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Forest Species Diversity in Upper Elevation Hardwood Forests in the Southern Appalachian Mountains

KATHERINE J. ELLIOTT[1] and DEIDRE HEWITT[2]

[1]USDA Forest Service, Southern Research Station, Coweeta Hydrological Laboratory, Otto, North Carolina 28763;
[2]Florida A&M University, Tallahassee, Florida 32310

ABSTRACT

Overstory, shrub-layer, and herb-layer flora composition and abundance patterns in eleven forest sites were studied to evaluate species diversity and richness before implementing three types of harvest treatments. The sites were within the Wine Spring Creek Watershed and were classified as high elevation, dry, *Quercus rubra-Rhododendron calendulaceum* based on McNab and Browning's Landscape Ecosystem Classification system. Evaluation of species diversity was determined by Shannon-Weiner's index of diversity (H') and Pielou's species evenness index (J'). Overstory H' based on tree density ranged from 1.62 to 2.50 and H' based on tree basal area ranged from 0.94 to 2.22. The importance values for woody species, showed four species that occurred on all sites (*Acer rubrum*, *Quercus rubra, Amelanchier arborea,* and *Castanea dentata)* accounted for 32 to 84% of overstory abundance. Shrub-layer $H'_{Density}$ ranged from 0.64 to 2.33 and H',, ranged from 0.40 to 2.26. *Rhododendron calendulaceum* and *Castanea dentata* were the only species present on all sites and accounted for 28.5 to 92.3% of the shrub-layer abundance. Herb-layer $H'_{Density}$ ranged from 1.72 to 3.02 and $J'_{Density}$ was low, between 0.5 and 0.6 on most sites. Herb-layer diversity was determined by a few dominant species. Although species richness ranged from 51 to 73, seven genera of understory herbs [*Prenanthes trifoliata, Thelypteris noveboracensis, Viola hastata*, *Medeola virginiana, Solidago* (*curtisii* and *arguta),* and *Carex* spp., and *Aster* spp.] occurred on all sites and accounted for 50 to 91% of the total density and 27 to 75% of the total cover. Early successional species were well represented at all sites. Seedling survivorship, germination, and overstory contribution of seeds, caused varied site representation of species. This study provides base line data for observing variation in species richness and diversity that will result from experimental harvest methods.

INTRODUCTION

Recent emphasis on the maintenance of biological diversity in forest ecosystems has prompted researchers to evaluate the impacts of forest management techniques on biodiversity (Swindel et al. 1984, Swindel et al. 1991; McMinn 1991, 1992). Forest practices that alter site conditions to improve tree regeneration may change biological diversity patterns. Harvesting and other disturbances in the eastern deciduous forests can change the relative composition of tree species (Parker and Swank 1982) and strongly influence species diversity (Elliott and Swank 1994). A wide variety of other community and ecosystem properties may be altered (Pastor and Post 1986, Huston and Smith 1987). Diversity is impacted by human disturbances, and potentially linked with ecosystem processes (Schulze and Mooney 1993, Vitousek and Hooper 1993, Tilman 1996), and long-term site productivity (see Huston 1979, 1994; Tilman 1996). Much of the overall diversity depends on plant diversity, because plants provide both food and habitat for other organisms (Hunter 1990). Knowledge of vascular plant diversity and changes that occur with disturbance may provide planning information to wildlife biologists and silviculturalists.

Natural community classification systems, in which a combination of physical habitat, vegetation, physiognomy, species composition, and soils or geology classify types, are useful in formulating management plans. The inherent variation within communities and ecosystems

