THE VASCULAR FLORA OF THE LULA LAKE LAND TRUST ON LOOKOUT MOUNTAIN
IN WALKER COUNTY, GEORGIA AND A BIOGEOGRAPHICAL ANALYSIS OF THE
COASTAL PLAIN ELEMENT ON THE CUMBERLAND PLATEAU

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ABSTRACT

The vascular flora of the Lula Lake Land Trust (LLLT) atop Lookout Mountain in Walker County, Georgia was surveyed from 2012 to 2014. A total of 60 collecting trips were made with 672 species and lesser taxa documented. Twenty-eight rare species of conservation concern were documented including the federally endangered *Spiraea virginiana* and four species previously unknown from the state (*Calamovilfa arcuata, Chelone lyonii, Populus grandidentata,* and *Solidago arenicola*). This inventory along with the vascular flora of Little River (Cherokee/Dekalb counties, AL) were added to the legacy database of the lab of Joey Shaw (UTC) and used to generate a species-area curve representing the full extent of the Cumberland Plateau. The proportion of Coastal Plain endemic species present in the Cumberland Plateau was compared to the surrounding physiographic provinces using the legacy database. This comparison indicated a significantly higher proportion of Coastal Plain endemics in the Cumberland Plateau than surrounding physiographic provinces.
AKNOWLEDGEMENTS

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ABBREVIATIONS

LLLT, Lula Lake Land Trust
U.S., United States
CU, Cumberland Plateau
CP, Coastal Plain
EHR, Eastern Highland Rim
GA, Georgia
AL, Alabama
MS, Mississippi
NA, North America
BP, Before Present
LGM, Last Glacial Maximum
EDF, Eastern Deciduous Forests
TN, Tennessee
MYA, Million Years Ago
NOAA, National Oceanic and Atmospheric Administration
H, Hectares
Km, Kilometers
GDNR, Georgia Department of Natural Resources
USDA, United States Department of Agriculture
GA-EPPC, Georgia Exotic Plants Pest Council
BONAP, Biota of North America Program
CHAPTER I

INTRODUCTION

With the stated purpose to protect and preserve the Rock Creek watershed (including the vascular plant species and communities) the Lula Lake Land Trust has created a protected landscape on the Cumberland Plateau (from here on referred to as CU) within Georgia suitable for a vascular inventory. The LLLT Master Plan includes a very limited checklist of vascular plants located on site, but no complete vascular inventory has been produced for the land trust (Lula Lake Land Trust Master Plan 1994). The lack of a complete vascular inventory for this protected area, along with multiple personal communications with regional botanists concerning species of conservation concern located within the LLLT, demonstrates the need for a complete inventory. Therefore, I ask the question: Is the flora of the LLLT and are the communities located therein worth protecting? To get at this question I have (1) inventoried the vascular flora of the LLLT and compared its floristic richness and composition to that of other protected areas on the CU to determine if the LLLT has a greater or lesser species richness than other protected areas on the CU, (2) documented the presence and location of species of conservation concern and the non-native vascular plant species and compared the composition of these within the LLLT to other natural areas of the CU, and (3) documented and mapped the ecological systems present within LLLT, according to NatureServe (NatureServe 2014), to determine if there are any communities of conservation concern on LLLT properties.
In order to make these kinds of comparisons I have (4) synonymized the current comparative plant list of the CU (Shaw lab legacy database) with the *Guide to the Vascular Flora of Tennessee* (Tennessee Flora Committee, in press) and (5) added additional floras from the CU of Alabama to extend the database to the CU’s full southern extent which allowed for comparisons between these protected areas and the LLLT.

In previous floristic inventories of the CU (and adjacent Eastern Highland Rim) botanists have noted the presence of a strikingly higher number of Coastal Plain species than in the surrounding physiographic provinces. However, no known statistical analysis of this distributional pattern has ever been attempted. Thus, it begs the question: Do the Cumberland Plateau floras contain significantly more Coastal Plain species than floras of surrounding physiographic provinces? To get at this question I have (6) add nine floras from equivalent latitudes of the Ridge and Valley, Blue Ridge, and Eastern and Western Highland Rim to the legacy database. This allowed me to statistically examine the possibility that there is a greater proportion of CP species on the CU when compared to surrounding provinces at the same latitude.

*Relevance of Floristic Studies to Broader Science*

Although humans have been classifying plants for millennia, it was not until the third century BCE that Theophrastus attempted to create a complete, systematic record of the plant species of the world in *Historia Plantarum*. Although earlier accounts may have existed they have not survived to the present. In the first century, Dioscorides wrote his description of approximately 600 plant species and their medicinal uses in *Materia Medica*, which relegated the
science of Botany for the next 1500 years to the position of doctor’s tool. This was due to the fact that the doctor’s pharmacy at the time consisted primarily of the flora of the surrounding region (Porter 1959). As late as the turn of the 20th century in the United States those conducting botanical research were primarily educated as medical doctors; however, the research being conducted by that time was beginning to take a form resembling that of modern botany (Shinners 1969). As the discipline of modern botany grew through the 18th and 19th centuries, Harvard Professor and botanist Asa Gray noted that collecting, identifying, and categorizing a large number of species is critical for a person to develop proficiency as a botanist (Gray 1836). The list of skills that Gray notes describes the components of conducting a floristic study, which in its most basic form is a botanical inventory of a specified area. The data acquired from a complete floristic study provides information for multiple venues of research and also adds to the accumulating understanding of species ranges over increasingly larger geographic areas. Accumulating and collating data in these areas is essential to research conducted in other fields, including biogeography, conservation, environmental science, ecology, and evolution (Briggs 1991, Palmer and Richardson 2012).

The contribution of floristic research to the discipline of ecology is well documented (Braun-Blanquet et al. 1932, Daubenmire 1978, Dunning et al. 1992). Through the 19th century scientists such as Alexander von Humboldt used floristic data to develop such ecological concepts as plant communities, and at the same time recognized and studied the influences on these communities by non-plant organisms, geology, and climate (Daubenmire 1978). Since that time debate has continued concerning the best method for sampling and classifying plant communities. Over large spatial scales (e.g., biomes) a classification system based on physiognomy has traditionally been favored, while regional or local scales are often classified
using a system based on floristic composition (associations) (Moravec 1993, Box 1995). The formation of the Federal Geographic Data Committee in 1990 in the United States began the development of a standardized system of vegetation classification that utilizes both physiognomic and floristic characteristics and is now available on NatureServe (Jennings et al. 2009). Developing standards for classifying vegetation associations would be impossible without floristic research, which provides invaluable raw data for synthesizing and understanding ecological data at a variety of spatial scales (Jennings et al. 2009). In turn, when conducting a floristic inventory of an area, vegetation association data is vital for the targeting of species based on their known association preferences (Huskins and Shaw 2010, Blyveis and Shaw 2012).

An increase in vascular plant collections between the 18th and 19th centuries began to reveal distributional patterns of plants throughout the world. Adolph Engler, a prominent botanist of the 19th century, used his position at the Botanical Gardens in Berlin and the information at his disposal to attempt to synthesize the evolutionary history of plants on Earth as it pertains to their distributions. He designated four botanic realms and 32 botanic regions based on his observations (Moreira-Muñoz 2007). As botanists began to take interest in these patterns the study of the distributions of plants and the method by which those distributions came to be developed into the discipline of biogeography (Daubenmire 1978). Biogeography synthesizes the species inventory research, ecology, evolution, climate, and geology of a geographic region to study the ecological and historical distribution and migration patterns of organisms (Avise 2004). Using floristic data from different spatial scales, comparisons can be made by botanists to elucidate distribution information, which can reveal patterns of vicariance or dispersal of plants. Simply stated, botanists can examine how plants came to be in their current locations using inferences made by plant collections (Ebach and Humphries 2003).
Around the turn of the twentieth century anthropogenic growth and development in the U.S. led to the disturbance and destruction of many natural areas, which prompted Engler in 1911 to stress the importance of a thorough floristic inventory of North America before the natural areas were degraded any further. As the conservation movement grew, with natural resource conservation as the impetus, a complete inventory of the natural resources of the U.S. was undertaken at that time, including vegetation (Engler and Drude 1911). This is because vegetation documentation and classification are central to biological conservation, from planning and inventory to direct resource management (Jennings et al. 2009). According to the International Union for the Conservation of Nature, 15 percent of U.S. land area is protected; however the majority of this area is located in the western half of the U.S. (United States Geological Survey 2009). The scarcity of protected lands in the eastern U.S. means investment in the protection of natural areas must be done in a manner ensuring that those lands have value as natural areas and that areas not protected but having significant ecological value can be located and protected. Analysis of the vegetation associations and species of an area will allow for better management of protected lands and targeting of adjacent property in a manner that most efficiently facilitates the protection of the biota of the area (Briggs 1991, Cutko 2009).

The science of botany has developed into a discipline that incorporates a wide range of physical sciences. As Asa Gray noted collecting, classifying, and identifying plants is essential to the science of botany and has been since the time of Theophrastus. The standardized plant community classification system developed by NatureServe as well as biogeographic studies of plant distributions depend on data provided by vascular plant inventory data. Clearly the conservation of plants necessitates the knowledge of where they are located. It is with the disciplines of floristics, ecology, biogeography, and conservation in mind that I have undertaken
the task to inventory the vascular flora of the LLLT. The completion of this inventory will serve several purposes. The first of these, which Asa Gray promoted as essential for the development of a botanist, is the invaluable educational experience gained from three years of collecting, identifying, and categorizing the large number of species contained within the vascular inventory of the LLLT.

*The Vascular Flora of the Cumberland Plateau*

The vascular flora of the CU is arguably more thoroughly studied than any other physiographic province in Tennessee (25 individual floras, Zach Irick, UTC, unpublished data). Inventories include: (Clark 1966, Sole et al. 1983, Schmalzer et al. 1985, Clements and Wofford 1991, Goodson 2000, Fleming and Wofford 2004, McEwan et al. 2005, Beck and Van Horn 2007, Huskins and Shaw 2010, Blyveis and Shaw 2012, Wofford et al. 1979, Allawos 1994, Weckman et al. 2003). Forests within the LLLT are consistent with the general description given by Hinckle (1989) of the CU’s southern district. These are described as being predominantly mixed oak communities on the gentle to moderate slopes, flatlands, and ridges. Some gradation occurs along the dry, shallow-soiled ridges and escarpments into forests co-dominant with *Pinus virginiana* (Virginia pine). *Acer rubrum* (red maple), *Liriodendron tulipifera* (tulip-tree), and *Nyssa sylvatica* (black gum) comprise a large component of the canopy within some of the poor draining sites that contain more mesic species. The composition of the ravines, coves, and some convex slopes fits within or approaches the mixed-mesophytic community described by Braun (1964) with *Quercus alba* (White Oak), *Liriodendron tulipifera* (Tulip tree), and *Tsuga canadensis* (Hemlock).
Similar to the floristic record of the LLLT, a limited vegetation community description and map was created for the LLLT master plan (Lula Lake Land Trust Master Plan 1994). Due to the age of this description and the recent standardization of vegetation communities that differs from that used for the original description, it is necessary to complete a new survey of the vegetation types within the LLLT.

Eleven inventories from Tennessee, along with two from Kentucky, were compiled into a database by S. Huskins (2010) and E. Blyveis (2012), both former students in the research laboratory of J. Shaw (University of Tennessee at Chattanooga). This database of floristic research on the CU extends geographically from central Kentucky to the southern border of Tennessee and lists approximately 2,000 species of vascular plants. Also included within the database is the size of the area in which the studies were conducted, the species of each study, and the geographic distributions of each species. Prior students of the Shaw lab (Huskins and Shaw 2010, Blyveis and Shaw 2012) synonymized the checklist of these studies according to USDA plants (USDA 2008, USDA 2011).

Because the foci of these earlier works (Blyveis and Shaw 2012, Huskins and Shaw 2010) was on the CU of Tennessee, they did not include the floristic studies from the southern extent of this physiographic province, which extends through the northwest corner of Georgia and into central Alabama. The vascular flora of the CU within Alabama has been well studied. David Whetstone (JSU) has studied extensively the CU within the state including the vascular flora of Lake Guntersville State Park (Whetstone 1981, Spaulding 1995). However, the most pertinent inventory of the CU in Alabama to that of the LLLT is the Vascular and Non-Vascular Flora of
Little River on Lookout Mountain in Northeast Alabama, which is located on the same mountain approximately 48 km southwest of LLLT (Dickson 1992).

Although the flora of the CU in Tennessee and Alabama has been well studied, within Georgia no vascular inventories have been conducted in the province. It is possible that the lack of floristic research within the CU of Georgia is due to the relatively small portion of Georgia through which the province occurs (482 km² or approximately 0.3 % of Georgia’s land area) (Jackson and Stakes 2004). Further floristic research can provide a clearer picture of the distributional, ecological, and conservation requirements of the vascular plants of this physiographic province.

Coastal Plain influence on the Cumberland Plateau Flora

With the data collected from the flora of the LLLT added to the comparative plant list of the CU, the floristic makeup of the Plateau and surrounding physiographic provinces can be compared to shed light on the current and historical distributions of the plants located therein. For over 75 years botanists have noted the presence of a high proportion of CP vascular plant species on the CU and Eastern Highland Rim (from here on referred to as EHR) in comparison to the physiographic provinces immediately adjacent at the same latitude (Braun 1937a). Research has often focused on two “hotspots” for this disjunction, the northern CU and EHR in Tennessee and Kentucky, and the Southern CU and EHR in Southern Tennessee and Northern Alabama (Braun 1937a, Harvill 1984, Sorrie and Weakley 2001). The mechanism responsible for these distributional patterns has been debated for as long as this pattern has been noted with two opposing theories being postulated as an explanation. Braun (1937b) proposed that during the
Pleistocene epoch the mixed mesophytic forests of southeastern North America encroached upon the contained refugia of relictual species from the Tertiary period distributed in the CU and EHR. Braun hypothesized that this Tertiary flora dispersed into the CP upon the development of favorable growing conditions leaving disjunct populations of related taxa in the uplands. Harvill (1984) provided the alternative hypothesis that the CP species on the CU/EHR represent more recent emigrants from the CP that dispersed into favorable habitats on the CU through northern Alabama. More recent phylogeographic, palynological, and distributional research indicates a more complex process of events determined the current distributions of the biota of the southeastern United States (Sorrie and Weakley 2001, Williams et al. 2004, Soltis et al. 2006, Gonzales et al. 2008).

The CP physiographic province of North America is a relatively long, narrow, and geologically unified region stretching from the Atlantic Coast of Massachusetts south to the tip of Florida and west to the Gulf Coast of Texas and northern Mexico. This province also extends north up the Mississippi embayment to southern Missouri and Illinois (Noss et al. 2015). The geological CP is made up of the exposed portion of the continental shelf and is composed of Cretaceous age or younger sedimentary deposits. It is geologically sharply defined on the Atlantic coast by the fall line, the point at which it abuts older Paleozoic formations of the Piedmont province. As the CP turns west through Georgia and Alabama the Paleozoic/Cretaceous boundary turns northwestward so that the Coastal Plain borders Montane/Plateau physiographic provinces (Sorrie and Weakley 2001).

Climatic fluctuations from the Tertiary through the Quaternary have had significant impacts on this province. Throughout the Tertiary the climate fluctuated between warmer and
cooler epochs during which temperate and tropical climates dominated southeastern North America (Manchester 1999). Glaciation events began to drastically affect the region during the Quaternary by altering sea levels, precipitation, and temperatures (Grimm et al. 2006). Just prior to the Pleistocene epoch sea levels rose to approximately 90 m above present levels and continued to fluctuate substantially during the Quaternary period (Sorrie and Weakley 2001). At its highest point during that period the sea level was up to 13 m above present, inundating much of the current state of Florida (Noss et al. 2015) while at its lowest point the peninsula of Florida was approximately twice as wide as today (Grimm et al. 2006). Glaciation to the north drove biota south with taiga species reaching as far south as Georgia, Alabama, and Mississippi. Although Spruce pollen has been found in ponds as far south as Louisiana and northern Florida, it is a fractional component of a mixed temperate forest (Watts 1980, Noss et al. 2015). Glacial events had the effect of compressing the temperature zones of the southeastern U.S. laterally as evidenced by the taiga species extending south as far as Georgia, Alabama, and Mississippi, while the temperatures of the Gulf and Atlantic Coast of the South were moderated by warm oceans that kept their climate relatively stable and similar to those at present (Stults et al. 2010). Pollen records and lake cores suggest that precipitation cycled from low/dry during stadial events to higher/wet during interstadial events due to the influence of sea levels and temperature (Stults et al. 2010, Grimm et al. 2006, Watts 1980).
Study Site

Geography

Located approximately 8 km southwest of Chattanooga, the LLLT currently owns approximately 1,416 ha with another 364 ha of adjacent lands protected through conservation easements (Figure 1). The site is located between 85.3673 and 85.4337 W longitudes and 34.8461 and 34.9341 N latitudes. The LLLT property is bordered on all sides by private property with the western border located in the interior of the plateau and the eastern border located just below the eastern edge of the escarpment, or brow. Rock Creek is the main drainage through the site, and the gorge it creates is located at the northern border, while the southern border abuts private property just south of Durham, Georgia (Figure 1). Long Branch, a tributary of Rock Creek, drains the southern half of the property and forms a valley running from south to north before emptying into Rock Creek. The northern half of the property is bisected from south to north by Rock Creek which also forms a valley surrounded by higher plateau land to the west and the high ridge of the eastern escarpment to the east (Lula Lake Land Trust Master Plan 1994).
Figure 1 Lula Lake Land Trust property boundary
Situated at the southern extension of the CU, Lookout Mountain extends 150 km northeast to southwest from its northern tip just south of Chattanooga, Tennessee to Gadsden, Alabama in Etowah County (Lookout Mountain Conservancy 2013). High Point is the highest elevation on Lookout Mountain at 729 m and is located within the study area. Lookout Mountain is widest just south of its union with Pidgeon Mountain at approximately 15 km and tapers to the north and south. To the west the mountain is bordered by Lookout Valley, which runs parallel to Lookout Mountain and divides Lookout and Sand Mountains. To the east the Mountain is bordered by the Chickamauga and Chattanooga valley which forms the eastern edge of the CU and borders the Ridge and Valley physiographic province (Churnet 1997).

