THE VASCULAR FLORA OF GRASSY MOUNTAIN, MURRAY COUNTY, GEORGIA

by

JENNIFER ALLISON MOORE

(Under the direction of David Giannasi)

ABSTRACT

Grassy Mountain is a 1,125m summit in northern Georgia, located at the southwestern terminus of the Blue Ridge Province of the Appalachian Mountains. The vascular flora of Grassy Mountain was surveyed and collected during the growing seasons of 2000 and 2001 over an area of approximately 5,270 hectares. Voucher specimens documented the presence of 554 taxa, representing 548 species and 6 varieties, 327 genera and 116 families. Exotic species comprised 11% of the flora documented in this study. No endangered or threatened plant species were encountered, however 20 taxa were found that are listed as sensitive, locally rare, or of special concern by the U.S. Forest Service or Georgia Natural Heritage Program. Grassy Mountain harbors an intact example of a southern Appalachian cove forest containing a boulderfield, which is botanically and ecologically significant for its species richness, pristine quality, and location at the southwestern extent of these habitats.

INDEX WORDS: Floristics, Grassy Mountain, Cohutta Mountains, Southern Blue Ridge province, Appalachian Mountains, Old growth forest, Murray County, Cove forest

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INTRODUCTION

Grassy Mountain is a 1,125m (3,692 ft) summit in Murray County, Georgia, located in the Cohutta Wildlife Management Area of the Chattahoochee National Forest. Rising steeply above the Great Valley, Grassy Mountain is situated at the southwestern edge of the Blue Ridge Province and Appalachian Mountains, in a relatively unstudied corner of a region renowned for its high biodiversity (Whittaker 1956, Currie & Piquin 1987, Delcourt et al. 1993, Pittillo 1998, Ricketts et al. 1999) and number of species at risk for endangerment (Flather et al. 1998) among temperate ecoregions. The steep topography near the summit of Grassy Mountain creates wetter microclimates on the north-facing slopes and has spared some forest patches from the intensive logging that had swept most of the southeastern U.S. by the 1930's. Consequently, Grassy Mountain today harbors one of the southernmost examples of southern Appalachian cove forests and one of the finest, least disturbed examples in Georgia. Although botanists have long been drawn to the Grassy Mountain area for its spectacular spring wildflower displays, there is a paucity of voucher specimens to document the flora in much of Georgia including Grassy Mountain. Furthermore, the vegetation of an area is dynamic over time (Kent & Coker 1992, Weakley 2000). The purpose of this floristic inventory (2000-2001) is to add to our knowledge of southeastern plant diversity and distribution by documenting the vascular plant species richness of Grassy Mountain.

STUDY AREA

Location

The Grassy Mountain study area is within Murray County and is part of the Cohutta Wildlife Management Area of the Cohutta Ranger District of the Chattahoochee National Forest. The study area was delineated to include the natural geographic boundaries of the mountain with consideration of physical accessibility and obtainability of plant collecting permits. Thus, only National Forest land, which encompasses most of the mountain, was surveyed. The study area is approximately 5,270 ha (13,017 acres), and lies between 34°49' and 34°54' N latitude and 84°44' W and 84°39' W longitude (Fig. 1). The northern portion of the study area is mostly bounded by roads that are drivable during much of the year. The northern boundary is formed by Mill Creek, and the northeastern boundary, by a ridge that separates Grassy Mountain and the Mill Creek watershed from the Cohutta Wilderness and the headwaters of the Conasauga River. The western and southwestern boundaries are near the Crandall-Ellijay road which runs along the base of the mountain and the Forest Service property boundary. The road is lined with private properties that were not included in the present survey. The southern boundary lies north of Holly Creek and is bordered by private land. Two unpaved, two-wheel-drive roads and one four-wheel-drive road penetrate the study area. One of these roads leads to several popular camping areas and Lake Conasauga, the highest body of water in Georgia, a 10 ha (25-acre) impoundment that sits in a relatively flat basin on the east side of the mountain. Several gated logging roads and certain trails are designated for off-road vehicle use. Aside from these roads and a few hiking trails, most of the study area is relatively inaccessible and constitutes one of the largest roadless areas in the Georgia mountains (USDA 1990).

Geomorphology

Grassy Mountain is the second highest summit in the Cohutta Mountains, a minor mountain range forming the southern tip of the Unaka Mountain chain (Fenneman 1938). The name "Cohutta" is derived from the Cherokee "Ga hu ta' yi" or "Ga hun ti", which means "poles that support the shed roof". This is said to refer to the appearance of the Cohutta Mountains, rising abruptly above the valley and usually shrouded in clouds, holding up the "roof" of the sky (MCHS 1987). The Unaka Mountains, which also include the Ocoee, Unicoi and Great Smoky Mountains, are the northwestern of the two main chains comprising the southern Blue Ridge Province of the Appalachian Highlands (Fenneman 1938). The Unaka Mountains parallel the Blue Ridge Mountains, that lie to the southeast. The Cohutta Mountains are clearly separated from the Blue Ridge Mountains to the east by the Murphy Syncline (Wharton 1978) and bounded in the north by the Jacks River Valley (LaForge & McCallie 1925). The Great Smoky Fault (aka Cartersville fault) runs along the western base of Grassy Mountain and the rest of the Cohutta massif, separating the precambrian, metamorphic Blue Ridge Province from the paleozoic, mostly sedimentary Valley and Ridge Province (Salisbury 1961, Palmes 1998). The Greenbriar Fault lies to the north of Grassy Mountain (Salisbury 1961). Grassy Mountain is situated at the western edge of both the Cohutta Mountains and the Blue Ridge Province and rises steeply and suddenly above the Great Valley (Appalachian Valley), gaining nearly 870m (3,000 ft.) in just under 6 km, and making it possibly the highest rise from base to crest in Georgia (Wooster 1999).

The Cohutta Mountains exhibit the highly wrinkled and convoluted topography and dendritic drainage patterns characteristic of the highly eroded southern Blue Ridge Province (Wharton 1978). The rather rounded or "subdued" (Fenneman 1938) summit of Grassy Mountain is formed by the convergence of a series of long, steep-sided ridges. The slopes range from 8 % to over 100%, and generally increase towards the summit, with slopes of 70% frequent on the southern, western and northern sides near the mountain's crest. On the east side of the mountain is a shallow basin and the high ridge joins a series of saddles and peaks, forming the spine of the

Cohutta Mountains. Slopes are more moderate on the lower flanks of the mountain, yet slopes as level as 8% are unusual. The mountain has an elevation gradient of 869 m (2,850 ft). The topography is mapped by the United States Geological Survey on two 7.5' quadrangles: Tennga, Georgia (1968) and Crandall, Georgia (1971).

Both sides of Grassy Mountain form tributaries to the Conasauga River system. The Conasauga watershed is notable for supporting one of the most species-rich assemblages of fish, freshwater mussels and other freshwater aquatic animals in the world, some of which are endemic to the watershed and 12 of which are threatened or endangered (Freeman et al. 1996, TNC 2002). The Conasauga River's animal diversity is now jeopardized by the degradation of water quality due to erosion, toxic chemicals and high-nutrient farm runoff (Freeman et al. 1996, Ivey 2000). The north side of Grassy Mountain forms the headwaters of Mill Creek. Lake Conasauga is formed from an impoundment near the head of the main branch of Mill Creek. After leaving Grassy Mountain, Mill Creek flows into the Conasauga River, which joins with the Coosawattee River to form the Oostanaula River, becoming the Coosa River after its confluence with the Etowah River. The Coosa River flows into the Alabama River in Alabama and empties into the Gulf of Mexico. The southern portion of Grassy Mountain drains into Holly Creek, known for its high mussel diversity (TNC 2002), which forms part of the southern boundary of the study area before joining the Conasauga River.

Geology

Geologically, the Cohutta Mountains are closely related to the better-studied Great Smoky Mountains of the Unaka chain and less closely related to the older and more highly metamorphosed Blue Ridge Mountains to the east (LaForge & McCallie 1925, Rast & Kohles 1986). The geology of the mountain is relatively homogeneous (GGS et al. 1976). Grassy Mountain is composed of crystalline, slightly metamorphosed clastic sedimentary rocks assigned to the Great Smoky Group of the Ocoee Supergroup (Salisbury 1961, Rast & Kohles 1986,

Palmes 1998). Sediments forming the Great Smoky Group were deposited during the late Precambrian, beginning ~700 mya (Hatcher 1987 in Pittillo 1998) over Precambrian-age (~1bya) Grenville basement (Rast & Kohles 1986) in a marine environment, the Iapetos Ocean, along the rifted margin of the Laurentian Continent (Rankin 1975). Subsequent to deposition, the sediments were subjected to several episodes of deformation during the orogenic events of the Ordovician (Taconic orogeny 480-440 mya), late Devonian (Acadian Orogeny 390-350 mya) and Permo-Carboniferous (Alleghenian Orogeny 325-240 MYA), creating major folds and cleavages and later completely recrystalizing the rocks (Rast & Kohles 1986). No fossils have been found within the Ocoee Supergroup (Rankin 1975, Rast & Kohles 1986), which is consistent with metamorphic activity but confounds interpretations of age and origin. However, the westernmost edge of the Blue Ridge Province, where Grassy Mountain stands, is generally the least metamorphosed part of the province. The lack of volcanic material found in the Ocoee Supergroup is unusual in the Blue Ridge province and may indicate distance from hypothetical spreading centers (Rankin 1975, Rast & Kohles 1986). The Appalachians reached their maximum height during the final Appalachian mountain-building cycle in the Permian Period, about 290 MYA, and Grassy Mountain has been eroding since then.

Detailed geologic surveys have been conducted in the northern part of the Grassy Mountain study area (Salisbury 1961) and in the immediately adjacent Cohutta Wilderness Area to the east (Gair & Slack 1982), which is part of the same masiff. Given the apparent geologic homogeneity of the mountain, it is likely that the Cohutta Wilderness geologic survey is broadly applicable to Grassy Mountain. Salisbury (1961) refers to the northern base of Grassy Mountain along Mill Creek as “the coarse-grained part of the Ocoee series”, of interbedded metagraywacke and phyllite, and notes that quartzite beds characteristically crop out as steep linear ridges while phyllite forms valleys and low spurs. The lithostratigraphic units found immediately to the east of the study site are designated as Panther Bluff Formation and Lower Boyd Gap Formation in Gair & Slack’s (1982) survey. The Panther Bluff Formation consists mostly of quartzose, feldspathic

and micaceous metasandstone and metagraywacke with minor interbedded metashale and metaconglomerate. The Lower Boyd Gap Formation consists of interbedded metasandstone, metagraywacke, meta-arkose, dark metasiltstone, and green, dark-gray or black (graphitic) metashale grading to phyllite and slate. Thick lenses of metasandstone hold up cliffs and waterfalls.

Soils

The soils of Grassy Mountain are predominantly well-drained due to the sloping to steeply sloping terrain, with very few small pockets of hydric soils in small depressions, along drainages and associated with beaver ponds. The ancient, metasedimentary rocks of the southern Blue Ridge Province typically weather slowly into acidic, highly weathered Hapludults with a low organic content (Buol 1973 in Perkins & F. T. Ritchie 1968, Pittillo 1998). Dystrochrepts are also common throughout the region on very steep slopes affected by erosion, old river terraces, and other places where weathering is not as extensive. In general, typic Hapludults of the Junalauska series have weathered from the low-grade metasedimentary rocks on the lower ridges and side-slopes of Grassy Mountain (Fig. 2). On the north, northwest and higher west aspect slopes are fine loamy Inceptisols of the Soco series. Soco stony loam is formed on the highest and steepest north to west aspect slopes, in the colluvium of narrow coves, and may underlie the mesophytic boulderfield hardwood forests. Soco gravelly loam is found down slope from the stony loam. Higher grade metamorphic or igneous rocks near the summit formed typic hapludults such as Edneytown and Cowee on the east and south sides of the summit, with some Porters series soils complexing with them. The flattest part of the study area, Rocky Flats ridge, is covered by Junaluska gravelly loam (National Cooperative Soil Survey 1998, Ahrens 2002, USFS 2002). There are many outcropping rocks of granite and biotite gneiss, especially on the steep western and southern aspect slopes near the summit, many of which are large but not large enough to escape from the forest canopy (Wooster 2002b).

Climate

The climate in the north Georgia mountains is classified as humid mesothermal, with abundant rainfall relative to the adjacent Piedmont and Valley and Ridge provinces due mostly to increased precipitation from summer thunderstorms (Carter 1970). The Georgia Mountains have more sunny days and a higher average temperature than similar terrain in North Carolina (LaForge & McCallie 1925). There is no weather monitoring station in the Cohutta Mountains and data from the closest stations (Blue Ridge, Ellijay and Chatsworth) are patchy. Based on a comparison of available temperature and data and elevations from surrounding stations in the region, temperatures recorded from Jasper (Jasper 1 NNW, station 94648), 40 km SSE of Grassy Mountain at an elevation of 447m (1,466 ft.), are probably reflective within 1ºC of temperatures for Grassy Mountain at a similar elevation near the base of the mountain. Climatic data based on the thirty-year average from 1971-2000 for Jasper are summarized in Table 1 (MRCC 2001). Accounting for adiabatic cooling in air of average humidity, temperatures at the summit of Grassy would be approximately 4.3 ºC (7.8 ºF) lower than those in Jasper, with the discrepancy being smaller in the summer due to increased humidity (Auld 1995-2002).

Summers in the north Georgia mountains are mild to warm and humid, with a mean maximum temperature of 30.2°C (86.3°F), surpassing 32°C (90°F) on average 22 days a year in Jasper (1961-1990). Winters are relatively short with ice and occasional snow (mean 2.2 in./yr.) and a mean minimum temperature of -0.44°C (31.2°F), falling below freezing an average of 64 days a year in Jasper. Based on a 30-year average (1961-1990), the mean January minimum was -1.7°C (29°F), the mean July maximum was 30.2 °C (86.3)°F, and the annual mean temperature was 14.6°C (58.3°F) in Jasper (MRCC 2001). Prevailing winds are from W and SW at Big Frog Mountain, which is 15 km NNE of Grassy Mountain in the same mountain chain (USFS in Murrell & Wofford 1987).

The frost-free growing season averaged 173 days and up to 202 days without a killing frost (-2.2 °C/ 28°F) in Blue Ridge (1957-1996, data for 23 years). Based on the same data, the median date of the last spring frost (0°C) was April 28, and the median first autumn frost occurred October 19 in Blue Ridge. Data from Blairsville (Blairsville Experiment Station, GA) demonstrate that winter temperatures averaging only 1°C lower can more than double the number of days below freezing, which indicates that the upper elevations of Grassy Mountain are likely to have considerably more freezing days than the lower elevations. The mean growing season temperature (Apr.-Oct.) in Jasper was 19.9°C (67.8 °F) (MRCC 2001).

The combination of Grassy Mountain's steep topography with its geographic position at the edge of the Great Valley creates orographic effects and a significant precipitation gradient. During my two-year study, the summit was commonly shrouded in rain clouds while surrounding areas were sunny. Although there is no weather station on the mountain, a model combining factors such as elevation, aspect, exposure and state precipitation data from 1961-1990 indicates that the summit of the mountain is expected to receive an average of 188 cm (74 in) of rainfall annually, while the lowest parts of the mountain near Chatsworth receive only 142 cm (56 in.) (USDA-NRCS 1998). Grassy Mountain is considerably wetter than Jasper (USDA-NRCS 1998), which averages 104 days a year with measurable precipitation. Precipitation is distributed fairly evenly throughout the year, with spring followed closely by winter as the wettest season and fall typically being the driest season. From about November to late-March, precipitation is predominantly from frontal storms bringing more prolonged rain. In late spring, there is a shift to more localized, convective storms of shorter duration and greater intensity, which generally increase in frequency into the summer and peak in July (Carter 1970).

During the years of 2000 and 2001, precipitation was below average and the mean temperatures were within 1°F of the 30-year average (1971-2000) (Table 1). Ellijay, the closest station for which recent precipitation data and 25 km southeast of Grassy Mountain at 396 m

(1300 ft.) elevation, receives less precipitation than Grassy Mountain (USDA-NRCS 1998). In Ellijay, rainfall in 2001 was 84.5% (133 cm.), and in 2000, 88.7% (139 cm.) of the 30-year normal of 156.8 cm. In 2001, the annual temperature averaged 59.5 °F, above the thirty-year average of 58.6°F, and in 2000 it was 58.3°F, below the 1971-2000 average in Jasper (MRCC 2001).

Present Vegetation

Despite its name, Grassy Mountain today is almost entirely forested. The name "Conasauga" given to the primary watershed originating from the Cohutta Mountains and to the lake created on Grassy Mountain comes from a Cherokee word for grass, "Kahnasagah." These names probably derive from a relatively brief period in the mountain's history before the land was acquired by the U. S. Forest Service. LaForge (1925) and Campbell (1920 in MCHS 1987) mention that peaks such as Grassy Mountain and its neighbor Bald Mountain were named for their "natural open spaces which are usually grassy or covered with low bushes and stunted trees and provided comprehensive views." However, the Appalachian grassy balds are most likely 19th century relicts created and maintained by some combination of grazing and burning (Gersmehl 1973). Native Americans practiced burning of mountaintops to provide forage for deer and elk they hunted (Gersmehl 1973, Davis 2000). Mountaintops unsuitable for agriculture were used by early settlers for grazing hogs, sheep and cattle (LaForge & McCallie 1925, Davis 2000). In recent history Grassy Mountain has not had an extensively "grassy" summit, although it appears to have been slightly more open when it was first acquired by the U.S. Forest Service. Aerial photographs from 1938 indicate that the summit had a grassy patch about 100m long paralleling the road to the tower and another grassy finger extending northwest along the west side about 100 yards (Surveys 1938 [April 23]), and the trees near the summit appear stunted as they are today. Currently, a fire lookout tower surrounded by a small mowed lawn sits on the summit, which on a

clear day provides a comprehensive view of the Cohutta mountains and the Great Valley of carpet-making fame.

Grassy Mountain is located at the southwestern edge of a large biogeographic area designated by Küchler (1964) as the Appalachian Oak Forest region. Although much variation in species assemblages is found within this region, various species of oaks (*Quercus*) are consistently present as major components of the forest across this large geographic area (Stephenson et al. 1993). The Appalachian Oak Forest as delimited by Küchler is generally synonymous with Braun's (1950) Oak-Chestnut Forest Region; Braun had retained "Chestnut" in the name in recognition of the chestnut's former importance and because at that time it was too soon to tell how the chestnut would be replaced. Oak species seem to have generally increased in importance in the absence of chestnut (Stephenson 1986). The lower-elevation flanks of Grassy Mountain grade into Küchler's Oak-Hickory-Pine forest region typical of the Piedmont province and extending into the Ridge and Valley region of northwest Georgia. Within the Appalachian Oak Forest region, the vegetation has been variously classified into more specific types reflecting local environmental variation. Present vegetation is further described in the "Vegetation Types" section of this paper.

Vegetation History

Grassy Mountain has an extremely long vegetation history, as it has never been glaciated or inundated by ocean or lava. The southern Blue Ridge Mountains are often cited as one of the world's oldest temperate floras (Cain 1943, Pittillo 1998). Grassy Mountain has been continuously available for colonization by land plants since before the evolution of Angiosperms. The mountain's extant plant species assemblage has been evolving via speciations, extinctions, and migrations at least since the last mountain-building event in the southern Appalachians, the Alleghenian orogeny, which commenced ~260 million years ago during the Early Permian Period of the late Paleozoic Era (Delcourt et al. 1993). At the close of the Alleghenian orogeny the

Laurentian continent (today's North American continent) was joined with Gondwana (today's African and European continents) into the supercontinent Pangaea and present-day eastern North America occupied a tropical position with the equator running north of today's southeastern U.S. (Mapes & Gastaldo 1986). The Permian flora of the southeastern U.S. (until about 245 MYA) was dominated by lycopsids, sphenopsids, tree ferns and primitive gymnosperms (Ash 1986). Many new taxa evolved during the early Mesozoic Era (Triassic and Jurassic Periods until the early Cretaceous Period about 120 MYA), and the flora was dominated by advanced gymnosperms such as seed-ferns, cycads, cycadeoids, and conifers (Ash 1986). The flora of the Southeast included members of the extant conifer families Pinaceae, Cupressaceae (*s.l.*), Taxaceae and Aurucariaceae by the late Jurassic, (Ash 1986, Delcourt et al. 1993). During the Triassic Period the supercontinent Pangaea began to break apart causing the opening and expansion of the Atlantic Ocean and creating a significant barrier to dispersal (Pittillo 1998). Angiosperms did not appear with certainty in the fossil record until the late Jurassic or early Cretaceous, about 150 - 130 MYA, after which they rapidly diversified and became increasingly dominant elements of the terrestrial flora (Doyle 1978, Sun et al. 1998). Evergreen, broad-leaved angiosperms comprised much of the Southeastern vegetation during the Cretaceous, when the climate was still humid and tropical.

The end of the Cretaceous Period and the Mesozoic Era was marked by a mass extinction event which eliminated many of the broad-leaved evergreen angiosperms, and allowed the radiation of deciduous angiosperms, such as species in the Betulaceae, Fagaceae, Juglandaceae, and Ulmaceae families during the early Cenozoic Era (Muller 1981, Wolfe 1986). By the Tertiary Period of the Cenozoic era (about 65 MYA), many extant southern Appalachian genera such as *Sassafras*, *Liriodendron*, *Liquidambar*, *Magnolia*, *Fagus, Castanea, Quercus, Prunus, Acer, Nyssa* and *Carya* were represented in the fossil record of the Southeast (Cain 1943, Muller 1981, Wolfe 1986). The southern Appalachians are renowned for the high proportion of Arctotertiary relicts in their flora – living representatives of the nearly circumboreal temperate mesophytic

forests that occupied northern latitudes during the Tertiary Period (Braun 1950, Pittillo 1998). Cain (1943) determined that in the Great Smoky Mountains National Park, 93% of the tree genera and 81% of all cove forest genera originated during or prior to the Tertiary Period. He further determined that all of the dominant trees and most "constant" (i.e. found in all or most sample plots) herbs of the Great Smoky Mountains National Park cove forests were of "Tertiary character", and therefore, these southern Appalachian cove forests are the best extant examples of a Tertiary forest.

