symphyotrichum undulatum (L.) Nesom	wavy-leaf aster	Native	G5, S5
Tipularia discolor (Pursh) Nutt.	crane-fly orchid	Native	G4G5, S4
Toxicodendron radicans (L.) Kuntze	poison ivy	Native	G5, S5
Tsuga caroliniana Engelm.	Carolina hemlock	Native	G3, S3
Uvularia sessilifolia L.	sessile-leaf bellwort	Native	G5, S4
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium pallidum Aiton	hillside blueberry	Native	G5, S5
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 14

Species Name	Common Name	Native/ Alien	Conservation Status

Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Hypnum imponens Hedw.	hypnum moss	Native	G5, SNR
Leskea gracilescens Hedw.	leskea moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Racomitrium heterostichum (Hedw.) Brid.	racomitrium moss	Native	G5, SNR
Scapania undulata (L.) Dumort.	scapania moss	Native	G5, SNR
Schistidium apocarpum (Hedw.) Bruch & Schimp.	schistidium moss	Native	G5, SNR
Sphagnum inundatum Russ.	water sphagnum	Native	G4, SNR
Thuidium delicatulum (Hedw.) Schimp.	delicate fern moss	Native	G5, SN3
Lichen			
Cladina rangiferina (L.) Nyl.	gray reindeer lichen	Native	G5, SNR
Cladina stellaris (Opiz) Brodo	star-tipped reindeer lichen	Native	G5, SNR
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Cladonia arbuscula (Wallr.) Hale & Culb.	reindeer lichen	Native	G5, SNR
Cladonia chlorophaea Flörke ex Sommerf.)	mealy pixie-cup	Native	G5, SNR

Sprengle			
Cladonia cristatella Tuck.	British soldiers	Native	G5?, SNR
Cladonia cylindrical (A. Evans) A. Evans	cylinder cup lichen	Native	G3G5, SNR
Cladonia digitata (L.) Hoffman	finger pixie-cup	Native	G3G5, SNR
Cladonia mitis (Sandst.) Hustich.	green reindeer lichen	Native	G5, SNR
Cladonia pleurota (Flörke) Schaerer	red-fruited pixie-cup	Native	G3G5, SNR
Cladonia squamosa (Scop.) Hoffm.	dragon cladonia	Native	G5, SNR
Cladonia subradiata (Vain.) Sandst.	powdery peg lichen	Native	G4G5, SNR
Dimelaena oreina (Ach.) Norman	mountain lichen	Native	G5, SNR
Diploschistes scruposus (Schreber) Norman	crater lichen	Native	G5, SNR
Lasallia papulosa (Ach.) Llano	toadskin lichen	Native	G5?, SNR
Lecanora sp. Ach.	lecanora lichen	Native	N/A
Lecidea lapicida (Ach.) Ach.	lecidea lichen	Native	G5, SNR
Lecidea tessellata Flörke	lecidea lichen	Native	G5, SNR
Lecidella carpathica Korber	disk lichen	Native	G5, SNR
Lepraria lobificans Nyl.	dust lichen	Native	GNR, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Micarea erratica (Korber) Hertel, Rambold & Pietschmann	erratic dot lichen	Native	GNR, SNR
Myelochroa obsessa (Ach.) Elix & Hale	myelochroa lichen	Native	G3G5, SNR
Parmelinopsis horrescens (Taylor) Elix & Hale	parmelinopsis	Native	G5, SNR
Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Polysporina simplex	polysporina lichen	Native	G5?, SNR

(Davies) Vezda			
Thelotrema subtile Tuck.	barnacle lichen	Native	GNR, SNR
Umbilicaria mammulata (Ach.) Tuck.	common rock tripe	Native	G4G5, SNR
Usnea amblyoclada (Müll. Arg.) Zahlbr.	rock beard lichen	Native	N/A
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR

CARL – Vascular Species – Outcrop 15

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Asplenium platyneuron (L.) B.S.P.	ebony spleenwort	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	GNR, SNA
Agrostis perennans (Walter) Tuck.	autumn bentgrass	Native	G5, S5
Carex scoparia	pointed broom sedge	Native	G5, S4
Carya glabra (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Carya alba (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Chionanthus virginicus L.	fringe tree	Native	G5, S5
Commelina communis L.	Asiatic dayflower	Alien	G5, SNA
Cypripedium acaule Ait.	moccasin flower	Native	G5, S5
Dichanthelium sp. (Hitchc. & Chase) Gould	a panic grass	Native	N/A
Eupatorium rotundifolium L.	roundleaf thoroughwort	Native	G5, S5