The U.S. environmental protection agency has described the ecoregions of the U.S. on several broad landscape scales (EPA 2010). The LLLT is located within the EPA level III ecoregion described as the Southwestern Appalachians while the level IV ecoregion is the Southern Table Plateaus (Figure 2) (EPA 2010). Landtypes are the smallest unit of the landscape described from the southern Cumberland Plateau and are visibly differentiated by their similar soils and productivity that are a result of comparable geological and climatic processes (Smalley 1979). Of the 21 lantypes described by Smalley (1979) from the southern Cumberland Plateau nine are found within the LLLT.
Figure 2 Outline of the Cumberland Plateau with Lookout Mountain (EPA Ecoregion 4 map)
Geology and Soils

Lookout Mountain is composed of sedimentary rock that was deposited primarily during the Mississippian and Pennsylvanian sub-periods of the Carboniferous (~360 to 286 MYA). The completion of the Pennsylvanian brought the Allegheny orogeny, which due to the collision of the African and North American continents, led to the uplifting of the Appalachian Mountains (Churnet 1997). This event created multiple ridge and valley chains also known as synclines and anticlines, throughout what is now the Appalachian Mountains. These synclines and anticlines eroded to create Lookout Mountain (Churnet 1996). Beginning as an anticline during the late Pennsylvanian, Lookout Mountain rose to prominence as the surrounding synclines eroded away due to the exposure of their softer limestones (relative to the anticlines’ harder sandstone). Over approximately 286 million years the synclines eroded up to 300 m below the current position of the anticline to form Lookout Valley in the west, Chattanooga Valley in the east, and Lookout Mountain in between (Churnet 1997). The sandstone cap now present atop Lookout Mountain is composed of Pottsville conglomerate sandstone of the Pennsylvanian. This cap, so characteristically seen in the exposed cliffs of the Cumberland Plateau, allowed for the sheltering of the plateau from erosion (Hack 1966, Dickson 1992). Below the sandstone cap the geology is characterized by the Mississippian aged Bangor limestone formation, which extends to the valley floor (Dickson 1992, Hack 1966, Churnet 1997). Because the survey area is situated completely atop the mountain there are no locations with exposed stone other than sandstone and shale.

As the Alleghany orogeny lifted the southeastern portion of the North American continent into highlands and they emerged from the waters that had previously covered them,
the underlying rock began to erode (Churnet 1997). Soils are formed as a direct consequence of the erosion of the stone over which they lay and that same erosion leads to their transportation via water downstream or by way of gravity downhill. Dickson (1992) describes the soils of Lookout Mountain as primarily Ultisols with moderate to excessive drainage, little organic matter, and little retention of bases. The Walker county soil survey (McLendon 1910) designated two soil groups located within the survey area, the Dekalb group and the Conasauga group. The later soil group reported from the survey area is reported only from the Durham area; however, the description approaches a slope, observed by the author, 200 m south of High Point. This soil type is described as Conasauga shale loam and is typically located in highly eroded slopes and is composed primarily of crumbled shale with small amounts of silt and clay. This is the only soil type located in the survey area that contains neutral to alkaline properties (McLendon 1910). However, updated data provided by the USDA Web Soil Survey lists three primary soil series located within the LLLT (USDA WSS 2013). The Hartsells series is composed of moderately deep, well drained soils formed of weathered sandstone. These soils are nutrient poor, acidic, composed of fine to coarse granules, and located on level to moderately steep slopes of the study site. The Hector series soils are similar to those of the Hartsells, but occur in a shollower layer over the sandstone bedrock and often on more severe slopes. These fine, sandy loams typically occur to depths of only 38 cm as compared to Hartsells series soils which reach depths of up to 100 cm. The Nauvoo series is deeper than the Hector series reaching depths of 150 cm however, its formation and composition are similar to the previous two series (USDA WSS 2013). There is no mention in the Web Soil Survey of any series similar to the Conasauga group described in the 1910 Walker County soil survey.
Climate

The LLLT is located approximately 8.8 km southwest from the nearest Lookout Mountain, Tennessee, NOAA weather station which is located at 35.010° N latitude and 85.344° W longitude and at 643 m elevation. This station has collected data from 1995 to 2012. The data indicate a climate consistent with that of the southern Cumberland Plateau with cool winters and warm, humid summers. The average annual temperature is 13.15°C with the lowest average monthly temperature occurring in January (-2.05°C) and the highest average monthly temperature occurring in July (28.1°C). The average annual precipitation is 134.24 cm with the highest average monthly precipitation occurring in March (14.02 cm and the lowest average monthly precipitation in August (7.80 cm). In the winter months light amounts of snow are not uncommon, however the snow on average remains no longer than a few days (NOAA 2012).

Conservation History and Land Use

Protecting and preserving the Rock Creek watershed has been the stated purpose of the LLLT since its formation in 1994 (Lula Lake Land Trust Master Plan 1994). Currently the property is used for education, recreation, and research and is divided into two halves. The Long Branch half makes up the southern portion of the LLLT and includes property surrounding Long Branch, High Point, and conservation easements along Durham road and GA state route 157. The Long Branch property is open at all times with access to the Long Branch trail along Nick-a-Jack road or GA state route 157. The trail also forms a section of the larger Cloudland Canyon Connector
Trail. The northern half of LLLT contains Lula Lake and Lula Falls and is only open to the public two days a month. When open, numerous trails cross the property offering access to vistas of the Chattanooga Valley, Lula Lake, and Lula Falls (Lula Lake Land Trust Master Plan 1994).

Although the LLLT does protect beautiful natural landscapes, the land trust has only existed for 20 years and previous land use has created multiple areas of anthropogenic disturbance within the collection site. Strip mining began in the 1920s in the town of Durham, which cleared properties, created piles of tailings, and saw the construction of a railway that ran from Durham through the current Lula Lake Property (Lula Lake Land Trust Master Plan 1994, Dickson 1992). Several roadways currently run through the property including GA state route 157, Durham Rd., the Lula Lake Property driveway, and Nick-a-Jack Rd. There are several cultivated meadows including the parking area for Lula Lake and the Parking are at the Northern trailhead of the Long Branch Trail, which consists of an old homesite that is mowed regularly. There are also regularly mown areas near Lula Lake including a American chestnut orchard and a portion of the ridgeline along the brow east of the lake (Lula Lake Land Trust Master Plan 1994). Bisecting the Long Branch property is a transmission line running east to west which is cleared using mowers every other year, but allows for the growth of many grassland species. Also located within the north end of the Long Branch property is the Long Branch Subdivision, a 121 h community that has left much of its property undeveloped and within a conservation easement.
CHAPTER II

METHODS

Specimen Collection

A total of 60 collecting trips were made between the fall of 2012 and 2014. Ecological systems in the collection area were identified early in the survey using personal observation, Google Earth, and NatureServe (NatureServe 2014). The identified systems were surveyed on a weekly basis according to the Intuitive Control survey method laid out by the United States Department of Agriculture (USDA FS 2005). Clippings of woody specimens were taken and herbaceous species were collected in their entirety to produce voucher specimens. USDA county records for Walker County, along with the comparative plant list of the Cumberland Plateau were used to create a list of target species and in the second growing season plants on the list not yet collected were targeted based on their ecological preference. Notes were taken to document the growing conditions and surrounding flora and a GPS point was taken for each collection area using a Garmin eTrex Vista Cx (accurate to 3 m). A topographical map of the collection area was created using ArcMap version 10.1 and the collection points, ecological systems, water systems, property boundaries, and trails were layered to the map. Specimens were identified using the Guide to the Vascular Flora of Tennessee (Tennessee Flora Committee in press), Weakley (2012), Radford (1968), and Cronquist (1980). Specimens that were difficult to determine were compared to specimens from the herbarium at the University of Tennessee.
at Chattanooga (UCHT) and images from the University of Tennessee’s online Database of Tennessee Vascular Plants (TENN 2014). Nomenclature follows the *Guide to the Vascular Flora of Tennessee* (Tennessee Flora Committee in press) with all species not located within the *Guide to the Vascular Flora of Tennessee* following (Weakley 2012). All specimens collected will be deposited at UCHT with duplicates sent to the herbarium of Austin Peay State University (APSU) and to the University of Tennessee (TENN).

**Statistical Comparison of the Lula Lake Land Trust to Cumberland Plateau Floras**

The number of species and total area (in hectares) of 14 of the CU floras of the comparative plant list were plotted to generate a species-area curve. SPSS was used to preform a nonlinear regression which generated values for the equation $S=cA^{z}$ (Preston 1962, Wade and Thompson 1991) where $S$ is the number of species present, $c$ is a constant which represents the number of species predicted per hectare, $A$ is the area surveyed, and $z$ is a constant derived from the regression and slope. Using the comparative plant list of the CU for the regression analysis provides values specific to the province which can be used to predict species numbers based on area as well as allow comparisons of species richness between floras (Huskins and Shaw 2010). Linear correlation analyses were generated for the three largest families of the CU floras (Asteraceae, Poaceae, and Cyperaceae) which allow for species richness and collection completeness comparisons of these taxonomically difficult groups (Huskins and Shaw 2010).
Phytogeographical Analysis

The comparative plant list of the CU compiled by Huskins (2010) and expanded by Blyveis (2012) was synonymized using the Guide to the Vascular Flora of Tennessee (Tennessee Flora Committee in press) with all species not located within the GVFT following Weakley (2012). This list contains presence/absence data and denotes rare and non-native status for the species of the floras of the CU, as well as a phytogeographic analysis of their distributions. The geographic “Center of Distribution” as described by Blyveis (2012) was determined for new additions to the comparative plant database using the range descriptions of the Biota of North America Program (Kartesz 2014) and added to the existing Phytogeographic data column. In addition to the contribution of the vascular flora of the LLLT, the species checklists from the Vascular Flora of Lake Guntersville State Park (Spaulding 1995) and the Vascular Flora of Little River Canyon (Dickson 1992) were added to the comparative plant list to extend the geographic range covered by the database to include the entire CU.

In order to examine the possible extension/affinity of CP species north along the CU, species present in the CU legacy database endemic to the CP (according to the list created by Sorrie and Weakley (2001) were designated with a “ç”. The proportion of CP species in each CU flora (minus Pilot Knob, Lilley Cornett Woods, and Big Everidge Hollow due to their small size) was calculated. Three floras from the Ridge and Valley (Upper Clinch River (Bullington 1997), Red Clay State Historical Area (Houck 1990), Chickamauga National Military Park (Van Horn 1981)), two from the Blue Ridge (Big Frog Mountain (Murrell and Wofford 1987), Grassy Mountain (Moore 2002)), and four from the Highland Rim (Short Mountain (McKinney 1986), Giles County (Estes 2005), Limestone County (Hofmann 1999), Duck River Unit (Chester 2003))
were added to the legacy database and there CP proportions were calculated in order to compare with the CU flora proportions. These additions constitute an additional 11 floras and 487 species added to the legacy database. The distance of each flora from the CP was estimated using GoogleMaps and used to analyze the effects of distance on the proportion of CP species per flora. A map was created of the region surrounding the CU and the floras located in the legacy database were plotted on the map along with their relative percentages of CP species. SPSS was used to run a two-way ANOVA treating CP proportion as the dependent variable after the proportion had been normalized using an arcsin-squareroot transformation. Presence of the flora on or off the CU and distance of the flora from the CP were treated as fixed factors. Distance from the CP was divided into 4 categories in both 85km and 100 km increments in order to run the analysis. This analysis, with the addition of a one-way ANOVA was used to test for interactions between distance and presence. An analysis of covariance was conducted with the transformed proportion as the dependent variable, presence or absence of the flora on the CU as the fixed factor, and the distance from the CP as the covariate. This analysis was used to determine if there is a correlation between distance and proportion of CP species and if there is a statistically higher proportion of CP species on the CU than the surrounding physiographic provinces.
CHAPTER III
RESULTS AND DISCUSSION

Floristic Summary

The survey of the LLLT documented 672 taxa of vascular plants representing 369 genera and 119 families. Asteraceae is the largest family in the collection with 98 taxa (14.6% of the flora, Figure 4) followed by Poaceae with 60 taxa collected (8.9% of the flora, Figure 5), Cyperaceae with 43 taxa collected (6.4% of the flora), and Fabaceae with 41 taxa (6.1% of the flora). Three hundred and twenty eight species are new records (to USDA) for Walker County, Georgia.

Comparison to Other Floras

A statistically significant positive relationship has been demonstrated between an area surveyed and the number of species located within that area (Figure 3) (Wade and Thompson 1991). This relationship can be used to demonstrate whether a natural area protects a greater or lesser number of species than expected, given its area. It also provides a rough estimate of the completeness of a floristic investigation. The floras of the CU legacy database range in area from 10,300 h to 52 h with corresponding plant numbers from 1,070 to 263 (Table 1). The species-area curve generated using the database produces a formula of $S = 151.6A^{0.187}$ with an
r² value of 0.82 (compared to an r² value of 0.78 for the species-area curve of Huskins and Shaw (2010) for just the CU in Tennessee). The addition of the inventory data from the LLLT and the flora of Little River not only refines the species-area curve of the CU previously generated by Huskins and Shaw (2010), but also generates a power curve that represents the entire CU physiographic province, not just that of Tennessee and Kentucky.

Figure 3 Species-area curve produced from the comparative plant list of the Cumberland Plateau
Table 1 Area and species totals from the comparative plant list of the Cumberland Plateau

<table>
<thead>
<tr>
<th>Study Site</th>
<th>Acres</th>
<th>Hectares</th>
<th>Species</th>
<th>Genera</th>
<th>Families</th>
<th>Introduced</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prentice Cooper¹</td>
<td>25,452</td>
<td>10,300</td>
<td>1,070</td>
<td>536</td>
<td>137</td>
<td>192</td>
<td>17.9</td>
</tr>
<tr>
<td>Fall Creek Falls²</td>
<td>21,992</td>
<td>8,900</td>
<td>879</td>
<td>445</td>
<td>131</td>
<td>110</td>
<td>12.5</td>
</tr>
<tr>
<td>White Oak Creek Gorge³</td>
<td>13,361</td>
<td>5,407</td>
<td>526</td>
<td>323</td>
<td>109</td>
<td>41</td>
<td>7.8</td>
</tr>
<tr>
<td>Tennessee River Gorge⁴</td>
<td>12,281</td>
<td>4,970</td>
<td>700</td>
<td>392</td>
<td>123</td>
<td>92</td>
<td>13.1</td>
</tr>
<tr>
<td>Savage Gulf⁵</td>
<td>10,000</td>
<td>4,047</td>
<td>680</td>
<td>360</td>
<td>111</td>
<td>42</td>
<td>6.1</td>
</tr>
<tr>
<td>Little River Canyon¹³</td>
<td>ca.10,000</td>
<td>4,047</td>
<td>623</td>
<td>No data</td>
<td>No data</td>
<td>51</td>
<td>8.2</td>
</tr>
<tr>
<td>Obed⁶</td>
<td>9,884</td>
<td>4,000</td>
<td>734</td>
<td>392</td>
<td>122</td>
<td>59</td>
<td>8</td>
</tr>
<tr>
<td>Fiery Gizzard</td>
<td>ca.8,960</td>
<td>3,626</td>
<td>597</td>
<td>No data</td>
<td>No data</td>
<td>36</td>
<td>6</td>
</tr>
<tr>
<td>NCCGSNA⁷</td>
<td>7,073</td>
<td>2,862</td>
<td>604</td>
<td>329</td>
<td>110</td>
<td>76</td>
<td>12.6</td>
</tr>
<tr>
<td>Lake Guntersville State Park⁸</td>
<td>6,248</td>
<td>2,528</td>
<td>1,072</td>
<td>521</td>
<td>143</td>
<td>189</td>
<td>17.6</td>
</tr>
<tr>
<td>Clear Fork/New River</td>
<td>4,685</td>
<td>1,896</td>
<td>584</td>
<td>No data</td>
<td>No data</td>
<td>47</td>
<td>8</td>
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<td>Lula Lake Land Trust⁹</td>
<td>4,398</td>
<td>1,780</td>
<td>672</td>
<td>369</td>
<td>119</td>
<td>91</td>
<td>13.5</td>
</tr>
<tr>
<td>Wolf Cove¹⁰</td>
<td>2,471</td>
<td>1,000</td>
<td>573</td>
<td>329</td>
<td>109</td>
<td>27</td>
<td>4.7</td>
</tr>
<tr>
<td>Pilot Knob¹¹</td>
<td>647</td>
<td>262</td>
<td>504</td>
<td>289</td>
<td>100</td>
<td>69</td>
<td>13.7</td>
</tr>
<tr>
<td>Lilley Cornett Woods</td>
<td>544</td>
<td>220</td>
<td>514</td>
<td>No data</td>
<td>No data</td>
<td>62</td>
<td>12.1</td>
</tr>
<tr>
<td>Big Everidge Hollow¹²</td>
<td>129</td>
<td>52</td>
<td>263</td>
<td>176</td>
<td>82</td>
<td>1</td>
<td>0.4</td>
</tr>
</tbody>
</table>
These floras were selected to create a species-area curve specific to the CU using the criteria set forth by Wade and Thompson (1991). The criteria are: 1) that the floras are from Braun’s Mixed Mesophytic region and 2) no floras of small, uncommon, or highly disturbed areas are included. The Lake Guntersville State Park and North White Oak Creek Gorge floras were excluded from the dataset used to create the species-area curve formula because both were unsuitable for this analysis according to the criteria set forth by Wade and Thompson. The inclusion of these two floras lowered the $r^2$ value of the species-area curve to 0.63. The Lake Guntersville State Park flora was excluded due to its abnormally high number of species for its area, including a high number of non-native species (17.6% of the flora). It is reasonable to conclude that the high proportion of non-native species within the park is a result of a high level of anthropogenic disturbance. The White Oak Creek Gorge flora contains an uncommonly low number of species for its area which renders it unsuitable for this analysis. Using the formula derived from the species-area curve provides an estimate of approximately 615 species within the LLLT. The results of this analysis indicate that the LLLT is richer, proportionally, than is predicted by the regression line (672 species documented, 615 predicted). Additionally, the natural logs of the areas and species numbers of the CU floras were used to generate a linear trend-line with 95% confidence intervals. The species total from the LLLT was higher than the upper bound generated (figure 4).
Figure 4 Trend-line of the natural log of the areas (h) of the Cumberland Plateau floras and the natural log of the species numbers for the corresponding floras with confidence intervals (Upper 95% and lower 95%) included
Pearson correlation values generated for the three largest families of the LLLT (Asteraceae, Poaceae, and Cyperaceae) using the CU flora data indicate a significant correlation between study area and number of species (0.747 for Asteraceae, 0.734 for Poaceae, and 0.720 for Cyperaceae). Species-area curves were also generated for the largest three families of the LLLT however; trend-lines produced a better fit of the data with higher $r^2$ values. The trend-lines created using species numbers of large and difficult to identify families are valuable tools to assess the richness and completeness of a flora (Huskins and Shaw 2010). The trend-lines created with the species numbers of these three families using 14 floras of the legacy database (the floras of Lake Guntersville State Park and Big Everidge Hollow created outliers in the analysis that dramatically reduced the $r^2$ values) indicate that the flora of the LLLT is proportionally richer for these families than what was predicted (Figures 5, 6, and 7 respectively). This analysis predicts 84 species of Asteraceae (98 were collected), 48 species of Poaceae (60 were collected), and 28 species for Cyperaceae (43 were collected).
Figure 5 Trend-line produced from the comparative plant list of the Cumberland Plateau for the Asteraceae with confidence intervals (upper 95% and lower 95%) included.
Figure 6 Regression line produced from the comparative plant list of the Cumberland Plateau for the Poaceae with confidence intervals (upper 95% and lower 95%) included
Figure 7 Regression line produced from the comparative plant list of the Cumberland Plateau for the Cyperaceae with confidence intervals (upper 95% and lower 95%) included
When compared to the two floras of the CU geographically closest to the study site (The Vascular Flora of the Tennessee River Gorge and A Vascular Flora of Little River) the LLLT contains 168 unique species (26%). Two hundred and eighty two species (44%) were documented in LLLT that were not found in the TRG, and 308 species (48%) were documented within the LLLT that were not found at Little River. When compared to the entire legacy database 101 taxa present at the LLLT have been documented at only two or less of the other CU floras, and species unique to LLLT totaled 36 (6%; 23 native and 13 non-native).

