COMMONWEALTH of VIRGINIA

Ecological Communities of the Bull Run Mountains, Virginia

Baseline Vegetation and Floristic Data for Conservation Planning and Natural Area Stewardship

Prepared by:
Virginia Department of Conservation and Recreation
Division of Natural Heritage
Richmond, Virginia

Prepared for:
Virginia Outdoors Foundation
Aldie, Virginia

Natural Heritage Technical Report 02-12
July, 2002

Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

ECOLOGICAL COMMUNITIES OF THE BULL RUN MOUNTAINS, VIRGINIA
Baseline Vegetation and Floristic Data for Conservation Planning and Natural Area Stewardship

Natural Heritage Technical Report 02-12
July 2002

by
Gary P. Fleming
Virginia Department of Conservation and Recreation
Division of Natural Heritage
217 Governor Street, 3rd Floor
Richmond, Virginia 23219

prepared for
Virginia Outdoors Foundation
Aldie Mill
39395 John Mosby Highway
Aldie, Virginia 20105

This report may be cited as follows:
Fleming, G.P. 2002. Ecological communities of the Bull Run Mountains, Virginia: baseline vegetation and floristic data for conservation planning and natural area stewardship. Natural Heritage Tech. Rep. 02-12. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report submitted to the Virginia Outdoors Foundation. 274 pp. plus appendix.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHIC PLATES

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ac – acre(s).
acidic – having a pH value < 7.0, often indicating moderate or low fertility; in practice, the following degrees of soil acidity are recognized by the USDA: < pH 4.5 = extremely acidic; pH 4.5 to 5.0 = very strongly acidic; pH 5.1 to 5.5 = strongly acidic; pH 5.6 to 6.0 = moderately acidic; pH 6.1 to 6.5 = slightly acidic.
Al – aluminum.
allelopathic – of or pertaining to the release by an organism of a chemical substance that acts as an inhibitor to the germination or growth of another organism.
alluvial – of or pertaining to deposition of sediment by a stream.
alluvium – unconsolidated sand, silt, clay, or gravel deposited by running water; see also *colluvium*.
aspect – the direction a slope faces (*e.g*., a north aspect).
B – boron.
basal area – the cross-sectional area of a tree at breast height; extrapolated to a larger area, basal area is an estimated measure of how much of a site is occupied by trees.
base cation – the positively-charged ions of substances (*e.g*., calcium and magnesium) that in solution can bind and remove hydrogen ions or protons.
basic – as applied to soils, having high levels of base cation (*e.g*., calcium, magnesium) saturation, typically indicating high fertility; as applied to rocks, having high concentrations of iron, magnesium, and calcium.
basin wetland – a depression wetland with no or limited surface outlet.
biomass – the total weight of all living organisms in a biological community; in vegetation science, usually the total weight of all above-ground plant parts.
bog – in strict usage, an ombrotrophic peatland with organic soils > 40 cm deep; more generally applied (in the southeastern United States) to any non-forested, oligotrophic wetland with groundwater-controlled hydrology.
boulderfield – a sheet of coarse, loose, rock fragments mantling a slope; a collective term including talus, scree, block fields, and bouldery colluvium.
bryophyte – a non-vascular green plant; includes mosses, hornworts, and liverworts. See *non-vascular*.
Ca – calcium.
calcareous – having high levels of calcium carbonate; applied to both soils and rock; in practice, DCR-DNH ecologists consider soils with calcium levels of >1200 parts per million to be calcareous.
carbonate rock – collective term for limestone and dolomite.
categorical variable – a property or quantity that is represented by discrete units, *e.g*., geologic rock types or vegetation types, rather than by a gradient.
CEC – cation exchange capacity, *i.e*., the total amount of exchangeable cations that a particular soil or material can bind at a given pH; exchangeable cations are held mainly on the surface of colloids of clay or humus; measured in milligrams per 100 g of soil.
cm – centimeter(s).
clone – a group of genetically identical individuals derived from a common ancestor by asexual division; applied in vegetation science to a colony or group of plants generated by vegetative sprouting from underground rootstocks. See *rhizomatous*.
clonal – producing clones by vegetative sprouting from underground rootstocks; rhizomatous.
cluster analysis – a method of numerical classification that evaluates the similarity of quantitative samples and, through an interactive statistical process, fuses into clusters those samples that are most similar; two different types of cluster analysis have been used in vegetation ecology: DCR-DNH ecologists use *agglomerative-hierarchical cluster analysis*, which starts with each sample in its own group and progressively fuses them into larger groups.
cohort – a group of individuals of the same age or generation.
collinearity – a numerical problem that results when variables in a regression model are highly correlated.
colluvial – of or pertaining to colluvium.
colluvium – unconsolidated earth materials deposited on steep slopes by direct gravitational action and local unconcentrated run-off. See also *alluvium*.
community – as applied to plants, any unit of vegetation regardless of rank or development; an aggregation of plants on the landscape; in broader terms, any assemblage of organisms that co-occur and interact.

community type – an abstract unit of vegetation representing concrete plant communities sharing a similar structure and floristic composition, and occurring under similar environmental conditions; more or less equivalent to the "association" used in traditional phytosociological studies and the U.S. National Vegetation Classification.
continuous variable – a property or quantity that could be any conceivable value within an observable or measurable range.
cover – the percentage of the ground covered by the vertical projection of above-ground plant parts.
crustose lichen - a lichen adhering closely to, and difficult or impossible to separate from, its substrate; crustose lichens abundantly cover most exposed rock outcrops. See *lichen*.
Cu – copper.
dbh – diameter at breast height (1.4 m [4.6 ft] above the ground); the standard position at which woody stems are measured in forestry procedures.
dendrogram – a tree-like graphic that depicts the results of cluster analysis.
density – the number of plants per unit area; used more specifically in this study as a measure of the number of woody stems ≥ 2.5 cm (1 in) in diameter at breast height per hectare.
dip slope – a side slope determined by and approximately aligned with the angle of the underlying bedrock plane.
diabase – an intrusive, mafic, volcanic rock composed largely of plagioclase feldspar and dark silicate minerals; similar to, and intermediate in texture between, gabbro and basalt.
dolomite – a sedimentary rock composed of calcium and magnesium carbonate. See also *limestone*.
dominant – of or pertaining to an organism or taxon that by its size, abundance, or coverage exerts considerable influence on a community's biotic and abiotic conditions.
dry-mesic – intermediate between dry and moist but well drained; submesic to subxeric.
duff – the matted, partly decomposed organic surface layer of forest soils.
dummy variable – a binary variable of 0's and 1's, which is one if the observation belongs to a category and zero if it does not.
ecotone – a transitional area where characteristics of adjacent communities or environments intermingle or intergrade.
ecosystem – a complete interacting system of organisms and their environment, applicable at any spatial scale.
edaphic – of or pertaining to the influence of soils on living organisms, particularly plants.
endemic – geographically restricted; a species or taxonomic group restricted to a particular geographic region.
environmental gradient - a spatially varying aspect of the environment (*e.g*., elevation, slope position, soil pH) that is expected to be related to species composition.
environmental variable - a measure of the environment that is presumably related to an environmental gradient; environmental variables can be continuous, or they can be represented by ordinal or dummy variables. See *continuous variable*, *dummy variable*, *environmental gradient*, *ordinal variable*.
ericaceous – of the Heath Family (*Ericaceae*). See *ericad*.
ericad – a plant of the Heath Family (*Ericaceae*); for example, blueberries (*Vaccinium* spp.), rhododendrons (*Rhododendron* spp.), and mountain-laurel (*Kalmia latifolia*).
exotic – an introduced, non-native species.
Fe – iron.
fen – in strict usage, a minerotrophic, enriched peatland with organic soils > 40 cm deep; more generally applied (in the southeastern United States) to similar wetlands lacking, or with only superficial, organic soils.
flora – all the plants that make up the vegetation of a specified area. See also *vegetation*.
floristic – of or pertaining to the flora of an area and the geographic patterns of distribution represented by its taxa. See also *floristics*.
floristics – the study of a flora and the geographic distributions of its taxa.
floodplain – a nearly level alluvial plain that borders a stream and is subject to inundation (non-tidal) under flood-stage conditions.
foliose lichen - a lichen typically lying flush to its substrate, but removable such that the lower surface is visible; foliose lichens are often attached to rocks and other substrates by numerous fine structures called rhizines. See *lichen*.
forb – a broad-leaved herbaceous plant.
forest – vegetation dominated by trees (≥ 6m [20 ft] tall) producing a more or less closed canopy, typically with 60-100% cover; some forests may temporarily have < 60% canopy cover following disturbances such as windthrow, disease, etc. See also *woodland*.

fruticose lichen – a lichen that grows erect or pendent, with thalli that have no clearly distinguishable upper and lower surfaces; includes species that are branched and shrubby, as well as those that form unbranched stalks. See *lichen*.
ft – foot (feet).
gabbro – an intrusive igneous, mafic rock composed primarily of plagioclase feldspar and pyroxene.
geomorphic – of or pertaining to processes that change the form of the earth (*e.g.*, volcanic activity, running waters, glaciers).
graminoid – grasses and grass-like plants (*e.g.*, sedges and rushes).
granite – an igneous rock composed predominately of feldspar and quartz.
greenstone – a metamorphosed basalt composed predominantly of plagioclase, chlorite, epidote, and albite.
groundwater – water occurring below the earth's surface in bedrock and soil.
ha – hectare(s).
heath - a plant of the Heath Family (*Ericaceae*); an Ericad; for example, blueberries (*Vaccinium* spp.), rhododendrons (*Rhododendron* spp.), and mountain-laurel (*Kalmia latifolia*).
herb – a vascular plant lacking woody tissue at or above ground level.
herbivory – the consumption of plants by animals.
hibernacula – over-wintering den sites used by animals such as bats, snakes, and insects that hibernate in a state of torpor.
Holocene – an Epoch of the Quaternary Period of geologic time, from approximately ten thousand years ago to the present.
humus – decomposed organic matter that has lost all trace of the structure and composition of the vegetable or animal matter from which it was derived.
hydric –wet and poorly drained (in the broad sense; see Table 3, p. 21 for a more specific definition).
in – inch(es).
indirect gradient analysis – an analytical technique in which gradients are unknown a priori, and are inferred from species composition data; in vegetation ecology, usually performed using an ordination technique.
interstice – an intervening space or crevice.
interstitial – of or pertaining to interstices.
Jurassic – the second period of the Mesozoic era (following the Triassic), from approximately 190 to 135 million years ago.
K – potassium.
km – kilometer(s).
liana – a woody vine.
lichen – a symbiotic association between a fungus and one or more species of algae and/or blue-green algae; although not based on genetic relationships, lichen species, for the aid of identification, are divided into foliose, fruticose, crustose, and umbilicate groups based on their growth strategies. See *crustose lichen*, *foliose lichen*, *fruticose lichen*, *umbilicate lichen*.
limestone – a sedimentary rock composed predominantly of the mineral calcium carbonate (calcite). See also *dolomite*.
lithologic – of or pertaining to the physical characteristics of a rock.
lithology – the description of rocks on the basis of physical characteristics such as color, mineralogical composition, and grain size.
lithophyte – a vascular plant confined to or particularly characteristic of rock habitats (outcrop crevices, shelves, ledges).
lithophytic – of or pertaining to lithophytes.
liverwort - a nonvascular, chlorophyll-containing plant closely related to mosses and hornworts, but differing in reproductive structures; liverworts have two dominant growth forms, one which resembles moss with overlapping leaves, the other forming prostrate leafless bodies. See *non-vascular*.
m – meter(s).
macroinvertebrate – an animal lacking a backbone (invertebrate) and visible without the aid of magnification.
mafic – geologically, containing large amounts of dark-colored silicate minerals rich in magnesium and iron, *e.g.*, pyroxene, amphibole, and biotite mica; examples include igneous and metamorphic rocks such as amphibolite, basalt, diabase, gabbro, and greenstone; also applied to soils with high levels of magnesium and iron that are derived from these formations. See also *ultramafic*.
MANOVA – see multivariate analysis of variance.
mesic – of intermediate moisture conditions (*i.e.*, moist and well-drained).
mesophyte – a plant characteristic of mesic environments.

mesophytic – of or pertaining to plants or vegetation adapted to environments of moist, well-drained sites.
Mesozoic – an Era of geologic time, from the end of the Paleozoic to the beginning of the Cenozoic, or about 225 to 65 million years ago; includes the Triassic, Jurassic, and Cretaceous periods.
metabasalt – metamorphosed basalt, a fine-grained igneous rock composed largely of plagioclase feldspar, pyroxene, and volcanic glass. See *greenstone*, a metabasalt underlying extensive portions of the northern Blue Ridge and western Piedmont foothills in Virginia.
metamorphic – altered in mineral composition, chemical composition, and structure by heat, pressure, and hot fluids at some depth below the earth's surface; applied to rocks of igneous and sedimentary origin.
metasedimentary – consisting of sedimentary rock that shows evidence of having been subject to metamorphism; examples include quartzite (= metasandstone) and metasiltstone.
metavolcanic – consisting of metamorphosed rocks of volcanic origin, *e.g*., metabasalt.
Mg – magnesium.
mi – mile(s).
microclimate – the local climate of a small site; this may vary from the climate of the larger, surrounding area due to aspect, tree cover, elevation, wind exposure, and other local factors.
microhabitat – within a habitat, a subdivision or precise location that has distinctive environmental characteristics; *e.g*., a tree-base hummock in a flooded swamp.
microtopography – the fine-scale variation in topography within a habitat; *e.g*., the pattern of vertical rock faces, shelves, and crevices on a cliff.
Mn – manganese.
monadnock – an isolated hill or range of hills, resulting from erosion of the surrounding terrain; usually underlain by relatively resistant rocks.
monospecific – consisting wholly or largely of a single species.
moss - a nonvascular chlorophyll-containing plant closely related to liverworts and hornworts, but differing in reproductive structures. See *non-vascular*.
multivariate analysis of variance – a technique which simultaneously tests differences between more than one dependent variable by relating variation to a set of independent variables.
multivariate technique – any analysis that simultaneously examines the behavior of more than one dependent variable.
muscovite – a mineral of the mica group that is common in gneisses and schists; also known as "white mica."
Na – sodium.
NMDS – see *non-metric multidimensional scaling*.
non-metric multidimensional scaling – an ordination technique, based on indirect gradient analysis, that maximizes, to the extent possible, the rank-order (*i.e*., non-parametric) correlation between inter-sample dissimilarity and inter-sample distance in ordination space.
non-vascular – lacking a structural system of tissue (xylem and phloem) that conducts water and soluble nutrients; non-vascular plants include mosses, lichens, and liverworts.
oligotrophic – infertile; nutrient-poor.
ordinal variable – a property or quantity that may be represented by an ordered or ranked scale of values that denote relative magnitude.
ordination – a multivariate technique that arranges vegetation samples in relation to each other based on compositional similarity and relative species-abundances. Ordination procedures summarize multidimensional data in a reduced coordinate system, extracting those axes that explain the most variation in the data. See *non-metric multidimensional scaling*.
overstory – the uppermost layer of trees forming the canopy of a forest or woodland.
p – the probability of observed data if a null hypothesis is true; if the p-value is small (typically, < 0.05), then the result is considered statistically significant.
P – phosphorus.
palustrine – of or pertaining to non-tidal wetlands.
patch-dominant – a species that exerts dominance by forming dense but spatially discrete colonies; such a species typically varies from abundant to completely absent within a given habitat.
pathogen – an organism that causes disease in another organism.
pH – a value on the scale 0 to 14 that gives a measure of the acidity or alkalinity of a medium.
phyllite – a metamorphosed sedimentary rock intermediate in grade between slate and mica schist; minute crystals of sericite mica impart a silky, silvery sheen to the cleavage surfaces.
physiognomic – of or pertaining to vegetative form and structure.
physiognomy – the form and structure of vegetation.

phytogeography – the study of the geographic distribution of plants and vegetation , with an emphasis on environmental determinants of distribution.

Pleistocene – the first Epoch of the Quaternary Period of geologic time, from approximately two million to ten thousand years ago.

pyrophytic – of or pertaining to plants or vegetation adapted to environments in which fire is an important ecological process.

quartzite –metamorphosed sandstone; see *sandstone*.

r – correlation coefficient, a number which reflects the strength of the relationship between two variables; this value varies between -1 (for a perfect negative relationship) and +1 (for a perfect positive relationship).

r^2 – correlation coefficient squared, a value between 0 and 1 known as the coefficient of determination; indicates the proportion of variance in a dependent variable that can be explained by its dependence on independent variables. In cluster analysis, the r^2 cut-off level is a measure of within-cluster variance, which increases as more units are added to a cluster (*i.e.*, $r^2 = 1$ when all samples are in their own cluster, and $r^2 = 0$ when all samples are in one cluster).

recruitment – generally, the trees involved in natural supplementation of a forest stand; more specifically, trees that have entered a particularly category (age or size class) during a given period.

refugia – sites where plants or vegetation that formerly had much wider distributions have survived locally through periods of unfavorable conditions in a region.

regolith – all unconsolidated earth materials above solid bedrock.

rhizomatous – having a horizontal, creeping, perennial rootstock that produces smaller roots and vegetative shoots.

riparian – of the area beside a stream, especially a river.

rill – a small streamlet or rivulet.

ruderal vegetation – vegetation resulting from succession following anthropogenic disturbance of an area; generally characterized by unnatural combinations of species (primarily native though including small to substantial numbers of exotics) and relatively short persistence in the absence of additional disturbance.

sandstone – a medium-grained sedimentary rock composed of rounded sand grains cemented together by silica, iron oxide, or calcium carbonate.

saturated – wet for extended periods during the growing season, but never or rarely flooded by surface water; usually applied to wetlands maintained by seepage inputs or perched water tables.

scalar – a synthetically derived measure of the environment that functions as a pseudo-continuous or ordinal variable; examples include TRMI and Relative Slope Position (see 23). See *continuous variable*, *environmental variable*, *ordinal variable*.

schist – a metamorphic rock containing abundant, visible platy minerals (*e.g.*, mica), giving it a pronounced foliation and cleavage; see *muscovite*, the common mica in schists of the Bull Run Mountains.

sedimentary – formed from the deposition and compression of mineral and rock particles, and sometimes material of organic origin; examples of sedimentary rocks include sandstone, shale, and limestone.

seep – a small area of groundwater discharge, either non-forested or shaded by trees rooted in adjacent, upland habitats; seeps generally support characteristic herbaceous wetland species but are too small or narrow to support hydrophytic woody vegetation.

seepage swamp – a large area of groundwater discharge supporting wetland forest or shrubland vegetation.

seral – of or pertaining to an intermediate or transitional stage in plant succession.

serotinous cone – the cone of a pine that remains closed for a period of time, sometimes years, following maturation; the opening of such cones are often triggered by the heat of fires; a reproductive adaptation that ensures seed dispersal under optimal conditions.

shale - a fine-grained sedimentary rock composed of mud, silt, and clay grains and characteristically splitting into thin layers.

snag – a standing dead tree.

sp. – a species.

spring ephemeral – a plant that completes its reproductive cycle early in the growing season, typically before or during the period in which trees leaf out; such species usually die back and become dormant during unfavorable summer months when habitats are characterized by high temperatures and deep shade.

spp. – species (plural).

ssp. – subspecies, a taxonomic rank below species.

stratigraphy – the arrangement of bedrock strata, particularly their geographic position and chronological order of sequence.

stratum – a distinct vertical layer of vegetation defined by relative height (*e.g.*, overstory, understory) and/or by a specific range of heights (see p. 20).

sub-canopy – the understory tree layer immediately below the overstory.
submesic – somewhat moist but well drained, or intermediate between dry and moist; dry-mesic.
sub-shrub – a low, slightly shrubby plant, usually dying back annually to a woody base; such plants often are treated as herbs; examples include *Chimaphila maculata* (spotted wintergreen) and *Hypericum hypericoides* ssp. *multicaule* (St. Andrew's cross).
subxeric – somewhat dry and drought-prone; intermediate between submesic and xeric.
succession – natural change in the composition and structure of a plant community over time in the absence of disturbance.
successional – of or pertaining to the process of succession.
surface substrate – a collective term for the abiotic materials (*e.g.*, leaf litter, rocks, dead wood) that constitute the ground cover of a site.
TBS – see total base saturation.
terrestrial – of or pertaining to upland (non-wetland) environments.
total base saturation – the extent to which the exchange sites of a soil are occupied by exchangeable base cations (*e.g.*, calcium and magnesium), expressed as a percentage of the total cation exchange capacity. See *CEC*.
Triassic – the earliest period of the Mesozoic Era, from approximately 225 million to 190 million years ago.
TRMI – Topographic Relative Moisture Index, a synthetic environmental variable used to quantitatively estimate potential site moisture (see p. 23).
ultramafic – derived from igneous rocks with little feldspar and large amounts of mafic minerals; compared to mafic rocks, ultramafic rocks contain larger quantities of heavy metals and were formed deeper in the earth's mantle; examples include serpentinite, soapstone, and talc-tremolite schist. See also *mafic*.
umbilicate lichen - a leaf-like lichen attached to rocks by a single cord; umbilicate lichens, especially those of the genus *Umbilicaria*, are often referred to as "rock tripes." See *lichen*.
understory – collective term for the small trees and shrubs growing beneath the canopy in a forest or woodland.
var. – variety, a taxonomic rank below species.
vascular – having a structural system of tissue (xylem and phloem) that conducts water and soluble nutrients; vascular plants include ferns and flowering plants.
vegetation – the plant life of an area, including its floristic composition, structure, biomass, and phenology. See also *flora*.
woodland – vegetation dominated by trees (≥ 6m [20 ft] tall) producing an open canopy, typically with 5-60% cover; such vegetation with canopy cover from 5 to 25% is referred to as a sparse woodland; some woodlands may have > 60% canopy cover following elimination or reduction of natural disturbances (*e.g.*, fire). See also *forest*.
xeric – dry; drought-prone.
xerophyte – a plant or vegetation type adapted to dry environments.
Zn – zinc.

ACKNOWLEDGMENTS

First and foremost I would like to thank Leslie Grayson, Director of the Virginia Outdoors Foundation (VOF) Northern Virginia office, for supporting biological research in the Bull Run Mountains and working tirelessly over many years to protect the area's important habitats. Without her advocacy and logistical support, this project could not have been completed. I am also indebted to Michael Kieffer (Executive Director, Friends of Bull Run) and Susan Leopold (Indian Pipe Outdoor Technical School and VOF) for their capable assistance with much of the field work and some of the logistics for the project. Susan Leopold also transcribed most of the plot data, and Tamara Hager (Arlington Outdoor Education Association) assisted in arranging access to several key properties in the southern part of the study area.

My colleague Dean P. Walton participated in several days of field work, collected and identified many lichens, and was instrumental in assembling the annotated list of lichens. As always, DCR-DNH ecologist Philip P. Coulling provided sound guidance on quantitative analysis and statistics, as well as continuous collaboration on issues of community classification. DCR-DNH ecologist Karen D. Patterson reviewed the manuscript and suggested a number of editorial improvements. DCR-DNH ecology technician Gina Pisoni also assisted with editorial and administrative tasks.

Other individuals who contributed to the field work are Tanya Amrhein, Diane Barnes, Leslie Grayson, Curtis Hutto, Mike Leahy, Kathleen McCoy, Rick Myers, Michelle Parrish, Patrick Somers, Howard Thompson, and Tamara Hager. I am grateful to Charles E. Stevens for sharing the results of many years of botanical work in the area; to Chris Ulrey (National Park Service ecologist) for producing the Potential Solar Radiation Index using a custom program in SAS; to C. Scott Southworth (U.S. Geological Survey) for valuable help in understanding the study area’s geology; and to Mark Strong (Smithsonian Institution, U.S. National Herbarium) for checking several historical plant specimens collected in the Bull Run Mountains.

Private landowners who generously allowed me to study vegetation on their properties include the Arlington Outdoor Education Association (Neil Heinekamp and Tamara Hager), Lavinia Currier, Claude Schoch, Tod Sedgwick, Doug Fout, Andrea Currier, Dr. F. Turner Reuter, Mr. and Mrs. F. Turner Reuter, Jr., Mr. and Mrs. Harry Rositzke, Mr. and Mrs. David Rochester, and the Federal Aviation Administration.

Finally, I would like to express my appreciation to the anonymous donor whose funding supported many aspects of this work.

Plate 1. High Point cliffs, the Bull Run Mountains' most dramatic and well-known geomorphic feature. A woodland dominated by *Pinus pungens* (Table-Mountain Pine) covers the clifftop, while a lichen-dominated community covers the vertical rock faces. Photo © Gary P. Fleming.

Plate 2. Wooded boulderfield in Jackson Hollow, north of Thoroughfare Gap. Because of the gnarled growth form of trees, these habitats were largely passed over by loggers and now support some of the oldest trees in the area. Photo: Gary P. Fleming, DCR-DNH.

Plate 3. Large colony of *Aralia nudicaulis* (wild sarsaparilla) on north-facing slope of High Point Mountain above Hopewell Gap. This northern and montane herb forms clones up to about one hectare in extent from creeping rootstocks. Photo: Gary P. Fleming, DCR-DNH.

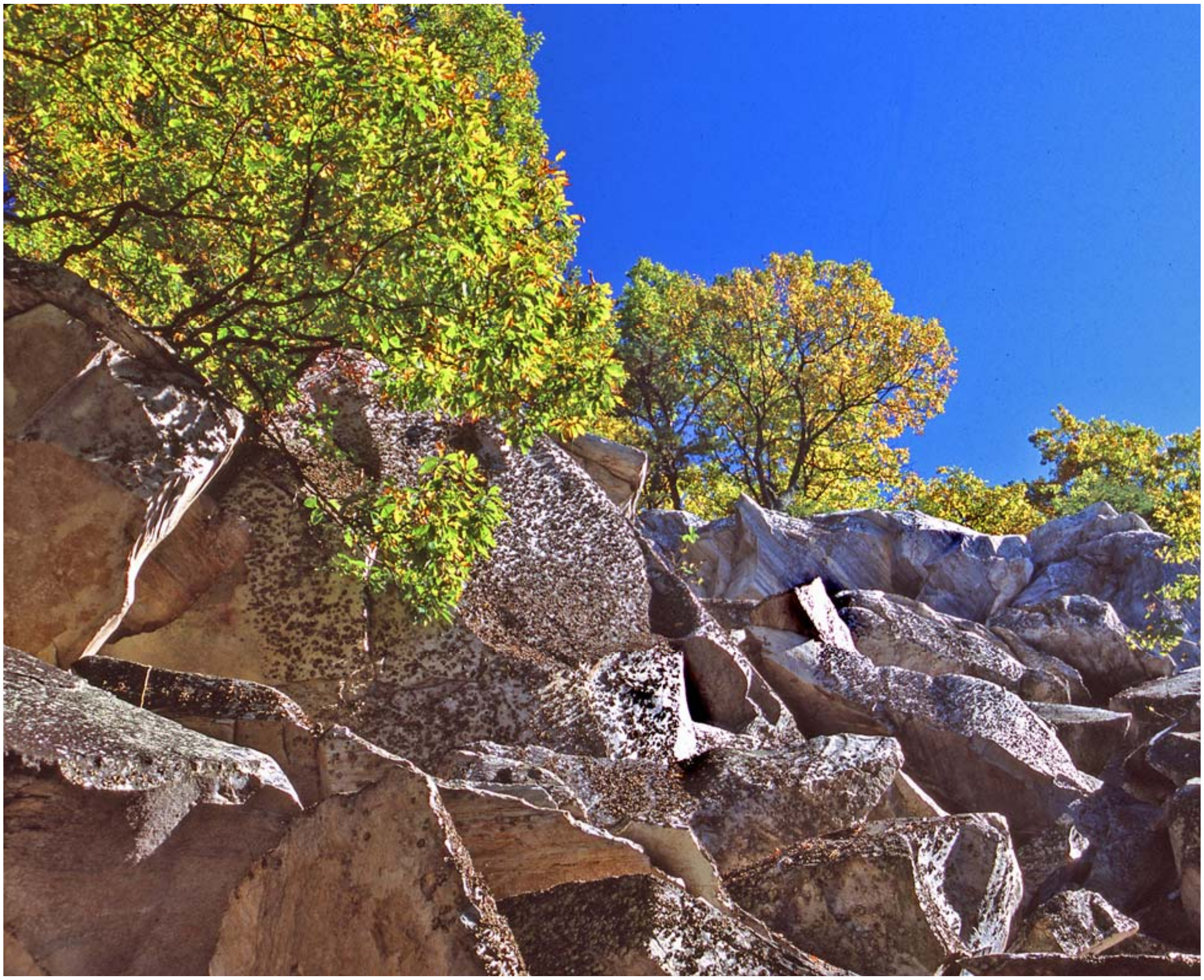


Plate 4. Large quartzite talus blocks weathered from, and lying below, High Point cliffs. Photo © Gary P. Fleming.

Plate 5. Summer foliage reflecting in Catletts Branch, one of several pristine, spring-fed interior streams in the Bull Run Mountains. Photo © Gary P. Fleming.

INTRODUCTION

In May of 2002, the Bull Run Mountain Natural Area was formally dedicated as the 34th State Natural Area Preserve. Consisting of nearly 1,000 hectares (2,500 acres), the property is owned by the Virginia Outdoors Foundation (VOF), an organization whose mission is to preserve natural, scenic, open-space, and recreational lands in the Commonwealth. Development of a comprehensive stewardship plan for the Natural Area will demand a collaborative approach involving VOF; the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR-DNH), the agency responsible for management of the state natural area preserve system; Friends of Bull Run (FoBR), a community-based group that has leased and managed 320 hectares (800 acres) of VOF land for public uses since 1994; and private landowners whose properties neighbor the preserve.

The events leading up to and culminating in this dedication span nearly seven decades, during which time the Bull Run Mountains have probably received more scrutiny by scientists, conservationists, and planners that any comparable landscape in Virginia. Standing alone as a narrow, monadnock-like series of ridges, the Bull Run Mountains comprise a prominent, isolated area of rugged highland terrain within the gentle, lower-lying Piedmont. Located only about 56 km (35 mi) west of Washington, D.C., the area also now lies just beyond the westernmost sprawl of the greater D.C. metropolitan region.

History of Scientific Studies and Conservation Efforts in the Bull Run Mountains

From 1934 to 1952, USDA Plant Pathologist Harry A. Allard conducted extensive botanical studies in the Bull Run Mountains, collecting more than 15,000 specimens of vascular plants and lichens. During the first eight years of this study alone, Allard made close to 55 visits to the area a year and claimed to have exceeded 4,800 kilometers (3,000 miles) of actual walking (Allard and Leonard 1943). Fortunately, most results of this study were published (Allard 1940, 1942, 1944a, 1961; Allard and Leonard 1943, 1944a, 1944b, 1952). In these papers Allard, a keen student of ecological processes and habitat conditions, provides an exceptionally detailed depiction of the Bull Run Mountains' landscape, vegetation, and flora as it was in the 1930's and 1940's. The specimens collected by Allard and his colleague E.C. Leonard now reside largely at the Smithsonian Institution.

In the 1960's, the Natural Areas Council, Inc., with funding from America the Beautiful Fund and private contributions, began to buy land to protect the Bull Run Mountains. Various regional studies recognized the area as a unique natural and scenic site, a recreational resource, and the source of headwaters to Goose Creek and the Occoquan River, both vital to the Northern Virginia drinking water supply (National Park Service 1965, Wirth and Associates 1965). In 1965, the first Virginia Outdoors Plan identified the Bull Run Mountains as the highest priority for a State Park (Virginia Outdoor Recreation Study Commission 1965).

In the Critical Environmental Areas report prepared under the direction of the 1972 General Assembly's Senate Bill 436 (Virginia Division of State Planning and Community Affairs 1972), the Bull Run Mountains met four of five possible criteria to qualify as a Virginia Critical Environmental Area: 1) unusual natural features, 2) crucial to an ecological system, 3) natural, scenic, and historical environments that are endangered, and 4) appropriateness for public use through future acquisition. During the 1970's, there were further calls for the establishment of a State Park on the mountain, and preliminary plans for such a facility were drawn up for the Virginia Department of Conservation and Economic Development, Division of Parks (Abbott Associates 1972). During the 1970's, the area was evaluated by several groups and recommended to the National Park Service for National Landmark status (Radford and Martin 1975, Racine 1978, Bleil and Shea 1980). These reports considered the undisturbed forests and disjunct mountain species of the High Point Mountain / Catletts Branch area to be unusual or unique for the Piedmont, as well as "nationally significant" (Racine 1978). Finally, in 1979, the Virginia Outdoors Plan recommended the preservation of the Bull Run Mountains as a State Natural Area, recognizing limitations to developing the area for recreational use (Commission on Outdoor Recreation 1979).

By the late 1970's, facing funding problems, the Natural Areas Council transferred its land holdings in the Bull Run Mountains to VOF, whose Trustees adopted a primary management objective "to preserve the Bull Run Mountains as a natural area" (Minutes, Oct. 1979 VOF Trustees meeting). Through the 1980's, VOF continued to acquire land for conservation with funds contributed by private individuals while also commissioning additional studies of potential uses (*e.g.*, Stovall 1980).

In 1980, a popular treatment of the Bull Run Mountains' ecology, containing numerous factual errors, was published in A Sierra Club Naturalist's Guide to The Piedmont (Godfrey 1980). In the late 1970's and 1980's three individuals – Charles E. Stevens, F. Raymond Fosberg (Smithsonian Institution), and the current author – conducted periodic botanical studies in the Bull Run Mountains, documenting a number of species not found in Allard's earlier work. During the same period, William H. Martin began monitoring geographically isolated populations of the timber rattlesnake (*Crotalus horridus horridus*) in the area.

In 1994, Friends of Bull Run (FoBR) was founded as a non-profit, community organization and leased 320 ha (800 ac) of the Bull Run Mountains from VOF to provide educational and recreational opportunities to the public. As water quality became more of an issue in Northern Virginia, the Wetlands Science Institute included Broad Run at Thoroughfare Gap in a four-year study of fish diversity as an index of water quality (Teels and Danielson 2001). The Audubon Naturalist Society also began conducting a long-term study of several northern Virginia streams, revealing that the Bull Run Mountains' Catletts Branch (Plate 5) supports an exceptionally high diversity of macroinvertebrates for the region (C. Fairweather, ANS, pers. comm.). During this period, the Virginia Department of Forestry provided VOF with recommendations for wildlife habitat enhancement and preservation of forest cover. A consultant study (Earth Design Associates 1997), as well as the 1996 Virginia Outdoors Plan (Virginia Dept. of Conservation and Recreation 1996), recommended a master plan for preservation of the mountain as a natural area and the development of a trail traversing the ridges from Aldie Mill on the north to Thoroughfare Gap on the south.

In 1998, DCR-DNH conducted a reconnaissance inventory of VOF land holdings in the Bull Run Mountains (Fleming *et al.* 1999). This study identified nine outstanding occurrences of five natural community types, as well as populations of seven uncommon odonates (dragonflies and damselflies) and two uncommon groundwater amphipods. Moreover, this evaluation recognized the Bull Run Mountains for its 1) biogeographic significance as a meeting ground of disjunct species from both the mountains and the Coastal Plain; 2) high quality and diversity of natural communities, including some that are uncommon or rare in the Piedmont; and 3) viability on an ecosystem scale due to a large, unfragmented forest cover and relatively pristine hydrology. As a result, DCR-DNH recommended Natural Area Dedication as the most appropriate tool for long-term, permanent conservation of VOF lands in this area. VOF Trustees subsequently adopted a resolution accepting this recommendation, leading to the formal dedication in the spring of 2002.

Purpose of the Current Study

Despite the nearly continuous attention lavished on the Bull Run Mountains by botanists and land planners of various discipline, the area's ecological communities and the environmental factors associated with them have never been defined in a systematic, quantitative way. Many of the reports cited above, including the DCR-DNH study, have employed varying, somewhat ambiguous, generic community names (*e.g.*, oak-hickory forest, mixed mesophytic forest) and forest "cover types" to describe the landscape-level ecological units that characterize the area. A more rigorous classification of communities, based on field-collected data and their analysis, will be crucial for providing baseline information to guide stewardship of, and specific management decisions for, the new Natural Area Preserve. In addition, such information will help inform ongoing conservation activities by VOF and may be useful to the area's many private property owners who care deeply about their land and the future of the region.

Therefore, the objectives of this study are to:

- provide a detailed ecological community classification for the Bull Run Mountains using quantitative methods;

- update and consolidate data on the vascular flora and lichens of the area;

- use the wealth of available historical data to identify significant past and ongoing changes affecting the local biota, and

- identify specific threats, problems, data gaps, and research opportunities that need to be addressed by future work.

An **ecological community** is defined as an assemblage of co-existing, interacting species, considered together with the physical environment and associated ecological processes, that usually recurs on the landscape. The present study is restricted to **natural communities**, those which have experienced only minimal human alteration or have recovered from anthropogenic disturbance under mostly natural regimes of species interaction and disturbance. No portion of Virginia's landscape, however, has altogether escaped modern human impacts – direct or indirect – and only a few small, isolated habitats support communities essentially unchanged from their condition before European settlement. Most of the Bull Run Mountain communities treated here, while somewhat modified in composition or structure, are in mid- to late-successional stages of recovery from some form of human disturbance, such as agricultural conversion or logging. As far as can be ascertained with existing data, they represent the potential natural communities of the study area landscape. Early-successional forests that have experienced recent disturbance and communities of highly modified habitats such as fields, roadsides, and plantation forests were not studied in detail and are given only cursory treatment. Such communities may nevertheless develop into natural systems given sufficient time and freedom from further anthropogenic disturbance.

Classifications of natural communities can be based on various components (*e.g.*, vegetation, fauna, landforms, hydrologic regime), used singly or in combination. Except in deepwater systems, however, plants have proven to be the most useful components for characterizing finer-scale communities and providing a basis for comparing classifications covering different geographic areas. Although animals, especially invertebrates, can be very important in natural communities, they are often highly mobile, difficult to document, and found in many different ecological settings. Likewise, environmental conditions and processes encompass a spatially diverse array of factors from regional climate to site-specific moisture conditions that are usually impossible or excessively time- and labor-intensive to measure directly. On the other hand, the plants that together form the vegetation of a site are immobile, are easy to measure in a variety of ways, and typically reflect (both individually and as an assemblage) specific site conditions. Despite the drawback that it can be dynamic over short time periods,

> Vegetation is often chosen as the basis for a single-factor system for classifying terrestrial ecological systems because it generally integrates the ecological processes operating on a site or landscape more measurably than any other factor or set of factors .... Because patterns of vegetation and co-occurring plant species are easily measured, they have received far more attention than those of other components, such as fauna. Vegetation is a critical component of energy flow in ecosystems and provides habitat for many organisms in an ecological community. In addition, vegetation is often used to infer soil and climatic patterns. For these reasons, a classification ... based on vegetation can serve to describe many (though not all) facets of biological and ecological patterns across the landscape (Grossman *et al.* 1998).

Accordingly, DCR-DNH ecologists use vegetation as the standard for defining ecological communities. Our program is strongly committed to a "specimen-based" approach to community classification that depends on structural, floristic, and environmental plot data collected from uniform areas supporting homogeneous stands of vegetation. Although the analogy is imperfect, data from each plot represents a "specimen" that may be compared with other plot data in order to delimit vegetation "taxa," in much the same way as a botanist analyzes preserved plant specimens to determine and describe the taxonomic limits of species. As a result, procedures for observing, measuring, describing, and comparing vegetation are standardized to a specific scale, which facilitates more precise and objective characterization of vegetation types than is possible through purely qualitative field observation. It is important to note that our method uses the *full floristic composition* of stands, not just the woody species, in community classification.

Ecological studies of distinctive landscapes such as the Bull Run Mountains contribute heavily toward a long-term goal of providing a comprehensive classification of all natural communities in Virginia. This goal is integral to the mission of the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR-DNH), which is responsible by statutory authority for documenting, protecting, and managing "the habitats of rare, threatened, or endangered plant and animal species, rare or state-significant communities, and other natural features" (*Code of Virginia* 10.1: 209-217). As part of its work, the Division maintains database information on the status, distribution, and ecology of all natural communities and rare native species; protects and manages these resources through a system of natural area preserves; and provides information and technical advice to other agencies, organizations, and individuals. Within this context, community inventory and classification represent an important "coarse-filter" approach to biological conservation that ensures the viability of diverse organisms. By identifying and protecting excellent examples of all natural community types, the majority of native plant and animal species, including a host of cryptic and poorly known ones, can be conserved without redundant individual attention.

STUDY AREA

Physiography and Hydrology

The study area is located in northern Virginia, approximately 56 km (35 mi) west of Washington, D.C., encompassing portions of Fauquier, Prince William, and Loudoun Counties (Fig. 1). This area is situated in the western, or inner, part of the Piedmont Plateau physiographic province (Fenneman 1938) and consists of a complex of sharp ridges with narrow, intervening valleys. This highland complex extends north from New Baltimore (Fauquier County) for approximately 24 km (15 m) to Aldie (Loudoun County), varying from about 1.5 to 3.5 km (0.9 to 2.2 mi) wide and rising conspicuously above the surrounding terrain (Figs. 2-5).

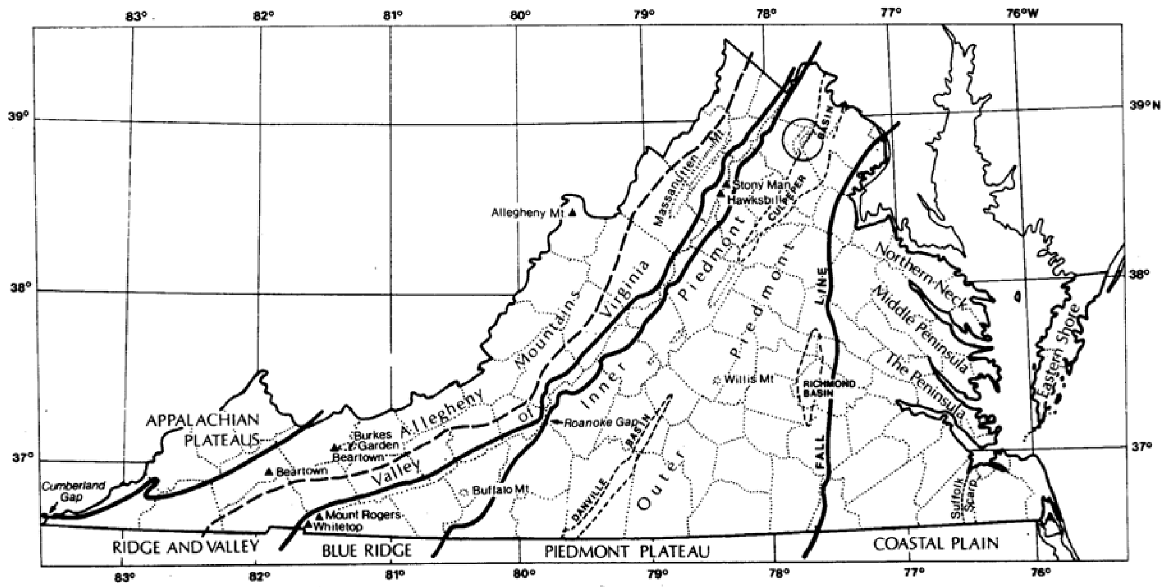


Figure 1. Location of the study area (circled) in Virginia. Modified from Woodward and Hoffman (1991), with permission.