Chimaphila maculata (L.) Pursh	striped prince's pine	Native	G5, S5
Hypericum gentianoides (L.) B.S.P.	pineweed	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrew's cross	Native	G5, S5
Juniperus virginiana L.	red cedar	Native	G5, S5
Juncus effusus L.	soft rush	Native	G5, S5
Juncus tenuis Willd.	path rush	Native	G5, S5
Juncus dichotomus Ell.	forked rush	Native	G5, S3S4
Microstegium vimineum (Trin.) A. Camus	Japanese stiltgrass	Alien	GNR, SNA
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Phytolacca americana L.	pokeweed	Native	G5, S5
Pinus strobus L.	white pine	Native	G5, S5
Pinus virginiana P. Mill.	Virginia pine	Native	G5, S5
Polygonum cespitosum Blume var. *longisetum* (Bruijn) A.N. Steward	Oriental smartweed	Alien	SNA. GNR
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus alba L.	white oak	Native	G5, S5
Polygonum sp.	smartweed	Native	N/A
Quercus coccinea Muenchh.	scarlet oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	red oak	Native	G5, S5
Quercus stellata Wangenh.	post oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Rumex acetosella L.	sheep sorrel	Alien	GNR, SNA
Rhynchospora capitellata (Michx.) Vahl	brownish beaksedge	Native	G5, SNR
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Packera anonyma	Small's ragwort	Native	G5, S5

(Wood) W.A. Weber & A. Love			
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Solidago canadensis L.	Canada goldenrod	Native	G5, SNR
Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium stamineum L.	deerberry	Native	G5, S5
Uvularia sessilifolia L.	sessile-leaf bellwort	Native	G5, S4

CARL – Moss and Macrolichen Species – Outcrop 15

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Leskea gracilescens Hedw.	leskea moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio pincushion moss	Native	G5, SNR
Lichen			
Cladonia arbuscula (Wallr.) Hale & Culb.	reindeer lichen	Native	G5, SNR
Cladina stellaris (Opiz) Brodo	star-tipped reindeer lichen	Native	G5, SNR
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR
Cladonia apodocarpa Robbins	reindeer lichen	Native	G5, SNR
Cladonia chlorophaea Flörke ex Sommerf.)	mealy pixie-cup	Native	G5, SNR

Sprengle			
Cladonia digitata (L.) Hoffman	finger pixie-cup	Native	G3G5, SNR
Cladina mitis (Sandst.) Hustich.	green reindeer lichen	Native	G5, SNR
Cladonia subradiata (Vain.) Sandst.	powdery peg lichen	Native	G4G5, SNR
Diploschistes scruposus (Schreber) Norman	crater lichen	Native	G5, SNR
Lecidea tessellata Flörke	lecidea lichen	Native	G5, SNR
Lepraria lobificans Nyl.	dust lichen	Native	GNR, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Usnea amblyoclada (Müll. Arg.) Zahlbr.	rock beard lichen	Native	N/A
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR

CARL – Vascular Species – Outcrop 16

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Ageratina altissima (L.) King & H. Rob. var. *altissima*	white snakeroot	Native	G5, S5
Ailanthus altissima (P. Mill.) Swingle	tree-of-heaven	Alien	GNR, SNA
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Anthoxanthum odoratum L.	sweet vernal grass	Alien	GNR, SNA
Asplenium platyneuron (L.) B.S.P.	ebony spleenwort	Native	G5, S5

Carya glabra (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Dichanthelium sp. (Hitchc. & Chase) Gould	a panic grass	Native	N/A
Dryopteris marginalis (L.) Gray	marginal woodfern	Native	G5, S5
Heuchera americana L.	alumroot	Native	G5, S5
Hypericum punctatum Lam.	spotted St. Johnswort	Native	G5, S5
Hypericum hypericoides (L.) Crantz	St. Andrews cross	Native	G5, S5
Ilex opaca Ait.	American holly	Native	G5, S5
Ligustrum sinense Lour.	Chinese privet	Alien	GNR, SNA
Liriodendron tulipifera L.	tulip poplar	Native	G5, S5
Lonicera japonica Thunb.	Japanese honeysuckle	Alien	G5, SNA
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Phytolacca americana L.	pokeweed	Native	G5, S5
Pinus strobus L.	white pine	Native	G5, S5
Polystichum acrostichoides (Michx.) Schott	Christmas fern	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus rubra L.	northern red oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Quercus stellata Wangenh.	post oak	Native	G5, S5
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus flagellaris Willd.	northern dewberry		G5, S5
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli	elderberry	Native	G5, S5
Maianthemum racemosum (L.) Link ssp. *racemosum*	False Solomon’s seal	Native	G5,
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Toxicodendron radicans (L.) Kuntze	poison ivy	Native	G5, S5

Vitis aestivalis Michx.	summer grape	Native	G5, S5
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 16

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio pincushion moss	Native	G5, SNR
Thuidium delicatulum (Hedw.) Schimp.	delicate fern moss	Native	G5, SN3
Lichen			
Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Xanthoparmelia sp. (Vain.) Hale	Xanthoparmelia sp.	Native	N/A

CARL – Vascular Species – Outcrop 17

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Ambrosia artemisiifolia L.	annual ragweed	Native	G5, S5
Amelanchier arborea (Michx. f.) Fern.	common serviceberry	Native	G5, S5
Amelanchier laevis Wieg.	Allegheny serviceberry	Native	G4G5, S3
Carya alba - (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra - (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Celastrus orbiculata Thunb.	Oriental bittersweet	Alien	GNR, SNA