The species richness of the LLLT along with the richness of the three largest families of the survey is statistically high when compared to other floras of the CU and indicate an area worthy of protection.

*Species of Conservation Concern*

In the two and a half growing seasons surveyed at the LLLT, 28 species of conservation concern (4.2% of the total flora) were documented (Table 2). The Endangered Species Act gives the United States Fish and Wildlife Service the responsibility to protect rare species by designating them as either listed endangered or listed threatened. Georgia also designates rare species by labeling them as endangered, threatened, rare, or unusual with endangered being the most rare and unusual being the least (Georgia department of Natural Resources: GDNR 2014). NatureServe has also created both global and state rarity ranks based on distribution data for species with 1 being very rare to 5 being very common (NatureServe 2014).
<table>
<thead>
<tr>
<th>Threatened</th>
<th>Spiraea virginiana</th>
<th>Riverscour and Creek Banks</th>
<th>S1, G2, T, LT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rare</td>
<td>Lysimachia fraseri</td>
<td>Circumneutral Rocky Woods and Openings</td>
<td>S1S2, G3, R</td>
</tr>
<tr>
<td>Unusual</td>
<td>Cypridedium acuale</td>
<td>Mesic Acidic Woods</td>
<td>S4, G5, U</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Agalinis obtusifolia (listed as A. decemloba)</td>
<td>Roadsides and Openings</td>
<td>SNR, G4</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Cypripedium calceolus</td>
<td>Mesic Prairie Remnant</td>
<td>S1, G3</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Agalinis obtusifolia</td>
<td>Roadsides and Openings</td>
<td>S1, G3</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Castilleja coccinea</td>
<td>Mesic Prairie Remnant</td>
<td>S2, G5</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Delphinium tricorne</td>
<td>Circumneutral Rocky Woods</td>
<td>S2, G5</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Glyceria melicaria</td>
<td>Roadsides and Openings</td>
<td>S1, G5</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Juncus filipendulus</td>
<td>Roadsides and Openings</td>
<td>S2, G5</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Lonicera dioica</td>
<td>Shale Outcrops</td>
<td>S1, G5</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Marshallia trinervia</td>
<td>Circumneutral Rocky Woods</td>
<td>S1S2, G3</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Parax quinquefolius</td>
<td>Circumneutral Rocky Woods</td>
<td>S3, G3G4</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Scirpus pendulus</td>
<td>Roadside ditches</td>
<td>S1, G5</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Scutellaria pseudoserrata</td>
<td>Mesic Acidic Woods</td>
<td>S2, G3</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Silene rotundifolia</td>
<td>Sandstone Cliff</td>
<td>S1, G4</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Silphium mohri</td>
<td>Roadsides and Openings</td>
<td>S1, G3</td>
</tr>
<tr>
<td>Special Concern</td>
<td>Thermopsis mollis</td>
<td>Acidic Woods</td>
<td>S1, G3G4</td>
</tr>
<tr>
<td>New State Record</td>
<td>Calamovilfa arquata</td>
<td>Riverscour and Creek Banks</td>
<td>S1, G2G3</td>
</tr>
<tr>
<td>New State Record</td>
<td>Chelone lyonii</td>
<td>Moist Talus and Small Streams</td>
<td>SNR, G4</td>
</tr>
<tr>
<td>New State Record</td>
<td>Solidago arenicola</td>
<td>Riverscour and Creek Banks</td>
<td>SNR, G2G3</td>
</tr>
<tr>
<td>New State Record</td>
<td>Populus grandidentata</td>
<td>Steppe/Field</td>
<td>SNR, G5</td>
</tr>
<tr>
<td>Limited Range</td>
<td>Agalinis plukenettii</td>
<td>Roadsides and Openings</td>
<td>S3, G3G5</td>
</tr>
<tr>
<td>Limited Range</td>
<td>Diervilla rivularis</td>
<td>Dry/Mesic Acid Woods, Talus, and Creeks</td>
<td>S3, G3</td>
</tr>
<tr>
<td>Limited Habitat</td>
<td>Phemeranthus teretifolius</td>
<td>Sandstone Outcrops</td>
<td>S3, G3</td>
</tr>
<tr>
<td>Limited Habitat</td>
<td>Deschampsia flexuosa</td>
<td>Rocky outcrops</td>
<td>S3, G5</td>
</tr>
</tbody>
</table>
The species with the highest federal and state rarity ranks include *Spiraea virginiana* (Virginia meadowsweet) which is federally and state listed as threatened and has a NatureServe rank of G2/S1. *Lysimachia fraseri* (fraser’s loosestrife) is state listed as rare with a NatureServe rank of G3/S1 and *Cypripedium acuale* (pink ladyslipper) is state listed as unusual due to heavy collection and has a NatureServe rank of G5/S4.

Four species of conservation concern are new state records and as such have no state rarity rank. *Calamovilfa arcuata* (Cumberland sand-reed) occurs with disjunct populations in Tennessee/Alabama and Arkansas/Oklahoma. It is listed as endangered in Tennessee and is found in only one county in Alabama with no record in Georgia. Max Medley, while we were on a collecting trip, pointed out *Solidago arenicola* (southern racemose goldenrod), which occurs in only a few counties in Tennessee and one in Alabama with no record in Georgia. *Calamovilfa arcuata* and *S. arenicola* co-occur along with *Spiraea virginiana*, a federally listed species, on cobble bars and river scour along approximately 2,000 meters of Rock Creek. The third new state record, *Chelone lyonii* (pink turtlehead) occurs primarily in the Unaka Mountains with a small disjunct population on the southern CU. Records exist from Alabama and Tennessee adjacent to the LLLT, but no state records exist from Georgia. The last state record, *Populus grandidentata* (bigtooth aspen), was found in the fall of 2014 near the conclusion of this survey and is represented by one specimen growing in an artificially maintained field (Oak/Hickory Savannah) atop the overlook on the eastern brow of Lookout Mountain east of Lula Lake. The specimen was growing in direct contact with a mature hickory tree which suggests that it was not planted in this location. Several collecting trips were taken after this discovery to search for more occurrences of this species, but none were located. If this is a naturally occurring, then it
represents a significant extension of its known range (it is approximately 60km to the nearest occurrence in Grundy County, TN).

Several species have severely restricted ranges or habitat within Georgia. This list includes *Agalinis plukenetii* (chattahoochee false foxglove) (a CP species with county records from only seven counties in Georgia), *Diervilla rivularis* (mountain bush honeysuckle) (listed as threatened in Tennessee with only two county records from Georgia), and *Phemeranthus teretifolius* (rock fameflower) (limited habitat, especially at LLLT). The remaining species of conservation concern are state listed as special concern with most having a NatureServe state rank of S1 or S2.

*Introduced Species*

Introduced species account for 13.5 percent of the collection (91 species). Comparisons between the floras of the CU contained within the legacy database reveal that the LLLT contains a slightly higher than average percentage of non-native species relative to the study area. The average percentage of species per flora not native to the CU is 10.22%. The median is 12.1% (Table 1).

The Georgia Exotic Plant Pest Council assigns ranks to introduced plants based on their threat level to natural environments with a 1 being the most severe threat through a 4 which is a naturalized non-native plant that poses no threat to natural areas or is in need of further study. Nine species documented in the LLLT have the rank of 1 including *Ligustrum sinense* (Chinese privet), *Lonicera japonica* (Japanese honeysuckle), and *Pueraria montana var. lobata* (kudzu). Although this system does provide information useful for the management of natural
areas, the age of the list (last updated in 2006) and the broad scale with which it is intended leaves a need for a more up to date and specific ranking system of non-native species for the management purposes at the LLLT (GA-EPPC 2006).

For their vascular plant species survey of the proposed highway corridors through the Ocoee River Gorge, Shaw and Estes (in prep) propose categorizing non-native species according to their priority for management (Estes and Shaw in prep). This system was used, with slight modifications, to rank the non-native species found within the LLLT. Six levels of priority have been created with the highest priority (level 1) being small populations of highly invasive species that may be eradicated with relatively little effort. Priority level 2 species are those that are invasive and may be eradicated, or at least managed, with a moderate amount of effort. Priority level 3 species are those that are highly invasive and are already well established within the LLLT and can only feasibly be managed at small scales where they threaten rare species or communities. Species listed as priority level 4 are those which pose a low threat of invasion into natural areas and are restricted primarily to disturbed habitats such as roads and trails. Priority level 5 species are cultivated species restricted to old homesites that do not pose a threat of invasion. The priority level 6 species is one that is native to the United States but whose distribution does not extend naturally to the survey site. The complete list of non-native species along with their GA-EPPC rank and Priority level is located in appendix A.

It should be noted that the presence of non-native species at the LLLT is principally restricted to areas with high anthropogenic disturbance such as old homesites, roadways, and power line clearings. Eight of the 91 introduced species are found exclusively at old home sites and do not appear to have spread to surrounding natural areas of the survey area (Euphorbia
cyperissias (cypress spurge), *Hemerocallis fulva* (day-lily), *Kerria japonica* (Japanese rose), *Narcissus pseudonarcissus* (daffodil), *Philadelphus coronarius* (wreath mock-orange), *Prunus glandulosa* (dwarf flowering almond), and *Pyracantha fortuneana* (Chinese fire-thorn), and *Vinca minor* (common periwinkle). Without these species, the introduced species composition of the LLLT would be 12%. Also, 68 of the 91 non-native species found within the survey site are restricted to disturbed areas accounting for 74.7% of non-native species.

**LLLT Ecological Systems**

**Overview**

No Less than 11 distinct ecological systems are located in the LLLT with an estimated 40 to 45 natural associations contained within those systems (list located in Appendix B). Identification of associations would ideally be done quantitatively through plot sampling, but due to the scope of this research and the large size of the survey area it was not possible. With that in mind it should be understood that these association assignments represent an inclusive list of the possible associations located within the survey site or those listed by NatureServe that are the closest approximation to the actual associations present. More discussion will accompany each description of the ecological systems if an association is noted as representing the closest approximation of the present vegetation.

Twenty-two of the assigned associations are listed as G3/Vulnerable by NatureServe, which account for at least one association per system. Two associations (*Quercus stellata* - *Pinus virginiana* / (*Schizachyrium scoparium, Piptochaetium avenaceum*) Woodland, and *Pinus*...
 strobus / Kalmia latifolia - (Vaccinium stamineum, Gaylussacia ursina) Forest) are listed as G2/Imperiled while the Hydrangea arborescens / Heuchera villosa - Asplenium trichomanes - Shrubland is listed as G2/naturally rare. The Andropogon gerardii - (Sorghastrum nutans) Kentucky Herbaceous Vegetation association is listed as G1/Critically Imperiled due to loss of habitat and limited geographic distribution.

Seven of the 11 ecological systems identified within the survey are primarily composed of associations listed as G3/Vulnerable or rarer (Southern Appalachian Low-Elevation Pine Forests, Cumberland Sandstone Glade and Barrens, Cumberland Riverscour, South-Central Interior Small Stream and Riparian, Cumberland Acidic Cliff and Rockhouse, Southern Appalachian Montane Cliff and Talus, and Cumberland Wet-mesic Meadow and Savannah). These seven systems make up only 12.9 percent of the survey area, with 6 of them making up one percent or less each. Due to the small area that these systems make up in the overall survey area, the rarity of the associations they contain, and the rare plants that these systems host, it is recommended that these systems be afforded special attention when considering protective/conservation measures, land use, and access. It is also clear for the same reasons listed above that the LLLT does indeed contain natural habitat worth protecting.

Allegheny-Cumberland Dry Oak Forest and Woodland

The LLLT is predominately Allegheny-Cumberland Dry Oak Forest and Woodland (consistent with "Mixed Mesophytic Forest Region" of Braun (1950) and Greller (1988)) (Natureserve2014). This system occurs on the gentle to moderate slopes, flatlands, and ridges within the LLLT and grades into South-Central Interior Mesophytic Forests in deeper, more
mesic soil and protected slopes or Southern Appalachian Low-Elevation Pine Forests in shallower more xeric soils and more exposed habitat. Dominant canopy species include *Quercus montana* (chestnut oak), *Carya pallida* (sand hickory), and *Acer rubrum* (red maple) with various combinations of other *Quercus* (oak) and *Carya* (hickory) species. The understory is composed primarily of tree recruits from the canopy species with occasional *Oxydendrum arboreum* (sourwood) and *Pinus* species interspersed. *Ericaceae* species such as *Vaccinium pallidum* (lowbush blueberry) and *V. arboreum* (farkleberry) as well as *Viburnum acerfolium* (maple-leaved viburnum) dominate the shrub layer. Due to the xeric nature of this habitat the herbaceous layer is sparse with dominant plants such as *Polystichum acrostichoides* (Christmas fern), *Toxicodendron radicans* (poison ivy), and *Piptochaetium avenaceum* (needle-grass).

The fourteen associations identified as present within this system are presented in appendix B. Three are listed as G3/vulnerable and one (*Quercus stellata - Pinus virginiana / Schizachyrium scoparium, Piptochaetium avenaceum* Woodland) is listed as G2/imperiled. This *Quercus stellata* (post oak) - *Pinus virginiana* woodland is an open woodland/barren like habitat with sparse tree cover and an herb layer dominated by grasses and is known from southeast TN and northern GA (NatureServe specifically lists Lookout Mountain). Several examples of this association are scattered throughout the LLLT’s Long Branch area with a prime example located on the southeastern slope of the highpoint of Lookout Mountain. Several plant species (*Asclepius viridiflora* (green comet milkweed), *Lonicera dioica* (wild honeysuckle), and *Philadelphus hirsutus* (Cumberland mock-orange)) located on this slope indicate the presence of the basic substrate mentioned in the description of this association. This, along with the presence of other herbaceous species present (*Andropogon gerardii* (big bluestem), *Euphorbia*...
corollata (flowering spurge), and Manfreda virginica (false aloe)) that are described in the vegetation summary suggest that this association is located within the LLLT (NatureServe 2014).

Rare plants located within this system include Carex muehlenbergii var. enervis (muhlenberg's sedge), Diervilla rivularis Lonicera dioica, and Thermopsis mollis (Allegheny mountain golden banner).

Fire may have historically played an important role in maintaining this system, especially the more open associations such as the Quercus stellata - Pinus virginiana woodland. Without somewhat regular fires these more open woodlands may be altered by the development of denser shrub and canopy layers. The specific location of the Quercus stellata - Pinus virginiana woodland near highpoint also borders a transmission line right of way that is maintained by mowing every few years. This disturbance does provide habitat for a host of species, but if this right of way is ever sprayed with herbicide it could be detrimental to this imperiled association.

South-Central Interior Mesophytic Forest

South-Central Interior Mesophytic Forests make up a large portion of the survey area (27.6%) and consists of forests similar to those of the Allegheny-Cumberland Dry Oak Forest and Woodland yet with deeper, richer soils, more mesic species, and are more often located in coves or lower concave slopes (NatureServe 2014). These forests are dominated by Quercus alba (white oak), Liriodendron tulipifera, and Tsuga canadensis (eastern hemlock) with Quercus coccinea (scarlet oak), Carya tomentosa (mockernut hickory), Nyssa sylvatica, and Acer rubrum present in lower quantities. Common understory shrubs include Calycanthus floridus (sweetshrub), Rhododendron canescens (southern pinxter azalea), R. catawbiense (catawba
rosebay), *Vaccinium stramineum* (deerberry), and *Viburnum acerfolium*. The herbaceous layer of this system is often more rich than the preceding one, and includes species such as *Anemone quinquefolia* (wood anemone), *Botrypus virginianus* (rattlesnake fern), *Carex nigromarginata* (black-edge sedge), *Dentaria multifida* (forkleaf toothwort), *Dryopteris marginalis* (marginal wood fern), *Iris cristata* (dwarf crested iris), and *Veratrum parviflorum* (Appalachian bunchflower).

Four associations of this system are located within the LLLT (see appendix B). All are listed as G4/apparently secure except for the *Quercus alba* - (*Liriodendron tulipifera*, *Liquidambar styraciflua* / *Calycanthus floridus* / *Athyrium filix-femina* Forest which is listed a G3/vulnerable. This association can be found on the lower slopes bordering the upper stretches of Long Branch and its tributaries.

Species of conservation concern found in this system include *Cypripedium acuale*, *Delphinium tricorne* (dwarf larkspur), *Marshallia trinervia* (broad-leaved Barbara’s buttons), *Panax quinquefolius* (ginseng), *Scutellaria pseudoserrata* (falseteeth skullcap), and the state listed *Lysimachia fraseri*.