The ridges are interrupted by three major gaps. From south to north, these are Thoroughfare Gap, where the mountain is breeched by the passage of Broad Run; Hopewell Gap, which is cut by the headwaters of Little Bull Run; and Cold Spring Gap, which is cut by the headwaters of Bull Run. Broad Run, the largest stream in the area, originates in the Watery Mountains about 12 km to the southwest and generates floodplain and aquatic habitats not found elsewhere in the study area. The interior valleys are drained by Catletts Branch, a tributary of Broad Run; Catharpin Creek (Jackson Hollow), a tributary of Little Bull Run; and the headwaters of Bartons Creek and Hungry Run, tributaries of the Little River. All waters originating in the Bull Run Mountains ultimately drain to the Potomac River, those flowing north via Goose Creek, and those flowing southeast via the Occoquan River. The interior drainages are characterized by cold, spring-fed brooks and braided stream channels with numerous lateral seeps and springs. The abundant and usually continuous outflow of groundwater seepage in the valleys is due in large part to the favorable geotechnical properties of the area's bedrock and soils.

The southern end of these highlands, from New Baltimore to Thoroughfare Gap, consists of knobs and short ridges referred to as the Pond Mountains (Fig. 2). North of Thoroughfare Gap, the area becomes wider and higher, consisting of High Point Mountain on the west and a parallel ridge to the east (Fig. 3).

Bull Run Mountains Study Area

Southern Section: Pond Mountains

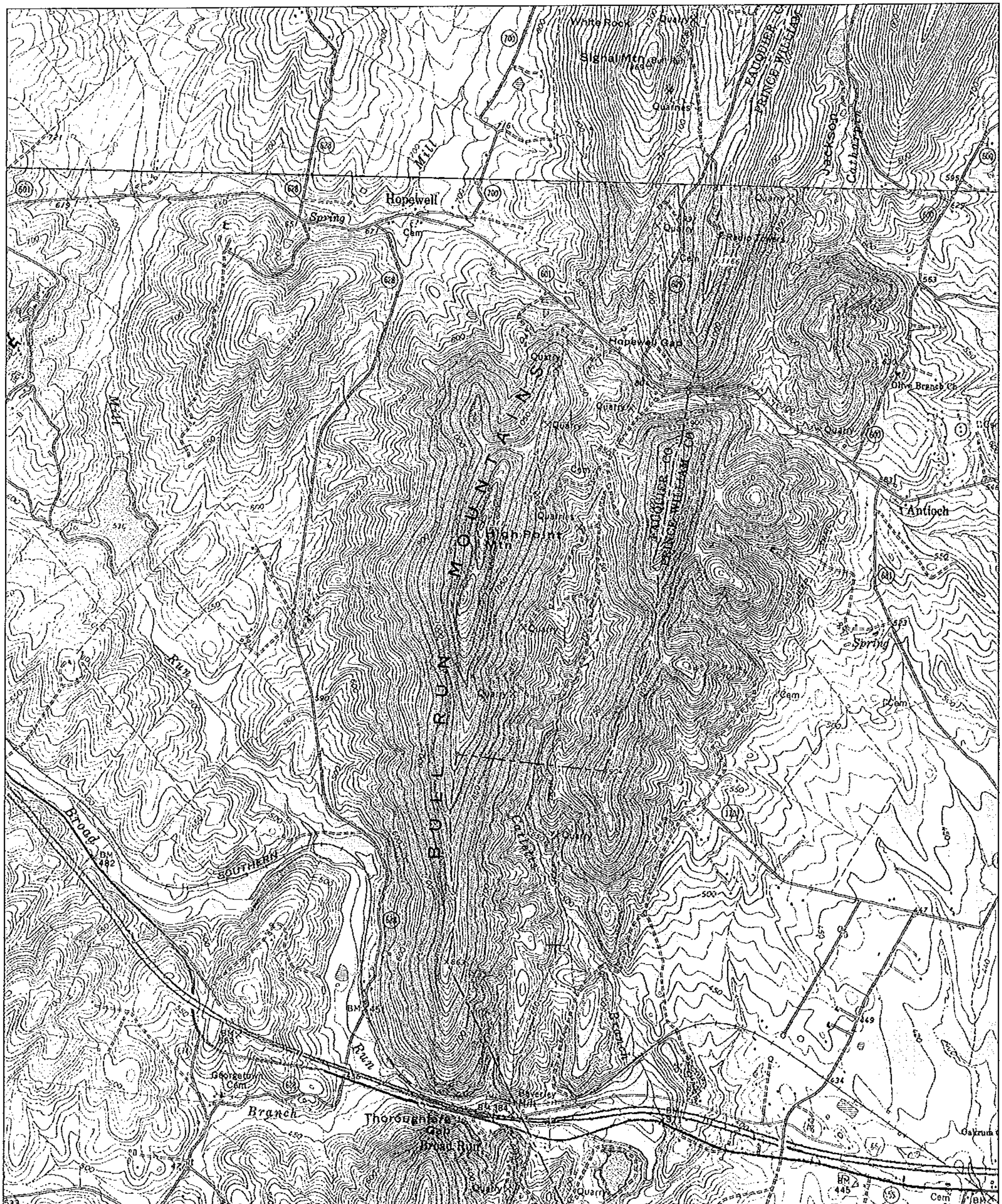
USGS Thoroughfare Gap 7.5' Quadrangle

FIGURE 2

300 0 300 600 Meters

1:30000

N



Bull Run Mountains Study Area

Central Section: Thoroughfare Gap to Signal Mtn

USGS Thoroughfare Gap and Middleburg 7.5' Quadrangles

300 0 300 600 Meters

1:30000

N

FIGURE 3

Bull Run Mountains Study Area

Central Section: North of Signal Mtn

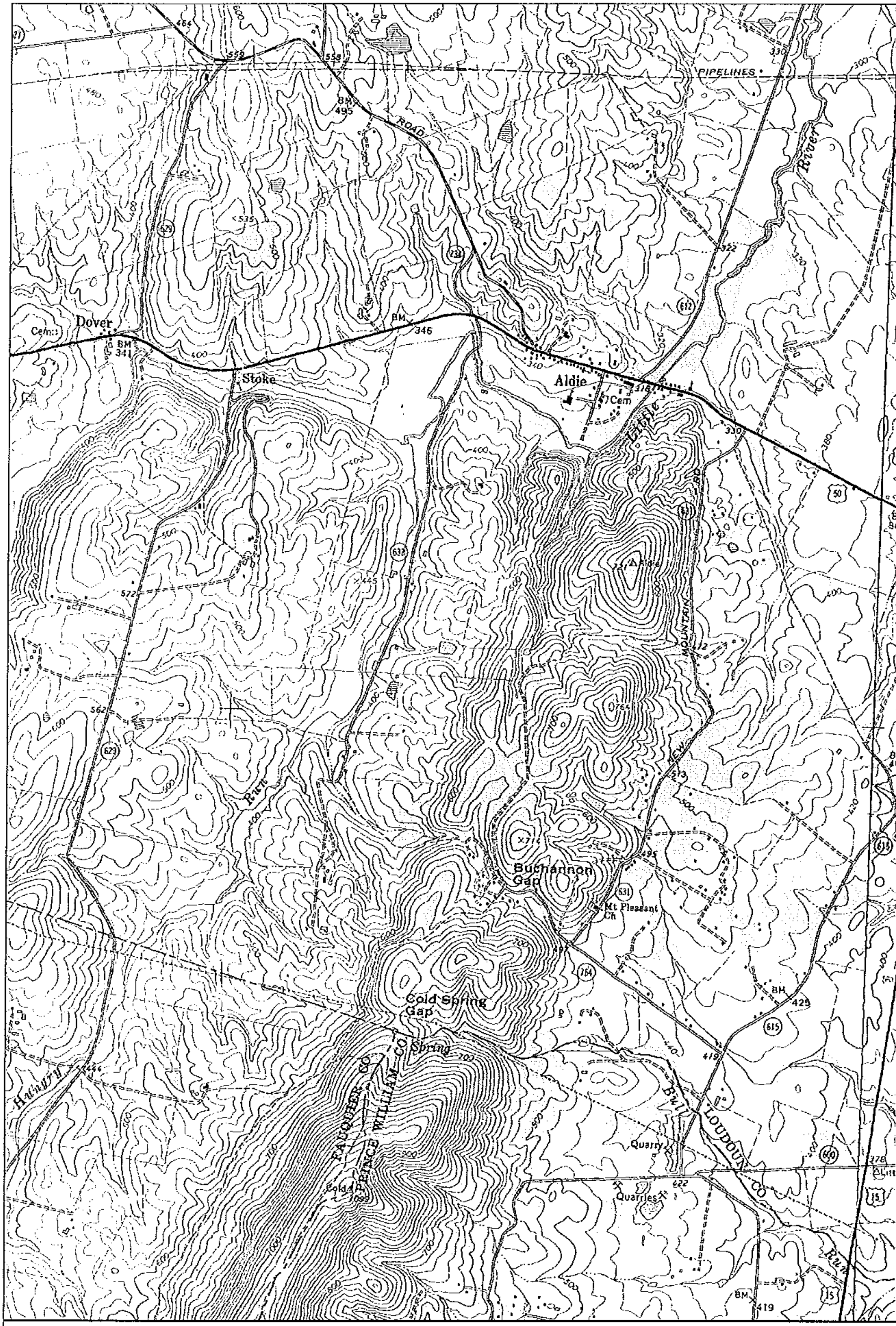
USGS Middleburg 7.5' Quadrangle

FIGURE 4

300 0 300 600 Meters

1:30000

N



Bull Run Mountains Study Area

Northern Section

USGS Middleburg 7.5' Quadrangle

FIGURE 5

300 0 300 600 Meters

1:30000

N

North of Hopewell Gap, the area reaches maximal width, with three parallel ridges (Figs. 3 and 4). At the north end, the complex is again reduced to a series of low knobs, which terminate abruptly in a steep bluff along the Little River at Aldie (Fig. 5). Maximum elevations of 366-417 m (1,200-1,369 ft) are attained between Thoroughfare Gap and Cold Spring Gap on the highest ridges, which lie about 180-215 m (600-700 ft) above irregularly rolling to hilly terrain on the west, and about 215-245 m (700-800 ft) above the nearly flat Culpeper Basin to the east (Plates 6 and 7).

Climate

Detailed climatic data are not available for the study area proper. Relatively complete data collected at Manassas, approximately 21 km (13 mi) SE of the Bull Run Mountains, indicated a mean annual minimum temperature of 6.7º C (44.0º F) and a mean annual maximum temperature of 19.6º C (67.2º F). The mean minimum temperature for January was -4.4º C (24.1º F) and the mean maximum temperature for July was 31.3º C (88.3º F) during the period 1950-1985. Annual average precipitation averaged 904 mm (35.59 in), with the highest amounts falling in May and August. Annual snowfall averaged 414 mm (16.3 in). Data collected during the period 1954-2000 at The Plains, approximately 5 km (3 mi) west of the study area, indicated higher annual average precipitation of 1077 mm (42.4 in; highest in May and August) and average annual snowfall of 688 mm (27.1 in) (Southeast Regional Climate Center 2002).

Geology

Although detailed geological work has not yet been conducted in the study area, professional consultation with USGS geologist C. Scott Southworth and a preliminary map of bedrock units by USGS geologist Peter Lyttle have provided information critical to this project. While occupying the physiographic Piedmont, the Bull Run Mountains form part of the eastern limb, or flank, of the Blue Ridge anticlinorium, a large linear fold that presumably resulted from Late Paleozoic Alleghanian orogeny. This great uplift extends in a southwest-to-northeast direction across Virginia and Maryland into southern Pennsylvania (Espenshade 1970). Its core is underlain by Middle Proterozoic gneissic and granitic basement rocks that are unconformably overlain on both flanks by a sequence of Late Proterozoic and Early Cambrian metavolcanic and metasedimentary rocks (Southworth *et al.* 1999). In Virginia, the physiographic Blue Ridge is formed by the western flank and western part of the core, while the eastern flank is expressed by a somewhat discontinuous series of low, isolated Piedmont foothills that include Catoctin Mountain (Loudoun Co.), the Bull Run Mountains, Pignut Mountain (Fauquier Co.), the Watery Mountains (Fauquier Co.), Clark Mountain (Orange Co.), and the Southwest Mountains (Orange and Albemarle Cos.). Mesozoic faulting has dissected the eastern flank of the anticlinorium and reduced the metasedimentary portion of the sequence to very thin units in many places (C. S. Southworth, pers. comm.). Consequently, most of the Piedmont monadnocks marking the flank are underlain by metavolcanic rocks, primarily metabasalt (greenstone), of the Catoctin Formation.

The Bull Run Mountains (including the Pond Mountains), however, are largely underlain by metasedimentary rocks of the Chilhowee Group, which is represented here by two major lithologies. Massive, thick-bedded quartzite is highly resistant and well exposed along the upper west slope of High Point Mountain north of Thoroughfare Gap (Plates 1 and 8), at White Rock north of Hopewell Gap, and in numerous other localities. The strongly eastward-dipping quartzite strata are powerful ridge-forming features that have thoroughly shaped the local topography and relief. Substantial portions of the study area, especially on the eastern dip slopes of the ridges, are underlain by thin-bedded quartzite with local interbeds of muscovite schist and phyllite. During the late 19th and early 20th centuries, this "flaggy" quartzite was quarried by numerous small operators and many abandoned pits are scattered through the study area. Structurally, these mountains comprise a homoclinal ridge complex that is faulted off on the east along its contact with Triassic and Jurassic sandstone, siltstone, and diabase of the gently westward dipping Culpeper Basin. The Catoctin Formation underlies the lower to middle, western slope of the Bull Run Mountains, but is generally well covered by colluvium of quartzite. A narrow, discontinuous belt of Catoctin metabasalt is also present along a thrust fault extending north from Thoroughfare Gap across the Catletts Branch drainage. The possibility that the Catoctin Formation is exposed elsewhere in the

Plate 6. View of High Point Mountain looking east from near The Plains. Massive, white quartzite cliffs cap the ridge. Photo © Gary P. Fleming.

Plate 7. View of the Bull Run Mountains, looking west across the Culpeper Basin. *Bidens aristosa* (tickseed sunflower) abundantly covers the foreground fields. Photo © Gary P. Fleming.

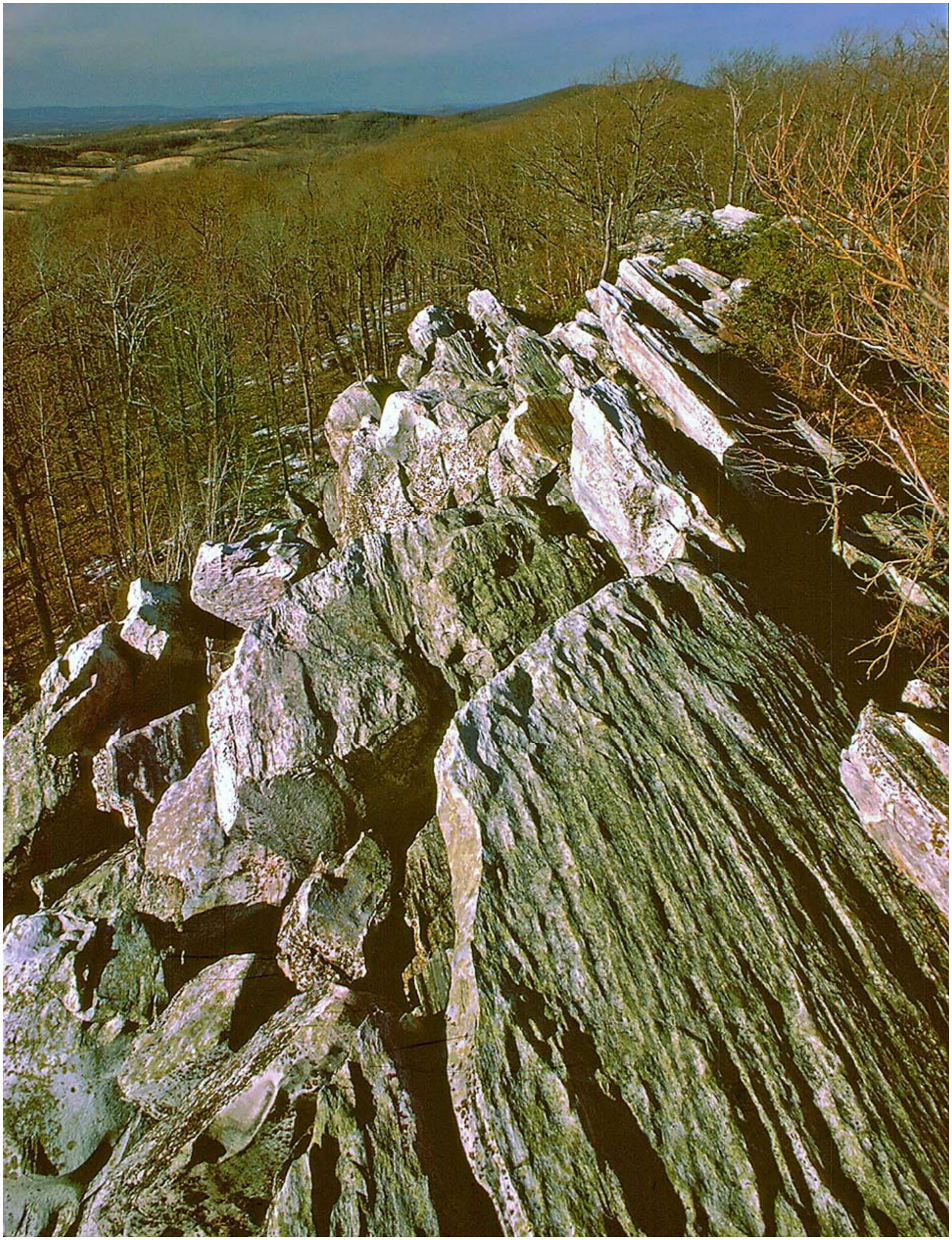


Plate 8. Resistant cap of massive, thick-bedded quartzite on High Point Mountain, showing the strong eastward dip of the strata. Photo © Gary P. Fleming.

study area needs investigation.

The Bull Run Mountains represent the largest exposures of metasedimentary rocks along the eastern flank of the Blue Ridge anticlinorium and contain a number of geological features that are significant at the state and regional levels (C. S. Southworth, pers. comm.). Large, nearly vertical cliffs such as those at High Point and White Rock, for instance, are exceptional features of the Piedmont region. Moreover, the many small quarry operations that extracted quartzite for use as building stones and flagstones were once important to the local economy of this area.

Soils

Soil surveys and maps for the three study area counties were completed at different times using divergent classification systems and nomenclatural conventions (Petro 1956, Porter 1960, Elder 1989). As a result, soil maps for different portions of the Bull Run Mountains are essentially incompatible. According to the survey for Prince William County (Elder 1989), which is based on the most contemporary taxonomy, soils of the Bull Run Mountains belong to the Airmont-Weverton-Stumptown major group. Component map units are shown in Table 1.

Table 1. Soils of the Bull Run Mountains, based on the treatment for Prince William County by Elder (1989).

Map Unit(s)	**Extent**	**Topography / Drainage**	**Classification**
Airmont-Weaverton complex, 2 to 7%, 7 to15%, 15 to 25%, 25 to 50% slopes	major	broad ridges, side slopes; Airmont soils have fragipan at ± 70 cm; Weaverton soils are well-drained with clayey subsoils.	loamy-skeletal, mixed, mesic Typic Fragiudults; loamy-skeletal, mixed, mesic Typic Hapludults
Baile loam, 0 to 4% slopes	minor	stream bottoms; poorly drained.	fine-loamy, mixed, mesic Typic Ochroaquults
Braddock loam, 7 to 15% slopes	minor	toe slopes; deep, well drained.	Clayey, mixed, mesic Typic Hapludults
Hatboro-Codorus complex, 0 to 2% slopes	minor	stream terraces and bottoms; poorly drained to moderately well drained.	fine-loamy, mixed, nonacid, mesic Typic Fluvaquents; fine-loamy, mixed, mesic Fluvaquentic Dystrochrepts
Meadowville loam, 0 to 5% slopes	minor	toe slopes, concavities, swales; moderately well drained to well drained.	fine-loamy, mixed, mesic Typic Hapludults
Stumptown very flaggy loam, 7 to 25%, 25 to 50% slopes	major	narrow ridges, very steep side slopes; well drained.	loamy-skeletal, mixed, mesic Typic Hapludults

The prevalent soils of the area are described as dark to light yellowish-brown, very flaggy (*i.e.*, with numerous rock fragments), very strongly acidic loams with low natural fertility (Elder 1989). Empirically, however, variations in surface soil texture and chemistry, depth to bedrock, stoniness, and duff cover are much greater than these unit descriptions indicate and have a much stronger correlation than soil map units with variations in vegetation composition across the landscape.

Vegetation and Land-Use History

The natural vegetation of the study area was broadly described by Braun (1950) as belonging to the Piedmont Section of the Oak-Chestnut Forest Region. Centered in the Appalachian Mountains, this vegetation unit was formerly characterized by various mixtures of *Quercus* spp. (oaks) and *Castanea dentata* (American chestnut), with small inclusions of *Pinus* spp. (pines) on xeric ridges and mixed mesophytic forest in coves, ravines, and stream bottoms. Following the removal of American chestnut as an overstory tree by an introduced fungal blight (*Cryphonectria parasitica*) during the early decades of the 20th century, this region is now broadly characterized as mixed oak forest (Küchler 1964, Stephenson *et al*. 1993). The chestnut blight reached Fauquier County in 1915-16, and extensive salvage operations were carried out during the 1920's to harvest viable wood from the dying trees (J.K. Gott, pers. comm.).

Even before the chestnut calamity struck, forests of the Bull Run Mountains had experienced many post-Columbian human disturbances, beginning with the earliest land grants and settlements in the 1720's (Fauquier County Bicentennial Committee 1959). In all likelihood, the lowest and most fertile slopes of this area were occupied first, with higher and more marginal home sites established as the population density increased. Most of the timber in the rolling lands at the foot of the Bull Run Mountains was probably destroyed. In addition, evidence from historical plats, deeds, and photographs indicate that extensive areas of the mountain slopes near home sites were cleared, but later abandoned at various times. For example, an 1820 plat map of property boundaries, homesteads, and forest cover on the eastern slope of High Point Mountain clearly shows fields in areas indicated as "woods" on a 1939 plat; these sites are now covered by mature forest. The steeper and rockier slopes, however, were never suitable for settlement or agriculture but were later cut over, probably by small, portable mill operators. The prevalence of stump-sprouted oaks on almost all of the more rugged slopes indicates that virtually the whole area was logged at one time or another. Only a few very small patches of timber that occupy boulderfields and rock outcrop areas escaped because of the poor growth form of trees.

The dry, exposed ridges of the Bull Run Mountains have probably always been susceptible to natural, lighting-ignited fires. However, the importance and frequency of fire in pre-settlement forests is uncertain, in part because few studies have successfully reconstructed past fire regimes and because human activities have altered fire regimes for millennia. The original inhabitants of the study area were members of the Manahoac tribe of Sioux stock, who hunted extensively in the region between the Piedmont fall line and the Blue Ridge (Fauquier County Bicentennial Committee 1959). These and other native American tribes frequently used fire as a tool for range management, hunting, and agriculture, resulting in open forests and some savanna-like vegetation dominated by fire-tolerant species in the upper Piedmont (Maxwell 1910, Van Lear and Waldrop 1989, Brown 2000). In the post-settlement era, fires fueled by careless logging operations or deliberately set by residents to "burn off" fields or blueberry patches are well documented in the Central Appalachians (Clarkson 1964, Van Lear and Waldrop 1989). The 20th century has been a period of increasing fire suppression. Abrams and Nowacki (1992) determined that in Pennsylvania, the total area burned annually and the average size of individual fires decreased by 99% and 98% respectively from 1908 to 1989, and a similar pattern holds true for Virginia from 1925 to 1991 (Orwig and Abrams 1994b). Although few details of the study area's fire history are known, evidence in the form of burn scars and charcoal fragments in soil was documented from many parts of the Bull Run Mountains during this study, indicating that past fires were pervasive and influential.

Natural, gap-forming disturbances such as ice storms, windthrow, and senescence of old trees remain important in the ecological dynamics of the area's forests, particularly in the older stands that have not been recently manipulated by cutting. The introduced chestnut blight fungus decimated the formerly co-dominant and economically important *Castanea dentata* in this area by the 1930's (Allard and Leonard 1943). More recently, the advent of several other exotic pests and diseases, *e.g*., gypsy moth (*Lymantria dispar*), hemlock woolly adelgid (*Adelges tsugae*), and dogwood anthracnose (*Discula destructiva*), has placed additional stresses on the study area's forests.

Although the Bull Run Mountains proper support a relatively sparse human population, construction of individual residences, vacation homes and small developments has increased in recent years. The ridges are crossed by Interstate 66 and US Rt. 55 in Thoroughfare Gap and by County Rt. 628 in Hopewell Gap. One public road, County Rt. 629, and numerous private roads penetrate the area. Two large developments, Bull Run Mountain Estates and Thunder Oak, occupy parts of the easternmost mountain slope. Immediately to the east, a large population influx of more than 50,000 people is underway along the US Rt. 15 corridor in Prince William County, bringing the western sprawl of the Washington, D.C. metropolitan area literally to the doorstep of the mountain.

Condition of the Study Area and Vegetation in the period 1934-1952

Few published studies have examined patterns of vegetation in the western Piedmont region of Virginia, and none has examined vegetation types based on total floristic composition. We are fortunate, however, to have a relatively detailed, descriptive record of the Bull Run Mountains' vegetation and flora as it was 50 to 68 years ago, during the period of H.A. Allard's intensive field work (1934-1952). In addition to habitat and location data for thousands of preserved plant specimens, Allard published many observations about the composition of forests, successional patterns, site conditions, land uses, and other ecological factors. Despite limitations imposed by its qualitative nature, this information provides a number of benchmarks for evaluating environmental and vegetation change during recent decades.

In the early 1940's, Allard and Leonard (1943) assessed the general vegetation of the study area and found that

> "... the original forest of the Bull Run highlands was Oak-Chestnut in composition, the chestnut oak, *Quercus montana*, being the major dominant, with the chestnut, *Castanea dentata*, formerly occupying a high place in its composition, together with red oak, *Quercus rubra*, black gum, *Nyssa sylvatica*, tulip poplar, *Liriodendron tulipifera* and hickory (*Carya*). The forest is rapidly changing following the elimination of the chestnut, and if a consistent terminology is used, will in the future have to be called an Oak-Hickory association. This is most obvious everywhere, for the hickory reproduction for some reason has assumed an unusual prominence and the young saplings occur in enormous numbers, although the old parent trees show a rather scattered distribution. It is obvious that there is some fundamental reason for this change toward a pronounced hickory understory .... Owing to the thin, sandy, porous soils on some of the ridges the drier sites are occupied by almost pure stands of the ubiquitous chestnut oak, *Quercus montana*, which of all our oaks is best adapted to these xeric habitats. Some of these forests amount to stands nearly 100 per cent pure, but even in these, hickory reproduction appears to be making more headway than the chestnut oak itself in some situations .... On the deeper and moister soils the climax originally was largely a mixed mesophytic forest with the white oak, *Quercus alba*, chestnut oak, red oak, black oak, *Quercus velutina*, black gum, hickory, tulip poplar, white ash, *Fraxinus americana*, and some beech, *Fagus grandifolia*, intimately intermingled."

Although of rather general distribution on the eastern slopes, *Fagus grandifolia* seemed to have reach a "static condition," since little or no reproduction could be found anywhere (Allard and Leonard 1943). Stands of *Pinus pungens* (table-mountain pine) were found on the high, wind-swept ridge crests while *Pinus rigida* (pitch pine) and *Populus grandidentata* (bigtooth aspen) were "common invaders" of severely burned ridges. Allard's collection labels make frequent reference to the sandy, barren, "exposed" soils of ridge-top "pine groves," which supported a number of xerophytic herbs such as *Baptisia tinctoria* (yellow wild-indigo), *Comandra umbellata* (bastard-toadflax), *Helianthemum canadense* (Canada frostweed), *Lechea* spp. (pinweeds), *Paronychia* spp. (nailworts), and many fruticose lichens of the genera *Cladina* (reindeer lichens) and *Cladonia* (Allard and Leonard 1944a).

Although the ridges of the area were well wooded throughout, large areas of the lower and less rocky slopes had been cleared in the past and supported various successional communities. Moreover, many homes and log cabins in the area had been abandoned or burned (Allard and Leonard 1943, Allard 1961). A distinct graminoid phase of early succession, dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem) or *Andropogon virginicus* var. *virginicus* (broomsedge), prevailed on many abandoned fields and pastures, its tenure sometimes prolonged by repeated fires. In other situations, or in later successional stages, thickets of *Pinus virginiana* (Virginia pine), *Juniperus virginiana* var. *virginiana* (eastern red cedar), *Rhus* spp. (sumac), *Cornus florida* (flowering dogwood), *Diospyros virginiana* (persimmon), *Sassafras albidum* (sassafras), and other woody species had occupied old fields as pioneers of forest regeneration. However, many mesic lower slopes, on which grazing or cultivation must have ceased many years before Allard's work, already supported "exceptionally beautiful groves of tulip poplars at least 50 feet tall" or even-age *Robinia pseudoacacia* (black locust) forests "25 years old."

Allard and Leonard (1943) also found "striking differences" in shrub and herbaceous composition varying with site conditions and successional status. They give special treatment to the heath family (Ericaceae) flora, for

> "... so generally abundant is the mountain laurel, *Kalmia latifolia* in some areas that this highland complex could well merit the name the Heath or Kalmia Mountains. Among the heaths, mountain laurel is the dominant underbrush over great areas of slope and ridge, and on the dry, arid ridge crests, *Vaccinium vacillans* [= *V. pallidum*, early lowbush blueberry], the forms of *Gaylussacia baccata* [black huckleberry], *Vaccinium stamineum* [deerberry], and *Epigaea repens* [trailing arbutus] are the dominant undershrubs .... The mountain laurel produces almost impenetrable jungles of undergrowth in some situations, but more especially where pines are intermingled with the hardwoods on the more stony xeric ridges. The distribution of this shrub is frequently peculiarly restricted to sharply defined zones, often stopping abruptly as if on a line on some slopes or ridges. These distributions and sharp restrictions are not always easily explained, but the habitat seems to be the controlling factor. In the past, fires were particularly frequent and destructive in the Bull Run area, and these seem to have been a factor favoring this plant as well as the other heaths mentioned."

On the other hand, mixed mesophytic "climax" forests occupying better sites with deeper soils exhibited well developed understory and herb layers,

> "... the former consisting of *Cornus florida* [flowering dogwood] largely, the later of *Galium latifolium* [purple bedstraw] and many others, together with such nitrogen gatherers as *Desmodium nudiflorum* [naked-flowered tick-trefoil] and hog peanut, *Amphicarpa bracteata*, and varieties. The two last-named legumes being exceedingly abundant in an almost continuous layer contribute generously to the nitrogen supplies of this forest habitat."

Even the early-successional, monospecific groves of tulip poplar were characterized by an abundance of native, herbaceous mesophytes such as *Aplectrum hyemale* (putty-root) and *Sanguinaria canadensis* (bloodroot).

Allard and Leonard (1943) identified the small streams bottoms with their "cold, spring-fed swamps" as noteworthy habitats supporting an abundance of two northern plants, *Chrysosplenium americanum* (American golden-saxifrage) and *Veratrum viride* (American false hellebore). In their annotated flora, additional unusual species were noted as restricted to these swamps, including *Dryopteris goldiana* (Goldie's fern), *Maianthemum canadense* (Canada mayflower), *Toxicodendron vernix* (poison sumac), and *Trillium cernuum* (nodding trillium).

Among exotic plant species, which accounted for 15% of Allard and Leonard's (1943) total vascular flora, *Lonicera japonica* (Japanese honeysuckle) alone was singled out as a rampant invader destructive to the native flora. It was reported to be most problematic in early successional vegetation such as groves of *Robinia pseudoacacia*, but usually did not invade "vigorous, established forests of oaks and other native trees of the climax type."

I.

VEGETATION ECOLOGY
OF THE BULL RUN MOUNTAINS

METHODS

Field Methods

At the outset of the project, site information and data from previous studies of the Bull Run Mountains were examined to assess vegetation patterns on the landscape. The author's long-term familiarity with the area and surrounding region greatly reduced the amount of on-the-ground reconnaissance needed for this initial evaluation. Subsequently, vegetation and environmental data were collected from 66 plot samples established in representative vegetation throughout the study area. Data collected earlier by the author from six plot samples completed a 72-plot data set. Site selection was guided by previous experience and reconnaissance, aerial photographs, and maps depicting topography, geology, and soils. Within a targeted site, specific plot locations were chosen subjectively in order to capture both homogeneous vegetation within plots and a wide range of compositional variation across the larger landscape. Since the purpose of the study was to define persistent, late-successional community types, data were not collected from early-successional forests and recently disturbed habitats.

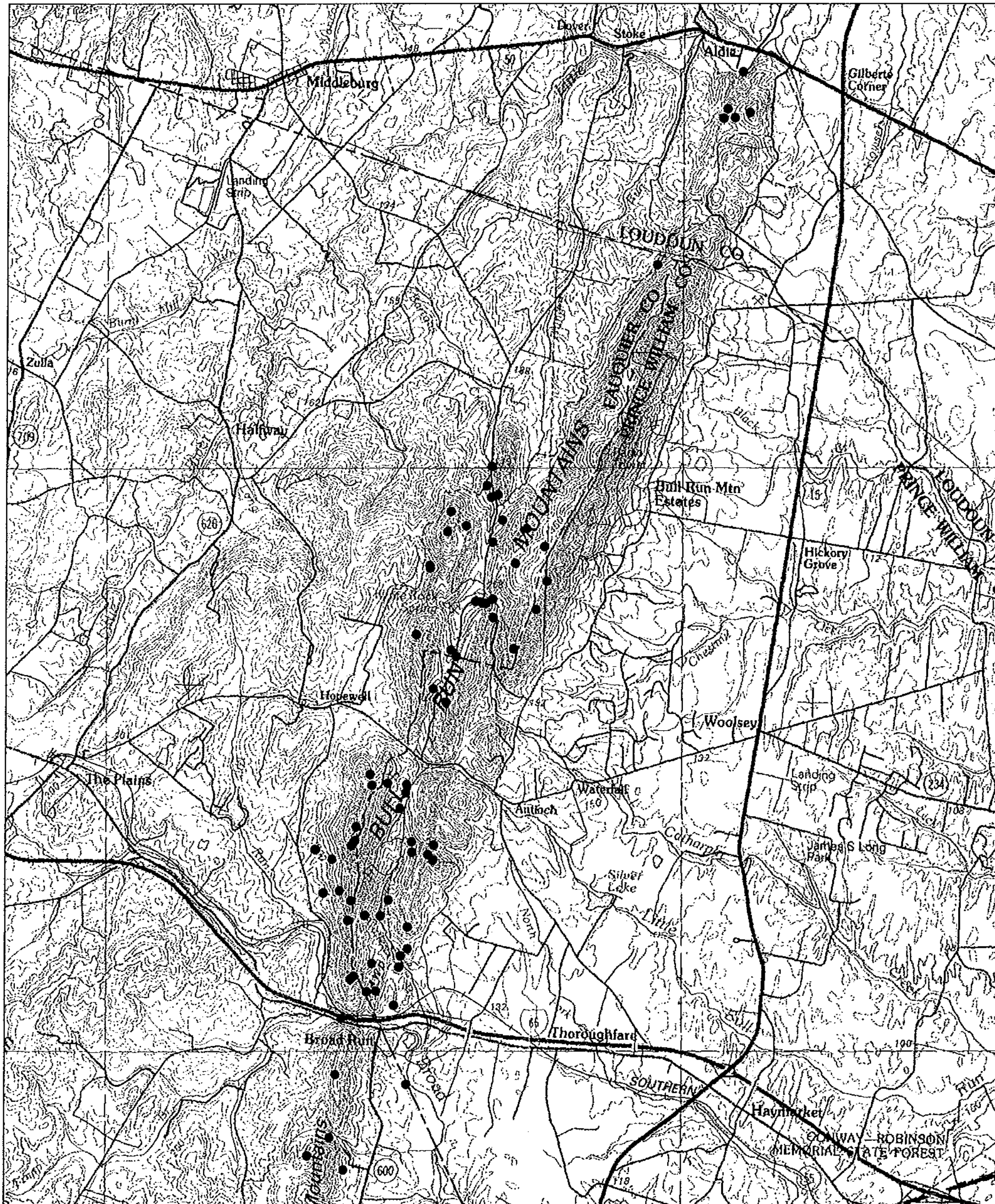
Within restrictions of time and access, an attempt was made to distribute plot samples over the entire study area and across the full range of site conditions, including geologic substrate, aspect, elevation, and local topography. However, the distribution of sampling sites was heavily concentrated (59 plots) from Thoroughfare Gap to about 5.6 km (3.5 mi) north of Hopewell Gap, in the central section where all of the VOF lands are situated. Selected areas in the Pond Mountains and in the northern Bull Run Mountains from near Cold Spring Gap to Aldie were explored when landowner permission could be obtained. A relatively small number of plots – six in the Pond Mountains and seven in the northern section – were sampled in these areas. The general distribution of all 72 plots is shown in Figure 6. USGS 7.5' quadrangle maps showing each plot location are included with the plot forms in the Appendix.

Plots were sampled using the relevé method (sensu Peet *et al.* 1998), following standard procedures employed by DCR-DNH. As a rule, 400 m^2 (4,312 ft^2) plots with 20 x 20 m or 16 x 25 m (66 x 66 ft or 53 x 82 ft) configurations were established and sampled. At ten plots, however, more rectangular configurations (mostly 10 x 40 m [33 x 131 ft]) were used to conform with narrow vegetation zones of cliffs, ridge crests, ravines, and stream bottoms. In two cases, rocks and very dense, scrubby vegetation made it impractical to sample anything larger than a 200 m^2 (2,156 ft^2) plot. In order to facilitate long-term monitoring and re-sampling in the future, 48 plots were marked at a corner or centerline end with numbered metal tree tags placed ≤ 25 cm (1 ft) above ground level. Vegetation sampling was conducted between 23 May and 16 August 2001; the six previously established plots were completed on 26 May 1998, 27 May 1998, and 7 June 2000. Several plots were visited more than once to collect floristic data at different seasons.

Vegetation Measurements

To the extent possible, plots were placed in homogeneous stands of vegetation. Every vascular plant taxon present was recorded and its cover, defined as the percentage of the ground covered by the vertical projection of above-ground plant parts, was visually estimated over the full plot area. Cover was assigned using a nine-point scale of cover classes (Table 2).

The overall cover of mosses, lichens, and liverworts was estimated, but the individual covers of non-vascular taxa were not estimated. Vascular plants characteristic of the stand, but located outside the plot, were recorded parenthetically if visible from the boundary, and assigned a cover class score of "1." The total vegetative cover in each stratum was also estimated by assignment to one of six broad classes: dense (80-100%), somewhat open (60-80%), open (40-60%), very open (25-40%), sparse (5-25%), and very sparse (0-5%).



General Location of 72 Vegetation Plot Samples

Bull Run Mountains, Virginia

USGS Washington West 60' Quadrangle

FIGURE 6

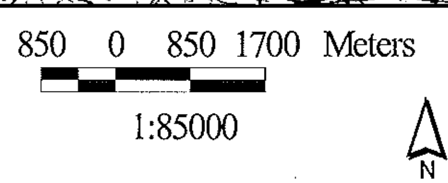


Table 2. Cover class scores used in field sampling and data analysis

Cover Class:	Percent Cover Range:	Area of Coverage:	Cover Class Midpoint (%):
(p)	present outside plot	-	0.05
1	< 0.1%	< 20 cm^2	0.05
2	0.1% to 1%	20 cm^2 to 4 m^2	0.55
3	1 to 2%	4 m^2 to 8 m^2	1.50
4	2 to 5%	8 m^2 to 20 m^2	3.50
5	5 to 10%	20 m^2 to 40 m^2	7.50
6	10 to 25%	40 m^2 to 100 m^2	17.50
7	25 to 50%	100 m^2 to 200 m^2	37.50
8	50 to 75%	200 m^2 to 300 m^2	62.50
9	75 to 100%	300 m^2 to 400 m^2	87.50

In addition to recording presence and cover for all species, stand structure was quantified by measuring the size distribution and vertical stratification of woody plants. The diameter at breast height (1.4 m [4.6 ft]; dbh) of each woody stem (trees, shrubs, lianas) ≥ 2.5 cm (1 in) dbh and < 40 cm (15.7 in) dbh was measured by size class. Classes used were 2.5-5, 5-10, 10-15, 15-20, 20-25, 25-30, 30-35, and 35-40 cm. Stems ≥ 40 cm (15.7 in) dbh were measured to the nearest 1 cm (0.4 in). Moreover, the maximum canopy height was measured using a clinometer and the cover of each woody species was estimated (if present) at each of six height strata:

- herb layer, < 0.5 m (< 20 in)
- shrub layer, 0.5 to 6 m (20 in to 20 ft)
- tree layer, 6 to 10 m (20 to 33 ft)
- tree layer, 10 to 20 m (33 to 66 ft)
- tree layer, 20 to 35 m (66 to 115 ft)
- tree layer, > 35 m (> 115 ft)

Increment cores were extracted from a few selected stands to establish stand ages and examine the relationships between tree size and age.

Environmental Measurements

A standard set of environmental data was measured or estimated at each plot (Table 3). Slope inclination and aspect were measured to the nearest degree from plot center. In plots with variable microtopography, slope was measured at several points and averaged. Elevation was determined to the nearest 10 ft (~ 3 m) using a topographic map or altimeter. The percent cover of different surface substrates was estimated visually, with precision varying such that values summed to 100%. Topographic position, slope shape (both horizontally and vertically), soil drainage class, soil moisture regime, and inundation were assessed using scalar values. Bedrock geology was determined to the greatest precision possible by using existing geological maps, while the characteristics of surface rocks present in a plot were recorded in the field.

Soil samples were collected from the top 10 cm (4 in) of mineral soil (below the surficial litter and humus) at all 72 plots. As a rule, soil was collected from several locations within a plot and mixed into a composite sample. Depth of surface duff, soil color, and texture were evaluated in the field and recorded on the plot forms. Soil samples were oven-dried, sieved (2mm), and analyzed for pH, phosphorus (P), soluble sulfur (S), exchangeable cations (calcium [Ca], magnesium [Mg], potassium [K], and sodium [Na] in ppm), extractable micronutrients (boron [B], iron [Fe], manganese [Mn], copper [Cu], zinc [Zn], and aluminum [Al], in ppm), total exchange capacity (CEC; m.e.q./100g), total base saturation (%TBS), percent organic matter (%OM), and texture (percentages of clay, sand, and silt). Chemical and textural analyses were conducted by Brookside Laboratories, Inc. New Knoxville, Ohio. Extractions were carried out using the Mehlich III method (Mehlich 1984) and percent organic matter was determined by loss on ignition. Textural analysis was determined using the Bouyoucos hydrometer method (Patrick 1958).

Table 3. Topographic / hydrologic environmental indices recorded at each plot-sampling site.