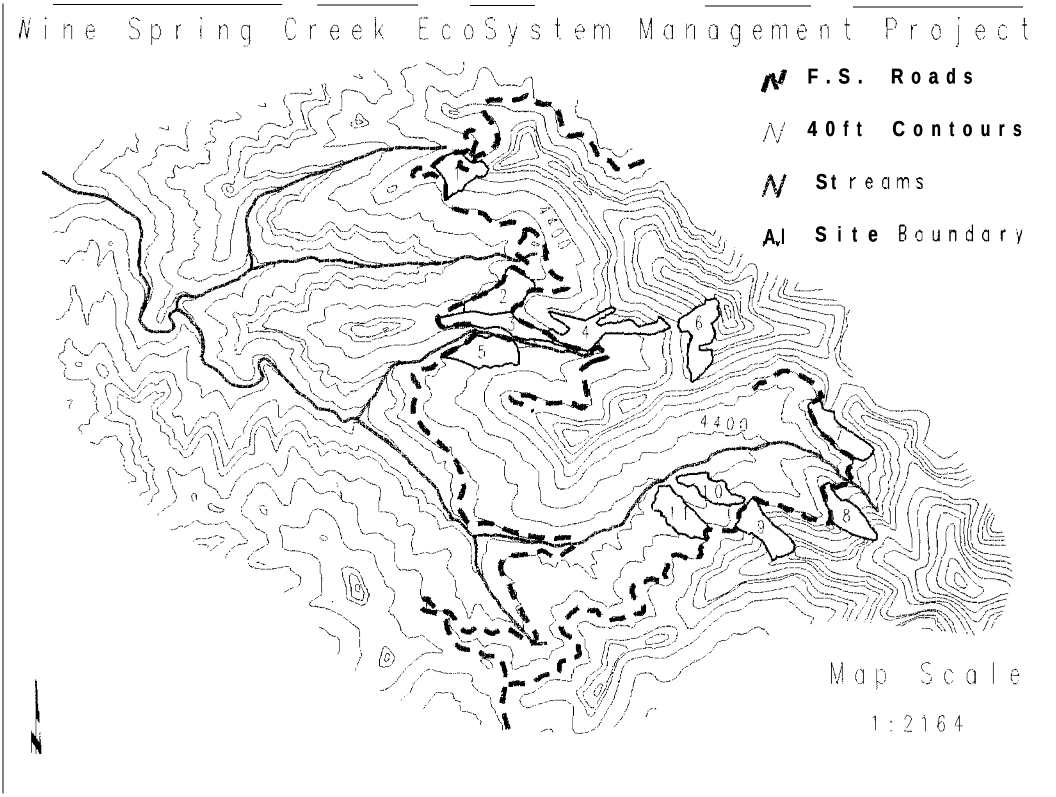

Figure 1. Map of the 11 study site locations (site numbers correspond to values in Tables 1–4), Wine Spring Creek, Nantahala National Forest, western North Carolina.

must be documented and used for base-line data to effectively predict the outcome of disturbances, such as regeneration harvest methods, on floristic diversity and richness.

Our objective was to describe the variation in plant species diversity and richness among *Quercus rubra-Rhododendron calendulaceum* communities within the Wine Spring Creek Watershed in the Nantahala National Forest, western North Carolina. All species nomenclature follows Radford et al. (1968). This study is the beginning of a long-term ecosystem research project planned for the watershed to evaluate the impacts of several regeneration harvest methods on plant diversity of Southern Appalachian mixed-hardwoods. The initial species diversity and richness before treatment should influence the long-term results of various harvest methods.

METHODS

Site Descriptions

The study area was located in the Wine Spring Creek watershed in the Nantahala National Forest of the Southern Appalachian Mountains in western North Carolina (35°15′N latitude, 83°35′W longitude). Wine Spring Creek is within the Blue Ridge Mountain District of the Blue Ridge physiographic province. Three tributaries (Wine Spring Creek, Bearpen Creek, and Indian Camp Branch) converge and drain into Nantahala Lake at the western edge of the watershed boundary (Figure 1). Eleven sites ranging from 4.0 ha to 6.6 ha in size were chosen based on similarity in overstory and shrub-layer composition, topography, geology, and elevation (Figure 1). Sites were located (Figure 1) using the Landscape Ecosystem Classification (LEC) system of

McNab and Browning (1992), which classifies sites according to overstory, topography, and elevation. The areas are described as dry, high-elevation (1,370–1,670 m), intermediate mixed-hardwoods (McNab and Browning 1992). The dominant overstory species is *Quercus rubra* (northern red oak), with *Rhododendron calendulaceum* (flame azalea), a mid-story dominant. Although sites 2, 3, and 4 are adjacent, Site 2 and Site 3 are separated by a ridge crest, and Site 3 and Site 4 are separated by a road. Portions of Site 2 and Site 5 (<25% of the area) have north-facing slopes (hence more mesic conditions), so sample plots were located on south- and west-facing slopes within *Quercus rubra/Rhododendron calendulaceum* communities.