Chimaphila maculata (L.) Pursh	striped prince's pine	Native	G5, S5
Commelina communis L.	Asiatic dayflower	Alien	G5, SNA
Crataegus flava Ait.	hawthorn	Native	N/A
Dichanthelium dichotomum (cf.) var. *dichotomum* (L.) Gould	tapered rosette grass	Native	G5, SNR
Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry	Native	G5, S5
Hedera helix L.	English ivy	Alien	GNR, SNA
Ilex opaca Ait.	American holly	Native	G5, S5
Juniperus virginiana L.	red cedar	Native	G5, S5
Ligustrum sinense Lour.	Chinese privet	Alien	GNR, SNA
Liriodendron tulipifera L.	tulip poplar	Native	G5, S5
Lonicera japonica Thunb.	Japanese honeysuckle	Alien	GNR, SNA
Lycopus virginicus L.	Virginia bugleweed	Native	G5, S5
Maianthemum racemosum (L.) Link ssp. *racemosum*	false solomon's seal	Native	G5, S5
Microstegium vimineum (Trin.) A. Camus	Japanese stiltgrass	Alien	GNR, SNA
Miscanthus sinensis Anderss.	Chinese silvergrass	Alien	GNR, SNA
Nyssa sylvatica Marsh.	black gum	Native	G5, S5
Amelanchier laevis Wiegand	downy serviceberry	Native	G4G5, S3
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Phytolacca americana L.	American pokeweed	Native	G5, S5
Pinus strobus L.	white pine	Native	G5, S5
Prenanthes altissima L.	rattlesnake root	Native	G5, S5
Quercus alba L.	white oak	Native	G5, S5
Quercus phellos L.	willow oak	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5

Quercus rubra L.	northern red oak	Native	G5, S5
Quercus velutina Lam.	black oak	Native	G5, S5
Rosa multiflora Thunb. ex Murr.	multi-flora rose	Native	GNR, SNA
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli	elderberry	Native	G5, S5
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S5
Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Selaginella rupestris (L.) Spring	ledge spikemoss	Native	G5, S3
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species Outcrop 17

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Leskea gracilescens Hedw.	leskea moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Polytrichum ohioense Ren. & Card.	Ohio pincushion moss	Native	G5, SNR
Racomitrium heterostichum (Hedw.) Brid.	racomitrium moss	Native	G5, SNR

Scapania nemorosa (L.) Grolle.	scapania moss	Native	G5, SNR
Thuidium delicatulum (Hedw.) Schimp.	delicate fern moss	Native	G5, SN3
Lichen			
Cladina stygia (Fr.) Ahti	black-footed reindeer lichen	Native	G5, SNR

CARL - Vascular Species – Outcrop 18

Species Name	Common Name	Native/ Alien	Conservation Status
Acer palmatum Thunb.	Japanese maple	Alien	GNR, SNA
Acer rubrum L.	red maple	Native	G5, S5
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke	dense-tuft hairsedge	Native	G5, S4
Campsis radicans (L.) Seem. ex Bureau	trumpet creeper	Native	G5, S5
Carya glabra - (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Carex pensylvanica Lam.	Pennsylvania sedge	Native	G5, S5
Carex scoparia Schkuhr ex Willd.	pointed broom sedge	Native	G5, S4
Chionanthus virginicus L.	fringe tree	Native	G5, S5
Commelina communis L.	Asiatic dayflower	Alien	G5, SNA
Cypripedium acaule Ait.	moccasin flower	Native	G5, S5
Cyperus retrorsus Chapman	retrorse flat-sedge	Native	G5, S5
Dennstaedtia punctilobula (Michx.) T. Moore	hay-scented fern	Native	G5, S5
Deschampsia flexuosa (L.) Trin.	wavy hairgrass	Native	G5, S3
Eupatorium purpureum L.	joe-pye-weed	Native	G5, S5
Fraxinus americana L.	white ash	Native	G5, S5
Hedera helix L.	English ash	Alien	GNR, SNA

Ilex opaca Ait.	American holly	Native	G5, S5
Juncus effusus L.	soft rush	Native	G5, S5
Juncus tenuis Willd.	path rush	Native	G5, S5
Ligustrum sinense Lour.	Chinese privet	Alien	GNR, SNA
Liriodendron tulipifera L.	tulip poplar	Native	G5, S5
Lycopus virginicus L.	Virginia bugleweed	Native	G5, S5
Microstegium vimineum (Trin.) A. Camus	Japanese stiltgrass	Alien	GNR, SNA
Oenothera biennis L.	evening primrose	Native	G5, S5
Oxydendrum arboreum (L.) DC.	sourwood	Native	G5, S5
Phemeranthus teretifolius (Pursh) Raf.	quill fameflower	Native	G4, S3
Physocarpus opulifolius (L.) Maxim.	common ninebark	Native	G5, S4
Phytolacca americana L.	pokeweed	Native	G5, S5
Pinus strobus L.	white pine	Native	G5, S5
Prunus serotina Ehrh.	black cherry	Native	G5, S5
Quercus prinus L.	chestnut oak	Native	G5, S5
Quercus stellata Wangenh.	post oak	Native	G5, S5
Rhynchospora capitellata (Michx.) Vahl	brownish beaksedge	Native	G5, SNR
Robinia pseudoacacia L.	black locust	Native	G5, S5
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Rubus hispidus L.	bristly dewberry	Native	G5, S4
Rumex acetosella L.	sheep sorrel	Alien	GNR, SNA
Saxifraga michauxii Britt.	Michaux's saxifrage	Native	G4G5, S4
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Scutellaria integrifolia L.	hyssop skullcap	Native	G5, S5
Smilax glauca Walt.	cat greenbrier	Native	G5, S5
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Thelypteris noveboracensis	New York fern	Native	G5, S5
Toxicodendron radicans (L.) Kuntze	poison ivy	Native	G5, S5