Topographic position:
- A – plain / level
- B – toe
- C – lower slope
- D – middle slope
- E – upper slope
- F – escarpment / face
- G – ledge / terrace
- H – crest
- I – basin / depression
- J – floodplain
- K – stream bottom

Surface Substrate: % cover
- decaying wood
- bedrock
- boulders (> 60 cm diam.)
- stones (> 25 cm diam.)
- cobbles (8-25 cm rounded)
- channery (8-25 cm flattened)
- gravel
- mineral soil
- organic matter
- water
- other

Measured Slope (degrees)

Slope shape

Vertical
- C – concave
- X – convex
- S – straight

Horizontal
- C – concave
- X – convex
- S – straight

H – hummock and hollow microtopography
I – irregular craggy/bouldery microtopography

Measured Aspect

______ degrees
F (flat)
V (variable)

Soil Drainage Class:
- A – very poorly drained
- B – poorly drained
- C – somewhat poorly drained
- D – moderately well drained
- E – well drained
- F – rapidly drained

Inundation:
- A - never
- B - infrequently
- C – regularly, for < 6 mos.
- D – regularly, for > 6 mos.
- E – always submerged by shallow water (< 30 cm)
- F – always submerged by deep water (> 30 cm)

Soil Moisture Regime:

A – very xeric (moist for negligible time after precipitation)
B – xeric (moist for brief time)
C – somewhat xeric (moist for short time)
D – submesic (moist for moderately short time)
E – mesic (moist for significant time)
F – subhygric (wet for significant part of growing season; mottles at < 20 cm)
G – hygric (wet for most of growing season; permanent seepage / mottling)
H – subhydric (water table at or near surface for most of the year)
I – hydric (water table at or above surface year round)

Hydrologic Regime:

Terrestrial (*i.e.*, not a wetland)
Non-Tidal
- A – Permanently flooded
- B – Semipermanently flooded
- C – Seasonally flooded
- D – Intermittently flooded
- E – Temporarily flooded
- F – Saturated

Evidence of any past or ongoing disturbances, including but not limited to logging, fire, exotic plants, erosion, grazing/browsing, wind or ice damage, hydrologic alterations, chestnut blight, dogwood anthracnose, southern pine beetle, gypsy moth, and hemlock woolly adelgid, was recorded from each sampling site.

Sampling Site Metadata
Standard metadata, or information regarding the implementation of the sampling protocol, were recorded at each plot. These included plot numbers, date(s) of sampling, participants, geopolitical locality (county/city), survey site name, USGS quadrangle, plot size and configuration, photographic documentation, and a written description of the plot location. Plots were assigned unique alphanumeric codes. A global positioning system (GPS) unit was routinely used to record locational data with greater precision. The UTM (Universal Trans Mercator) coordinates of each plot location were determined to 10 m (~ 33 ft) precision using ArcView GIS (Version 3.2; ESRI 1999), and all plot locations were mapped as precisely as possible on USGS 7.5' quadrangle maps.

Data Analysis

Data Preparation and Transformation
Stem diameter measurements were used to compute density (stems/ha) and basal area (m^2/ha) for all woody plants at each sampling site. Basal area was calculated by multiplying the geometric mean of each diameter class by the density of stems within that class. The use of the geometric, rather than arithmetic, mean for this calculation has been recommended if the distribution of values within a class is not symmetric or normal, which is probably the case for most species (Oksanen 1976). Since the geometric mean is always less than the arithmetic mean, the use of the former to calculate basal area is more conservative, although the effect of such a correction may be minor. Density and basal area were used to calculate importance value, defined as the average of relative density and relative basal area for each species. Woody stem computations were executed in Excel using a macro written in Visual Basic by DCR-DNH ecologist Philip P. Coulling.

Prior to analysis, most environmental variables were transformed, either to normalize frequency distributions or to assign numeric values to categorical variables. Topographic position, slope shape in vertical and horizontal directions, and soil moisture regime were converted to ordinal variables (Table 4). While the resulting absolute values of these variables are arbitrary, the rank orders of values correspond to putative underlying environmental gradients. Aspect was transformed using the cosine method of Beers *et al.* (1966), using the formula $A' = \cos(45^{o} - A) + 1$, where A' = transformed aspect and A = aspect in degrees. This transformation standardizes aspect to a linear variable from 0 (225º; SW, dry, solar-exposed) to 2 (45º; NE, moist, sheltered), reflecting a purported gradient in topographic moisture and solar exposure. Categories of surface substrate were reduced by combining channery and gravel classes into a single "gravel" class. To avoid collinearity problems, since the values for all substrate classes sum to 100 and thus each can be defined as a linear combination of the others, a non-vascular (bryophyte and lichen) substrate cover was added to eliminate collinearity in surface substrate for most plots. Substrate values were converted to decimals and arcsine transformed to normalize their distributions.

Values for all soil variables with non-normal distributions were natural log-transformed (B, Ca, Cu, K, Mg, Mn, P, S, Zn, total base saturation) or arcsine-transformed (% clay, sand, silt) to normalize their distributions and make the values more biologically interpretable (Palmer 1993). Additionally, in order to determine major patterns of variability in soil chemistry and to explore potential relationships between soil fertility and species richness, a Spearman (non-parametric) correlation matrix was calculated for the full set of untransformed soil variables and total species richness values for each plot. This analysis was implemented in SPSS (Version 7.5.3, 1997).

Table 4. Ordinal variables used in analysis for scalar topographic and soil moisture variables estimated in the field.

Topographic Position	Soil Moisture Regime
I – basin/depression = -1	A – very xeric = 1
A, J, K – plain/level, floodplain, stream bottom = 0	B – xeric = 2
B – toe = 1	C – somewhat xeric = 3
C – lower slope = 2	D – submesic = 4
D, G = middle slope, ledge/terrace = 3	E – mesic = 5
E, F = upper slope, escarpment/face = 4	F – subhygric = 6
H = crest = 5	G – hygric = 7
	H – subhydric = 8
Slope Shape – Vertical and Horizontal	I – hydric = 9
C – concave = -1	
X – convex = +1	
S – straight – 0	

The topographic characteristics of each plot were more objectively quantified by manually measuring the distance downslope to the nearest stream (Dstream) and the distance upslope to the nearest ridge top (Dridge) using ArcView GIS, with measurements made perpendicular to elevation contour lines. These measures were used to calculate a relative slope position (Relslope) for each plot, where RELSLOPE = DSTREAM / DRIDGE + DSTREAM. Relative slope position thus functions as a continuous variable scaled from 0 (stream bottom) to 1 (ridge top).

Horizontal and vertical slope shape were also converted to a single ordinal variable (scale = 0 to 10) using a modification of Parker (1982):

VERT. PROFILE +	HORIZ. PROFILE =	SLOPE SHAPE SCALAR
concave	concave	10
concave	straight	9
straight	concave	7
straight	straight	5
straight	convex	3
convex	straight	2
convex	convex	0

A synthetic Topographic Relative Moisture Index (TRMI) was calculated for each plot using a procedure modified from Parker (1982). TRMI is a scalar ranging from 0 (lowest moisture potential) to 60 (highest moisture potential) and combining four topographic variables that potentially influence water runoff, evapotranspiration, and soil moisture retention:

- Slope inclination (10-point scale; per Parker [1982])
- Slope shape (10-point scale; as above)
- Aspect (20-point scale) = Beers-transformed aspect x 10
- Topographic position (20-point scale) = 1-relative slope position x 20

In order to examine the possible influence of solar insolation on site moisture potential and vegetation, a synthetic potential solar radiation index (SOLAR) scaled from 0 to 1 was generated for each plot following Frank and Lee (1966). This index is a crude and purely theoretical measure, derived from latitude, aspect, and slope inclination, that represents the potential direct solar irradiation a site receives on an annual basis. Generally, higher values of this index indicate flats and steep, south-facing slopes that receive intense solar exposure, while lower values indicate sheltered, north-facing slopes with more limited solar exposure. Indices for 39 degrees N latitude were interpolated using a custom program written in SAS (SAS Institute Inc. 1996) by Thomas R. Wentworth (C. Ulrey, pers. comm.).

Because mapped bedrock formations of the Bull Run Mountains are somewhat heterogeneous and contain similar lithologic units, each plot was assigned to one of three aggregate geological classes (Table 5) based on the prevalent surface rocks at the site; if no surface rocks were present, the assignment was based on the mapped bedrock unit. A multivariate analysis of variance (MANOVA; JMP, version 3.2.6, 1999) was performed on a scalar lithologic variable (values corresponding to the aggregate classes = 1, 2, and 3), with the full set of soil variables as independent variables. This analysis revealed significant differences in soil chemistry among the aggregate geological classes (Pillai's Trace: $F = 6.9064$, $p = <0.0001$; Wilks' Lambda: $F = 5.4351$, $p = <0.0001$; Hotelling-Lawley: $F = 8.6263$, $p = <0.0001$; Roy's Max Root: $F = 15.3697$, $p = <0.0001$). An additional MANOVA, performed using only aggregate classes 1 and 2, revealed significant variations in soil chemistry between "quartzite" and "flagstone" classes (all tests: $F = 3.4885$, $p = 0.0003$). These results must be regarded with caution due to likely errors in mapping, distinguishing between formations, and identifying rocks in the field. Nevertheless, geologic substrate was used in subsequent quantitative analysis by defining dummy (binary) variables for classes 1 and 2, with class 3 as the reference (ter Braak and Looman 1995).

Table 5. Aggregate geological classes used in MANOVA tests and as dummy variables in data analysis.

No.	Aggregate Geological Class:	Definition and relationship to formations mapped by USGS (Lyttle, unpublished data) and by Rader and Evans (1993)[1]:
1	"QUARTZITE"	outcrops and debris of massive, thick-bedded quartzite prevalent in **Ꞓw**
2	"FLAGSTONE"	outcrops and debris of thin-bedded, flaggy quartzite mapped as **Ꞓh**; also includes local interbeds of muscovite schist and phyllite (**Ꞓw**, **Ꞓh**), one site underlain by Triassic **c**, and two sites underlain by colluvium-covered **ꞒZc**
3	"ALLUVIUM"	heterogeneous, bouldery and cobbly stream-bottom alluvium derived from and underlain by various formations

[1] Names of formations:
Ꞓh – Harpers Formation (Chilhowee Group)
Ꞓw – Weaverton Formation (Chilhowee Group)
ꞒZc – Catoctin Formation
c (Newark Supergroup) – conglomerate (mixed clasts)

Botanical nomenclature generally follows the Flora of North America where completed (Flora of North America Editorial Committee 1993, 1997, 2000) and otherwise Kartesz (1999) or Gleason and Cronquist (1991). Exceptions include treatments of *Carya ovalis* and *Hepatica americana*, which follow Gleason and Cronquist (1991), and the treatment of the *Dichanthelium dichotomum* complex, which follows LeBlond (2001). In general, taxa were treated at the highest level of resolution possible, but the identification of varieties and subspecies was not always possible. A few taxa identified only at generic or higher levels (*e.g.*, "*Carex* sp." or "unidentified woody seedling") were deleted prior to analysis.

Cluster Analysis

Hierarchical, agglomerative cluster analysis, implemented in the software program PC-ORD (version 4.17; McCune and Mefford 1999), was employed to generate a classification from the 72-plot data set. Cluster analysis is a form of numerical classification that evaluates the floristic composition and species abundances in samples and, through an interactive statistical process, fuses into clusters those samples that are most similar. Results are displayed as a dendrogram, a tree-like graphic that shows the branches of the progressively fused clusters. In this project, the Lance-Williams Flexible-Beta linkage method (Lance and Williams 1966, 1967) was used in conjunction with the Bray-Curtis coefficient of community (Bray and Curtis 1957) to identify compositionally similar groups. The Lance-Williams method is a generalized sorting strategy, the performance of which varies with user-specified emphasis (beta) on different measures of between-group distance. In general, beta settings ranging from the default –0.25 to –0.5 produce optimal results with vegetation data, performing very similarly to minimum-variance clustering, *i.e.*, Ward's method (Ward 1963). The Bray-Curtis coefficient, also known as the Czekanowski or Sorenson coefficient, has been used with demonstrable success in a wide range of ecological studies (Beals 1984). Among available measures of ecological "distance," represented as a mathematical dissimilarity between samples, the Bray-Curtis coefficient is a balanced measure that places some emphasis on dominant (*i.e.*, high-cover) species while still giving minor (*i.e.*, low-cover) species considerable weight in the analysis (Gauch 1982).

Preliminary analyses were conducted using two data treatments: 1) raw cover class scores, and 2) cover class scores relativized by site totals. Moreover, analyses using each data treatment were run with three beta settings: 1) –0.25 (the default), 2) –0.375, and 3) –0.5. All six combinations of data treatments and clustering strategies performed comparably, producing dendrograms with similar major divisions and plot groupings, and a high percentage of plots with the same finer-level group memberships. Although it may be desirable in some classifications to relativize species cover by site totals, thus equalizing the contributions of plots to an analysis, in this case all analyses with relativized data resulted in at least one group containing environmentally dissimilar plots. In the three procedures using raw cover class scores, manipulation of beta values produced subtle differences in the relative levels at which groups reached resolution in the dendrograms. After examining the results from all six combinations, the arrangement of plots produced by clustering with raw cover class scores and beta set at –0.375 was accepted because it was the most ecologically interpretable. Four major clusters, or stems, of the accepted dendrogram were recognized at a coarse level in the hierarchy as vegetation classes while finer-level clusters were recognized as community types. Community types were accepted at the $r^2 = 0.570$ level. All vegetation classes and community types formed discrete branches in the agglomerative hierarchy.

Compositional Summary Statistics

Compositional statistics were calculated to evaluate the adequacy of groups recognized in cluster analysis and ultimately to assist in naming and describing the community types. Initially, total mean cover and total frequency across all 72 plots were determined for every taxon. Cover class scores were converted to the midpoints of their respective percent ranges, the midpoints were averaged, and resulting values were back-transformed to cover class scores (see Table 2, p. 20). For each taxon in each group under consideration, the following summary statistics were then calculated:

- **Frequency** – the number of samples in a group in which a species occurs.
- **Mean Cover** – back-transformed cover class value corresponding to mean percent cover calculated from midpoint values of cover class ranges. All samples assigned to a group were considered when calculating mean cover, not just those in which a taxon was present; absences were assigned a cover value of 0.
- **Relative Cover** – the arithmetic difference between mean cover (for a given group of samples) and total mean cover (for the entire data set) (= Mean Cover – Total Mean Cover). Expressed by plus or minus symbols, this value provides a *relative* approximation of how much more, or less, abundant a particular species is in a community type compared to the overall data set.
- **Constancy** – the proportion of samples in a group in which a species occurs, expressed as a percentage (= Frequency / Number of samples in group x 100). Because they are scaled to 100, constancy values can be compared across community types with unequal numbers of plots.
- **Fidelity** – the degree to which a species is restricted to a group, expressed as the proportion of

total frequency that frequency in a given group constitutes (= Frequency / Total Frequency x 100). An accidental or exotic species can have maximal (100) fidelity to a type if it occurs in only one sample in the entire data set. As a result, fidelity alone can perform poorly as a criterion for identifying characteristic species and distinguishing among types.

- **Indicator Value** (IV) (= Constancy x Fidelity / 100). A synthetic value indicating species that are both frequent within and relatively restricted to a group of plots.
- **Indicator Value Adjusted by Cover, Scaled** (Scaled Adj IV) (= Indicator Value x Mean Cover / 9). By dividing IV by 9, the maximum possible cover value, this statistic synthesizes information about frequency, diagnostic value, and mean abundance. A species entirely restricted to a particularly community type, occurring in every sample of that type, and attaining maximum mean cover will have a Scaled Adjusted IV of 100 for that type. Empirically, taxa with Scaled Adjusted IVs ≥ 15 are almost always those most characteristic of a type, although the exact range of values in any given type or data set may vary considerably.
- **Indicator Value Adjusted by Cover, Unscaled** (Unscaled Adj IV) (= Indicator Value x $2^{\text{relative cover}}$). An alternative, unscaled synthetic measure of adjusted IV, using relative cover as the modifier of IV. Since cover classes form a logarithmic, rather than linear scale of values, Unscaled Adjusted IV is a statistically more legitimate means of incorporating information on cover, and has the advantage of not favoring only dominant species and better identifying species that are considerably more abundant within a given type than in the data set as a whole. This statistic is sensitive, however, to vegetation types containing few samples and to species with low overall frequency.

Additionally, the following statistics were generated for each group:

- **Mean Species Richness** – the average number of species present per plot (*S*); only species rooted inside plot boundaries were included in this calculation.
- **Homoteneity** – the mean constancy of the *S* most constant species, expressed as a fraction. This value (sensu Curtis 1959) can be considered the constancy of the average species in a community type; higher values for homoteneity indicate greater uniformity in species composition among plots. Although homoteneity is not independent of group size, often increasing as the number of group members decreases, it can be used to evaluate whether community types have been defined at an appropriate level.

These procedures were executed in Excel using a macro written in Visual Basic by DCR-DNH ecologist Philip P. Coulling. This macro greatly reduced the time required for calculations and made it possible to efficiently evaluate a sizeable number of groups in the competing dendrograms generated by different cluster analysis protocols. During cluster analysis, the group membership of one plot (BRM067) in particular proved problematic, shifting among several groups depending on the clustering protocol used. This sample was ultimately assigned to one group by evaluating the statistical interpretability of each affected group with and without the questionable plot, and by examining the position of this sample on the axes of non-metric multidimensional scaling ordinations (see below).

Community Type Structural Characterization

The standard forestry statistics calculated for each plot (see p. 22) representing a community type were averaged to obtain a composite characterization of woody vegetation for that type. In addition, the typical vertical structure of each community type was determined by averaging cover class scores of all woody species in each stratum across all plots representing the type. As in compositional statistics, cover class scores were converted to the midpoints of their respective percent cover ranges, the midpoints were averaged, and resulting values were back-transformed to cover class scores. Similarly, mean canopy height for a community type was obtained by averaging the canopy height measurements from all representative plots. The mean vegetation cover in each stratum was also calculated by averaging the midpoints of stratum cover class scores 1) across all plots (including those with no cover in the stratum), and 2) across only plots in which the stratum is developed (see *Vegetation Measurements*, p. 18).

Environmental Summary Statistics

Mean values for continuous and ordinal environmental variables were calculated for each group to aid in describing the units and identifying the differences between them. These calculations were performed with raw (untransformed) values, which were averaged across all plots representing a given group. Mean aspect was calculated as the average position along an arc defined by the range of aspect values.

Ordination

The ordination method non-metric multidimensional scaling (NMDS; Kruskal 1964) was used to validate the classification, detect compositional variation and trends that are obscured in cluster analysis, and aid in identifying the environmental gradients along which vegetation classes and community types are distributed. Ordination is a collective term for multivariate techniques that arrange vegetation samples in relation to each other based on compositional similarity and relative species-abundances. Ordination procedures summarize multidimensional data in a reduced coordinate system, extracting those axes that explain the most variation in the data. While ordination methods can reveal groups of similar composition, their primary aim is to show a pattern of continuous variation in a dataset. Ordination is often used in combination with numerical classification methods (*e.g.*, cluster analysis), providing complementary analyses that examine patterns and search for group structure in compositional data.

NMDS is a type of indirect gradient analysis that assigns samples to coordinates in ordination space in a way that maximizes, to the extent possible, the rank-order (*i.e*., non-parametric) correlation between inter-sample distance in ordination space and inter-sample dissimilarity (*i.e.*, ecological distance; Minchin 1987). NMDS initially assigns spatial coordinates to samples at random, then calculates stress as the mismatch between the set of ordination distances and the matrix of dissimilarity between plots. Sample points are then moved such that stress is reduced, stress is recalculated, and the process is repeated iteratively. Since NMDS does not converge on a single, tractable solution for a given ordination, a sufficient number of iterations are required to reach a point at which decreases in stress are negligible, and several starting configurations are necessary in order to avoid reaching local *minima* of stress. Additionally, the dimensions of an NMDS ordination do not form a decreasing series of variance in composition explained, and actual axis numbers are arbitrary. NMDS will extract as many dimensions as are specified, and an appropriate number of dimensions must be determined *a priori* by examining the rate at which stress declines with an increasing number of dimensions.

NMDS was implemented in PC-ORD (version 4.17; McCune and Mefford 1999). The Bray-Curtis index was used to calculate dissimilarity and VARIMAX rotation was employed to optimize axis placement in all ordination studies for this project. Each ordination was computed using 40 random starting configurations, and configurations with the lowest stress levels were used for interpretation. Based on preliminary plots of stress vs. dimensionality, ordination of the overall data set was extracted in two dimensions. Two or three-dimensional ordinations were used to examine compositional variation within vegetation classes and community types. Pearson correlations between environmental variables and sample coordinates on each axis were calculated, and significant correlations were displayed through joint plot overlays. Environmental variables used in ordination analyses were ordinal variables for slope shape; continuous variables for arcsine-transformed surface substrate values, Beers-transformed aspect, slope, elevation, distance to nearest stream, distance to nearest ridge, raw and natural log-transformed soil chemistry values; synthetic scalars for relative slope position, topographic relative moisture index (TRMI), and potential solar radiation index; and dummy variables for geologic substrate (see pp. 20-24 for detailed discussion of these variables). After preliminary studies, ordinal variables for topographic position and soil moisture regime were eliminated from the analysis since they are redundant with, and less objective measures than, relative slope position and TRMI respectively.

RESULTS

Floristics and General Vegetation Characteristics

A total of 366 vascular plant taxa was recorded from the 72 plot samples. Each taxon occurred, on average, in 8.1 plots. Only 16 taxa were present in half or more of the plots, accounting for 25% of all species-occurrences (Table 6). Forty-six taxa account for 50% of all species-occurrences. Nearly half (47%) of the recorded taxa occurred in three or fewer plots, and 25% were recorded from only one plot. Eleven species that attained a mean cover ≥ 5 (≥ 5%) across all 72 plots can be considered the most generally "abundant" plants of the study area, at least in terms of cover (Table 6).

Table 6. Most frequent and abundant vascular plants of the 72-plot data set, listed by decreasing frequency. Included are all taxa occurring in 50% (36) or more of the plots or attaining a mean cover ≥ 5 across all plots. The total abundance (sum of all cover class scores) of each species is also listed.

Taxon	Common Name	Growth Form	Total Freq. (no. of plots)	Total Mean Cover	Sum of Cover Class Scores
Acer rubrum	red maple	tree	64	6	341
Quercus montana	chestnut oak	tree	59	7	382
Nyssa sylvatica	black gum	tree	55	6	276
Vaccinium pallidum	early lowbush blueberry	shrub	52	5	233
Quercus rubra	northern red oak	tree	51	5	244
Liriodendron tulipifera	tulip-poplar	tree	49	6	264
Smilax rotundifolia	common greenbrier	woody vine	45	3	108
Sassafras albidum	sassafras	tree / shrub	44	3	133
Chimaphila maculata	spotted wintergreen	perennial sub-shrub	43	2	82
Quercus velutina	black oak	tree	42	4	141
Maianthemum racemosum ssp. *racemosum*	Solomon's-plume	perennial herb	42	2	77
Parthenocissus quinquefolia	Virginia creeper	woody vine	42	2	98
Kalmia latifolia	mountain-laurel	shrub	40	6	215
Rhododendron periclymenoides	wild azalea	shrub	38	3	114
Dioscorea quaternata	whorled wild yam	perennial herb	37	2	73
Cornus florida	flowering dogwood	tree / shrub	36	4	146
Fagus grandifolia	American beech	tree	33	5	149
Quercus alba	white oak	tree	32	5	145
Gaylussacia baccata	black huckleberry	shrub	28	5	142
Pinus rigida	pitch pine	tree	12	5	71

Eighteen taxa, representing less than 5% of the recorded flora, were exotics. These accounted for less than 3% of all occurrences and six of the exotics each occurred in a single plot. The relatively low numbers of exotics in this data set reflect a strong bias in sample site selection toward mid- to late-successional forests occupying relatively undisturbed habitats away from roads and clearings.

The alpha diversity (*i.e.*, species richness, or number of species) of plot samples ranges from 10 to 88. Mean species richness per plot is 40.97. Beta diversity (*i.e.*, the total flora divided by mean species richness per plot) is 8.96. Beta diversity is a useful measure of floristic similarity in a range of habitats or samples (Magurran 1988). Theoretically, a beta diversity of 8.96 means that about nine plot samples would capture the full floristic diversity of the study area if no species occurred more than once. In practice, however, a much higher number of plots would be required since many species widely distributed in nature occur in multiple samples.

Among woody species, *Quercus montana* (chestnut oak) has the highest large tree (≥ 40 cm [15.7 in]) density, basal area, and importance value over the whole study area (Table 7). Second only to the abundant clonal shrub *Kalmia latifolia* (mountain-laurel) in total density, *Quercus montana* is clearly the most ubiquitous overstory tree in the Bull Run Mountains. *Liriodendron tulipifera* (tulip-poplar) is second in importance value due to its strong dominance on mesic sites. Despite rather low basal area and density of trees ≥ 40 cm dbh, *Acer rubrum* (red maple) is the only other woody species with an importance value > 10.00, in large part because it is a prolific understory tree in many of the area's prevalent, oak-dominated forests. These three species alone account for almost 30% of total woody stem densities and more than 50% of basal area in the 72 sites sampled during this study.

Table 7. Woody stem data summary for the Bull Run Mountains study area. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged across the entire 72-plot data set. Species with IV > 1.00 are listed in descending order of IV.

SPECIES	**COMMON NAME**	**Tree Density**	**Large Tree Density**	**Total Density**	**Relative Density**	**Basal Area**	**Relative Basal Area**	**IV**
Quercus montana	chestnut oak	130	25	155	13.07	10.54	28.33	20.70
Liriodendron tulipifera	tulip-poplar	38	21	59	6.47	7.01	17.69	12.08
Acer rubrum	red maple	143	4	147	12.64	2.20	7.61	10.13
Nyssa sylvatica	black gum	130	1	130	9.69	1.15	3.37	6.53
Quercus rubra	northern red oak	18	12	30	3.13	3.92	8.40	5.77
Kalmia latifolia	mountain-laurel	165	0	165	8.45	0.21	0.70	4.57
Fagus grandifolia	American beech	33	5	38	4.60	1.83	3.71	4.15
Pinus rigida	pitch pine	40	2	42	2.75	1.69	5.48	4.12
Carya ovalis	red hickory	36	2	39	3.72	1.03	2.86	3.29
Quercus alba	white oak	9	7	17	1.68	2.13	4.79	3.23
Carya alba	mockernut hickory	34	0	34	3.81	0.41	1.25	2.53
Cornus florida	flowering dogwood	36	0	36	4.07	0.09	0.26	2.16
Pinus pungens	table-mountain pine	24	0	24	1.43	0.72	2.84	2.13
Quercus velutina	black oak	8	4	12	1.06	1.17	3.04	2.05
Quercus coccinea	scarlet oak	10	3	13	0.93	1.07	2.75	1.84
Pinus virginiana	Virginia pine	30	1	31	1.89	0.48	1.51	1.70
Sassafras albidum	sassafras	27	0	27	2.23	0.09	0.29	1.26
Fraxinus americana	white ash	10	1	11	1.31	0.32	1.14	1.23
Hamamelis virginiana	witch-hazel	25	0	25	2.25	0.04	0.16	1.21
Carya glabra	pignut hickory	17	0	18	1.48	0.30	0.81	1.14
other species	-	160	2	161	13.34	1.12	3.02	8.18
TOTALS		**1123**	**90**	**1213**	**100.00**	**37.53**	**100.00**	**100.00**

Community Classification

Classification Principles and Nomenclature

The vegetation classification for this study is a hierarchical one, generated entirely from the bottom up using plot-based, quantitative data. It was initially produced by the application of objective analytical techniques and subsequently refined through subjective interpretation. The basic unit of classification is the community type, represented by a group of vegetation samples of relatively homogeneous composition that share a set of characteristic species and occur under a set of similar environmental conditions. In two cases, distinct compositional subgroups within a community type are tentatively recognized as community subtypes, the finest level of the classification hierarchy.

The community type is more or less equivalent to the "association" recognized in traditional vegetation studies (Barbour, Burk, and Pitts 1987; Mueller-Dombois and Ellenberg 1974), except that distinct vegetation types at the local landscape scale may reflect geographically restricted units that would be subsumed into broader associations in a classification such as the U.S. National Vegetation Classification (USNVC; Grossman *et al.* 1998). Since one of the major objectives of this study is to produce a practical classification to guide future inventory, stewardship, and ecological management in the Bull Run Mountains, classification at the local landscape scale is warranted.

It is important to recognize that vegetation types are not only scale-dependent but conceptually abstract, since the composition of concrete stands of vegetation in nature typically changes gradually along a continuum of environmental gradation. These changes reflect the independent but overlapping responses of individual species to environmental gradients, so that the artificial partitioning of vegetation into discrete classes and the degree of compositional variation allowed is almost always somewhat arbitrary (van Tongeren 1995). Webb (1954) succinctly described this apparent paradox:

> "The fact is that the pattern of variation shown by the distribution of species among quadrats on the earth's surface chosen at random hovers in a tantalizing manner between the continuous and the discontinuous. If variation were continuous and all possible combinations of species could be realized, then the science of plant-sociology would be impossible. If variation were discontinuous, with a finite and manageable number of combination of species which could be realized, and sharp boundaries between the communities, then a satisfactory taxonomy of communities would have been agreed on long ago, and no problem would exist. What we find, however, is that variation is continuous, but in some regions sudden and in others very gradual, and that there is a series of often striking but never perfect correlations between different pairs of species. We find, in consequence, that there is a recognizable but very imperfect predictability of the remaining species of a community when some of the principle ones have been ascertained."

Despite encompassing an inevitable degree of variation, the community types defined in this study are generally recognizable in the field and potentially mappable. However, because the classification is based on composition in all layers, not just the tallest, these community types differ considerably from "cover types" (*sensu* Eyre 1980) used in forestry and large-scale vegetation mapping. Since our purpose is to define ecological units, all plants at a site are considered. In forests, for instance, shrubs and herbs often respond to more subtle environmental gradients and may reveal more about local site conditions and associated animal species than do trees, which tend to be more broadly distributed and exhibit less environmental specificity. Likewise, herbaceous species occurring with low cover may be more restricted to certain site conditions and thus far more diagnostic of a community type than more widespread, dominant shrubs and trees.

For convenience, community types are aggregated into vegetation classes, representing the upper tier of the hierarchy and the coarser divisions of the cluster analysis. These are essentially *ad hoc* units, generated by this specific classification, that reflect broad environmental and compositional affiliation among the component types within the context of the Bull Run Mountains.

A consistent methodology is followed for naming the hierarchical classification units. Vegetation classes are named using prevailing habitat, site, and physiognomic features (*e.g*., basic ravine and slope forests). The nomenclatural approach to community types and subtypes is comparable to that of the USNVC for associations, using the scientific names of up to six characteristic species, with distinct vertical strata indicated. As a rule, species are listed by descending order of importance and structural position, *i.e.*, canopy species are listed first, followed by understory species, shrubs, and herbs. Nominal species in the same stratum are separated by a dash (-), while different strata are separated by a slash (/). Redundant varietal and subspecific epithets (*e.g*., *Quercus rubra* var. *rubra*) are not used in community names. The characteristic physiognomy (*i.e*., forest, woodland, shrubland, etc.) of a type is listed at the end of its name, although the approach taken here allows some physiognomic, as well as floristic, variability in delineating ecological communities.

The species used as nominals may be characteristic of a type because of their abundance, constancy, or relative restriction to the type. Although they can never be surrogates for descriptions, the names of communities are constructed so that one can distinguish among types, identify types readily in the field, and assign new stands to previously classified types. In order to meet the first objective, an emphasis has been placed on diagnostic species (*e.g*., those with high adjusted IV values; see p. 26). However, in the prevailing mixed forests of this area and other regions in the eastern United States, characteristic canopy trees are usually not restricted to a particular type. Many forested types, despite having distinctive total floristic compositions, have variable overstories composed of wide-ranging tree species with low fidelity and indicator value. Exclusion of such species from a community name altogether is not desirable and obfuscates the ready identification of the type in the field. Hence the approach typically taken by DCR-DNH ecologists in naming forest community types involves the combined use of indicator, constant, and dominant species, with nominal species of the tree strata often common to multiple types and nominal species of the shrub and herb strata contributing more diagnostic value.

Hierarchical Classification of Vegetation Classes and Community Types

Based on the results of hierarchical agglomerative cluster analysis using the Lance-Williams Flexible Beta method and Bray-Curtis dissimilarity, four broad vegetation classes, 10 community types, and four community subtypes were recognized (Table 8, Figs. 7 and 8). Seventy-two sampling sites and 366 vascular plant taxa were used in this classification. Vegetation classes were identified as major stems of the cluster dendrogram, and community types nested within vegetation classes were recognized at the $r^2 = 0.570$ level. Membership in community types ranges from two to 15 plots. The classification is entirely hierarchical and both community types and ecological groups represent distinct "lineages" in the dendrogram.

Homoteneity values for community types (see *Compositional Summary Statistics*, p. 26) range from 0.656 to 0.763, with a mean of 0.702. These values are comparable to corresponding values obtained in a similar landscape-scale classification of Peters Mountain in Allegheny County, Virginia (Fleming and Moorhead 2000; 51 plots, 407 taxa, 20 community types, mean = 0.721, range = 0.638 to 0.818). On the other hand, they are considerably higher than homoteneity values generated in a wide-ranging study of limestone / dolomite vegetation in western Virginia (Fleming 1999; 64 plots, 654 taxa, 11 community types, mean = 0.660, range = 0.574 to 0.785). These differences probably reflect the more restricted geographic scope and somewhat finer level of classification in the current study, since homoteneity generally increases as group membership and floristic diversity decrease.

Table 8. Hierarchical classification of vegetation types in the Bull Run Mountains study area. The three hierarchical levels represented are Vegetation Class (*e.g*., code 3), Community Type (*e.g*., code 3.2), and Community Subtype (*e.g*, code 3.2.1). A "common" or natural community name is listed after each formal syntaxonomic name and the number of plots in each group is given parenthetically. For a list of sample sites in each group, see the individual community type descriptions.

1. Non-Alluvial Wetlands (9 plots)

> **1.1. *Acer rubrum – Liriodendron tulipifera* / *Ilex verticillata – Vaccinium fuscatum* / *Osmunda cinnamomea –Symplocarpus foetidus* Forest** - Mountain/Piedmont Acidic Seepage Swamp (9 plots)

2. Acidic Ravine and Slope Forests (19 plots)

> **2.1. *Fagus grandifolia – Liriodendron tulipifera – Quercus rubra* / *Polystichum acrostichoides – Carex laxiculmis* Forest** - Mesic Mixed Hardwood Forest (5 plots)
>
> **2.2. *Quercus montana – Quercus alba – Carya glabra* / *Cornus florida* Forest** - Acidic Oak-Hickory Forest (7 plots)
>
> **2.3. *Tsuga canadensis – Quercus montana* / *Hamamelis virginiana* Forest** - Eastern Hemlock-Hardwood Forest (2 plots)
>
> **2.4. *Quercus montana – Quercus rubra* / *Vitis aestivalis* var. *bicolor – Parthenocissus quinquefolia* / *Aralia nudicaulis – Dryopteris marginalis* Forest** - Low-Elevation Boulderfield Forest / Woodland (5 plots)

3. Basic Ravine and Slope Forests (17 plots)

> **3.1. *Liriodendron tulipifera – Quercus rubra* / *Asimina triloba* / *Lindera benzoin* / *Amphicarpaea bracteata* – (*Adiantum pedatum*) Forest** - Basic Mesic Forest (7 plots)
>
> **3.2. *Quercus montana – Quercus rubra – Carya ovalis* / *Desmodium nudiflorum – Dichanthelium boscii* Forest** - Basic Oak-Hickory Forest (10 plots)
>
> > **3.2.1. *Carya ovalis – Quercus rubra* / *Solidago ulmifolia – Carex pensylvanica* Subtype** (6 plots)
> >
> > **3.2.2. *Quercus montana – Liriodendron tulipifera* / *Cimicifuga racemosa – Galium latifolium* Subtype** (4 plots)

4. Xeric Oak and Pine Forests (27 plots)

> **4.1. *Pinus pungens – Quercus montana* / *Kalmia latifolia – Gaylussacia baccata* Woodland** - Table-Mountain Pine – Oak / Heath Woodland (3 plots)
>
> **4.2. *Pinus rigida – Quercus montana* – (*Pinus virginiana*) / (*Quercus marilandica*) / *Kalmia latifolia* Woodland** - Pitch Pine – Oak / Heath Woodland (9 plots)
>
> **4.3. *Quercus montana* – (*Quercus coccinea, Quercus velutina*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest** - Chestnut Oak Forest (15 plots)
>
> > **4.3.1. *Quercus montana* – (*Quercus velutina*) / *Kalmia latifolia* Subtype** (10 plots)
> >
> > **4.3.2. *Quercus montana* – (*Quercus coccinea*) / *Gaylussacia baccata* Subtype** (5 plots)

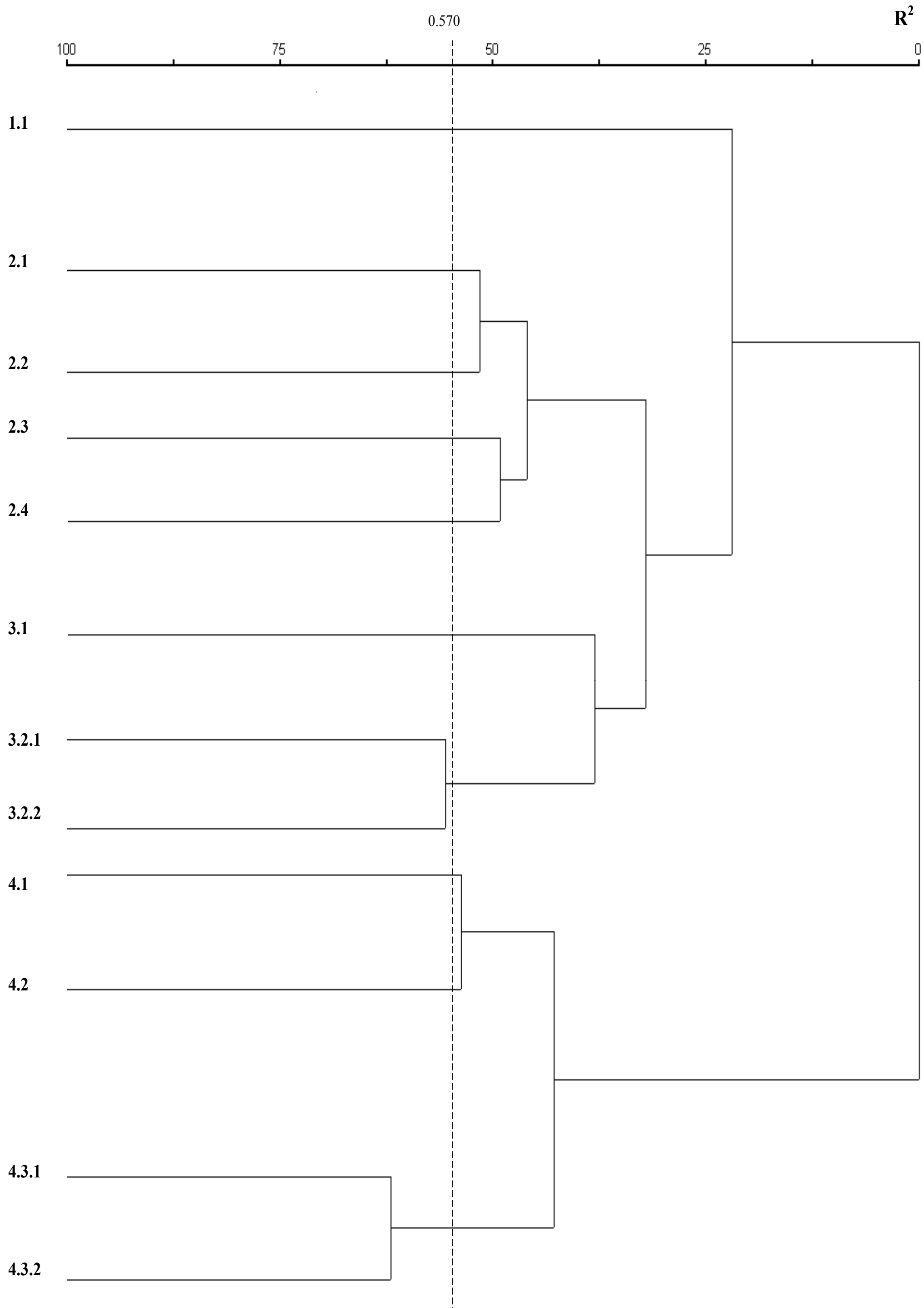


Figure 7. Dendrogram showing major vegetation groupings produced by cluster analysis of the 72-plot data set using the Lance-Williams Flexible Beta method and Bray-Curtis coefficient of community. The dashed line indicates the level at which community types were recognized. For full community type names, see Table 8, p. 32.

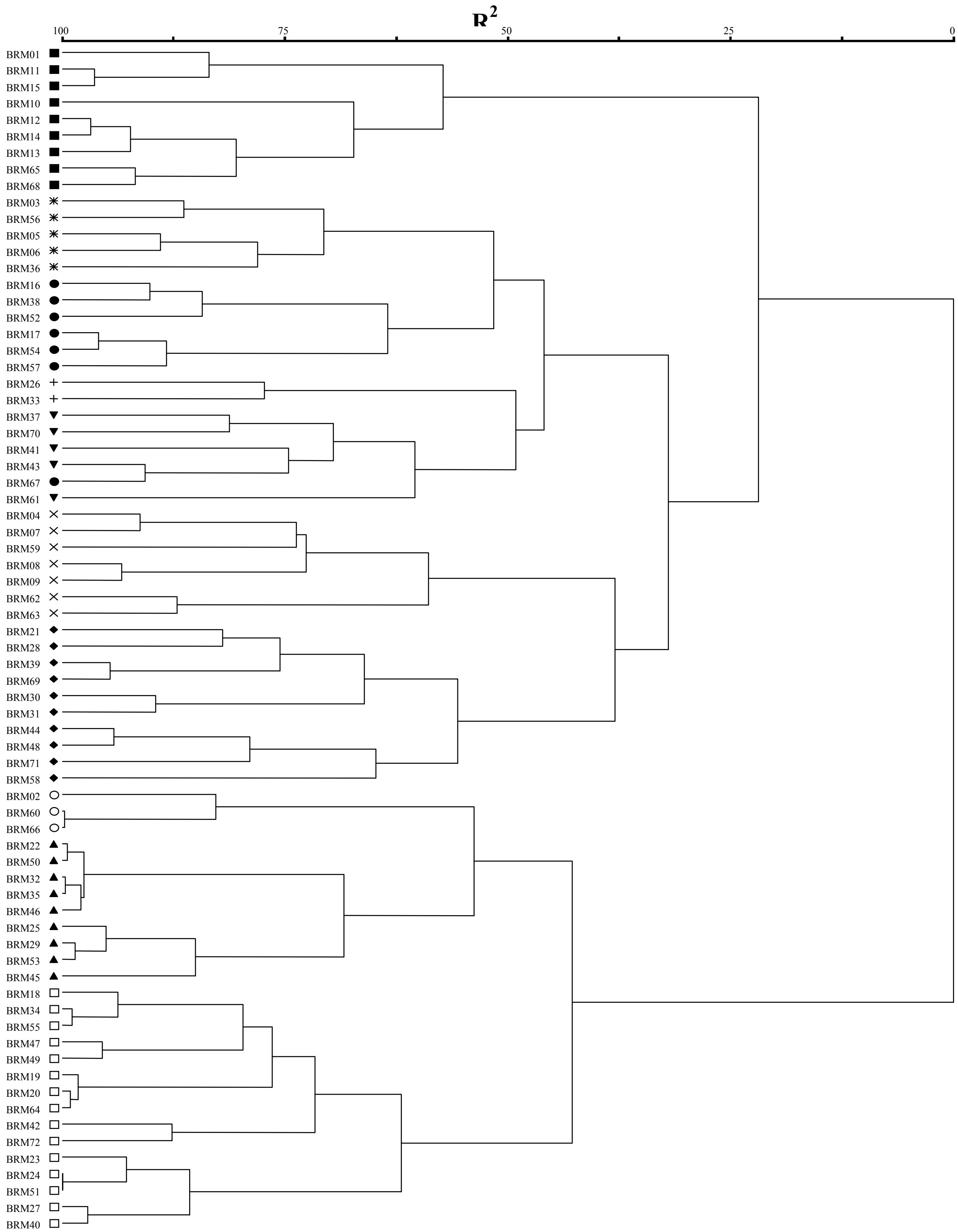


Figure 8. Dendrogram showing the group membership of all 72 plots. Each community type is coded with a unique symbol. For names of groups see Fig. 7 and Table 8. Note that plot BRM067 was ultimately reassigned to a different group based on statistical analysis and ordination results (see p. 26).