Soils on the sites are derived from gneiss and granite bedrock (Thomas 1993). Elevations range from 1,380 to 1,580 m. During the last 3 years, average annual precipitation and average annual temperature were 180 cm and 11.5°C, respectively. Average minimum temperature in January was 1.0°C and average maximum temperature in July was 21.9°C (Swift, unpubl. data).

Disturbance history

Prior to 1842, Winespring Creek was occupied by Cherokee Native Americans who practiced semiannual burning to improve forage for livestock and game. Between 1842 and 1900, European settlers continued light semiannual burning (Alger 1993, unpubl. report). All of the study areas were acquired by USDA Forest Service from private ownership in 1912. Most of the land was logged prior to Forest Service acquisition. The death of *Castanea dentata* caused by chestnut blight fungus [*Endothia parasitica* (Murr.) P.] began in the early 1920s and by 1940 virtually all chestnut trees over 10 cm dbh were killed (Woods and Shanks 1959). In the mid-1950s small sales focused primarily on the salvage of blight-killed C. *dentata*. These sites were selectively cut in the early 1970s (Bill Culpepper, pers. comm.). This history of disturbance and timber management practices are typical for the Southern Appalachian Mountains (Swank and Culpepper 1992, Swank et al. 1994).

Sampling Design

Within each of the 11 sites, four randomly located 0.08-ha plots were permanently marked and inventoried for overstory and understory plants. Diameter of all tree stems ≥5.0 cm diameter at breast height (dbh) was measured to the nearest 0.1 cm and recorded by species in each 0.08 ha plot. Diameter at the base (5 cm from ground level) was measured on shrub-layer species (woody stems, <5.0 cm dbh and >1.0 m in height) in two 3 by 5 m subplots in the NW and SE corner of each 0.08-ha plot. Within each of the four plots per site, four 2.0 m^2 quadrats were placed diagonally 2.0 m from each corner, and herbaceous vegetation was surveyed during May and June. Presence, number, and percent cover for each species within quadrats were sight estimated 10% interval classes.

Data Analysis

Species diversity was evaluated using Shannon-Weiner's index of diversity (H') and Pielou's (1966) evenness index (J'). Shannon-Weiner's index incorporates both species richness and the evenness of species abundance (Magurran 1988). Because determining the degree to which each factor contributes to diversity is impossible from the calculated value of H' alone (Peet 1974, Patil and Taillie 1982, Christensen and Peet 1984), a separate measure of evenness (J') was calculated. Diversity was calculated as: $H'_{Density} = p_i \ln p_i$, where p_i = proportion of total density of species i; or H',, = $p_i \ln p_i$, where p_i = total basal area of species i. Species evenness was calculated as: $J'_{Density}$ or J',, = $H'_{Density}$ or H',, $\div H'_{MAX}$, where H'_{MAX} = maximum level of diversity possible within a given population = ln(number of species). Importance values (IV) for woody species were calculated as: (relative density + relative basal area) ÷ 2. Separate analyses were performed for each vegetative layer (i.e., overstory, shrub-layer, and herb-layer). Overstory and herb-layer diversity measures were related using Pearson's correlation analysis (SAS 1987).