Tsuga caroliniana Engelm.	Carolina hemlock	Native	G3, S3
Tsuga canadensis Engelm.	Canada hemlock	Native	G4G55, S5
Vaccinium sp. L.	blueberry	Native	G5, S5
Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium stamineum L.	deerberry	Native	G5, S5
Vitis aestivalis Michx.	summer grape	Native	G5, S5
Uvularia sessilifolia L.	sessile-leaf bellwort	Native	G5, S4

CARL – Moss and Macrolichen Species – Outcrop 18

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Aulacomnium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Hypnum imponens Hedw.	hypnum moss	Native	G5, SNR
Leucobryum glaucum (Hedw.) Angstr. in Fries	pincushion moss	Native	G5, SNR
Sphagnum inundatum Russ.	water sphagnum	Native	G5, SNR
Lichen			
Cladonia apodocarpa Robbins	reindeer lichen	Native	G5, SNR
Cladonia digitata (L.) Hoffman	finger pixie-cup	Native	G3G5, SNR
Cladonia sp. P. Browne	cladonia lichen	Native	N/A
Lecidea tessellata Flörke	lecidea lichen	Native	G5, SNR
Lecidella carpathica Korber	disk lichen	Native	G5, SNR
Leproloma membranaceum	leproloma lichen	Native	GNR, SNR

(Dickson) Vainio			
Micarea erratica (Korber) Hertel, Rambold & Pietschmann	erratic dot lichen	Native	GNR, SNR
Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR

CARL – Vascular Species – Outcrop 19

Species Name	Common Name	Native/ Alien	Conservation Status
Acer rubrum L.	red maple	Native	G5, S5
Ambrosia artemisiifolia L.	annual ragweed	Native	G5, S5
Buxus sp. L.	boxwood	Alien	GNR, SNA
Campsis radicans (L.) Seem. ex Bureau	trumpet creeper	Native	G5, S5
Carya alba (L.) Nutt. ex Ell.	mockernut hickory	Native	G5, S5
Carya glabra (P. Mill.) Sweet	pignut hickory	Native	G5, S5
Commelina communis L.	Asiatic dayflower	Alien	G5, SNA
Dichanthelium sp. (Hitchc. & Chase) Gould	a panic grass	Native	N/A
Narcissus sp. L.	daffodil	Alien	N/A
Dactylis glomerata L.	orchard grass	Alien	GNR, SNA
Danthonia compressa Austin	flattened oatgrass	Native	G5, S3
Digitalis sp. L.	foxglove	Alien	N/A
Corydalis sempervirens (L.) Pers.	pale corydalis	Native	G4G5, S3
Hedera helix L.	English ivy	Alien	GNR, SNA
Juniperus virginiana L.	red cedar	Native	G5, S5

Ligustrum sinense Lour.	Chinese privet	Alien	GNR, SNA
Liriodendron tulipifera L.	tulip poplar	Native	G5, S5
Lysimachia quadrifolia L.	whorled loosestrife	Native	G5, S5
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Native	G5, S5
Phemeranthus teretifolius (Pursh) Raf.	quill fameflower	Native	G4, S3
Phytolacca americana L.	pokeweed	Native	G5, S5
Physocarpus opulifolius (L.) Maxim.	common ninebark	Native	G5, S4
Pinus strobus L.	white pine	Native	G5, S5
Potentilla canadensis L.	dwarf cinquefoil	Native	G5, S5
Prenanthes altissima L.	rattlesnake root	Native	G5, S5
Quercus marilandica Muenchh.	blackjack oak	Native	G5, S5
Quercus stellata Wangenh.	post oak	Native	G5, S5
Rhododendron maximum L.	great laurel	Native	G5, S5
Rubus argutus Link	sawtooth blackberry	Native	G5, S5
Schizachyrium scoparium (Michx.) Nash	little bluestem	Native	G5, S5
Selaginella rupestris (L.) Spring	ledge spikemoss	Native	G5, S3
Smilax rotundifolia L.	roundleaf greenbrier	Native	G5, S5
Toxicodendron radicans (L.) Kuntze	poison ivy	Native	G5, S5
Tsuga canadensis Engelm.	Canada hemlock	Native	G4G55, S5
Tsuga caroliniana Engelm.	Carolina hemlock	Native	G3, S3
Symphyotrichum dumosum (L.) Nesom	bushy aster	Native	G5, S5
Vaccinium sp. L.	blueberry	Native	G5, S5

Vaccinium corymbosum L.	highbush blueberry	Native	G5, S4
Vaccinium stamineum L.	deerberry	Native	G5, S5