Relationship of Vegetation to the Environment

The relationship between major compositional groups and environmental gradients was examined in a two-dimensional NMDS ordination of the 72-plot data set (Fig. 9). In order to further elucidate relationships between the three upland vegetation classes, a three-dimensional ordination of plots in the Acidic Ravine and Slopes Forests and the Basic Ravine and Slope Forests classes (Figs. 10 and 11) and a two-dimensional ordination of plots in the Acidic Ravine and Slope Forests and the Xeric Oak and Pine Forests classes (Fig. 12) were also performed. Separate ordinations showing the relationships of community types within each vegetation class and of subtypes within the Basic Oak-Hickory Forest and Chestnut Oak Forest community types are presented in the sections describing the units.

The results of ordination analyses are depicted by diagrams, in which each point represents a plot and the distance between points indicates the degree of compositional similarity. Important topographic / hydrologic and soil chemistry gradients are identified by joint plot vector overlays on each ordination diagram. Each environmental factor with a Pearson product-moment correlation of $r > |0.45|$ with stand scores on any of the axes is plotted as a vector, the direction of which indicates the direction of maximum correlation through ordination space. Vector line lengths are determined by the strength of the correlation. This critical value for the correlation coefficient is provided in the caption for each ordination diagram. Significance levels are uncorrected for multiple comparisons. Joint plots differ from biplots in that vectors emanate from the centroid of ordination space rather than the origin of the axes, and vectors are based on correlations instead of least-squares regression equations (McCune and Mefford 1997). Because vectors in PC-ORD joint plots are not scaled, the strengths of environmental gradients are not comparable between ordination diagrams.

When stand distributions in the various ordination diagrams are examined, the disposition of vegetation classes and community types generally corresponds well with clusters identified by the Lance-Williams flexible beta method. The four major classes (Fig. 9) segregate along both a soil fertility gradient and a complex topographic-moisture gradient. The soil fertility gradient is indicated by high levels of Mg, Mn, Ca, pH, and total base saturation (%TBS) associated with the distribution of plots in the lower part of the ordination diagram; high levels of Fe and cation exchange capacity (CEC) occur near the opposite end of this gradient. MANOVA tests confirm significant differences in soil chemistry both among the four vegetation classes (Pillai's Trace: $F = 5.9596$, $p = <0.0001$; Wilks' Lambda: $F = 8.1586$, $p = <0.0001$; Hotelling-Lawley: $F = 10.1976$, $p = <0.0001$; Roy's Max Root: $F = 19.6154$, $p = <0.0001$) and among the 10 community types (Pillai's Trace: $F = 2.1379$, $p = <0.0001$; Wilks' Lambda: $F = 3.2048$, $p = <0.0001$; Hotelling-Lawley: $F = 5.0787$, $p = <0.0001$; Roy's Max Root: $F = 29.1239$, $p = <0.0001$).

The topographic-moisture gradient is indicated by high values for convex slope shape, topographic position (Relslope), and underlying or surficial rocks of massive, thick-bedded quartzite in the upper right portion of the ordination, and by high values for potential site moisture (TRMI), concave slope shape, and underlying or surficial rocks of flaggy quartzite or phyllite in the lower left portion.

The Xeric Oak and Pine Forests (4) are positioned at the infertile end of the soil chemistry gradient and also at the higher, drier end of the topographic-moisture gradient. This is consistent with the middle- to upper-slope and ridge crest habitats occupied by community types in this group, as well as with the low base status of, and downslope leaching of nutrients from, thin rocky soils weathered from massive quartzite. On the other hand, the Basic Ravine and Slope Forests (3) occur in association with the high end of the fertility gradient but are less directly positioned at the lower and more mesic end of the topographic-moisture gradient. Stands of the Acidic Ravine and Slope Forests (2) occupy more or less intermediate positions along both gradients. High values for surface water and sand content of mineral soil correspond to the position of the Non-Alluvial Wetlands (1) in ordination space. In addition, the CEC gradient in this dataset is generated by the very low values associated with sandy soils of the Non-Alluvial Wetlands.

Since the Acidic Ravine and Slope Forests (2) lie near the center of ordination space and environmental gradation, additional NMDS ordinations were performed to explore the relationship of this vegetation class and its component community types with the other two upland classes. The two plots constituting the Eastern Hemlock-Hardwood Forest community type (2.3) were removed before running the final analyses, since they performed as outliers and distorted initial ordination diagrams. A three-dimensional ordination of the Acidic (2) and Basic (3) classes indicates a gradual but definite separation of these major groups along axes 1 and 2, in association with soil fertility and, to a lesser extent, topography (Fig. 10). The divergent vectors for Mg, %TBS, pH, K, Ca, Mn, Al, and S indicate that the fertility gradient is a complex one and not simply a function of base saturation. Plots of both classes are dispersed along a site moisture gradient indicated by high TRMI values in the upper right part of the diagram near the Basic Mesic Forests (3.1) and the Mesic Mixed Hardwood Forests (3.2), both of which are characteristic of moist, lower-slope habitats. Plots of both the Acidic Oak-Hickory Forests (2.2) and the Basic Oak-Hickory Forests (3.2) are situated on the drier end of this gradient. A weaker topographic gradient runs right to left in the ordination, the two ends marked by Basic Oak-Hickory Forests (3.2) of relatively high topographic positions (Relslope, Dstream, Elev), and Mesic Mixed Hardwood Forests (2.1) typical of low-elevation, lower slopes and ravine bottoms. The Low-Elevation Boulderfield Forest (2.4) segregates strongly along the third axis in association with high values for exposed boulder substrate and moss/lichen cover (Fig. 11).

A two-dimensional ordination of the Acidic Ravine and Slope Forests (2) and Xeric Oak and Pine Forests (4) shows a pronounced separation of these classes corresponding to multiple soil chemistry and topographic gradients. Community types within the Xeric Oak and Pine Forests are separated by increasingly infertile soils and higher topographic positions. Community types of the Acidic Ravine and Slope Forests are separated by differences in site moisture, surface substrate cover, and base cation concentrations in soil.

The results of all three ordinations presented here indicate that soil fertility, topographic position, slope shape, site moisture potential, and bedrock parent material are the most important, interrelated environmental factors influencing the composition and distribution of major vegetation groups in the Bull Run Mountains. Soil texture, slope inclination, elevation, aspect, and potential solar radiation appear to be less important correlates of major vegetation patterns, although they may characterize differences between community types within the classes.

The stratigraphy of bedrock units in the Bull Run Mountains exerts strong topographic control that results in regularly recurring landforms, as well as somewhat predictable variation in site moisture and soil chemistry. On most of the area's major ridges, oligotrophic soils and chestnut oak or pine vegetation with abundant ericaceous (heath) shrubs characterize rocky summits and upper slopes underlain by massive quartzite. Because the ridge-forming quartzites dip steeply to the east, cliffs and boulderfield deposits weathered from them are usually confined to the western slopes. Eastern slopes are usually marked by abrupt transitions from chestnut oak forest to diverse oak-hickory forest, evidently related to changes in underlying bedrock from massive quartzite to flaggy quartzite, muscovite schist, and phyllite. Soils weathered from the two lithologic units are similar in texture (% sand, silt, clay), but the thinner-bedded, flaggy rocks produce darker soils with demonstrably higher base status. Although difficult to quantify, it also appears that residual dip-slope soils weathered from these more erosive rocks are relatively deep and have a greater capacity for moisture retention.

Patterns of Species Richness

Mean species richness, or the average number of vascular plant taxa recorded at a site, varies widely across both vegetation classes and community types. The Non-Alluvial Wetlands and Basic Ravine and Slope Forests have the highest mean richness, with averages of 63 and 60 taxa per 400 m^2, respectively. Mean species richness for the Acidic Ravine and Slope Forests (44) is close to that for the entire data set (41). The Xeric Oak and Pine Forests vegetation class is characterized by the lowest mean richness, with

19 taxa per 400 m^2. Excepting the Non-Alluvial Wetlands, which has only nine member plots, variation in the total number of taxa recorded from sites belonging to each class parallels differences in mean richness, despite differences in the number of samples in each class. A total of 245 taxa was sampled in the Basic Ravine and Slope Forests (17 plots), 212 taxa in the Acidic Ravine and Slope Forests (19 plots), and 88 taxa in the Xeric Oak and Pine Forests (27 plots).

Mean species richness values for community types range from 10 to 88. The Basic Oak-Hickory Forest (3.2.) has the highest mean richness (64 taxa) among types, as well as the individual plot (BRM028; Plate 16, p. 106) with the highest mean richness value (88 taxa) in the entire data set. Four community types have similar, moderately high mean numbers of taxa: 1.1. Mountain/Piedmont Acidic Seepage Swamp (60 taxa), 2.1. Mesic Mixed Hardwood Forest (57 taxa), 3.1. Basic Mesic Forest (55 taxa), and 2.2. Acidic Oak-Hickory Forest (49 taxa). Community types 2.4. Low-Elevation Boulderfield Forest/Woodland (33 taxa), 2.3. Eastern Hemlock-Hardwood Forest (25 taxa), and 4.3. Chestnut Oak Forest (22 taxa) have mean richness values well below average for the data set. The lowest mean numbers of taxa occur in community types 4.2. Pitch Pine – Oak / Heath Woodland (15 taxa) and 4.1. Table-Mountain Pine – Oak / Heath Woodland (14), both of which can be considered floristically depauperate.

Spearman correlations reveal strong associations between species richness and untransformed values for several measured soil variables. The strongest positive correlates are % total base saturation ($r = 0.81$, $p = <0.001$), Mg ($r = 0.74$, $p = <0.001$), Mn ($r = 0.68$, $p = <0.001$), pH ($r = 0.66$, $p = <0.001$), Ca ($r = 0.63$, $p = <0.001$), and Zn ($p = 0.63$, $p = <0.001$). The strongest negative correlates are cation exchange capacity ($r = -0.56$, $p = <0.001$), Fe ($r = -0.40$, $p = 0.001$), Sulfur ($r = -0.39$, $p = 0.001$), and % organic matter ($r = -0.32$, $p = 0.006$). The significant positive correlations between species richness and Mg, Mn, pH, and Ca, as well as negative correlation with Fe, are generally consistent with the results of similar studies (Coulling and Rawinski 2001, Fleming and Moorhead 2000) and are generally unimodal, *i.e.*, low levels of positive correlates always support low numbers of species whereas high levels result in a much wider range of richness values.

Highly infertile, drought-prone soils with dense organic horizons and root mats from rhizomatous heaths preclude most herbs and many woody plants from the species-poor community types of the Xeric Oak and Pine Forests class. Species richness in stands of the Low-Elevation Boulderfield Forest/Woodland is limited by the high cover of exposed rock substrate, while dense shade induced by steep, north-facing habitats and woody evergreen species (*e.g.*, *Tsuga canadensis*, *Rhododendron maximum*) is a limiting factor in the Eastern Hemlock-Hardwood Forest. The relatively high species richness of Mountain/Piedmont Acidic Seepage Swamps is partially explained by the complex, hummock-and-hollow microtopography of braided stream bottom habitats, which provide suitable niches for both wetland species and upland mesophytes. Notably, the highest mean richness occurs in a community type (Basic Oak-Hickory Forest) which is associated with submaximal soil fertility and site moisture. A similar pattern has been documented in other studies, both in Virginia (*e.g.*, Fleming 1999, Coulling and Rawinski 1999) and elsewhere (Peet 1988, Newell and Peet 1996).

Summary of Community Type Structural and Environmental Characteristics

To facilitate comparisons between different vegetation groups, mean values of structural characteristics, measured and scalar topographic variables, and soil variables for all classified community types are presented in Table 9. Tables containing mean, minimum, and maximum values for each community type are presented in the descriptive sections that follow.

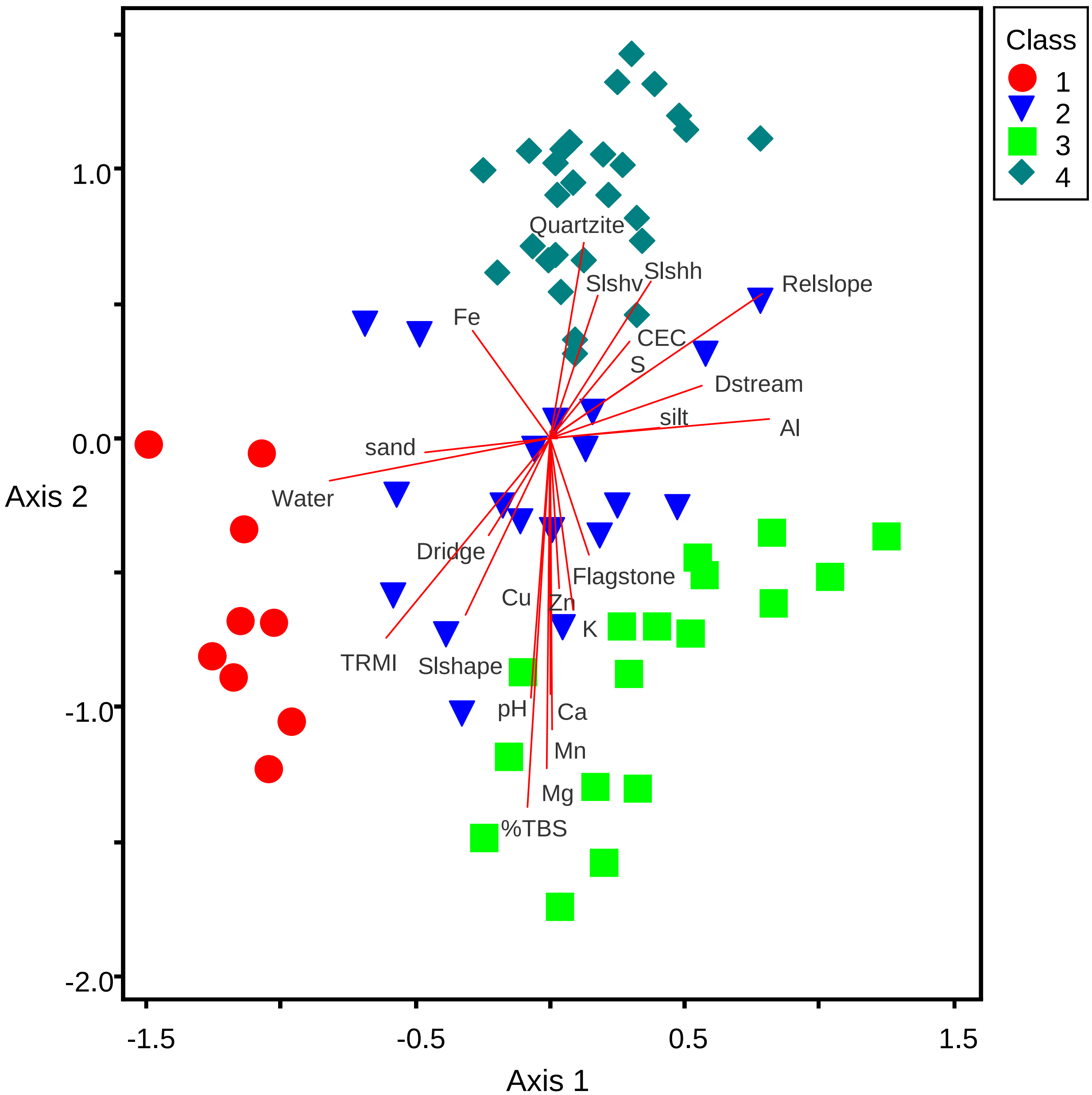


Figure 9. Scatterplot diagram for two-dimensional NMDS ordination of the overall 72-plot data set showing distribution of the four major vegetation classes: 1 – Non-Alluvial Wetlands, 2 – Acidic Ravine and Slope Forests, 3 – Basic Ravine and Slope Forests, 4 – Xeric Oak and Pine Forests. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients ($p = <0.001$). Dridge = distance to nearest ridge top. Dstream = distance to nearest stream. Flagstone = surface rocks predominantly flaggy quartzite, schist, or phyllite. Quartzite = surface rocks predominantly massive thick-bedded quartzite. Relslope = relative slope position; high values indicate higher topographic positions. Sand = % sand in mineral soil. Silt = % silt in mineral soil. Slshape = slope shape index; high values indicate concave slopes. Slshh = horizontal slope shape; positive values correspond to convex slopes. Slshv = vertical slope shape; positive values correspond to convex slopes. TRMI = topographic relative moisture index; high values indicate greater site moisture potential. Water = surface water. See pp. 20-21 for full names of soil chemistry variables.

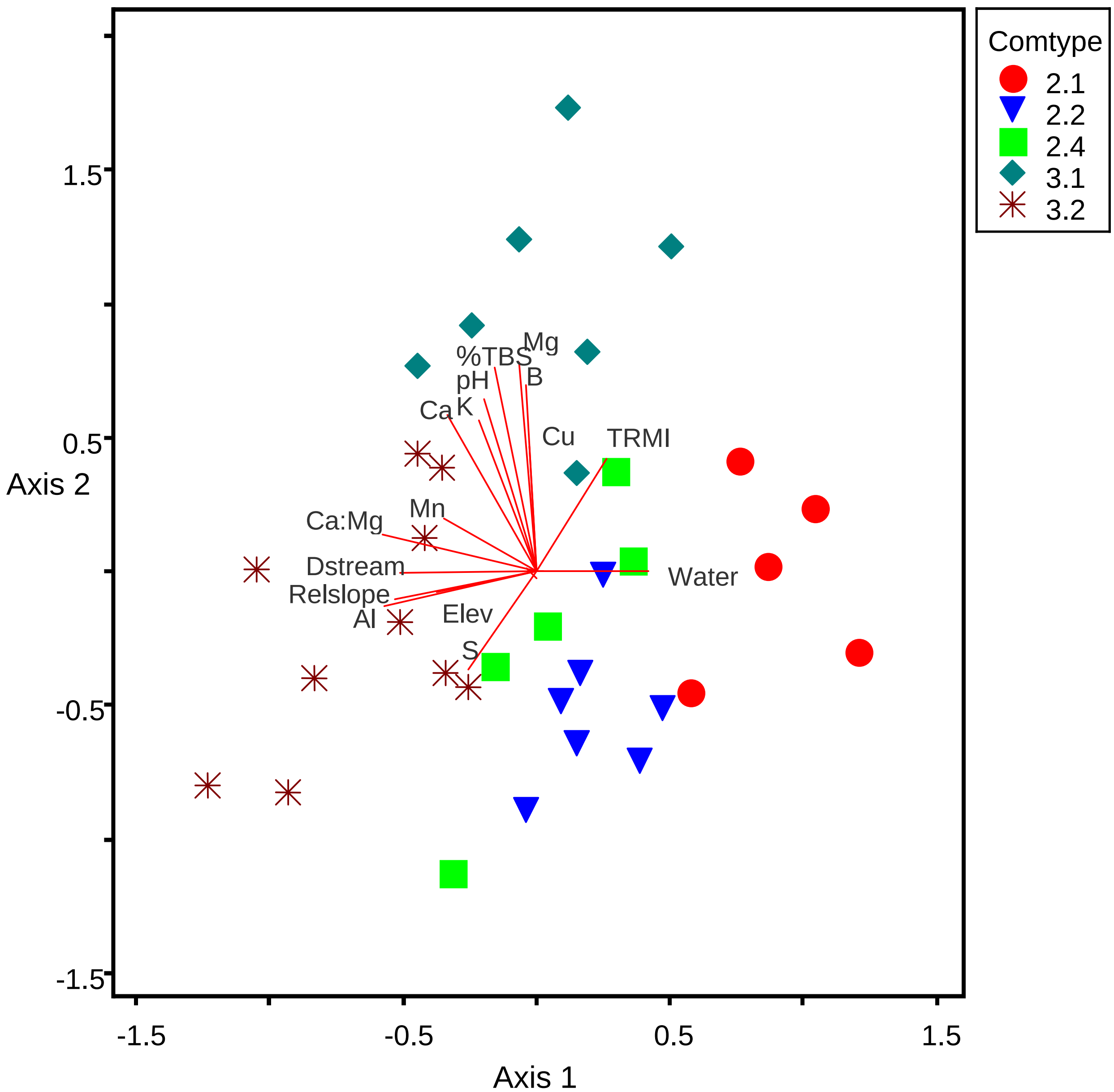


Figure 10. Scatterplot diagram for three-dimensional NMDS ordination of the ACIDIC RAVINE AND SLOPE FORESTS (2) and BASIC RAVINE AND SLOPE FORESTS (3) vegetation classes, showing the distribution of community types on the first and second axes: 2.1 – Mesic Mixed Hardwood Forest, 2.2 – Acidic Oak-Hickory Forest, 2.4 – Low-Elevation Boulderfield Forest/Woodland, 3.1 – Basic Mesic Forest, 3.2 – Basic Oak-Hickory Forest. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients ($p = <0.010$). Dstream = distance to nearest stream, Elev = elevation, Relslope = relative slope position; high values indicate higher topographic positions. TRMI = topographic relative moisture index; high values indicate greater site moisture potential. Water = surface water. See pp. 20-21 for full names of soil chemistry variables.

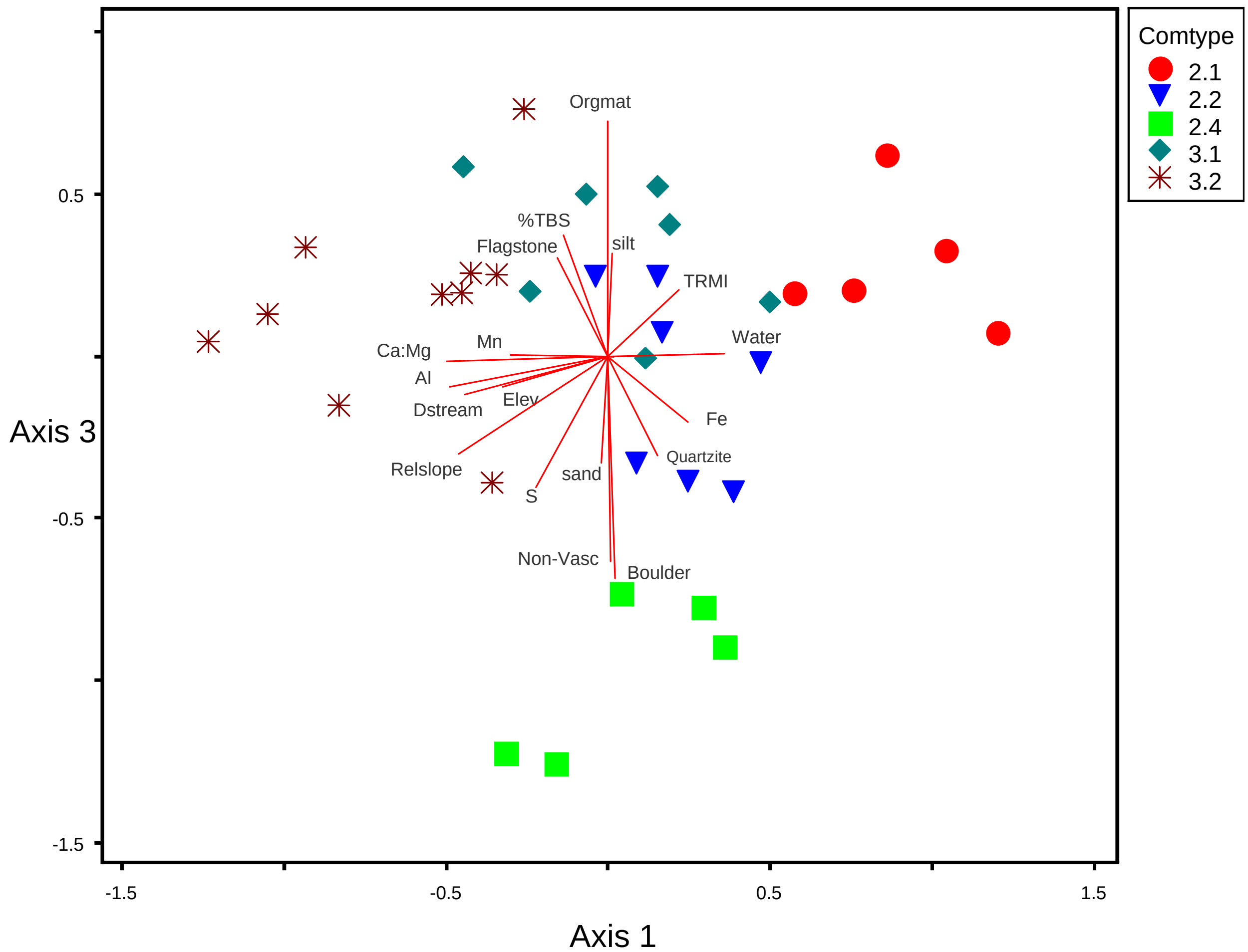


Figure 11. Scatterplot diagram for three-dimensional NMDS ordination of the ACIDIC RAVINE AND SLOPE FORESTS (2) and BASIC RAVINE AND SLOPE FORESTS (3) vegetation classes, showing the distribution of community types on the first and third axes: 2.1 – Mesic Mixed Hardwood Forest, 2.2 – Acidic Oak-Hickory Forest, 2.4 – Low-Elevation Boulderfield Forest/Woodland, 3.1 – Basic Mesic Forest, 3.2 – Basic Oak-Hickory Forest. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients ($p = < 0.010$). Boulder = exposed boulder surface cover. Dstream = distance to nearest stream. Elev = elevation. Flagstone = surface rocks predominantly flaggy quartzite, schist, or phyllite. Non-Vasc = bryophyte/lichen surface cover. Orgmat = organic matter surface cover. Quartzite = surface rocks predominantly massive thick-bedded quartzite. Relslope = relative slope position; high values indicate higher topographic positions. Sand = % sand in mineral soil. Silt = % silt in mineral soil. TRMI = topographic relative moisture index; high values indicate greater site moisture potential. Water = surface water. See pp. 20-21 for full names of soil chemistry variables.

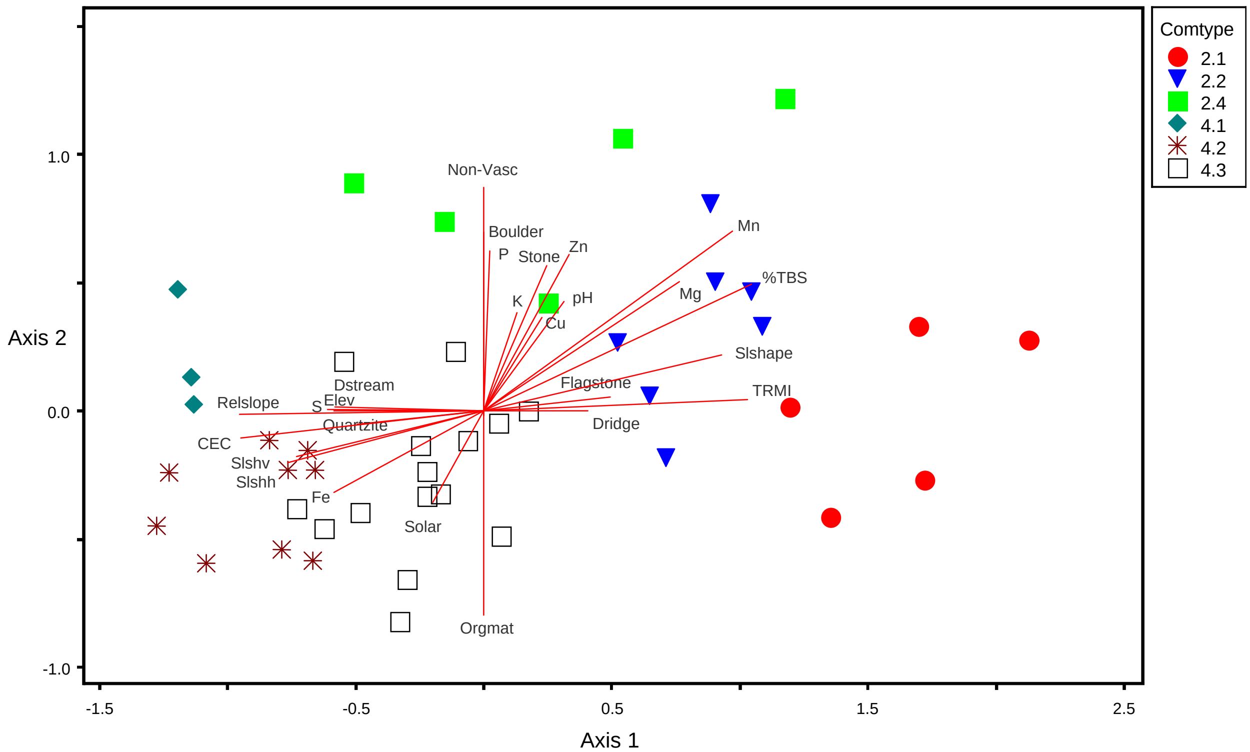


Figure 12. Scatterplot diagram for two-dimensional NMDS ordination of the ACIDIC RAVINE AND SLOPE FORESTS (2) and XERIC OAK AND PINE FORESTS (4) vegetation classes, showing the distribution of community types: 2.1 – Mesic Mixed Hardwood Forest, 2.2 – Acidic Oak-Hickory Forest, 2.4 – Low-Elevation Boulderfield Forest/Woodland, 4.1 – Table-Mountain Pine – Oak / Heath Woodland, 4.2 – Pitch Pine – Oak / Heath Woodland, 4.3 – Chestnut Oak Forest. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients ($p = <0.010$). Boulder = exposed boulder surface cover. Dridge = distance to nearest ridge top. Dstream = distance to nearest stream. Elev = elevation. Flagstone = surface rocks predominantly flaggy quartzite, schist, or phyllite. Non-Vasc = bryophyte/lichen surface cover. Orgmat = organic matter surface cover. Quartzite = surface rocks predominantly massive thick-bedded quartzite. Relslope = relative slope position; high values indicate higher topographic positions. Slshape = slope shape index; high values indicate concave slopes. Slshh = horizontal slope shape; positive values correspond to convex slopes. Slshv = vertical slope shape; positive values correspond to convex slopes. Solar = solar radiation index; high values indicate greater potential solar exposure. Stone = exposed stone surface cover. TRMI = topographic relative moisture index; high values indicate greater site moisture potential. See pp. 20-21 for full names of soil chemistry variables.

Table 9. Structural and environmental information summary for ten classified community types. Mean values for canopy height, density, basal area, stratum cover, measured and scalar topographic variables, and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

COMMUNITY TYPE	1.1 Acidic Seepage Swamp	2.1 Mesic Mixed Hardwood Forest	2.2 Acidic Oak-Hickory Forest	2.3 Hemlock-hardwood Forest	2.4 Boulderfield Forest / Woodland	3.1 Basic Mesic Forest	3.2 Basic Oak-Hickory Forest	4.1 Table-Mt. Pine/Oak Woodland	4.2 Pitch Pine-Oak Woodland	4.3 Chestnut Oak Forest
Mean Species Richness	60	57	49	25	33	55	64	14	15	22
Canopy Height (m)	33	33	32	31	29	38	31	10	18	27
Density (stems/ha)	1050	745	1214	2000	870	825	945	1717	1731	1423
Basal Area (sq.m/ha)	21.33	48.28	44.01	52.63	49.18	45.84	36.68	25.8	30.93	37.74
Cover by Stratum (%)										
herb layer, < 0.5m	83	23	23	3	48	59	38	27	31	28
shrub layer, 0.5-6m	55	40	43	70	26	54	27	83	74	66
tree layer, 6-10m	17	27	40	41	26	28	28	44	38	34
tree layer, 10-20m	25	12	33	33	26	13	27	41	45	43
tree layer, 20-35m	61	67	73	80	71	21	74	-	77	73
tree layer, >35m	5	30	25	-	30	79	-	-	-	8
ENVIRON. VARIABLE:										
Elevation (ft)	818	596	767	540	890	661	945	1223	1013	746
Elevation (m)	249	182	234	165	271	202	288	373	309	227
Topographic Position	stream bottom	lower slope	middle slope	lower slope	upper slope	lower slope	upper slope	crest	upper slope	upper slope
Distance - stream (m)	0	32	162	47	436	250	376	674	498	257
Distance - ridgetop (m)	334	222	230	248	101	337	155	13	93	134
Rel. Slope Position (0 to 1)	0	0.22	0.4	0.16	0.78	0.3	0.68	0.98	0.88	0.65
Surface Substrate (%):										
Wood	2	2	3	2	2	3	3	3	2	3
Bedrock	0	0	<1	0	5	0	3	13	10	0
Boulders	5	3	2	0	45	5	1	14	6	2
Stones	6	1	4	0	11	2	4	<1	1	2
Cobbles	3	<1	0	0	0	0	0	0	0	1
Gravel	1	<1	1	0	0	0	<1	0	0	<1
Mineral Soil	1	9	10	<1	0	4	8	2	<1	1
Organic Matter	79	84	80	98	37	86	81	68	81	91
Water	3	1	0	<1	0	0	0	0	0	0
Non-Vascular Plants	20	9	9	2	50	4	7	24	13	4
Solar Radiation Index (0 to 1)	0.4905	0.4551	0.4435	0.3453	0.4292	0.4225	0.4797	0.4767	0.4855	0.4675
Slope (degrees)	3	16	16	22	18	14	15	24	11	13
Slope Shape: Vertical	straight	straight	straight	concave	straight	straight	straight	convex	convex	convex
Slope Shape: Horizontal	concave	straight	straight	concave	straight	straight	straight	convex	convex	convex
Slope Shape Index (0 to 10)	7	6.8	5	9	5	6.42	3	0	1	1
Mean Aspect (degrees)	276	258	282	343	355	92	144	214	244	180
Mean Aspect (direction)	W	WSW	WNW	NNW	N	E	SE	SSW	WSW	S
Beer's Aspect (0 to 2)	0.93	0.72	0.95	1.43	1.05	1.26	1.19	0.88	0.48	0.78
Moisture Regime	hygric	mesic	submesic	mesic	submesic	mesic	submesic	xeric	xeric	subxeric
TRMI (0 to 60)	45.7	34.55	31.02	42.68	23.87	38.64	27.16	13.24	14.49	22.13
Soil Chemistry and Texture:										
pH	5.2	4.2	4.4	4	4.5	5.3	4.8	4.1	4.1	4.1
Calcium (ppm)	459	138	236	126	358	1629	766	132	132	116
Magnesium (ppm)	99	62	87	54	76	286	115	34	34	42
Iron (ppm)	391	268	187	310	261	120	144	375	340	328
Manganese (ppm)	66	45	94	4	97	175	129	5	6	19
Zinc (ppm)	4.28	2.91	3.56	1.91	4.01	3.69	4.25	2.29	2.19	1.96
Phosphorus (ppm)	28	30	24	19	107	37	74	23	21	27
Potassium (ppm)	50	43	66	61	71	158	90	44	43	39
Aluminum (ppm)	472	854	875	719	1155	836	1334	1343	1097	898
Copper (ppm)	0.97	0.86	1.1	0.55	0.98	1.7	1.12	0.7	0.66	0.8
Boron (ppm)	0.5	0.3	0.31	0.34	0.39	0.64	0.4	0.42	0.36	0.33
Sodium (ppm)	11	11	10	11	12	11	11	11	11	10
Soluble Sulphur (ppm)	36	32	39	37	48	32	44	56	44	41
% Organic Matter	4.93	5.01	6.49	11.8	11.45	8.35	9.75	10.75	10.12	8.29
Cation Exchange Capacity	7.55	8.89	11.27	16.97	15.53	14.85	14.05	22.27	17.93	16.39
Total Base Saturation (%)	46.19	20	18.83	7.53	17.86	74.22	34.57	5	6.17	6.86
Calcium/magnesium ratio	4.17	2.07	3.03	2.34	4.61	5.66	6.21	3.91	3.7	2.8
% Clay	2	4	2	3	1	4	3	6	4	4
% Silt	13	38	44	35	28	42	39	44	37	40
% Sand	85	58	54	62	71	54	58	50	59	56

DESCRIPTION OF ECOLOGICAL COMMUNITY TYPES

Format
The ten ecological community types classified in this project are described in detail on the following pages. In addition, a brief summary of each of the four major vegetation classes identified in cluster analysis is provided. Descriptions follow a standard, consistent format to facilitate comparisons between units. Plants are referred to by scientific names, with common names in parentheses; in any given report section, subsequent references to a plant are by scientific name only. Animals are referred to by common names, with scientific names in parentheses.

VEGETATION CLASSES
A brief summary of geographic, environmental, and biotic attributes is given. Ordinations demonstrating the classification and relationships of community types and subtypes in the group are presented and discussed. Photographs of community types that constitute the group are presented.

COMMUNITY TYPES
Nomenclature
Three names are given for each community type:

1) A <u>scientific name</u>, consisting of the Latin names of up to six characteristic (constant, dominant, and/or indicator) species. The names follow the USNVC protocol for nomenclature. As a rule, species are listed by descending order of importance and structural position (*i.e.*, overstory species are listed first, followed by sub-canopy species, shrubs, and herbs). Nominal species in the same height stratum are separated by a dash (-) while the different strata are separated by slashes (/). Species listed in parentheses are less constant, although locally important, in a type. Epithets of typical varieties and subspecies are not used in community type names; *e.g.*, *Quercus rubra* var. *rubra* is listed simply as *Quercus rubra*.

2) The <u>scientific name, translated</u> with the common names for nominal plant species.

3) A <u>"common," natural community name</u>, by which the community type may be more easily recognized or described. With minor modifications, these follow Fleming *et. al* (2001) and designate the larger ecological community group to which the community type belongs.

Habitat and Distribution
The general distribution of the community type in the Bull Run Mountains is described. Specific site conditions with which the unit is typically associated are enumerated, including information on topography, elevation, geology, soils, hydrology, and disturbance regimes. Characterization of soil pH follows standard USDA definitions:

pH < 4.5 = extremely acidic
4.5 to 5.0 = very strongly acidic
5.1 to 5.5 = strongly acidic
5.6 to 6.0 = moderately acidic

Composition and Physiognomy
Four lists are included: 1) all species with ≥ 80% constancy in plots representing the community type (<u>Constant Species</u>, listed alphabetically); 2) species with mean cover class ≥ 6 (<u>Dominant Species</u>, listed in descending order of abundance and with mean cover class scores provided parenthetically); 3) species with 100% fidelity to the type (<u>Diagnostic Species</u>, listed alphabetically); and 4) up to ten species with the highest unscaled adjusted indicator values for the type (<u>Indicator Species</u>, listed in descending order). Note that since fidelity is determined only within the context of this data set and, by itself, often performs

poorly as a criterion for distinguishing between types, Diagnostic Species lists sometimes include low-cover or accidental species with negligible ecological significance. See p. 20 for a definition of cover classes and pp. 25-26 for a more detailed discussion of these summary statistics. This section also includes a general description of vegetation structure, composition, spatial distribution, floristic variation, dominance patterns, and species richness.

Community Subtypes
Classified subtypes (if any) are described.

Distinguishing Features
Diagnostic features, both floristic and environmental, that distinguish each community type from similar units are noted. Spatial relationships with other community types on the landscape are also discussed.

Global Conservation Rank
The Nature Conservancy (TNC), NatureServe, and all Natural Heritage programs use a system for ranking the range-wide conservation status of vegetation types at the association level. This global conservation rank is provided for each described type. New types are assigned global ranks in consultation with NatureServe regional ecologists responsible for the development of the USNVC. Global (G-) ranks are defined as follows. Intermediate ranks (*e.g.*, G3G4) may also be used.

- G1 – Critically imperiled globally
- G2 – Imperiled globally
- G3 – Rare or uncommon
- G4 – Widespread, abundant, and apparently secure, but with cause for long-term concern.
- G5 – Demonstrably widespread, abundant, and secure.
- G? – unranked
- G_? – rank uncertain or approximate

State Conservation Rank
DCR-DNH employs a similar system for ranking the state-wide status of community types. This rank is provided for each described type. State (S-) ranks are defined below. Intermediate ranks (*e.g.*, S3S4) may also be used.

- S1 – extremely rare, generally with ≤ 5 occurrences state-wide, and/or covering < 50 ha (124 ac) in aggregate; or covering larger area but highly threatened with destruction or modification.
- S2 – Very rare, generally with 6 to 20 occurrences state-wide, and/or covering < 250 ha (618 ac) in aggregate; or covering larger area but threatened with destruction or modification.
- S3 – Rare to uncommon, generally with 21 to 100 occurrences state-wide; or with a larger number of occurrences subject to relatively high levels of threat; may be of relatively frequent occurrence in specific localities or geographic parts of the state.
- S4 – Common, at least in certain regions of the state, and apparently secure.
- S5 – Very common and demonstrably secure.
- S? – Unranked
- S_? – Rank uncertain or approximate.

Synonymy
This section provides a cross-reference to comparable vegetation types identified in other classifications employing different nomenclatural conventions, primarily the U.S. National Vegetation Classification (USNVC; Grossman *et al.* 1998); unpublished technical reports produced by DCR-DNH (*e.g.*, Fleming and Coulling 2001, Fleming 2002); and the Society of American Foresters cover types (Eyre 1980). A considerable portion of available information in the USNVC about montane community types in Virginia is based on Fleming and Coulling (2001). The USNVC global element code (CEGL) is provided for

types with a USNVC equivalent. Partial overlap in species composition and ecological concept is indicated by the modifier *pro parte*.

Comments

Comments about successional trends, disturbance regimes, regional distribution, biodiversity and conservation status, associated fauna, threats, classification issues, and relationships to similar vegetation types are included here.

Representative Plots and Examples

The number and alphanumeric codes of plot samples supporting the type are given. Representative or noteworthy sites for the community in the Bull Run Mountains are discussed.

Table: Environmental Information Summary

Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Table: Floristic Composition

Mean cover by cover class, relative cover (Rel. Cover), constancy (Const.), community type indicator value (IV), scaled adjusted indicator value (scaled Adj IV), and unscaled adjusted indicator value (unscaled Adj IV) are given for every vascular plant taxon recorded in the type. Mean cover across all plots of the community type is calculated by converting cover class scores to the midpoints of the ranges, averaging these midpoints, and back-transforming to cover class scores. Relative cover is expressed as the difference (in cover classes) between total mean cover across the entire 72-plot data set and mean cover within the community type. Constancy is the percentage of plots within a community type that the taxon was recorded in. Fidelity is calculated as community type frequency / total frequency in the 72-plot dataset, expressed as a percentage. Community Type Indicator Value is calculated as constancy x fidelity / 100. Indicator Value adjusted by cover, scaled is calculated as indicator value x mean cover / 9 (the maximum possible cover value). Indicator Value adjusted by cover, unscaled is calculated as indicator value x $2^{\text{relative cover}}$. In addition, the mean species richness and homoteneity of the type are given at the top of the table. Homoteneity is the average constancy of the *S* most constant species, where *S* = mean species richness for the type. Constancy values for the *S* most constant species are underlined in the table. See p. 20 for a definition of cover classes and pp. 25-26 for a more detailed discussion of these summary statistics.

Table: Woody Stem Summary

Standard forestry statistics for tree density (stems ≥ 2.5 and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density, relative density, basal area, relative basal area, and importance value are provided in tabular form. Density was calculated in stems/ha and basal area was calculated in m^2/ ha. Importance value (IV) equals the mean of relative density and relative basal area. Species with IV > 0.95 are listed in descending order of IV.

Table: Vertical Structure of Woody Vegetation

The mean cover of all woody taxa across all plots in six height strata is presented by cover classes in tabular form. Mean total vegetation cover is also given for each stratum as 1) an average across all plots and 2) an average across plots containing vegetation in the stratum.