By the Pleistocene Epoch at the end of the Tertiary (about 2.4 MYA), global climate fluctuations became much more extreme (Delcourt et al. 1993). In the northern hemisphere, the Pleistocene is characterized by over two dozen glacial/interglacial cycles. The cycles last approximately 100,000 years each, with gradual cooling for about 90,000 year followed by comparatively rapid warming for ~10,000 years and fluctuations of mean temperatures of about 18°C. Although the Laurentide Ice Sheet only reached a latitude of about 40° north, the associated climate changes triggered major episodes of plant migration, extinction, speciation and resulting shifts in vegetation in the southeastern United States (Delcourt et al. 1993). The Southeast is likely to have provided "glacial refugia" for boreal and temperate species in North America during full-glacial conditions, serving as a seed source for recolonization of more northern regions during warmer periods (Delcourt et al. 1993).

Most species found on Grassy Mountain today have probably not occupied the area continuously but their distributions have shifted as environmental conditions changed. Present large-scale vegetation patterns in much of the Southeast have existed only for the past several thousand years (Delcourt et al. 1993). Pleistocene changes in plant assemblages in the vicinity of Grassy Mountain can be inferred by comparing fossil pollen in radio-carbon dated sediment cores with modern pollen assemblages, as well as other fossil evidence (Delcourt & Delcourt 1980, Webb 1988). Palynological data for 25,000 years BP are available for northern Georgia. These data encompass the last glacial maximum, that occurred around 18,000 years ago (Delcourt &

Delcourt 1980, Webb 1988). Forty thousand years ago, Grassy Mountain was positioned near the interface of Mixed Conifer-Northern Hardwoods to the north and Oak-Hickory-Southern Pine to the south. A period of mild warming 25,000 years ago shifted the vegetation in northern Georgia to an oak-hickory forest (Watts 1970). During the peak of the Late Wisconsin Glaciation, Grassy Mountain was probably occupied by a primarily coniferous forest dominated by Jack-pine (*Pinus banksiana*) with spruce (*Picea*) and fir (*Abies*) subdominants (Watts 1970, Delcourt & Delcourt 1980). Today, similar Jack-pine forests are found at least 700 miles northward (Watts 1970). A broad expanse of mixed hardwood forest that included a large proportion of oaks (*Quercus* spp.), encompassed Grassy Mountain and north Georgia during a cool, moist climate regime 10,000 years ago. By about 5,000 years ago, the climate was similar to that of today with nearly year-round precipitation. Sea level had returned to its present position, and fire frequency increased. Vegetation patterns in the Southeast 5,000 years ago were similar to those just prior to extensive European settlement in the southern Appalachians around 200 years ago, with Grassy Mountain situated at the southern edge of the Oak-Chestnut Forest region.

Land use history

Humans have occupied the Southeast and impacted the landscape for at least 12,000 years (Delcourt et al. 1993). Therefore, further consideration of vegetation history is entwined with land use history. Prior to European contact, Native American populations in the Southeast were large enough to significantly alter the vegetation (DeVivo 1990). DeVivo (1990) postulates that pre-Columbian Indians may have been numerous enough to clear all land below 3,000 feet. Native American settlements were concentrated along major and intermediate-sized river corridors, so environmental impacts were more pronounced in the valleys (Delcourt et al. 1993). The most significant way that Native Americans affected upland vegetation such as that of Grassy Mountain was through their use of fire. They may have been responsible for increasing the distribution of plants that were useful to them such as fruit or nut-bearing trees. Selective

harvesting of lumber and edible or medicinal plants could have changed dominance structures in upland forests (DeVivo 1990).

Following the arrival of the first humans to the Southeast, the general trend was increasing population and increasing permanence of settlements (Delcourt et al. 1993). Bifaced, fluted spear tip points found throughout the southeast indicate relatively large human populations during the Paleo-Indian Cultural Period from about 12,000 – 10,500 YBP. During the Archaic Cultural Period (10,500-3000 YBP), human populations grew and became more widespread. Midden deposits indicate relatively large populations in villages of at least seasonal permanence. By the late Archaic period (5000-3000 BP), squash (*Cucurbita pepo*), gourds (*Lagenaria siceraria*), and dogs (*Canis domsticus*) were domesticated. Indians of the Woodland Cultural Period (3000 to about 1200 YBP) practiced horticulture and cleared patches of alluvial forests for use as garden plots along major river valleys of the Southeast, using fire and stone tools (Delcourt et al. 1993). Eastern Woodland Indians also set deliberate fires to burn accumulated litter and undergrowth, and to maintain canebreaks and grasslands (DeVivo 1990).

The culture broadly classified as Mississippian originated along the Mississippi River around 700 AD and spread to the southern Appalachians by around 900 AD (Davis 2000). Mississippian Culture was distinguished from earlier cultures in part by use of the bow and arrow and the adoption of maize (*Zea mays*), introduced from the southwestern U. S. as a major subsistence crop. The cultivation of maize, beans (*Phaseolus vulgaris*) and squash (*Cucurbita pepo*) allowed for significant population growth and expansion that was accompanied by extensive clearing of floodplain forests and river terraces for agriculture. Estimates of pre-contact population based on "depopulation ratios" are 150,000 to 250,000 for southern Appalachian Indians (DeVivo 1990). American chestnuts (*Castanea dentata*), acorns (*Quercus* spp.), and hickory nuts (*Carya* spp.) were important food sources harvested from the mountains. Mississippian culture at its apex in the southern Appalachians, around 1300 AD, had a complex religious and social organization (Davis 2000). The Mississippian Indians practiced slash-and-

burn agriculture and constructed log palisades surrounding their villages. Woodworking tools from the Mississippian Cultural Period indicate the increased sophistication in use of lumber (Delcourt et al. 1993). Throughout the Mississippian Period, populations became increasingly concentrated in areas with the most fertile soil, such as floodplains of large rivers (Delcourt et al. 1993).

The Mississippian Cultural Period ended with the first European explorations, which marked the beginning of the Historic Period. The first written accounts of the southern Appalachians come from the expedition of the Spanish conquistador Hernando de Soto, who journeyed through the southern Appalachians with an army of six hundred men during the spring and summer of 1540. The Gentleman of Elvas, one of the chroniclers of the expedition, describes the abundance of American chestnut trees in the Appalachian uplands with the widely-quoted phrase: "where there are mountains, there are chestnuts" (Davis 2000). By some accounts, De Soto's party camped on the Conasauga River near the present-day town of Eton, from where they would have seen Grassy Mountain looming to the east, on their way to the township of Coosa (MCHS 1987, Davis 2000). In describing the large Mississippian township of Coosa, the Gentleman of Elvas mentions expanses of open fields several miles in length, and many native persimmon and plum trees and muscadine grapes in the surrounding fields (Davis 2000). By some accounts the township of Coosa was located near the confluence of the Coosawattee River and Talking Rock Creek, the present-day site of Carter's Lake and only about 25 km from Grassy Mountain, where Missippian mounds have been found (MCHS 1987).The abundance of edible plants species such as trees bearing sweet or oily fruits (i.e., the black walnut *Juglans nigra* and the mockernut hickory *Carya cordiformis*) near human habitations and "semi-domesticated groves" of species such as mulberry (*Morus rubra*) indicates that the Mississippians practiced selective alteration of vegetation by gathering and planting seeds of desirable plants or inhibiting unwanted competition by burning or cutting (DeVivo 1990, Davis 2000).

Following contact with the De Soto expedition, Mississippian Indians experienced a drastic population decline of 80-96% during the 16th and 17th centuries due to the introduction of European diseases. This was associated with a reduction of burning across the north Georgia landscape and an increase in the proportion of forested land (DeVivo 1990). By the early 1600's, the Native Americans of north Georgia possessed European weapons, tools, cloth, trinkets, and horses from trading furs and skins with the Spanish (Davis 2000).

In historic times, the north Georgia mountains were occupied by the Cherokee, a cultural group of the Iroquoian family that moved down from the Northeast (Fairbanks 1974). It is unclear whether de Soto's expedition encountered people of Cherokee tribes (Davis 2000), Muskogee Indians of the Creek confederation (MCHS 1987), or both in the vicinity of Grassy Mountain. By most accounts the Cherokee did not colonize the southern Appalachians until after European contact (Swanton 1946). Native American tribes fought each other for territory and their distributions shifted, which was exacerbated by pressures from European settlers, resulting in increased tribal movements around the time of European contact. As European settlers pushed the Cherokee further south during the 18th century, battles resulted in the Cherokee displacing Creek Indians in parts of northern Georgia. Creek Indians remaining in the Coosawattee River Valley, approximately 30 km south of Grassy Mountain, gave Cherokee permission to occupy the valley. The name Coosawattee means "old creek place" (Swanton 1946). The Cherokee not only traded with Europeans but adopted many of the cultural ways of the European settlers. They built log cabin houses, developed their own alphabet, printed their own newspaper, set up schools for their children, implemented a constitution, and owned slaves.

In addition to extensive burning to clear fields for agriculture, the Cherokee used fire as a forest management tool and as a hunting technique, to drive game (DeVivo 1990, Martin & Boyce 1993). The burning of less valuable species (*Acer, Betula, Tsuga*) promoted the growth of more valuable species in the forest such as *Quercus* spp. (oaks), *Castanea dentata* (American chestnut), and *Vaccinium* spp. (blueberries). Burning also cleared the underbrush to make forests

easier to travel through and improve visibility, and in some areas created open grasslands that would have provided good forage for game animals (DeVivo 1990).

As in other areas, the Cherokee villages and farms of the Cohutta area were in river valleys, with the uplands used mainly as hunting grounds, for recreation, and probably for gathering herbs, lumber, and fuel (Thompson 1976, DeVivo 1990). According to forest service ranger W. W. Bergoffen in the 1930's (in Thompson 1976), at the top of Bald Mountain, the next summit east of Grassy and the highest in the Cohuttas, was a large rectangular field surrounded by oaks and chestnuts. A different group of Indians lived on either side of the mountain and they reportedly met at the top to challenge each other to ball games that were quite violent (Thompson 1976). One of the few references to the Cohutta Mountains is the following Cherokee hunting legend related by Thompson (1976). A great serpent called the Ustu'tli or Ustri'tli (in Gardner 1982) lived in the Cohutta Mountains. Ustu'tli meant "foot-snake", referring to the many suckered feet borne at each end of its body. It had no legs but chased people by moving like an inchworm. This monster "could catch anyone going uphill or down, but could not travel well along the sides of the ridges." A Cherokee hunter chased by the serpent set a ring of fire around the base of the mountain, burning the serpent to death.

The discovery of gold near Dahlonega, Georgia in the 1820's triggered a rush of Euro-American colonists into the north Georgia mountains. The Cherokee were pressured into selling their land, which the states of Georgia, Tennessee and North Carolina, and northeast Alabama obtained by the Treaty of New Echota in 1835. The treaty also stipulated that the Cherokee relocate west of the Mississippi River. Those that did not leave willingly were removed by military force in 1838-1839, although some hid in the mountains and later received permission to live on a Cherokee reservation in western North Carolina (Swanton 1946, Fairbanks 1974). The miners did not reside long in the north Georgia mountains once the gold was extracted and were followed by farmers.

The farmers continued the Native American custom of burning the land, and by some accounts, they did so over-zealously to the detriment of the land (Thompson 1976, USDA 1990). One north Georgia mountaineer is quoted, "Fire do a heap of good. It kill the boll weevil, snakes, ticks, an' bean beetle [and] greens up the grass" (Shea 1940 in Davis 2000). The large amount of downed woody debris created by the intensive logging may have also increased the intensity of fires in hardwood forests (Komarek 1974). These settlers also farmed on steep slopes and did not plant cover crops in the winter, which further deteriorated the land (USDA 1990). Raising livestock was a significant activity in the southern Appalachians at this time. Mountaintops unsuitable for agriculture were cleared by early settlers for grazing hogs, sheep and cattle (LaForge & McCallie 1925, Davis 2000), which were commonly allowed to range freely until they were rounded up once a year (Wigginton 1973, Davis 2000). Hogs are particularly destructive because they up-root and devour native vegetation and are estimated to have consumed large enough quantities of chestnuts and acorns to inhibit regeneration of these tree species (Davis 2000). By the 1880's the land was no longer agriculturally productive, and many farmers sold to large timber companies (USDA 1990).

The Copper Basin area of Polk Co., Tennessee and Fannin County, Georgia, just to the northeast of the Cohutta Mountains, was the last place in Tennessee and Georgia to be taken over by white settlers. These settlers entered north Georgia from further north in the early 1830's and like their predecessors, settled mostly in the valleys (Thompson 1976, Gardner 1982). A few families settled in the Cohutta Mountains, and in the 1890s there were several cabins on top of Grassy Mountain (MCHS 1987). The settlers of the area mostly used the Cohutta Mountains for fishing and hunting, including the "popular amusement" of bear hunting (Thompson 1976).

Logging history

Until the early twentieth century, the Cohutta Mountains were probably one of the least accessible and least human-impacted mountain areas in Georgia or even the southeastern United

States (Thompson 1976). In 1912, the Cohuttas contained the last untouched timber in Murray, Fannin, and Gilmer Counties. The Conasauga Lumber Company of Conasauga, Tennessee, just north of the Georgia border, owned most of the Cohutta Mountains at that time. In 1912, the Conasauga Lumber Company "set their sights on the virgin timber of the Cohutta Mountains" (Thompson 1976). Mr. Weyman Dooly of the Conasauga Lumber Company recorded the statement: "the railroad heads for the Alaculsy Valley and 80,000 acres of virgin timber." A narrow-gauge railroad was built from the sawmill in Conasauga south up the Conasauga and Jacks Rivers to their headwaters in the Cohutta Mountains, a distance of 65 to 70 miles (Gardner 1982). Between 1915 and 1935, 70% of the present day Cohutta Wilderness, which encompasses the Jacks River and upper Conasauga watersheds, was logged. The lumber mill in Conasauga was believed to have been the largest east of the Mississippi at that time. In 1929, 75,000 board feet of lumber per day was carried to the sawmill by steam engines called shays, that were specialized for operating on steep grades. After the trees were felled by two men using a cross-cut saw, the logs were pulled out ("skidded") by large horses. Special skidding roads were made for sliding logs on by leveling the ground and laying small logs, held in place with stakes, along the ground in a ladder-like formation. Several special techniques were developed for logging the steep slopes, including use of a "j-grab" for "j-holeing" and "ball hooting". When the terrain was too steep or the log moved too quickly for the horses, the handler signaled the trained horses to veer off to the side into a "j-hole", and special hooks called "j-grabs" would unhook the horse from the log when it made the turn, the logs continuing down the hill. "Ball hooting" was skinning the bark from the bottom of a log and pushing it down the hill "long-ways." Early logging practices in the Cohuttas usually involved "high-grading", where only the larger or more desirable timber was cut, and smaller trees were left standing. However, clear-cutting was also practiced to some extent.

Apparently, parts of the top of Grassy Mountain were logged during the first few years of timbering and the logs were sent from the present-day site of Lake Conasauga 7 or 8 miles down

the mountain on a wooden flume line to a sawmill in Crandell (Gardner 1982). A significant quantity of timber must have been extracted to make it worth the trouble of building a wooden flume of that length. Old railroad tracks that may be remnants from railroad logging days still exist in the lower-elevation hardwood forest along Rockflat Branch Creek near Mill Creek (pers. obs. 2001). The Cohutta Mountains were probably their most populated during the heyday of logging in the 1920s and 1930s. "More people lived back in the mountains in them days, a lot of people. There was a cabin up every holler" (Boatwright and Tankersley interviewed in Gardner 1982). The land was undesirable after mining, farming and logging, and much was sold to the government (USDA 1990).

Chattahoochee National Forest

The U. S. Forest Service began purchasing the logged-over land in the Cohuttas from Conasauga Lumber Company and several other smaller landowners beginning in 1930 (Gardner 1982, Wooster 2002a). The Chattahoochee National Forest was officially created in 1936 (USDA 1990). Lake Conasauga and most of the public-access roads to Grassy Mountain were built between 1933 and 1935 by the Civilian Conservation Corps (Gardner 1982). Aerial photographs of Grassy Mountain from 1938, shortly after the U.S. Forest Service acquired the land, show cleared areas mostly on the east side of the summit ridge, in the headwaters of Mill Creek and towards Little Bald and Big Bald Mountains. However, only a few places on Grassy Mountain, such as on Little Bald Mountain near the junction of FR 68 and FR 78, look as cleared as the area of today's Cohutta Wilderness (Surveys 1938 [April 23]). Either the remainder of the top of the mountain was extensively logged prior to 1938, or possibly it was logged earlier than the headwaters of the Conasauga river and had more time to regenerate before the 1938 photo. The canopy was generally much sparser in 1938 than it is today (USDA 1983 [May 6]) but it is difficult to discern whether this is due to selective logging or the effect of Chestnut blight. Mill Creek Road, which today is the primary access to the top of Grassy Mountain, was not yet

completed by 1940. At that time the Tibbs Cycle Trail (FR 78), which is currently closed to automobiles, was the principle route from Chatsworth, Eton and Crandall up to the mountaintop (Georgia 1940).

The Forest Service manages the area under their policy of "multiple use," which includes timber harvesting, wildlife management, and maintenance of public recreation areas. Most areas of Grassy Mountain have been logged by the Forest Service, accompanied by the creation of numerous logging roads (USDA 1990). Logging techniques, or "prescriptions," vary among different stands and "management types," and include "even-aged" management such as clear-cutting with a variety of rotation intervals and re-stocking regimes, and "uneven-aged" management such as group selection or thinning of individual trees (USFS 1992). In the 1970's-1980's, about 4 million board feet of timber per year were cut. Harvesting was primarily of *Pinus virginiana* and by clear-cutting due to its low timber value. Many logged areas, particularly on the lower slopes, were replanted with Loblolly pine (*Pinus taeda*), a widely planted timber tree whose native range was further east in the lower piedmont and coastal plain. No logging has taken place on Grassy Mountain since 1994 due to a law suit by environmental groups concerned that the Forest Service was not gathering enough data on threatened, endangered and sensitive species when planning timber sales. The law suit is also currently preventing the Forest Service from practicing prescribed burning (Wooster 2002a).

Five "Wildlife Openings" have been created throughout the Grassy Mountain study area. These are cleared areas of one to 10 acres maintained by mowing or burning and planted with introduced herbaceous species designed to attract and provide forage for deer. "Fescue" (*Festuca* spp. *s.l.*, including *Vulpia* and *Shedonorus*) was planted in the 1970's but was too noxious and the practice was abandoned. Today "rye" (*Elymus* s.l.) and "clover" (*Securigera varia* and *Trifolium* spp.) are planted in lower-elevations, and higher-elevation openings are generally no longer planted. *Elaeagnus umbellata*, *Dactylis glomerata*, and *Triticum aestivum* have also been planted (Wooster 2002a).

Today the Cohutta Wildlife Management Area offers camping, hiking trails, mountain-bike and off-road-vehicle (ORV) trails, equestrian trails, fishing and swimming in Mill Creek and Lake Conasauga, as well as canoeing in Lake Conasauga. Deer, turkey and bear hunting and ORV-riding are particularly popular activities on Grassy. There is a small campground located at Hicky Gap on Mill Creek and several camping areas near Lake Conasauga in a basin near the top of the mountain (USDA 1990).

Effects of logging on vegetation

Logging has changed the composition of the dominant tree species in the Georgia Blue Ridge province. On ridges and drier slopes, *Pinus virginiana* increases following heavy logging while *Pinus echinata* does not recruit well (Wooster 2002a). *Pinus strobus* (white pine) has also become much more prevalent. Prior to the logging of the 1930's, *Pinus strobus* occurred predominantly in drainages but today it is becoming one of the major understory trees on the south, west, and east slopes (Wharton 1978, Wooster 2002a)) and is frequently encountered in the north slopes. A general decline in *Quercus* (oak) regeneration and its replacement by more shade-tolerant species following clear-cutting is a recognized problem among hardwood silviculturists (VanLear 1990, Abrams 1992). *Robinia pseudo-acacia*, a shade-intolerant early successional species, increases following heavy disturbance (Schafale & Weakley 1990). *Acer rubrum* also increases following logging, tending to replace *Pinus echinata* on the south slopes, and has become especially common on north slopes. Selective harvesting of commercially important species has changed the canopy composition. In cove forests where *Quercus* spp. and *Liriodendron tulipifera* were selectively harvested, *Betula lenta* and *Aesculus flava* are successional species that increase following heavy logging (Wharton 1978). Even-aged stands of *Liriodendron tulipifera,* an aggressive colonizer of fertile and more mesic sites, are indicative of past disturbance events such as logging, fire, large windthrows, or previous sites of pastures and orchards (Wharton 1978, Lorimer 1980, Runkle 1985).

Herb digging

The selective gathering of certain herb species has probably affected the vegetation of Grassy Mountain by decreasing the abundance of particularly desirable species. Certainly Native Americans collected many forest herbs for medicinal purposes. Following the Civil War, the southern Appalachians became one of the most important areas for herb gathering in the United States (Cuzzo 1999). In the early twentieth century, herb gathering was a primary source of cash for many rural families (Cuzzo 1999). Sassafras (*Sassafras albidum*), ginseng (*Panax quinquefolius*) and goldenseal (*Hydrastis canadensis*) are among the most well-known medicinal herbs gathered from the southern Appalachians. Effects of over-harvesting on ginseng populations were noticed as early as 1798 by the French botanist Andre Michaux (Harriman 1977). Goldenseal is listed as endangered in Georgia due to over-harvesting. Additionally, slow-growing perennial herbs such as *Cypripedium* orchids and *Trillium* spp. have been over-collected from forest lands for use as ornamentals and for sale in the nursery business, which has caused their populations to decline.