CARL – Moss and Macrolichen Species – Outcrop 19

Species Name	Common Name	Native/ Alien	Conservation Status
Moss			
Aulacomium palustre (Hedw.) Schwaegr.	aulacomnium moss	Native	G5, SNR
Campylopus tallulensis Sull. & Lesq.	Tallul campylopus moss	Native	G4, SNR
Dicranum scoparium Hedw.	broom moss	Native	G5, SNR
Grimmia laevigata (Brid.) Brid.	grimmia dry rock moss	Native	G5, SNR
Thuidium delicatum (Hedw.) Schimp.	delicate fern moss	Native	G5, SNR
Lichen			
Cladonia apodocarpa Robbins	cup lichen	Native	G3G5, SNR
Cladonia digitata (L.) Hoffman	finger pixie-cup	Native	G3G5, SNR
Leproloma membranaceum (Dickson) Vainio	leproloma lichen	Native	GNR, SNR
Physcia halei Thomson	Hale's rosette lichen	Native	G3, SNR
Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale	Plitt's xanthoparmelia lichen	Native	G5, SNR
Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale	peppered rock shield	Native	G5, SNR

APPENDIX B

INCREMENT CORE DATA FOR THE GRANITIC ROCK OUTCROPS OF CARL

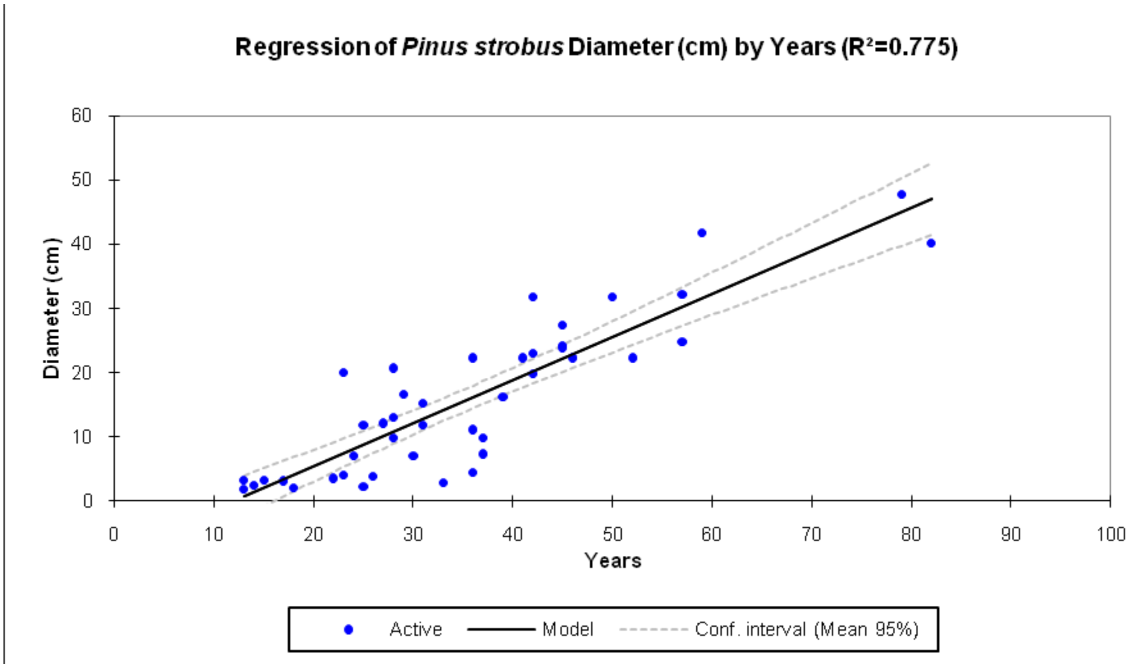

Figure 10. Regression of white pine diameter and age.

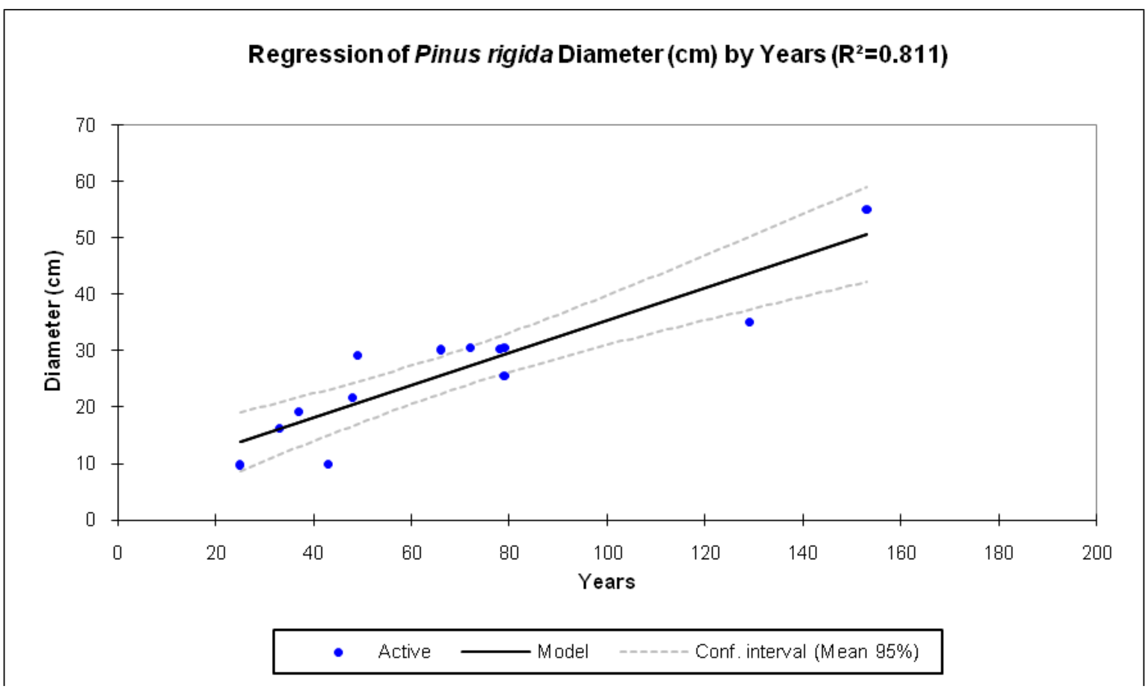

Figure 11. Regression of pitch pine diameter and age.