VEGETATION CLASS 1
NON-ALLUVIAL WETLANDS

Non-alluvial wetlands represent groundwater-controlled wetlands that are not associated with alluvial soils or riparian environments subject to overland flooding. Included are bogs, fens, seeps, and ponds supporting shrubby or herbaceous vegetation, as well as forested seepage and basin wetlands. In the Bull Run Mountains, the Non-Alluvial Wetlands vegetation class is represented by a single community type that occupies low, nearly flat sites along spring runs and the bottoms of small, headwaters streams. This community type belongs to the Mountain / Piedmont Acidic Seepage Swamps ecological group, which contains saturated palustrine forests of more or less infertile substrates derived from sandstone, quartzite, acidic shales, and base-poor granite (Fleming *et al*. 2001). Habitats are best characterized as saturated (*sensu* Cowardin *et al*. 1979) or seasonally saturated (*sensu* Golet *et al*. 1993), with perched water tables maintaining damp to wet soil conditions for most or part of the growing season. Small areas of shallow water commonly occur in springs, seepage rills, mucky depressions, and streamlets, but these habitats are never inundated by overland flood waters. Hummock-and-hollow microtopography with braided streamlets is typical; hence the communities tend to “capture” from adjacent mesic habitats many common upland species which occupy well-drained hummocks among the more typical wetland flora.

Mountain / Piedmont Acidic Seepage Swamps are locally scattered throughout the western Virginia mountains and inner Piedmont, up to about 900 m (3,000 ft) elevation, tending to occur in small, linear patches along sloping stream headwaters and ravine bottoms. Complex microtopography, braided streamlets, areas of coarse gravel and cobble deposition, muck-filled depressions, and abundant *Sphagnum* mats are typical microhabitat features. Soils vary from strongly to very strongly acidic, with relatively low base status. Composition is variable over the range of this group, with several community types probably represented. *Acer rubrum* (red maple), *Nyssa sylvatica* (black gum), *Liriodendron tulipifera* (tulip-poplar), and *Pinus rigida* (pitch pine) are typical trees, while *Ilex verticillata* (winterberry), *Rhododendron viscosum* (swamp azalea), and *Vaccinium* spp. (highbush blueberries) are widespread shrubs. *Symplocarpus foetidus* (skunk cabbage) and *Veratrum viride* (false hellebore) are abundant herbaceous patch-dominants in some of the communities but entirely absent from others. A number of seepage swamps occupying headwaters streams cutting through large alluvial fans at the base of the Blue Ridge in Augusta County, Virginia, contain populations of the rare, beautiful, and federally listed lily *Helonias bullata* (swamp-pink).

Early historical homesteads in the Bull Run Mountains were entirely dependent on springs and streams for domestic water, as indicated by the remains of several springhouses and weirs. Similarly, these wetlands also provide a critical resource for the area’s wildlife. Because of their special microhabitats, seepage swamps are likely to harbor a number of amphibians, odonata (dragonflies and damselflies), and other invertebrates that are restricted to or dependent on wetlands.

Based on the results of cluster analysis and summary statistical analysis, the Bull Run Mountains’ representative of Mountain / Piedmont Acidic Seepage Swamp is classified as:

- *Acer rubrum – Liriodendron tulipifera* / *Ilex verticillata – Vaccinium fuscatum* / *Osmunda cinnamomea – Symplocarpus foetidus* Forest
  (Red Maple – Tulip-poplar / Winterberry – Hairy Highbush Blueberry / Cinnamon Fern – Skunk Cabbage Forest)

Plate 9. **Mountain / Piedmont Acidic Seepage Swamp** along Bartons Creek headwaters (plot BRM013). *Veratrum viride* (American false hellebore, leaning in foreground), *Symplocarpus foetidus* (skunk-cabbage), and *Osmunda cinnamomea* (cinnamon fern) are large, leafy dominants. Photo: Gary P. Fleming, DCR-DNH.

Plate 10. **Mountain / Piedmont Acidic Seepage Swamp** in Jackson Hollow (plot BRM012). Dense and extensive colonies of *Symplocarpus foetidus* (skunk-cabbage) dominate the herb layer. Photo: Gary P. Fleming, DCR-DNH.

ECOLOGICAL COMMUNITY TYPE 1.1.

Acer rubrum – Liriodendron tulipifera / Ilex verticillata – Vaccinium fuscatum / Osmunda cinnamomea – Symplocarpus foetidus Forest

Red Maple – Tulip-poplar / Winterberry – Hairy Highbush Blueberry / Cinnamon Fern – Skunk Cabbage Forest

MOUNTAIN / PIEDMONT ACIDIC SEEPAGE SWAMP

Habitat and Distribution: This community occurs on groundwater-saturated flats along the headwaters and small tributaries of Catletts Branch, Little Bull Run, Mill Run, Catharpin Creek (Jackson Hollow), Bartons Creek, Hungry Run, Bull Run, and other streams. Occurrences are usually narrow and elongate, but may cover as much as 80 ha (200 ac) in aggregate due to the abundance of groundwater seepage in the study area's interior valleys. Hydrologically, these habitats are classified as "groundwater slope wetlands," where seepage discharged at the ground surface is drained away as stream flow (Golet *et al*. 1993). Sites are slightly sloping (mean slope = 3º) with hummock-and-hollow microtopography and substrates of heterogeneous, fine to coarse alluvium. Along the larger streams, groundwater emerging from lateral, slope-base springs drains through irregular streamlets on flats bordering a central stream channel. In smaller swamps, drainage often consists entirely of small, intricately braided channels. One occurrence, situated in the bottom of a ravine on the western slope of High Acre Ridge, is characterized by diffuse drainage through unusually steep, bouldery colluvium. Surface substrate is highly variable and may contain substantial cover of boulders, stones, cobbles, gravel, and/or wood debris. Moss mats, often of *Sphagnum* spp., and thick mantles of organic duff are common on stabilized hummocks. Soils are predominantly mineral (mean organic matter content = 4.9%), although local areas of organic muck sometimes accumulate in depressions or intermittent channels. Soil samples extracted from plots have by far the highest sand content (mean = 85%, maximum = 96%) and lowest silt content (mean = 13%, minimum = 2%) of any community type documented in this study. Nevertheless, these soils are only moderately acidic (mean pH = 5.2, range = 4.8 to 5.7), with moderately low cation levels and mean total base saturation (46.19%) second among classified community types (Tables 9 and 10).

Composition and Physiognomy:

Constant Species (constancy ≥ 80%):
Acer rubrum, *Alnus serrulata*, *Arisaema triphyllum*, *Aster divaricatus*, *Athyrium filix-femina* var. *asplenioides*, *Chelone glabra*, *Ilex verticillata*, *Impatiens capensis*, *Lindera benzoin*, *Liriodendron tulipifera*, *Medeola virginiana*, *Osmunda cinnamomea*, *Rhododendron periclymenoides*, *Smilax rotundifolia*, *Symplocarpus foetidus*, *Thelypteris noveboracensis*, *Vaccinium fuscatum*, *Viola cucullata*.

Dominant Species (mean cover ≥ 6):
Acer rubrum (7), *Liriodendron tulipifera* (7), *Symplocarpus foetidus* (7), *Nyssa sylvatica* (6), *Osmunda cinnamomea* (6), *Thelypteris noveboracensis* (6).

Diagnostic Species (fidelity = 100%):
Anemone quinquefolia var. *quinquefolia*, *Apios americana*, *Aronia arbutifolia*, *Bidens frondosa*, *Campanula aparinoides*, *Cardamine pensylvanica*, *Carex gynandra*, *Carex leptalea*, *Carex seorsa*, *Carex stipata* var. *stipata*, *Carex styloflexa*, *Chrysosplenium americanum*, *Cinna arundinacea*, *Clematis virginiana*, *Dryopteris carthusiana*, *Dryopteris cristata*, *Dryopteris goldiana*, *Fraxinus nigra*, *Galium obtusum* ssp. *obtusum*, *Glechoma hederacea*, *Glyceria melicaria*, *Glyceria striata*, *Huperzia lucidula*, *Hydrocotyle americana*, *Isoetes caroliniana*, *Juncus effusus*, *Leersia virginica*, *Ligustrum obtusifolium*, *Lobelia cardinalis*, *Mikania scandens*, *Mimulus alatus*, *Osmunda regalis* var. *spectabilis*, *Oxypolis rigidior*, *Platanthera clavellata*, *Platanthera lacera*, *Polygonum arifolium*, *Polygonum sagittatum*, *Rubus argutus*, *Rubus hispidus*, *Rudbeckia laciniata* var. *laciniata*, *Rumex crispus*, *Sagittaria latifolia*, *Scirpus polyphyllus*, *Sphenopholis pensylvanica*, *Thelypteris palustris* var. *pubescens*, *Toxicodendron vernix*,

Trientalis borealis ssp. *borealis*, *Veratrum viride*, *Viburnum dentatum* var. *lucidum*, *Vitis labrusca*.

Indicator Species (highest unscaled adj. IVs):
Symplocarpus foetidus, *Viola cucullata*, *Osmunda regalis* var. *spectabilis*, *Athyrium filix-femina* var. *asplenioides*, *Alnus serrulata*, *Osmunda cinnamomea*, *Thelypteris noveboracensis*, *Ilex verticillata*, *Veratrum viride*, *Vitis labrusca*.

This forest community has a tall, usually open overstory dominated by *Acer rubrum* (red maple; stems up to 67 cm [26 in] dbh) and *Liriodendron tulipifera* (tulip-poplar; stems up to 65 cm [26 in] dbh). Mean canopy height is 33 m (108 ft) and mean canopy cover is 61%. *Nyssa sylvatica* (black gum; stems up to 60 cm [24 in] dbh) and *Fraxinus americana* (white ash; stems up to 44 cm [17 in] dbh) are minor but occasionally co-dominant overstory associates. Understory tree layers are generally sparse and consist mainly of young representatives of the overstory species; locally, *Carpinus caroliniana* (American hornbeam), *Toxicodendron vernix* (poison sumac), *Fraxinus nigra* (black ash), and various upland trees occur in the understory. The shrub layer varies from open to very dense (range = 33 to 90% total stratum cover) and typically contains *Alnus serrulata* (smooth alder), *Ilex verticillata* (winterberry), *Vaccinium fuscatum* (hairy highbush blueberry), *Rhododendron periclymenoides* (wild azalea), *Lindera benzoin* (spicebush), *Chionanthus virginicus* (fringetree), *Smilax rotundifolia* (common greenbrier; a woody vine), and *Vitis labrusca* (fox grape; a woody vine). Occasionally, *Hamamelis virginiana* (witch-hazel), *Kalmia latifolia* (mountain-laurel), and *Viburnum dentatum* var. *lucidum* (northern arrow-wood) are important shrub associates.

The dense herb layer (mean stratum cover = 83%) is characterized by early-season patch-dominance of *Symplocarpus foetidus* (skunk-cabbage) and, at a subset of sites, *Veratrum viride* (false hellebore). Ferns, especially *Osmunda cinnamomea* (cinnamon fern), *Thelypteris noveboracensis* (New York fern; on hummocks), and *Athyrium filix-femina* var. *asplenioides* (southern lady fern; on hummocks) are abundant. Other more or less constant, high-cover (mean cover ≥ 4) herbs include *Viola cucullata* (marsh violet), *Arisaema triphyllum* (jack-in-the-pulpit), *Osmunda regalis* var. *spectabilis* (royal fern), *Boehmeria cylindrica* (false nettle), and *Carex prasina* (a sedge). Among the most characteristic low-cover wetland herbs are *Carex gynandra* (a sedge), *Carex leptalea* (a sedge), *Carex radiata* (a sedge), *Chelone glabra* (white turtlehead), *Chrysosplenium americanum* (American golden-saxifrage), *Cinna arundinacea* (wood reed grass), *Glyceria striata* (fowl mannagrass), *Impatiens capensis* (spotted jewelweed), *Leersia virginica* (Virginia cutgrass), *Lycopus virginicus* (Virginia bugleweed), *Onoclea sensibilis* (sensitive fern), *Oxypolis rigidior* (cowbane), *Platanthera clavellata* (small green wood orchid), *Ranunculus recurvatus* (hooked buttercup), and *Thalictrum pubescens* (tall meadowrue). Well-drained hummocks provide suitable microhabitats for *Aster divaricatus* (white wood aster), *Medeola virginiana* (Indian cucumber-root), *Uvularia sessilifolia* (sessile-leaf bellwort), and many other herbs more typical of mesic upland forests. Many additional species occur at lower constancies (Table 11).

Mean species richness of plot-sampled stands is 63 taxa per 400 m^2, second highest among community types classified in this study. Intermediate soil fertility and the presence of diverse microhabitats supporting a range of wetland and upland species are likely factors contributing to the floristic richness.

Distinguishing Features: This unit is the most distinctive of all community types in the Bull Run Mountains and is easily recognized in the field. Its wetland, stream-bottom habitats and vegetation are usually separated from adjacent communities by abrupt transitions. Occasionally, it intermingles with stands of Mesic Mixed Hardwood Forest on the larger stream bottoms that have variable soil drainage conditions (*e.g.*, along lower Catletts Branch). Many species recorded in plots of this community type are restricted to this vegetation or nearly so, including several of the most abundant and characteristic species such as *Alnus serrulata*, *Ilex verticillata*, *Osmunda cinnamomea*, *Symplocarpus foetidus*, *Vaccinium fuscatum*, and *Veratrum viride*.

Global Conservation Rank: G3G4

State Conservation Rank: S3?

Synonymy: USNVC CEGL007853: *Acer rubrum – Nyssa sylvatica –* (*Pinus rigida*) / *Ilex verticillata* / *Osmunda cinnamomea* Forest. *Acer rubrum – Nyssa sylvatica* / *Vaccinium fuscatum – Ilex verticillata* / *Osmunda cinnamomea* Forest (Fleming and Coulling 2001; Fleming 2002). SAF: no equivalent.

Comments: The most frequent disturbances noted in plots were windthrows, perhaps encouraged by wet, very rocky soils, and exotic plants, primarily *Microstegium vimineum* (Japanese stilt grass). The current overstory co-dominance of *Liriodendron tulipifera* in stands of this community may be an artifact of past logging disturbances. Incomplete canopy closure and frequent gaps created by windthrows have also allowed considerable recruitment of this species in the lower woody layers, suggesting that *Liriodendron tulipifera* will remain important long into the future.

Late-season sampling in one plot (BRM065) revealed heavy white-tailed deer herbivory on *Osmunda cinnamomea* and other herbs. A sizeable area in Jackson Hollow (downstream from Rt. 629) that probably once supported this community was impounded in the 1960's for the development of a resort fishing lake. After the lake was abandoned, beavers (*Castor canadensis*) invaded the area and have subsequently destroyed other forests in the drainage.

The cool, wet habitats occupied by this community type support a number of plant species that are significantly disjunct from higher elevations on the main Blue Ridge and other mountains to the west. Good examples of disjuncts rarely or not found elsewhere in the Piedmont are *Dryopteris goldiana* (Goldie's wood fern), *Fraxinus nigra*, *Glyceria melicaria* (slender mannagrass), *Trientalis borealis* ssp. *borealis* (northern starflower), *Trillium cernuum* (nodding trillium), and *Veratrum viride*. By contrast, *Carex seorsa* (a sedge), *Dryopteris celsa* (log fern), *Mikania scandens* (climbing hempweed), *Toxicodendron vernix*, and *Woodwardia areolata* (netted chain fern) are plants more typical of Coastal Plain and lower Piedmont wetlands.

This community is likely to harbor a number of animals that are more or less restricted to seepage wetland habitats. Included are amphibians such as the northern dusky salamander (*Desmognathus fuscus*) and northern red salamander (*Pseudotriton ruber ruber*); odonates (damselflies and dragonflies) such as the eastern red damsel (*Amphiagrion saucium*), aurora damsel (*Chromagrion conditum*), gray petaltail (*Tachopteryx thorei*), and *Cordulegaster* spp.; and amphipods that inhabit interstitial groundwater. Two uncommon species of the latter, *Gammarus pseudolimnaeus* and *Stygobromus tenuis*, were documented in a 1998 DCR-DNH inventory of VOF lands (Fleming *et al*. 1999).

The *Acer rubrum – Liriodendron tulipifera* / *Ilex verticillata – Vaccinium fuscatum* / *Osmunda cinnamomea – Symplocarpus foetidus* Forest of the Bull Run Mountains is similar to acidic seepage swamps documented elsewhere in western Virginia and is currently interpreted as a variant of the USNVC global type (see above). The known geographic range of the type, as currently circumscribed, encompasses the central Appalachian region of Pennsylvania, Maryland, Virginia, West Virginia, and possibly the Cumberland Mountains of Kentucky. Because of its narrow geographic distribution, restriction to localized wetland conditions, and small patch sizes, this vegetation is considered uncommon throughout its range. It is also under-represented by plot data, both in Virginia and elsewhere. Therefore, community characterization and nomenclature are subject to change pending further data collection and analysis, ideally based on wider geographic sampling. The recognition of segregate associations, subassociations, or variants may also be warranted following additional assessment. For example, *Symplocarpus foetidus*, the most characteristic herbaceous plant of the Bull Run Mountain stands is absent from many stands in the Ridge and Valley region. Species occurring elsewhere in this community type but entirely absent from the Bull Run Mountains include *Calamagrostis coarctata* (Nuttall's reed grass), *Carex folliculata* (a sedge), *Platanthera ciliaris* (yellow fringed orchid), *Rhododendron viscosum* (swamp azalea), *Viburnum nudum* var. *nudum* (possum-haw), and *Viola primulifolia* (primrose-leaved violet) (Fleming and Coulling 2001; Fleming and Van Alstine 1999). In addition, *Pinus rigida* (pitch pine), which is restricted in the study area to the xeric ridges, is also a frequent tree in oligotrophic, Ridge and Valley seepage swamps.

The Mountain / Piedmont Acidic Seepage Swamp has many affinities to the Coastal Plain / Piedmont Acidic Seepage Swamp (Fleming *et al.* 2001; Fleming 2002), which, however, lacks montane species and contains a number of lowland species that absent or rare in the Bull Run Mountains, *e.g.*, *Pinus taeda* (loblolly pine), *Magnolia virginiana* (sweetbay), *Clethra alnifolia* (sweet pepperbush), *Leucothoe racemosa* (fetterbush), *Ilex opaca* var. *opaca* (American holly; rare in Bull Run Mountains); *Woodwardia areolata* (netted chain fern; rare in Bull Run Mountains), *Carex atlantica* ssp. *capillaris* (a sedge; rare in Bull Run Mountains), and *Carex collinsii* (Collins' sedge).

There are also unresolved issues regarding conceptual overlap and intergradations between this unit and Montane Basic Seepage Swamps that are situated on calcareous soils derived from metabasalt (greenstone) and carbonate rock substrates (see Fleming and Coulling 2001, Fleming 1999). Although each type is represented by a group of strongly diagnostic plants, both share a large number of prominent species and may become locally confluent along a soil fertility gradient. Seepage swamps of the Bull Run Mountains' have strong affinities with other acidic-soil stands but contain scattered populations of species usually diagnostic of basic-soil seepage wetlands, *e.g.*, *Fraxinus nigra*, *Caltha palustris* (marsh marigold), *Dryopteris goldiana*, *Deparia acrostichoides* (silvery spleenwort), and *Trillium cernuum*. Soil chemistry data suggests that at some sites in the study area, oligotrophy may be ameliorated by groundwater in contact with basic rocks of the Catoctin Formation shallowly underlying metasedimentary alluvium and colluvium. Alternatively, nutrient-rich alluvium from the thinly-bedded quartzite / muscovite schist / phyllite lithologic suite may be responsible for this phenomenon.

Representative Plots and Examples: This unit is represented by nine plot samples: BRM001, 010, 011, 012, 013, 014, 015, 065, and 068. Outstanding occurrences stretch along the head branches of Catharpin Creek (Jackson Hollow; Plate 10, p. 48) both east and west of Rt. 629, Barton's Creek (Plate 9, p. 47), Mill Run, Little Bull Run, upper Catletts Branch, and a tributary of Broad Run on the lower west slope of High Point Mountain. The largest occurrence is probably along the head of Hungry Run and its many short tributaries flowing off the eastern ridge north of Hopewell Gap. Altogether, the Bull Run Mountains support more high quality examples of this community type than most other areas of comparable size.

Table 10. Environmental information summary for nine plots of the *Acer rubrum – Liriodendron tulipifera* / *Ilex verticillata – Vaccinium fuscatum* / *Osmunda cinnamomea – Symplocarpus foetidus* Forest community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	**MEAN**	**MIN**	**MAX**
Elevation (m / ft)	249 / 818	165 / 540	305 / 1000
Topographic Position	stream bottom	stream bottom	stream bottom
Relative Slope Position (0 to 1)	0	0	0
SURFACE SUBSTRATE COVER (%):			
Wood	2	0	4
Bedrock	0	0	0
Boulders	5	0	10
Stones	6	0	20
Cobbles	3	0	20
Gravel	1	0	5
Mineral Soil	1	0	5
Organic Matter	79	49	98
Water	3	0	5
Bryophytes and Lichens	20	3	50
Slope (degrees)	3	1	5
Slope Shape: Vertical	straight	straight	straight
Slope Shape: Horizontal	concave	concave	concave
Aspect (degrees [direction])	276 (W)	132 (SE)	45 (NE)
Moisture Regime	hygric	subhygric	subhydric
Topographic Relative Moisture Index (0 to 60)	45.7	37.3	57.0
SOIL CHEMISTRY AND TEXTURE:			
pH	5.2	4.8	5.7
Calcium (ppm)	459	192	1299
Magnesium (ppm)	99	58	185
Iron (ppm)	391	249	564
Manganese (ppm)	66	9	211
Zinc (ppm)	4.3	2.0	6.2
Phosphorus (ppm)	28	21	35
Potassium (ppm)	50	24	85
Aluminum (ppm)	472	206	788
Copper (ppm)	0.97	0.44	2.94
Boron (ppm)	0.50	0.31	0.79
Sodium (ppm)	11	9	14
Soluble Sulphur (ppm)	36	22	99
% Organic Matter	4.93	2.01	11.72
Total Cation Exchange Capacity	7.55	2.05	13.15
Total Base Saturation (%)	46.19	13.18	77.46
% Clay	2	1	3
% Silt	13	2	27
% Sand	85	70	96

Table 11. Floristic composition of the *Acer rubrum – Liriodendron tulipifera* / *Ilex verticillata – Vaccinium fuscatum* / *Osmunda cinnamomea – Symplocarpus foetidus* Forest community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the nine plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 63

Community Type Homoteneity = 0.704

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acer rubrum	7	+	100	14	11	28
Agrostis perennans var. *perennans*	1	-	11	1	0	0
Alnus serrulata	5	++	100	90	50	360
Amelanchier arborea var. *arborea*	2	0	22	2	0	2
Amelanchier laevis	1	-	11	2	0	1
Amphicarpaea bracteata	4	0	56	13	6	13
Anemone quinquefolia var. *quinquefolia*	1	0	11	11	1	11
Apios americana	1	0	11	11	1	11
Aralia nudicaulis	1	- - -	11	1	0	0
Arisaema triphyllum	5	++	100	38	21	150
Aronia arbutifolia	2	+	33	33	7	67
Asimina triloba	2	- -	22	3	1	1
Aster divaricatus	2	0	100	33	7	33
Aster lateriflorus	2	0	56	13	3	13
Athyrium filix-femina var. *asplenioides*	5	+++	100	56	31	450
Bidens frondosa	1	0	11	11	1	11
Boehmeria cylindrica	4	++	78	60	27	242
Botrychium virginianum	2	0	33	6	1	6
Brachyelytrum erectum var. *erectum*	2	+	22	6	1	13
Campanula aparinoides	1	0	11	11	1	11
Cardamine pensylvanica	1	0	11	11	1	11
Carex atlantica ssp. *atlantica*	2	+	33	25	6	50
Carex blanda	1	0	11	2	0	2
Carex debilis var. *debilis*	2	+	44	36	8	71
Carex gracillima	2	+	33	25	6	50
Carex gynandra	2	+	44	44	10	89
Carex intumescens	2	+	33	25	6	50
Carex laxiculmis var. *laxiculmis*	2	0	44	15	3	15
Carex leptalea	2	+	56	56	12	111
Carex prasina	4	++	67	44	20	178
Carex radiata	2	+	56	40	9	79
Carex rosea	1	-	11	1	0	0
Carex seorsa	2	+	11	11	2	22
Carex stipata var. *stipata*	2	+	22	22	5	44
Carex styloflexa	2	+	22	22	5	44
Carex swanii	1	0	11	2	0	2
Carex virescens	2	+	22	6	1	13
Carpinus caroliniana	4	+	33	13	6	25

Table 11 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Carya glabra	1	- - -	11	0	0	0
Carya ovalis	1	- - -	11	1	0	0
Chelone glabra	2	+	100	90	20	180
Chimaphila maculata	1	-	22	1	0	1
Chionanthus virginicus	4	++	78	54	24	218
Chrysosplenium americanum	2	+	33	33	7	67
Cimicifuga racemosa	1	- -	11	1	0	0
Cinna arundinacea	3	+	78	78	26	156
Circaea lutetiana ssp. *canadensis*	2	0	67	17	4	17
Clematis virginiana	2	+	33	33	7	67
Collinsonia canadensis	2	0	56	20	4	20
Cornus florida	2	- -	33	3	1	1
Corylus americana	2	+	11	2	0	4
Cryptotaenia canadensis	2	0	33	25	6	25
Deparia acrostichoides	4	++	33	17	7	67
Desmodium nudiflorum	1	-	11	0	0	0
Dichanthelium clandestinum	1	0	11	3	0	3
Dichanthelium dichotomum	2	0	56	12	3	12
Dioscorea quaternata	2	0	78	15	3	15
Dryopteris carthusiana	2	+	44	44	10	89
Dryopteris cristata	2	+	33	33	7	67
Dryopteris goldiana	1	0	22	22	2	22
Epifagus virginiana	1	0	11	3	0	3
Eupatorium purpureum	2	+	44	15	3	30
Fagus grandifolia	5	0	56	8	5	8
Festuca subverticillata	2	+	22	4	1	8
Fraxinus americana	5	++	67	12	7	48
Fraxinus nigra	3	+	22	22	7	44
Galearis spectabilis	1	0	11	3	0	3
Galium circaezans	2	0	33	4	1	4
Galium obtusum ssp. *obtusum*	1	0	11	11	1	11
Galium triflorum	2	0	67	18	4	18
Geum canadense	1	0	11	3	0	3
Glechoma hederacea	2	+	22	22	5	44
Glyceria melicaria	2	+	11	11	2	22
Glyceria striata	2	+	56	56	12	111
Goodyera pubescens	1	0	11	1	0	1
Hamamelis virginiana	4	0	44	16	7	16
Huperzia lucidula	1	0	11	11	1	11
Hydrangea arborescens	1	-	11	1	0	0
Hydrocotyle americana	1	0	11	11	1	11
Ilex verticillata	5	++	89	71	40	284
Impatiens capensis	3	+	89	65	22	129
Isoetes caroliniana	1	0	11	11	1	11

Table 11 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Isotria verticillata	1	0	11	2	0	2
Juncus effusus	2	+	22	22	5	44
Kalmia latifolia	4	- -	33	3	1	1
Leersia virginica	2	+	67	67	15	133
Ligustrum obtusifolium	1	0	11	11	1	11
Lindera benzoin	4	0	89	27	12	27
Liriodendron tulipifera	7	+	100	18	14	37
Lobelia cardinalis	2	+	22	22	5	44
Lonicera japonica	2	0	44	15	3	15
Luzula echinata	1	0	11	2	0	2
Lycopodium obscurum	1	0	11	6	1	6
Lycopus virginicus	2	+	78	60	13	121
Lysimachia ciliata	2	+	22	9	2	18
Maianthemum canadense	2	+	22	15	3	30
Maianthemum racemosum ssp. *racemosum*	2	0	67	10	2	10
Medeola virginiana	2	0	89	34	8	34
Microstegium vimineum	2	0	44	13	3	13
Mikania scandens	2	+	33	33	7	67
Mimulus alatus	1	0	11	11	1	11
Nyssa sylvatica	6	0	78	10	7	10
Onoclea sensibilis	2	+	56	40	9	79
Osmunda cinnamomea	6	++	100	82	55	327
Osmunda regalis var. *spectabilis*	5	+++	67	67	37	533
Oxalis dillenii	1	0	11	2	0	2
Oxypolis rigidior	2	+	67	67	15	133
Paronychia canadensis	1	0	11	4	0	4
Parthenocissus quinquefolia	2	0	78	13	3	13
Phryma leptostachya	1	0	11	1	0	1
Pilea pumila var. *pumila*	2	0	22	11	2	11
Platanthera clavellata	2	+	56	56	12	111
Platanthera lacera	1	0	11	11	1	11
Poa trivialis	1	0	11	6	1	6
Podophyllum peltatum	1	0	44	18	2	18
Polygonum arifolium	2	+	22	22	5	44
Polygonum sagittatum	2	+	33	33	7	67
Polygonum sp.	1	0	11	11	1	11
Polygonum virginianum	2	+	22	6	1	11
Polystichum acrostichoides	2	-	56	12	3	6
Prenanthes altissima	2	+	33	17	4	33
Prunus serotina var. *serotina*	2	0	22	2	0	2
Quercus alba	3	- -	56	9	3	2
Quercus montana	2	- - - - -	33	2	0	0
Quercus rubra var. *rubra*	2	- - -	56	5	1	1

Table 11 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Ranunculus recurvatus	2	+	67	44	10	89
Rhododendron periclymenoides	5	++	89	19	10	75
Rubus allegheniensis var. *allegheniensis*	1	0	11	4	0	4
Rubus argutus	1	0	11	11	1	11
Rubus flagellaris	2	0	33	5	1	5
Rubus hispidus	2	+	11	11	2	22
Rubus phoenicolasius	2	0	11	1	0	1
Rubus sp.	1	0	11	11	1	11
Rudbeckia laciniata var. *laciniata*	1	0	11	11	1	11
Rumex crispus	1	0	11	11	1	11
Sagittaria latifolia	1	0	11	11	1	11
Sambucus canadensis	2	+	56	40	9	79
Sanguinaria canadensis	1	0	11	2	0	2
Sanicula canadensis	2	0	44	9	2	9
Sassafras albidum	1	- -	11	0	0	0
Scirpus polyphyllus	2	+	22	22	5	44
Scutellaria elliptica	1	0	11	1	0	1
Smilax glauca	2	0	44	6	1	6
Smilax herbacea	1	0	11	2	0	2
Smilax rotundifolia	5	++	89	16	9	63
Sphenopholis pensylvanica	2	+	22	22	5	44
Stellaria pubera	1	0	11	2	0	2
Symplocarpus foetidus	7	+++	100	82	64	655
Taraxacum officinale ssp. *officinale*	1	0	22	9	1	9
Thalictrum pubescens	2	+	78	60	13	121
Thalictrum thalictroides	1	0	11	1	0	1
Thelypteris noveboracensis	6	++	100	75	50	300
Thelypteris palustris var. *pubescens*	2	+	22	22	5	44
Toxicodendron radicans ssp. *radicans*	2	0	56	11	2	11
Toxicodendron vernix	3	+	11	11	4	22
Trientalis borealis ssp. *borealis*	1	0	11	11	1	11
Ulmus americana	2	+	11	6	1	11
Ulmus rubra	2	0	11	1	0	1
Uvularia perfoliata	2	0	22	2	0	2
Uvularia sessilifolia	2	0	67	50	11	50
Vaccinium fuscatum	5	++	89	55	30	219
Vaccinium pallidum	2	- - -	33	2	0	0
Veratrum viride	5	++	67	67	37	267
Viburnum dentatum var. *lucidum*	2	+	56	56	12	111
Viburnum prunifolium	1	-	11	1	0	1
Viola cucullata	5	+++	100	75	42	600
Vitis labrusca	4	++	67	67	30	267
Vitis vulpina	2	0	22	3	1	3

Table 12. Woody stem data summary for the *Acer rubrum – Liriodendron tulipifera / Ilex verticillata – Vaccinium fuscatum / Osmunda cinnamomea – Symplocarpus foetidus* Forest community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for nine plots representing the type. Species with IV > 0.95 are listed in descending order of IV.

SPECIES	Tree Density	Large Tree Density	TOTAL DENSITY	RELATIVE DENSITY	BASAL AREA	RELATIVE BASAL AREA	IV
Liriodendron tulipifera	161	17	178	16.41	8.72	40.38	28.40
Acer rubrum	103	25	128	14.57	8.28	37.78	26.18
Nyssa sylvatica	67	3	69	6.68	1.59	7.54	7.11
Alnus serrulata	108	0	108	8.20	0.16	0.74	4.47
Hamamelis virginiana	103	0	103	7.61	0.18	0.90	4.25
Vaccinium fuscatum	78	0	78	7.65	0.10	0.55	4.10
Fraxinus americana	28	3	31	3.74	0.67	4.01	3.88
Rhododendron periclymenoides	58	0	58	5.96	0.07	0.36	3.16
Ilex verticillata	56	0	56	5.59	0.05	0.23	2.91
Toxicodendron vernix	19	0	19	3.38	0.29	1.25	2.31
Chionanthus virginicus	50	0	50	4.25	0.06	0.36	2.30
Carpinus caroliniana	28	0	28	2.63	0.21	0.92	1.78
Fagus grandifolia	33	0	33	2.50	0.23	1.01	1.75
Fraxinus nigra	17	0	17	1.42	0.25	1.92	1.67
Kalmia latifolia	14	0	14	2.22	0.07	0.30	1.26
other species	81	0	81	7.18	0.37	1.75	4.47
TOTALS	**1003**	**47**	**1050**	**100.00**	**21.33**	**100.00**	**100.00**

Table 13. Vertical structure of woody taxa and total stratum cover in nine plots of the *Acer rubrum – Liriodendron tulipifera / Ilex verticillata – Vaccinium fuscatum / Osmunda cinnamomea – Symplocarpus foetidus* Forest community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	<0.5m	0.5-6m	6-10m	10-20m	20-35m	>35m
Acer rubrum	2	4	2	4	7	
Alnus serrulata	2	5	2			
Amelanchier arborea	2	2				
Amelanchier laevis		1				
Aronia arbutifolia	1	2				
Asimina triloba		2				
Carpinus caroliniana	2	3	4			
Carya glabra		1				
Carya ovalis	1	1				
Chionanthus virginicus	1	4	2			

Table 13 – continued

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Cornus florida	1	2				
Corylus americana	1	2				
Diospyros virginiana	1					
Fagus grandifolia	2	3	3	3	2	
Fraxinus americana	2	2	3	2	4	
Fraxinus nigra	1	2	2	3		
Hamamelis virginiana	2	3	2			
Hydrangea arborescens	2					
Ilex verticillata	1	5				
Kalmia latifolia	2	4				
Ligustrum obtusifolium		1				
Lindera benzoin	2	4				
Liriodendron tulipifera	2	3	4	5	6	3
Lonicera japonica	1	2				
Nyssa sylvatica	2	4	4	4	4	
Parthenocissus quinquefolia	2	2		1		
Prunus serotina var. *serotina*		2				
Quercus alba	2	2	2		2	
Quercus montana	1	2		2	2	
Quercus rubra var. *rubra*	1	2		2	2	
Rhododendron periclymenoides	2	5				
Rubus allegheniensis var. *allegheniensis*	1					
Rubus argutus	1					
Rubus flagellaris	2					
Rubus hispidus	2					
Rubus phoenicolasius	2	1				
Sambucus canadensis	2					
Sassafras albidum			1			
Smilax glauca	2					
Smilax rotundifolia	3	4				
Toxicodendron radicans	2	2				
Toxicodendron vernix	1	2	2	2		
Ulmus americana				2		
Ulmus rubra	1		2			
Vaccinium fuscatum	2	5				
Vaccinium pallidum	2					
Viburnum dentatum var. *lucidum*	2	2				
Viburnum prunifolium		1				
Vitis labrusca	2	4	2		2	
Vitis vulpina		2				
Total Stratum Cover (%):						
Mean: all plots in type	**83**	**55**	**17**	**25**	**61**	**2**
Mean: plots w/cover in stratum	**83**	**55**	**17**	**25**	**61**	**5**

VEGETATION CLASS 2

ACIDIC RAVINE AND SLOPE FORESTS

Plots of this vegetation class occupy mesic to submesic (exceptionally subxeric) sites with very strongly acidic to extremely acidic soils. Mean soil chemistry values for this class as a whole are close to average for the entire dataset and indicate an association with distinctly infertile substrates. Communities of the Acidic Ravine and Slope Forests occupy more or less limited niches in the Bull Run Mountains' landscape, forming small to medium patches in the mosaic of vegetation types. Based on cluster analysis and summary statistical analysis, four community types are recognized:

- MESIC MIXED HARDWOOD FOREST
  Fagus grandifolia – Liriodendron tulipifera – Quercus rubra / *Polystichum acrostichoides – Carex laxiculmis* Forest
  (American Beech – Tulip-poplar – Northern Red Oak / Christmas Fern – Spreading Sedge Forest)

- ACIDIC OAK – HICKORY FOREST
  Quercus montana – Quercus alba – Carya glabra / *Cornus florida* Forest
  (Chestnut Oak – White Oak – Pignut Hickory / Flowering Dogwood Forest)

- EASTERN HEMLOCK – HARDWOOD FOREST
  Tsuga canadensis – Quercus montana / *Hamamelis virginiana* Forest
  (Eastern Hemlock – Chestnut Oak / Witch-hazel Forest)

- LOW-ELEVATION BOULDERFIELD FOREST / WOODLAND
  Quercus montana – Quercus rubra / *Vitis aestivalis* var. *bicolor – Parthenocissus quinquefolia* / *Aralia nudicaulis – Dryopteris marginalis* Forest
  (Chestnut Oak – Northern Red Oak / Silver-leaf Grape – Virginia Creeper / Wild Sarsaparilla – Marginal Wood Fern Forest)

These community types separate by topography, moisture regime, and soil texture (Fig. 13). The Mesic Mixed Hardwood Forest (2.1) occupies lower-slope sites with high moisture potential (TRMI), often near streams (Water). Additionally, its soils have higher clay content and higher cover of surface duff than those of the other two community types represented in the ordination. At the opposite end of these gradients, the Low-Elevation Boulderfield Forest / Woodland (2.4) occupies drier, upper-slope positions (high Relslope) at higher elevations (Elev), in association with abundant surface cover of bedrock, boulders, bryophytes, and lichens (Non-Vasc). Soils extracted from these habitats have relatively high sand content. The Acidic Oak-Hickory Forest (2.2) has an intermediate position on the topographic-moisture gradient, consistent with its typical submesic, middle-slope habitats. Surface substrate of these habitats is marked by thin duff and areas of exposed mineral soil. Soil samples collected from Acidic Oak-Hickory Forests have higher silt content than soils of other communities in this class

The two plots constituting the Eastern Hemlock – Hardwood Forest.(2.3) were not included in the ordination since they performed as outliers and distorted preliminary ordination diagrams. This community type is confined to two sheltered, mesic sites that are steep (mean slope = 22˚), N- to NW-facing, and characterized by low Solar Radiation Index values (mean = 0.3453).

The community types of the Acidic Ravine and Slope Forests class have mixed biogeographic affinities. In Virginia, the Mesic Mixed Hardwood Forest is characteristic of the Piedmont and inner Coastal Plain while the other three units, though defined from Piedmont data, have more floristic similarities to montane vegetation types. With the exception of the Low Elevation Boulderfield Forest/Woodland, forests of this class occupy productive sites for timber growth and all have a history of logging. The loss of *Castanea dentata* (American chestnut) probably caused profound compositional changes in these forests as well, but many stands have now reached a mid to late successional stage of development following a peak in various disturbance regimes early in the 20th century. Further changes, however, are now underway in response to the elimination of wildfires, a dramatic increase in herbivore populations, and the advent of exotic insect and fungal pathogens such as *Lymantria dispar* (gypsy moth) and *Discula destructive* (dogwood anthracnose). The specific dynamics and manifestations of these changes will be examined in the community type descriptions that follow.

Among animals of the study area, neo-tropical songbirds, lepidopterans (butterflies and moths), and tree-dwelling bats are especially dependent on relatively mature forests. If the Bull Run Mountains follow larger geographic trends in the Appalachian oak forest region, birds are the most abundant vertebrate component of the forests (Stephenson *et al*. 1993). Breeding bird populations are dominated by area-sensitive migrants such as the wood thrush (*Hylocichla mustelina*), red-eyed vireo (*Vireo olivaceus*), scarlet tanager (*Piranga olivacea*), ovenbird (*Seiurus aurocapillus*) and Kentucky warbler (*Oporornis formosus*), which require large forest patches for successful breeding. The most prevalent and ecologically influential mammal in the area is now the white-tailed deer (*Odocoileus virginianus*). This species, which was nearly extirpated from the Virginia mountains and Piedmont by 1900, has fully recovered following re-stocking efforts initiated from 1926 to 1951 (Knox 1997). Most forest mammals typical of the region, including raccoon (*Procyon lotor*), bobcat (*Felis rufus*), and gray fox (*Urocyon cinereoargenteus*), occur in the study area; black bear (*Ursus americanus*) are frequent visitors but not verified as residents. The chipmunk (*Tamias striatus*), and probably other small mammals, are particularly abundant in the area's rocky boulderfield habitats. Although communities of this class are unlikely to harbor many restricted animal species or assemblages, they contribute to a large, unfragmented forest-mosaic with the microhabitats and resources necessary to support a diverse fauna.

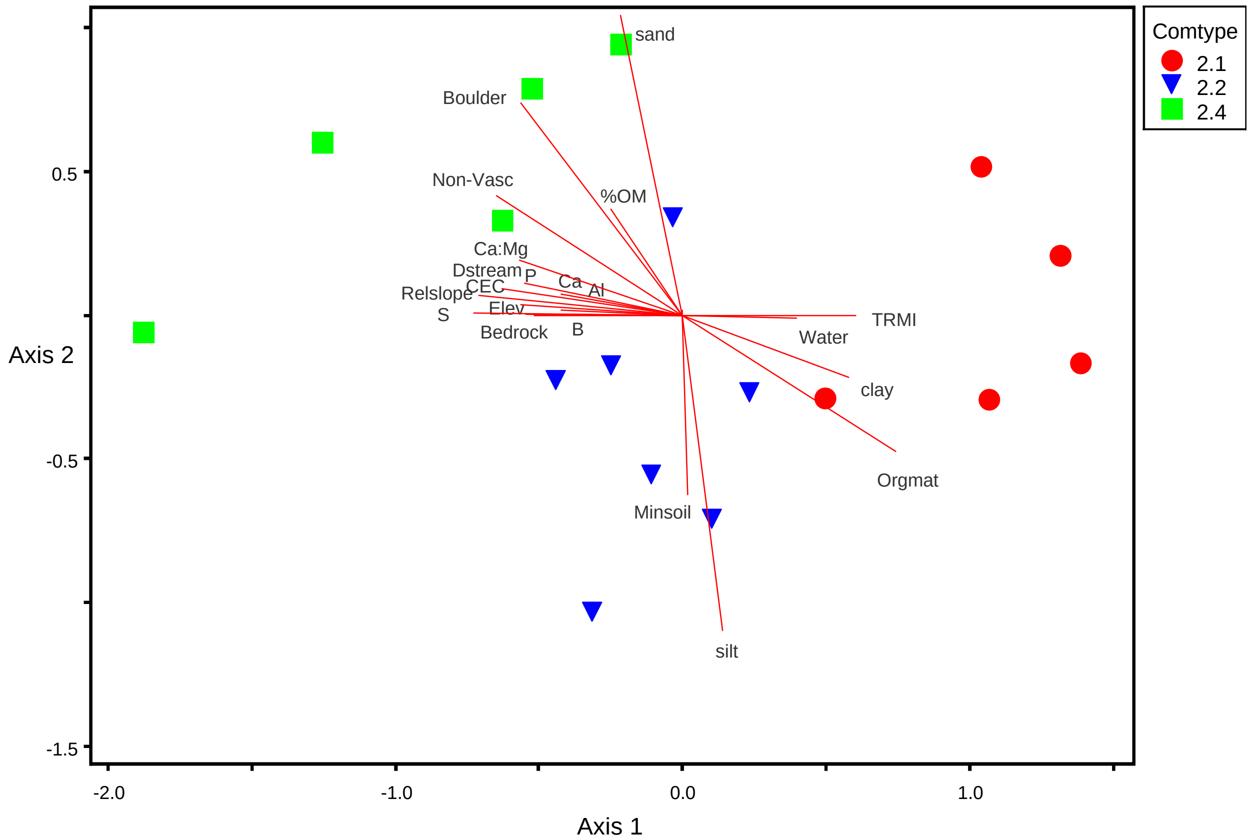


Figure 13. Scatterplot diagram for two-dimensional NMDS ordination of the ACIDIC RAVINE AND SLOPE FORESTS vegetation class, showing the distribution of three community types: 2.1 – Mesic Mixed Hardwood Forest, 2.2 – Acidic Oak-Hickory Forest, 2.4 – Low-Elevation Boulderfield Forest/Woodland. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients (p = <0.100). Bedrock = exposed bedrock surface cover. Boulder = exposed boulder surface cover. Clay = % clay in mineral soil. Dstream = distance to nearest stream. Elev = elevation. Minsoil = exposed mineral soil surface cover. Non-Vasc = bryophyte/lichen surface cover. Orgmat = organic matter surface cover. Relslope = relative slope position; high values indicate higher topographic positions. Sand = % sand in mineral soil. TRMI = topographic relative moisture index; high values indicate greater site moisture potential. Water = surface water. See pp. 20-21 for full names of soil chemistry variables.