Fire and fire suppression

Fire has played a very important role in shaping forest composition and structure in the Southern Appalachians, especially over the past 10,000 years (Lorimer 1980, DeVivo 1990, VanLear 1990, Abrams 1992, Martin & Boyce 1993). Prior to human occupation of the Southeast 12,000 years ago, periodic lightening-caused fires were important in shaping the vegetation of the Southeast, but are thought to have been generally small in scale, with occasional larger fires occurring predominantly on drier sites (Komarek 1974, Major 1996). The more humid mesic forests do not support intense, large-scale natural fires (Schafale & Weakley 1990, Major 1996). Historically, most large-scale fires in the southern Appalachians are thought to have been of anthropogenic origin. Following the arrival of Native Americans to the Southeast 12,000 to 10,000 years ago, the incidence of fire increased dramatically to frequencies greater than

expected due only to lightening, suggesting that Indians as far back as the Archaic Period deliberately burned the forests (DeVivo 1990, Abrams 1992, Delcourt et al. 1993, Martin & Boyce 1993).

The species composition of southern Appalachian forests has been profoundly affected by fire. There is much evidence that the oak-chestnut and pine forests of the southern Appalachians have been established and historically maintained by fire (VanLear 1990, Abrams 1992, Major 1996). A major vegetational change to *Quercus* dominated forests in the eastern U.S. by about 10,000 YBP coincides with the increase in human occupation and fire frequency (Webb 1988, DeVivo 1990, Abrams 1992). The mid-Holocene (8,000 to 5,000 YBP) vegetational change to oak-chestnut dominated forests in the southern Appalachian highlands also coincides with further increases in fire frequency and human habitation (Delcourt & Delcourt 1980). *Castanea dentata* (American chestnut) became a prominent component of the forest by about 5,000 YBP and then dramatically increased in abundance about 2,000 years ago to comprise up to 40% of the forest canopy by the time of European contact (Delcourt & Delcourt 1980, Bonnicksen 2000). Native Americans likely used fire deliberately to manage for *Castanea dentata* because of its importance as a food source (Davis 2000).

Vegetational responses to fire vary considerably depending on site characteristics and timing and intensity of fires (DeSelm & Clebsch 1990, Major 1996). In general, periodic fire seems to promote the growth of early- to mid-successional tree species intermediate in shade tolerance, such as oaks, chestnuts and diploxylon ("yellow") pines (Abrams 1992, Major 1996). Fire is thought to promote development of oak forests, particularly in more mesic sites where oaks tend to get out-competed by shade tolerant species such as *Acer rubrum* and *Liriodendron tulipifera* in the absence of periodic disturbance. Fire disturbance on more xeric sites and ridge tops with thinner soils, or greater fire frequency or intensity, encourages the growth of "pioneer species" pines such as *Pinus virginiana* and *Pinus echinata* (DeVivo 1990, Delcourt et al. 1993, Major 1996).

Forest structure was also affected by periodic fire. Periodic fires can maintain an open understory and allow established trees to grow larger by eliminating competition from seedlings, saplings and shrubs (Martin & Boyce 1993). Numerous early European explorers of Eastern North America (e.g. the Gentleman of Elvas with DeSoto's expedition, Alvar Nunez Cabeza de Vaca, and Giovanni da Verrazzano) were impressed by the open understory and park-like nature of the forests (Bonnicksen 2000, Davis 2000). Similarly, early Euro-American loggers commented on the forest structure prior to logging. Two men who helped log the Cohuttas in the 1920's described the virgin forests as "looking different from today," having trees up to 100 feet high and no undergrowth. They claimed "you could see for miles" through the forest. They also mention that the tree species composition was different then, with more hardwood and no pine on the high ridges (Boatwright and Tankersley interviewed by Gardner 1982). Fire, along with lack of clear-cutting, is thought to have been a primary force in maintaining the open understory of these forests (Martin & Boyce 1993, Davis 2000).

The Forest Service has practiced active suppression of wildfires for most of its stewardship. By the time the Forest Service obtained the land, forest fires were seen as a "menace" to the already depleted supply of timber, and state legislation was enacted to "control and regulate forest fires and ... cooperate in stamping them out" (LaForge & McCallie 1925). The Organic Act of 1891 states that "the secretary of the interior shall make provisions for the protection against destruction by fire" (Organic Act 1897, accessed from USDA-USFS 2002). The following quote from F. W. Harley, a Forest Service district ranger, exemplifies the agency's early attitude towards fire: "The Forest Service, in the administration of the forests have no more important duty to perform than keeping the fire down to a minimum" (letter from district ranger, Klamath National Forest, Orleans, CA, 1918, accessed from USDA-USFS 2002). By the mid-1940's, the Forest Service developed the Smoky the Bear icon to promote fire suppression awareness to the public. Fire was not seen as a management tool for the Chattahoochee National Forest until the 1970's and '80's, when it was used to "increase browse" (Wooster 2002a). On

Grassy Mountain, the Forest Service started burning in 1992 to create early-successional "grass-forb" habitat for the Golden-winged warbler (*Vermivora chrysoptera*). Controlled burning was conducted near Little Bald Mountain in March of 1995 and 1999 in an effort to control the invasion of *Pinus strobus* (white pine) and promote the growth of herbaceous plants such as *Cypripedium* spp. (lady's slipper orchids) and *Trillium* spp. Other controlled burn projects are planned to reduce the cover of *Kalmia* and *Rhododendon* and enhance songbird habitat for the Golden-winged warbler and other songbirds (Wooster 2002a).

Decades of fire suppression have had a profound effect on the composition of southern Appalachian forests. The absence of fire promotes the growth of shade-tolerant species and late-successional species that can regenerate in the absence of disturbance. On mesic and dry-mesic sites, the absence of fire has led to a decline in the abundance of most oak species and an increase in shade-tolerant species in the overstory and understory (VanLear 1990, Major 1996). Shade-tolerant species such as *Acer rubrum, Carya glabra, C. tomentosa, Liriodedron tulipifera, Nyssa sylvatica, Pinus strobus* and *Quercus coccinea* have been found in drier sites and more commonly in the overstory in the absence of fires (VanLear 1990). In the understory, ericoid shrubs such as *Kalmia, Vaccinium* and *Rhododendron* increase in abundance with fire suppression, forming dense shrub layers and inhibit germination of many other tree and herb seedlings (Major 1996). On drier sites such as south-facing slopes, the absence of fires leads to a decrease in the relative abundance of certain pines such as *Pinus echinata* and *Pinus virginiana* and the expansion of *Acer rubrum* into more xeric sites.

Wind disturbance

In mesic cove forests of north-facing slopes, fire disturbance is infrequent due to increased humidity and soil moisture (Lorimer 1980, Schafale & Weakley 1990, Hardt 1993). The primary natural disturbance vector in cove forests is wind causing blow-down of individual canopy trees (Runkle 1985). Large-scale natural disturbance is rare in these habitats but tree-fall

gaps from small-scale wind disturbance can have a large cumulative effect on forest dynamics. Gaps from blowdown can allow shade-intolerant seedlings to grow and are sufficient to account for uneven age-structures of climax cove forests of the Eastern U.S. (Lorimer 1980, Runkle 1985) (Busing 1998). Variation in gap size promotes tree diversity in later-successional forests by allowing colonization by species with varying shade tolerances (Runkle 1985).

Chestnut blight

A major vegetation change affecting the canopy composition of Grassy Mountain in recent history was caused by the chestnut blight that also coincided with the logging of the primary forests and its acquisition by the U.S. Forest Service. Grassy Mountain is located at the southern tip of a huge region encompassing all of the Blue Ridge Province that had been known as the Oak-Chestnut Forest Region (Braun 1950). The American chestnut (*Castanea dentata*) comprised over 40% of the trees of moderate-elevation (1300-4500 ft.) slope forests and rounded ridges and often occurred in almost pure stands in parts of this region (Braun 1950, Keever 1953, Wharton 1978). The oak-chestnut forest typically had an abundance of ericaceous shrubs such as the flame azalea (*Rhododendron calendulaceum*) and mountain laurel (*Kalmia latifolia*) in the understory, although this forest type was so widespread that the associations varied geographically and with environmental conditions such as exposure and soil moisture (Braun 1950). In more mesic forests of lower elevations, the American chestnut trees grew very large; reports of chestnut trees up to 13 ft. in diameter and with crowns elevated over 120 ft. above the forest floor, along with their rot-resistant wood, earned them the name “Redwood of the East” (Bonnicksen 2000, Davis 2000).

A virulent blight affecting the American chestnut was introduced into the United States from a nursery stock Japanese chestnut some time before 1904 (Keever 1953). The chestnut blight, caused by the Ascomycete *Endothia parasitica*, spread rapidly from its introduction point in New York City, reaching north Georgia by 1926. By 1940, almost all American chestnut trees

were diseased or dead standing snags (Davis 2000). The lumber companies' reaction to the rapidly spreading infection killing this valuable timber species was to increase the rate of harvesting it (Keever 1953). Chestnut trees were useful for timber and as a tanning agent for leather even when dead, so salvage logging of dead trees continued for about twenty years after the blight hit until few standing snags remained (Davis 2000). The ecological effects of the chestnut demise were particularly pronounced on wildlife because these trees produced much of their food (Davis 2000).

Southern Appalachian forests are probably still in a transitional state following the widespread death of the American chestnut trees, and several generations will be required to determine what types of "climax" equilibria will be reached (Braun 1950). Overall, no single species has assumed the dominant or co-dominant role formerly filled by the chestnut. Successional patterns depend on how prominent the chestnut had formerly been in the canopy as well as what other species are present (Stephenson et al. 1993). Keever (1953) studied unlogged, blight affected areas in western North Carolina about twenty years after the blight hit to determine which tree species would become dominant in the absence of the American chestnut. She found several oak species (*Quercus rubra, Q. prinus, Q. alba*) and hickory (*Carya ovalis* and/or *C. glabra*) prevalent and reproducing in all four size classes measured on both north- and south-aspect slopes, and predicted that if the observed trend were to continue, the forest would be best considered an "oak-hickory" forest. In north Georgia, there are reports of hickory (*Carya ovalis*) or an assemblage of pioneer and typically understory trees (*Robinia pseudo-acacia, Sassafras albidum, Hamamelis virginiana*) plus *Prunus serotina, Carya ovalis, C. glabra,* and *Quercus alba* filling in the gaps of former chestnut ridge forests (DuMond 1970, Wharton 1978). In former oak-chestnut-hickory forests (*sensu* Wharton) of north Georgia slopes, one of several oak species (*Quercus velutina, Q. rubra, Q. alba*) become dominant depending on soil, moisture, and aspect. In more mesic coves formerly supporting chestnut trees, tulip poplar (*Liriodendron tulipifera*) often becomes dominant (Wharton 1978).

Old growth

Grassy Mountain today harbors several tracts of forest that have apparently never been logged (Wooster 2000). These are forests of inaccessible places, or of steep slopes or near the top of the mountain where the trees did not grow particularly large and therefore were not commercially desirable. Aerial photographs from 1938 show intact forests in some of these areas (Surveys 1938 [April 23]), that have not been subsequently logged by the Forest Service. Forest Service tree-core data indicate that fourteen stands of approximately 8-20 ha (20-50 acres) contain trees over 150 years old, and one of these stands contains 200-year-old trees (USFS 1990) (Fig. 3).

METHODS

Survey of the Flora

The vascular flora of Grassy Mountain was surveyed at frequent (approximately biweekly) intervals throughout the growing seasons of 2000 and 2001. Surveys were conducted by foot during 33 trips to the study area between February 26, 2000 and April 21, 2002. Due to the large, relatively inaccessible and rugged nature of the study area, certain sites were selected as representative of distinct habitats based on aerial photographs, topographic maps (USDA 1983 [May 6]), stand maps (USFS 1990), and reconnaissance of accessible roads and trails. These representative sites were sampled regularly to collect as much of the flora of the mountain as possible within available time, although new sites were also visited (Fig. 4). Additionally, four long transects were walked through the study area in 2001 in order to search for additional species, new microhabitats or vegetational differences not apparent from remote sensing. Special emphasis was placed on surveying areas identified as harboring old growth and/or southern Appalachian cove forests. Voucher specimens are deposited at the University of Georgia Herbarium (GA).

Species were identified using *Flora of the Carolinas and Virginia* (Weakley 2000) when possible, supplemented by other standard references such as *Manual of the Vascular Flora of the Carolinas* (Radford et al. 1968) and *Flora of North America north of Mexico* (FNA 1993), monographs, revisions, and specific references for certain families [e.g. Hitchcock (1971) for Poaceae, Cronquist (1980) for Asteraceae, Case (1997) for *Trillium*, Gleason (1952) for Lamiaceae, Godfrey (1979) for certain Cyperaceous wetland species, Naczi (2001) for upland *Carex* of the section *Careyanae*), Nelson (Nelson 1981) for *Stachys*], and by comparison with voucher specimens in the GA collection. Identifications were made by the author (with the exception of certain *Quercus* specimens identified by Dr. Wilbur Duncan) unless otherwise noted.

The taxonomy of many Southeastern plants currently has little consensus among specialists with respect to certain taxon designations (Weakley 2000). Nomenclature for this study follows Weakley (2000), supplemented by the PLANTS database (USDA-NRCS 2001). However, infraspecific taxa have only been distinguished when their characteristics seemed unambiguous to the author. Authorities are abbreviated after Brummit & Powell (1992). The state, federal, and U. S. Forest Service status rarity ranks of uncommon plant species were determined by consulting lists provided by the Georgia Natural Heritage Program (1999) and the Chattahoochee-Oconee National Forest (USFS 1996, USFS 1999, USFS 2000). Information on rarity in adjacent states (Tennessee, North Carolina) was obtained from Weakley (2000). Taxa were designated as native or introduced to the United States (USDA-NRCS 2001) or to the local region (Weakley 2000), although in some cases this status is unclear due to the long history of anthropogenic disturbance in the Southeast. Species distribution information was obtained from Jones & Coile (1988), Radford et al. (1968), the PLANTS database (USDA 2001), and by searching the GA herbarium collection.

Species Richness

Species richness estimates depend on the scale of observation and are difficult to compare across different locations and studies (Peet et al. 1998). Three plots were used to record species richness across a range of several scales and to investigate an appropriate scale for sampling plant species richness in the Grassy Mountain cove forest. Three quadrat locations were chosen using stratified random sampling (Kent & Coker 1992) within each of three sub-types of the southern Appalachian cove forest: a rocky nose, a broadly concave slope supporting a typic montane cove forest (*sensu* NatureServe), and a steep boulderfield forest with rich cove species. Quadrats were laid out in a nested design modified from Whittaker (Schmida 1984) and Peet et al.'s (1998) "intensive module." Each 3m × 4m quadrat was subdivided into four subplots to yield a range of 1, 2, 3, 4, 6, 9, and 12 m^2 areas by combination (Fig. 5). This technique was employed

in order to determine a useful quadrat size for measuring species richness in the cove forest and to facilitate comparisons with other studies. Within each subplot, the number of species was recorded on May 15, 2001, when early spring ephemerals were still visible and many later-season plants had begun to emerge. A species-area curve was generated for each 12 m^2 quadrat using the smaller nested quadrats (Cain 1938). Cover classes were also recorded for each species following the NCVS 10-point scale (Peet et al. 1998) for the purpose of estimating diversity using the Shannon diversity index (*H'*) (Kent & Coker 1992):

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

where s = number of species, and p_i = the abundance or proportion of individuals of the i^{th} species expressed as a proportion of total cover. Shannon diversity index values were calculated using the 12 m^2 quadrats. Evenness (Equitability *J*) was calculated from *H'* by the formula:

$$J = \frac{H'}{\ln s}$$

Comparison with Other Floras

The floristic composition of Grassy Mountain was compared with that of four other locations where floristic inventories were conducted using similar methodology in the Southern Blue Ridge Province and the adjacent Piedmont Province. The Grassy Mountain flora was also compared to two smaller floristic inventories: two boulderfields and a cove forest in the Georgia Blue Ridge mountains, and an old-growth mixed mesophytic forest in southwestern Ohio which is just west of the Appalachian mountains. Similarity in species composition between Grassy Mountain and each other site was calculated using Sørensen's coefficient of similarity (Kent & Coker 1992). Sørensen's coefficient of similarity is an index for assessing the degree of compositional similarity of qualitative data based on the presence or absence of species in each

sample and was developed specifically for comparing plant species assemblages (Sorensen 1948, Kent & Coker 1992). Sørensen's coefficient of similarity (S_s) is calculated as:

$$S_s = \frac{2c}{a+b} \times 100$$

where a = number of species in sample a, b = number of species in sample b,

and c = number of species shared by both samples.

RESULTS

Survey of the Flora

A total of 554 taxa of vascular plants including 332 genera (548 species and 6 varieties) in 118 families were identified from 1,008 voucher specimens. Table 2 is a summary of taxonomic distributions of species. Twenty-three taxa (4.4%) are considered endemic to the southern Appalachian Mountains or southern Blue Ridge Province (Little 1970, Wood 1970, Murrell & Wofford 1987). Sixty-one exotic species were encountered, comprising 11 % of the flora (Table 2). The four most speciose families were Asteraceae (83 species, 15%), Poaceae (46 species, 8%), Cyperaceae (28 species) and Fabaceae *s.l.* (27 species), that together comprise one-third of the species collected. The genera containing the most species were *Carex* (22 spp.), *Viola* (14 spp.) , and *Aster* (12 spp.). Two hundred and thirty-two taxa are not listed by Jones & Coile (1988) as being previously collected and may therefore represent county collection records for Murray County. The flora is presented in an annotated checklist (Appendix A).

Rare Taxa

No endangered or threatened species were located on Grassy Mountain during this survey. However, 20 species identified in this study are listed by the US Forest Service (1996, 1999, 2000) and/or the Georgia Natural Heritage Program (1999) as having some level of rarity or concern. *Trillium simile*, *Coreopsis latifolia*, and *Carex communis* var. *amplisquama* are listed as sensitive by the Forest Service; *Xerophyllum asphodeloides* is listed as rare in Georgia and locally rare by the Forest Service; *Acer spicatum, Cypripedium parviflorum* vars. *parviflorum* and *pubescens (Cypripedium calceolus), Dryopteris goldiana, Prosartes maculata*, and *Triosteum aurantiacum* are considered locally rare by the Forest Service and of special concern or watch-listed by the Georgia Natural Heritage Program. *Carex appalachica, Carex torta,*

Cypripedium acaule, Lonicera dioica, and *Penstemon pallidus* are of special concern in Georgia, and *Boykinia aconitifolia, Carex allegheniensis* (*Carex debilis* var. *pubera*), *Collinsonia tuberosa, Solidago sphacelata, Thermopsis fraxinifolia*, and *Thermopsis mollis* are on the Georgia watch list (Georgia Natural Heritage Program 1999). An additional seven taxa are rare or of special concern in Tennessee or North Carolina: *Euonomys obovatus, Euphorbia mercurialina, Hieracium scabrum, Krigia biflora, Panax quinquefolius, Smilax hugeri* and *Stachys eplingii* (Weakley 2000). The general habitats where these plants are found are given in Table 3. Complete state, global and U.S. Forest Service rarity ranks are given in Appendix A.

Invasive Plants

Sixty-one introduced species were found on Grassy Mountain in this study, comprising 11% of the described flora. Most of these plants were found in areas of regularly maintained disturbance, such as roadsides, wildlife clearings and recent clear-cuts. Species considered invasive (Murphy 2000) but predominantly confined to areas of maintained disturbance on Grassy Mountain include *Ligustrum sinense, Lonicera japonica, Elaeagnus umbellata, Albizia julibrissin, Schedonorus arundinaceus* (*=Festuca arundinacea*)*, Sorghum jalapense, Lespedeza bicolor, L. cuneata,* and *Paulownia tomentosa.* In addition*,* a large patch of *Pueraria lobata* near the beginning of Mill Creek Rd. does not quite enter the study area.

Several exotic species are notable for their ability to invade forested habitats of Grassy Mountain. *Microstegium vimineum (Eulalia viminea)*, a shade-tolerant C_4 grass native to tropical southeast Asia (Barden 1987), commonly occurs in small drainages and seepy areas within the forest and was observed spreading from roadsides into adjacent forest understories. *Microstegium vimineum* can form thick, extensive mats of vegetation and is of particular concern due to its ability to proliferate in shady understory habitats. Weakley (2000) calls this species, which is spreading rapidly in the Southeast, “one of the most destructive introduced plants in the area.” *Ailanthus altissima*, an east Asian tree that Weakley (2000) refers to as an “aggressive and

noxious weed able to out-compete native vegetation in undisturbed forests," exhibits recruitment in dense patches along lower Mill Creek Road, adjacent to Mill Creek. *Persicaria longiseta* (=*Polygonum cespitosum*) was also found forming thick patches in wet forested areas such as small seeps.

Comparison of Grassy Mountain with Other Floras

The total number of species found in this study is similar to those found in other floristic surveys in the region (Table 4). The flora is most similar to that of Big Frog Mountain (S_s = 64%), which is located approximately 18 km from Grassy Mountain in the same mountain chain (Murrell & Wofford 1987). However, Grassy Mountain has a much higher percentage of introduced taxa (11%) than Big Frog (4%). All other comparisons yielded a similarity index below 60%, with a pattern of decreasing similarity with increasing distance. Eighty-one percent (144 species) of the taxa found in Chafin's (1988) boulderfield and cove forest study were also found on Grassy Mountain. Fifty-five percent (121 species) of the taxa found in the Ohio old-growth forest (Swanson & Vankat 2000) were also found on Grassy Mountain, compared with 43% and 49% of Piedmont studies (Howell 1991, Cruse 1997) that were 400 km or more closer to Grassy Mountain. A Sørensen's test was not appropriate for comparing these smaller studies with Grassy Mountain due to the unequal sample size.

Species Richness and Diversity

Species richness measured in the cove forest ranged from seven to 16 species in one square meter and 16 to 33 species in 12 m^2 (Fig. 6; Table 5). The boulderfield forest subtype supported the highest species richness and diversity, whereas the rocky nose was less speciose and less diverse. The species-area curves leveled slightly but did not plateau at 12m^2 for all plots. The Shannon diversity index measured in the boulderfield forest quadrat was H' = 2.56, and was H' = 1.17 and H' = 1.40 in the rocky nose and typic cove forest plots, respectively (Table 5).