Table 1. Overstory richness (S, number species present per site), average density and basal area (BA), species diversity (H′), and species evenness (J′) of the 11 sites at Wine Spring Creek Watershed, Nantahala National Forest, western North Carolina

Site		S	Density (stems ha⁻¹)	BA (m^2 ha^{-1})	$H'_{Density}$	$J'_{Density}$	H'_{BA}	J'_{BA}
1		14	759	26.86	1.81	0.686	1.74	0.658
2		19	1,050	33.09	2.32	0.787	2.09	0.708
3		22	997	28.66	2.11	0.682	1.98	0.639
4		17	1,191	28.15	2.03	0.715	1.79	0.632
5		19	1,088	26.78	2.16	0.732	1.95	0.662
6		14	631	26.13	1.76	0.668	0.68	0.258
7		9	900	27.10	1.59	0.724	1.20	0.545
8		17	1,081	21.84	1.86	0.657	1.35	0.478
9		16	1,056	25.79	2.25	0.812	1.67	0.603
10		17	1,062	27.78	1.80	0.636	1.57	0.556
11		15	1,219	24.81	1.92	0.710	1.66	0.613
Community	X	16	1,003	27.0	1.96	0.710	1.61	0.577
	SE	1.02	53.3	0.83	0.068	0.016	0.121	0.037
	CV	20.7%	17.6%	10.2%	11.5%	7.5%	25.1%	21.4%

Note: H′ = Shannon-Wiener index of diversity, ($-\Sigma$ pilnpi). J′ = Pielou's estimate of evenness of species distribution, (H'/H_{max}) where H_{max} = ln(S). X = average; SE = standard error of the estimate; CV = coefficient of variation.

RESULTS

Twenty-seven tree species, 13 shrubs, and 108 herbaceous species were present in the 11 study sites (the complete species list is available from Coweeta Hydrologic Laboratory, USDA Forest Service). The tree species included three groups: shade-tolerant species characterized by Nyssa *sylvatica, Fagus grandifolia, Tsuga canadensis, Oxydendrum arboreum, Amelanchier arborea,* and *Hamamelis virginiana;* intermediate species characterized by *Acer rubrum, Fraxinus americana, Halesia carolinia, Quercus prinus, Quercus rubra,* and *Quercus alba*; and shade-intolerant species characterized by *Betula lenta, Carya* spp., *Castanea dentata,* and *Robinia pseudoacacia* (Burns and Honkala 1990). Additional overstory species infrequently encountered included *Tilia heterophylla, Prunus serotina, Prunus pensylvanica, Sassafras albidum, Quercus velutina, Betula alleghaniensis, Magnolia fraseri, Magnolia acuminata, Aesculus octandra, Acer pensylvanicum,* and *Acer saccharum.* A mixture of early and late successional species was found in the herb stratum. Early successional species were represented by genera such as *Solidago, Aster,* and *Eupatorium.* Late successional species were represented by genera such as *Lilium, Viola,* and *Thelypteris.*

Overstory

Although the basal areas of the 11 sites were quite similar, ranging from 22 to 33 m^2 ha^{-1} with nine of the eleven sites between 25 and 29 m^2 ha^{-1}; the densities ranged from 631 to 1,219 stems ha^{-1}, almost a two-fold difference (Table 1). Richness (number of species present per site) ranged from 9 to 22 with an average of 16 tree species per site. Overstory $H'_{Density}$ ranged from 1.59 to 2.32, with an average of 1.96. Overstory H',, ranged from 0.68 to 2.09, with an average of 1.61. The coefficient of variation in basal area among sites was less than the coefficient of variation in density, yet the variation in H'_{BA} and J'_{BA} was greater than the variation in $H'_{Density}$ and $J'_{Density}$.

Site 6 had the lowest H',, and J',, (Table 1) because *Quercus rubra* was dominant with an IV of 63%. *Acer rubrum, Quercus rubra, Amelanchier arborea,* and *Castanea dentata* were present on all sites. On the basis of IV of overstory species, these four species represented 32 to 84% of the overstory abundance. *Halesia Carolina* was the most important species on Site 2 and second most important on Site 5; with this species absent or not well represented on the other sites. *Fagus grandifolia* had a high IV on Site 10, made a small contribution to three

Table 2. Shrub-layer richness (S, number species present per site), average density and basal area (BA), species diversity (H′), and species evenness (J′) of the 11 sites at Wine Spring Creek Watershed, Nantahala National Forest, western North Carolina