Plate 11. **Mesic Mixed Hardwood Forest** with large *Fagus grandifolia* (American beech) along Catletts Branch, northeast of Thoroughfare Gap (plot BRM005). Photo © Gary P. Fleming.

Plate 12. **Eastern Hemlock – Hardwood Forest** on steep, NW-facing bluff along the Little River (near plot BRM033). *Hydrangea arborescens* (wild hydrangea) in foreground. Photo: Gary P. Fleming, DCR-DNH.

Plate 13. **Acidic Oak – Hickory Forest** on east slope of High Point Mountain near Thoroughfare Gap. Photo: Gary P. Fleming, DCR-DNH.

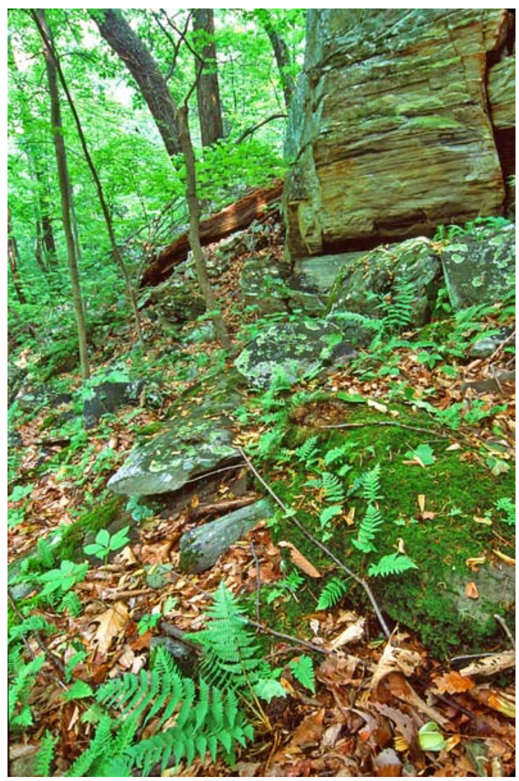


Plate 14. **Low-Elevation Boulderfield Forest / Woodland** on slope of Jackson Hollow, north of Hopewell Gap (plot BRM037). Photo: Gary P. Fleming, DCR-DNH.

Fagus grandifolia – Liriodendron tulipifera – Quercus rubra / Polystichum acrostichoides – Carex laxiculmis Forest

American Beech – Tulip-poplar – Northern Red Oak / Christmas Fern – Spreading Sedge Forest
MESIC MIXED HARDWOOD FOREST

Habitat and Distribution: This community type is associated with infertile ravines, lower slopes, and well-drained flats along streams. Stands are scattered irregularly in the Bull Run Mountains, most frequently in the interior valleys. Most sites were subjectively assessed as mesic but varied to submesic, corresponding with moderately high to moderately low TRMI values. Sideslope habitats are usually steep (> 20˚ in three plots), with a straight or concave shape, at least in one direction. Aspect is variable. Soils of most habitats appear to be the products of colluvial or alluvial deposition. Samples collected from plots were light- to dark-colored sandy loams, very strongly to extremely acidic, with low base status (Table 14).

Composition and Physiognomy:

Constant Species (constancy ≥ 80%):
Acer rubrum, *Aster divaricatus*, *Aster lateriflorus*, *Athyrium filix-femina* var. *asplenioides*, *Carex digitalis*, *Carex laxiculmis* var. *laxiculmis*, *Carex swanii*, *Chimaphila maculata*, *Cornus florida*, *Desmodium nudiflorum*, *Dioscorea quaternata*, *Fagus grandifolia*, *Fraxinus americana*, *Lindera benzoin*, *Liriodendron tulipifera*, *Luzula echinata*, *Maianthemum racemosum* ssp. *racemosum*, *Medeola virginiana*, *Nyssa sylvatica*, *Parthenocissus quinquefolia*, *Polystichum acrostichoides*, *Quercus montana*, *Quercus rubra* var. *rubra*, *Smilax rotundifolia*, *Toxicodendron radicans* ssp. *radicans*.

Dominant Species (mean cover ≥ 6):
Fagus grandifolia (8), *Carpinus caroliniana* (6), *Hamamelis virginiana* (6), *Liriodendron tulipifera* (6), *Polystichum acrostichoides* (6), *Quercus rubra* var. *rubra* (6).

Diagnostic Species (fidelity = 100%):
Castanea pumila var. *pumila*, *Juglans nigra*, *Poa cuspidata*, *Scutellaria lateriflora*, *Tilia americana* var. *americana*, *Viola blanda* var. *blanda*.

Indicator Species (highest unscaled adj. IVs):
Polystichum acrostichoides, *Athyrium filix-femina* var. *asplenioides*, *Fagus grandifolia*, *Luzula echinata*, *Carex laxiculmis* var. *laxiculmis*, *Carex swanii*, *Dichanthelium clandestinum*.

Fagus grandifolia (American beech; stems up to 99 cm [39 in] dbh) is the most characteristic and prevalent woody species of this community type. It dominates or co-dominates the overstory (mean canopy height = 33 m [108 ft]) of every plot-sampled stand, and also tends to be the most abundant species in each of the lower woody strata, with densities up to 500 stems/ha. Typical overstory associates that often co-dominate with *Fagus* are *Liriodendron tulipifera* (tulip-poplar; stems up to 94 cm [37 in] dbh), *Quercus rubra* var. *rubra* (northern red oak; stems up to 63 cm [25 in] dbh), *Acer rubrum* (red maple; stems up to 59 cm [23 in] dbh) and, less frequently, *Quercus alba* (white oak; stems up to 56 cm [22 in] dbh), *Q. montana* (chestnut oak), and *Q. velutina* (black oak; stems up to 55 cm [22 in] dbh). *Tilia americana* var. *americana* (American basswood) is an important associate in one stand (BRM033; Jackson Hollow) but is not known to occur elsewhere in the Bull Run Mountains. Frequent or locally important understory associates of *Fagus grandifolia* include *Acer rubrum*, *Carpinus caroliniana* (American hornbeam), *Carya alba* (mockernut hickory), *Cornus florida* (flowering dogwood), *Fraxinus americana* (white ash), *Hamamelis virginiana* (witch-hazel), *Kalmia latifolia* (mountain-laurel), *Lindera benzoin* (spicebush), and *Nyssa sylvatica* (black gum).

The herb layer of this forest is commonly patchy (mean stratum cover = 23%; range = 2.5 to 50%) and contains many low-cover woody seedlings. *Polystichum acrostichoides* (Christmas fern), *Athyrium filix-femina* var. *asplenioides* (southern lady fern), *Aster divaricatus* (white wood aster), and *Carex laxiculmis* var. *laxiculmis* (spreading sedge) are the most constant and abundant herbs in plot-sampled stands, with the two ferns often exerting patch-dominance. Other herbaceous plants occurring frequently (constancy ≥ 60%) but with low cover in the type include *Arisaema triphyllum* (jack-in-the-pulpit), *Aster lateriflorus* (calico aster), *Carex digitalis* (a sedge), *Carex swanii* (a sedge), *Desmodium nudiflorum* (naked-flowered tick-trefoil), *Dioscorea quaternata* (whorled wild yam), *Festuca subverticillata* (nodding fescue), *Galium triflorum* (sweet-scented bedstraw), *Goodyera pubescens* (downy rattlesnake-plantain), *Luzula echinata* (spreading wood-rush), *Maianthemum racemosum* ssp. *racemosum* (Solomon's-plume), and *Medeola virginiana* (Indian cucumber-root). Herbs occurring with lower constancies in plots but locally common in the type include *Thelypteris noveboracensis* (New York fern), *Poa cuspidata* (short-leaved bluegrass), and *Epifagus virginiana* (beechdrops). Many additional herbs occur with low constancy and cover in plot samples (Table 15).

The preceding description applies to relatively mature, mid- to late-successional stands. Early successional variants that became established on old clearings along Catletts Branch within the past 70 years are composed of nearly monospecific stands of *Liriodendron tulipifera*, with scattered *Fagus* in the understory and dense ground cover of *Polystichum acrostichoides* and *Diphasiastrum digitatum* (common running-pine).

Distinguishing Features: Distinguishing characteristics of this community type include the prevalence of *Fagus grandifolia* in all age classes along with patch-dominance of *Polystichum acrostichoides* in an open to sparse herb layer. Characteristic site conditions – mesic lower slopes and flats, usually near streams – are topographically similar to those of the Basic Mesic Forest. The Mesic Mixed Hardwood Forest, however, is associated with distinctly infertile soils and lacks the lush aspect and high cover of nutrient-demanding species of the Basic Mesic Forest, in which *Fagus grandifolia* is usually unimportant. For the most part, these mesic forests communities occupy discrete niches and may be readily distinguished by inspection. Nevertheless, confusing stands with intermediate composition can sometimes occur on sites with intermediate soil fertility.

More often, stands of Mesic Mixed Hardwood Forest grade into Acidic Oak-Hickory Forest in a lower-to-middle slope transition zone. Co-occurring stands of these community types often have very indistinct boundaries, although *Fagus grandifolia* usually decreases and oaks (especially *Quercus alba* and *Quercus montana*) increase with higher slope position and lower soil moisture. The relationship between the types is further confounded by the presence, or even dominance, of young *Fagus grandifolia* in the understory of some Acidic Oak-Hickory Forests (*e.g.*, plot BRM017), suggesting possible future replacement of these stands with Mesic Mixed Hardwood Forest. The expansion of young *Fagus* into submesic or subxeric, oak-dominated habitats is a widespread phenomenon in the Bull Run Mountains and may be the result of a period of fire suppression. See additional discussion under "Comments" below.

Global Conservation Rank: G?

State Conservation Rank: S4

Synonymy: USNVC CEGL006075: *Fagus grandifolia – Quercus alba – Liriodendron tulipifera – Carya* spp. Forest. *Fagus grandifolia – Liriodendron tulipifera – Quercus* (*alba*, *rubra*) / *Polystichum acrostichoides – Aster divaricatus* Forest (Fleming 2002). SAF Cover Type 59: Yellow-Poplar – White Oak – Northern Red Oak, *pro parte*.

Comments: Herbivory by white-tailed deer was a problem in two of the five plots, where a number of normally robust shrubs and herbs (*e.g.*, *Lindera benzoin*, *Cimicifuga racemosa*, *Podophyllum peltatum*) were essentially dwarfed (< 10 cm tall) by repeated topping. The rather sparse herb cover in some of the plots may be the general result of grazing by overpopulous deer over a period of years.

Small numbers of exotic plants were recorded in four of the plots and mortality or damage to *Cornus florida* from the fungal pathogen *Discula destructiva* (dogwood anthracnose) was noted in three plots. The most serious potential threat to the compositional integrity of Mesic Mixed Hardwood Forest stands comes from the exotic Asian grass *Microstegium vimineum* (Japanese stilt grass). This species is a relatively recent introduction to the study area, first documented in 1986 (C.E. Stevens; see Annotated List of Vascular Plants). Within the past decade, it has rampantly invaded moist, shaded habitats throughout the Bull Run Mountains and elsewhere in the region, forming monospecific carpets of tangled culms that tend to crowd out competing herbaceous species (Tu 2000).

Fagus grandifolia is probably the most shade-tolerant hardwood species in the study area and also one of the longest lived (Fowells 1965). Saplings and understory trees of this species are capable of enduring long, recurrent periods of suppression under a closed canopy and can grow exceedingly well under moderate light regimes afforded by small canopy gaps (Canham 1990). Some of the large specimens (80 to 100 cm dbh) in the Catletts Branch and Bartons Creek drainages are undoubtedly 100-150 years old, and possibly much older. *Fagus grandifolia* has little timber value and its overwhelming dominance in some stands may be an artifact of logging which removed the more economically valuable oaks. Although Allard and Leonard (1943) found "little or no reproduction" of *Fagus* in the Bull Run Mountains, saplings and pole-sized trees of this species are now abundant throughout the area, commonly invading submesic stands of Acidic Oak-Hickory Forest and even appearing in small numbers on the xeric ridge crests. Since the thin-barked *Fagus* is easily killed by fire (Fowells 1965), the likely explanation for this phenomenal expansion is the suppression of fires from many parts of the area during the last 50 years. At the same time, the presence of large *Fagus* in ravines suggests that these mesic habitats are less susceptible to fire than the drier slopes and ridge crests. Similar patterns have been documented elsewhere in the Piedmont (Abrams and Copenheaver 1999) and the central Appalachians (Abrams and Downs 1990).

Preliminary analysis of a regional dataset (Fleming 2002) indicates that the *Fagus grandifolia – Liriodendron tulipifera – Quercus rubra* / *Polystichum acrostichoides – Carex laxiculmis* Forest is widespread in the Piedmont and extreme inner Coastal Plain of northern Virginia, extending south in the central and western Piedmont at least to Prince Edward County. It ranges northward on the Coastal Plain to New Jersey and southeastern Pennsylvania. Over most of the Coastal Plain and southern Piedmont in Virginia, it is replaced by the similar *Fagus grandifolia – Quercus* (*rubra*, *alba*) *– Liriodendron tulipifera* / *Ilex opaca –* (*Asimina triloba*) Forest (Fleming 2002), which differs in its much lower species richness (n = 38 for 41 plot samples) and abundance of austral species such as *Ilex opaca* var. *opaca* (American holly), *Oxydendrum arboreum* (sourwood), and *Vitis rotundifolia* (muscadine grape).

Representative Plots and Examples: This unit is represented by five plot samples: BRM003, 005, 006, 036, and 056. The best examples in the study area are located along the lower portion of Catletts Branch NE of Thoroughfare Gap (Plate 11, p. 63), and along the headwaters of Bartons Creek NE of High Acre Ridge. Small stands containing impressively old trees occur at both sites. Younger, less pristine patches of the type can be found on lower slopes along most internal drainages of the study area.

Table 14. Environmental information summary for five plots of the *Fagus grandifolia – Liriodendron tulipifera – Quercus rubra* / *Polystichum acrostichoides – Carex laxiculmis* Forest community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	**MEAN**	**MIN**	**MAX**
Elevation (m / ft)	182 / 596	143 / 470	244 / 800
Topographic Position	lower slope	stream bottom	middle slope
Relative Slope Position (0 to 1)	0.22	0.04	0.81
SURFACE SUBSTRATE COVER (%):			
Wood	2	1	2
Bedrock	0	0	0
Boulders	3	0	10
Stones	1	0	3
Cobbles	<1	0	1
Gravel	<1	0	1
Mineral Soil	9	0	44
Organic Matter	84	50	99
Water	1	0	3
Bryophytes and Lichens	9	0	25
Slope (degrees)	16	4	24
Slope Shape: Vertical	straight	concave	convex
Slope Shape: Horizontal	straight	concave	straight
Aspect (degrees [direction])	258 (WSW)	130 (SE)	26 (NNE)
Moisture Regime	mesic	submesic	mesic
Topographic Relative Moisture Index (0 to 60)	34.6	25.8	45.9
SOIL CHEMISTRY AND TEXTURE:			
pH	4.2	3.7	4.9
Calcium (ppm)	138	30	325
Magnesium (ppm)	62	24	89
Iron (ppm)	268	183	373
Manganese (ppm)	45	18	79
Zinc (ppm)	2.9	1.7	5.0
Phosphorus (ppm)	30	11	84
Potassium (ppm)	43	32	67
Aluminum (ppm)	854	585	1047
Copper (ppm)	0.86	0.49	1.34
Boron (ppm)	0.30	0.20	0.38
Sodium (ppm)	11	10	13
Soluble Sulphur (ppm)	32	19	44
% Organic Matter	5.01	2.57	9.37
Total Cation Exchange Capacity	8.89	2.98	17.59
Total Base Saturation (%)	20.00	7.40	43.81
% Clay	4	2	6
% Silt	38	19	46
% Sand	58	50	78

Table 15. Floristic composition of the *Fagus grandifolia – Liriodendron tulipifera – Quercus rubra / Polystichum acrostichoides – Carex laxiculmis* Forest community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the five plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 57

Community Type Homoteneity = 0.684

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acer rubrum	5	-	100	8	4	4
Ageratina altissima var. *altissima*	1	-	20	3	0	1
Agrostis perennans var. *perennans*	2	0	60	15	3	15
Amelanchier arborea var. *arborea*	2	0	60	9	2	9
Amphicarpaea bracteata	2	- -	60	9	2	2
Antennaria plantaginifolia var. *plantaginifolia*	2	+	20	4	1	8
Arisaema triphyllum	2	-	60	8	2	4
Asimina triloba	2	- -	20	1	0	0
Aster divaricatus	3	+	100	19	6	37
Aster lateriflorus	2	0	80	15	3	15
Athyrium filix-femina var. *asplenioides*	4	++	100	31	14	125
Boehmeria cylindrica	2	0	40	9	2	9
Botrychium virginianum	1	-	40	5	1	3
Brachyelytrum erectum var. *erectum*	2	+	20	3	1	6
Cardamine concatenata	2	+	20	5	1	10
Carex albicans var. *albicans*	2	+	60	26	6	51
Carex atlantica ssp. *atlantica*	1	0	20	5	1	5
Carex blanda	2	+	20	4	1	8
Carex debilis var. *debilis*	2	+	20	4	1	8
Carex digitalis	2	0	80	12	3	12
Carex gracillima	2	+	20	5	1	10
Carex grisea	2	+	20	10	2	20
Carex intumescens	2	+	20	5	1	10
Carex laxiculmis var. *laxiculmis*	4	++	80	27	12	107
Carex platyphylla	2	+	20	10	2	20
Carex prasina	2	0	40	9	2	9
Carex radiata	2	+	20	3	1	6
Carex rosea	2	0	20	2	0	2
Carex swanii	2	+	80	46	10	91
Carex virescens	2	+	20	3	1	6
Carpinus caroliniana	6	+++	20	3	2	20
Carya alba	2	- -	40	3	1	1
Carya glabra	2	- -	60	8	2	2
Castanea pumila var. *pumila*	2	+	20	20	4	40
Chelone glabra	1	0	20	2	0	2
Chimaphila maculata	2	0	100	11	3	11
Cimicifuga racemosa	2	-	40	4	1	2

Table 15 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Circaea lutetiana ssp. *canadensis*	2	0	20	1	0	1
Collinsonia canadensis	2	0	40	6	1	6
Conopholis americana	2	+	20	3	1	5
Cornus florida	3	-	100	14	5	7
Crataegus sp.	1	0	20	20	2	20
Danthonia spicata	2	0	40	7	1	7
Deparia acrostichoides	2	0	20	3	1	3
Desmodium nudiflorum	2	0	80	10	2	10
Dichanthelium clandestinum	2	+	60	45	10	90
Dichanthelium dichotomum	2	0	40	3	1	3
Dioscorea quaternata	2	0	100	14	3	14
Diospyros virginiana	1	-	20	1	0	1
Epifagus virginiana	2	+	40	20	4	40
Eupatorium purpureum	2	+	20	2	0	3
Fagus grandifolia	8	+++	100	15	13	121
Festuca subverticillata	2	+	60	16	4	33
Fraxinus americana	3	0	80	10	3	10
Galium circaezans	2	0	40	3	1	3
Galium triflorum	2	0	60	8	2	8
Goodyera pubescens	2	+	60	20	4	40
Hamamelis virginiana	6	++	60	16	11	65
Hieracium paniculatum	2	+	20	4	1	8
Hieracium venosum	2	+	20	3	1	5
Houstonia purpurea var. *purpurea*	2	0	60	11	2	11
Hydrangea arborescens	2	0	60	15	3	15
Hypoxis hirsuta	2	+	20	7	1	13
Ilex verticillata	2	-	20	2	0	1
Impatiens capensis	1	-	20	2	0	1
Juglans nigra	2	+	40	40	9	80
Kalmia latifolia	4	- -	40	2	1	1
Lindera benzoin	2	- -	80	12	3	3
Liriodendron tulipifera	6	0	100	10	7	10
Lonicera japonica	2	0	40	7	1	7
Luzula echinata	2	+	80	53	12	107
Lycopus virginicus	2	+	40	9	2	18
Maianthemum racemosum ssp. *racemosum*	2	0	100	12	3	12
Medeola virginiana	2	0	80	15	3	15
Microstegium vimineum	2	0	40	6	1	6
Monotropa hypopithys	1	0	20	4	0	4
Nyssa sylvatica	4	- -	100	9	4	2
Osmunda cinnamomea	2	- -	20	2	0	0
Osmunda claytoniana	2	+	20	10	2	20
Oxalis violacea	2	0	20	7	1	7

Table 15 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Parthenocissus quinquefolia	2	0	100	12	3	12
Phegopteris hexagonoptera	2	0	40	11	3	11
Poa cuspidata	2	+	20	20	4	40
Podophyllum peltatum	2	+	20	2	0	4
Polygonatum biflorum var. *biflorum*	2	0	40	3	1	3
Polygonum virginianum	2	+	20	3	1	5
Polypodium virginianum	2	0	20	5	1	5
Polystichum acrostichoides	6	+++	100	21	14	167
Potentilla canadensis	2	+	20	2	0	4
Prenanthes altissima	2	+	20	3	1	7
Prenanthes trifoliolata	2	+	40	27	6	53
Prunus serotina var. *serotina*	2	0	60	6	1	6
Quercus alba	4	-	40	3	1	1
Quercus montana	2	- - - - -	80	5	1	0
Quercus rubra var. *rubra*	6	+	80	6	4	13
Quercus velutina	3	-	60	4	1	2
Ranunculus abortivus	1	0	20	7	1	7
Ranunculus recurvatus	2	+	20	2	0	4
Rhododendron periclymenoides	3	0	60	5	2	5
Rosa multiflora	2	+	20	10	2	20
Rubus flagellaris	2	0	20	1	0	1
Rubus phoenicolasius	2	0	20	2	0	2
Sambucus canadensis	2	+	20	3	1	6
Sanicula canadensis	2	0	40	4	1	4
Sassafras albidum	2	-	40	2	0	1
Scutellaria lateriflora	2	+	20	20	4	40
Smilax glauca	2	0	40	3	1	3
Smilax herbacea	1	0	20	4	0	4
Smilax pulverulenta	2	+	20	10	2	20
Smilax rotundifolia	2	-	80	7	2	4
Solidago caesia	2	0	40	4	1	4
Stellaria pubera	2	+	40	11	3	23
Symplocarpus foetidus	2	- -	40	7	2	2
Thalictrum pubescens	2	+	40	9	2	18
Thelypteris noveboracensis	4	0	40	7	3	7
Tilia americana var. *americana*	4	++	20	20	9	80
Toxicodendron radicans ssp. *radicans*	2	0	80	13	3	13
Uvularia perfoliata	2	0	40	4	1	4
Uvularia sessilifolia	2	0	40	10	2	10
Vaccinium corymbosum	1	0	20	5	1	5
Vaccinium fuscatum	2	-	20	2	0	1
Vaccinium pallidum	2	- - -	60	3	1	0
Viburnum acerifolium	2	0	60	14	3	14
Viburnum prunifolium	2	0	40	9	2	9

Table 15 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Viola blanda var. *blanda*	2	+	20	20	4	40
Viola cucullata	2	0	40	7	1	7
Viola sororia	2	0	60	13	3	13
Vitis vulpina	2	0	40	5	1	5

Table 16. Woody stem data summary for the *Fagus grandifolia – Liriodendron tulipifera – Quercus rubra* / *Polystichum acrostichoides – Carex laxiculmis* Forest community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for five plots representing the type. Species with IV > 0.95 are listed in descending order of IV.

SPECIES	Tree Density	Large Tree Density	TOTAL DENSITY	RELATIVE DENSITY	BASAL AREA	RELATIVE BASAL AREA	IV
Fagus grandifolia	200	60	260	42.59	22.21	42.66	42.62
Liriodendron tulipifera	10	30	40	5.55	8.97	18.49	12.02
Quercus rubra var. *rubra*	20	25	45	5.48	6.48	15.42	10.45
Acer rubrum	60	10	70	8.84	3.95	8.55	8.70
Hamamelis virginiana	120	0	120	13.55	0.21	0.56	7.05
Tilia americana var. *americana*	55	0	55	4.89	1.00	2.35	3.62
Quercus alba	0	10	10	1.30	2.46	5.69	3.49
Carpinus caroliniana	45	0	45	4.00	0.61	1.44	2.72
Nyssa sylvatica	30	0	30	3.37	0.73	1.86	2.62
Cornus florida	25	0	25	4.46	0.04	0.08	2.27
Quercus velutina	0	5	5	0.69	1.19	2.08	1.38
other species	40	0	40	5.28	0.43	0.81	3.05
TOTALS	**605**	**140**	**745**	**100.00**	**48.28**	**100.00**	**100.00**

Table 17. Vertical structure of woody taxa and total stratum cover in five plots of the *Fagus grandifolia – Liriodendron tulipifera – Quercus rubra / Polystichum acrostichoides – Carex laxiculmis* Forest community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Acer rubrum	2	2	2	4	5	
Amelanchier arborea	2	2				
Asimina triloba	2	2				
Carpinus caroliniana	2	2	6			
Carya alba	1			2		
Carya glabra	2	2				
Castanea pumila var. *pumila*	2					
Cornus florida		3				
Crataegus sp.	1					
Diospyros virginiana	1					
Fagus grandifolia	2	6	6	4	7	6
Fraxinus americana	2	2	2			
Hamamelis virginiana	2	6	2			
Hydrangea arborescens	2	2				
Ilex verticillata	2					
Juglans nigra	2					
Kalmia latifolia	3	3				
Lindera benzoin	2	2				
Liriodendron tulipifera	2			2	6	5
Nyssa sylvatica	2	2	3	4		
Parthenocissus quinquefolia	2					
Prunus serotina var. *serotina*	2					
Quercus alba	2				4	
Quercus montana	2	2		2	3	
Quercus rubra var. *rubra*	2	2	2	2	6	4
Quercus velutina	2				3	
Rhododendron periclymenoides	2	3				
Rosa multiflora		2				
Rubus flagellaris	2					
Rubus phoenicolasius	2					
Sambucus canadensis	2					
Sassafras albidum	2	2				
Smilax glauca	2					
Smilax rotundifolia	2	2				
Tilia americana var. *americana*		2	3		4	
Toxicodendron radicans	2			2		
Vaccinium corymbosum	1					
Vaccinium fuscatum	2					
Vaccinium pallidum	2					

Table X – continued

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Viburnum acerifolium	2	2				
Viburnum prunifolium	2					
Vitis vulpina	2			2		
Total Stratum Cover (%):						
Mean: all plots in type	**23**	**40**	**27**	**12**	**67**	**24**
Mean: plots w/cover in stratum	**23**	**40**	**27**	**15**	**67**	**30**

ECOLOGICAL COMMUNITY TYPE 2.2.

***Quercus montana – Quercus alba – Carya glabra / Cornus florida* Forest**

Chestnut Oak – White Oak – Pignut Hickory / Flowering Dogwood Forest
ACIDIC OAK – HICKORY FOREST

Habitat and Distribution: Typical sites for this community type are west- to north-facing middle slopes (mean inclination = 16˚) with submesic to subxeric moisture regimes. Sampling sites have a relatively narrow range of TRMI values (24.61 to 40.23) indicative of intermediate moisture conditions. Substrates include both colluvial soils and soils weathered in residuum from massive quartzite, flaggy quartzite, and phyllite. The surface substrate typically includes patches of exposed mineral soil covering up to 25% of a 400 m^2 plot. Elsewhere, surficial duff and humus are rarely more than a few cm deep and often much thinner. None of the sampling sites are very rocky, containing a scattering of small boulders and stones (mean cover = 6%) at the surface. Soil samples extracted from plots are very strongly to extremely acidic, with low base status, except for much higher than average Mn levels in three plots (Table 18). This community does not cover large areas in the Bull Run Mountains but forms scattered patches on suitable side slopes, grading in and out of closely associated types (see "Distinguishing Features" below). All sites have been logged at least once and some may have recovered from agricultural uses during the 19^{th} century.

Composition and Physiognomy:

Constant Species (constancy ≥ 80%):
Acer rubrum, *Aster divaricatus*, *Aster lateriflorus*, *Carex digitalis*, *Carya glabra*, *Cornus florida*, *Dioscorea quaternata*, *Liriodendron tulipifera*, *Maianthemum racemosum* ssp. *racemosum*, *Nyssa sylvatica*, *Parthenocissus quinquefolia*, *Polygonatum biflorum* var. *biflorum*, *Polystichum acrostichoides*, *Quercus alba*, *Quercus montana*, *Quercus rubra* var. *rubra*, *Quercus velutina*, *Sassafras albidum*, *Smilax rotundifolia*, *Solidago caesia*, *Vaccinium pallidum*.

Dominant Species (mean cover ≥ 6):
Acer rubrum (7), *Carya glabra* (6), *Cornus florida* (6), *Fagus grandifolia* (6), *Liriodendron tulipifera* (6), *Quercus montana* (6), *Quercus alba* (6).

Diagnostic Species (fidelity = 100%):
Betula lenta, *Carex glaucodea*, *Elephantopus carolinianus*, *Gleditsia triacanthos*, *Viola hirsutula*.

Indicator Species (highest unscaled adj. IVs):
Carya glabra, *Cornus florida*, *Goodyera pubescens*, *Cunila origanoides*, *Potentilla simplex*, *Quercus velutina*, *Quercus alba*.

This forest community has a mixed overstory (mean canopy height = 32 m [105 ft]) with variable co-dominance by *Quercus alba* (white oak; stems up to 73 cm [29 in] dbh), *Quercus montana* (chestnut oak; stems up to 90 cm [35 in] dbh), *Quercus rubra* var. *rubra* (northern red oak; stems up to 64 cm [25 in] dbh), *Quercus velutina* (black oak; stems up to 56 cm [22] dbh), *Liriodendron tulipifera* (tulip-poplar; stems up to 59 cm [23 in] dbh), and *Carya glabra* (pignut hickory; stems up to 44 cm [17 in] dbh). Minor overstory associates include *Quercus coccinea* (scarlet oak; stems up to 83 cm [33 in] dbh), *Acer rubrum* (red maple; stems up to 25 cm [10 in] dbh), *Fraxinus americana* (white ash; stems up to 57 cm [22 in] dbh), and *Betula lenta* (sweet birch; stems up to 40 cm [16 in] dbh). Although still quite common, *Cornus florida* (flowering dogwood) was formerly abundant in the understory prior to the advent of the fungal pathogen *Discula destructiva* (dogwood anthracnose); most plots are now littered with snags and downed wood from anthracnose-killed trees. The current understory dominant is *Acer rubrum*, which attains densities up to 725 stems/ha and the highest IV in plots of this type (Table 20), despite reaching the overstory in only one plot. *Fagus grandifolia* (American beech) is also present in the understory of several plots, completely dominating one (BRM017). *Carya alba* (mockernut hickory), *Carya glabra*, *Nyssa sylvatica* (black gum), and *Sassafras albidum* (sassafras) are other frequent understory species.

The herb layer is typically rather sparse (mean stratum cover = 23%), with the majority of cover contributed by low patches of *Vaccinium pallidum* (early lowbush blueberry), and tree seedlings. Plot BRM057 is an exception in which a large clone of *Aralia nudicaulis* (wild sarsaparilla) covers > 25% of the quadrat. Herbaceous species occurring more or less regularly with low cover include *Aster divaricatus* (white wood aster), *Aster lateriflorus* (calico aster), *Carex digitalis* (a sedge), *Desmodium nudiflorum* (naked-flowered tick-trefoil), *Dioscorea quaternata* (whorled wild yam), *Maianthemum racemosum* ssp. *racemosum* (Solomon's-plume), *Polygonatum biflorum* var. *biflorum* (Solomon's-seal), *Polystichum acrostichoides* (Christmas fern), and *Solidago caesia* (bluestem goldenrod). Herbs that are less frequent but nevertheless characteristic of this community are *Cunila origanoides* (dittany), *Goodyera pubescens* (downy rattlesnake-plantain), and *Potentilla canadensis* (Canada cinquefoil).

It should be noted that Plot BRM067 is a somewhat anomalous sample that lacks *Quercus alba*, has an understory dominated by large *Rhododendron periclymenoides* (wild azalea) and *Kalmia latifolia* (mountain-laurel), and has a fairly typical herb layer. This stand has mixed affinities to the Acidic Oak-Hickory Forest, Chestnut Oak Forest, and Low-Elevation Boulderfield Forest/Woodland community types; its group membership in cluster analyses shifts among these types depending on which protocol is used (see p. 26). The plot was ultimately assigned to the Acidic Oak-Hickory Forest type based on statistical analysis, but is the least representative of all seven samples.

Distinguishing Features: Distinguishing features of this community include dry-mesic, middle-slope sites with areas of thin duff and exposed mineral soil; the prominence of *Quercus alba* and *Carya glabra* in a mixed overstory; and an open herb layer containing patches of low deciduous ericads and low-cover, dry-site herbaceous species. *Quercus alba* and *Carya glabra* both reach maximum statistical importance in this type, the latter occurring more numerously in the understory than in the overstory. This community intergrades with both the Chestnut Oak Forest and Basic Oak-Hickory Forest, but lacks the dense, mixed ericaceous shrub layer of the former and the more continuous, species-rich herb layer of the latter. Further, the Basic Oak-Hickory Forest occurs most extensively on the eastern flanks of the ridges, while the Acidic Oak-Hickory Forest is most frequent on the western flanks. The most problematic stands for interpretation are located in the lower-to-middle slope transition zones where this community intergrades with Mesic Mixed Hardwood Forest. Co-occurring stands of these community types often have very indistinct boundaries, although *Fagus grandifolia* usually decreases and oaks (especially *Quercus alba* and *Quercus montana*) increase with higher slope position and lower soil moisture. The relationship between the types, however, is further confounded by the presence, or even dominance, of young *Fagus grandifolia* in the understory of some Acidic Oak-Hickory Forests (*e.g*., plot BRM017), suggesting possible future replacement of these stands with Mesic Mixed Hardwood Forest. The expansion of young *Fagus* into submesic or subxeric, oak-dominated habitats is a widespread phenomenon in the Bull Run Mountains and may be the result of a period of fire suppression. See additional discussion under "Comments" below.

Global Conservation Rank: G?

State Conservation Rank: S?

Synonymy: USNVC CEGL008515: *Quercus alba – Quercus prinus – Carya glabra* / *Cornus florida* / *Vaccinium pallidum* / *Carex pensylvanica* Forest, *pro parte*. *Quercus prinus – Quercus rubra – Carya* (*ovalis*, *glabra*) / *Viburnum acerifolium* Forest, *pro parte* (Fleming 2002). *Quercus alba – Quercus velutina – Carya* (*alba*, *glabra*) / *Cornus florida* / *Vaccinium stamineum* Forest, *pro parte* (Fleming 2002). SAF Cover Type 52: White Oak – Black Oak – Northern Red Oak, *pro parte*.

Comments: The most frequent disturbances recorded in plots were dogwood anthracnose (5 plots), herbivory by white-tailed deer (5 plots), and exotic plants (4 plots; very small populations). Minor wind or ice damage was recorded in three plots, while light gypsy moth damage, caterpillars, and/or egg masses were noted in two plots. Old *Castanea dentata* (American chestnut) wood debris was common in three plots. Grazing by deer may contribute to the relatively sparse cover of herbaceous plants in stands of this community, which offers more in the way of palatable forbs than does the more extensive Chestnut Oak Forest. Evidence of herbivory was pervasive where noted and included consistent damage (topped-off stems and leaves) on *Aster* spp. (asters), *Carex* spp. (sedges), *Desmodium nudiflorum*, *Polygonatum biflorum* var. *biflorum*, *Cornus florida*, and *Viburnum acerifolium* (maple-leaved viburnum) (see Table 51, p. 176). A potentially serious outbreak of the exotic insect pest gypsy moth (*Lymantria dispar*), whose larvae prefer and feed voraciously on oaks, was averted during the summer of 2001 by the naturalized fungal pathogen *Entomophaga maimaiga* (Andreadis and Weseloh 1990, Hajek *et al*. 1996b). This moth poses a serious threat to the compositional and biotic integrity of all oak-dominated forests in the study area. Unchecked infestations frequently result in total defoliation of preferred trees. Successive years of defoliation greatly weaken trees and make them susceptible to mortality from secondary causes such as drought stress and heartwood infections (Schweitzer 1987). Moreover, removal of leaf canopies during late spring and early summer may impact forest understories by increasing insolation, soil drying, and the establishment of light-demanding weeds.

In all likelihood, *Castanea dentata* was once a major overstory associate of *Quercus alba* and other oaks on sites now occupied by the Acidic Oak-Hickory Forest. *Liriodendron tulipifera* and *Carya glabra* probably increased following elimination of *Castanea* by the chestnut blight by the 1930's. Currently, many stands of Acidic Oak-Hickory Forest again appear to be in a state of compositional flux, reflected by the great understory dominance of *Acer rubrum* and, at fewer sites, of *Fagus grandifolia*. Although some recruitment of oaks (particularly *Quercus montana*) was documented at most sampling sites, it appears that the successional trajectory of many stands is toward dominance by the shade-tolerant, more mesophytic *Fagus* and *Acer rubrum*, with reduced dominance by oaks. Abrams and Copenheaver (1999) documented similar increases of *Acer rubrum* and *Fagus*, along with *Liriodendron tulipifera*, *Quercus rubra*, and *Carya glabra* in an old-growth *Quercus alba* forest in Fairfax County, Virginia. In another old-growth *Quercus alba* forest in southwestern Pennsylvania, Abrams and Downs (1990) described the gradual replacement of oaks by *Fagus*, *Liriodendron*, and *Acer rubrum* over a period of 70-100 years. The widespread development during the 20th century of *Acer rubrum* understories in oak forests of the Piedmont and Appalachians has also been well documented (Abrams 1992, Abrams 1998, Abrams and Nowacki 1992, Lorimer 1984, McDonald *et al.* 2002). The principal reason for these changes is hypothesized to be a dramatic reduction of fires during the 20th century in conjunction with a variety of large-scale disturbances such as chestnut blight and logging (Abrams 1992). The thin bark of *Acer rubrum* and *Fagus grandifolia*, in particular, makes these species more sensitive to fire than other forest trees (Abrams 1992, Fowells 1965). It is noteworthy that Allard and Leonard (1943) could find "little or no reproduction" of *Fagus* and described *Acer rubrum* as only "frequent" during a period (1930's and 1940's) that marked the end of a period of frequent and intense fires in the Bull Run Mountains.

The *Quercus montana – Quercus alba – Carya glabra* / *Cornus florida* Forest of the Bull Run Mountains has an uncertain relationship to members of the Acidic Oak-Hickory Forests ecological group elsewhere in Virginia. It is similar to three community types that have been tentatively identified from the Watery Mountains (Fauquier County), the Culpeper Basin, and the Ridge and Valley (see "Synonymy" above). At present however, it is not clear whether these units merit recognition as separate types, or as variants of a single community. Further data collection and analysis is needed to resolve classification issues at a regional scale.

Representative Plots and Examples: This unit is represented by seven plot samples: BRM016, 017, 038, 052, 054, 057, and 067. No outstanding occurrences have been identified but representative examples can be seen on the western slope of the middle ridge, north of Hopewell Gap opposite High

Acre Ridge (*e.g.*, plots BRM016 and 017) and on the western slope of the east ridge above Catletts Branch (*e.g.*, plots BRM038 and BRM052). See Plate 13, p. 64.