VEGETATION TYPES

The major vegetational habitats found on Grassy Mountain do not easily conform with available classifications, probably in part due to Grassy Mountain's location at the edge of a major biogeographic region with some ecotonal properties, and in part due to disturbance and fire suppression. At the southwestern edge of the Appalachian Oak forest region, where Grassy Mountain is located, the predominantly deciduous Appalachian oak forest merges with the Oak-Hickory-Pine forest characteristic of the Piedmont and the Ridge and Valley provinces (Braun 1950, Kuchler 1964, Stephenson et al. 1993). Furthermore, some species that may be characteristic of a particular vegetation type in the center of its distribution (i.e. *Acer saccharum* for mid-elevation, late-successional cove forests (Clebsch & Busing 1989, NatureServe 2001)) may drop out towards the edges. The canopy of the majority of the mountain is composed of some combination of evergreen and deciduous trees. In general, pines increase in proportion on drier, south-aspect slopes and ridges or where they have been planted, and broadleaf deciduous trees predominate in more mesic sites. Tree species such as *Liriodendron tulipifera, Acer rubrum,* and *Pinus strobus*, considered to be early and mid-successional (Clebsch & Busing 1989), are ubiquitous throughout the study area and occur in a variety of habitats. Some less acidic sites have lush herbaceous layers, while more acidic sites contain predominantly ericaceous species and herbs are generally sparser. *Tsuga canadensis* is found in drainages particularly on the north side of the mountain.

Much work has been done on the vegetation of North Carolina (Radford et al. 1968, Schafale & Weakley 1990) and of the Great Smoky Mountains (Cain 1943, Whittaker 1956, Golden 1981, Callaway et al. 1987). This work can be applied to northern Georgia but with some qualifications. Wharton (1978) has presented the most complete vegetation classification for Georgia to date, although a National Vegetation Classification Standard (NVCS) is currently

being developed based on work done by the Nature Conservancy (Grossman et al. 1998, NatureServe 2001). The following vegetation descriptions follow the NatureServe Explorer (2001) classification system where applicable, under which Forest Alliances are further categorized into Associations, and are supplemented by the works of Schafale & Weakley (1990), Wharton (1978) and Braun (1950). Major vegetation types found on Grassy Mountain are summarized in Table 3 and their distribution on Grassy Mountain is shown in Fig. 4; however, these vegetation types intergrade throughout the study area.

Southern Appalachian Cove Forest

Southern Appalachian Cove Forests are the predominantly deciduous, mixed mesophytic forests (Braun 1950) locally referred to as "cove forests," Cove Hardwood Forests (Whittaker 1956), Rich Cove Forests (Schafale & Weakley 1990), or Broadleaf Deciduous Cove Forests (Wharton 1978). NatureServe (2001) classifies this forest as part of the *Liriodendron tulipifera – Tilia americana* var. *heterophylla – Aesculus flava – Acer saccharum* Forest Alliance. In the canopy, nutrient-demanding mesophytic tree species such as *Tilia americana* var. *heterophylla* and *Aesculus flava* are prevalent, mixed with more widely-tolerant species such as *Liriodendron tulipifera, Betula lenta, Tsuga canadensis, Prunus serotina,* and *Acer rubrum*. These forests are renowned for their lush, diverse herbaceous strata (Cain 1943, Whittaker 1956, Wharton 1978, Schafale & Weakley 1990) with seasonally changing suites of species flowering and dominating vegetatively (Cain 1943, NatureServe 2001). Cain referred to the "vernal" and "aestival" aspects of cove forest flora. Conspicuous vernal herbs include *Trillium grandiflorum, Sanguinaria canadensis, Stellaria pubera, Caulophyllum thalictroides,* and *Podophyllum peltatum*. During the summer, prevalent herbs are *Cimicifuga racemosa, Impatiens pallida, Laportea canadensis, Circaea lutetiana* ssp. *canadensis, Sanicula odorata*, *Osmorhiza claytonii* and *Collinsonia canadensis*. The fall flowering herbs include many asteraceous plants such as *Ageratina altissima, Solidago curtisii* and species of *Aster*. The shrub strata are often sparse and typical

species include *Calycanthus floridus, Lindera benzoin*, and *Hydrangea arborescens*. The soil is generally deep, dark, and humus-rich, supporting species that need nutrient-rich or circumneutral soils (Wharton 1978, Schafale & Weakley 1990). On Grassy Mountain, this forest type occurs on upper (above 2500 ft.), north-aspect concave slopes with Soco stony or gravelly loam soils (USFS 2002), and typically does not include *Acer saccharum*.

Cove forests are a complex and variable vegetation type, and have been variously classified into subtypes. Most of the Grassy Mountain Southern Appalachian Cove Forest conforms best to the Typic Montane Type (*Liriodendron tulipifera – Aesculus flava – Fraxinus americana, Tilia americana* var. *heterophylla – Cimicifuga racemosa – Laportea canadensis* Forest) (NatureServe 2001), although some areas contain elements of the Rich Montane Type, distinguished by the presence of calciphilous species. Schafale and Weakley (1990) distinguish an Acidic Cove Forest from the Typic Cove Forest. Acidic Cove Forests have many of the same canopy trees as Typic Cove Forests but the understory is dominated by ericaceous shrubs such as *Rhododendron maximum*, and the herb layer is sparser and contains acid-loving species such as *Galax urceolatum, Polystichum acrostichoides, Mitchella repens, Thelypteris noveboracensis,* and *Viola* spp.

Southern Appalachian Hardwood Boulderfield Forest (Typic Type: *Betula allegheniensis/Acer spicatum/Hydrangea arborscens-Ribes cynosbati/ Dryopteris marginalis* Forest Association.)

Boulderfield forests are generally associated with higher elevation cove forests in steep, northeast to northwest-facing draws with cool, humid microclimates at elevations between 2000-4000 ft. (Wharton 1978, Chafin 1988, Schafale & Weakley 1990, NatureServe 2001). Boulderfield forests are characterized by a ground cover of jumbled, moss-covered boulders thought to be periglacial relicts, fractured by freezing and thawing during Pleistocene glaciation cycles (Chafin 1988). The shrub and woody vine strata are typically better developed than in

typical cove forests and include conspicuous amounts of *Aristolochia macrophylla* and *Parthenocissus quinquefolius* in addition to the species mentioned in the Association type above (NatureServe 2001). *Ribes cynosbati, Euonymus obovatus,* and *Rubus odoratus* are diagnostic of boulderfield habiats in north Georgia (Wharton 1978). Windthrow is common and generates gaps in the canopy that increase species diversity (Chafin 1988).

The steepest, north-facing draw near the top of Grassy Mountain contains a forest that approaches a boulderfield forest. Although the boulder-strewn area is not extensive, the Grassy Mountain boulderfield forest contains the species listed by Wharton (1978) as diagnostic, as well as other typical boulderfield components such as an increase in shrub and vine cover. In the Grassy Mountain boulderfield forest, the typical boulderfield canopy dominants, *Tilia americana* var. *heterophylla, Aesculus flava* and *Betula* sp., are more prevalent but the canopy is not strikingly distinct from the surrounding cove forest, probably due to the narrowness of the boulder strewn area. At the Grassy Mountain study site, certain plant species such as *Dicentra cucullaria* and *Acer spicatum* were found only among the mossy fractured boulders. This area is best considered a boulderfield forest within a cove forest.

An interesting forest is found on the saddle between Grassy Mountain and Little Bald Mountain. It is not clear how to classify this forest, which has an even-aged canopy composed almost exclusively of second-growth *Liriodendron tulipifera.* Even-aged stands of *Liriodendron tulipifera* are considered indicative of past intermediate-sized to large-scale disturbance events (Runkle 1985); in this case probably clear-cutting, although old Native America settlements are implicated in some cases (DeVivo 1990). However, in this stand there is a conspicuously rich herbaceous layer including perennial herbs such as *Cypripedium parviflorum*, *Galearis spectabilis*, *Spigelia marilandica*, *Triosteum aurantiacum*, and several species of *Trillium* that on Grassy Mountain are uncommon or typically found only in the richer sites. The Forest Service conducted prescribed burns in this stand in 1995 and 1999 “to eliminate white pine” and encourage showy herbaceous perennials such as *Cypripedium acaule, Cypripedium parviflorum*

and *Trillium* spp. (Wooster 2000). The controlled burns were apparently quite successful in promoting the growth of showy herbaceous perennials and repressing white pine regeneration (pers. obs. 2000-2002).

Appalachian Oak Forests

The submesic deciduous forests of Grassy Mountain's slopes and ridges have various combinations of oaks (i.e *Quercus alba*, *Q. coccinea, Q. velutina*), hickories (i.e. *Carya cordiformis, C. glabra, C. ovata, C. tomentosa*), other deciduous and evergreen trees, and formerly *Castanea dentata* in their canopy. There are many described subtypes associated with oak-dominated forests. NatureServe (2001) defines at least seven forest alliances of oak or oak and pine occurring in the north Georgia mountains, many of which are distinguished by which oak species are predominant. On Grassy Mountain the red and black oak species are difficult to distinguish: even when leaves, buds, and acorns are available, specimens were described as "intermediate" or "unusual forms" (Duncan 2001), and hybridization among Grassy Mountain oak species is possible. Therefore, differentiating among oak forests on Grassy Mountain is beyond the scope of this project. Wharton (1978) refers to the Oak-Chestnut-Hickory Forest as the dominant slope forest of much of Appalachians. Schafale and Weakley (1990) distinguish between Dry Oak-Hickory Forests of more exposed sites and drier soils, and Dry-Mesic Oak - Hickory Forests of less exposed sites and moister soils. *Quercus alba* (White Oak) is an important component of both forest types; dry-mesic forests contain more *Liriodendron tulipifera, Fagus grandifolia,* and *Quercus rubra,* and *Tsuga canadensis* whereas *Quercus montana* and *Pinus* spp.(pines) are often an important component in the drier forest, especially following large disturbances. Disturbance also increases the incidence of "weedy" hardwoods such as *Acer rubrum* and *Liquidambar styraciflua* (NatureServe 2001). Typical understory trees are *Oxydendrum arboreum, Nyssa sylvatica,* and *Cornus florida.* Ericaceous shrubs such as *Rhododendron* spp., *Vaccinium* spp. and *Kalmia latifolia* are common, and herbs are often sparse.

Wharton (1978) also distinguishes an Oak Ridge Forest on high, dry ridgetops along the crest of the Georgia Blue Ridge and the Cohutta Mountains, where trees are often stunted, gnarled, and grow slowly. These forests are dominated by *Quercus alba* or *Q. rubra***,** often with ericaceous shrubs and *Carex* spp. in the understory. According to Wharton (1978), these stunted trees were never desirable timber and they were spared from being logged. Today many of Georgia's oak ridge forests contain original, "virgin timber." A small example of an oak ridge forest is found at the summit of Grassy Mountain.

Mixed Evergreen-Deciduous Forests

The majority of Grassy Mountain's present-day forests have a combination of deciduous and evergreen tree species. Oak – Pine/Heath Forests have a canopy of yellow pines (i.e. *Pinus echinata* or *P. virginiana*) and/or xerophytic oaks (i.e. *Quercus coccinea, Q. marilandica, Q. montana*) and a dense shrub layer. Chestnut-Oak Forests are similar to Oak – Pine/Heath Forests but are dominated by *Quercus montana* (*Q. prinus*) and are usually on more exposed sites such as ridges and steep, south-facing slopes. Both of these vegetation types are found on thin, rocky, acidic Dystrocrepts and are thought to depend on periodic, severe fire disturbance (Schafale & Weakley 1990). Shrubs are predominantly eriaceous, such as *Rhododendron* spp., *Kalmia latifolia,* and *Vaccinium stamineum*. *Smilax* species are also frequent. Common herbs include *Galax urceolata, Epigaea repens,* and *Pteridium aquilinum*.

Forests similar to the Southern Appalachian Cove Forest but containing more *Tsuga canadensis* and fewer rich-site trees and herbs can be classified as *Tsuga canadensis – Liriodendron tulipifera* Forest Alliance (NatureServe 2001) or Broadleaf Deciduous – Hemlock Forest (Wharton 1978). *Magnolia fraseri, Ilex opaca,* and *Pinus strobus* are found in the understory, and *Rhododendron maximum* can be an abundant shrub. Typical herbs include acid-tolerant species such as *Polystichum acrostichoides, Goodyera pubescens, Mitchella repens,*

Thelypteris novaboracensis, Galax ureolata, Hexastylis shuttleworthii, and *Tiarella cordifolia* (Schafale & Weakley 1990).

A Mesic Mixed Hardwood Forest (Piedmont Subtype) (Schafale & Weakley 1990), more typical of mesic Piedmont sites, is found at lower elevations on the north side of Grassy Mountain on somewhat acidic soils. It is a predominantly hardwood forest with a pine component that is perhaps related to past logging disturbance. Canopy trees in this forest association include *Liriodendron tulipifera, Quercus* spp., *Carya* spp., *Acer rubrum, Fagus canadensis, Tsuga canadensis, Cornus florida, Ilex opaca,* and *Vaccinium* spp. There is one site at low elevation on Mill Creek that is strikingly richer in herbaceous species than most sites with similar elevation, aspect and canopy composition. The site has likely been subject to considerable past disturbance evidenced by its proximity to the valley and the presence of old roads, a gauging station, and species that were most likely planted (i.e., *Yucca filamentosa* and *Pinus taeda*). The soil was not mapped as distinctive. Possibly because of its position near the bottom of a valley the site may have less acidic soil due to some type of alluvial or colluvial deposition. *Collinsonia tuberosa*, found at this site, is an uncommon plant on the Georgia Natural Heritage Program watch-list that is usually found over calcareous or mafic substrates (Program 1999, Weakley 2000).

Predominantly Evergreen Forests

Pinus virginana-dominated forests are found on exposed sites such as narrow ridges, and steep slopes on the west and south sides of the mountain, over thin infertile soils. The *Pinus virginiana* Forest Alliance or Appalachian Low Elevation Mixed Pine Forest is characterized by *Pinus virginiana, P. echinata, P. strobus* and *Quercus montana* in the canopy, with *Vaccinium pallidum, V. stamineum* and *Kalmia latifolia* as the typical shrubs (NatureServe 2001). On Grassy Mountain, *Pinus virginiana* is often dominant following large disturbances such as logging or fire on drier sites, often replacing *Pinus echinata* that was formerly more common but does not regenerate as easily (Wooster 2002a). This forest grades into xeric oak forests in more protected

sites. In the absence of occasional fire, deciduous understory trees such as *Oxydenrum arboruem, Nyssa sylvatica, Acer rubrum*, and *Quercus* spp. proliferate (NatureServe 2001).

According to Wharton (1978), "pure pine forests [in Georgia] are almost always the result of human modification". White pine forest is often dominant following logging or other large disturbances in acidic, dry-mesic areas (Wharton 1978, Schafale & Weakley 1990) , and is often associated with *Quercus montana, Tsuga canadensis,* and *Rhododendron* spp. *Pinus taeda* was often planted following clear-cutting in a variety of sites on Grassy Mountain (Wooster 2002a).

Palustrine Forests

There are small, scattered pockets of alluvial soils along some flatter segments of Mill Creek and minor drainages which supports some Alluvial Forest species such as *Platanus occidentalis, Carpinus caroliniana, Alnus serrulata, Itea virginica,* and *Polygonum punctatum* (*Persicaria punctata*) (Schafale & Weakley 1990) . There is one small Swamp Forest- Bog (Schafale & Weakley 1990) or *Acer rubrum – Nyssa sylvatica* Saturated Forest Alliance (NatureServe 2001) containing *Sphagnum* sp., *Liquidambar styraciflua, Osmunda regalis, Carex intumescens,* and *Chasmanthium* spp.

Flooded Beaver Impoundment

The only natural non-forested habitat presently found on Grassy Mountain is a beaver-created marsh. The marsh vegetation is dominated by aquatic plants such as *Scirpus cyperinus, S. purshianus, Dichanthelium scoparium,* and *Carex frankii,* with *Oxypolis rigidior* and *Ludwigia palustris*.

Wildlife Openings

Wildlife openings are human-created and maintained areas where the forest has been cleared and planted with predominantly non-native grasses such as *Festuca* spp. (*sensu lato*, including *Shedonorus arundinaceus*) and herbs ("clovers" such as *Trifolium* spp. and *Securigera varia*). These clearings are maintained by occasional mowing to provide forage for wildlife. There are about five openings on Grassy Mountain, ranging from one to ten acres in size, mostly at lower elevations (Wooster 2002a).

Disturbed areas

Recent clear-cuts, roadsides, campgrounds and other disturbed areas are frequent habitats on Grassy Mountain. Species composition of these areas is variable and depends on adjacent habitats and degree of disturbance. The majority of exotic taxa on the mountain are found in these disturbed areas. Roadsides tend to be the most species-rich areas on Grassy Mountain. Canopy gaps created by roads provide habitat for both native and introduced species. Today, roads may play a role in creating habitat heterogeneity similar to that played by other types of disturbance, such as fire, in the past. Many native shade-intolerant species that are not found within the forest grow along roads, such as the locally uncommon native herbs *Thermopsis fraxinifolia, T. mollis*, and *Liatris* spp.

DISCUSSION

Species of interesting distributions

The vascular flora of Grassy Mountain is predominantly allied with that of the southern Blue Ridge. However, Grassy Mountain's position at the southwestern edge of the Blue Ridge Province gives the mountain some ecotonal properties. Many typical Appalachian species near or reach the southern limit of their range on Grassy Mountain while other plant species approach their northern or easternmost distributions. Distributional data were obtained from PLANTS database (USDA-NRCS 2001), Jones & Coile (Jones & Coile 1988), and Weakley (2000).

Twenty-four taxa (4.4%) collected in this study are considered southern Appalachian endemics (Wood 1970, Murrell & Wofford 1987) and are designated as such in Appendix A. Cain et al. (in Whittaker 1956) estimated that 3.1% of the flora of the Great Smoky Mountains flora is endemic to the Unaka range, and 8.5% endemic to the southern Appalachian mountains. Murrell & Wofford found 6.7% of the flora of Big Frog mountain endemic to the southern Blue Ridge province or Southern Appalachians (Murrell & Wofford 1987). A lower proportion of southern Appalachian endemics would be expected on Grassy Mountain as compared to sites more central to this region.

Most taxa considered Appalachian or southern Appalachian endemics (see Appendix A) are, therefore, at or near the southern limit of their distribution. Notable are some species that have been collected in Georgia only from a few of the northernmost counties, such as *Dryopteris goldiana, Stachys eplingii, Boykinia aconitifolia, Euonymus obovaus, Acer spicatum* and *A. pensylvanicum*. *Acer spicatum* is uncommon in the southeast but common in the northeastern United States. In North Carolina it is generally associated with high elevation forests such as northern hardwoods and Spruce-fir forests that do not occur in Georgia. It is often found in

boulderfield forests, that generally have cooler microclimates than other forests of similar elevation and are known for harboring disjunct populations of more typically northern species.

Many characteristically rich-site species are found on Grassy Mountain only in the cove forest habitat. Among the cove forest species, some have further limited distributions on the mountain. The presence of several species known to be calciphilous or generally associated with mafic rocks or circumneutral soils is interesting because all the Grassy Mountain soils are mapped as more acidic types, and there is no indication of calcareous or mafic rocks on available geologic maps. These species, not abundant on the mountain, include *Solidago flexicaulis, Dryopteris goldiana, Solidago flexicaulis, Deparia acrostichoides, Cystopteris protrusa*, *Triosteum aurantiacum,* and *Collinsonia tuberosa* (Weakley 2000, NatureServe 2001). These plants occur in areas that have been burned or have significant organic buildup, that can act to decrease soil acidity (pers. obs. 2001). *Aquilegia canadensis* is often associated with mafic or calcareous substrates (Weakley 2000); however, on Grassy Mountain it was found only on outcropping rocks of granite, biotite-gneiss, or boulderfield rocks. Also of limited distribution on Grassy Mountain are species that are generally limited in Georgia to boulderfield forests, including *Euonymus obovatus, Acer spicatum, Ribes cynosbati,* and *Rubus odorata* (Wharton 1978). *Dicentra cucullaria, Asarum canadense,* and *Hydrophyllum canadense* are also only found among the boulders.

Only a few species are typically not found in the mountains and are not considered plants of the Blue Ridge Province. *Prunus umbellata* is typically a Piedmont species. *Berchemia scandens* and *Cocculus carolinus* are more typical of the Piedmont and Coastal Plain. *Euphorbia mercurialina* is a Cumberland Plateau species which ranges into the Valley and Ridge province of northwest Georgia but is rare in North Carolina. Two more western species, though common on Grassy Mountain, reach their northeastern range limits on the mountain. *Hydrangea quercifolia,* which is common along drainages on the southwest side of the mountain, occurs all along the western edge of Georgia and western Tennessee into Alabama, Mississippi, Louisiana

and the Florida panhandle, although it is planted as an ornamental and has been introduced further north of its native range (Weakley 2000). *Trillium decumbens* is a species of limited distribution, occurring from northwest Georgia into northcentral Alabama and southeastern Tennessee but is not known from North Carolina (Weakley 2000).

Comparison with other floras

The number of species found on Grassy Mountain is comparable to other southern Blue Ridge floristic surveys (DuMond 1970, Tucker 1972, Murrell & Wofford 1987, Chafin 1989, Stiles & Howell 1996, Milsted 1997, Stiles & Howell 1998). Surveys in non-Blue Ridge Southeastern regions such as the Piedmont generally seem to have resulted in somewhat higher species per area counts (Clements & Wofford 1991, Howell 1991, Ramsey et al. 1993, Joyner & Chester 1994, Cruse 1997) (Carpenter & Chester 1987) (Coile 1979), (Tobe et al. 1992, Floyd 1996). According to Rickets et al. (1999), the Piedmont province has the highest plant species richness among 110 North American (north of Mexico) ecoregions, so higher species richness would be expected. However, comparisons among different sites have potential error. The number of species collected could vary considerably based on factors such as the habitat diversity of the study area, the number of collectors, and the total amount of time spent collecting.