Site		S	Density (stems ha^{-1})	BA (m^2 ha^{-1})	$H'_{Density}$	$J'_{Density}$	H'_{BA}	J'_{BA}
1		14	7,750	1.71	1.97	0.746	1.92	0.728
2		12	4,083	0.64	2.03	0.817	2.18	0.877
3		16	13,333	2.36	1.53	0.552	1.32	0.476
4		18	21,916	2.57	1.77	0.612	1.76	0.609
5		17	6,833	1.24	2.33	0.822	2.26	0.798
6		9	13,667	3.35	1.51	0.687	1.28	0.582
7		6	13,249	2.76	0.64	0.357	0.40	0.223
8		11	9,917	1.90	1.79	0.742	1.67	0.696
9		13	7,500	1.58	1.94	0.756	1.55	0.604
10		12	11,667	2.11	1.33	0.535	0.85	0.342
11		14	15,000	2.92	1.37	0.519	1.17	0.443
Community	X	12	11,356	2.10	1.66	0.650	1.49	0.580
	SE	1.45	‘1,480	0.794	0.136	0.044	0.169	0.059
	CV	40.2%	43.2%	37.8%	27.4%	22.6%	37.6%	33.9%

Note: H’ = Shannon-Wiener index of diversity, ($-\Sigma$ pilnpi). J’ = Pielou’s estimate of evenness of species distribution, (H'/H_{max}) where H_{max} = ln(S). X = average; SE = standard error of the estimate; CV = coefficient of variation.

additional sites, **and** was absent from the others. *Quercus prinus* occurred on nine of the 11 sites, with IV ranging from 0.5 to 25.9%, and with an IV of more than 11% in seven of the sites.

Shrub-Layer

Variation in species composition and diversity was greater in the shrub-layer than in the overstory stratum (Table 2). Basal area ranged from 0.64 to 3.35 m^2 ha^{-1} and density ranged from 4,083 to 21,916 stems ha^{-1}, a five-fold difference. Woody species richness in the shrub-layer ranged from 6 to 18. A greater range in $H'_{Density}$ and H’,, also existed in the shrub-layer as compared to the overstory.

Site 7 had the lowest $H'_{Density}$, $J'_{Density}$, H'_{BA}, and J’,, because *Rhododendron calendulaceum* dominated the site with an IV of 87%. *Rhododendron calendulaceum* and *Castanea dentata* were the only species present on all sites and accounted for 28.5 to 92.3% of the shrub-layer abundance. *Quercus rubra* occurred on 10 sites and *Vaccinium corymbosum* and *Amelanchier arborea* occurred on 9 sites. *Ilex ambigua* var. *montana* and *Magnolia acuminata* made a moderate contribution to Site 2, with a combined IV of 35.8%, but made much smaller contributions to the other sites.

Herb-layer

Herb-layer H’ ranged from 1.74 to 3.01, with an average of 2.36 (Table 3). Site 3 had the highest species diversity and Site 9 had the lowest species diversity. Species evenness (J′) ranged from 0.436 to 0.706. However, most of the sites were relatively similar in evenness (ranged between 0.5 to 0.6). Richness ranged from 51 to 73 species per site. The most common species were *Thelypteris noueboracensis, Prenanthes trifoliolata, Carex* spp. (including C. *pensylvanica*), *Viola hasta, Medeola uirginiana, Solidago* spp. *(arguta* or *curtisii),* and *Aster* spp. (Table 4). These species occurred frequently in all sites, occupying from 50 to 91% of the density, and 27 to 75% of the ground cover. *Anemone quinquefolia* occurred frequently in nine of the 11 sites; *Melampyrum lineare* and *Angelica triquinata* occurred in eight sites; and *Gaylussacia ursina* occurred in large numbers in seven sites (Table 4).