Table 18. Environmental information summary for seven plots of the *Quercus montana – Quercus alba – Carya glabra* / *Cornus florida* Forest community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	**MEAN**	**MIN**	**MAX**
Elevation (m / ft)	234 / 767	171 / 560	283 / 930
Topographic Position	middle slope	lower slope	middle slope
Relative Slope Position (0 to 1)	0.40	0.19	0.51
SURFACE SUBSTRATE COVER (%):			
Wood	3	1	5
Bedrock	<1	0	2
Boulders	2	0	5
Stones	4	0	13
Cobbles	0	0	0
Gravel	1	0	5
Mineral Soil	10	0	25
Organic Matter	80	66	95
Water	0	0	0
Bryophytes and Lichens	9	0	20
Slope (degrees)	16	10	24
Slope Shape: Vertical	straight	concave	convex
Slope Shape: Horizontal	straight	concave	convex
Aspect (degrees [direction])	282 (WNW)	120 (ESE)	2 (N)
Moisture Regime	submesic	subxeric	submesic
Topographic Relative Moisture Index (0 to 60)	31.0	24.6	40.2
SOIL CHEMISTRY AND TEXTURE:			
pH	4.4	3.9	5.1
Calcium (ppm)	236	137	463
Magnesium (ppm)	87	42	142
Iron (ppm)	187	142	255
Manganese (ppm)	94	14	172
Zinc (ppm)	3.6	1.6	5.7
Phosphorus (ppm)	24	18	31
Potassium (ppm)	66	41	98
Aluminum (ppm)	875	718	1065
Copper (ppm)	1.10	0.69	1.63
Boron (ppm)	0.31	0.27	0.34
Sodium (ppm)	10	6	17
Soluble Sulphur (ppm)	39	32	46
% Organic Matter	6.49	3.73	10.35
Total Cation Exchange Capacity	11.27	9.57	13.83
Total Base Saturation (%)	18.83	10.58	32.81
% Clay	2	1	3
% Silt	44	31	60
% Sand	54	38	68

Table 19. Floristic composition of the *Quercus montana – Quercus alba – Carya glabra* / *Cornus florida* Forest community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the seven plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 49

Community type Homoteneity = 0.697

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acer rubrum	7	+	100	11	9	22
Agrimonia rostellata	1	0	14	2	0	2
Agrostis perennans var. *perennans*	2	0	29	5	1	5
Amelanchier arborea var. *arborea*	2	0	57	11	2	11
Amelanchier laevis	2	0	14	3	1	3
Antennaria plantaginifolia var. *plantaginifolia*	1	0	14	3	0	3
Aralia nudicaulis	5	+	29	5	3	10
Aristolochia serpentaria	1	0	43	11	1	11
Asimina triloba	2	- -	29	4	1	1
Asplenium platyneuron	2	+	43	13	3	26
Aster divaricatus	2	0	86	19	4	19
Aster lateriflorus	2	0	86	24	5	24
Aster undulatus	2	+	43	13	3	26
Aureolaria laevigata	1	0	14	3	0	3
Betula lenta	3	+	14	14	5	29
Botrychium virginianum	1	-	14	1	0	0
Bromus pubescens	1	0	14	7	1	7
Carex albicans var. *albicans*	1	0	14	2	0	2
Carex blanda	1	0	14	3	0	3
Carex cephalophora	1	0	14	4	0	4
Carex digitalis	2	0	86	20	4	20
Carex glaucodea	1	0	14	14	2	14
Carex hirsutella	1	0	14	7	1	7
Carex laxiculmis var. *laxiculmis*	1	-	14	1	0	1
Carex laxiflora var. *laxiflora*	2	0	57	15	3	15
Carex pensylvanica	2	0	43	12	3	12
Carex rosea	2	0	29	5	1	5
Carex virescens	1	0	14	2	0	2
Carpinus caroliniana	2	-	29	7	2	4
Carya alba	5	+	57	8	4	15
Carya glabra	6	++	86	21	14	86
Castanea dentata	2	0	29	3	1	3
Celtis occidentalis	1	0	14	7	1	7
Cercis canadensis var. *canadensis*	2	0	14	2	0	2
Chimaphila maculata	2	0	29	1	0	1
Chionanthus virginicus	2	0	14	1	0	1
Cimicifuga racemosa	1	- -	14	1	0	0

Table 19 – continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Clitoria mariana	1	0	14	7	1	7
Collinsonia canadensis	1	-	14	1	0	1
Conopholis americana	2	+	29	7	2	14
Cornus florida	6	++	86	14	10	57
Cunila origanoides	2	+	43	21	5	43
Danthonia spicata	4	++	29	5	2	19
Dennstaedtia punctilobula	1	0	29	11	1	11
Desmodium nudiflorum	3	+	71	11	4	22
Desmodium rotundifolium	1	0	14	7	1	7
Dichanthelium boscii	2	0	29	5	1	5
Dichanthelium dichotomum	2	0	57	10	2	10
Dioscorea quaternata	2	0	100	19	4	19
Elephantopus carolinianus	1	0	14	14	2	14
Epifagus virginiana	1	0	14	4	0	4
Eupatorium purpureum	1	0	29	5	1	5
Fagus grandifolia	6	+	71	11	7	22
Fraxinus americana	3	0	71	11	4	11
Galium circaezans	2	0	43	5	1	5
Galium triflorum	1	-	14	1	0	0
Gaylussacia baccata	2	- - -	43	5	1	1
Geranium maculatum	1	0	29	7	1	7
Gleditsia triacanthos	1	0	14	14	2	14
Goodyera pubescens	2	+	57	25	6	51
Hamamelis virginiana	2	- -	14	1	0	0
Hepatica americana	1	0	14	3	0	3
Hieracium paniculatum	1	0	29	11	1	11
Hieracium venosum	2	+	29	7	2	14
Houstonia purpurea var. *purpurea*	2	0	57	13	3	13
Hydrangea arborescens	2	0	29	5	1	5
Hypoxis hirsuta	1	0	14	5	1	5
Juniperus virginiana var. *virginiana*	2	+	14	5	1	10
Kalmia latifolia	3	- - -	43	3	1	0
Lespedeza intermedia	1	0	14	4	0	4
Lindera benzoin	1	- - -	14	1	0	0
Liriodendron tulipifera	6	0	100	14	10	14
Lobelia spicata var. *scaposa*	1	0	14	7	1	7
Lysimachia quadrifolia	1	0	29	11	1	11
Maianthemum canadense	1	0	14	5	1	5
Maianthemum racemosum ssp. *racemosum*	2	0	86	12	3	12
Medeola virginiana	2	0	57	11	2	11
Monotropa hypopithys	1	0	14	3	0	3
Monotropa uniflora	2	0	57	13	3	13
Muhlenbergia sobolifera	1	0	14	4	0	4

Table 19 – continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Nyssa sylvatica	5	-	86	9	5	5
Oxalis dillenii	2	+	29	10	2	19
Parthenocissus quinquefolia	2	0	100	17	4	17
Pinus virginiana	2	-	14	1	0	0
Podophyllum peltatum	1	0	14	1	0	1
Polygonatum biflorum var. *biflorum*	2	0	100	28	6	28
Polystichum acrostichoides	2	-	86	21	5	11
Populus grandidentata	1	0	14	7	1	7
Potentilla canadensis	2	+	43	13	3	26
Potentilla simplex	2	+	29	19	4	38
Prenanthes altissima	2	+	29	10	2	19
Prenanthes serpentaria	1	0	14	7	1	7
Prunus avium	1	0	14	4	0	4
Prunus serotina var. *serotina*	2	0	43	4	1	4
Quercus alba	6	+	86	16	11	32
Quercus coccinea	4	0	57	11	5	11
Quercus montana	6	-	100	12	8	6
Quercus rubra var. *rubra*	5	0	100	14	8	14
Quercus velutina	5	+	100	17	9	33
Rhododendron periclymenoides	5	++	57	6	3	24
Robinia pseudoacacia	1	0	14	7	1	7
Rosa carolina	1	0	14	2	0	2
Rubus flagellaris	2	0	57	11	2	11
Rubus phoenicolasius	1	-	29	4	0	2
Sambucus canadensis	1	0	14	2	0	2
Sanguinaria canadensis	1	0	14	2	0	2
Sanicula canadensis	1	-	14	1	0	0
Sassafras albidum	3	0	100	16	5	16
Scirpus verecundus	1	0	14	7	1	7
Scutellaria elliptica	1	0	14	1	0	1
Smilax glauca	2	0	43	4	1	4
Smilax rotundifolia	2	-	86	11	3	6
Solidago bicolor	1	0	14	4	0	4
Solidago caesia	2	0	86	26	6	26
Solidago erecta	1	0	14	5	1	5
Taraxacum officinale ssp. *officinale*	1	0	14	3	0	3
Thalictrum thalictroides	2	+	43	12	3	23
Toxicodendron radicans ssp. *radicans*	1	-	29	2	0	1
Ulmus rubra	2	0	29	6	1	6
Uvularia perfoliata	2	0	57	10	2	10
Vaccinium corymbosum	1	0	14	4	0	4
Vaccinium pallidum	4	-	100	13	6	7
Vaccinium stamineum	2	0	43	5	1	5
Viburnum acerifolium	2	0	43	10	2	10

Table 19 – continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Viburnum prunifolium	5	+++	14	2	1	13
Viola hirsutula	1	0	14	14	2	14
Viola sororia	2	0	29	4	1	4
Viola triloba var. triloba	1	0	14	2	0	2
Vitis aestivalis var. *aestivalis*	1	-	14	2	0	1
Vitis aestivalis var. *bicolor*	1	-	14	1	0	0
Vitis vulpina	2	0	57	13	3	13

Table 20. Woody stem data summary for *Quercus montana – Quercus alba – Carya glabra* / *Cornus florida* Forest community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for seven plots representing the type. Species are listed in descending order of IV.

SPECIES	Tree Density	Large Tree Density	TOTAL DENSITY	RELATIVE DENSITY	BASAL AREA	RELATIVE BASAL AREA	IV
Acer rubrum	296	0	296	25.15	2.01	4.85	15.00
Quercus alba	29	36	64	5.39	10.11	23.23	14.31
Quercus montana	61	21	82	6.89	9.27	20.75	13.82
Liriodendron tulipifera	50	36	86	7.77	8.44	19.18	13.48
Cornus florida	139	0	139	13.79	0.30	0.73	7.26
Quercus rubra var. *rubra*	14	18	32	2.74	5.68	11.15	6.95
Carya glabra	100	4	104	7.88	1.76	4.45	6.17
Nyssa sylvatica	111	0	111	7.61	0.55	1.49	4.55
Fagus grandifolia	71	0	71	6.93	0.48	0.96	3.94
Viburnum prunifolium	79	0	79	5.07	0.14	0.36	2.72
Quercus velutina	0	7	7	0.65	1.47	4.03	2.34
Quercus coccinea	0	4	4	0.35	1.93	3.74	2.04
Rhododendron periclymenoides	43	0	43	2.58	0.04	0.12	1.35
Fraxinus americana	0	4	4	0.23	0.91	2.38	1.30
Sassafras albidum	29	0	29	1.95	0.05	0.14	1.05
Carya alba	18	0	18	1.57	0.18	0.35	0.96
other species	43	4	46	3.48	0.71	2.05	2.77
TOTALS	**1082**	**132**	**1214**	**100.00**	**44.01**	**100.00**	**100.00**

Table 21. Vertical structure of woody taxa and total stratum cover in seven plots of the *Quercus montana – Quercus alba – Carya glabra / Cornus florida* Forest community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	<0.5m	0.5-6m	6-10m	10-20m	20-35m	>35m
Acer rubrum	2	5	6	5	3	
Amelanchier arborea	2	2				
Amelanchier laevis		2				
Asimina triloba	1	1				
Betula lenta	1	2			3	
Carpinus caroliniana	1	2				
Carya alba	2	2	3	4		
Carya glabra	2	4	3	4	4	
Castanea dentata	1	2				
Celtis occidentalis	1					
Cercis canadensis var. *canadensis*	1	2				
Chionanthus virginicus		2				
Cornus florida	1	5	4			
Fagus grandifolia	2	3	5	4		
Fraxinus americana	2	1			3	
Gaylussacia baccata	2	1				
Gleditsia triacanthos	1					
Hamamelis virginiana		2				
Hydrangea arborescens	2					
Juniperus virginiana var. virginiana	1	2				
Kalmia latifolia	2	3				
Lindera benzoin	1					
Liriodendron tulipifera	2	2	3	4	6	4
Nyssa sylvatica	2	4	4	4		
Parthenocissus quinquefolia	2					
Pinus virginiana					2	
Populus grandidentata	1					
Prunus avium	1					
Prunus serotina var. *serotina*	2					
Quercus alba	2		1	3	6	
Quercus coccinea	2					4
Quercus montana	2	1		5	6	
Quercus rubra var. *rubra*	2	2		2	5	
Quercus velutina	2	2			4	4
Rhododendron periclymenoides	2	5				
Robinia pseudoacacia	1					
Rosa carolina	1					
Rubus flagellaris	2					
Rubus phoenicolasius	1					

Table 21 - continued

Species	<0.5m	0.5-6m	6-10m	10-20m	20-35m	>35m
Sassafras albidum	2	2	2			
Smilax glauca	2					
Smilax rotundifolia	2	2				
Toxicodendron radicans	1					
Ulmus rubra	1					
Vaccinium corymbosum	1					
Vaccinium pallidum	4	2				
Vaccinium stamineum	2					
Viburnum acerifolium	2					
Viburnum prunifolium	1	4	4			
Vitis aestivalis var. *aestivalis*	2	1				
Vitis vulpina	2					
Total Stratum Cover (%):						
Mean: all plots in type	**23**	**43**	**40**	**33**	**73**	**7**
Mean: plots w/cover in stratum	**23**	**43**	**40**	**33**	**73**	**25**

ECOLOGICAL COMMUNITY TYPE 2.3.

***Tsuga canadensis* – *Quercus montana* / *Hamamelis virginiana* Forest**

Eastern Hemlock – Chestnut Oak / Witch-hazel Forest
EASTERN HEMLOCK – HARDWOOD FOREST

Habitat and Distribution: This community type is known from two restricted sites in the Bull Run Mountains: a steep (slope = 28˚), NW-facing bluff undercut by the Little River just south of Aldie; and a deep, narrow, north-facing ravine on the east ridge, 1.72 km (1.0 mi) SSE of Hopewell Gap. The two sites are quite different in their topographic context but occupy similarly sheltered landforms with northerly aspects. Soils at both sites are extremely acidic and infertile, with relatively high organic matter content (mean = 11.8%), and a thick surface horizon of duff, humus, and fine roots up to 10 cm deep. High TRMI values (mean = 42.68) for these habitats are consistent with mesic, sheltered, lower-slope positions. Although no surface rocks were present in plot samples, large bryophyte-covered outcrops of weathered, flaggy quartzite are prominent features on the Little River bluff.

Composition and Physiognomy:

Constant Species (constancy ≥ 80%):
Acer rubrum, *Chimaphila maculata*, *Fagus grandifolia*, *Hamamelis virginiana*, *Kalmia latifolia*, *Liriodendron tulipifera*, *Nyssa sylvatica*, *Quercus montana*, *Quercus rubra* var. *rubra*, *Rhododendron periclymenoides*, *Tsuga canadensis*.

Dominant Species (mean cover ≥ 6):
Nyssa sylvatica (7), *Quercus montana* (7), *Rhododendron maximum* (7), *Tsuga canadensis* (7), *Fagus grandifolia* (6), *Quercus rubra* var. *rubra* (6).

Diagnostic Species (fidelity = 100%):
Gaultheria procumbens, *Mitchella repens*, *Rhododendron maximum*, *Tsuga canadensis*.

Indicator Species (highest unscaled adj. IVs):
Rhododendron maximum, *Tsuga canadensis*, *Pinus strobus*, *Gaultheria procumbens*, *Mitchella repens*, *Poa trivialis*, *Hamamelis virginiana*.

The two stands vary considerably in composition despite a relatively high (n = 0.720) homoteneity value. *Tsuga canadensis* (eastern hemlock) overwhelmingly dominates the understory and co-dominates the overstory (canopy height = 30 m [99 ft]) with *Quercus montana* (chestnut oak), *Quercus rubra* var. *rubra* (northern red oak), and *Fagus grandifolia* (American beech) at the Little River site. Overstory dominants in the plot range from 50-60 cm [20-24 in] dbh, but much larger trees (up to 90 cm [35 in] dbh) occur elsewhere on the bluff. Associated understory species here include *Nyssa sylvatica* (black gum), *Acer rubrum* (red maple), *Hamamelis virginiana* (witch-hazel), and *Kalmia latifolia* (mountain-laurel). The herb layer is extremely sparse (< 1% cover), consisting mostly of scattered woody seedlings, *Mitchella repens* (partridge-berry), and a few *Carex* spp. (sedges). Although not captured in the plot sample, *Hydrangea arborescens* (wild hydrangea) is common on rocky slopes, while colonies of *Asplenium montanum* (mountain spleenwort) inhabit the mossy faces and crevices of quartzite outcrops.

The east ridge stand differs dramatically in its understory, where *Rhododendron maximum* (great rhododendron; stems up to 10 cm dbh) forms a dense, 2-3 m tall shrub layer. In this stand, *Tsuga canadensis* and *Fagus grandifolia* are confined to the understory, while the overstory (canopy height = 32 m [105 ft]) is dominated by mixtures of *Quercus montana*, *Liriodendron tulipifera* (tulip-poplar), and *Pinus strobus* (eastern white pine) < 50 cm [20 in] dbh. Associated trees and shrubs here include *Acer rubrum*, *Alnus serrulata* (smooth alder; along a small drain), *Hamamelis virginiana*, *Kalmia latifolia*, *Nyssa sylvatica*, *Rhododendron periclymenoides* (wild azalea), and *Vaccinium fuscatum* (hairy highbush blueberry). The very sparse herb layer includes *Aralia nudicaulis* (wild sarsaparilla), *Aster divaricatus* (white wood aster), *Gaultheria procumbens* (wintergreen), and *Medeola virginiana* (Indian cucumber-root).

Distinguishing Features: The mesic, north-facing, infertile habitats and dominance of evergreen species such as *Tsuga canadensis* and *Rhododendron maximum* readily distinguish this community from all others in the study area. This unit occupies limited, environmentally discrete niches, and its boundaries with co-occurring communities on the landscape are abrupt.

Global Conservation Rank: G?

State Conservation Rank: S2

Synonymy: USNVC: no equivalent. *Tsuga canadensis – Quercus prinus* Forest (Fleming 2002). SAF Cover Type 23: Eastern Hemlock, *pro parte*. SAF Cover Type 44: Chestnut Oak, *pro parte*.

Comments: The introduced Asiatic insect hemlock woolly adelgid (*Adelges tsugae*; Morisawa 2000) is present in both stands of this community type. First reported in the eastern U.S. from Richmond, Virginia in 1954, this pest reached outbreak levels in western Virginia during the 1980's, and has devastated hemlock stands in many localities over the past 15 years. On the east ridge, the relatively few understory *Tsuga canadensis* are heavily infested and will be probably die in the near future. Scattered mortality of overstory and understory *Tsuga* was evident at the Little River site, although the community was still compositionally intact. Barring the emergence of a natural control, *Tsuga canadensis* will probably be eliminated from these stands within the foreseeable future. Such an event would not heavily alter the east ridge stand, where *Tsuga* is a minor tree, but would drastically alter the composition and environment of the Little River bluff.

The Little River stand is a "classic" Piedmont hemlock bluff similar to that described by Nemeth (1973) from the Tye River in Nelson County, Virginia, and also known (unpublished data) from the Potomac River (Fairfax County), Bull Run (Prince William County), North Anna River (Spotsylvania County), Byrd Creek (Fluvanna County), and James River (Buckingham County). The stand is less similar to *Tsuga canadensis* forests described by Coulling (1999) from Chopawamsic Creek (Prince William County) that lack *Quercus montana*. Although fairly common in the mountains, *Tsuga canadensis* becomes increasingly restricted in the Piedmont to protected habitats with cool, moist microclimates. Steep, north-facing bluffs along major waterways provide optimal conditions throughout much of the Piedmont, and hemlock communities are present very locally along all of the province's rivers and some larger tributaries. Such sites have often been considered Pleistocene refugia, *i.e.*, stations where *Tsuga* has persisted from a wider distribution in colder climates of the late Wisconsin or early Holocene (Nemeth 1973). Paleoecological studies, however, indicate that these hemlock communities became established later in the Holocene, when streams probably served as migration corridors for *Tsuga* as the climate warmed (Prentice *et al.* 1991).

The east ridge stand is somewhat anomalous and has fewer affinities to typical Piedmont hemlock-hardwood forests than to Acidic Cove Forests of the southern Appalachians, where *Rhododendron maximum* is a widespread and abundant species (see Fleming *et al*. 2001). Although this shrub is characteristic of southwestern Virginia landscapes, its distribution becomes spotty and localized in northern Virginia, especially east of the Blue Ridge, where it is decidedly rare. Despite this status, a handful of Piedmont populations are present in sheltered habitats along the Potomac, Occoquan, and Rappahannock Rivers (Hitchcock and Standley 1919; C.E. Stevens, pers. comm.). In a comparison of environmental and physiological factors influencing the distribution of several ericaceous shrubs, Lipscomb and Nilsen (1990a, 1990b) found that the photosynthesis and growth of *Rhododendron* *maximum* were most sensitive to both high solar irradiance and water stress, thus reaching optimal capacity in shaded valley sites.

A second population of *Rhododendron maximum* in the Bull Run Mountains raises questions about the nativity of the population treated here. Located 11.5 km (7.1 mi) to the north, on the SE side of Cold Spring Gap, the second population originated from hundreds of shrubs that were imported from North Carolina and planted around 1930 (Dr. F.T. Reuter, pers. comm.). Despite occupying an uncharacteristic, SE-facing, open slope and lacking evidence of sexual reproduction, these plants have expanded over the decades by root-sprouted clones into an impressive colony now approximately 0.4 ha (one ac) in extent. The success of these introductions suggests that the east ridge population, which is comparable in size, also could have originated from plantings. Other factors, however, argue against that possibility. First, the population is not connected in any way to the original planting effort in Cold Spring Gap, to the landowner responsible for those plantings, or to any outplantings from Cold Spring Gap (Dr. F.T. Reuter, pers. comm.). Second, the east ridge site is located in a remote, rugged area with difficult access and no nearby house sites. Finally, the sheltered, mesic, north-facing site supporting other restricted species (*e.g.*, *Tsuga canadensis*, *Pinus strobus*) and the presence of *Rhododendron* seedling reproduction located at considerable distances from the main colony are consistent with indigenous occurrences elsewhere. Nonetheless, the possibility that this population was introduced, either directly or indirectly through seed dispersal from another cultivated population, cannot be dismissed completely.

Representative Plots and Examples: This unit is represented by two plot samples: BRM026 and 033. The stand represented by BRM033 along the Little River (Plate 12, p. 64) is an outstanding occurrence, but is imminently threatened with destruction by the hemlock woolly adelgid.

Table 22. Environmental information summary for two plots of the *Tsuga canadensis – Quercus montana* / *Hamamelis virginiana* Forest community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	MEAN	MIN	MAX
Elevation (m / ft) Topographic Position	165 / 540 lower slope	110 / 360 lower slope	219 / 720 lower slope
Relative Slope Position (0 to 1)	0.16	0.10	0.21
SURFACE SUBSTRATE COVER (%):			
Wood	2	1	2
Bedrock	0	0	0
Boulders	0	0	0
Stones	0	0	0
Cobbles	0	0	0
Gravel	0	0	0
Mineral Soil	<1	0	1
Organic Matter	98	97	98
Water	<1	0	1
Bryophytes and Lichens	2	1	2
Slope (degrees)	22	15	28
Slope Shape: Vertical	concave	concave	straight
Slope Shape: Horizontal	concave	concave	concave
Aspect (degrees [direction])	343 (NNW)	321 (NW)	4 (N)
Moisture Regime	mesic	mesic	mesic
Topographic Relative Moisture Index (0 to 60)	42.7	38.8	46.6
SOIL CHEMISTRY AND TEXTURE:			
pH	4.0	3.8	4.1
Calcium (ppm)	126	104	148
Magnesium (ppm)	54	44	64
Iron (ppm)	310	297	322
Manganese (ppm)	4	3	4
Zinc (ppm)	1.9	1.7	2.1
Phosphorus (ppm)	19	16	21
Potassium (ppm)	61	55	67
Aluminum (ppm)	719	295	1143
Copper (ppm)	0.55	0.51	0.58
Boron (ppm)	0.34	0.27	0.40
Sodium (ppm)	11	10	12
Soluble Sulphur (ppm)	37	34	40
% Organic Matter	11.80	7.82	15.77
Total Cation Exchange Capacity	16.97	16.18	17.75
Total Base Saturation (%)	7.53	6.86	8.20
% Clay	3	1	5
% Silt	35	17	53
% Sand	62	42	82

Table 23. Floristic composition of the *Tsuga canadensis – Quercus montana* / *Hamamelis virginiana* Forest community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the two plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 25
Community Type Homoteneity = 0.720

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acer rubrum	5	-	100	3	2	2
Alnus serrulata	3	0	50	5	2	5
Aralia nudicaulis	2	- -	50	5	1	1
Aster divaricatus	2	0	50	2	0	2
Carex digitalis	1	-	50	2	0	1
Carex prasina	2	0	50	6	1	6
Carex sp.	2	+	50	25	6	50
Chimaphila maculata	2	0	100	5	1	5
Cornus florida	2	- -	50	1	0	0
Fagus grandifolia	6	+	100	6	4	12
Fraxinus americana	2	-	50	2	0	1
Gaultheria procumbens	2	+	50	50	11	100
Hamamelis virginiana	5	+	100	18	10	36
Ilex verticillata	2	-	50	5	1	3
Isotria verticillata	2	+	50	7	2	14
Kalmia latifolia	4	- -	100	5	2	1
Liriodendron tulipifera	5	-	100	4	2	2
Medeola virginiana	2	0	50	2	1	2
Mitchella repens	2	+	50	50	11	100
Monotropa hypopithys	1	0	50	10	1	10
Nyssa sylvatica	7	+	100	4	3	7
Osmunda cinnamomea	2	- -	50	5	1	1
Parthenocissus quinquefolia	2	0	50	1	0	1
Pinus strobus	5	+++	50	25	14	200
Poa trivialis	2	+	50	25	6	50
Prunus serotina var. *serotina*	1	-	50	2	0	1
Quercus montana	7	0	100	3	3	3
Quercus rubra var. *rubra*	6	+	100	4	3	8
Rhododendron maximum	7	+++++	50	50	39	1600
Rhododendron periclymenoides	4	+	100	5	2	11
Sassafras albidum	2	-	50	1	0	1
Smilax rotundifolia	2	-	50	1	0	1
Thelypteris noveboracensis	2	- -	50	4	1	1
Toxicodendron radicans ssp. *radicans*	1	-	50	2	0	1
Tsuga canadensis	7	++++	100	100	78	1600

Table 23 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Vaccinium fuscatum	2	-	50	4	1	2
Vaccinium pallidum	2	- - -	50	1	0	0
Viburnum acerifolium	2	0	50	4	1	4
Viola cucullata	2	0	50	4	1	4

Table 24. Woody stem data summary for the *Tsuga canadensis – Quercus montana* / *Hamamelis virginiana* Forest community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for two plots representing the type. Species with IV > 0.95 are listed in descending order of IV.

SPECIES	Tree Density	Large Tree Density	TOTAL DENSITY	RELATIVE DENSITY	BASAL AREA	RELATIVE BASAL AREA	IV
Tsuga canadensis	463	38	500	36.13	15.03	24.04	30.09
Rhododendron maximum	863	0	863	32.55	1.41	3.74	18.15
Quercus montana	38	63	100	5.59	14.72	28.94	17.27
Nyssa sylvatica	150	13	163	7.04	6.20	12.67	9.85
Quercus rubra var. *rubra*	13	38	50	3.25	8.35	12.54	7.89
Liriodendron tulipifera	13	13	25	0.94	3.29	8.72	4.83
Acer rubrum	125	0	125	5.17	1.13	2.98	4.07
Pinus strobus	0	13	13	0.47	2.17	5.74	3.11
Fagus grandifolia	63	0	63	3.72	0.23	0.41	2.07
Hamamelis virginiana	38	0	38	2.78	0.04	0.05	1.42
other species	63	0	63	2.36	0.06	0.16	1.26
TOTALS	**1825**	**175**	**2000**	**100.00**	**52.63**	**100.00**	**100.00**

Table 25. Vertical structure of woody taxa and total stratum cover in two plots of the *Tsuga canadensis – Quercus montana* / *Hamamelis virginiana* Forest community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Acer rubrum	2	4	4		3	
Alnus serrulata		3				
Cornus florida	2					
Fagus grandifolia	2	5		4		
Fraxinus americana	2					
Hamamelis virginiana	2	5				
Ilex verticillata	2					
Kalmia latifolia	3	4				
Liriodendron tulipifera	2				5	
Nyssa sylvatica	2	4	6	5	4	
Parthenocissus quinquefolia	2					
Pinus strobus					5	
Prunus serotina var. *serotina*	1					
Quercus montana	2				7	
Quercus rubra var. *rubra*	2		3		5	
Rhododendron maximum		7				
Rhododendron periclymenoides	2	3				
Sassafras albidum	2					
Smilax rotundifolia		2				
Toxicodendron radicans	1					
Tsuga canadensis	2	5	6	6	5	
Vaccinium fuscatum		2				
Vaccinium pallidum	3	2				
Total Stratum Cover (%):						
Mean: all plots in type	**3**	**70**	**41**	**33**	**80**	
Mean: plots w/cover in stratum	**3**	**70**	**41**	**33**	**80**	

ECOLOGICAL COMMUNITY TYPE 2.4.

Quercus montana – Quercus rubra / Vitis aestivalis var. *bicolor – Parthenocissus quinquefolia / Aralia nudicaulis – Dryopteris marginalis* Forest

Chestnut Oak – Northern Red Oak / Silver-leaf Grape – Virginia Creeper / Wild Sarsaparilla – Marginal Wood Fern Forest
LOW-ELEVATION BOULDERFIELD FOREST / WOODLAND

Habitat and Distribution: The most extensive sites for this community type are west- to north-facing upper slopes below outcrop escarpments of massive, eastward-dipping quartzite. Less extensive occurrences are situated on lower to middle slopes in gaps, where stream incision has exposed and eroded the underlying bedrock. The surface substrate of plot-sampling sites is dominated by rock debris and often some weathered-in-place bedrock. The term “boulderfield” is applied here in a broad sense to include debris mantles that a geologist might strictly classify as talus, scree, block fields, or bouldery / stony colluvium. Exposed boulder cover ranges from 25 to 75% (mean = 45%), while cover of stones and bedrock average 11% and 5% respectively. Lichen cover is often > 50% and usually includes *Umbilicaria mamulata* (smooth rock tripe), *Lasallia papulosa* (common toadskin), *Flavoparmelia baltimorensis* (rock greenshield lichen), and many crustose taxa. Site moisture ranges widely and is difficult to interpret because of variations in rock cover, interstitial soil, cold-air drainage, and subsurface water. Soils extracted, often with great difficulty, from sampling sites are very strongly to extremely acidic (mean pH = 4.5), with relatively high organic matter content and low base status (Table 26). Cold-air drainage is pronounced in a few localities, especially at the base of the High Point Mountain cliffs. This community type is scattered locally throughout the study area, often in linear patches below cliffs and outcrops. Because of their extremely rugged character, boulderfields were never cleared or utilized for agriculture, and one or two were evidently never logged.

Composition and Physiognomy:

Constant Species (constancy ≥ 80%):
Acer rubrum, *Aralia nudicaulis*, *Carya alba*, *Cornus florida*, *Dioscorea quaternata*, *Dryopteris marginalis*, *Maianthemum racemosum* ssp. *racemosum*, *Parthenocissus quinquefolia*, *Prunus serotina* var. *serotina*, *Quercus montana*, *Quercus rubra* var. *rubra*, *Toxicodendron radicans* ssp. *radicans*, *Vaccinium pallidum*, *Vitis aestivalis* var. *bicolor*.

Dominant Species (mean cover ≥ 6):
Quercus montana (8), *Aralia nudicaulis* (7), *Liriodendron tulipifera* (7), *Acer rubrum* (6), *Quercus rubra* var. *rubra* (6).

Diagnostic Species (fidelity = 100%):
Asplenium rhizophyllum, *Bidens bipinnata*, *Clematis ochroleuca*, *Cornus alternifolia*, *Juglans cinerea*, *Phytolacca americana*, *Rubus odoratus* ssp. *odoratus*, *Toxicodendron pubescens*.

Indicator Species (highest unscaled adj. IVs):
Aralia nudicaulis, *Dryopteris marginalis*, *Corylus americana*, *Vitis aestivalis* var. *bicolor*, *Toxicodendron radicans* ssp. *radicans*, *Parthenocissus quinquefolia*, *Asplenium rhizophyllum*, *Juglans cinerea*, *Polypodium virginianum*, *Rubus odoratus* ssp. *odoratus*.

Overstory composition is limited, with *Quercus montana* (chestnut oak; stems up to 108 cm [43 in] dbh) usually the most abundant tree, followed by *Quercus rubra* var. *rubra* (northern red oak; stems up to 75 cm [30 in] dbh) and *Liriodendron tulipifera* (tulip-poplar; stems up to 90 cm [35 in] dbh). One exceptionally mesic sites, *Quercus rubra* var. *rubra* or *Liriodendron* may be the leading dominant. *Carya glabra* (pignut hickory; stems up to 25 cm [10 in] dbh) and *Pinus virginiana* (Virginia pine; stems up to

44 cm [17 in] dbh) are the only other species present in the overstory, each reaching that stratum in a single plot. On most sites, overstory trees have a somewhat gnarled and spreading growth form indicative of older ages and crown damage from ice and wind disturbances. Typical stand structure is an open forest (mean canopy height = 29 m [95 ft]; mean canopy cover = 71%; Table 29) but may vary to woodland stature on the most exposed, xeric sites. Lower woody layers tend to be rather open and contain significant cover from climbing and scrambling woody vines of *Vitis aestivalis* var. *bicolor* (silverleaf grape), *Parthenocissus quinquefolia* (Virginia creeper), and *Toxicodendron radicans* (poison ivy). *Quercus montana*, however, generally contributes the highest cover to every understory stratum. By contrast, little recruitment of *Quercus rubra* var. *rubra* or *Liriodendron tulipifera* was documented in plots or otherwise noted, except in major canopy gaps. Minor understory species include *Acer rubrum* (red maple), *Amelanchier laevis* (smooth serviceberry), *Carya glabra*, *Cornus florida* (flowering dogwood), *Corylus americana* (American hazelnut), *Juglans cinerea* (butternut), *Nyssa sylvatica* (black gum), and *Sassafras albidum* (sassafras).

Considerable variation in herb-layer cover (range = 15 to 90%) and composition corresponds to variations in surface substrate, moisture, and site protection. Woody seedlings and vines are common herb-layer components, and species richness is somewhat limited by high rock cover, regardless of microhabitat conditions. *Dryopteris marginalis* (marginal wood fern) is one of the more characteristic herbaceous species, adaptable to both rock crevices and rocky interstitial soils. *Aralia nudicaulis* (wild sarsaparilla) is also characteristic and tends to form large clones (up to ca. 1.0 ha in extent) on finer bouldery and stony colluvium with well-developed soils. The lithophytic fern *Polypodium virginianum* (rock polypody) dominates in one plot (BRM037, Jackson Hollow). Many other herbs occur inconstantly and with low cover. Localized areas on the lower, more protected parts of the boulderfields support surprisingly lush vegetation that may include colonies of *Asimina triloba* (paw-paw) and robust patches of mesophytic herbs such as *Arisaema triphyllum* (jack-in-the-pulpit), *Cimicifuga racemosa* (black bugbane), *Circaea lutetiana* ssp. *canadensis* (enchanter's nightshade), and *Dryopteris carthusiana* (spinulose wood fern). The conditions that allow such lush patches to develop in what appear to be rather harsh environments are not clearly understood, but may include the enhancement of soil fertility and moisture-holding capacity by colluvial processes, reduced air temperature, and insulating rock cover. The near immunity of boulderfields to deer grazing may also be a contributing factor (Abrams *et al*. 1998).

Distinguishing Features: The Low-Elevation Boulderfield Forest / Woodland occupies environmentally distinct sites with surface substrates dominated by boulders, stones, and outcrops. Compositionally, it is variable but differs from similar forest communities by its lower species richness, a limited overstory composed mostly of three tree species, an abundance of scrambling and climbing woody vines in the understory, and the prevalence of rock-loving herbaceous species and locally extensive clones of *Aralia nudicaulis*. It usually occurs in small or linear patches, its distribution controlled by the presence of large rock outcrops and associated rubble. Boundaries with co-occurring community types may be either sharp or gradual, varying with local topographic gradients.

Global Conservation Rank: G?

State Conservation Rank: S?

Synonymy: USNVC: no equivalent. *Quercus rubra – Quercus prinus* / *Parthenocissus quinquefolia* / *Aralia nudicaulis – Dryopteris marginalis* Forest (Fleming 2002). SAF Cover Type 44: Chestnut Oak: chestnut oak – northern red oak variant, *pro parte*.

Comments: Old wood debris and persistent root sprouts in three plots indicate that *Castanea dentata* (American chestnut) was once a component of this community, although perhaps not a particularly abundant one. Other evidence of disturbance recorded from sampling sites included fire scars in two plots, very minor exotic plant populations in two plots, minor gypsy moth defoliation in one plot, and mortality from dogwood anthracnose in one plot. Because of rugged, inaccessible terrain and the poor growth form of trees, some of these sites appear to have escaped logging. The ecological dynamics of boulderfield vegetation are not well understood and may vary considerably with bedrock chemistry, size and depth of surface substrate, elevation, and aspect. Because of exposure and/or loose substrates, boulderfield forests may be particularly susceptible to blow-downs and crown damage from wind and ice storms. Abrams *et al*. (1998) found that, because of such frequent small-scale disturbances, *Quercus rubra* was unusually competitive with the far more tolerant *Acer saccharum* (sugar maple) and *Tilia americana* (American basswood) on a fertile, high-elevation boulderfield in Pendleton County, West Virginia. On two comparatively xeric, old-growth *Quercus montana*-dominated boulderfields in Pennsylvania, oak recruitment has decreased and potential successors such as *Acer rubrum*, *Betula alleghaniensis* (yellow birch), *Betula lenta* (sweet birch), and *Nyssa sylvatica* have increased during the 20th century, consistent with a general trend of oak decline in the Appalachians (Mikan *et al.* 1994, Ruffner and Abrams 1998). However, the replacement of *Quercus montana* by more mesophytic successors may be slowed considerably on some sites by droughty rock substrates and the continuing possibility of fires (Ruffner and Abrams 1998). On the other hand, Abrams *et al*. (1997) documented continuous recruitment and little sign of successional advance in a 300-year old *Quercus montana* talus slope community in the Virginia Blue Ridge.

Acer rubrum is the only shade-tolerant mesophyte that has become established with any significant density in the boulderfield forests of the Bull Run Mountains. This species is not present in the overstory of any sampled stand, nor does it produce large numbers of stems except in the deeper-soiled peripheries of these habitats. At present, *Quercus montana* has a far greater density of stems < 40 cm dbh and outnumbers *Acer rubrum* in the pole-sized and sub-canopy classes in most stands. *Quercus montana* was probably the main beneficiary of canopy gaps caused by the death of *Castanea dentata* 80 years ago, and currently appears to be more aggressive than *Acer rubrum* in filling small gaps. The potential continued recruitment and dominance of *Quercus montana* is probably enhanced by the absence of *Betula lenta* from these habitats. This birch is usually an abundant tree on low- to middle-elevation boulderfields in western Virginia, and has an uncanny ability to establish itself in deep interstices or directly on large-block boulders of the most rigorous boulderfields (Fleming and Coulling 2001; Fleming and Moorhead 2000). Its absence from these habitats in the Bull Run Mountains is somewhat of a mystery, since scattered populations occur in other habitats of the study area.

The inventory and classification of boulderfield forests in Virginia is incomplete. Several community types, none of them with clear affinities to the vegetation described here, were defined by Fleming and Coulling (2001). The *Quercus montana – Quercus rubra* / *Vitis aestivalis* var. *bicolor – Parthenocissus quinquefolia* / *Aralia nudicaulis – Dryopteris marginalis* Forest of the Bull Run Mountains appears to be comparable to vegetation sampled in the Watery Mountains, a metabasalt foothill located approximately 12 km (7.5 mi) SW of the study area in Fauquier County (Fleming 2002). It is likely that this vegetation also occurs on the northern Blue Ridge proper, and more field investigation and sampling of boulderfield habitats is needed. The animal life of boulderfield forests is worthy of investigation as certain groups, particularly invertebrates, may have special adaptations to these unusual environments. Crevices of wooded outcrops and block fields at several locations in the Bull Run Mountains serve as hibernacula for isolated Piedmont populations of the timber rattlesnake (*Crotalus horridus horridus*).

Representative Plots and Examples: This unit is represented by five plot samples: BRM037, 041, 043, 061, and 070. Two outstanding occurrences have been identified: an old-age stand that stretches for approximately 0.5 km (0.3 mi) along the base of the cliffs at the summit of High Point Mountain; and a somewhat interrupted occurrence on the western slope of the Pond Mountains from Thoroughfare Gap south to the south flank of a water gap on property of the Arlington Outdoor Education Association. Another small but interesting example occurs on the middle ridge, just south of Jackson Hollow and just east of Rt. 629 (Plates 2 and 14). The High Point Mountain occurrence contains specimens of *Quercus montana* and *Quercus rubra* var. *rubra* up to 108 cm (43 in) dbh and *Liriodendron tulipifera* up to 90 cm

(35 in) dbh. Although all of the larger trees had heart rot and could not be fully aged, extrapolation of increment cores from *Quercus montana* indicated ages > 200 years and possibly much older.

Table 26. Environmental information summary for five plots of the *Quercus montana – Quercus rubra* / *Vitis aestivalis* var. *bicolor – Parthenocissus quinquefolia* / *Aralia nudicaulis – Dryopteris marginalis* Forest community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	**MEAN**	**MIN**	**MAX**
Elevation (m / ft)	271 / 890	186 / 610	354 / 1160
Topographic Position	upper slope	lower slope	crest
Relative Slope Position (0 to 1)	0.78	0.22	1.00
SURFACE SUBSTRATE COVER (%):			
Wood	2	0	4
Bedrock	5	0	25
Boulders	45	25	75
Stones	11	0	30
Cobbles	0	0	0
Gravel	0	0	0
Mineral Soil	0	0	0
Organic Matter	37	20	50
Water	0	0	0
Bryophytes and Lichens	50	35	70
Slope (degrees)	18	3	30
Slope Shape: Vertical	straight	straight	convex
Slope Shape: Horizontal	straight	concave	convex
Aspect (degrees [direction])	355 (N)	135 (SE)	24 (NNE)
Moisture Regime	submesic	xeric	mesic
Topographic Relative Moisture Index (0 to 60)	23.9	12.6	47.0
SOIL CHEMISTRY AND TEXTURE:			
pH	4.5	4.1	5.2
Calcium (ppm)	358	178	573
Magnesium (ppm)	76	57	119
Iron (ppm)	261	125	426
Manganese (ppm)	97	47	166
Zinc (ppm)	4.01	2.32	6.29
Phosphorus (ppm)	107	34	339
Potassium (ppm)	71	48	97
Aluminum (ppm)	1155	807	1742
Copper (ppm)	0.98	0.83	1.09
Boron (ppm)	0.39	0.29	0.49
Sodium (ppm)	12	10	13
Soluble Sulphur (ppm)	48	39	70
% Organic Matter	11.45	8.71	16.70
Total Cation Exchange Capacity	15.53	11.23	20.86
Total Base Saturation (%)	17.86	10.76	31.65
% Clay	1	1	2
% Silt	28	17	35
% Sand	71	64	82

Table 27. Floristic composition of the *Quercus montana* – *Quercus rubra* / *Vitis aestivalis* var. *bicolor* – *Parthenocissus quinquefolia* / *Aralia nudicaulis* – *Dryopteris marginalis* Forest community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the five plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 33
Community Type Homoteneity = 0.685

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acer rubrum	6	0	100	8	5	8
Amelanchier arborea var. *arborea*	2	0	20	1	0	1
Amelanchier laevis	3	+	20	4	1	8
Aralia nudicaulis	7	+++	80	29	23	233
Arisaema triphyllum	2	-	40	3	1	2
Asimina triloba	3	-	40	5	2	3
Asplenium platyneuron	2	+	60	18	4	36
Asplenium rhizophyllum	2	+	20	20	4	40
Aster divaricatus	2	0	20	1	0	1
Bidens bipinnata	2	+	20	20	4	40
Carex blanda	2	+	20	4	1	8
Carex digitalis	2	0	40	3	1	3
Carex tonsa	2	+	40	11	3	23
Carya alba	4	0	80	11	5	11
Carya cordiformis	2	0	20	4	1	4
Carya glabra	4	0	60	8	3	8
Carya ovalis	2	- -	20	1	0	0
Castanea dentata	2	0	40	5	1	5
Cercis canadensis var. *canadensis*	2	0	20	3	1	3
Chimaphila maculata	2	0	60	4	1	4
Cimicifuga racemosa	2	-	20	1	0	1
Circaea lutetiana ssp. *canadensis*	3	+	40	3	1	7
Clematis ochroleuca	1	0	20	20	2	20
Cornus alternifolia	2	+	20	20	4	40
Cornus florida	4	0	80	9	4	9
Corylus americana	2	+	60	36	8	72
Danthonia spicata	2	0	20	2	0	2
Desmodium nudiflorum	2	0	60	6	1	6
Dichanthelium dichotomum	2	0	20	1	0	1
Dioscorea quaternata	2	0	100	14	3	14
Diospyros virginiana	2	0	40	5	1	5
Dryopteris marginalis	3	+	80	64	21	128
Erechtites hieraciifolia var. *hieraciifolia*	2	+	20	7	1	13
Fraxinus americana	2	-	40	2	1	1
Galium circaezans	2	0	20	1	0	1
Gaylussacia baccata	3	- -	60	6	2	2
Heuchera americana	2	+	20	10	2	20
Houstonia purpurea var. *purpurea*	2	0	20	1	0	1

Table 27 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Hydrangea arborescens	2	0	40	7	1	7
Impatiens capensis	2	0	20	2	0	2
Juglans cinerea	3	+	20	20	7	40
Kalmia latifolia	4	- -	60	5	2	1
Lindera benzoin	2	- -	40	3	1	1
Liriodendron tulipifera	7	+	60	4	3	7
Lonicera japonica	2	0	20	2	0	2
Maianthemum racemosum ssp. *racemosum*	2	0	80	8	2	8
Medeola virginiana	2	0	20	1	0	1
Microstegium vimineum	2	0	20	1	0	1
Monotropa uniflora	2	0	20	1	0	1
Nyssa sylvatica	3	- - -	60	3	1	0
Parthenocissus quinquefolia	4	++	100	12	5	48
Phryma leptostachya	1	0	20	2	0	2
Phytolacca americana	2	+	20	20	4	40
Pinus virginiana	4	+	20	1	0	2
Polygonatum biflorum var. *biflorum*	2	0	60	7	2	7
Polypodium virginianum	5	+++	20	5	3	40
Prunus avium	2	+	20	5	1	10
Prunus serotina var. *serotina*	2	0	80	11	2	11
Quercus montana	8	+	100	8	8	17
Quercus rubra var. *rubra*	6	+	100	10	7	20
Quercus velutina	2	- -	60	4	1	1
Rhododendron periclymenoides	2	-	60	5	1	2
Rubus allegheniensis var. *allegheniensis*	2	+	20	7	1	13
Rubus odoratus ssp. *odoratus*	2	+	20	20	4	40
Rubus phoenicolasius	2	0	40	6	1	6
Sanicula canadensis	1	-	20	1	0	1
Sassafras albidum	4	+	60	4	2	8
Scirpus verecundus	2	+	20	10	2	20
Smilax rotundifolia	2	-	40	2	0	1
Solidago caesia	2	0	20	1	0	1
Stellaria pubera	2	+	20	3	1	6
Symphoricarpos orbiculatus	1	0	20	3	0	3
Toxicodendron pubescens	2	+	20	20	4	40
Toxicodendron radicans ssp. *radicans*	4	++	80	13	6	51
Ulmus rubra	2	0	20	2	0	2
Vaccinium pallidum	4	-	80	6	3	3
Vaccinium stamineum	3	+	40	3	1	6
Viburnum prunifolium	3	+	20	2	1	4
Vitis aestivalis var. *bicolor*	3	+	100	33	11	67
Vitis vulpina	2	0	20	1	0	1

Table 28. Woody stem data summary for the *Quercus montana – Quercus rubra* / *Vitis aestivalis* var. *bicolor – Parthenocissus quinquefolia* / *Aralia nudicaulis – Dryopteris marginalis* Forest community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for five plots representing the type. Species are listed in descending order of IV.