The Grassy Mountain flora is most similar to the flora of Big Frog Mountain ($S_s = 64\%$), which is not surprising considering the proximity (18 km) of the two sites and that they are in the same mountain chain and share the same basic geology (Table 4). However the species complements do differ, and Cruse (1997) and Howell (1991) both found only 70% similarity between sites 4.8 and 12.9 km apart, respectively. This emphasizes the heterogeneity of locales and underscores the value of floristic inventories. The Grassy Mountain flora also has Piedmont affinities, supported by the 48% similarity with Curahee and Soapstone Mountains (Cruse 1997) and 44% similarity with the High Falls and Indian Springs state parks (Howell 1991) in the Georgia Piedmont. However, 55% of species found in an old-growth mixed mesophytic forest in

Ohio (600 km away) occurred on Grassy Mountain, while only 43 to 49% of species in the Piedmont studies (125-200 km away) were found on Grassy Mountain. This suggests that the Grassy Mountain flora has more affinity with the mixed mesophytic forests of the eastern United States than with the Piedmont forests. Sørensen's comparisons of floristic data should be viewed cautiously because factors such as collector bias, habitat differences, and climatic fluctuations such as drought years could account for considerable variation in species found during a floristic inventory.

The Grassy Mountain flora contains a substantially larger percentage of introduced taxa than the Big Frog flora. Actually, the Big Frog flora is notable among southeastern inventories (e.g. Carpenter & Chester 1987; Ramsey et al. 1993) for the low proportion of introduced taxa, and may be attributable to its management as a wilderness area. The majority of introduced species on Grassy Mountain are found in anthropogenically disturbed habitats such as along roads, in wildlife clearings, in campgrounds, and in recent clear-cuts.

Species richness

High species richness of an area is generally considered desirable by conservationists interested in the preservation of biodiversity and is often interpreted as reflecting health or intactness of an area (Meier 1995). High floristic diversity is also interpreted as arising from long periods of floristic stability, at least at the generic level (Cain 1943, Whittaker 1956). Meier (1995) compared vernal herb richness in ten pairs of primary and secondary cove forests in the southern Appalachians and found primary forest floors to be significantly richer in vernal herb species than secondary forests, a result attributed to slow recovery following logging disturbance.

The richness of vernal herbs found in the old-growth cove forest of Grassy Mountain compares favorably with vernal herb richness measured by Meier (1995) in primary cove forests. The species richness measured in the Grassy Mountain cove forest ranged from seven to 16 species per m^2, with an average of 10.33 per m^2, which is slightly below the average of 10.9 per

m^2 (range 9-14.5 species per m^2) measured by Meier for primary forests but well above his secondary forest average of 6.6 species per m^2 (range 2.5-8.75 species per m^2) (Table 5). The richest part of the Grassy Mountain cove forest is in the boulderfield forest, with a species richness of 16 species per m^2, exceeding the highest average measured by Meier in primary forests. However, the Grassy Mountain plots were sampled a couple weeks later and therefore, include some species, such as *Solidago* and *Aster* seedlings, that may not have been considered "vernal" by Meier, and may skew the comparison. Among temperate forest habitats, boulderfield forests have high herb diversity (Bratton 1976, Chafin 1988). This diversity is attributed to the diversity of available microhabitats due to substrate variety, which includes soil, rocks of various sizes, moss, and downed logs in various states of decay. The variation in microtopography also creates an assortment of different sized canopy gaps that further contribute to microhabitat diversity (Bratton 1976, Hicks 1980). Richness of the rocky cove forest plot, which may have been logged because of its proximity to a main ridge, is lower than values for primary forest but nearly equal to the highest average found in second growth forests. The fact that the species-area curves generated do not level off indicates that $12m^2$ was not a large enough plot for measuring species richness in the cove forest.

Diversity indices such as the Shannon diversity index (*H'*) combine information about relative abundance and evenness of species with species richness (Kent & Coker 1992). The herb diversity measured in the Grassy Mountain cove forest (*H'* = 2.56) was greater than that measured by Chafin (*H'* = 1.5) for herb strata in both boulderfield forest sites and the cove forest site on Coosa Bald (Table 5). The diversity measurements in the non-boulderfield parts of the cove forest were lower than Chafin's. The Shannon diversity index assumes that all the species in the community are included in the sample (Kent & Coker 1992). Therefore, estimates from small sample quadrats cannot be interpreted as representing the diversity of the community type, yet may still be valuable in evaluating the evenness of species distribution in the sampled plots. Indices involving percent cover, such as the Shannon index (*H'*), should also be compared very

cautiously among different sites as this measurement can fluctuate dramatically throughout the season in a temperate forest. Chafin measured percent cover in June, while I measured it in mid-May; thus, these measurements were made during similar times but during a season of rapid herb growth.

From these measurements, the old-growth cove forest area on Grassy Mountain and particularly the boulderfield forest are rich in herbaceous species compared with similar rich habitats. The Grassy Mountain boulderfield forest is comparatively diverse, and the other cove forest areas sampled are not very diverse. These comparisons indicate that the Grassy Mountain cove and boulderfield forests probably represent intact examples of the southwestern extent of these unique Appalachian habitats.

Habitats of significance

Appalachian cove forests are botanically and ecologically significant due to the high plant species richness and diversity found in all strata (Schafale & Weakley 1990, Pittillo 1998) and their large proportion of "ancient," Tertiary genera (Cain 1943). In fact, Cain (1943) touts the "virgin hardwood forests" of the Great Smoky Mountains National Park as the finest present representation of Tertiary temperate forests. Species richness of plot-sampled stands in Appalachian cove forests ranges from 46 to 59 taxa per 400 m^2 (mean = 52) (NatureServe 2001).

Boulderfield forests are also ecologically and botanically significant for having high plant diversity among temperate forested habitats, and they are more restricted in distribution than cove forests. The Grassy Mountain boulderfield forest is significant because it is at the southwest corner of the range for this habitat and contains species that are rare in Georgia. However, the Grassy Mountain boulderfield forest is not as well differentiated as the ones studied by Chafin (1988). In these more typical boulderfields, *Betula allegheniensis* dominated the canopy in the boulder-strewn areas but was a minor proportion of the typical cove forest canopy. The tree stratum in the Grassy Mountain boulderfield does not differ dramatically from that of the

surrounding cove forest. This could be attributed to the small size of the boulder-strewn area on Grassy Mountain not being extensive enough to escape the cove forest canopy. However, like the boulderfields studied by Chafin, *Tilia americana* does increase in importance in the Grassy Mountain boulderfield, and fewer tree species are found among the boulders.

The cove and boulderfield forest areas of Grassy Mountain also have aesthetic value due to their spectacular vernal wildflower displays. The mountain is particularly well endowed with species of showy monocots, including bellwort (*Uvularia perfoliata*), American lily-of-the-valley (*Convallaria majuscula*), Solomon's seal (*Polygonatum biflorum*), false Solomon's seal (*Maianthemum racemosum*), speckled wood-lily (*Clintonia umbellulata*), mandarin (*Prosartes languinosa* and *P. maculata*), dwarf Irises (*Iris cristata* and *I. verna*), and several species of orchids *(Cypripedium parviflorum* vars. *pubescens* and *parviflorum* and *Glaearis spectabilis)* and *Trillium*. The hillsides of the cove forests become carpeted with *Trillium* flowers around early May. Eight species of *Trillium* were found on the mountain, many in proximity to each other, making Grassy Mountain notable as a center of *Trillium* diversity within the United States (Case & Case 1997).

Old growth

The total amount of primary forest remaining in the Eastern United States is still uncertain and depends on the particular definitions and the minimum area considered. If primary forest is defined as forest that has never been clear-cut or extensively logged but may have been grazed, burned, or selectively logged, then primary forest probably comprises less than 1% of forested land in the Eastern U.S. (Meier 1995). A 1993 estimate of total old growth forest in Georgia was 14,000 acres, including all forest types for the entire state such as isolated swamp forests. In 1996, the Chattahoochee Ringer District was estimated to contain "a couple thousand acres... that have been selectively cut for people's personal use" (Sanders 1993 in Davis 1993). In 1996, this estimate was updated to 2,000 – 4,000 acres (80-160 ha) of "unlogged upland oak and

pine forests" (Leverett in Davis 1996). The old-growth estimates for Georgia are still increasing as more old growth is discovered (Davis 2002).

Grassy Mountain harbors at least one stand of primary forest for with no record of past logging. The extent of primary forest in this stand is difficult to delineate but is probably approximately 80 ha (200 acres). This primary forest is of particular significance because it is an Appalachian cove forest containing a boulderfield forest, and pristine examples of this forest type are uncommon in Georgia. The Grassy Mountain old growth forests were probably originally spared because they are located on steep slopes, and therefore, did not support trees as large as coves of more sheltered sites (Wooster 2000). Today, however, there are some large-diameter (~ 4.5 ft.) trees of many hardwood species: *Liriodendron tulipifera*, *Quercus* spp., *Carya* spp., *Aesculus flava,* and *Prunus serotina*. This forest also has structural features that typically characterize old-growth, such as an uneven canopy structure with multiple strata and a well-developed herb layer, and standing snags, fallen logs and other woody debris in various states of decay (Whitney 1987, Hardt 1993, Yarrow 2002).

The currently developing definition of "old-growth" for the eastern United States is more lenient than "primary" or "virgin" forest, and recognizes the value of "old-growth" forests that have experienced some level of logging disturbance in the past. Among other features, eastern old-growth hardwood forests are a late-successional community and should have at least six trees per acre over 150 years old (Yarrow 2002). By this definition there are fourteen old-growth fragments of approximately 8-20 ha (20-50 acres) on Grassy Mountain, representing south, west, and north aspects. Most of these old-growth stands are near the top of the mountain but there are some lower elevation stands at the northwest corner of the study site (USFS 1990). A small old-growth stand containing large-diameter trees (*Liriodendron tulipifera* and *Aesculus flava*) and a fairly rich herb cover that includes some uncommon species (i.e. *Triosteum aurantiacum*) is found on the west side of Windy Gap and is currently threatened by off-road vehicle use.

However, none of the other old-growth stands approach the richness of the cove-boulderfield area in which there is no evidence of previous logging (pers. obs. 2001).

SUMMARY

In this study, five hundred and forty-eight species of vascular plants were collected on Grassy Mountain, which are summarized in an annotated list in Appendix A. Most species are characteristic of the Southern Blue Ridge Province; however, some exceptions include species typically found to the south or west. No endangered or threatened species were encountered on Grassy Mountain. However, 20 species are listed by the US Forest Service and/or the Georgia Natural Heritage Program with some sort of status of rarity or concern. Sixty-one of the species identified are exotic, including twelve that are considered invasive.

Grassy Mountain supports areas of special botanical significance, especially on the upper slopes of the mountain in areas that have been less disturbed by logging. Of particular interest is the presence of an old-growth cove forest containing a boulderfield forest. Cove forests, boulderfield forests, and particularly old-growth examples are all uncommon as far south in the Appalachians as Georgia, and this forest type is located at the southwestern edge of its geographic range. These are excellent Georgia examples of these habitats, with rich diverse herbaceous strata and spectacular displays of vernal wildflowers. The primary forest area on Grassy Mountain deserves protection from logging, off-road-vehicles and development as a designated botanical area and is under consideration for protection by the U. S. Forest Service (Wooster 2000).

Table 1. Climate Data. Mean monthly temperatures and total precipitation for 2000 and 2001 for weather stations near Grassy Mountain are compared with 30-year normals. Temperatures are from Jasper, GA (MRCC, 2001) and estimated for the summit of Grassy Mountain by subtracting 4.3 °C. Precipitation data are from Ellijay, GA (MRCC, 2001).

	2000			**2001**			**1971-2000**		
	Mean Temp.		Precip.	Mean Temp.		Precip.	Mean Temp.		Precip.
	Jasper	Estimated for top of Grassy	Ellijay	Jasper	Estimated for top of Grassy	Ellijay	Jasper	Estimated for top of Grassy	Ellijay
	°C	°C	cm	°C	°C	cm	°C	°C	cm
Jan	4.7	0.4	15.95	3.5	-0.8	16.13	4.0	-0.3	16.64
Feb	8.0	3.7	5.21	8.8	4.5	11.38	6.1	1.8	14.78
Mar	12.1	7.8	11.48	8.7	4.4	14.68	10.5	6.2	16.71
Apr	13.7	9.4	19.74	16.1	11.8	6.02	14.5	10.2	12.60
May	20.6	16.3	7.87	19.3	15.0	13.67	18.8	14.5	12.73
Jun	23.0	18.7	16.26	22.2	17.9	14.33	22.6	18.3	11.46
Jul	24.8	20.5	6.20	23.7	19.4	8.33	24.7	20.4	13.00
Aug	24.2	19.9	9.96	24.0	19.7	14.91	24.1	19.8	10.19
Sep	20.7	16.4	18.39	19.8	15.5	9.09	21.0	16.7	10.49
Oct	16.0	11.7	0.84	14.3	10.0	4.85	15.1	10.8	10.19
Nov	6.3	2.0	17.09	14.1	9.8	7.95	10.1	5.8	13.82
Dec	1.1	-3.2	10.16	8.9	4.6	11.73	5.8	1.5	14.17
Mean	**14.6**	**10.3**		**15.3**	**11.0**		**14.8**	**10.5**	
Annual	Precip.		**139.14**			**133.07**			**156.77**

Table 2. Summary of species distribution among major taxonomic groups and proportions of introduced species in each group documented for Grassy Mountain, Georgia. Nomenclature follows Weakley (2000) for families and subfamilial categories, Gleason & Cronquist (1991) for divisions, and the Angiosperm Phylogeny Group (Stevens, 2001) for major groups within the Magnoliophyta.

Division	Families	Genera	Species	% Introduced
Lycopodiophyta	1	2	2	0
Polypodiophyta	9	16	20	0
Pinophyta	1	2	5	0
Magnoliophyta:				
"Basal Group"	5	9	10	0
Eudicots	82	235	387	11
Monocots	20	68	124	15
Total	118	332	548	11

Table 3. Summary of vegetation types and associated rare plant species on Grassy Mountain. Vegetation type names have been abbreviated, or the shortest synonym used. Vegetation types are compiled from NatureServe (2001), Schafale & Weakley (1990), and Wharton (1978).

Vegetation Type	**Selected characteristic plant species**	**Rare plants**
Southern Appalachian cove forest	*Liriodendron tulipifera, Tilia americana, Quercus rubra, Calycanthus floridus, Laportea canadensis, Impatiens pallida, Caulophyllum thalictroides, Trillium grandiflorum.*	*Coreopsis latifolia, Cypripedium parviflorum, Dryopteris goldiana.*
Boulderfield forest	*Tilia americana, Aesculus flava, Ribes cynosbati, Aristolochia macrophylla, Dicentra cucullaria.*	*Trillium simile, Acer spicatum, Euonymus obovatus.*
Appalachian oak forests:		
Oak-hickory forest	*Quercus alba, Q. coccinea, Q. velutina, Carya* spp., *Liriodendron tulipifera*, *Oxydendrum arboreum, Calycanthus floridus, Ilex montana, Vaccinium corymbosum.*	*Carex communis* var. *amplisquama, Xerophyllum asphodeloides.*
Oak ridge forest	*Quercus alba, Q. coccinea, Q. montana, Q. velutina, Carex pensylvanica, Rhododendron catawbiense, Vaccinium* spp.	*Thermopsis fraxinifolia Solidago sphacelata Carex appalachica*
Oak-hickory-pine	*Quercus alba, Q. coccinea, Q. velutina, Carya glabra, Carya* spp., *Pinus strobus, P. virginiana, Vaccinium* spp.	*Cypripedium acaule*
Oak-pine/ heath forest	*Quercus montana, Pinus virginiana, Kalmia latifolia, Hamamelis virginiana, Galax urceolata, Vaccinium* spp.	
Broadleaf deciduous – hemlock forest	*Tsuga canadensis, Liriodendron tulipifera, Rhododendron maximum, Magnolia fraseri, Quercus montana.*	
Mesic mixed hardwood forest	*Liriodendron tulipifera, Acer rubrum, Cornus florida, Ostrya virginiana, Calycanthus floridus, Quercus* spp.*, Pinus strobus, Trillium cuneatum.*	*Collinsonia tuberosa* (over basic substrates)
Swamp Forest - Bog	*Nyssa sylvatica, Quercus alba, Osmunda regalis, Carex intumescens, Leersia virginica, Sphagnum* sp.*,*	
Riparian (Alluvial Forests)	*Liquidambar styriciflua, Carpinus caroliniana, Alnus serrulata, Itea virginica, Rhododendron maximum, Houstonia caerulea, Xanthorhiza simplicissima.*	*Carex torta, Boykina aconitifolia*
Pinus virginiana forest alliance	*Pinus echinata, P. strobus, P. virginiana, Quercus montana, Kalmia latifolia, Vaccinium pallidum, V. stamineum.*	
Beaver marsh	*Scirpus cyperinus, S. purshianus, Juncus effusis, Carex crinita, C. frankii, Oxypolis rigidior, Ludwigia palustris.*	

Table 4. Comparison of the Grassy Mountain flora with six other floristic surveys. Sørensen's coefficient of similarity (S_s) was used to estimate similarity in species composition between Grassy Mountain and the other six sites. Big Frog Mountain, TN is located in the Unaka Range of the southern Blue Ridge Province (Murrell & Wofford, 1987). Coosa Boulderfield, Mossy Cove and Boulderfield (Chafin 1988), and Warwoman Wildlife Management Area (Milsted, 1997) are in the Georgia Blue Ridge Mountains of the southern Blue Ridge Province. Soapstone and Curahee Mountains (Cruse, 1997) and High Falls and Indian Springs State Parks (Howell, 1991) are located in the Piedmont Province of Georgia. Emery Forest is a an old-growth mixed mesophytic forest in southwestern Ohio, west of the Appalachian Plateau (Swanson & Vankat, 2000).

	Area (ha)	Distance from Grassy Mtn. (km)	Elevation (m)	% Native	Species richness	No. species in common	% of flora on Grassy Mtn.	Similarity (S_s)
Grassy Mtn.	5,270	0	256-1125	89	548	---	100	100%
Big Frog Mtn.	2,843	18	570-1288	95	479	330	69	64%
Coosa & Mossy Boulderfields & Mossy Cove	60	89	1040-1340	---	178	144	81	40%**
Warwoman WMA	6,880	120	488-1098	---	523	317	61	59%
Soapstone & Curahee Mtns.	1,579	125	274-540	---	529	260	49	48%
High Falls & Indian Springs	309*	200	152-198	85	556	240	43	44%
Emery Woods	6.3	600	191-211	95	219	121	55	32%**

* area only includes uplands

** Unequal sample size decreases similarity, so Sørensen's index is not entirely appropriate or informative for these comparisons.

Table 5. Summary of species richness and diversity for Grassy Mountain cove forest plots and a comparison with two other studies. One study compares old-growth and second growth southern Appalachian cove forests (Meier 1995), and one compares two boulderfields and one cove forest in north Georgia (Chafin 1988). An asterisk (*) denotes mean values. *H'* = Shannon diversity index value; *J* = equitability, calculated from *H'*. Total cover measured within plots, which affects *H'* values, is also presented.

	No. spp. /1 m^2	**No. spp./ 12m^2**	***H'***	***J***	**Total cover**
Rocky nose in cove forest	8	20	1.17	.39	38%
Cove forest	7	26	1.40	.43	38%
Boulderfield forest	16	33	2.56	.73	90%
mean for Grassy Mountain plots	10.33	26.33	1.71	.52	55%
10 Second-growth forests (Meier 1995)	10.9*	-	-	-	53%*
10 Old-growth forests (Meier 1995)	6.6 *	-	-	-	21%*
Cove forest (Chafin 1988)	-	-	1.5	-	68%
2 Boulderfield forests (Chafin 1988)	-	-	1.5*	-	60%*

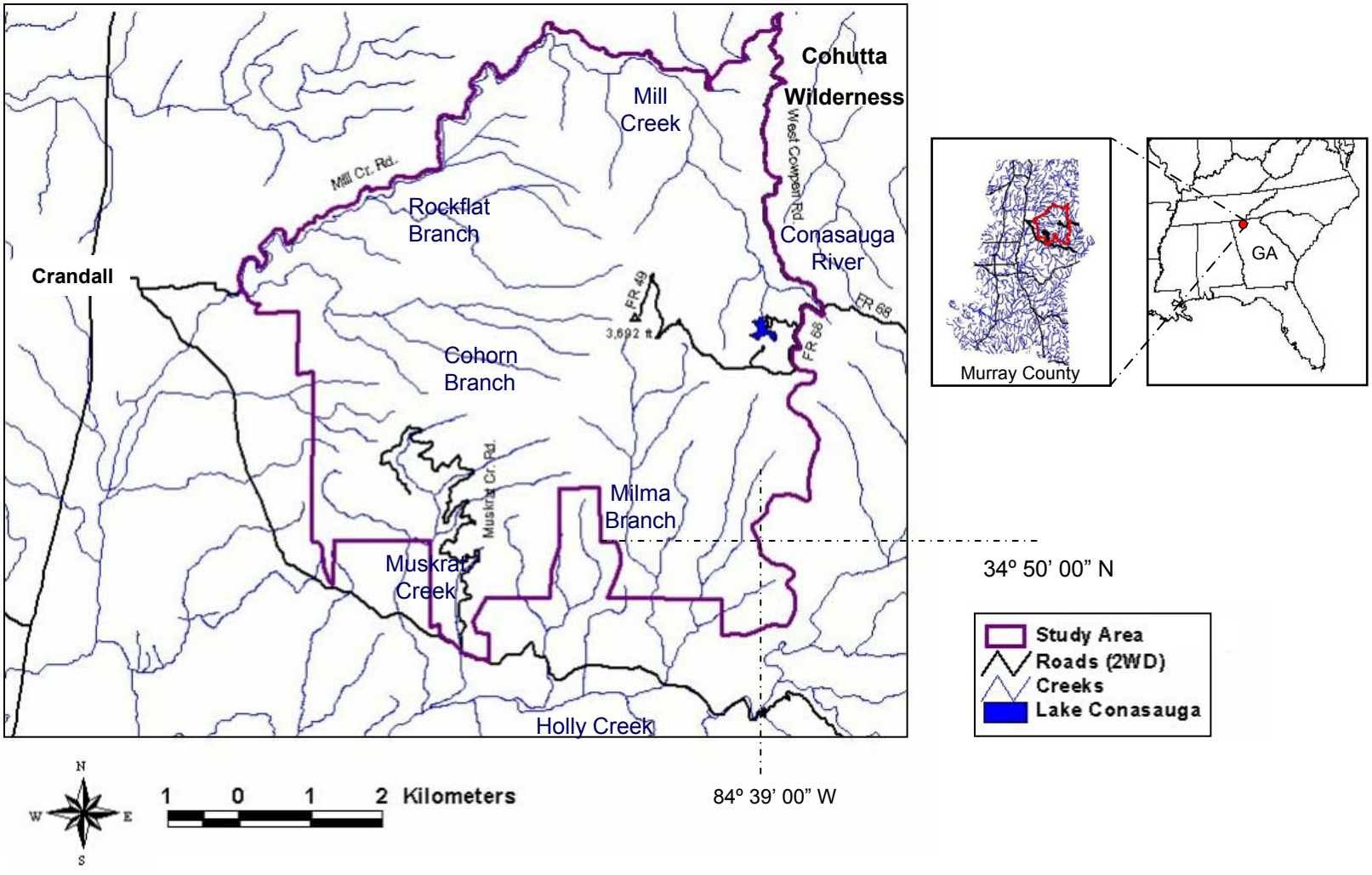

Figure 1. Grassy Mountain study area boundary, creeks, and general location in Georgia.