Threats to this system include the Hemlock wooly adelgid (*Adelges tsugae*), and invasion by non-native species that favor more mesic sites such as *Albizia julibrissin* (mimosa) and *Ligustrum sinense*. A rich specimen of this system is located just below the western slope of highpoint that could be adversely impacted by increased traffic and development of the area. Currently several radio/TV antennas are located within a few hundred yards of this habitat as well as a gravel access road. While this road cut does provide open habitat for several rare
species (*Marshallia trinervia* and *Lysimachia fraseri*) future use, maintenance, and development of this road should consider the impacts on this system and its plant species.

**Southern Appalachian Low-Elevation Pine Forest**

The Southern Appalachian Low-Elevation Pine Forests make up approximately 8% of the LLLT and are scattered throughout. This system is dominated by *Pinus virginiana* with occasional *P. echinata* (short-leaf pine) and *Quercus montana*. These forests are typically found in xeric, exposed conditions with thin, stoney, and sandy soils. Shrub layers are mostly composed of *Rhus copallinum* (winged sumac), *R. glabra* (smooth sumac), *Toxicodendron pubescens* (poison oak), and *Vaccinium arboretum* with sparse occurrences of herbaceous species such as *Andropogon virginicus* (broomsedge), *Goodyera repens* (downy rattlesnake-plantain), and *Mitchella repens* (partridge-berry). This system grades into Allegheny-Cumberland Dry Oak Forest and Woodland in more protected habitats with deeper soils, and Cumberland Sandstone Glade and Barrens in more exposed habitats or habitats with very thin to no soil.

Three associations are found within this system all with a NatureServe ranks of G3 or rarer. These associations are vulnerable due to the rarity of the edaphic conditions (shallow acidic soils/exposed rock) that provide and maintain suitable habitat for them as well as the value of these sites for development due to their proximity to the bluffs and overlooks of the CU. The *Pinus strobus / Kalmia latifolia - (Vaccinium stamineum, Gaylussacia ursina)* Forest is ranked G2/imperiled and is the closest approximation of the forest located east of Highway 157 down to the Lula Lake Road that is used for access to Lula Lake. This forest is probably
anthropogenically altered by the planting of *Pinus strobus* which has now dispersed creating a dense understory of *P. strobus* in patches along with more mature specimens. Though this association may not be naturally occurring at this site, it is still worth noting and protecting (see Appendix B).

No rare plants have been located within this system in the LLLT although NatureServe lists Desmodium ochroleucum as a rare species known to inhabit the Southern Appalachian Low-Elevation Pine Forests and having a range that includes the survey site.

Threats to this system include anthropogenic disturbance, loss of fire regime that was historically involved in maintaining the system, and infestations from pine beetles. Although the occurrences of this system in the LLLT do not contain any known rare plant species, it is still worth protecting due to its rarity as a system.

**Cumberland Sandstone Glade and Barrens**

Another system located within the survey site is the Cumberland Sandstone Glade and Barrens. This system makes up less than 1% of the area of the LLLT and is located primarily on the bluffs and ridges of the escarpment on the east side of the mountain. This system has an open to non-existent canopy with a limited presence of *Pinus virginiana*, *Acer rubrum*, and *Quercus montana* and scattered *Vaccinium arboreum* and *Rhus* species. The vegetation is dominated by grasses such as *Andropogon virginicus*, *A. gerardii*, and *Danthonia sericea* (poverty oat grass) and non-Poaceae such as *Liatris microcephala* (smallhead blazing star) and *Selaginella rupestris* (rock spike-moss). This system is primarily restricted to an exposed sandstone ridge that runs north/south at the eastern edge of the LLLT and is divided in the
middle by the gorge that Nick-a-Jack road runs through. The southern half of the ridge is located at the southern end of the survey site in the Long Branch area and includes the highpoint of Lookout Mountain. The northern end of the ridge runs east of Lula Lake.

Four associations are located within this system and all are ranked G3/vulnerable. These four associations consist of Grassland/Steppe and Shrubland habitats that require the exposed conditions, shallow/xeric/acidic soils, and historically fire to be maintained. In locations where conditions transition to deeper, more mesic soils, and more protected habitats, this association transitions to Southern Appalachian Low-Elevation Pine Forest or Allegheny-Cumberland Dry Oak Forest and Woodland (see Appendix B).

Species of conservation concern located within this system are Deschampsia flexuosa (hair-grass) and Paronychia argyrocoma (silvery nailwort) which are found exclusively on the southern ridge and Phemeranthus teretifolius which is found in one 5 m² area on the northern ridge.

The most immediate threats to this system are trampling by people hiking to these sites for the overlook view and encroachment by the Southern Appalachian Low-Elevation Pine Forest due to lack of natural disturbance (fire). Trampling occurs in limited amounts at highpoint and at the overlook east of Lula Lake. Encroachment appears to have occurred in the areas surrounding the Phemeranthus teretifolius occurrence which may account for the current small population size. Future threats include increased anthropogenic travel, especially to highpoint. The current access to highpoint travels through several rare associations and in the immediate vicinity are located no less than 10 species of conservation concern. Highpoint, and the area immediately surrounding it, are perhaps the most ecologically diverse, unique, and
rare of the habitats contained within the LLLT and the species located within the area demonstrate that. Protecting this area of the LLLT should be a high priority.

Down the southern slope of highpoint is located a barren/prairie like habitat that is underlain by shale and inhabited by species such as *Asclepius viridiflora*, *Carex muenlenbergii* var. *enervis*, *Lonicera dioica*, and *Philadelphus hirsutus*, suggesting an alkaline substrate. No NatureServe association fully describes this habitat, but it grades into *Quercus stellata - Pinus virginiana / (Schizachyrium scoparium, Piptochaetium avenaceum)* Woodland to the north and what resembles Cumberland Wet-mesic Meadow and Savannah to the south. The presence of the rare species *Carex muenlenbergii* var. *enervis* and *Lonicera dioica* within this association further support the protection of the area surrounding highpoint.

**Cumberland Riverscour**

This system is restricted to high-gradient streams of the CU and surrounding physiographic province and is characterized by the absence of successional woody species due to periodic large volume and high velocity scouring events. Cumberland riverscour is dominated exclusively by shrubland or herbaceous plants, although tree species can be present. Typical substrate is composed of bedrock, cobble bars, or sandbars. This system is maintained by the disturbance of scouring events which prevent the encroachment of successional tree growth (NatureServe 2014). Common species for this system include *Alnus serrulata* (smooth alder), *Betula nigra* (river birch), *Carex torta* (twisted sedge), *Osmunda regalis* var. *spectabilis* (royal fern), *Platanus occidentalis* (sycamore), and *Xanthorhiza simplicissima* (yellowroot). This system
makes up less than 1% of the LLLT and is confined to the stretch of Rock Creek that runs from the LLLT parking area to the northern border of the property just past Lula Falls.

Four associations are present within this system in the LLLT and three of the four are listed as G3/vulnerable due to the limited amount of area of the CU made up of creeks and rivers suitable to produce such habitat (see Appendix B).

This system hosts the most globally rare species found within the LLLT. *Spiraea virginiana* is a shrub that grows scattered through the Appalachians and is found growing on the banks and cobble bars throughout the stretch of Rock Creek where this system occurs. This shrub is federally listed as threatened with a global NatureServe rank of G2. Within Georgia it is listed as threatened and has been designated as S1 by NatureServe. Growing within the same habitats as the *Spiraea virginiana* can also be found *Calamovilfa arcuata* and *Solidago arenicola*. Both species are new records in the state of Georgia and as such are known from only the LLLT. *Calamovilfa arcuata* is a grass that is restricted to a few locations on the CU of TN, KY, and AL, and as a disjunct in eastern Oklahoma and western Arkansas. In total it is recorded from 12 counties in the World (Kartesz 2014). *Solidago arenicola* is an Aster family forb restricted to a few sights on the CU of TN and one in AL. BONAP lists it as present in only three counties in the World. *Carex torta* is also present in this system and is state listed as species of special concern with a NatureServe rank of S1/G5.

Due to the rarity of the species contained within this system, and the rarity of the system itself, its protection should be considered a high priority when planning and implementing management or development of the LLLT. There are at present several invasive species that should be the focus of maintaining and protecting this rare system as well. There is
a single occurrence of *Celastrus orbiculatus* (oriental bittersweet) growing on the west bank of Rock Creek 200 m north of the Lula Lake parking area that is still a manageable size. Removing this occurrence immediately would prevent its spread and endangerment of this rare system. There are also isolated occurrences of *Albizia julibrissin* and *Ligustrum sinense* throughout this system that, although probably impossible to eradicate, could be reasonably managed to protect the rare species within. Directly upstream from one cobble bar containing all three of the rare species of this system is a river crossing maintained by the land trust for vehicle traffic. Continued maintenance of this crossing should be done in a manner that limits the impacts on this rare system including limited brush clearing and weed trimming, care when maintaining or grading the gravel road, and understanding that any changes to the hydrology due to silt runoff or mechanical alteration of the streambed could have a negative impact.

**South-Central Interior Small Stream and Riparian**

South-Central Interior Small Stream and Riparian occurs along Long Branch, Rock Creek, and their tributaries within the LLLT. Examples occur in lower gradient sections of these waterways and extend into the small floodplains and wet forest that surround these streams (NatureServe 2014). Within the LLLT this system is predominantly forest, woodland, and occasionally Shrubland. Dominant canopy trees species include *Acer rubrum*, *Betula nigra*, *Liriodendron tulipifera*, and *Tsuga canadensis*. *Alnus serrulata*, *Cornus amomum* (silky dogwood), *Halesia tetraperta* (Carolina silverbell), *Rhododendron arborescens* (smooth azalea), *Rhododendron catawbiense*, and *Xanthorhiza simplicissima* are commonly found within the subcanopy and shrub layer of this system. The herbaceous layer is commonly composed of
ferns, sedges, and rushes such as *Carex crinita* (fringed sedge), *Carex torta, Juncus effusus* (common rush), *Osmundastrum cinnamomea* (cinnamon fern), and *Osmunda regalis var. spectabilis*. In total this system makes up less than 1% of the LLLT.

There are nine associations of this system that are either located with the LLLT or are the closest approximation to the vegetation present. Six of the nine associations are ranked by NatureServe as G3/vulnerable (see Appendix B).

Rare plants identified within this system include the federally listed *Spiraea virginiana*, *Carex torta*, and *Chelone lyonii*. *Chelone lyonii* is a southern Appalachian and CU endemic that occurs in neighboring TN and AL but has never been documented in Georgia. This species is listed as G4 by NatureServe and has no state listing due to no record of its existence in Georgia. Two populations have been located in the LLLT. One occurrence is found alongside a tributary of Long Branch in the southern portion of the LLLT and the other is growing on the upper slope of the talus immediately northeast of Lula Falls. These small occurrences are the only two known from Georgia and should continue to be protected.

The most immediate threat to this system is invasion by non-native plants such as *Ligustrum sinense* and *Albizia julibrissin* which commonly invade these moist locations and have been observed during this research in this system.

**Cumberland Acidic Cliff and Rockhouse and Southern Appalachian Montane Cliff and Talus**

Within this analysis these two systems are combined because there is some overlap in their location and vegetation. The occurrence of these systems is restricted to the sandstone cliffs and talus surrounding Lula Lake and Lula Falls and the eastern brow of Lookout Mountain.
These rock faces and talus are often sparsely vegetated with little or no canopy. The habitat can range from dry exposed rock to moist, seeping cliff faces and talus slopes and are dominated by a few indicative species of vascular plants as well as numerous non-vascular species (NatureServe 2014).

The *Asplenium montanum* - *Heuchera parviflora* var. *parviflora* - *Silene rotundifolia* Sparse Vegetation association is found on the sandstone face on the western side of Lula Lake and is listed as G3/vulnerable. This association contains the only occurrence of *Silene rotundifolia* (round-leaved catchfly) in the LLLT, a species nearly restricted in distribution to the CU and ranked by NatureServe as S1/G4. In Georgia it is only known from Walker and Dade counties. The *Asplenium montanum* - *Heuchera villosa* Felsic Cliff Sparse Vegetation and *(Hydrangea arborescens) / Heuchera villosa - Asplenium trichomanes - Thalictrum clavatum / Conocephalum salebrosum* Shrubland associations most closely approach the vegetation located on the cliff at the bottom of Lula Falls. Upon this wall grows *Asplenium montanum* (mountain spleenwort), *Asplenium trichomanes* (maidenhair spleenwort), and *Heuchera villosa* (hairy alumroot), and although none of these is a rare species, the associations are listed as G3/vulnerable and G2/naturally rare respectively. Near the upper slope on the east side of the falls is an occurrence of the rare species *Chelone lyonii* and *Spiraea virginiana*.

The most immediate threats to these systems are traffic from sightseers and invasion by non-natives. There is no indication that people climb these cliff faces, but the ground beneath is often trampled by people visiting the waterfall and can severely impact the vegetation. The non-native invasive *Paulownia tomentosa* (princess tree), here ranked as a priority 1 species, has been observed growing at the upper slopes of the talus in this system and favors open and
disturbed habitat for invasion. The low number of individuals and sensitivity of these associations warrant immediate action to eradicate this species.

**Appalachian Forested Acidic Seep**

This system is known from the southern CU and Appalachians and occurs at streamheads or on broad ridges and develops from perched water tables. It is represented in the LLLT by the *Acer rubrum var. trilobum - Nyssa sylvatica / Osmunda cinnamomea - Chasmanthium laxum - Carex intumescent / Sphagnum lescurii* Forest association. Dominant tree species include *Acer rubrum, Liquidambar styraciflua* (sweetgum), *Nyssa sylvatica*, and *Quercus alba* with *Aronia melanocarpa* (black chokeberry), *Ilex opaca* (American holly), and *Viburnum cassinoides* (withe-rod) in the shrub layer. The composition of the herbaceous layer includes *Bartonia virginica* (yellow screwstem), *Carex debilis* (white-edge sedge), *Carex intumescent* (greater bladder sedge), *Cypripedium acuale, Medeola virginiana* (Indian cucumber root), *Osmundastrum cinnamomea, Osmunda regalis var. spectabilis*, and *Thelypteris noveboracensis* (New York fern). The single occurrence of this system is located along the Five Points connector trail west of highway 157 and adjacent to the transmission line clearing that transects the Long Branch property. This system has been documented to host such rare species as *Cypripedium kentuckiense* (Kentucky lady’s-slipper), *Platanthera integr* (yellow fringless orchid), *Platanthera integrilabia* (monkeyface orchid), and *Vaccinium hirsutum* (hairy blueberry) although none of these have been observed during the course of this survey. A species of *Lilium* has been observed growing in this system which could be one of several species of conservation concern, but has not flowered during the time of this survey so it has
not been identified. Threats to this system include invasion by the non-natives listed as threats to the South-Central Interior Small Stream and Riparian particularly *Ligustrum sinense* as well as anthropogenic destruction. There are several well-travelled trails nearby used for mountain biking and occasional ATV use that could potentially constitute a threat to this system.

**Cumberland Wet-mesic Meadow and Savannah**

Within the transmission line running east/west bisecting the Long Branch end of the LLLT and is a system maintained by mowing that approaches Cumberland Wet-mesic Meadow and Savanna. This system is dominated by grasses such as *Schizachyrium scoparium* (little bluestem), *Andropogon* (*gyrans*, *ternarius*, and *virginicus*), *Dichanthelium clandestinum* (deer-tongue panic-grass), and *Sorghastrum nutans* (Indian grass). Also found within this meadow is *Frasera caroliniensis* (American columbo), *Paspalum floridanum* (Florida crown-grass), *Pteridium aquilinum* (bracken fern), *Solidago altissima* (tall goldenrod), and *S. nemoralis* (gray-stemmed goldenrod). The vegetation grades between Cumberland Wet-mesic Meadow and Savanna and Cumberland Sandstone Glade and Barrens depending on soil depth and soil moisture.

The association that best describes this vegetation is the *Andropogon gerardii* - (*Sorghastrum nutans*) Kentucky Herbaceous Vegetation which has a NatureServe listing of G1/critically imperiled due to its extremely limited distribution and occurrences (NatureServe 2014). It does grade into *Schizachyrium scoparium* - *Andropogon* (*gyrans*, *ternarius*, and *virginicus*) Herbaceous Vegetation of the Cumberland Sandstone Glade and Barrens and is
artificially maintained by mowing. Despite this fact the association is made up of predominantly
native species.

Although this system makes up less than 1% of the LLLT it contains 5 of the species of
conservation concern found within. They include *Lysimachia fraseri* which is state listed as rare,
*Agalinis obtusifolia* (obtuseleaf false foxglove, state listed as special concern), *Calystegia
catesbeiana* (Catesby’s false bindweed, S1/G3), and *Castilleja coccinea* (Indian paintbrush,
S2/G5).

Threats to this system include invasion by non-native species and the possible spraying
of herbicide to maintain the power line right-of-way.

**Anthropogenically Disturbed Sites**

The last system located within the Rock Creek Drainage includes the anthropogenically
disturbed sites which I divide into 3 different types. There are multiple roadways, gravel drives,
and trails transecting the survey area, which are paralleled by mowed areas. These are
dominated by grasses such as *Anthoxanthum odoratum* (sweet vernal-grass), *Dichanthelium
spp.*, *Schedonorus arundinaceus* (tall fescue) and small forbs such as *Kummerowia striata*
(Japanese clover), *Melilotus alba* (white sweet clover), and *Trifolium repens* (white clover).
However, there are road cuts and seepage walls along these trails that are more ecologically
interesting and contain species such as *Agalinis obtusifolia* (SNR/G4), *Agalinis plukenetii*
trinervia* (G3/S1), and *Silphium mohrii* (Mohr’s rosinwood, S1/G3).
There are also two parking areas within the survey area, one for the main Lula Lake property and the other at the north end of the Long Branch trail. Both are surrounded by fields that are composed of ruderal grasses and forbs such as *Anthoxanthum odoratum*, *Juncus tenuis* (path rush), and *Plantago lanceolata* (English plantain) and maintained by mowing. The parking area and accompanying field at the Long Branch trailhead also contain species that indicate an old homesite including *Euphorbia cyparissias*, *Pyracantha fortuneana*, and *Pyrus calleryana* (Bradford pear). The parking area for the main Lula Lake property contains *Wisteria floribunda* (Japanese wisteria) which is still a small enough specimen to remove with minimal effort.