Because the area of landscape covered was large, finding identical species in every site would be unlikely. Some of the species that did not occur on all sites were seedlings of tree species

Table 3. Herb-layer richness (S, number species present per site), diversity **(H′)**, and evenness (J') of the 11 sites at Wine Spring Creek Watershed, Nantahala National Forest, western North Carolina

Site		S	H'	J'
1		72	2.98	0.697
2		63	1.97	0.475
3		71	3.01	0.706
4		60	2.63	0.642
5		71	2.48	0.582
6		73	2.08	0.485
7		62	2.17	0.525
8		67	2.47	0.587
9		54	1.74	0.436
10		51	2.15	0.546
11		65	2.24	0.536
Community	X	64	2.36	0.565
	SE	2.22	0.121	0.027
	CV	11.5%	17.1%	15.6%

Note: H' = Shannon-Wiener index of diversity. J' = Pielou's estimate of evenness of species distribution. X = average; SE = standard error of the estimate; CV = coefficient of variation.

such as *Tilia americana, Aesculus octandra,* and *Betula lenta.* The absence of these seedlings at certain sites may result from poor seed production, poor seed germination or poor seedling survival. Uncommon herbaceous species that occurred in only one *2.0* m^2 subplot per site included *Oxypolis rigidior, Chelone glabra, Impatients pallida, Isotria vertieullata, Cypripedium acaule, Heuchera villosa, Aruncus dioicus, Pycnanthemum incanum, Solidago erecta, Cacalia atriplicifolia, Polypodium virginianurn, Tradescantia* spp., *Dryopteris intermedia, Phlox caroliniana,* and *Ranuculus* spp.

Many genera and species were found in each of the 11 sites. The genera provided an additional assessment of the high level of floristic richness in these areas. The 144 species and 111 genera tallied were distributed among 55 families. Families represented by the greatest numbers of taxa were the Asteraceae (12 genera, 22 species), Liliaceae (11 genera, 15 species), Ericaceae (7 genera, 12 species), and Rosaceae (7 genera, 8 species). Other families represented by a number of species were the Ranunculaceae, Scrophulariaceae, Lamiaceae, and Aspidiaceae. However, more than half the families were represented by only one genus with a single species.

Although a range in values among sites was found for both overstory (i.e., density, basal area, richness, $H'_{Density}$, $J'_{Density}$, H'_{BA}, J'_{BA}) and herb-layer measures (i.e., richness, H', or J'), overstory measurements were not significantly related to herb-layer measurements of diversity. H',, was more highly related to evenness of distribution of species basal area (J'_{BA})(r = 0.948, p = 0.0001) than to tree richness (r = 0.658, p = 0.0277). $H'_{Density}$ was equally influenced by evenness of density distribution and richness (r = 0.675, p = 0.0227 for $J'_{Density}$; r = 0.741, p = 0.009 for tree richness). Although H',, was significantly related to tree density, no significant relationship existed between $H'_{Density}$ and tree density. In addition, overstory basal area was not significantly related to any of the overstory measures of diversity (species richness, H', or J' based on basal area or density).

DISCUSSION

In general, vegetation diversity was lower in the *Quercus rubra-Rhododendron calendulaceum* communities of Wine Spring Creek than in other nearby forested watersheds. Overstory diversity was much lower in the Wine Spring Creek study sites than in a low elevation, 29-year-old clearcut forest in the Coweeta Basin (Elliott and Swank 1994). Even diversity estimated by community types (cove-hardwoods, H', = 1.98; mixed-oak, H',, = 2.08; and oak-pine, H',, = 2.08)

Table 4. Distribution of the most abundant ground flora species among the 11 sites at Wine Spring Creek Watershed, Nantahala National Forest, western North Carolina; listed above parentheses as proportional density [(n_i/N)*100], average percent cover in parentheses, and frequency of occurrence (out of a possible 16 plots per site) below parentheses