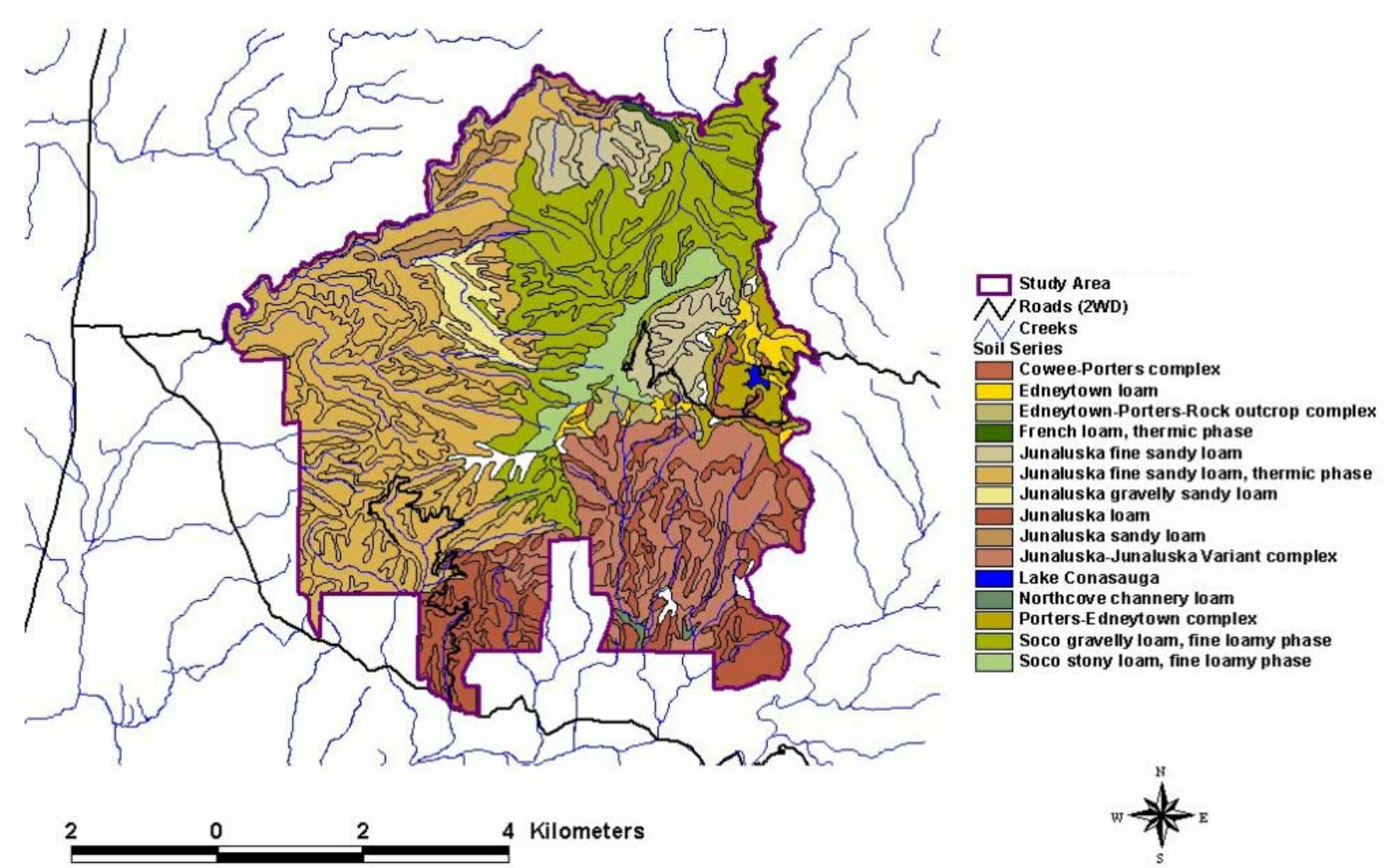

Figure 2. Soils of Grassy Mountain, adapted from USFS soil unit maps (2002).

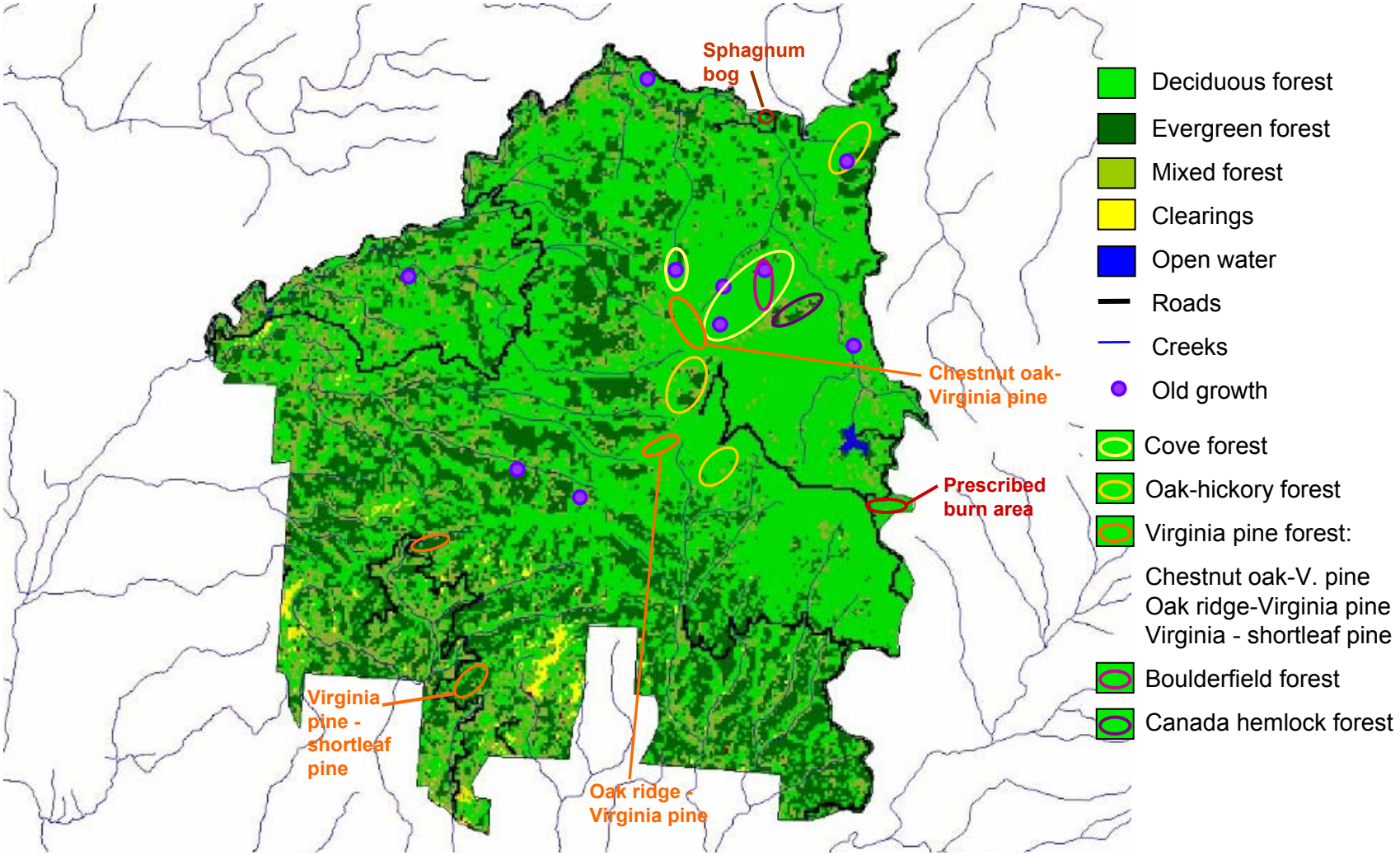

Figure 3. Map of vegetation types and old growth stands on Grassy Mountain. Generalized cover type, depicted by green shading representing deciduous, evergreen and mixed forest, is based on satellite data with 30 m pixels (NARSAL 1998). Examples of more specific vegetation types are indicated by ellipses. Old growth designations are stands containing trees over 150 years old, according to USFS stand maps (1990).

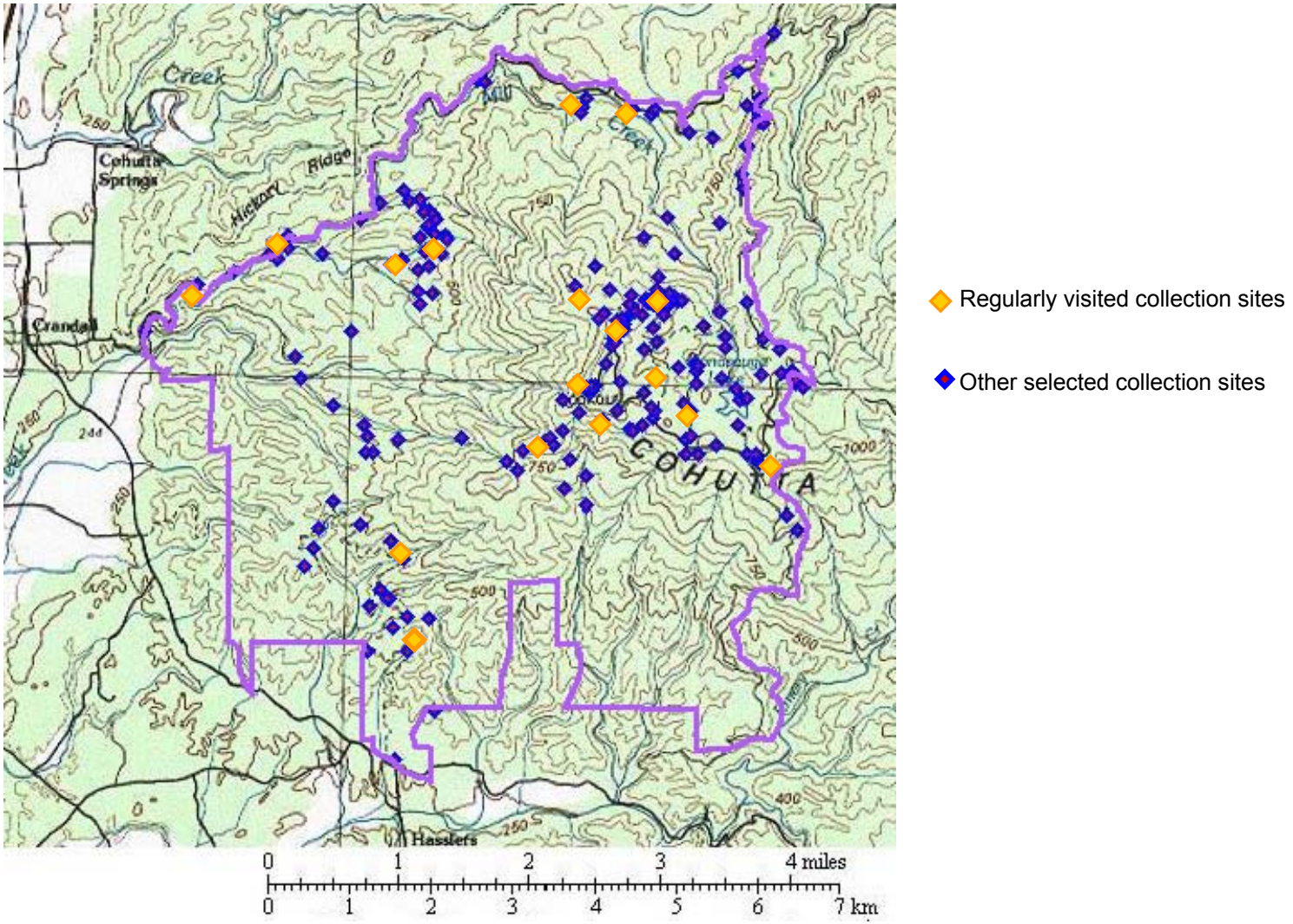

Figure 4. Collection sites on Grassy Mountain. This is an example of collection sites but does not represent all areas visited.

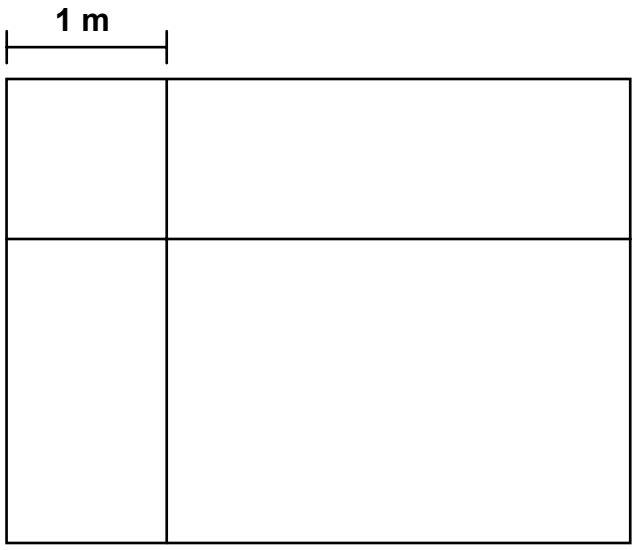

Figure 5. Layout of nested quadrats used for sampling species richness and diversity. Each of the four subdivided quadrats was inventoried independently, allowing species richness measurements at seven scales: $1m^2$, $2m^2$, $3m^2$, $4m^2$, $6m^2$, $8m^2$, and $12m^2$.

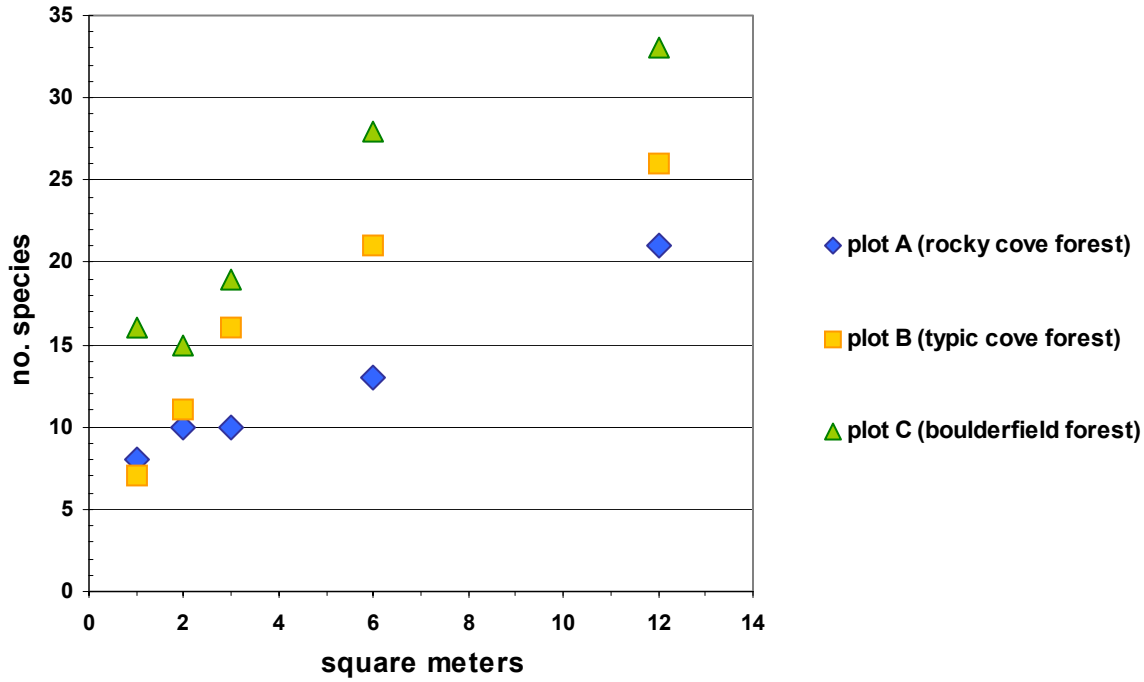

Fig. 6. Species richness of three quadrats with the southern Appalachian cove forest of Grassy Mountain. Three subtypes of cove forest were sampled: a rocky nose, a boulderfield forest and a typic montane subtype. Quadrats were subdivided and sampled in a nested fashion to obtain estimates of richness at several different scales.

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APPENDIX A
ANNOTATED CHECKLIST OF PLANT SPECIES COLLECTED AT GRASSY MOUNTAIN, GEORGIA

Vascular plant families are arranged alphabetically within their respective divisions. Taxa are listed alphabetically within families by genus, species, and subspecific epithet where applicable. Introduced taxa are indicated with an asterisk (*) preceding the scientific name. Common names follow the authority. Rarity ranks are listed for rare taxa, where FS denotes U. S. Forest Service status (USFS 2000), GA denotes Georgia status (Georgia Natural Heritage Program 1999), and NC and TN denote North Carolina and Tennessee respectively. Taxa endemic to the southern Appalachian Mountains are denoted as "S. App. endemic". Nomenclature follows Weakley (2000) unless otherwise noted. Collection numbers of the author are provided. Vouchers are deposited at the University of Georgia Herbarium (GA). A plus symbol (+) denotes species that have not been previously vouchered from Murray County as of 1988.

LYCOPODIOPYHTA

LYCOPODIACEAE

Diphasiastrum digitatum (Dillenius ex. A. Braun) Holub, Common Running-cedar. 506, 592
Lycopodium clavatum L., Running clubmoss. 507. +

POLYPODIOPHYTA

ASPLENIACEAE

Asplenium platyneuron (L.) Britton, Sterns, & Poggenberg var. *platyneuron*, Common ebony spleenwort. 186

BLECHNACEAE

Woodwardia areolata (L.) T. Moore, Netted Chain Fern. 527

DENNSTAEDTIACEAE

Dennstaedtia punctilobula (Michx.) T. Moore, Hay-scented fern. 298, 346, 387
Pteridium aquilinum (L.) Kuhn, Bracken Fern. 764.

DRYOPTERIDACEAE

Athyrium asplenioides (Michx.) A.A. Eaton, Southern lady fern. 270, 299, 436, 715
Cystopteris protrusa (Weath.) Blasdell, Lowland Bladder Fern. 228, 358, 670 +
Deparia acrostichoides (Swartz) M. Kato, Silvery Glade Fern. 315, 352 +
Dryopteris goldiana (Hook. ex. Goldie) A. Gray, Goldie's Wood Fern. G4/S3, FS locally rare, GA watch. 668, 691 +
Dryopteris intermedia (Muhl. ex. Willd.) A. Gray, Fancy Fern. 227, 674, 676 +
Dryopteris marginalis (L.) A. Gray, Marginal wood fern. 212, 766
Polystichum acrostichoides (Michx.) Schott, Christmas fern. 189

OPHIOGLOSSACEAE

Botrychium biternatum (Savigny) Underw., Southern grapefern. 1139
Botrychium virginianum (L.) Swartz, Rattlesnake Fern. 114, 156

OSMUNDACEAE

Osmunda cinnamomea L., Cinnamon Fern. 100, s.n.
Osmunda regalis L., Royal Fern. 269

POLYPODIACEAE

Pleopeltis polypodioides (L.) E.G. Andrews & Windham, Resurrection Fern. 82, 814
Polypodium virginianum L., Common rockcap fern. 221,1069

PTERIDACEAE

Adiantum pedatum L., Northern Maiden-hair Fern. 215

THELYPTERIDACEAE

Phegopteris hexagonoptera (Michx.) Fee, Broad Beech Fern.
Thelypteris noveboracensis (L.) Nieuwl., New York Fern.