There is another old homesite in the forest at the south end of the Homesite trail in the main Lula Lake property. This area is located within Allegheny-Cumberland dry oak forest and woodland and contains species such as *Kerria japonica*, *Narcissus pseudonarcissus*, and *Prunus glandulosa*.

Lastly, there are two groves located within the main Lula Lake property that occur east of Lula Lake. The first is an American chestnut grove that was created by the American Chestnut Foundation and is maintained by mowing so that only young chestnut trees, sparse mature oak and hickory species, and grasses occur within. The second is an oak/hickory grove/savannah that is maintained to provide open space as an overlook at the east brow of the mountain. This area does contain the single individual of *Populus grandidentata* on the property which should be considered when planning maintenance regimes for this grove.
Notable Exceptions

Several rare species have either been reported by LLLT employees or found within a kilometer of the survey site, but not located within the LLLT during this survey. These include *Scutellaria montana* (large-flowered skullcap) and *Diamorpha smallii* (elf orpine). It is possible that the similar looking *Scutellaria pseudoserrata*, which is found throughout the survey site, has been misidentified as *S. montana*. However, the study site is within the natural range of *S. montana* so it is not unreasonable that it could occur within the LLLT.

Two species were observed during the course of the survey that were not collected due to the lack of fertile parts. One is a *Lilium* species located in the acidic seep on the Five Points connector trail. It was unidentifiable due to its lack of flowers. There are also two occurrences of what appear to be *Hymenocallis caroliniana* (Carolina spiderlily) along the bank of Rock Creek, however, neither had fertile parts during the course of this survey and as a consequence were not identifiable.

Of the species located within the Cumberland Plateau floras of the comparative plant list, 36 species not located within the LLLT are found within at least all but three of the other floras (see Appendix C). Common species found in all Cumberland Plateau floras but the LLLT include *Danthonia spicata* (poverty oat-grass), *Dichanthelium boscii* (Bosc’s panic-grass), *Asimina triloba* (pawpaw), *Carpinus caroliniana* (American hornbeam), *Ostrya virginiana* (ironwood), and *Sedum ternatum* (woodland stonecrop). One reasonable explanation for the absence of many of the 36 species on this list is the lack of their preferred habitats in the LLLT. Many of the species of this list, such as *Asimina triloba*, *Carpinus caroliniana*, and *Ostrya virginiana* are typically located within bottomland habitats, which are absent from the LLLT.
Other species, such as *Erythronium americanum* (trout lily) and *Phacelia bipinnatifida* (purple phacelia) prefer more basic soils or limestone substrates that are also absent from the LLLT. The absence of these hydric and edaphic conditions within the LLLT provides a reasonable explanation for the lack of most of the species of this list.

**Coastal Plain influence on the Cumberland Plateau**

The map generated showing the CP percentages in regional floras suggests that the proportion of CP species in the floras of the CU is higher than the proportion of CP species in the floras of the surrounding provinces (Figure 8)

![Figure 8 Coastal Plain species proportions for the floras of the comparative plant list database](image-url)

---

55
In order to statistically analyze this hypothesis a scatterplot was generated with the distance of each flora from the CP on the X axis and the proportion of CP species per flora on the Y axis. The scatterplot indicated a negative linear relationship between the distance from the CP and the proportion of CP species per flora \( r^2 = 0.223 \), Figure 9, Appendix D. This regression analysis showed the Chickamauga National Military Park to have a higher proportion of CP species than expected with one of these species representing an occurrence over 100 km from the next closest occurrence. This collection is housed at the UTC herbarium which allowed for examination of the specimens, and it was determined that two of the six specimens identified as CP endemics (Eleocharis tricostata (three-angle spike-rush) and Scirpus lineatus (drooping bulrush)) were identified incorrectly (they were actually Eleocharis bifida (glade spike-rush) and Scirpus pendulus (rufous bulrush)). Two other CP endemics (Viola septemloba and Smilax walteri (red-berried greenbrier)) listed in the flora were searched for in the herbarium but could not be located. It is reasonable to conclude that these two species were identified and annotated as different species than originally determined and were moved to the correspondingly correct folder. Correcting the number of CP species in this flora from six to two provided a data point that more closely fit the regression line created for the relationship of proportion and distance from the CP.
Figure 9 Scatterplot of Coastal Plain species proportion data and the distance of the floras from the Coastal Plain for 22 of the floras of the legacy database (includes regression line, formula, and r² value)
The two-way ANOVA results indicate a significant relationship between both distance and presence on or off the CU on proportion of CP species (Table 3). The analysis using 85 km increments for the distance from the CP indicated no significant interaction between distance from the CP and Presence on the CU on proportion however; the analysis using the 100 km increments did indicate an interaction. Analyzing the interaction between distance and presence using a one-way ANOVA generated non-significant results for data sets using both 85 km and 100 km increments.

Table 3 Results of one-way and two-way ANOVA analyzing the affects of distance and presence on CU on proportion of CP species per flora

<table>
<thead>
<tr>
<th>Two-way ANOVA results</th>
<th>85 km distance categories</th>
<th>100 km distance categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from CP</td>
<td>p = 0.012 *</td>
<td>p = &lt; 0.001 *</td>
</tr>
<tr>
<td>Presence on CU</td>
<td>p = 0.004 *</td>
<td>p = &lt; 0.001 *</td>
</tr>
<tr>
<td>Interaction between factors</td>
<td>p = 0.435</td>
<td>p = 0.028 *</td>
</tr>
<tr>
<td>One-way ANOVA results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction between factors</td>
<td>p = 0.342</td>
<td>p = 0.279</td>
</tr>
</tbody>
</table>

Analyzing the affect on proportion by distance as a continuous variable using an ANCOVA generated a statistically significant negative relationship between distance from the CP and the proportion of CP species found within a flora ($F_{1, 19} = 19.6$, $p < 0.001$). More interestingly, the results indicate a significantly greater proportion of CP species are found in the CU floras than those of the surrounding physiographic provinces ($F_{1, 19} = 16.2$, $p = 0.001$, $r^2 = 0.60$).
It is also worth noting that 82.7% (67 of 81) of the species listed by Braun, Harvill, Jones, and Sorrie/Weakley as representative of the CP/CU,EHR distribution pattern are listed as obligate wetland or facultative wetland species by the U.S. Army Corps of Engineers. Many of the species listed by Braun come from her study of a Kentucky wetland, and the plants listed by Jones are from his surveys of wetlands of the CU, which would explain the high number of wetland species in the lists that they provide. However, the surveys conducted by Harvill and Sorrie/Weakley did not specifically target wetlands, which indicates that, as both Braun and Harvill note, a major influence on the distribution of CP species on the CU,EHR appears to be wetland habitat.
CHAPTER IV

CONCLUSIONS

Survey Conclusions

The results of the vascular flora of the LLLT have provided support for the unique natural value of the plant species and communities protected within. The land trust currently protects 672 species of vascular plants, which is 60 species higher than predicted by the CU species area curve. The higher than expected richness of the LLLT is also demonstrated by the richness of the systems located within which contain multiple rare associations. It is also clear from the 28 species of conservation concern located by the survey that the LLLT protects many rare species including four that are found nowhere else in the state. With the value of the area protected by the land trust demonstrated, I suggest that special attention is afforded to three areas of the LLLT.

The first area is High Point and the forest and power clearing contained within the approximately 100 h immediately surrounding its southern and eastern slope. Protection of this area most efficiently guards what is arguably one of the most unique areas in the land trust. The area surrounding and including highpoint contains 8 of the 11 systems and 11 of the 28 species of conservation concern located in the LLLT. Currently this area contains a man-made and maintained power clearing; several radio/cell towers, and a gravel drive providing access to these towers. This anthropogenic disturbance provides beneficial habitat for rare species such
as *Calystegia catesbeiana*, *Castilleja coccinea*, and *Lysimachia fraseri* however, it also allows for the introduction of non-native species that pose a threat to the species of conservation concern. Because of the possibility of non-native invasion this area should be periodically monitored and maintained when necessary. A second possible threat to this area is the management practice used to maintain the power line right-of-way. Currently the area is mowed, but maintenance could include spraying with herbicides or soil sterilants. Such an action could severely impact the species of this area and should be avoided unless used to selectively remove non-native species.

Personal communication with former LLLT land manager Noel Durant indicated aspirations, by the land trust, to open highpoint to rock climbing in the future. It is already evident from trampling of the plants at highpoint that a fair amount of traffic is occurring. I fear that allowing rock climbing would increase traffic of this site thus affecting not just the species on the bluff such as *Paronychia argyrocoma*, but also those in the surrounding area by an increase in motorized traffic. I recommend that the impacts to the flora of this area be thoroughly investigated before beginning such a program.

The second area is approximately 1 h of glade and bluff at the northern extent of the east overlook in the main Lula Lake property. This area contains habitat similar to that at highpoint as well as similar threats. What is unique about this area is the presence of *Phemeranthus teretifolius* which represent the only occurrence on the property and *Populus grandidentata* which is represented by only one specimen from the LLLT and is new to the state of Georgia. Due to the small size of the occurrence and the susceptibility to trampling caused by foot traffic the occurrence of *Phemeranthus* should be protected from disturbance by means of
a sign or a barrier. There is habitat suitable for *Phemeranthus teretifolius* in other locations within this hectare, but its absence from this habitat could be a result of the high amount of foot traffic.

The third area to target for protection is the stretch of Rock Creek and surrounding habitat that runs from the LLLT’s northern boundary to approximately 2000 meters to the south. This area contains five of the 11 systems located within the LLLT and seven of the 28 species of conservation concern. The uniqueness of the associations and species present in this area is unrivaled by any other location in the LLLT and is demonstrated by the presence the (*Hydrangea arborescens* / *Heuchera villosa* - *Asplenium trichomanes* - *Thalictrum clavatum* / *Conocephalum salebrosum*) Shrubland association which is listed by NatureServe as G2 (naturally rare). Other examples of the state and global rarity of this area include the presence of three species not recorded from Georgia (*Calamovilfa arcuata*, *Chelone lyonii*, and *Solidago arenicola*) and severely restricted in range globally. It is due to the extreme uniqueness of this area that care should be exercised in managing its habitats and species. Current threats to this area include invasion by non-natives and the presence of a gravel crossing for motorized vehicles directly upstream from a cobblebar containing three of the rarest species of the LLLT, both of which have been discussed in the ecological systems section.

The three areas presented in this conclusion together include, within approximately 175 h, every system of the LLLT and 20 of the 28 species of conservation concern. The purpose of focusing on these three areas is not to designate them as the only areas within the LLLT worthy of protection to the exclusion of the rest of the land trust, but rather to encourage increased management of these extremely unique areas to ensure there continued protection. Treating
the protection of these areas as a high priority for the land trust aligns with the continued fulfillment of its mission to protect and preserve the Rock Creek watershed.

**Biogeographical Conclusions**

The composition of the post-Cretaceous flora of southeastern North America has been much studied over the past century with some debate about its make-up continuing at present. Braun (1937b) suggested that the interior southeastern US retained a mixed mesophytic forest throughout the Quaternary period particularly during sea level inundations of the interstadial events. She theorized that the flora of the CP of North America was wiped out by inundation events and recolonized, after the seas receded, by dispersal of plants from the mixed mesophytic forests of the uplands of the interior. She cited genera such as *Conradina*, *Sarracenia*, *Stewartia*, and *Taxodium* as evidence of this process (Sorrie and Weakley 2001). Recently Thorne (1993) reiterated the same theory supporting the youth of the CP flora.

Harvill (1984), however, theorized that the migration of species in the Southeast progressed in the opposite direction. Citing Flint (1971) and Delcourt and Delcourt (1979), he proposed that the current deciduous forest dispersed from CP refugia into the interior of the southeast as glaciers retreated in the late Pleistocene.

Although there are taxa of the CP of relatively young age, the idea that the entire flora must be young due to the youth of the geological terrain is not supported by science. Reconstructions of the CP land mass have indicated that portions have been available for colonization since the Eocene epoch and that successive inundation events left at least fragments of the current coastal plain exposed. Pollen samples have also shown that much of
the flora of the Gulf and Atlantic CP during the past 40,000 years has remained relatively similar to that of today, containing taxa as familiar as *Carya, Nyssa, Pinus,* and *Quercus* (Grimm et al. 2006, Watts 1980, Sorrie and Weakley 2001).

In northwestern GA, pollen records from approximately 20,000 years ago have shown a flora of mixed boreal and temperate trees and herbs that demonstrate, to some degree, the growing conditions of the interior southeast at the end of the last glacial event (Watts 1975). Analysis of available pollen records from North America have been used to reconstruct plant distributions since the end of the Pleistocene, and the data from 21,000 years BP illustrates a biome composed of a cool mixed forest dominated by *Pinus, Quercus, Picea, Fraxinus,* and *Ostrya/Carpinus* inhabited most of non-glaciated eastern North America. Modern day Florida, along with southern Georgia and Alabama (the southeastern CP), was comprised of warm mixed forests (Williams et al. 2004). Although most of the taxa from these biomes are present today, the associations that they currently belong to were most likely different during the LGM, and many have no modern analog. Biomes present in the late-Pleistocene have disappeared, while new ones have developed. It is then an over simplification to state that the biomes present today represent the current extent of a progressive shift in distribution driven by climate, as has often been theorized. Plant associations and migrations are the result of individual responses to their environment and do not always correlate with present observations (Wall et al. 2010, Stults et al. 2010, Gonzales et al. 2008).

The biogeographic mechanism proposed by Braun (1937b, 1955) for the disjunct distribution of certain plant species on the CU/EHR of Tennessee and Kentucky involves the peneplanation of much of the Southeast in the Neogene period. These conditions presented
terrain with relatively low relief, swampy lowlands, and sandy soils. Braun theorized that the edaphic and climatic conditions were similar to those of the current CP and as such must have been suitable habitat for the evolution and presence of what we now know as the CP flora. As sea levels began to retreat during the Quaternary period, exposing greater areas of the CP, the plants of the peneplain were already adapted to the conditions present in the newly exposed area and began to migrate from the uplands. At the same time the uplands were undergoing dissection as a result of weathering that reduced the amount of viable habitat (particularly swampy lowlands) for these CP taxa. As a result, the mixed-mesophytic forest began to encroach upon the uplands and the CP taxa were forced into refugia that exist to the present in a few locations on the CU/EHR.

Shinners (1962), addressing the biogeographic theory proposed by Braun to explain the CP element on the CU/EHR, proposed that this disjunction might better be explained as a recent migration event in the other direction. He noted that there have been coasts for as long as the land and sea have been differentiated and theorized that there was never a need for CP plants to inhabit another area/province. Using distribution maps of species with the CP, CU/EHR distribution pattern, Harvill (1984) proposed that the migration pathway appears to occur through Alabama. With the lack of a distinct geographic barrier between the CP and CU/EHR in northern Alabama Harvill argued that migration could occur geologically unimpeded. Furthermore, citing a CU/EHR Quaternary habitat formed by increased inundation, wetland formation, and dissection due to glacier melt, and lacking a significant geographic barrier into the CP of Alabama, Harvill argues that weedy wetland CP species easily migrated into these suitable and available habitats from the coast. At the time of Harvill’s publication the existing
data supported the theory that the eastern deciduous forest was completely relegated to refugia far south of the modern Interior Plateau. Harvill used these data to support the idea of a retreating taiga on the CU/EHR at the end of the Pleistocene that left the plateau exposed to immigration, and proposed that the weedy wetland CP species invaded quickly and were subsequently slowly succeeded by the northern migrating eastern deciduous forests. What remains of the CP element on the CU/HER, according to Harvill, occurs in only the most favorable of habitats (Harvill 1984).

Recent biogeographical research into the distribution and migration of the flora of southeastern NA during the Quaternary have concluded that much more complex processes were involved than those proposed by Braun and Harvill. Analysis of available pollen records from North America by Williams et al. (2004) has been used to reconstruct plant distributions since the end of the Pleistocene. These reconstructions demonstrate that it is an over simplification to state that the biomes present today represent the current extent of a progressive shift in biome distribution driven by climate. Plant associations and migrations are the result of individual responses to their environment and do not always correlate with present observations (Williams et al. 2004, Gonzales et al. 2008, Stults et al. 2010, Wall et al. 2010).

Pollen and microfossil records of the CP reveal that pines of the Strobus sub-genus (White Pines) were present as recently as the early Holocene. This is significant because the co-occurring pollen indicates a flora otherwise similar to that of the modern CP. At present the distribution of the nearest pines of the subgenus Strobus (Pinus strobus (white pine), currently native to the CU but not the CP) are located hundreds of kilometers to the north of the CP with
a disjunct population of a closely related species (*Pinus chiapensis*, Chiapas pine) disjunct by approximately 2,400 km in Mexico. Historically these two populations probably constituted one taxon distributed throughout the southern part of North America, but changing climatic conditions (possibly precipitation amounts increasing) caused their extinction within the CP and left the taxa distributed as two recently evolved species (Stults et al. 2010).

Phylogeographic analyses of two plant species currently native to the CP help to further illustrate the complexity and individuality of the biogeography of biota in the Southeast. *Pyxidanthera*, a genus of Atlantic CP endemics, has a distribution of disjunct north and south populations separated by over 300 km. Wall et al. (2010) using phylogeographic analysis showed that, contrary to the popular paradigm of southern migration by species during stadial events followed by northern expansion following glacial retreat, *Pyxidanthera* populations remained in their northern range through the last ice age. It is possible that this genus was able to retain its northern distribution through colder periods due to the moderating effects of the Atlantic on its coastal habitat. However, phylogeographic analysis of *Trillium cuneatum* (cuneate trillium) indicates that temperate species of the interior may have had distributions farther north during the LGM than previously believed as well. This analysis indicates two refugia during the LGM, the first located in the current southwestern extent of the range of *T. cuneatum* (Southern Mississippi). Fossil records indicate a refuge of EDF within this area of the lower Mississippi Valley giving support to the phylogeographic results. The second refugium was in multiple locations of the southeastern extent of the current range, but further north than previously hypothesized for such a temperate species. Geographically distinct haplotypes from the eastern clade indicate refuge locations in central or southern Alabama, central or
southern Georgia, the southern Appalachians, and possibly northern Alabama or central Tennessee during the LGM and migration patterns that demonstrate a consistent southwest to northeast trajectory afterward. The results also indicate that the current distributions of temperate vegetation in southeastern North America are not solely a result of northeastern expansion from a refuge in the lower Mississippi valley during the LGM (Gonzales et al. 2008).