Species	Sites 1	2	3	4	5	6	7	8	9	10	11
Carex spp. (including *pensylvanica*)	0.08	0.02	0.13	6.4	0.02	25.9	4.8	24.0	22.7	41.3	24.6
	(0.1)	(0.1)	(0.2)	(2.5)	(0.1)	(1.2)	(0.2)	(7.0)	(7.0)	(8.9)	(8.9)
	2	2	3	1	1	8	3	13	6	10	10
Prenanthes trifoliolata	6.3	54.7	25.1	25.9	44.7	5.5	7.2	15.2	49.0	10.0	9.8
	(3.1)	(17.5)	(5.1)	(6.2)	(9.4)	(5.1)	(5.1)	(6.3)	(19.4)	(6.3)	(5.1)
	5	16	7	5	12	8	8	11	12	7	10
Thelypteris noveboracensis	26.8	6.0	9.6	20.3	4.5	43.1	45.3	22.4	6.0	4.7	4.9
	(15.6)	(10.0)	(5.0)	(7.6)	(6.9)	(51.9)	(28.1)	(23.1)	(7.1)	(6.9)	(9.4)
	15	15	5	8	12	16	16	16	11	6	9
Viola hasta	12.7	6.0	10.9	5.5	8.0	0.65	16.0	7.2	5.2	3.4	7.8
	(6.3)	(10.0)	(7.5)	(4.4)	(9.4)	(1.2)	(11.9)	(9.4)	(9.4)	(5.1)	(7.6)
	10	15	10	7	13	2	16	15	10	9	14
Medeola virginiana	1.2	2.0	0.27	0.51	4.1	0.37	2.7	3.0	6.6	4.8	2.5
	(2.6)	(3.9)	(1.2)	(0.7)	(5.0)	(0.8)	(6.3)	(5.9)	(11.4)	(5.7)	(5.7)
	5	9	2	2	8	3	10	13	11	9	10
Solidago spp. (mostly *curtisii* and *arguta)*	5.1	0.63	2.4	1.7	2.8	1.7	1.7	2.0	0.57	0.76	0.50
	(17.0)	(8.9)	(11.2)	(3.8)	(8.9)	(10.7)	(13.4)	(10.4)	(6.5)	(3.8)	(5.1)
	16	16	11	6	10	11	14	15	12	7	8
Aster spp. (mostly *divaricatus, lateriflorus, cordifolius, undulatus*	3.5	0.09	1.4	0.36	2.1	0.38	0.66	0.65	0.51	0.22	0.31
	(8.0)	(0.3)	(4.8)	(1.4)	(5.9)	(4.4)	(3.1)	(3.6)	(5.4)	(0.3)	(2.0)
	11	5	9	2	9	6	9	10	10	5	4

Table 4. Continued.

Species	Sites 1	2	3	4	5	6	7	8	9	10	11
Anemone quinquefolia	0.67 (0.6) 1	10.1 (5.6) 6		8.8 (3.2) 5	6.9 (1.9) 2	5.0 (6.2) 8	6.0 (5.7) 9	7.7 (6.9) 12	2.9 (4.6) 8	1.3 (1.3) 3	0.01 (0.1) 1
Galax aphylla			2.7 (1.2) 2	1.9 (0.6) 1	—	—				14.1 (7.6) 7	31.4 (25.6) 8
Gaylussacia ursina			—	0.48 (1.9) 1	3.6 (13.8) 4	—	1.1 (4.4) 1	1.9 (6.9) 2	0.47 (6.2) 3	8.2 (38.2) 16	5.2 (35.7) 11
Melampyrum lineare	2.9 (3.8) 6	—	6.3 (8.2) 13	6.2 (5.0) 8	3.2 (6.2) 8	—	0.01 (0.1) 1	—	0.10 (0.7) 2	2.2 (6.4) 13	3.0 (9.4) 15
Angelica triquinata	0.14 (1.4) 4	—	—	0.33 (1.2) 2	0.10 (1.9) 2	0.35 (2.5) 3	2.3 (11.3) 16	0.78 (5.8) 10	0.97 (8.9) 9	—	0.42 (5.0) 8
Proportional density of above species (%) (percent cover)	59.4 (58.5)	79.5 (56.3)	58.8 (44.4)	78.4 (38.5)	80.0 (69.3)	82.9 (84.0)	86.6 (89.6)	84.8 (85.3)	95.0 (86.6)	91.0 (90.5)	90.5 (119.6)