PINOPHYTA

PINACEAE

Pinus echinata P. Miller, Shortleaf pine. +
Pinus strobus L., Eastern white pine. 785 +
Pinus taeda L., Loblolly pine. 198 +
Pinus virginiana P. Miller, Virginia pine. 52, 69, 286
Tsuga canadensis (L.) Carriere, Eastern hemlock. 274 +

MAGNOLIOPHYTA

ACANTHACEAE

Ruellia caroliniensis (J.F.Gmel.) Steud., Carolina wild-petunia. 374

ACERACEAE

Acer pensylvanicum L., Striped maple. 596 +
Acer rubrum L. var. *rubrum*, Eastern red maple. 37, 63, 97, 350, 621
Acer spicatum Lam., Mountain Maple. G5/S2, FS locally rare, GA concern. High elevation boulder fields. 230, 667+

ADOXACEAE

Sambucus canadensis L. var. *canadensis*, Elderberry. 371, 795
Viburnum acerifolium L., Mapleleaf viburnum. 194, 223
Viburnum nudum L. var. *nudum*, Possumhaw. 1119 +

AGAVACEAE

Yucca filamentosa L., Curlyleaf yucca. 1166 +

ALISMATACEAE

Sagittaria graminea Michx., Grassleaf Sagittaria. 108

ALLIACEAE

* *Allium canadense* L. var. *canadense*, Wild Onion. 713 +
Allium tricoccum Aiton, Rampscallions. 1071 +
* *Allium vineale* L., Field Garlic. 768 +

ANACARDIACEAE

Rhus copallina L. var. *latifolia* Engler, Winged sumac. 396
Rhus glabra L., Smooth sumac. 783, 784
Toxicodendron radicans (L.) Kuntze, Poison Ivy. 1191 +

ANNONACEAE

Asimina triloba (L.) Dunal, Pawpaw. 40, 282, 566, 627

APIACEAE

Angelica venenosa (Greenway) Fernald, Hairy Angelica. 392, 803, 832 +
Chaerophyllum tainturieri Hook. var. *tainturieri*, Southern chervil. 179
Cryptotaenia canadensis (L.) DC., Honewort. 213, 1066 +
* *Daucus carota* L., Wild carrot. 293
Ligusticum canadense (L.) Britton, American Loveage. 411, 727
Osmorhiza claytonii (Michx.) Clarke, Hairy Sweet Cicely. 149, 214, 666 +
Oxypolis rigidior (L.) Raf., Cowbane. 1079, 1118
Sanicula canadensis L. var. *canadensis*, Black snakeroot. 756

Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe, Clustered Sanicle. 665 +
Sanicula smallii Bicknell, Southern Sanicle. 284, 725 +
Thaspium barbinode (Michx.) Nutt., Meadow parsnip. 78, 207, 557, 1145
Thaspium trifoliatum (L.) A. Grayvar. aureum(L.) Britton, Meadow parsnip. 169, 518
Zizia aurea (L.) Koch, Golden Alexander. 471 +
Zizia trifoliata (Michx.) Fernald, Golden Alexander. 758

APOCYNACEAE

Apocynum cannibinum L., Indian hemp. 368 +
Asclepias exaltata L., Tall milkweed. 310, 749
Asclepias quadrifolia Jacq., Whorled Milkweed. 167, 261, 697
Asclepias tuberosa L.ssp. tuberosa, Common butterfly weed. 285
Asclepias variegata L., White milkweed. 761

AQUIFOLIACEAE

Ilex ambigua (Michx.) Torr., Carolina holly. 485, 683 +
Ilex montana Torr. & A. Gray ex A. Gray, Mountain winterberry. 536, 1075 +
Ilex opaca Aiton var. *opaca*, American holly. 205 +

ARACEAE

Arisaema triphyllum (L.) Schott, Jack-in-the-pulpit. 319, 415

ARALIACEAE

Aralia racemosa L. ssp. *racemosa*, Spikenard. 472, 1165
Panax quinquefolius L., American ginseng. TN & NC special concern list. 1152, 1164

ARISTOLOCHIACEAE

Aristolochia macrophylla Lam., Pipevine. 663, 1067
Asarum canadense L., Wild ginger. 675
Hexastylis shuttleworthii (Britten & Baker f.) Small, Wild Ginger. 177, 606

ASTERACEAE

Achillea millefolium L., Yarrow. 334 +
Ageratina altissima King & H. Rob. var. *altissima*, White snakeroot. 442, 455 +
Ambrosia artemesiifolia L., Common ragweed. 468 +
Antennaria plantaginifolia (L.) Richardson, Plantain pussytoes. 138 +
Antennaria solitaria Rydb., Southern single-head pussytoes. 28, 94, 102
* *Anthemis arvensis* L., Corn chamomile. s.n. +
* *Arctium minus* Bernhardi, Burdock. 416, 796
Arnoglossum atriplicifolium (L.) H. Rob., Pale Indian Plantain. 280
Aster concinnus Willd., Narrow-leaved smooth aster. 489
Aster divaricatus L., Aster. 378, 410, 453, 470, 789
Aster dumosus L., Long-stalked aster. 1183
Aster laevis (s.l.) L., Aster. 445, 1093
Aster lateriflorus (L.) Britton, Aster. 542
Aster lowrieanus Porter, Aster. 1147 +
Aster macrophyllus L., Big-leaved Aster. 711 +
Aster phlogifolius Muhl. ex Willd., Appalachian Clasping Aster. 487 +
Aster pilosus Willd., Aster. 540 +
Aster radula Aiton, Aster. 1190
Aster retroflexus DC., Aster. 467, 484, 1162 +
Aster sagittifolius Willd., Aster. 538 +
Aster surculosus Michx., Aster. 1051, 1174 +
Bidens bipinnata L., Spanish needles. 469, 1099
Bidens frondosa L., Devil's beggar-ticks. 1096 +
Bidens polylepis Blake, Ozark beggar-ticks. 449, 1052
* *Carduus acanthoides* L., Thistle. 1134
Chrysopsis mariana (L.) Elliott, Golden Aster. 1088, 1181
* *Cirsium vulgare* (Savi) Tenore, Bullthistle. 767
Conoclinium coelestinum (L.) DC., Mistflower. 1045 +
Conyza canadensis (L.) Cronquist var. *canadensis*, Common horseweed. 1098 +
Coreopsis latifolia Michx., Broadleaf tickseed. G3/S1, FS sensitive, GA special concern. S. App. endemic. 504

Coreopsis major Walter var. *major*. Whorled-leaf Coreopsis. 364
Coreopsis major Walter var. *rigida* (Nutt.) F.E. Boynton, Whorled-leaf Coreopsis. 276, 834
Elephantopus carolinianus Raeusch., Leafy-stemmed elephant's-foot. 1169
Elephantopus tomentosus L., Elephant's-foot. 1114, 1168 +
Erechtites hieracifolia (L.) Raf., Fireweed. 508 +
Erigeron annuus (L.) Pers., Daisy fleabane. 201
Erigeron philidelphicus L. var. *philidelphicus*, Philidelphia-daisy. 68, 109 +
Erigeron pulchellus Michx. var. *pulchellus*, Robin's plantain. 582
Eupatorium fistulosum Barratt, Joe-pye weed. 418
Eupatorium hyssopifolium L.var. *laciniatum*, Hyssopleaf Eupatorium. 431 +
Eupatorium purpureum L .var. *purpureum*, Joe-pye weed. 413, 457, 1039 +
Eupatorium serotinum Michx., Late Eupatorium. 432
Eupatorium sessilifolium L., Britton's Eupatorium. 1038 +
Gamochaeta purpurea (L.) Cabrera, Spoonleaf purple everlasting. 613, 623
Gnaphalium obtusifolium L., Rabbit-tobacco. s.n. +
Helenium flexuosum Raf., Southern sneezeweed. 423, 440 +
Helianthus angustifolius L., Narrow-leaved sunflower. 1182
Helianthus atrorubens L., Appalachian sunflower. 476, 497
Helianthus decapetalus L., Woodland sunflower. 501, 1065, 1149
Helianthus divaricatus L., Spreading sunflower. 437, 495, 397, 466 +
Hieracium gronovii L., Beaked hawkweed. 1161
Hieracium paniculatum L., Leafy hawkweed. 1062
Hieracium scabrum Michx., Rough hawkweed. TN threatened. 451 +
Hieracium venosum L., Veiny hawkweed. 86, 101, 607
* *Iva annua* L. var. *annua*, Sumpweed. 1158 +
Krigia biflora (Walter) S.F. Blake, Orange dwarf-dandelion. NC watch list. 726, 753
Lactuca floridana (L.) Gaertn., Woodland lettuce. 513, 1105
* *Lactuca serriola* L., Prickly Lactuca. 816 +
* *Leucanthemum vulgare* Lam., Oxeye daisy. 738
Liatris scariosa (L.) Willd., New England Blazing-star. NC watch list. 1127
Liatris squarrulosa Michx., Blazing-star. NC significantly rare. 1179 +
Packera anonyma (Wood) W.A. Weber & A. Love, Squaw-weed. 103, 706
Packera glabella (Poir.) C. Jeffrey, Butterweed. 608 +
Packera obovata (Muhl. ex. Willd.) W.A. Weber & A. Love, Running ragwort. 130, 554, 701
Pityopsis graminifolia (Michx.) Nutt. var. *latifolia* Fernald, Grass-leaved goldenaster. 452
Prenanthes altissima L., Tall rattlesnake-root. 509, 1157
Prenanthes trifoliata (Cass.) Fernald, Gall-of-the-Earth. 1126
Rudbeckia hirta L., Black-eyed Susan. 365, 494, 741
Rudbeckia laciniata L., Cutleaf coneflower. 520
Sericocarpus asteroides (L.) Britton, Toothed white-topped Aster. 404
Silphium compositum Michx., Rosinweed. 843
Smallanthus uvedalius (L.) Mack. ex Small, Bearsfoot. 388, 443
Solidago caesia L., Axillary goldenrod. 1186 +
Solidago canadensis L., Common goldenrod. 526 +
Solidago curtisii Torr. & A. Gray, Curtis's goldenrod. 456, 521, 532, 1187
Solidago flaccidifolia Small, Appalachian goldenrod. 1131 +
Solidago flexicaulis L., Zig-zag goldenrod. 531, 1150 +
Solidago gigantea Aiton, Smooth goldenrod. 1083 +
Solidago juncea Aiton, Early goldenrod. 459, 445 +
Solidago odora Aiton, Licorice goldenrod. 444, 1094
Solidago sphacelata Raf., Licorice goldenrod. G4G5/S3?, GA watch. 1163
* *Sonchus asper* (L.) Hill, Prickly sow-thistle. 19, 614
* *Taraxacum officinale* Weber, Common dandelion. 56 +
Vernonia gigantea (Walter) Trel. var. *gigantea*, Ironweed. 1055
* *Youngia japonica* L., Asiatic hawk's-beard. 615 +

BALSAMINACEAE

Impatiens capensis Meerb., Spotted touch-me-not. 830
* *Impatiens hybrid* "F-1 super elfin coral" , Impatiens. Planted, apparently not naturalizing. 752
Impatiens pallida Nutt., Yellow jewelweed. 314

BERBERIDACEAE

Caulophyllum thalictroides (L.) Michx., Blue Cohosh. 71, 216, s.n. +
Podophyllum peltatum L., May Apple. 146

BETULACEAE

Alnus serrulata (Aiton) Willd., Hazel Alder. 173, 191
Betula alleghaniensis Britton, Yellow birch. 1074 +
Betula lenta L., Sweet birch. 604, 628, 812, 209, 257
Carpinus caroliniana Walter, Musclewood. 571, 585, 809 +
Corylus cornuta Marshall, Beaked hazelnut. 535, 1073
Ostrya virginiana (Mill.) K. Koch, Hop Hornbeam. 1173

BIGNONIACEAE

Bignonia capreolata L., Cross Vine. 61 +
Campsis radicans (L.) Seemans, Trumpet Creeper. 1185 +

BORAGINACEAE

Cynoglossum virginianum L., Wild comfrey. 91

BRASSICACEAE

Arabis canadensis L., Canada rockcress. 206, 260, 366
* *Barbarea vulgaris* R. Br., Common wintercress. 158, 312, 558
Cardamine concatenata (Michx.) O. Schwartz, Toothwort. 58, 151, 568, 669
* *Cardamine hirsuta* L., Hairy bittercress. 13 +
Lepidium virginicum L., pepperwort. s.n. +

CAESALPINIACEAE

Cercis canadensis L., Eastern redbud. 41
Chamaecrista fasciculata (Michx.) Greene, Common partridge-pea. 1040
Chamaecrista nictitans (L.) Moench var. *nictitans*, Common sensitive-plant. 424 +

CALOCHORTACEAE

Prosartes languinosa (Michx.) D. Don, Yellow mandarin. 219, 657
Prosartes maculata (Buckley) A. Gray, Spotted Mandarin. G3/G4/S3?, FS locally rare; GA watch list. 1197 +

CALYCANTHACEAE

Calycanthus floridus L. var. *floridus*, hairy sweet-shrub. 38, 48, 652, 664, 707, s.n.

CAMPANULACEAE

Campanula divaricata Michx., Appalachian bellflower. S. App. endemic. 439, 1033
Campanulastrum americanum (L.) Small, Tall bellflower. 385, 797
Lobelia amoena Michx., Lobelia. 492
Lobelia cardinalis L., Cardinal flower. 419, 1132
Lobelia inflata L., Indian tobacco. 426, 462, 828, 1095, 1110
Lobelia puberula Michx., Lobelia. 427, 493, 775, s.n.
Triodanis perfoliata (L.) Nieuwl., Venus's looking-glass. 326 +

CAPRIFOLIACEAE

Lonicera dioica L. var. *orientails* Gleason, Honeysuckle. G5/S1, GA concern. 204, 474
* *Lonicera japonica* Thunberg, Japanese honeysuckle.
Triosteum aurantiacum Bicknell, Wild coffee. G5/S1, FS locally rare, GA concern. 461

CARYOPHYLLACEAE

* *Arenaria serpyllifolia* L., Large thyme-leaved sandwort. 266 +
* *Dianthus armeria* L., Deptford pink. 287, 498, 806 +
Silene stellata (L.) Aiton, Starry campion. 369, 406, 1032
Silene virginica L., Fire-pink. 15, 755
Stellaria pubera Michx., Giant chickweed. 16, 90, 262

CELASTRACEAE

Euonymus americanus L., Strawberry Bush. 168, 530
Euonymus obovatus Nutt., Trailing strawberry bush. Special concern in TN. 673 +

CLUSIACEAE

Hypericum hypericoides (L.) Crantz, St. Andrew's Cross. 626
Hypericum prolificum L., Shrubby St. John's-wort. 1167 +
Hypericum punctatum L., Spotted St. John's-wort. 765 +
Hypericum stragulum P. Adams & Robson, St. John's-wort. 383, 1050

COLCHICACEAE

Uvularia perfoliata Michx. var. puberula, Perfoliate bellwort. 121, 131, 229, 650

COMMELINACEAE

* *Commelina communis* L., Asiatic dayflower. 1100 +
Tradescantia subaspera Ker-Gawler var. *montana* (Shuttlew. ex. Small & Vail) Anderson & Woodson, Appalachian wide-leaved spiderwort. 239, 256, 307, 398, 696, 787, 1196

CONVALLARIACEAE

Convallaria majuscula Greene, American Lily-of-the-Valley. S. App. endemic. 122, 682
Maianthemum racemosum (L.) Link ssp. *racemosum*, False Solomon's seal. 112
Polygonatum biflorum (Walter) Elliott var. *biflorum*, Solomon's-seal. 210

CONVOLVULACEAE

Ipomoea pandurata (L.) G.F.W. Meyer, Manroot. 386, 391, 813 +

CORNACEAE

Cornus alternifolia L., Alternate-leaved dogwood. 251
Cornus florida L., Flowering Dogwood. 62

CUCURBITACEAE

Melothria pendula L., Creeping cucumber. 823

CUSCUTACEAE

Cuscuta gronovii Willd., Dodder. 1064
Cuscuta rostrata Shuttlew. ex Engelm., Dodder. 502 +

CYPERACEAE

Carex abscondida Mack., Sedge. 722 +
Carex allegheniensis Mack., Weak sedge. GA watch (=*C. debilis* var. *pubera*). 272 +
Carex appalachica J. Webber & P.W. Ball, Appalachian sedge. G4/ S1?, GA concern. 125, 222, 263 +
Carex atlantica Bailey, Sedge. 732
Carex austrocaroliniana Bailey, Fort Mountain Sedge. S. App. endemic. This specimen more closely resembles *C. ormostachya*, which is rare & out of range. 678
Carex blanda Dewey, Sedge. 89 +
Carex communis Bailey var. *amplisquama* (F. J. Hermann) J. Rettig, Sedge. G3/S3, FS sensitive, GA watch. 679, 694
Carex crinita Lam., Sedge. 99, 728
Carex cumberlandensis Naczi, Kral & Bryson, Cumberland Sedge. Recently described species; see Naczi et al. 2001. 317 +
Carex digitalis Willd., Sedge. 118, 255, 651 +
Carex flexuosa Muhl. ex Willd., Sedge. 124, 491 +
Carex frankii Kunth, Sedge. 304, 836, 1082 +
Carex intumescens Rudge, Sedge. 273, 781 +
Carex lucorum Willd. ex Link var. *austrolucorum* J. Rettig, Appalachian Woodland Sedge. 33, 54, 680 +
Carex lurida Wahlenb., Sedge. 271, 729
Carex pensylvanica Lam., Sedge. 136, 234 +
Carex retroflexa Muhl. ex Willd., Sedge. 180
Carex torta Boott, Sedge. G5/S1?, GA concern. 560 +
Carex tribuloides Wahlenb., Sedge. 736 +
Carex umbellata Schkuhr, Sedge. 25, 51 +
Carex virescens Muhl. ex Willd., Sedge. 685, 793, 1035, 1148 +
Carex vulpinoidea Michx., Sedge. 735 +
Cyperus strigosus L., Sedge. 837, 1137, 1160
Eleocharis obtusa (Willd.) Schul., Sedge. 733 +
Scirpus cyperinus (L.) Kunth, Woolgrass. 1080, 1156

Scirpus polyphyllus Vahl, Bullrush. 831, 1103
Scirpus purshianus Fernald, Bullrush. 110, 1077 +
Scleria oligantha Michx., Few-flowered nutrush. 190 +

DIAPENSIACEAE

Galax urceolata (Poir.) Brummitt, Galax. S. App. endemic. 188

DIOSCOREACEAE

Dioscorea villosa L. var. *villosa*, Wild Yam. 217, 232, 311, 345, 717, s.n.

EBENACEAE

Diospyros virginiana L., Persimmon. s.n.

ELAEAGNACEAE

* *Elaeagnus umbellata* Thunb. var. *parvifolia*, Spring silverberry. 49, 291, 598, 827

ERICACEAE

Chimaphila maculata (L.) Pursh, Spotted wintergreen. 278 +
Epigaea repens L., Trailing Arbutus. 50
Hypopitys monotropa Crantz, Pinesap. 481 +
Kalmia latifolia L., Mountain Laurel. 106
Monotropa uniflora L., Indain pipes.
Oxydendrum arboreum (L.) DC., Sourwood. 441, 517, 825
Rhododendron arborescens (Pursh) Torr., Sweet Azalea. 369
Rhododendron calendulaceum (Michx.) Torr., Flame azalea. S. App. endemic. 241
Rhododendron canescens (Michx.) Sweet, Piedmont Azalea. 81, 611
Rhododendron catawbiense Michx., Mountain Rosebay. S. App. endemic. 693
Rhododendron maximum L., White Rosebay. 372, 769
Rhododendron minus Michx., Gorge Rhododendron. 84, 187
Vaccinium corymbosum L., Smooth Highbush Blueberry. 44, 80, 236, 602, 649, 684
Vaccinium pallidum Aiton, Hillside Blueberry. S. App. endemic. 373, 609, 772
Vaccinium stamineum L., Deerberry. 79, 600, s.n.

EUPHORBIACEAE

Acalypha virginica L., Virginia copperleaf. 1101 +
Chamaesyce nutans (Lagasca ex Segura) Small, Eyebane. 516 +
Euphorbia corollata L., Flowering spurge. 450, 1138
Euphorbia mercurialina Michx., Cumberland Spurge. Rare in N.C.; more of a Cumberland Plateau species, into NW GA. 77, 586
Euphorbia pubentissima Michx., Southeastern flowering spurge. 164 +

FABACEAE

Amorpha fruticosa L., Tall Indigo-bush. 96 +
Amphicarpaea bracteata (L.) Fernald, Hog Peanut. 465, 511, 1061
Centrosema virginianum (L.) Benth., Spurred butterfly pea. 807 +
Desmodium cuspidatum (Muhl. ex. Willd.) DC. ex Loudin, Toothed Tick-trefoil. 1060 +
Desmodium glutinosum (Muhl. ex Willd.) A. Wood, Heartleaf tick-trefoil. 399, 799 +
Desmodium nudiflorum (L.) DC., Naked tick-trefoil. 376, 801, 1123 +
Desmodium paniculatum (L.) DC. var. *paniculatum*, Beggar's-ticks. 375, 475, 483, 826
Desmodium perplexum Schub., Tick-trefoil. 421
* *Lespedeza bicolor* Turcz., Bicolor Lespedeza. 384, 454, 1031
* *Lespedeza cuneata* (Dumont) G. Don, Sericea. 425 +
Lespedeza hirta (L.) Hornem., Silvery Lespedeza. 1054 +
Lespedeza intermedia (S. Watson) Britton, Wand Lespedeza. Nomenclature follows Radford et al. (1968). 463, 1089
Lespedeza repens (L.) Barton, Smooth Trailing Lespedeza. 1049 +
* *Melilotus alba* Medik., White sweetclover. 370 +
Orbexilum pedunculatum (P. Miller) Rydb., Sampson's-snakeroot. 290
Robinia pseudoacacia L., Black-locust. 76
* *Securigera varia* (L.) Lassen, Crown vetch. 330, 515, 778 +
Thermopsis fraxinifolia (Nutt. ex Torr. & A. Gray) M. A. Curtis, Ash-leaf golden-banner. G3?/S3, GA watch. S. App. endemic. 161, 166
Thermopsis mollis (Michx.) M.A. Curtis, Downy bush-pea. G4/SU, GA watch. S. App. endemic. 687

* *Trifolium campestre* Schreb., Hop clover. 333 +
* *Trifolium incarnatum* L., Crimson clover. 17, 619 +
* *Trifolium pratense* L., Red clover. 332 +
* *Vicia villosa* Roth ssp. *varia* (Host) Carbiere, Winter vetch. 331 +

FAGACEAE

Castanea dentata (Marshall) Borkh., American chestnut. 1071
Castanea pumila (L.) P. Miller, Common chinquapin. 625 +
Fagus grandifolia Ehrh., American beech. 776
Quercus alba L., White oak. 197, 248, 250, 1151, 1194
Quercus coccinea Muenchh., Scarlet oak. 249, 544, 1189
Quercus marilandica Muenchh. var. *marilandica*, Blackjack oak. 433, 840
Quercus montana Willd., Rock Chestnut Oak. 193
Quercus rubra L., Northern red oak. 1193
Quercus velutina Lam., Black oak. 196, 660 +

FUMARIACEAE

Dicentra cucullaria (L.) Bernh., Dutchman's breeches. 59

GENTIANACEAE

Gentiana decora Pollard, Appalachian gentian. S. App. endemic. 528, 541

GERANIACEAE

Geranium carolinianum L. var. *confertiflorum* Fernald, Northern Carolina cranes-bill. 104
Geranium maculatum L., Wild Geranium. 127, 313, 579

GROSSULARIACEAE

Ribes cynosbati L., Dogberry. Mostly high elevation, moist slopes and periglacial boulderfields. 225, 644

HAMAMELIDACEAE

Hamamelis virginiana L., Witch-hazel. 83, 111, 242, 545
Liquidambar styraciflua L., Sweetgum. 1117

HIPPOCASTANACEAE

Aesculus flava Solander, Yellow Buckeye. 152, 155, 550, 1177, s.n.