Although the complexity of the historical biogeography of southeastern North America is beginning to be recognized, recent research continues to indicate a distributional affinity of CP species for the CU. A recent survey of CU/EHR amphibians identified 18 species, of which 7 have distributions primarily within the CP. Noted within the research was the antiquity (Pleistocene or older) of the distributions of the salamanders on the CU/EHR, while the Anurans, being much more mobile, are believed to be more recent migrants to the CU (Corser 2008). Sorrie and Weakley (2001) have also compiled a list of CP vascular plant endemics based on distributions ($\geq 90\%$ of distribution records must be within the CP). This list contains no less than 58 species with distinctly CP, CU/EHR distributions (out of just over 1,000) a number large enough to be termed ‘surprisingly large’ by the authors.

A comparison of the plant lists compiled by Braun, Harvill, and Jones demonstrating the CP/CU,EHR distributional pattern with the list of CP endemics compiled by Sorrie and Weakley (2001) does not wholly support the previous author’s assertions of this pattern due to the small number of CP endemics actually contained in their lists. Braun lists 23 species exhibiting this distributional pattern in her papers from 1937, but only two of the 23 species are contained within the Sorrie/Weakley CP endemics list. Possible explanations for the low number of CP endemics within Braun’s list include limited survey sites (one of which was a wetland of
southeast Kentucky, as opposed to an overall survey of the CU/EHR) and incomplete data at the time on the distributions of species (some species in her list are widespread in southern or eastern NA ex. *Woodwardia areolata* (netted chain fern) and *Helenium flexuosum* (purplehead sneezeweed)). Of the 33 species listed by Harvill only five are included within the Sorrie/Weakley list. None of the 13 species listed by Jones in his paper are also listed by Sorrie/Weakley as CP endemics (Jones notes that 44 of the 368 taxa identified in his survey (12%) are distributed primarily within the CP, but a complete species list is not provided in the publication). The fact that only seven of the 63 species listed by Braun, Harvill, and Jones are considered CP endemics by Sorrie/Weakley indicates that Braun/Harvill had a broader definition of CP species, one that may more appropriately be termed a CP affinity.

The results of the biogeographical analysis of the floras from TN, AL, and GA indicate a significant relationship between the CU and a higher proportion of CP species than the surrounding physiographic provinces. This supports the observations of an increased number of CP plants on the CU by Braun, Jones, Harvill, and Sorrie. Although this analysis of the CP element on the CU supports the observations of these researchers, it does not speak to the mechanism involved in forming this biogeographical pattern.

The biogeographical processes involved in determining the current distributions of plant species of southeastern NA are multivariate and unique to individual taxa. Plant migrations and extinctions in NA throughout the Tertiary and Quaternary were shaped by climatic processes such as temperature changes (which not only affected local temperatures, but also glaciation, available moisture, and sea levels), precipitation fluctuations, and geological processes. Not only do individual species respond uniquely to changes in their environment, but the
environment also changed in non-uniform ways. This allowed temperate pockets or refugia of temperate species within niche habitats/ micro-climates surrounded by a cold-mixed forest and located in a climate traditionally considered inhospitable. The nuances of climate and its changes through time also affect interspecific competition in ways that may not be analogous to the responses of current species to competition. Dispersal ability also affects the ease and speed of migration thus affecting the distributional patterns of plant species (*Pinus* subgenus *Strobus* has migrated great distances in 10,000 years while the genus *Pyxidanthera* has had nearly the same distribution since the LGM (Gonzales et al. 2008, Wall et al. 2010). The multiple influences on the distributions of plant species indicates that the apparent distributional pattern of the CP, CU/EHR could be a result of both refugia through the LGM (*T. cuneatum*) and recent migrations from the CP (*Pinus* subgenus *Strobus*). The distributional pattern of a higher proportion of CP species on the CUEHR than the surrounding physiographic provinces is supported by the statistical analysis of this research however; future insight into the processes leading to this pattern may be gained through phytogeographic analysis of species exhibiting this distribution.
LITERATURE CITED


Tennessee Flora Committee. in press. *Guide to the Vascular Flora of Tennessee*


APPENDIX A

INTRODUCED SPECIES AT LLLT
<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>GA-EPPC Rank</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ampelopsis brevipedunculata</em> (Maxim.) Trautv.</td>
<td>Category 3</td>
<td>Level 1</td>
</tr>
<tr>
<td><em>Celastrus orbiculatus</em> Thunb.</td>
<td>Category 1 Alert</td>
<td>Level 1</td>
</tr>
<tr>
<td><em>Clematis terniflora</em> DC.</td>
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<td>Level 1</td>
</tr>
<tr>
<td><em>Elaeagnus umbellata</em> Thunb. var. parviflora (Wall. ex Royle) C.K. Schneid.</td>
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<td>Level 1</td>
</tr>
<tr>
<td><em>Euonymus alatus</em> (Thunb.) Siebold</td>
<td>Category 4</td>
<td>Level 1</td>
</tr>
<tr>
<td><em>Euonymus hederaceus</em> Champ. &amp; Benth.</td>
<td>Category 3</td>
<td>Level 1</td>
</tr>
<tr>
<td><em>Koelreuteria paniculata</em> Laxm.</td>
<td></td>
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</tr>
<tr>
<td><em>Lonicera fragrantissima</em> Lindl. &amp; Paxton</td>
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<tr>
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<tr>
<td><em>Paulownia tomentosa</em> (Thunb.) Siebold &amp; Zucc. ex Steud.</td>
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<tr>
<td><em>Pueraria montana</em> (Lour.) Merr. var. lobata (Willd.) Maesen &amp; S. Almeida</td>
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<td><em>Lathyrus hirsutus</em> L.</td>
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<td><em>Lepidium densiflorum</em> Schrad.</td>
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<td><em>Leucanthemum vulgare</em> Lam.</td>
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<td><em>Medicago lupulina</em> L.</td>
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<td><em>Medicago orbicularis</em> (L.) Bartal.</td>
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<tr>
<td><em>Melilotus officinalis</em> (L.) Lam.</td>
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<td><em>Mosla dianthera</em> (Buch.-Ham. ex Roxb.) Maxim.</td>
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<td><em>Paspalum dilatatum</em> Poir.</td>
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<td><em>Persicaria longiseta</em> (Bruijn) Kitag.</td>
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<td><em>Poa annua</em> L.</td>
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<td><em>Ranunculus bulbosus</em> L.</td>
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<td><em>Rumex acetoella</em> L.</td>
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<td><em>Rumex crispus</em> L.</td>
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<td><em>Schedonorus arundinaceus</em> (Schreb.) Dumort.</td>
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<td><em>Setaria pumila</em> (Poir.) Roem. &amp; Schult.</td>
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<td><em>Sherardia arvensis</em> L.</td>
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<td><em>Sonchus asper</em> (L.) Hill</td>
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<td><em>Stellaria media</em> (L.) Vill.</td>
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<td><em>Taraxacum officinale</em> F.H. Wigg.</td>
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<tr>
<td>Species Name</td>
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<td><em>Trifolium campestre</em> Schreb.</td>
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<td><em>Trifolium pratense</em> L.</td>
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<td><em>Verbascum thapsus</em> L.</td>
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<td><em>Veronica arvensis</em> L.</td>
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<td><em>Veronica officinalis</em> L.</td>
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<td><em>Veronica persica</em> Poir.</td>
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<td><em>Vicia sativa</em> ssp. <em>sativa</em></td>
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<td><em>Viola arvensis</em> Murray</td>
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<td><em>Vulpia myuros</em> (L.) C.C. Gmel</td>
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<td><em>Youngia japonica</em> (L.) DC.</td>
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<td><em>Euphorbia cyparissias</em> L.</td>
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<td><em>Hemerocallis fulva</em> (L.) L.</td>
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<td><em>Kerria japonica</em> (L.) DC.</td>
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<td><em>Narcissus pseudonarcissus</em> L.</td>
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<td><em>Philadelphus coronarius</em> L.</td>
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<td><em>Prunus glandulosa</em> Thunb</td>
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<td><em>Prunus persica</em> (L.) Batsch</td>
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<td><em>Pyracantha fortuneana</em> (Maxim) Li</td>
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<td><em>Phlox subulata</em> L.</td>
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APPENDIX B

ECOLOGICAL SYSTEMS AT LLLT
<table>
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<tr>
<th>Ecological System</th>
<th>Component Association</th>
<th>Assoc. I.D. #</th>
<th>Status</th>
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<tbody>
<tr>
<td>Allegheny-Cumberland Dry Oak Forest and Woodland</td>
<td>Quercus prinus - Quercus (alba, coccinea, velutina) / Viburnum acerifolium - (Kalmia latifolia) Forest</td>
<td>CEGL005023</td>
<td>G4 Apparently Secure</td>
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<td></td>
<td>Pinus virginiana - Pinus (rigida, echinata) - (Quercus prinus) / Vaccinium pallidum Forest</td>
<td>CEGL007119</td>
<td>G3 vulnerable</td>
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<td></td>
<td>Quercus alba - Quercus velutina - Carya (ovata, alba, glabra) - Pinus sp. Forest</td>
<td>CEGL007231</td>
<td>G4 Apparently Secure</td>
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<td>Quercus falcata - Quercus alba - Carya alba / Oxydendrum arboreum / Vaccinium stamineum Forest</td>
<td>CEGL007244</td>
<td>G4 Apparently Secure</td>
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<td>Quercus falcata - Quercus (coccinea, stellata) / Vaccinium (pallidum, stamineum) Forest</td>
<td>CEGL007247</td>
<td>G4 Apparently Secure</td>
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<td>Quercus prinus - Carya spp. - Quercus velutina / Vaccinium arboreum / Iris verna var. smalliana Forest</td>
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<td>G3 Vulnerable</td>
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<td>Quercus prinus - Quercus rubra - Carya (ovata, glabra) - Pinus virginiana Forest</td>
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<td>G4 Apparently Secure</td>
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<tr>
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<td>Quercus prinus - Quercus spp. / Vaccinium arboreum - (Kalmia latifolia, Styrax grandifolius) Forest</td>
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<td>Quercus alba - Carya alba - (Quercus velutina) / Desmodium nudiflorum - (Carex picta) Forest</td>
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<td>Quercus stellata - Pinus virginiana / (Schizachyrium scoparium, Piptochaetium avenaceum) Woodland</td>
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<td>Quercus prinus - (Quercus coccinea) / Carya pallida / Vaccinium arboreum - Vaccinium pallidum Forest</td>
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<td></td>
<td>Quercus alba - Quercus (coccinea, velutina, prinus) / Gaylussacia baccata Forest</td>
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<td>G5 Secure</td>
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<td>Quercus alba - (Quercus prinus) / (Hydrangea quercifolia) - Viburnum acerifolium / Carex picta - Piptochaetium avenaceum Forest</td>
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<td>Quercus alba - Quercus falcata / Vaccinium (arboreum, hirsutum, pallidum) Forest</td>
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<td>South-Central Interior Mesophytic Forest</td>
<td>Liriodendron tulipifera - Tilia americana var. heterophylla - Aesculus flava - Acer saccharum / (Magnolia tripetala) Forest</td>
<td>CEGL005222</td>
<td>G4 Apparently Secure</td>
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<td>Quercus alba - Quercus rubra - Carya ovalis / Acer saccharum / Polystichum acrostichoides Forest</td>
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<td>G4 Apparently Secure</td>
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<td>Quercus alba - (Liriodendron tulipifera, Liquidambar styraciflua) - Calycanthus floridus / Athyrium filix-femina Forest</td>
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<td>Tsuga canadensis - (Fagus grandifolia, Tilia americana var. heterophylla) / Magnolia tripetala Forest</td>
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<td>Southern Appalachian Low-Elevation Pine Forests</td>
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<td>Cumberland Sandstone Glade and Barrens</td>
<td>Pinus virginiana - Pinus (rigida, echinata) - (Quercus prinus) / Vaccinium pallidum Forest</td>
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<tr>
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<td>Pinus virginiana - (Pinus rigida, Pinus pungens) / Schizachyrium scoparium Forest</td>
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<td>G3 vulnerable</td>
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<td>Pinus strobus / Kalmia latifolia - (Vaccinium stamineum, Gaylussacia ursina) Forest</td>
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<tr>
<td>Cumberland Sandstone Glade and Barrens</td>
<td>Schizachyrium scoparium - Danthonia sericea - Liatris microcephala - (Eurybia surculosa) Wooded Herbaceous Vegetation</td>
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<td>Pinus virginiana - Pinus (rigida, echinata) - (Quercus prinus) / Vaccinium pallidum Forest</td>
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<td>Kalmia latifolia - Gaylussacia (baccata, brachycera) Cumberland Shrubland</td>
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<td>Cumberland Riverscour</td>
<td>Schizachyrium scoparium - Andropogon (gyrans, ternarius, virginicus) Herbaceous Vegetation</td>
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<td>Alnus serrulata - Xanthorhiza simplicissima Shrubland</td>
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<td>Carex torta Herbaceous Vegetation</td>
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<td>Betula nigra - Platanus occidentalis / Alnus serrulata / Boehmeria cylindrica Forest</td>
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<td>Osmunda regalis var. spectabilis Seepage Scour Herbaceous Vegetation</td>
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<td>South-Central Interior Small Stream and Riparian</td>
<td>Platanus occidentalis - Betula nigra / Cornus amomum / (Andropogon gerardii, Chasmanthium latifolium) Woodland</td>
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<td>Juncus effusus Seasonally Flooded Herbaceous Vegetation</td>
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<td>Tsuga canadensis - Liriodendron tulipifera - Platanus occidentalis / Rhododendron maximum - Xanthorhiza simplicissima Temporarily Flooded Forest</td>
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<td>Liquidambar styraciflua - Liriodendron tulipifera - (Platanus occidentalis) / Carpinus caroliniana - Halesia tetraphera / Amplicarpaea bracteata Forest</td>
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<td>Asplenium montanum - Heuchera parviflora var. parviflora - Silene rotundifolia Sparse</td>
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<td>Felsic Cliff Sparse Vegetation</td>
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<td>(Hydrangea arborescens) / Heuchera villosa - Asplenium trichomanes -</td>
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<td>Thalictrum clavatum / Conocephalum salebrorum Shrubland</td>
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<td>Chasmanthium laxum - Carex intumescens / Sphagnum lescurii Forest</td>
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<td>Cumberland Wet-mesic Meadow and Savannah</td>
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<td>Andropogon gerardii - (Sorghastrum nutans) Kentucky Herbaceous</td>
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APPENDIX C

NOTABLE EXCEPTIONS LIST FOR LLLT
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<td>Carex rosea</td>
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<td>Thaspium barbinode</td>
<td>All but 3 floras and the LLLT</td>
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<td>Nabalus altissima</td>
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<td>Symphyotrichum dumosum</td>
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<td>Carpinus caroliniana</td>
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<td>Sedum ternatum</td>
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<tr>
<td>Quercus rubra</td>
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<td>Species</td>
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</tr>
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<td><em>Circaea lutetiana</em></td>
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<td><em>Sanguinaria canadensis</em></td>
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<td><em>Persicaria punctata</em></td>
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<td><em>Actaea pachypoda</em></td>
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<td><em>Ulmas americana</em></td>
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APPENDIX D

COASTAL PLAIN SPECIES PRESENCE ON THE CUMBERLAND PLATEAU
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<th>Study Site</th>
<th>Species</th>
<th>CP Species</th>
<th>Proportion</th>
<th>Distance from CP (km)</th>
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<tr>
<td><strong>Cumberland Plateau</strong></td>
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<td>Prentice Cooper</td>
<td>1,070</td>
<td>15</td>
<td>0.014</td>
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<td>Fall Creek Falls</td>
<td>879</td>
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<td>White Oak Creek Gorge</td>
<td>526</td>
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<td>Tennessee River Gorge</td>
<td>700</td>
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<td>Obed</td>
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<td>Fiery Gizzard</td>
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<td>0.0084</td>
<td>180</td>
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<tr>
<td>NCCGSNA</td>
<td>604</td>
<td>5</td>
<td>0.0083</td>
<td>230</td>
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<tr>
<td>Clear Fork/New River</td>
<td>584</td>
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<td>0.0068</td>
<td>305</td>
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<td>Lula Lake Land Trust</td>
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<td>Wolf Cove</td>
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<td>6</td>
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<td>170</td>
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<td><strong>Ridge and Valley</strong></td>
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<td>Upper Clinch River</td>
<td>524</td>
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<td>0</td>
<td>340</td>
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<td>Red Clay State Historical Area</td>
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<td>Chickamauga National Military Park</td>
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<td>0.0056</td>
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<tr>
<td><strong>Blue Ridge</strong></td>
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<tr>
<td>Big Frog Mountain</td>
<td>471</td>
<td>2</td>
<td>0.0042</td>
<td>265</td>
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<tr>
<td>Grassy Mountain</td>
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<td>0.0037</td>
<td>250</td>
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<td><strong>EHR/Central Basin/WHR</strong></td>
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<td>Short Mountain</td>
<td>438</td>
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<td>185</td>
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<td>Giles County</td>
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<td>Limestone County</td>
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<td>Duck River Unit</td>
<td>718</td>
<td>13</td>
<td>0.0181</td>
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APPENDIX E

LLLT PLANT LIST
Key to Relative Abundance Abbreviations (Murrell and Wofford 1987)

C - Common: Characteristic and dominant
F - Frequent: Generally encountered
O - Occasional: Well distributed, but not anywhere abundant
I - Infrequent: Scattered localities throughout
S - Scarce: Several localities
R - Rare: One or two localities, generally small populations
VR - Very Rare: A single locality, few localities

Key to Ecological Systems

ACDO - Allegheny-Cumberland Dry Oak Forest and Woodland
SCIM - South-Central Interior Mesophytic Forest
SALP - Southern Appalachian Low-Elevation Pine Forests
CSGB - Cumberland Sandstone Glade and Barrens
CR - Cumberland Riverscour
SCIS - South-Central Interior Small Stream and Riparian
CACR - Cumberland Acidic Cliff and Rockhouse
SAMC - Southern Appalachian Montane Cliff and Talus
AFAS - Appalachian Forested Acidic Seep
CWMS - Cumberland Wet-mesic Meadow and Savannah
AD - Anthropogenically disturbed sites

* - Introduced species

** - Species of Conservation Concern

□ - New Walker County Record
LTT Plant List

PTERIDOPHYTA

ASPLENIACEAE
Asplenium montanum Willd. ; I. CACR, SAMC, ACDO.
A. platyneuron (L.) Britton, Stearns & Poggenb.; O. ACDO, SCIM, SCIS, CACR, SAMC, CWMS, AD.
□ A. trichomanes L.; VR. SAMC.