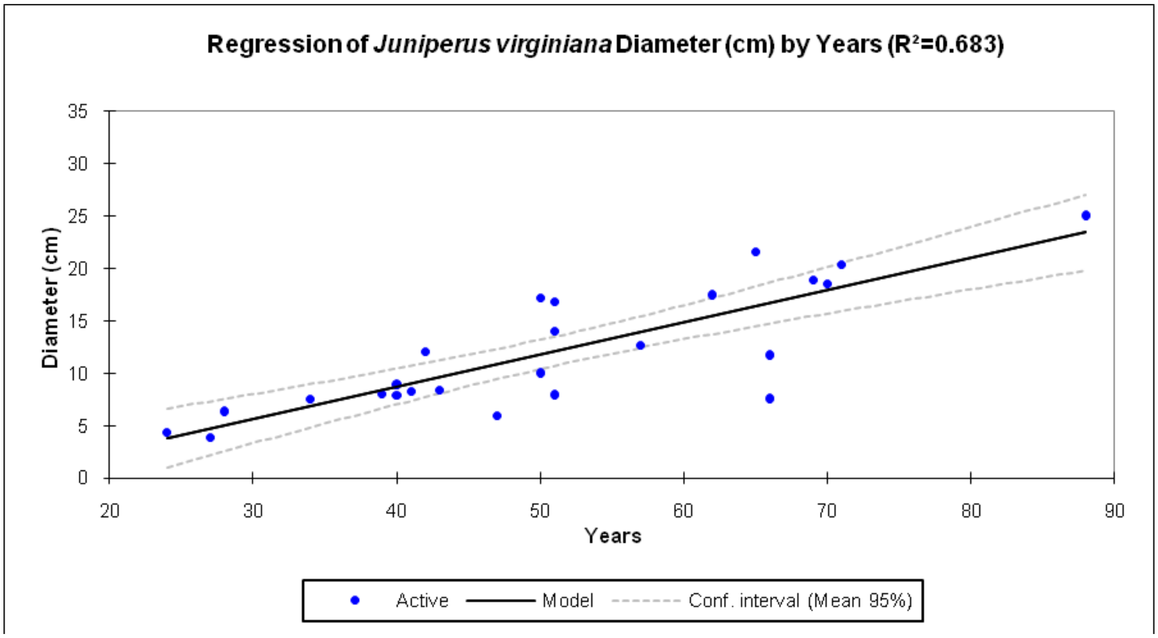

Figure 12. Regression of red cedar diameter and age.

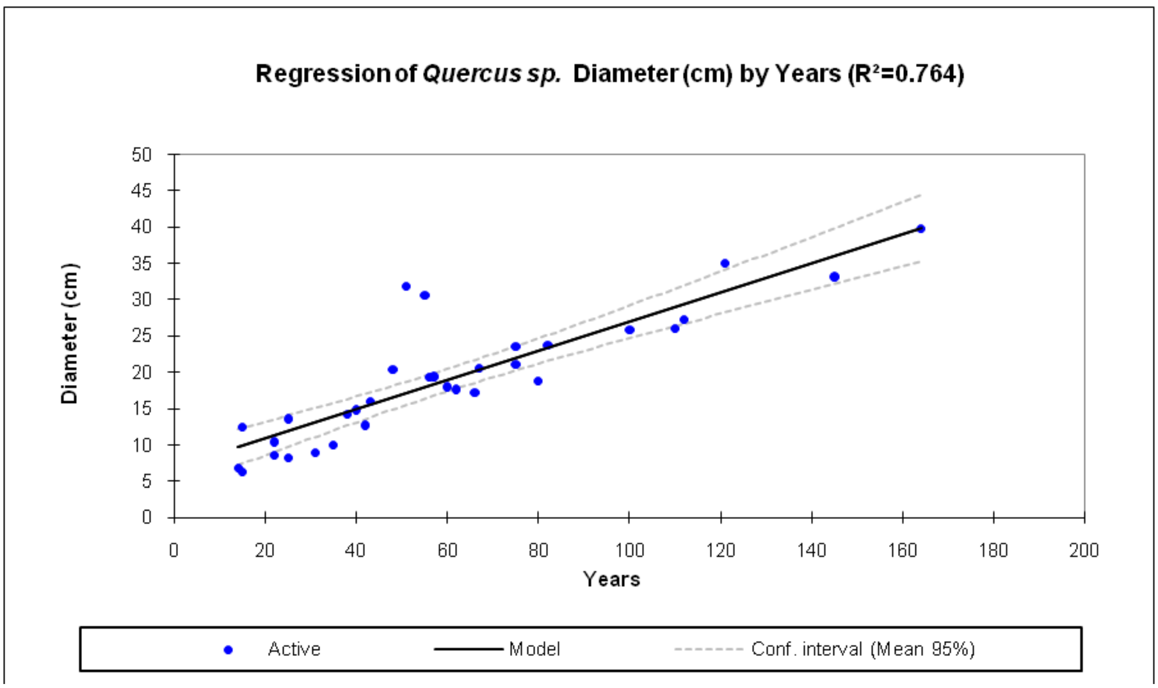

Figure 13. Regression of oak species diameter and age.