HYDRANGEACEAE

Decumaria barbara L., Climbing Hydrangea. 710, 724
Hydrangea arborescens L. ssp. *arborescens*, Smooth Hydrangea. 283
Hydrangea quercifolia Bartram, Oakleaf Hydrangea. 277

HYDROPHYLLACEAE

Hydrophyllum canadense L., Mapleleaf waterleaf. 226, 353
Phacelia bipinnatifida Michx., Fern-leaf Phacelia. 144, 655

HYPOXIDACEAE

Hypoxis hirsuta (L.) Coville, Yellow star-grass. 85, 359

IRIDACEAE

Iris cristata Aiton, Dwarf crested iris. 64, 578
Iris verna L. var. *smalliana* Fernald ex M. E. Edwards, Upland dwarf iris. 75, 588
Sisyrinchium angustifolium P. Miller, Blue-eyed grass. 139, 328, 737

ITEACEAE

Itea virginica L., Virginia-willow; sweetspire. 165, 192 +

JUGLANDACEAE

Carya cordiformis (Wangenh.) K. Koch, Bitternut hickory. 792
Carya glabra (P. Miller) Sweet, Pignut Hickory. 551, 690, 760
Carya ovata (P. Miller) K. Koch, Common Shagbark Hickory. 808 +
Carya pallida (Ashe) Engles & Graebner, Sand hickory. 811
Carya tomentosa (Poir.) Nutt., Mockernut Hickory. 1176 +
Juglans nigra L., Black walnut. 819

JUNCACEAE

Juncus acuminatus Michx. 773
Juncus effusus L. var. *pylaei* (Laharpe) Fernald & Wieg., Common rush. 340, 730 +
Juncus tenuis Willd., Path rush. 356, 734
Luzula acuminata Raf., Wood-rush. 584
Luzula echinata (Small) F. J. Hermann var. *echinata*, Wood-rush. 140
Luzula echinata (Small) F. J. Hermann var. *mesochorea* F. J. Hermann, Wood-rush. 583

LAMIACEAE

Collinsonia canadensis L., Northern Horsebalm. 414
Collinsonia tuberosa Michx., Stoneroot. G3G4/S3, GA watch. Rare in NC. 522, 1170 +
Cunilla origanoides (L.) Britton, Stone-mint. 1087
* *Glechoma hederacea* L., Gill-over-the-ground. 712
* *Lamium purpureum* L., Purple dead-nettle. 26 +
Lycopus virginicus L., Virginia bugle-weed. 1058, 1112
Monarda clinopodia L., Basil bergamot. 357
* *Perilla fructescens* (L.) Britton, Beefsteak plant. 519, 1109
Prunella vulgaris L. var. *lanceolata* (W. Barton) Fernald, American Self-heal. 422, 480
Pycnanthemum montanum Michx., Appalachian Mountain-mint. S. App. endemic. 349
Pycnanthemum pycnanthemoides (Leavenw.) Fernald var. *pycnanthemoides*, Mountain-mint. 395
Salvia lyrata L., Lyre-leaved sage. 142, 637 +
Scutellaria elliptica Muhl., Skullcap. 279, 743, 747
Scutellaria integrifolia L., Skullcap. 289 +
Scutellaria ovata Hill, Skullcap. 779 +
Stachys eplingii J. Nelson, Epling's hedge-nettle. Significantly rare in NC. Southern limit of distribution. 292, 342, 744 +
Stachys latidens Small ex Britton, Broad-toothed hedge-nettle. S. App. endemic. 759

LAURACEAE

Lindera benzoin (L.) Blume var. *benzoin*, Smooth Northern Spicebush. 671
Lindera benzoin (L.) Blume var. *pubescens*, Hairy Northern Spicebush. 723, 1106
Sassafras albidum (Nutt.) Nees, Sassafras. 43, 47, 587, 1195

LILIACEAE

Clintonia umbellulata (Michx.) Morong, Speckled wood-lily. 141
Erythronium umbillicatum Parks & Hardin, Trout Lily. 9, 548, 591, 605
Lilium superbum L., Turk's-cap lily. 400, 409 +
Medeola virginiana L., Indian Cucumber Root. 126, 203

LINACEAE

Linum striatum Walter, Ridgestem yellow flax. 842 +

MAGNOLIACEAE

Liriodendron tulipifera L., Tulip-tree. 243, 341
Magnolia acuminata L., Cucumber-tree. 318, 537, 748, 1133, 1154
Magnolia fraseri Walter, Fraser's Magnolia. S. App. endemic. 594, 597, s.n.

MALVACEAE

Tilia americana L. var. *caroliniana* (P. Mill.) Castigl., Carolina Basswood. 88, 154
Tilia americana L. var. *heterophylla* (Vent.) Loudon, Mountain Basswood. 689

MELANTHIACEAE

Stenanthium gramineum (Ker-Gawler) Morong var. *micranthum* Ferald, Small Featherbells. 490
Veratrum parviflorum Michx., False hellbore. S. App. endemic. 794, 1037 +
Xerophyllum asphodeloides (L.) Nutt., Turkybeard. G4/S1, FS locally rare, GA rare. 1141

MENISPERMACEAE

Cocculus carolinus (L.) DC., Carolina coralbeads. 821 +

MIMOSACEAE

* *Albizia julibrissin* Durazzini, Mimosa.

MORACEAE

Morus rubra L., Red mulberry. 1172 +

NYSSACEAE

Nyssa sylvatica Marshall, Black Gum. 235, 268, 610, 708

OLEACEAE

Fraxinus americana L., White ash. 822
Fraxinus pennsylvanica Marshall, Green ash. 549, 562, 709
* *Ligustrum sinense* Lour., Chinese Privet. 339 +

ONAGRACEAE

Circaea canadensis (L.) Hill, Canadian enchanter's nightshade. 351, 360, 757
Ludwigia alternifolia L., Alternate-leaf rattlebox. 835, 1136 +
Ludwigia palustris (L.) Elliott, Common water-purslane. 739, 1078
Oenothera biennis L., Common evening-primrose. 1124

ORCHIDACEAE

Corallorhiza odontorhiza (Willd.) Nutt., Autumn coral-root. 1121 +
Cypripedium acaule Aiton, Pink Lady's Slipper. G5/S4, GA concern. 1199 +
Cypripedium parviflorum Salisb. var. *parviflorum*, Small yellow lady's-slipper. G5/S2, FS locally rare. Coll. T. Patrick 5597
Cypripedium parviflorum Salisb. var. *pubescens* (Willd.) Knight, Large yellow lady's-slipper. G5/S3, FS locally rare. 143 +
Galearis spectabilis (L.) Raf., Showy orchis. 653
Goodyera pubescens (Willd.) R. Br. ex Aiton, Downy rattlesnake orchid. 394, 1084
Platanthera clavellata (Michx.) Luer, Small green wood orchid. 1056, 1120
Tipularia discolor (Pursh) Nutt., Crane-fly orchid. 1043

OROBANCHACEAE

Conopholis americana (L.) Wallr., Cancer-root. 117, 677 +
Epifagus virginiana (L.) W. Barton, Beechdrops. 523

OXALIDACEAE

Oxalis dillenii Jacq. ssp. *dillenii*, Southern yellow wood-sorrel. 107, 244, 624
Oxalis stricta L., Common yellow wood-sorrel. 408, 762 +
Oxalis violacea L., Violet wood-sorrel. 574

PAPAVERACEAE

Sanguinaria canadensis L., Bloodroot. 42

PASSIFLORACEAE

Passiflora lutea L. var. *lutea*, Passion-flower. 817 +

PHRYMACEAE

Phryma leptostachya L. var. *leptostachya*, American lopseed. 405 +

PHYTOLACCACEAE

Phytolacca americana L., Common pokeweed. 275, 524

PLANTAGINACEAE

? *Plantago rugelii* Decne., American plantain. 417 +

PLATANACEAE

Platanus occidentalis L., Sycamore. 1142, 1184

POACEAE

Agrostis hyemalis (Walter) Britton, Stearns & Poggenb., Tickgrass. 702 +
Agrostis perennans (Walter) Tuck., Upland bentgrass. 791, 1034
Andropogon virginicus L., Broomstraw. 288 +
Brachyelytrum erectum (Schreb. ex Spreng.) P. Beauv., Common shorthusk. 381, 500, 780, 802, 1122 +

* *Bromus inermis* Leyss., Hungarian brome. Rare introduction, mostly of CP. 157 +
* *Bromus japonicus* Thunb. ex Murray, Japanese chess. 296 +
* *Bromus tectorum* L., Cheatgrass. 245 +
Chasmanthium laxum (L.) Yates, Slender spikegrass. 435, 1130 +
Chasmanthium sessiliflorum (Poir.) Yates, Longleaf spikegrass. 1042 +
Cinna arundinacea L., Stout wood-reed. 1059 +
* *Dactylis glomerata* L., Orchard grass. 208
Danthonia compressa Austin ex Peck, Mountain oatgrass. 321, 731 +
Danthonia spicata (L.) P. Beauv. ex Roem. & Schult., Poverty oatgrass. 184, 246, 705 +
Dichanthelium acuminatum (Swartz) Gould & Clark var. *fasciculatum* (Torr.) Freckmann, Slender-stemmed witch-grass. 294 +
Dichanthelium boscii (Poir.) Gould & Clark, Bosc's witch grass. 129, 175, 253, 295, 316, 721, 1116 +
Dichanthelium commutatum (Schult.) Gould, Variable witch grass. 163, 620 +
Dichanthelium dichotomum group (L.) Gould, Witch grass. 183, 254, 482,1159 +
Dichanthelium laxiflorum (Lam.) Gould, Open-flower witch-grass. 1076 +
Dichanthelium scoparium (Lam.) Gould, Velvet witch grass. 1081, 1135 +
Dichanthelium sphaerocarpon (Elliott) Gould var. *isophyllum* (Schreb.) Gould & Clark, Small-fruited witch-grass. 380 +
* *Digitaria ischaemum* (Schreb.) Schreb. ex Muhl. var. *ischaemum*, Smooth crabgrass. 479, 1097 +
Elymus hystrix L. var. *hystrix*, Bottlebrush grass. 367 +
Eragrostis capillaris (L.) Nees, Lacegrass. 478+
Festuca subverticillata (Pers.) Alexeev, Nodding fescue. 123 +
* *Holcus lanatus* L., Velvet grass. 335 +
* *Hordeum pusillum* Nutt., Little barley. 302 +
Leersia virginica Willd., Whitegrass. 447, 1115 +
Melica mutica Walter, Two-flower melic. 176
* *Microstegium vimineum* (Trin.) A. Camus, Nepal-grass. 1178 +
Muhlenbergia schreberi J.F.Gmel., Nimblewill. 539 +
Muhlenbergia sylvatica Torr. ex A. Gray var. *sylvatica*, Woodland Muhly. 1041 +
Muhlenbergia tenuiflora (Willd.) Britton, Stearns & Poggenb. var. *variabilis* (Schribner) Pohl, Appalachian slender Muhly. S. App. endemic. 488 +
Panicum dichotomiflorum Michx., Spreading panic grass. 1104 +
* *Paspalum dilatatum* Poir., Dallis grass. 429, 838 +
Paspalum laeve Michx., Paspalum. 1046
* *Poa annua* L., Annual bluegrass. 53, 185 +
Poa cuspidata Nutt., Bluegrass. (Or *P. autumnalis*) 23, 39, 555, 643
* *Schedonorus arundinaceus* (Schreb.) Dumortier, Tall fescue. 301, 336, 616, 704 +
Schizachyrium scoparium (Michx.) Nashvar. scoparium, Little bluestem. 486, 1091, 1128, 1175
* *Setaria faberii* W. Herrmann, Nodding foxtail grass. 800 +
* *Setaria viridis* (L.) P. Beauv., Foxtail grass. 477 +
* *Sorghum halepense* (L.) Pers., Johnson grass. 434 +
Tridens flavus (L.) A. S. Hitchcock, Purpletop Tridens. 438, 1047
* *Triticum aestivum* L., Bread wheat. 113 +
* *Vulpia myuros* (L.) Gmelim, Rat-tail fescue. 297
Vulpia octoflora (Walter) Rydb., Six-weeks fescue. 703 +

POLEMONIACEAE

Phlox carolina L. ssp. *carolina*, Phlox. 742

POLYGALACEAE

Polygala curtissii A. Gray, Appalachian milkwort. 841, 1048
Polygala polygama Walter, Bitter milkwort. 699, 774

POLYGONACEAE

Fallopia scandens (L.) Holub, Crested climbing buckwheat. 496, 786
* *Persicaria longiseta* (de Bruijn) Moldenke, Longbristle smartweed. 458, 1057, 1102
Persicaria pensylvanica (L.) Gomez de la Maza, Common smartweed. 460 +
Persicaria punctata (Elliott) Small, Smartweed. 420
Persicaria virginiana (L.) Gaertner, Jumpseed. 473, 505
* *Rumex acetosella* L., Sheep-sorrel. 338
* *Rumex crispus* L., Curly dock. 337 +

PORTULACACEAE

Claytonia caroliniana Michx., Carolina spring-beauty. 57, 645 +

PRIMULACEAE

Lysimachia quadrifolia L., Whorled loosestrife. 308 +

RANUNCULACEAE

Actaea pachypoda Elliott, Doll's-eyes. 1063, 1200 +
Anemone quinquefolia L., Wood anemone. 60, 573
Anemone virginiana L., Thimbleweed. 393
Anemonella thalictroides (L.) Spach, Windflower. 21, 35, 264
Aquilegia canadensis L., Eastern columbine. 231, 323
Cimicifuga americana Michx., Mountain black cohosh. S. App. endemic. 533 +
Cimicifuga racemosa (L.) Nutt., Common black cohosh.
Clematis viorna L., Northern leatherflower. 320, 322, 354, 751 +
Clematis virginiana L., Virgin's bower. 1044
Hepatica acutiloba DC., Sharp-lobed Hepatica. 700
Hepatica americana (DC.) Ker-Gawler, Round-lobed Hepatica. 24
* *Ranunculus bulbosus* L., Bulbous buttercup. 601 +
Ranunculus recurvatus Poir., Hooked crowfoot. 115, 654, 672
Thalictrum clavatum DC., Mountain meadowrue. S. App. endemic. 681 +
Thalictrum dioicum L., Early meadowrue. 147, 148 +
Thalictrum pubescens Pursh. var. *hepaticum* (Green) Keener, Tall meadowrue. 763 +
Trautvetteria caroliniensis (Walter) Vail, False bugbane.325, 363, 402
Xanthorhiza simplicissima Marshall, Yellowroot. 18, 22

RHAMNACEAE

Berchemia scandens (Hill) K. Koch, Supplejack. 1140, s.n. +
Ceanothus americanus L., New Jersey Tea. 740, 833 +

ROSACEAE

Agrimonia rostellata Wallr., Woodland Agrimony. s.n. +
Amelanchier laevis Wiegand, Smooth serviceberry. 46, 572, s.n.
Aronia arbutifolia (L.) Pers., Red Chokeberry. 599 +
Aronia melanocarpa (Michx.) Elliott, Black Chokecherry. 237 +
Aruncus dioicus (Walter) Fernald, Goat's-beard. 267
Crataegus flabellata (Bosc) K. Koch, Common Hawthorn. 240, 510
Fragaria virginiana Duchesne, Wild strawberry. 688
Geum canadense Jacq., Avens. 820 +
Porteranthus trifoliatus (L.) Britton, Mountain Indian-physic. 137
Potentilla canadensis L., Running five-fingers. 27
Potentilla simplex Michx., Old-field five-fingers. 116
* *Prunus persica* (L.) Batsch, Peach. 11 +
Prunus serotina Ehrh., Wild black cherry. 98, 160, 195, 306, 815
Prunus umbellata Elliott, Hogplum. 547, 630 +
Rubus allegheniensis Porter, Allegheny blackberry. 199, 238, 692
Rubus argutus Link, Southern blackberry. 105
Rubus odoratus L., Flowering raspberry. 233, 1070 +

RUBIACEAE

Galium aparine L., Cleavers. 174
Galium latifolium Michx., Wideleaf bedstraw. S. App. endemic. 211, 259
Galium triflorum Michx., Straw-scented bedstraw. 362, 1068 +
Houstonia caerulea L., Common bluet. 29, 559, 577
Houstonia purpurea L. var. *purpurea*, Summer bluet. 133, 170, 181, 281, 512, 634
Mitchella repens L., Partridge Berry. 10, 182 +

RUTACEAE

Ptelea trifoliata L., Hop-tree. 265 +

SALICACEAE

Salix nigra Marshall, Black willow. s.n.

SANTALACEAE

Pyrularia pubera Michx., Buffalo Nut. S. App. endemic. 635

SAXIFRAGACEAE

Astilbe biternata (Vent.) Britton, Appalachian false goat'sbeard. S. App. endemic. 224
Boykinia aconitifolia Nutt., Brook-Saxifrage. GA watch list.S. App. endemic. 771 +
Heuchera villosa Michx., Crag-jangle. 401, 788, 1144
Parnassia asarifolia Vent., Appalachian Grass-of-Parnassus. Uncommon. 529
Tiarella cordifolia L., Foamflower. 34, 200

SCROPHULARIACEAE

Agalinus tenuifolia (Vahl) Raf., Agalinus. 1090, 1180
Aureolaria laevigata (Raf.) Raf., Appalachian Oak-leach. 1129
Aureolaria virginica (L.) Pennell, Downy Oak-leach. 377, 390, 1036 +
Chelone glabra L., Turtlehead. 1155
Melampyrum lineare Desr., Cow-wheat. 135
* *Paulownia tomentosa* (Thunb.) Steud., Princess Tree. 70, 305 +
Pedicularis canadensis L., Eastern lousewort. 553
Penstemon canescens Britton, Appalachian beardtongue. 202
Penstemon pallidus Small, Eastern white beardtongue. G5/S1?, GA concern.Questionable identification; *P. pallidus* is G5 on DNR list; Radford et al (1968) says introd. from further west. 633 +
Scrophularia marilandica L., Eastern Figwort. 1153
* *Verbascum thapsis* L., Woolly Mullein. 1125
* *Veronica arvensis* L., Wall speedwell. 55
* *Veronica officinalis* L., Common speedwell. 798 +

SIMAROUBACEAE

* *Ailanthus altissima* (Mill.) Swingle, Stink-tree. 824 +

SMILACACEAE

Smilax herbacea L., Common carrion-flower. 343
Smilax hugeri (Small) J.B.S. Norton ex Pennell, Huger's carrionflower. NC watch list. s.n.
Smilax rotundifolia L., common greenbriar. 618 +

SOLANACEAE

Physalis virginiana P. Miller, Virginia ground-cherry. 178, 348 +
Solanum carolinense L., Horse-nettle. 829 +
Solanum ptycanthum Dunal, Eastern black nightshade. 464, 1108 +

STRYCHNACEAE

Spigelia marilandica L., Pinkroot. 309, 754

STYRACACEAE

Halesia tetraptera Ellis, Silverbell. 1107, 1198

SYMPLOCACEAE

Symplocos tinctoria (L.) L'Her, Horse-sugar. 662, 698

TRILLIACEAE

Trillium catesbaei Elliott, Catesby's Trillium. 72, 119, 580,
Trillium cuneatum Raf., Purple toadshade. 14, 656
Trillium decumbens Harb., Decumbent Trillium. 87, 564, 569
Trillium erectum L. var. *albidum* (Michx.) Pursh., Wake-robin. 145
Trillium grandiflorum (Michx.) Salisb., Great White Trillium. 73, 153, 661
Trillium luteum (Muhl.) Harb., Yellow Toadshade. 695
Trillium simile Gleason, Sweet White Trillium. G3/S2, FS sensitive, GA concern. S. App. endemic. 658
Trillium vaseyi Harb., Vasey's trillium. S. App. endemic. 159

TYPHACEAE

Typha latifolia L., Common cattail. 839 +

ULMACEAE

Ulmus alata Michx., Winged elm. 818 +
Ulmus americana L., American elm. 93

URTICACEAE

Boehmeria cylindrica (L.) Swartz, False-nettle. 379, 428
Laportea canadensis (L.) Wedd., Wood-nettle. 220, 324, 347, 499, 534, 790 +
Pilea pumila (L.) A. Gray, Clearweed. 343, 1113

VIOLACEAE

Viola bicolor Pursh, Violet. 12
Viola blanda Willd., Sweet white violet. 30, 563
Viola canadensis L.var. canadensis, Canada violet. 150, 647
Viola hastata Michx., Sprearleaf violet. 32, 570
Viola pallens (Banks ex DC.) Brainerd, Wild white violet. 575 +
Viola palmata L. var. *palmata*, Wood violet. 581
Viola palmata L. var. *subsinuata* Greene, Wood violet. 468, 565
Viola pedata L., Bird's-foot violet. 20, 546
Viola pubescens Aiton var. *leiocarpon* (Fernald & Wieg.) Seymour, Smooth yellow forest violet. 382, 641 +
Viola rostrata Pursh, Long spurred violet. 36, 561
Viola rotundifolia Michx., Early yellow violet. 595
Viola sagittata Aiton, Arrowhead violet. 31, 593
Viola septemloba LeConte, Violet. 589 +
Viola sororia Willd., Dooryard violet. 74, 642, 646 +
Viola tripartita Elliott, Three-parted violet. 576, 590

VITACEAE

Parthenocissus quinquefolia (L.) Planch., Virginia creeper. 805 +
Vitis aestivalis Michx. var. *aestivalis*, Summer grape. 327
Vitis aestivalis Michx. var. *bicolor*, Silverfeaf grape. 804
Vitis rotundifolia Michx., Muscadine. 430, 777, 810 +