BLECHNACEAE
Woodwardia areolata (L.) T. Moore; I. SCIS, AFAS, AD.

DENNSTAEDTIACEAE
□ Dennstaedtia punctilobula (Michx.) T. Moore; F. ACDO, SCIM, SCIS, AFAS, AD.
□ Pteridium aquilinum (L.) Kuhn; F. ACDO, SALP, CSGB, CWMS, AD.

DROOPTRIDACEAE
□ Dryopteris marginalis (L.) A. Gray; F. ACDO, SCIM, SAMC.
Polystichum acrostichoides (Michx.) Schott; C. ACDO, SCIM, SALP, SCIS.

EQUISETACEAE
□ Equisetum arvense L.; VR. AD.

LYCOPODIACEAE
□ Pleopeltis polypodioides (L.) Andrews & Windham ssp. michauxiana (Weath.) Andrews & Windham; I. ACDO, SCIM.

OSMUNDACEAE
□ Osmunda regalis L.; O. SCIM, CR, SCIS, AFAS.

ONOCLEACEAE
Onoclea sensibilis L.; R. SCIS.

OPHOLOGLOSSACEAE
Botrypus virginianus (L.) Holub; O. ACDO, SCIM, SALP.
□ Sceptridium dissectum (Spreng) Lyon; I. ACDO, SCIM.

THELYPTERIDACEAE
□ Phegopteris hexagonoptera (Michx.) Fée; S. SCIM.
Theleyptis noveboracensis (L.) Nieuwl.; F. ACDO, SCIM, SCIS.

WOODSIACEAE
Athyrium filix-femina (L.) Roth; F. ACDO, SCIM, SCIS.
Woodsia obtusa (Spreng.) Torr. S. CSGB, SCIS, SAMC.

CONIFEROPHYTA

CUPRESSACEAE
□ Juniperus virginiana L.; I. ACDO, SALP, CSGB.

PINACEAE
□ Pinus echinata Mill.; O. ACDO, SCIM, SALP, CSGB.
□ P. strobus L.; O. ACDO, SCIM, SALP, SCIS.
□ P. taeda L.; S. SCIS, AD.
P. virginiana Mill.; F. ACDO, SCIM, SALP, CSGB, CACR, SAMC, AD.
□ Tsuga canadensis (L.) Carriere; O. SCIM, SCIS.

MAGNOLIOPHYTA - LILIOPSIDA

AGAVACEAE
Manfreda virginica (L.) Salisb. ex Rose; I. ACDO, SCIM, CWMS, AD.
□ Yucca filamentosa L.; I. ACDO, SALP, CSGB, CWMS.

ALISMATACEAE
Alisma subcordatum Raf.; VR. AD.

ALLIACEAE
□ Allium canadense L.; I. SCIS, AD.

AMARYLLIDACEAE
□ Narcissus pseudonarcissus L.; VR. AD.

ARACEAE
□ Arisaema quinatum (Buckley) Schott; R. SCIM.
A. triphyllum (L.) Schott; S. SCIM.

COLCHICACEAE
Uvularia perfoliata L.; I. ACDO, SCIM, SCIS.
U. sessilifolia L.; I. ACDO, SCIM, SCIS.

COMMELINACEAE
* □ Commelina communis L.; VR. AD.
□ C. erecta L.; R. AD.
Tradescantia subaspera Ker Gawl.; I. SCIM, CSGB, CWMS, AD.
CYPERACEAE

- Carex annectens (E.P. Bicknell) E.P. Bicknell; S. AD.
- C. atlantica L.H. Bailey var. capillacea (Bailey) Reznicek; S. AD.
- C. aureolensis Steud.; S. AD.
- C. austrocaroliniana L.H. Bailey; I. SCIM, SCIS.
- C. blanda Dewey; O. ACDO, SCIM, SCIS.
- C. cephalophora Muhl. ex Willd.; I. AD.
- C. cherokeesia Schwein.; R. AD.
- C. complanata Torr. & Hook.; I. ACDO, SCIM.
- C. crinita Lam. var. brevicirris Fernald; R. AD.
- C. cumberlandensis Naczi, Kral & Bryson; I. ACDO, SCIM.
- C. debilis Michx. var. debilis; I. ACDO, SCIM.
- C. digitalis Willd. var. macropoda Fernald; I. ACDO, SCIM.
- C. frankii Kunth; S. AD.
- C. hirsutella Mack.; I. ACDO, SCIM.
- C. intumescens Rudge; R. AFAS.
- C. laxiflora Lam.; I. ACDO, SCIM.
- C. lucorum Willd. ex Link var. austrolucorum J. Rettig; S. ACDO, SCIM.
- C. lurida Wahlenb.; S. AD.
- C. mesochorea Mackenzie; I. AD.
- C. muehlenbergii Schkuhr ex Willd. var. enervis Boott.; VR. CSGB.
- C. muehlenbergii Schkuhr ex Willd. var. muehlenbergii; I. ACDO, SCIM, AD.
- C. nigromarginata Schwein.; F. ACDO, SCIM, SALP.
- C. pensylvanica Lam.; S. SALP, CSGB.
- C. physorhyncha Liebm. ex Steud.; O. ACDO, SCIM, AD.
- C. projecta Mack.; I. ACDO, SCIM, AD.
- C. squarrosa L.; S. CR, SCIS, AFAS.
- C. styloflexa Buckley; S. ACDO, SCIM, AD.
- C. swanii (Fernald) Mack.; ACDO, SCIM, AD.
- C. umbellata Schkuhr ex Willd.; S. ACDO, SCIM, SALP.
- C. viridescens Muhl. ex Willd.; I. ACDO, SCIM.
- C. vulpinoidea Michx.; R. AD.
- Cyperus flavescens L.; I. CSGB, AD.
- C. lupulinus (Spreng.) Marcks; S. AD.
- C. retrorsus Chapm.; S. CSGB, AD.
- C. strigosus L.; S. AD.
- Rynchospora capitellata (Michx.) Vahl; I. CR, SCIS, SAMC, AD.
- R. glomerata (L.) Vahl; S. CWMS, AD.
- S. cyperinus (L.) Kunth; I. SCIS, AFAS, AD.
- S. pendulus Muhl.; R. AD.
- S. polyphyllus Vahl; S. AD.
- Scleria oligantha Michx.; R. CWMS, AD.

DIOSCOREACEAE

- Dioscorea polystachya Turcz.; I. ACDO, SCIM, SALP, SCIS.
- D. villosa L.; S. ACDO, SCIM, SCIS.

HEMEROCALLIDACEAE

- Hemerocallis fulva (L.) L.; VR. AD.

HYPOXIDACEAE

- Hypoxis hirsuta (L.) Coville; O. ACDO, SCIM, SALP.

IRIDACEAE

- Iris cristata Aiton; I. SCIM, SCIS.
- I. verna L.; O. ACDO, SCIM, SALP.
- Sisyrinchium atlanticum E.P. Bicknell; R. AD.
- S. nashii E.P. Bicknell; I. ACDO, AD.

JUNCACEAE

- Juncus acuminatus Michx; O. SCIS, AD.
- J. coriaceus Mack; I. SCIS, AD.
- J. debilis A. Gray; S. SCIS, AD.
- J. dichotomus Elliott; I. AD.
- J. effusus L.; I. SCIS, AD.
- J. filipendulus Buckley; S. AD.
- J. marginatus Rostk.; I. AD.
- J. tenuis Willd.; I. AD.
- J. validus Coville; S. AD.
- Luzula acuminata Raf. var. carolinae (S. Watson) Fern.; O. ACDO, SCIM, CWMS, AD.
- L. bulbosa (Alph. Wood) Smyth & Smyth; O. ACDO, SCIM, CWMS, AD.
- L. multiflora (Ehrh.) Lej.; O. ACDO, SCIM, CWMS, AD.

LILIACEAE

- Medeola virginiana L.; O. SCIM, SCIS, AFAS.
- Prosartes lanuginosa (Michx.) D. Don; S. SCIM, SCIS.

MELANTHIACEAE

- Amianthium muscitoxicum (Walter) A. Gray; I. ACDO, SCIM, AFAS.
- Chamaelirium luteum (L.) A. Gray; I. ACDO, SCIM, SALP.
- Melanthium parviflorum (Michx.) S. Watson; S. SCIM.
- Stenanthium gramineum (Ker Gawl.) Morong; I. ACDO, SCIM, AFAS.
- Trillium cuneatum Raf.; S. SCIM.

NARTHECIACEAE

- Aletris farinosa L.; VR. CWMS.

ORCHIDACEAE

- Cypripedium acaule Aiton; S. ACDO, SCIM, SALP, AFAS.
- Goodyera pubescens (Willd.) R. Br.; F. ACDO, SCIM, SALP.
- Malaxis unifolia Michx.; R. SCIM, SCIS.
- Platanthera ciliaris (L.) Lindl.; S. SCIS, CWMS, AD.
Aristida purpurascens
Agrostis hyemalis
A. virginicus
A. ternarius
Andropogon gerardii
ǂ
D. ravenelii
ǂ
D. polyanthes
Freckmann & Lelong; I. ACDO, SCIM, AD.
ǂ
D. depauperatum
ǂ
D. dichotomum
ǂ
D. clandestinum
ǂ
A. glomeratus
Datraxon hispidus (Thunb.) Makino; S. AD.
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Arundinaria appalachiana
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ADOXACEAE

- Sambucus canadensis L.; O. SCIS, AD.
- Viburnum acerifolium L.; C. ACDO, SCIM, SALP, SCIS.
- V. cassinoides L.; I. SCIM, SCIS, AFAS.
- V. dentatum L.; VR. SCIM.
- V. rufidulum Raf.; I. SCIS.

ALTINGIACEAE

- Liquidamber styraciflua L.; O. SCIM, CR, SCIS, SAMC, AFAS.

ANACARDIACEAE

- Rhus copallinum L.; O. ACDO, SALP, CSGB, CACR, AD.
- R. glabra L.; O. ACDO, SALP, CSGB, CACR, AD.
- Toxicodendron pubescens Mill.; I. ACDO, SALP, CSGB.
- Toxicodendron radicans (L.) Kuntze; C. ACDO, SCIM, SALP, SCIS, CACR, SAMC, AFAS.

APIACEAE

- Angelica venenosa (Greenway) Fernald; O. ACDO, SCIM, SALP.
- Chaerophyllum tainturieri Hook.; I. SCIM, AD.
- Cryptotaenia canadensis (L.) DC.; SCIM, SCIS.
- Daucus carota L.; I. AD.
- Ligusticum canadense (L.) Britton; SCIM, SCIS.
- Oxypolis rigidior (L.) Raf.; R. SCIM, SCIS.
- Sanicula canadensis L.; F. ACDO, SCIM, SCIS, AD.
- S. smallii E.P. Bicknell; I. ACDO, SCIM, SCIS, AD.
- Zizia aptera (A. Gray) Fernald; I. ACDO, SCIM.

APOCYNACEAE

- Amsonia tabernaemontana Walter var. tabernaemontana; O. SCIM, SCIS.
- Apocynum androsaemifolium L.; R. SCIM.
- Asclepias quadrifolia Jacq.; O. ACDO, SCIM, SCIS.
- A. tuberosa L. ssp. tuberosa; O. CWMS, AD.
- A. variegata L.; I. ACDO, CSGB, AD.
- A. verticillata L.; S. CWMS, AD.
- A. viridiflora Raf.; R. ACDO, CSGB, CWMS, AD.

ARALIACEAE

- Aralia spinosa L.; O. ACDO, SCIM, SALP.
- Panax quinquefolius L.; VR. SCIM.

ARISTOLOCHIACEAE

- Hexastylis arifolia (Michx.) Small var. ruthii (Ashe) Blomquist; S. SALP, SCIS.
- H. shuttleworthii (Britten & Baker f.) Small; F. ACDO, SCIM, SALP, SCIS.

ASTERACEAE

- Achillea millefolium L. var. occidentalis DC.; I. ACDO, SCIM, AD.
- Ageratina altissima (L.) King & H. Rob. var. altissima; O. ACDO, SCIM, SCIS.
- A. aromatica (L.) Spach.; O. ACDO, SCIM, SCIS, CWMS, AD.
- Ambrosia artemisiifolia L.; O. SCIS, CWMS, AD.
- A. tridentata (L.); O. CWMS, AD.
- Antennaria plantaginifolia (L.) Richardson; I. ACDO, SCIM, SALP.
- A. solitaria Rydb.; I. ACDO, SCIM, SALP.
- Arnoglossum atriplicifolium (L.) H. Rob.; O. ACDO, SCIM, SCIS, CWMS, AD.
- B. bipinnata L.; O. ACDO, SCIM, SCIS, CWMS, AD.
- B. frondosa L.; I. ACDO, SCIM, SCIS, CWMS, AD.
- B. polylepis S.F.Blake; I. CWMS, AD.
- Brickellia eupatorioides (L.) Shinn.; O. ACDO, SALP, CWMS, AD.
- *Carduus nutans L.; I. CWMS, AD.
- Chrysopsis mariana (L.) Elliot; O. SALP, CSGB, CWMS, AD.
- *Chicorium intybus L.; S. AD.
- Conoclinium coelestinum (L.) DC.; S. AD.
- *Conyza canadensis (L.) Cronquist var. canadensis; O. ACDO, SCIM, CWMS, AD.
- Coreopsis major Walter; O. SCIS, CWMS, AD.
- C. pubescens Elliot; I. SCIS, CWMS, AD.
- C. tripteris L.; O. SCIS, CWMS, AD.
- *Crepis capillaris (L.) Wallr.; I. AD.
- Doellingeria infirma (Michx.) Greene; O. ACDO, SCIM, AD.
- D. umbellata (Mill.) Nees; O. ACDO, SCIM, AD.
- Elephantopus carolinianus Raueusch.; F. ACDO, SCIM, AD.
- Erechtites hieracifolia (L.) Raf. ex DC.; I. AD.
- Erigeron annuus (L.) Pers.; O. ACDO, SCIM, CWMS, AD.
- E. philadelphicus L.; O. ACDO, SCIM, CWMS, AD.
- E. strigosus Muhl. ex Willd. var. strigosus; I. SCIM, CWMS, AD.
- Eupatorium capillifolium (Lam.) Small; I. ACDO, SCIM, CWMS, AD.
- E. perfoliatum L.; I. ACDO, SCIM, CWMS, AD.
- E. rotundifolium L. var. rotundifolium; O. ACDO, SCIM, CWMS, AD.
- E. serotinum Michx.; I. SCIM, CWMS, AD.
- E. sessilifolium L.; I. SCIM, CWMS, AD.
- Eurybia divaricata (L.) G.L. Nesom; O. SCIM, SCIS, CWMS.
- E. surculosa (Michx.) G.L. Nesom; I. ACDO, SALP, CSGB.
Eutrochium fistulosum (Barratt) E.E. Lamont; O. SCIM, SCIS, CWMS, AD.
E. purpureum (L.) E.E. Lamont; O. SCIM, SCIS, CWMS, AD.

- Gamochaeta argyrinea G.L. Nesom; S. ACDO, CSGB, CWMS, AD.
- G. purpurea (L.) Cabrera; O. ACDO, CSGB, CWMS, AD.
- Helianthus amarum (Raf.) H. Rock; S. CWMS, AD.
- H. flexuosum Raf.; S. CWMS, AD.
- Helianthus angustifolius L.; I. CR, SCIS, CWMS.
- H. divaricatus L.; F. ACDO, SCIM, SCIS, CWMS.
- H. microcephalus H. Rock & A. Gray; F. ACDO, SCIM, SCIS, CWMS.
- Heterotheca subaxillaris (Lam.) Britton & Rusby; S. AD.
- Hieracium gronovii L.; I. AD.
- H. venosum L.; I. AD.
- Krigia biflora (Walter) S.F. Blake; O. CWMS, AD.
- K. caespitosa (Raf.) K.L. Chambers; O. CWMS, AD.
- K. virginica (L.) Willld.; I. CWMS, AD.
- Lactuca floridana (L.) Gaertn.; O. AD.
- *Leucanthemum vulgare L.; I. CWMS, AD.
- L. var. (L.) Willd.; I. CWMS, AD.
- *Lactuca var. microcephala (L.) Willd.; I. CWMS, AD.
- Packera obovata (Muhl. ex Willld.) W.A. Weber & A. Löve; I. SCIS, CWMS, AD.
- P. paupercula (Michx.) A. Löve & D. Löve; I. SCIS, CWMS, AD.
- Parthenium integrifolium L. var. integrifolium; I. ACDO, SCIM, CWMS, AD.
- Pityopsis graminifolia (Michx.) Nutt. var. graminifolia; I. ACDO, SCALP, CSGB.
- Pseudognaphalium obtusifolium (L.) Hillard & B.L. Burtt; I. CSGB, AD.
- Pyrrhopappus carolinianus (Walter) DC.; I. AD.
- Rudbeckia fulgida Aiton var. fulgida; O. ACDO, SCIM, SCIS, CWMS, AD.
- R. hirta L. var. hirta; O. ACDO, SCIM, SCIS, CWMS, AD.
- *R. lacinia L. var. lacinia; I. SCIS, CWMS, AD.
- Sericocarpus asteroides (L.) Britton, Sterns & Poggenb.; I. ACDO, SCALP, CWMS, AD.
- Sericocarpus linifolius (L.) Britton, Sterns & Poggenb.; ACDO, SCALP, CSGB, CWMS, AD.
- Silphium asteriscus L. var. astericus; O. CWMS, AD.
- S. compositum Michx.; I. CWMS, AD.
- S. gatess C.Mohr; O. ACDO, SCIM, CWMS, AD.
- **S. mohrii Small; S. CWMS, AD.
- S. trifoliatum L.; O. ACDO, SCIM, CWMS, AD.
- Smallanthus uvedalius (L.) Mack. ex Small; S. CWMS, AD.
- Solidago altissima L. ssp. altissima; O. ACDO, SCIM, SCIS, CWMS, AD.
- **S. arenicola B. R. Keener & Kral; R. CR, SCIS.
- S. arguta Aiton var. caroliniana A. Gray; ACDO, CSIM, CWMS, AD.
- S. caesia L.; I. ACDO, SCIM, SALP.
- S. erecta Pursh; O. ACDO, SCIM, SALP, CWMS, AD.
- S. nemoralis Aiton; O. CWMS, AD.
- S. odora Aiton; I. CWMS, AD.
- S. patula Muhl. ex Willld.; O. ACDO, SCIM, SALP, SCIS, CWMS, AD.
- S. rugosa Mill. var. rugosa; I. CWMS, AD.
- S. rugosa P. Mill var. aspera (Aiton) Fernald; I. CWMS, AD.
- S. speciosa Nutt. var. rigidiuscula Torr. & A.Gray; O. CWMS, AD.
- S. sphecata Raf.; O. ACDO, SCIM, SALP, CWMS, AD.
- *Sonchus asper (L.) Hill; I. AD.
- Symphyotrichum lanceolatum (Willd.) Nesom var. latifolium (Semple & Chmielewski) G.L. Nesom; I. ACDO, SCIM, CWMS, AD.
- S. lateriflorum (L.) A. Löve & D. Löve; I. CWMS, AD.
- S. patens (Aiton) G.L. Nesom var. patens; O. ACDO, SCIM, SCIS, CWMS, AD.
- S. pilosum (Willld.) G.L. Nesom; I. CWMS, AD.
- S. undulatum (L.) G.L. Nesom; I. ACDO, SCIM, CWMS, AD.
- *Taraxacum officinale F.H. Wigg.; I. AD.
- Verbesina occidentalis (L.) Walter; I. CWMS, AD.
- V. virginica L.; I. CWMS, AD.
- Vernonia flaccidifolia Small; O. ACDO, SCIM, SCIS, CWMS, AD.
- *Youngia japonica (L.) DC.; S. AD.