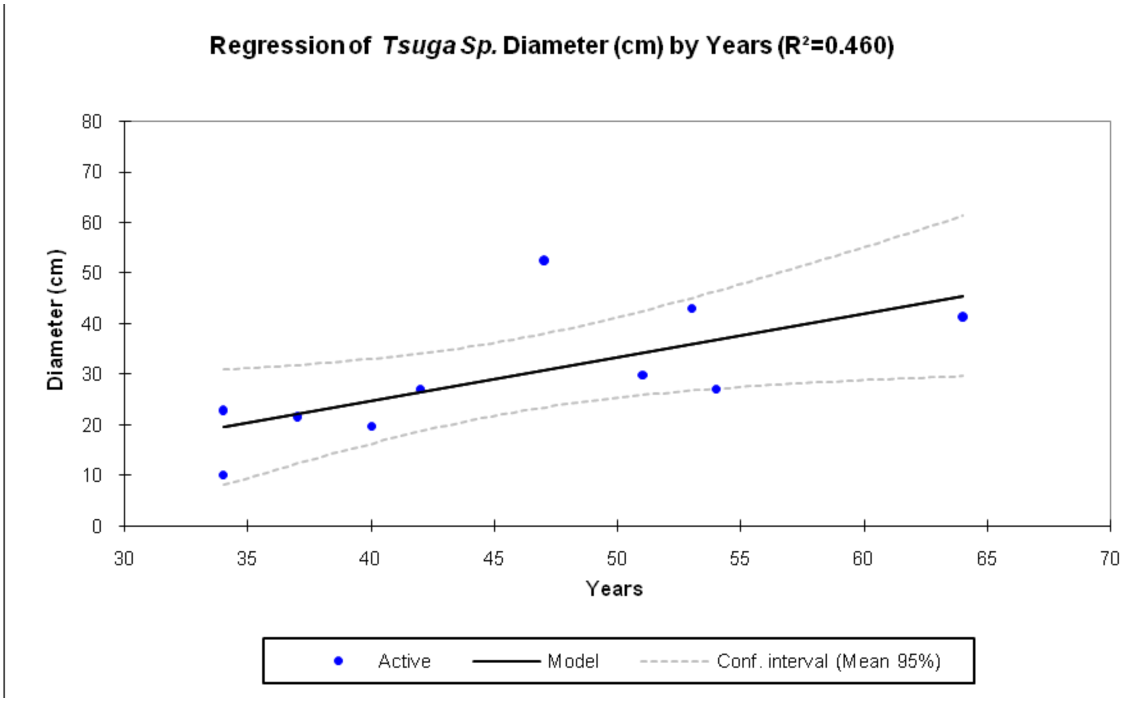

Figure 14. Regression of hemlock species diameter and age.