within the Coweeta Basin watershed (Elliott, unpubl. data) was higher than the average H'_{BA} for the Wine Spring Creek sites. Herb-layer diversity was also lower in the Wine Spring Creek study sites than in the Coweeta Basin watershed (H' = 2.99; Elliott, unpub. data). Although more species were present on the Wine Spring Creek sites than in the Coweeta Basin watershed herb-layer (S = 51, J' = 0.781, J' was much lower at Wine Spring Creek. Just five species out of the average of 64 species per site at Wine Spring Creek accounted for 64% of the total abundance. In addition, diversity of the herb-layer on a high-elevation, reference watershed (undisturbed since 1927) in Coweeta Basin was also higher (H' = 2.88) (Sankovski 1994) than the average herb-layer diversity of the *Quercus rubra-Rhododendron calendulaceum* community at Wine Spring Creek.

How communities differ in response to disturbance depends on their age, species composition, regeneration status, and the basic site conditions, such as soils, aspect, degree of slope, and moisture regime (Denslow 1980, Peet 1978). In addition, the effects of the frequency and intensity of disturbance will influence the level of change in species diversity and composition (Pickett and White 1985, Hobbs and Huenneke 1992, Roberts and Gilliam 1995). Elliott et al. (in review) found that community types within a Southern Appalachian watershed differed in vegetation diversity response to clearcutting. Some selective harvest methods may mimic natural disturbance regimes where the death of single or multiple trees occur due to drought, disease, insect, lightning, or windthrow (Smith 1991, Clinton et al. 1993), while other methods (e.g., clearcut, shelterwood cut) will reduce overstory basal area substantially, allowing for large openings in the forest canopy (Loftis 1983, 1990). Some studies note an increase in plant species diversity following forest cutting (Nixon and Brooks 1991, Reader and Bricker 1992), but others note a decline in species diversity after cutting (Parr 1992, Elliott and Swank 1994). Reader and Bricker (1992) found that selective harvesting a northern hardwoods forest did not decrease diversity of the understory herb community. Comparisons of harvesting techniques within a community classification framework has not been attempted. By first classifying vegetation into community types, and then imposing various harvesting techniques, the effects of different disturbance regimes on plant species diversity and richness may be evaluated.

This study provides a baseline of knowledge of the community structure and diversity of overstory, shrub-layer, and herb-layer species in high-elevation Southern Appalachian forests dominated by *Quercus rubra* and *Rhododendron calendulaceum* prior to the implementation of regeneration harvest treatments. Spatial heterogeneity within and among these 11 forest sites contributes to their current level of diversity. We found a relatively large number of many different species, genera, and families in these high-elevation, dry *Quercus rubra-Rhododendron calendulaceum* communities. The prior disturbance history (e.g., selective cutting ca. early 1970's) may have enhanced species richness found in these areas, but reduced diversity by favoring the dominance of relatively few species. However, the presence of many less dominant species contributed to high species richness. Of the families and genera present, some species tended to dominate the sites in each stratum. In the overstory, *Quercus rubra, Acer rubrum, Amelanchier arborea,* and *Castanea dentata* dominated the sites; *Rhododendron calendulaceum* and *Castanea dentata* were most abundant in the shrub-layer; and only seven understory herbs dominated the herb-layer. Dominance of certain species by density does not suggest an even distribution of a particular species across a plot. For example, *Carex* spp. had a very high density and frequency, but occurred in clumps rather than being evenly distributed throughout the sampled quadrats. However, *Thelypteris noveboracensis* and *Gaylussacia ursina* were high in frequency and density and covered a large percentage of the quadrat area.

Although classifying vegetation into unit types is important for management purposes, recognizing the variability within and among community types is equally important, even with the best classification system. Measuring that variability before site treatments, such as timber harvest, will help assess the effects of harvest on post-treatment vegetation responses. The 11 sites were different in composition and diversity and quantifying variation before implementing treatments will allow the use of analyses to better assess actual post treatment differences (Zar 1984, Snedecor and Cochran 1980).

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