** BALSAMINACEAE
- Impatiens capensis Meerb.; I. SCIS, SAMC, AD.

** BERBERIDACEAE

** BETULACEAE

- Alnus serrulata (Aiton) Willld.; F. CR, SCIS, AFAS.
- Betula lenta L.; F. ACDO, SCIM, SALP, SCIS, SAMC.
- B. nigra L.; S. CR, SCIS, SAMC.
- Corylus americana Walter; F. ACDO, SCIM, SALP.

** BIGNONIACEAE

- Bignonia capreolata L.; O. ACDO, SCIM, SALP, AD.
- Campsis radicans (L.) Seem. ex Bureau; S. AD.
- Catalpa bignonioides Walter; VR. AD.
BORAGINACEAE
Cynoglossum virginianum L.; R. SCIM.

BRASSICACEAE
* Barbarea vulgaris W.T. Aiton; S. CSGB, AD.
* Boeckera canadensis (L.) Al-Shehbaz; R. CSGB.
* Brassica rapa L.; S. AD.
* Cardamine hirsuta L.; O. AD.
* Dentaria heterophylla Nutt.; I. SCIM, SALP.
D. multifida Muhl. ex Ell.; I. SCIM, SALP.
* Draba brachycarpa Nutt. ex Torr. & Gray; R. AD.
* Lepidium densiflorum Schrad.; S. AD.
L. virginicum L.; O. AD.

CALYCANTHACEAE
* Calycanthus floridus L. var. floridus; C. ACDO, SCIM, SALP, SCIS.

CAMPANULACEAE
Campanula divaricata Michx.; F. ACDO, SCIM, SALP, SCIS, AMC, AD.
Lobelia cardinalis L.; SCIS.
L. inflata L.; O. ACDO, SCIM, SALP, CWMS, AD.
L. nuttallii Schult.; I. CSGB, CR, CWMS.
L. spicata Lam.; I. ACDO, SCIM, SCIS, CWMS.
* Triodanis perfoliata (L.) Nieuwl. var. perfoliata; O. AD.

CANNABACEAE
Celtis occidentalis L.; S. ACDO, SCIM.

CAPRIFOLIACEAE
* Lonicera dioica L.; VR. ACDO, CSGB, CWMS.
* L. fragrantissima Lindl. & Paxton; S. ACDO, AD.
* L. japonica Thunb.; O. ACDO, SCIM, SALP, SCIS, AD.
* L. maackii (Rupr.) Herder; I. ACDO, SCIM, AD.
L. sempervirens L.; S. SCIM, SCIS.
Symphoricarpos orbiculatus Moench; O. ACDO, SALP, CSGB.

CARYOPHYLACEAE
* Arenaria serpyllifolia L. var. serpyllifolia; R. AD.
* Cerastium brachypetalum Pers.; I. SCIM, SCIS, AD.
* C. fontanum Baumg. ssp. vulgare (Hartm.) Greuter & Burdet; O. SCIM, SCIS, AD.
* C. glomeratum Thuill.; I. SCIM, SCIS, AD.
* C. pumilum W. Curtis; SCIM, SCIS, AD.
* Paronychia argyrocoma (Michx.) Nutt.; R. CSGB.
Silene antirrhina L.; I. CWMS, AD.
* S. rotundifolia Nutt.; VR. CACR.
S. stellata (L.) W.T. Aiton; S. SCIM.
S. virginica L.; F. ACDO, SCIM, SALP.
* Stellaria media (L.) Vill.; O. AD.
Stellaria pubera Michx.; O. AD.

CELASTRACEAE
* Celastrus orbiculatus Thunb.; VR. SCIS.
* Euonymus alatus (Thunb.) Siebold; S. AD, SALP.
Euonymus americanus L.; F. ACDO, SCIM, SALP.
* E. hederaceus Champ. & Benth.; R. AD.

CISTACEAE
Lechea racemulosa Michx.; O. ACDO, CSGB, CWMS, AD.

CONVOLVULACEAE
* Calystegia catesbeiana Pursh; VR. CWMS.
Ipomoea pandurata (L.) G. Mey.; O. ACDO, SCIM, CR, SCIS, CWMS, AD.

CORNACEAE
* Cornus amomum Mill.; O. CR, SCIS.
C. florida L.; O. ACDO, SCIM, SALP.
C. foemina Mill.; S. SCIS.

DIERVILLACEAE
* Diervilla rivularis Gattinger; F. ACDO, SCIM, SALP, SCIS, SAMC, AD.

ELAEAGNACEAE
* Elaeagnus umbellata Thunb. var. parviflora (Wall. ex Royle) C.K. Schneid.; S. ACDO, SALP, AD.

ERICACEAE
Chimaphila maculata (L.) Pursh; F. ACDO, SALP.
Epigaea repens L.; O. ACDO, SALP.
Gaylussacia baccata (Wangenh.) K. Koch; O. ACDO, SALP, CSGB.
Kalmania latifolia L.; F. ACDO, SCIM, SALP, CSGB, SCIS.
Lyonia ligustrina (L.) DC. O. CR, SCIS.
Monotropa hypopitys L.; R. SALP.
* M. uniflora L.; S. ACDO, SALP.
Oxydendrum arboreum (L.) DC.; F. ACDO, SCIM, SALP, CSGB, SAMC.
Rhododendron alabamense Rehder; R. AD.
R. arborescens (Pursh) Torr.; I. CR, SCIS.
R. canescens (Michx.) Sweet; O. ACDO, SCIM, SCIS.
R. catawbiense Michx.; O. SCIS.
* R. cumberlandense E.L. Braun; O. ACDO, SALP.
Vaccinium arboreum Marsh.; F. ACDO, SALP, CSGB.
V. corymbosum L.; O. ACDO, SALP, CSGB.
V. pallidum Aiton; F. ACDO, SALP, CSGB.
V. stamineum L.; O. ACDO, SALP, CSGB, SAMC.

EUPHORBIACEAE
* Croton glandulosus L. var. septentrionalis Müll. Arg.; S. CWMS, AD.
C. monanthogynus Michx.; S. AD.
Euphorbia corollata L.; O. ACDO, CWMS, AD.
* E. cyparissias L.; VR. AD.
E. dentata Michx.; S. AD.
E. nutsans (Lag.) Small; O. AD.
E. pubentissima Michx.; O. ACDO, CWMS, AD.  

FABACEAE  
-Albizia julibrissin Durazz.; I. ACDO, SCIM, CR, SCIS.  
-Amphicarpa bracteata (L.) Fernald; F. ACDO, SCIM.  
-Apis americana Medik.; I. ACDO, SCIM.  
-Cercis canadensis L.; R. AD.  
-Chamaecrista fasciculata (Michx.) Greene; O. CWMS, AD.  
-C. nictitans (L.) Moench; O. CWMS, AD.  
-Cladrastis kentukea (Dum. Cours.) Rudd; VR. SCIS.  
-Clitoria mariana L.; O. ACDO, SALP, CSGB, SAMC, AD.  
-Desmodium ciliare (Muhl. ex Willd.) DC.; I. ACDO, SALP, AD.  
-Desmodium nudiflorum (L.) DC.; O. ACDO, SCIM, SALP.  
-Desmodium paniculatum (L.) DC.; F. ACDO, SACIM, SALP, CWMS, AD.  
-Desmodium viridiflorum (L.) DC.; F. ACDO, SCIM, CWMS, AD.  
-Galactia volubilis (L.) Britton; I. ACDO, SALP.  
-Kummerowia striata (Thunb.) Schindl.; S. AD.  
-Lathyrus hirsutus L.; S. AD.  
-Lespedeza bicolor Turcz.; S. ACDO, SCIM, AD.  
-L. cuneata (Dum. Cours.) G. Don; I. AD.  
-L. intermedia (S. Watson) Britton; I. ACDO, SALP, AD.  
-L. procumbens Michx; S. AD.  
-L. repens (L.) W. Bartram; S. AD.  
-Medicago lupulina L.; O. CWMS, AD.  
-M. orbicularis (L.) Bartal.; O. CWMS, AD.  
-Melilotus albus (L.) Lam.; O. ACDO, SALP, CSGB, CWMS, AD.  
-Vicia sativa L. ssp. sativa; I. CWMS, AD.  
-Wisteria floribunda (Willd.) DC.; VR. AD.  

FAGACEAE  
-Castanea dentata (Marsh.) Borkh.; I. ACDO.  
-Fagus grandifolia Ehrh.; I.  
-Quercus alba L.; C. ACDO, SCIM, SALP, SCIS.  
-Q. coccinea Münchh.; C. ACDO, SCIM, SALP.  
-Q. x ferronii Trel. (alba x stellata); S. ACDO, SALP, CSGB.  
-Q. marilandica Münchh.; O. ACDO, SALP, CSGB.  
-Q. montana Willd.; C. ACDO, SCIM, SALP, CSGB, CACR.  
-Q. phillos L.; S. SCIS.  
-Q. stellata Wangenh.; O. ACDO, SALP, CSGB.  

GELSEMIACEAE  
Gelsemium sempervirens (L.) W.T. Aiton; F. ACDO, SCIM, SALP, CSGB, SCIS.  

GENTIANACEAE  
-Bartonia virginica (L.) Britton, Stearns & Poggenb.; R. AFAS.  
-Frasera caroliniensis Walter; I. SCIM, CWMS, AD.  
-Sabatia angularis (L.) Pursh; O. CWMS, AD.  

GERANIACEAE  
-Geranium carolinianum L.; O. CWMS, SCIS.  
-G. dissectum L.; I. AD.  
-G. maculatum L.; I. CWMS, AD.  
-G. pusillum L.; I. AD.  

HAMAMELIDACEAE  
Hamamelis virginiana L.; F. ACDO, SCIM, SALP, SCIS.  

HYDRANGEACEAE  
-Hydrangea arborescens (L.) Ehrh.; F. ACDO, SCIM, SALP, AD.  
-Panicle hydrangea (Hydrangea paniculata) ; I. ACDO, CSIM, SAMC, CWMS.  

HYPERICACEAE  
-Hypericum crux-andreae (L.) Crantz; I. AD.  
-H. gentianoides (L.) Britton, Sterns & Poggenb.; F. ACDO, SALP, CSGB, CACR, AD.  
-H. gymnanthum (L.) Britton, Sterns & Poggenb.; O. CWMS, AD.  
-H. hypericoides (L.) Britton, Sterns & Poggenb.; S. CWMS, AD.  
-Hypericum punctatum Lam.; F. SCIM, SCIS, CWMS, AD.  

ITEACEAE  
Itea virginica L.; O. SCIM, CR, SCIS, SAMC.  

JUGLANDACEAE  
Carya ovata (Mill.) K. Koch; O. SCIM, SCIS.  

Vicia caroliniana Walter; I. CWMS, AD.  
-V. sativa L. ssp. sativa; I. CWMS, AD.  
-V. sativa L. ssp. sativa; I. CWMS, AD.  
-Wisteria floribunda (Willd.) DC.; VR. AD.  

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C. pallida (Ashe) Engl. & Graebn.; F. ACDO, SCIM, SALP, CSGB, CACR.
- C. tomentosa (Lam. ex Poir.) Nutt.; O. ACDO, SCIM, SALP.

Juglans nigra L.; VR, CSGB.

LAMIACEAE
- Collinsonia canadensis L.; O. SCIM, SCIS.
- C. tuberosa Michx.; O. SCIM, SCIS.
- C. verticillata Baldw.; O. SCIM, SCIS.

*Glechoma hederacea L.; R. AD.
- *Lamium purpureum L.; I. AD.
- Lycopus virginicus L.; O. SCIM, SCIS, CWMS, AD.
- Monarda fistulosa L.; I. CWMS, AD.
- *Mosla dianthera (Buch.-Ham. ex Roxb.) Maxim.; I. AD.
- Prunella vulgaris L. O. AD.
- Pycnanthemum loomisii Nutt.; O. ACDO, SCIM, SALP, CWMS, AD.
- P. tenuifolium Schrad.; I. CSGB, CWMS, AD.
- Salvia lyrata L.; O. CWMS, AD.
- S. urticifolia L.; CWMS.
- Satureja vulgaris (L.) Fritsch; I. AD.

*Scutellaria elliptica Muhl. var. hirsuta (Short & Peter) Fernald; O. ACDO, SCIM, SALP, CWMS, AD.
- *Scutellaria incana Biehler var. incana; O. ACDO, SCIM.
- *Scutellaria incana Biehler var. punctata (Chapm.) C. Mohr; O. ACDO, SCIM.
- S. integrifolia L.; S. SCIM.
- S. ovata Hill; R. SCIM.
- S. pseudoserrata Epling; I. ACDO, SCIM, SALP.
- *Trichostema setaceum Houtt.; VR. AD.

LAURACEAE
- Lindera benzoin (L.) Blume; VR. SCIS.

MALVACEAE
- Tilia americana L. var. americana; R. SAMC.

MELASTOMATACEAE
- Rhoea mariana L. var. mariana; S. CR, SCIS, SAMC, AD.
Diodia teres Walter; O. ACDO, SCIM, CWMS, AD.
Diodia virginiana L.; O. SCIM, CWMS, AD.
Galium aparine L.; S. CWMS, AD.
G. circaeans Michx.; I. ACDO, SCIM.
G. latifolium Michx.; S. ACDO, SCIM.
G. orizabense Hemsl. ssp. laevicaule (Weath. & S.F. Blake) Dempster; O. ACDO, SCIM.
G. pilosum Aiton; I. ACDO, AD.
G. triflorum Michx.; S. SCIM, AD.
Houstonia caerulea L.; I. ACDO, SCIM, SCIS, AD.
H. purpurea L. var. purpurea; C. ACDO, SCIM, CWMS, AD.
H. pusilla Schoepf; I. ACDO, AD.
Mitchella repens L.; F. ACDO, SALP.
*Sherardia arvensis L.; I. AD.

SAVILECACEAE

Populus grandidentata Michx., VR. AD.
Salix nigra Marsh.; S. CR, SCIS, SAMC, AD.

SANTALACEAE

Pyrularia pubera Michx.; F. ACDO, SCIM, SALP.

SAPINDACEAE

Acer negundo L.; R. SCIM.
A. rubrum L.; C. ACDO, SCIM, SALP, CSGB, SCIS, SAMC, AFAS.
A. saccharum Marsh. var. saccharum; R. ACDO.
Aesculus flava Aiton; VR. SCIM.
*Koelreuteria paniculata Laxm.; VR. AD.

SAXIFRAGACEAE

Astilbe biternata (Vent.) Britton; S. SCIM.
Heuchera americana L.; F. ACDO, SCIM, SALP, CSGB, CACR, SAMC.
H. villosa Michx. var. villosa; R. CACR, SAMC.
Tiarella cordifolia L.; O. SCIM.

SCROPHULARIACEAE

*Verbascum blattaria L. R. AD.
*V. thapsus L.; I. CWMS, AD.

SOLANACEAE

Physalis virginiana Mill.; S. ACDO, CWMS, AD.
Solanum carolinense L.; I. ACDO, CACR, SCIS, AMSC, CWMS, AD.

STYRACACEAE

Halesia tetraptera Ellis; I. SCIS, SAMC.

THEACEAE

Stewartia ovata (Cav.) Weath.; S. SCIM.

ULMACEAE

Ulmus alata Michx.; I. ACDO, SCIM.
U. rubra Muhl.; R. SCIM.

URTICACEAE

Boehmeria cylindrica (L.) Sw.; O. CR, SCIS, SAMC, CWMS, AD.
Laportea canadensis (L.) Weddell; S. CR, SCIS, SAMC.
VITA

Mr. Prater has been a student of the Southern Appalachian flora most of his life. As a resident of Chattanooga, TN his first exposure to the plants of this region came on hiking trips with his father, who would identify the species as they passed. His passion for native plants was further developed beginning at the age of 13 when he began volunteering as a native plant propagator for the local nature center. As an undergraduate student at East Tennessee State University, Mr. Prater began his formal education in Botany taking classes such as plant taxonomy and the flora of the Southern Appalachians. Mr. Prater’s experiences completing this flora include the identification of plant species in the field using regional floras (e.g., Tennessee Flora (in prep.), Weakley 2012, and Radford, Ahles, & Bell 1968), the use of herbarium specimens for comparisons, and the use of handheld GPS units for mapping plant occurrences and communities. In addition to his flora, Mr. Prater also has plant survey experience including a Scutellaria montana survey for the Tennessee Dept. of Environment and Conservation and a survey of Platanthera integrilabia on Starr Mountain in the Cherokee National Forest. While completing the research for this flora Mr. Prater has worked as a botanical consultant for Copperhead Environmental Consulting conducting botanical surveys of the Cherokee National Forests and the Savannah River Nuclear Site.