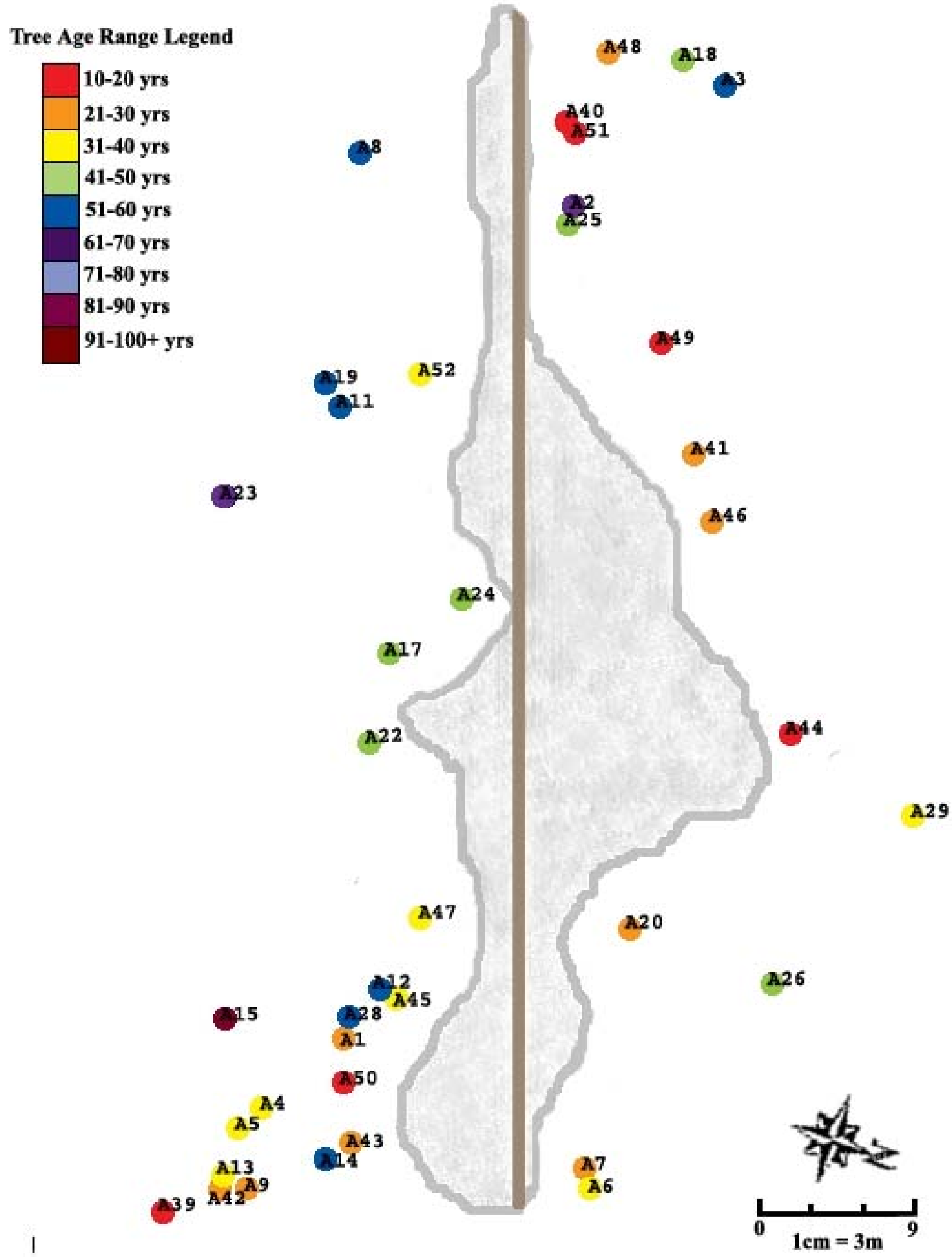

Figure 15. Map depicting tree core locations and age class for Outcrop #18 located behind the Main House.

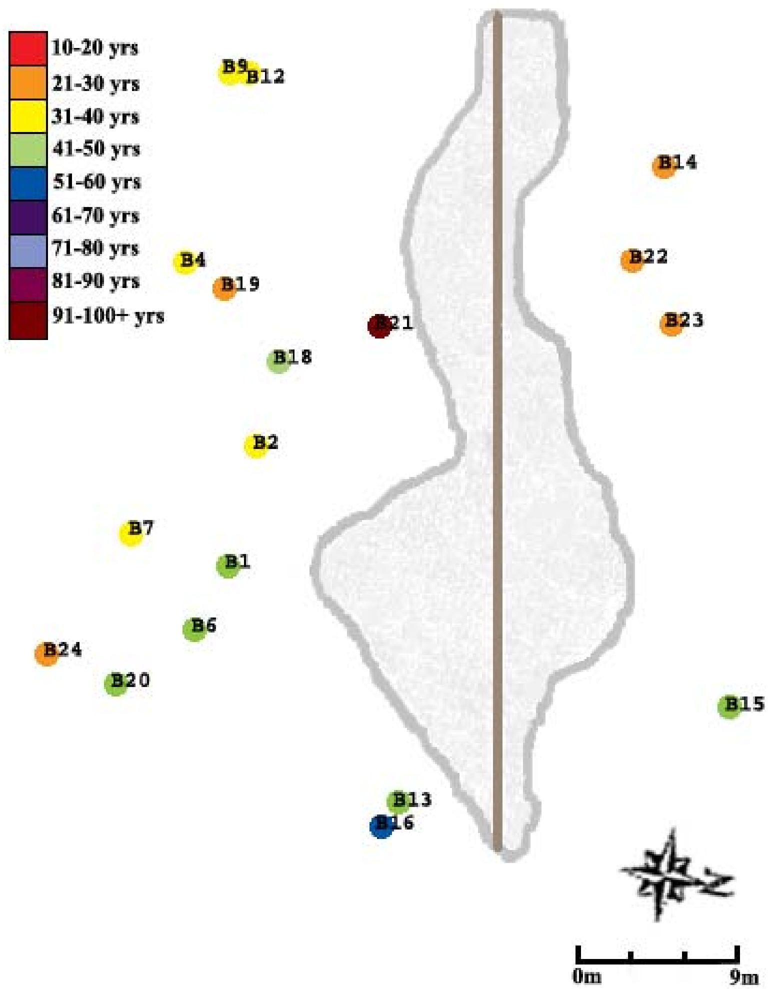

Figure 16. Map depicting tree core locations and age class for Outcrop #19.

VITA

Jared Adam Woolsey was born on July 23, 1976 in Stroudsburg, Pennsylvania. His parents are Lawrence and Christine Woolsey. He has one brother Joshua Woolsey. After graduating from Stroudsburg High School in 1995 Mr. Woolsey enrolled at the Pennsylvania State University. He was awarded the Bachelor of Science degree in 2001. In the fall of 2005 Mr. Woolsey enrolled in the graduate program at Appalachian State University and began study towards a Master of Science degree. The M.S. was awarded in December of 2010.

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