SPECIES	Tree Density	Large Tree Density	TOTAL DENSITY	RELATIVE DENSITY	BASAL AREA	RELATIVE BASAL AREA	IV
Quercus montana	225	45	270	29.01	22.10	51.03	40.02
Liriodendron tulipifera	20	35	55	7.15	13.39	22.06	14.61
Quercus rubra var. *rubra*	35	25	60	6.58	10.54	18.99	12.78
Acer rubrum	165	0	165	20.39	1.17	2.03	11.21
Sassafras albidum	55	0	55	6.22	0.08	0.20	3.21
Kalmia latifolia	50	0	50	5.92	0.05	0.12	3.02
Amelanchier laevis	35	0	35	4.67	0.08	0.33	2.50
Pinus virginiana	5	5	10	1.33	0.78	3.27	2.30
Carya glabra	25	0	25	3.51	0.50	1.01	2.26
Cornus florida	35	0	35	4.19	0.05	0.11	2.15
Carya alba	35	0	35	3.76	0.06	0.19	1.97
Viburnum prunifolium	15	0	15	1.94	0.07	0.20	1.07
other species	60	0	60	5.35	0.30	0.46	2.90
TOTALS	**760**	**110**	**870**	**100.00**	**49.18**	**100.00**	**100.00**

Table 29. Vertical structure of woody taxa and total stratum cover in five plots of the *Quercus montana – Quercus rubra* / *Vitis aestivalis* var. *bicolor – Parthenocissus quinquefolia* / *Aralia nudicaulis – Dryopteris marginalis* Forest community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Acer rubrum	2	4	5	5		
Amelanchier arborea		2				
Amelanchier laevis		2	2			
Asimina triloba	2	2				
Carya alba		3	2			
Carya cordiformis	2					
Carya glabra	2	2	2	2		3
Carya ovalis		2	2			
Castanea dentata	2	2				
Cercis canadensis var. *canadensis*	2	2				
Cornus alternifolia		2				
Cornus florida	2	4				
Corylus americana	2	2				
Diospyros virginiana	2	2				
Fraxinus americana	2	2				
Gaylussacia baccata	2	3				
Hydrangea arborescens	2					
Juglans cinerea			3			
Kalmia latifolia	2	4				
Lindera benzoin	2	2				
Liriodendron tulipifera	2			2	6	5
Lonicera japonica	2					
Nyssa sylvatica	2	2	3	2		
Parthenocissus quinquefolia	4	2	2			
Pinus virginiana		2		3		
Prunus avium	2	2	2			
Prunus serotina var. *serotina*	2	2				
Quercus montana	4	4	6	6	7	
Quercus rubra var. *rubra*	2	2	2	3	6	6
Quercus velutina	2	2				
Rhododendron periclymenoides	2	2				
Rubus allegheniensis var. *allegheniensis*		2				
Rubus odoratus var. *odoratus*		2				
Rubus phoenicolasius	2	2				
Sassafras albidum	2	3	2			
Smilax rotundifolia	2					
Symphoricarpos orbiculatus	1					
Toxicodendron pubescens	2					

Table 29 – continued

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Toxicodendron radicans	3	3				
Ulmus rubra	2					
Vaccinium pallidum	4	2				
Vaccinium stamineum	2	2				
Viburnum prunifolium		2	2			
Vitis aestivalis var. *bicolor*	2	3		2	2	
Vitis vulpina	2					
Total Stratum Cover (%):						
Mean: all plots in type	**48**	**26**	**26**	**26**	**57**	**18**
Mean: plots w/cover in stratum	**48**	**26**	**26**	**26**	**71**	**30**

VEGETATION CLASS 3

BASIC RAVINE AND SLOPE FORESTS

Plots of this vegetation class occupy mesic to subxeric sites with relatively fertile soils. Mean levels of soil Ca, Mg, Mn, P, K, pH, and total base saturation for the class are much higher than average for the overall dataset; mean levels of extractable Fe are much lower than average. These values indicate an association with soils enriched by colluvial processes or weathered in residuum from the flaggy quartzite / muscovite schist / phyllite lithologic suite. It is also possible that soils in a few plots are influenced by base-rich metabasalt of the Catoctin Formation, which underlies part of the western slope but is usually well covered by quartzite colluvium. Members of this class cover substantial area in the Bull Run Mountains, forming medium to large patches.

Basic Ravine and Slope Forests can usually be recognized by the prevalence of nutrient-demanding plants that are to some extent restricted to soils with higher base status. The absence or low importance of species strongly associated with oligotrophic substrates is also diagnostic. Some exemplary nutrient-demanding species in the Bull Run Mountains are *Adiantum pedatum* (maidenhair fern), *Amphicarpaea bracteata* (hog-peanut), *Asarum canadense* (wild ginger), *Asimina triloba* (paw-paw), *Cercis canadensis* var. *canadensis* (eastern redbud), *Cimicifuga racemosa* (black bugbane), *Cypripedium parviflorum* var. *pubescens* (yellow lady's-slipper), *Desmodium glutinosum* (pointed-leaf tick-trefoil), *Galearis spectabilis* (showy orchid), *Lindera benzoin* (spicebush), and *Ulmus rubra* (slippery elm). The abundance and importance of *Carya* spp. (hickories) in dry-mesic Piedmont forests has also been positively correlated with high pH, Ca, and Mg concentrations in soils (Farrell and Ware 1991, Ware 1992, DCR-DNH unpublished data). Species that are characteristic of oligotrophic substrates in the area and rarely, if ever, found in basic-soil habitats include *Cypripedium acaule* (pink lady's-slipper), *Gaylussacia baccata* (black huckleberry), *Kalmia latifolia* (mountain-laurel), *Pinus rigida* (pitch pine), *Pteridium aquilinum* var. *latiusculum* (northern bracken fern), and *Quercus coccinea* (scarlet oak).

Based on cluster analysis and summary statistical analysis, two community types are recognized:

- BASIC MESIC FOREST
  Liriodendron tulipifera – Quercus rubra / *Asimina triloba* / *Lindera benzoin* / *Amphicarpaea bracteata* – (*Adiantum pedatum*) Forest
  Tulip-poplar – Northern Red Oak / Paw-paw / Spicebush / Hog-peanut – (Maidenhair Fern) Forest

- BASIC OAK – HICKORY FOREST
  Quercus montana – Quercus rubra – Carya ovalis / *Desmodium nudiflorum – Dichanthelium boscii* Forest
  Chestnut Oak – Northern Red Oak – Red Hickory / Naked-flowered Tick-trefoil – Bosc's Panic Grass Forest

These community types are clearly segregated by topography, site moisture and soil fertility (Fig. 14). Plots of the Basic Mesic Forest (3.1) occupy relatively moist (high TRMI), lower slopes that tend to have concave curvature (Slshape) and more fertile soils indicated by vectors for high Mg, B, K, Ca, Cu, pH, and total base saturation. The Basic Oak-Hickory Forest (3.2) generally occurs on drier, less fertile, middle to upper slopes (high Relslope) that have greater solar exposure and convex curvature, especially in the vertical plane. Soils extracted from stands of Basic Oak-Hickory Forest also have significantly higher Al, S, and organic matter content than soils of the Basic Mesic Forest.

The results of cluster analysis indicate two segregates within the Basic Oak-Hickory Forest, and these are tentatively recognized as community subtypes. A two-dimensional ordination of plots constituting this type suggests that environmental gradients associated with the subtypes are complex (Fig. 15). It appears that the first subtype (1) is most closely associated with planar middle slopes with higher cover of rock substrates (bedrock, boulders, stones) and exposed mineral soil, whereas the second subtype (2) occurs on convex upper slopes and crests (high Relslope) with nearly complete duff cover (mean = 89%). It should be noted, however, that the small number of samples in this group lessens the significance level of correlations (see p. 35) and makes statements about the strength and importance of environmental gradients tenuous.

Because of their productivity, many sites now supporting forests of this vegetation class were probably cleared and utilized for agriculture in the 18th and 19th centuries. They are also the area's most favorable sites for timber growth. Those sites that were not cleared were logged, in some cases repeatedly. *Castanea dentata* (American chestnut) may have reached optimal importance on the dry-mesic sites now occupied by Basic Oak – Hickory Forest, and its elimination from the overstory caused major compositional shifts in the forest. Despite these setbacks, however, many Basic Ravine and Slope Forests have recovered to a mid or late successional stage following a peak in various disturbance regimes early in the 20th century. Further changes, however, are now underway in response to a new set of disturbances, including dramatic increases in exotic plant populations, selective grazing by large herbivore populations, and the advent of exotic insect and fungal pathogens such as *Lymantria dispar* (gypsy moth) and *Discula destructive* (dogwood anthracnose). The specific dynamics and manifestations of these changes will be examined in the community type descriptions that follow.

Basic Ravine and Slope Forests are probably utilized by a larger number of animal species than other vegetation classes because of their structural and floristic diversity. White-tailed deer (*Odocoileus virginianus*) appear to greatly favor these forb-rich, open forests compared to the more extensive, densely shrubby, and floristically poor Xeric Oak and Pine Forests. Populations of terrestrial salamanders that are sensitive to low soil moisture, *e.g.*, the red-backed salamander (*Plethodon cinereus*), would also be expected to reach maximum levels in the ground layer of these communities. The Basic Oak-Hickory Forest probably represents the optimal habitat for mast consumers such as the wild turkey (*Meleagris gallopavo*) and gray squirrel (*Sciurus carolinensis*).

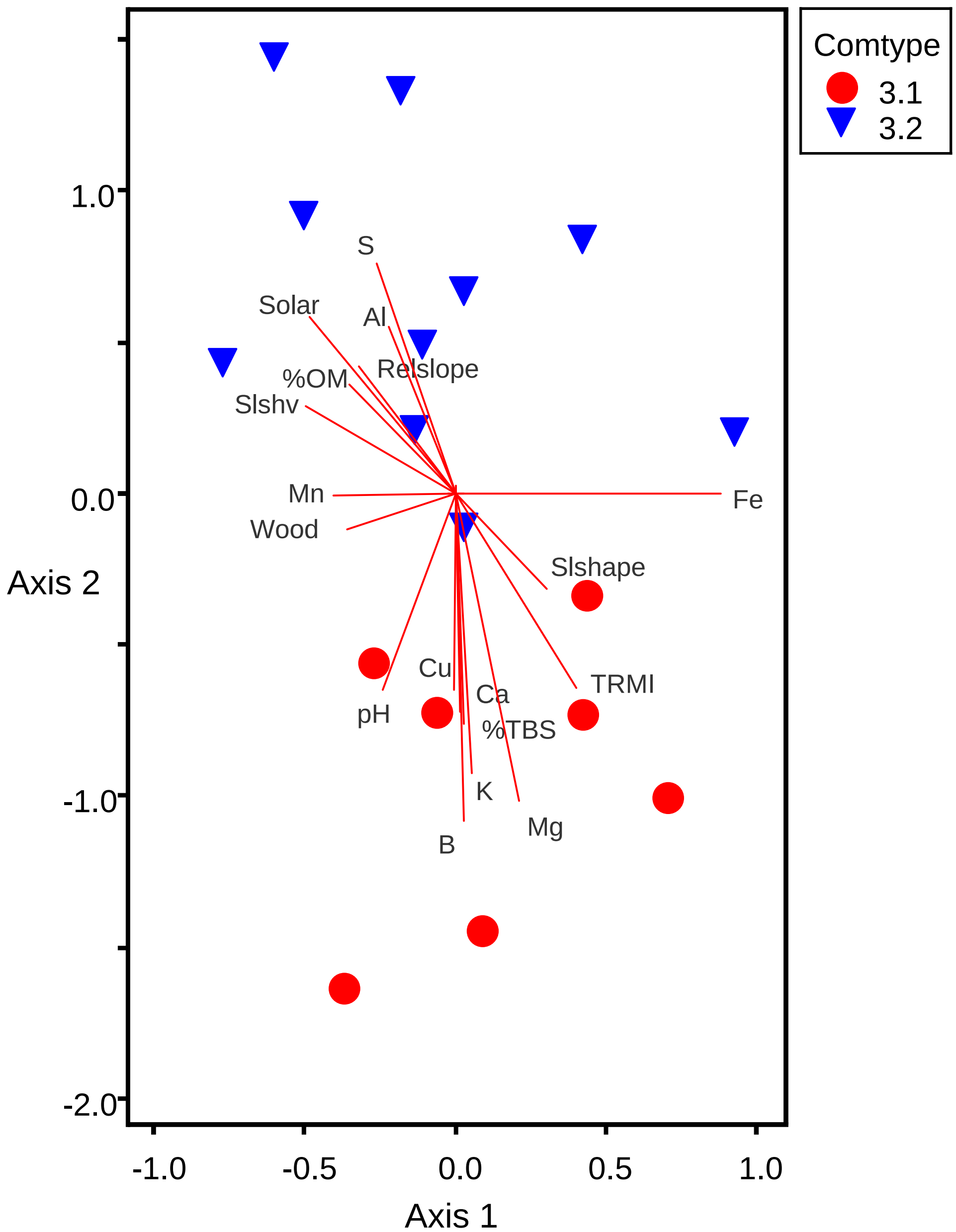


Figure 14. Scatterplot diagram for two-dimensional NMDS ordination of the BASIC RAVINE AND SLOPE FORESTS vegetation class, showing the distribution of two community types: 3.1 – Basic Mesic Forest, 3.2 – Basic Oak-Hickory Forest. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients ($p = <0.100$). Relslope = relative slope position; high values indicate higher topographic positions. Slshape = slope shape index; high values indicate concave slopes. Slshv = vertical slope shape; positive values correspond to convex slopes. Solar = solar radiation index; high values indicate greater potential solar exposure. TRMI = topographic relative moisture index; high values indicate greater site moisture potential. Wood = decaying wood surface cover. See pp. 20-21 for full names of soil chemistry variables.

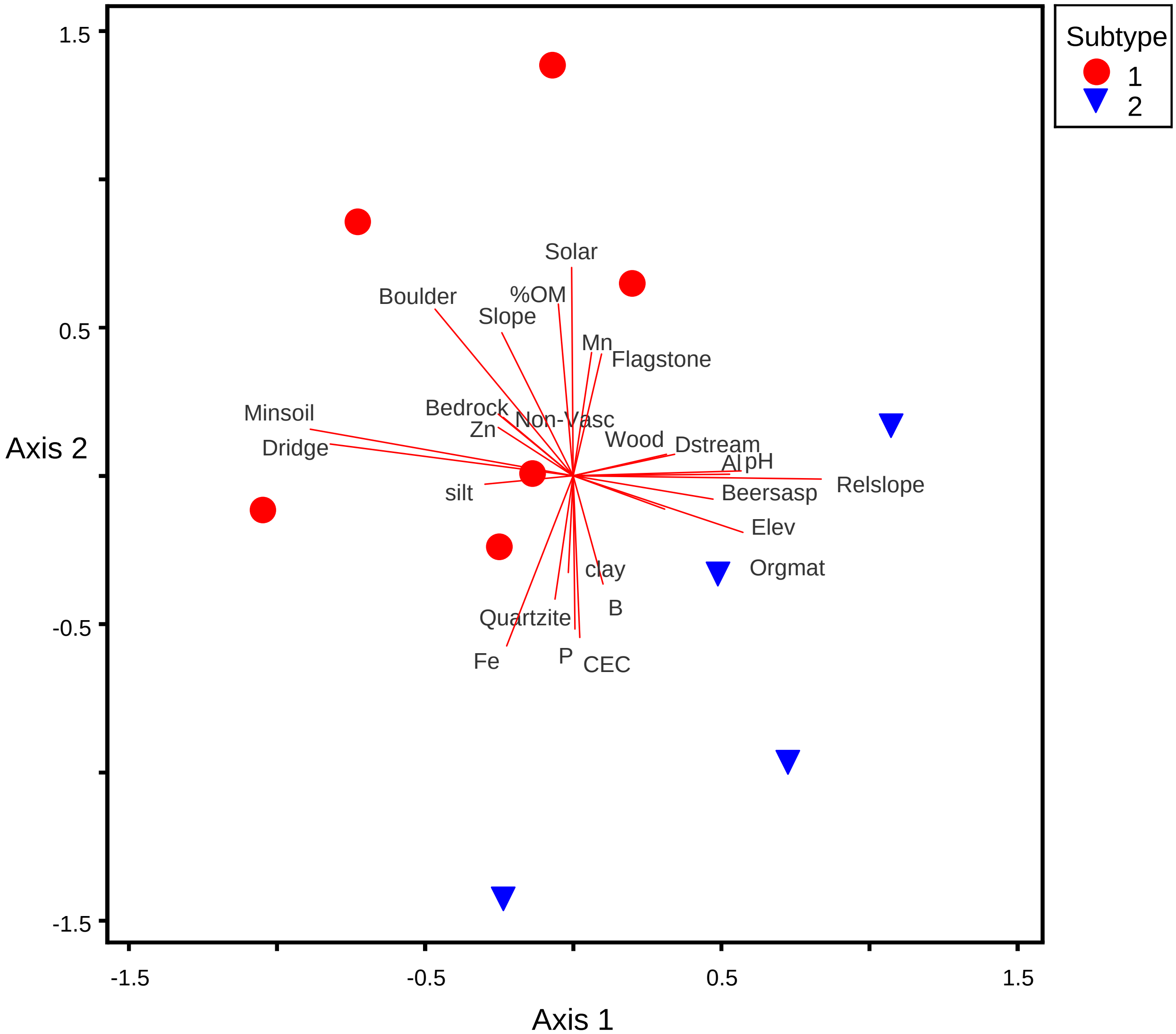


Figure 15. Scatterplot diagram for two-dimensional NMDS ordination of 10 stands of the BASIC OAK-HICKORY FOREST community type, showing the distribution of two community subtypes: 1 – *Quercus rubra – Quercus montana / Solidago ulmifolia – Carex pensylvanica* Subtype, 2 – *Quercus montana – Liriodendron tulipifera / Cimicifuga racemosa – Galium latifolium* Subtype. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients (p = <0.200). Bedrock = exposed bedrock surface cover. Beersasp = Beers-transformed aspect; northeastern aspects have the highest values, southwestern aspects have the lowest values. Boulder = exposed boulder surface cover. Clay = % clay in mineral soil. Dridge = distance to nearest ridge top. Dstream = distance to nearest stream. Elev = elevation. Flagstone = surface rocks predominantly flaggy quartzite, schist, or phyllite. Minsoil = exposed mineral soil surface cover. Non-Vasc = bryophyte/lichen surface cover. Orgmat = organic matter surface cover. Quartzite = surface rocks predominantly massive thick-bedded quartzite. Relslope = relative slope position; high values indicate higher topographic positions. Silt = % silt in mineral soil. Slope = slope inclination. Solar = solar radiation index; high values indicate greater potential solar exposure. Wood = decaying wood surface cover. %OM = % organic matter in soil (loss on ignition). See pp. 20-21 for full names of soil chemistry variables.

Plate 15. **Basic Mesic Forest** in ravine on the middle ridge, north of Hopewell Gap (plot BRM004). *Adiantum pedatum* (maidenhair fern) and *Deparia acrostichoides* (silvery spleenwort) are dominant herbs in the foreground. Photo: Gary P. Fleming, DCR-DNH.

Plate 16. **Basic Oak – Hickory Forest** on the east ridge, S of Hopewell Gap (plot BRM028). The open understory and patchy but diverse herb layer are typical of this community type. Michael Kieffer is collecting soil samples in background. Photo: Gary P. Fleming, DCR-DNH.

ECOLOGICAL COMMUNITY TYPE 3.1.

***Liriodendron tulipifera* – *Quercus rubra* / *Asimina triloba* / *Lindera benzoin* / *Amphicarpaea bracteata* – (*Adiantum pedatum*) Forest**

Tulip-poplar – Northern Red Oak / Paw-paw / Spicebush / Hog-peanut – (Maidenhair Fern) Forest
BASIC MESIC FOREST

Habitat and Distribution: This community type occupies fertile, well-drained soils of mesic lower slopes and ravines. Slopes vary from moderate to steep (range = 7 to 22˚) and are typically straight or concave. The surface substrate rarely has more than 10% exposed boulder and stone cover, or less than 90% cover of leaf litter and other humic material. However, plots BRM008 and BRM063 are representative of a stands occurring on well-weathered "boulder streams" that have been deposited in low-elevation ravine bottoms and slope concavities. Soils at most sampling sites are deep, dark loams or sandy loams of colluvial origin. Samples had the highest mean pH, Ca, Mg, Mn, K, Cu, B, and total base saturation, along with the lowest mean Fe levels, among classified types (Tables 9 and 30). Basic Mesic Forests are scattered in small to large patches throughout the study area. Sites now supporting this community are some of the most productive in the Bull Run Mountains, and most were cleared or cut over in the past. Sampling sites that have recovered from agricultural uses were abandoned at least 100 years ago, and some may have been among the many Virginia fields abandoned during the Civil War.

Composition and Physiognomy:

<u>Constant Species (constancy ≥ 80%):</u>
Amphicarpaea bracteata, *Arisaema triphyllum*, *Asimina triloba*, *Botrychium virginianum*, *Cimicifuga racemosa*, *Circaea lutetiana* ssp. *canadensis*, *Cornus florida*, *Fraxinus americana*, *Galium circaezans*, *Galium triflorum*, *Lindera benzoin*, *Liriodendron tulipifera*, *Maianthemum racemosum* ssp. *racemosum*, *Parthenocissus quinquefolia*, *Phryma leptostachya*, *Quercus rubra* var. *rubra*, *Sanicula canadensis*, *Toxicodendron radicans* ssp. *radicans*, *Uvularia perfoliata*.

<u>Dominant Species (mean cover ≥ 6):</u>
Liriodendron tulipifera (8), *Amphicarpaea bracteata* (7), *Asimina triloba* (6), *Cornus florida* (6), *Lindera benzoin* (6), *Quercus rubra* var. *rubra* (6).

<u>Diagnostic Species (fidelity = 100%):</u>
Agrimonia pubescens, *Angelica venenosa*, *Asarum canadense*, *Carex nigromarginata*, *Carex retroflexa*, *Carex sparganioides*, *Cypripedium parviflorum* var. *pubescens*, *Cystopteris protrusa*, *Galium aparine*, *Hackelia virginiana*, *Hydrophyllum virginianum*, *Menispermum canadense*, *Morus rubra*, *Obolaria virginica*, *Ostrya virginiana*, *Sisyrinchium angustifolium*, *Smilax tamnoides*, *Staphylea trifolia*, *Viola pubescens*.

<u>Indicator Species (highest unscaled adj. IVs):</u>
Adiantum pedatum, *Staphylea trifolia*, *Amphicarpaea bracteata*, *Asimina triloba*, *Phegopteris hexagonoptera*, *Phryma leptostachya*, *Lindera benzoin*, *Carya cordiformis*, *Ulmus rubra*.

The overstory of most stands is dominated by tall, straight *Liriodendron tulipifera* (tulip-poplar; stems up to 98 cm [39 in] dbh). Mean canopy height is 38 m (125 ft) and mean canopy cover is 79% in plot-sampled stands. *Quercus rubra* var. *rubra* (northern red oak; stems up to 94 cm [37 in] dbh) is present in most stands but rarely co-dominant. Less frequent overstory associates include *Quercus alba* (white oak; stems up to 64 cm [25 in] dbh), *Carya ovalis* (red hickory; stems up to 56 cm [22 in] dbh), and *Fraxinus americana* (white ash; stems up to 57 cm [22 in] dbh). Sub-canopy tree layers contain representatives of the overstory species and *Acer rubrum* (red maple), *Carya alba* (mockernut hickory), *Carya cordiformis* (bitternut hickory), *Nyssa sylvatica* (black gum), *Quercus montana* (chestnut oak), and *Ulmus rubra* (slippery elm). The lowest tree and shrub layers usually contain small to large colonies of *Asimina triloba* (paw-paw) and *Lindera benzoin* (spicebush), along with *Cercis canadensis* var. *canadensis* (eastern redbud) and *Cornus florida* (flowering dogwood). The shrub layer of one plot (BRM063) is heavily dominated (> 50% cover) by *Staphylea trifolia* (bladdernut), a species of very local distribution in the study area. The typical stand structure of this community type consists of a tall, closed overstory, with very open understory tree layers, and a variably dense shrub layer (Table 33).

The herb layer is usually lush and dense, except where boulder streams prevail or deer grazing is severe. Patch-dominance of ferns and leafy forbs is characteristic; species achieving local abundance in the type include *Adiantum pedatum* (maidenhair fern), *Amphicarpaea bracteata* (hog-peanut), *Arisaema triphyllum* (jack-in-the-pulpit), *Asarum canadense* (wild ginger), *Cimicifuga racemosa* (black bugbane), *Deparia acrostichoides* (silvery spleenwort), *Phegopteris hexagonoptera* (broad beech fern), *Polystichum acrostichoides* (Christmas fern), and *Uvularia perfoliata* (perfoliate bellwort). Other constant but low-cover herbs are *Botrychium virginianum* (rattlesnake fern), *Circaea lutetiana* ssp. *canadensis* (enchanter's nightshade), *Collinsonia canadensis* (horse-balm), *Galium circaezans* (licorice bedstraw), *Galium triflorum* (sweet-scented bedstraw), and *Phryma leptostachya* (lopseed). Less constant herbaceous species that are not often found in other community types of the study area and thus might be considered diagnostic of Basic Mesic Forest include *Cypripedium parviflorum* var. *pubescens* (yellow ladyslipper), *Cystopteris protrusa* (lowland brittle fern), *Galearis spectabilis* (showy orchid), *Hydrophyllum virginianum* (Virginia waterleaf), *Obolaria virginica* (pennywort), *Osmunda claytoniana* (interrupted fern), and *Viola pubescens* (downy yellow violet). Many additional herbs occur at low cover and constancy in plots (Table 31).

Distinguishing Features: The Basic Mesic Forest is distinguished by its fertile, mesic, lower-slope sites, overstory dominance by *Liriodendron tulipifera*, shrub layer dominance by *Asimina triloba* and/or *Lindera benzoin*, and lush herb layer featuring patch-dominance by nutrient-demanding ferns and leafy forbs. Sites occupied by this community are topographically similar to those of the Mesic Mixed Hardwood Forest, which is associated with infertile soils and has *Fagus grandifolia* (American beech) as a major overstory component. *Fagus* is absent or unimportant in the Basic Mesic Forest, and the two community types usually occupy discrete niches in the landscape. Nevertheless, stands with intermediate composition can sometimes occur on sites with intermediate soil fertility. With increasing slope position and decreasing moisture, stands of Basic Mesic Forest frequently grade into the Basic Oak-Hickory Forest community type, which can be distinguished by its greater abundance of overstory oaks (particularly *Quercus montana*) and hickories and its patchy but diverse herb layer containing both mesophytic and xerophytic species.

Global Conservation Rank: G?

State Conservation Rank: S4

Synonymy: USNVC: no equivalent. *Liriodendron tulipifera – Quercus rubra* / *Asimina triloba* / *Arisaema triphyllum – Cimicifuga racemosa* Forest (Fleming 2002). SAF Cover Type 57: Yellow-Poplar, *pro parte*. SAF Cover Type 59: Yellow-Poplar – White Oak – Northern Red Oak, *pro parte*.

Comments: Most likely because of their moist, fertile soils, habitats of this community type are very favorable for shade-tolerant, invasive exotic plants, particularly following small-scale soil disturbances. Populations of exotics were documented in all seven plots, with BRM062 containing the largest number of exotics (8 spp.) of any plot in the dataset. Species occurring most frequently and/or attaining greatest cover were *Microstegium vimineum* (Japanese stilt grass; 5 plots), *Rubus phoenicolasius* (wineberry; 4 plots), *Lonicera japonica* (Japanese honeysuckle; 3 plots), and *Alliaria petiolata* (garlic-mustard; 2 plots). While each of these species is capable of displacing native vegetation and degrading natural environments, the Asiatic grass *Microstegium vimineum* may be the most problematic. This species is a relatively recent introduction to study area, first documented in 1986 (C.E. Stevens; see Annotated List of Vascular Plants). Within the past decade, this grass has rampantly invaded moist, shaded habitats throughout the Bull Run Mountains and elsewhere in the region, forming monospecific carpets of tangled culms that tend to crowd out competing herbaceous species (Tu 2000). While it has not yet attained such abundance in the older, established stands of Basic Mesic Forest, it has already become dominant the younger successional forests occupying similar sites (see discussion below).

Mortality or partial die-back of *Cornus florida* resulting from the fungal pathogen *Discula destructiva* (dogwood anthracnose) was recorded in six plots. Visible damage to herbaceous plants by grazing white-tailed deer was noted in only one plot. It appears, however, that long-term selective grazing in this community type has already resulted in the patch-dominance of unpalatable species that are normally avoided by deer (personal observation).

Dominance of *Liriodendron tulipifera* in this community is no doubt indicative of its establishment long ago following abandonment of fields, logging, and natural, large-scale forest disturbances. Yet *Liriodendron* presents somewhat of a paradox among trees. While it is fast growing, intolerant of shade, and requires a mineral soil seedbed for successful germination (Fowells 1965), it is also long-lived (up to 300 years or more) and often considered one of the dominant species in Appalachian mixed mesophytic forests (Braun 1950, Buckner and McCracken 1978). Dominant trees may attain considerable age, but their tall, large-crowned form makes them susceptible to windthrow (Buckner and McCracken 1978). The ability of *Liriodendron* to opportunistically occupy and outgrow competitors in gaps created by windthrow and other disturbances apparently enables this species to maintain a position in older-aged mixed forests (Orwig and Abrams 1994a, Busing 1995). Although stands representing this community in the study area have probably reached an intermediate successional stage (70 to 140 years old), their future development is unclear. Most plots contain *Quercus rubra* var. *rubra* or *Quercus alba* in the overstory, but recruitment of these oaks is very low. In several plots, 20+ m (66+ ft) tall *Liriodendron* is recruiting into small gaps in the 35+ m (115+ ft) tall overstory. However, the most numerous potential canopy species now present in the understory are hickories (*Carya alba*, *Carya cordiformis*, and *Carya ovalis*), *Fraxinus americana*, and *Nyssa sylvatica*. In the absence of longer-lived and more tolerant species such as *Fagus grandifolia* (unimportant in the type) or *Acer saccharum* (sugar maple; absent from study area), we can only guess that maturing stands in the Bull Run Mountains will gradually contain more mixed dominance by *Liriodendron*, *Carya* spp., *Fraxinus*, and perhaps *Nyssa*, with fewer *Quercus* spp.

Sizeable areas of the Bull Run Mountains support young successional forests that established on fields abandoned approximately 50 to 70 years ago. These forests, which potentially represent an early seral stage of Basic Mesic Forest, are also characterized by *Liriodendron* dominance in monospecific stands or in mixed stands with *Juglans nigra* (black walnut), *Celtis occidentalis* (hackberry), *Platanus occidentalis* (sycamore), *Prunus serotina* var. *serotina* (black cherry), *Robinia pseudoacacia* (black locust), and other shade-intolerant trees. The understory in such forests tends to have thick shrub cover by *Lindera benzoin*, along with rampant woody exotics such as *Lonicera japonica*, *Rosa multiflora* (multiflora rose), and *Celastrus orbiculatus* (oriental bittersweet). Although some native herbs occur, exotics such as *Microstegium vimineum*, *Alliaria petiolata*, and *Polygonum caespitosum* var. *longisetum* (long-bristled smartweed) are exceedingly abundant and completely dominate the herbaceous flora. Highly competitive, rapidly growing exotics are so ubiquitous in these assemblages that the possibility of their development into vegetation resembling Basic Mesic Forest has probably already been compromised. Although the hypothesis needs more research, it seems possible that the older, mid-successional stands of Basic Mesic Forest now have comparatively low numbers of exotics because they became established prior to the advent of many invasive species in this area.

The *Liriodendron tulipifera – Quercus rubra* / *Asimina triloba* / *Lindera benzoin* / *Amphicarpaea bracteata* – (*Adiantum pedatum*) Forest of the Bull Run Mountains is a community type that appears to be widely distributed throughout the northern Virginia Piedmont and southward in the western Piedmont and lower Blue Ridge, at least north of the James River (Fleming 2002). The geographic range probably extends north through the Blue Ridge and Piedmont of Maryland, Pennsylvania, and Delaware, and possibly west into the Ridge and Valley province of Virginia, Maryland, and West Virginia. One of the finest examples of this community is located at Montpelier, the historical estate of James Madison in Orange County, Virginia, where the type constitutes most of an 81 ha (200 acre), old-age (but not original-growth) stand. *Liriodendron* is probably the leading dominant of the Montpelier Landmark Forest, in mixed stands with *Quercus alba*, *Quercus rubra* var. *rubra*, *Carya* spp., and other mesophytic hardwoods. Trees 130-140 years old and 90 cm (3 ft) dbh are common in this forest, with scattered individuals 200-300 years old and up to 137 cm (54 in) dbh present (Environmental Timber Management 2000, Davis 1993).

Representative Plots and Examples: This unit is represented by seven plot samples: BRM004, 007, 008, 009, 059, 062, and 063. Excellent examples have been identified at the following localities: on slopes at the north end of the Pond Mountains, just south of Thoroughfare Gap; in a deep, north-facing ravine at the north end of High Point Mountain; and on the lower slopes of High Point Mountain, to the east and SE of the main house at Roland Farm. See Plate 15, p. 105.

Table 30. Environmental information summary for seven plots of the *Liriodendron tulipifera – Quercus rubra* / *Asimina triloba* / *Lindera benzoin* / *Amphicarpaea bracteata* – (*Adiantum pedatum*) Forest community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	**MEAN**	**MIN**	**MAX**
Elevation (m / ft)	202 / 661	119 / 390	308 / 1010
Topographic Position	lower slope	lower slope	lower slope
Relative Slope Position (0 to 1)	0.30	0.06	0.70
SURFACE SUBSTRATE COVER (%):			
Wood	3	2	4
Bedrock	0	0	0
Boulders	5	0	20
Stones	2	0	5
Cobbles	0	0	0
Gravel	0	0	0
Mineral Soil	4	0	25
Organic Matter	86	70	98
Water	0	0	0
Bryophytes and Lichens	4	0	15
Slope (degrees)	14	7	22
Slope Shape: Vertical	straight	concave	convex
Slope Shape: Horizontal	straight	concave	convex
Aspect (degrees [direction])	92 (E)	0 (N)	236 (SW)
Moisture Regime	mesic	mesic	mesic
Topographic Relative Moisture Index (0 to 60)	38.6	22.2	49.0
SOIL CHEMISTRY AND TEXTURE:			
pH	5.3	4.6	5.9
Calcium (ppm)	1629	560	2473
Magnesium (ppm)	286	167	358
Iron (ppm)	120	94	189
Manganese (ppm)	175	69	374
Zinc (ppm)	3.7	2.1	5.6
Phosphorus (ppm)	37	17	61
Potassium (ppm)	158	121	209
Aluminum (ppm)	836	678	1142
Copper (ppm)	1.70	0.98	2.61
Boron (ppm)	0.64	0.29	0.90
Sodium (ppm)	11	7	14
Soluble Sulphur (ppm)	32	23	37
% Organic Matter	8.35	6.52	11.13
Total Cation Exchange Capacity	14.85	9.77	19.54
Total Base Saturation (%)	74.22	46.35	100.02
% Clay	4	2	7
% Silt	42	28	59
% Sand	54	38	70

Table 31. Floristic composition of the *Liriodendron tulipifera – Quercus rubra* / *Asimina triloba* / *Lindera benzoin* / *Amphicarpaea bracteata* – (*Adiantum pedatum*) Forest community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the seven plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 55

Community Type Homoteneity = 0.670

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acer rubrum	5	-	43	2	1	1
Adiantum pedatum	5	+++	43	32	18	257
Agrimonia pubescens	1	0	14	14	2	14
Agrimonia rostellata	2	+	57	25	6	51
Ailanthus altissima	1	0	14	5	1	5
Alliaria petiolata	3	+	29	19	6	38
Amphicarpaea bracteata	7	+++	86	24	19	196
Angelica venenosa	1	0	14	14	2	14
Arisaema triphyllum	4	+	100	29	13	58
Aristolochia serpentaria	1	0	14	1	0	1
Asarum canadense	4	++	14	14	6	57
Asimina triloba	6	++	86	34	23	137
Asplenium platyneuron	1	0	14	1	0	1
Aster divaricatus	2	0	29	2	0	2
Aster lateriflorus	2	0	29	3	1	3
Athyrium filix-femina var. *asplenioides*	2	0	29	4	1	4
Botrychium virginianum	2	0	100	44	10	44
Brachyelytrum erectum var. *erectum*	2	+	57	33	7	65
Cardamine angustata	1	0	14	7	1	7
Cardamine concatenata	2	+	43	32	7	64
Carex blanda	1	0	14	3	0	3
Carex cephalophora	1	0	14	4	0	4
Carex digitalis	2	0	71	14	3	14
Carex grisea	1	0	14	7	1	7
Carex laxiculmis var. *laxiculmis*	1	-	14	1	0	1
Carex laxiflora var. *laxiflora*	2	0	57	15	3	15
Carex nigromarginata	1	0	14	14	2	14
Carex radiata	1	0	14	2	0	2
Carex retroflexa	1	0	14	14	2	14
Carex rosea	2	0	43	11	2	11
Carex sp.	1	0	14	7	1	7
Carex sparganioides	1	0	14	14	2	14
Carpinus caroliniana	2	-	29	7	2	4
Carya alba	5	+	71	12	7	24
Carya cordiformis	4	++	43	26	11	103
Carya ovalis	5	+	71	20	11	40
Castanea dentata	2	0	14	1	0	1
Celtis occidentalis	1	0	14	7	1	7

Table 31 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Cercis canadensis var. *canadensis*	4	++	43	16	7	64
Cimicifuga racemosa	4	+	100	39	17	78
Circaea lutetiana ssp. *canadensis*	2	0	100	30	7	30
Collinsonia canadensis	2	0	57	16	4	16
Conopholis americana	2	+	43	16	4	32
Cornus florida	6	++	100	19	13	78
Corylus americana	1	0	14	3	0	3
Cryptotaenia canadensis	1	-	14	4	0	2
Cynoglossum virginianum var. *virginianum*	1	0	14	5	1	5
Cypripedium parviflorum var. *pubescens*	1	0	14	14	2	14
Cystopteris protrusa	2	+	14	14	3	29
Deparia acrostichoides	4	++	29	10	4	38
Desmodium nudiflorum	2	0	57	7	2	7
Dichanthelium boscii	2	0	29	5	1	5
Dichanthelium commutatum	1	0	14	4	0	4
Dioscorea quaternata	2	0	29	2	0	2
Dryopteris marginalis	2	0	14	3	1	3
Elymus hystrix var. *hystrix*	2	+	29	19	4	38
Eupatorium purpureum	2	+	29	5	1	10
Fagus grandifolia	3	- -	43	4	1	1
Festuca subverticillata	2	+	43	12	3	23
Fraxinus americana	5	++	86	16	9	62
Galearis spectabilis	2	+	29	14	3	29
Galium aparine	1	0	14	14	2	14
Galium circaezans	2	0	100	27	6	27
Galium triflorum	2	0	100	32	7	32
Geranium maculatum	2	+	43	16	4	32
Geum canadense	2	+	43	32	7	64
Hackelia virginiana	1	0	14	14	2	14
Hamamelis virginiana	4	0	14	1	1	1
Hepatica americana	2	+	29	11	3	23
Heuchera americana	1	0	14	7	1	7
Houstonia purpurea var. *purpurea*	1	-	14	1	0	0
Hydrangea arborescens	2	0	57	19	4	19
Hydrophyllum virginianum	2	+	29	29	6	57
Impatiens capensis	1	-	14	1	0	1
Lindera benzoin	6	++	100	27	18	108
Liriodendron tulipifera	8	++	86	10	9	42
Lobelia inflata	1	0	14	5	1	5
Lonicera japonica	4	++	43	11	5	43
Lysimachia ciliata	1	0	29	11	1	11
Maianthemum racemosum ssp. *racemosum*	2	0	100	17	4	17
Medeola virginiana	1	-	29	3	0	1

Table 31 – continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Menispermum canadense	1	0	29	29	3	29
Microstegium vimineum	2	0	71	26	6	26
Monotropa uniflora	1	-	14	1	0	0
Morus rubra	1	0	14	14	2	14
Muhlenbergia tenuiflora	1	0	14	4	0	4
Nyssa sylvatica	5	-	71	6	4	3
Obolaria virginica	2	+	43	43	10	86
Onoclea sensibilis	2	+	14	2	0	4
Osmunda claytoniana	2	+	14	7	2	14
Ostrya virginiana	2	+	14	14	3	29
Oxalis dillenii	1	0	14	2	0	2
Oxalis stricta	1	0	29	19	2	19
Oxalis violacea	4	++	14	5	2	19
Parthenocissus quinquefolia	2	0	100	17	4	17
Phegopteris hexagonoptera	4	++	57	33	15	131
Phryma leptostachya	2	+	100	58	13	117
Pilea pumila var. *pumila*	2	0	29	14	3	14
Podophyllum peltatum	2	+	43	13	3	26
Polygonatum biflorum var. *biflorum*	2	0	43	5	1	5
Polygonum caespitosum var. *longisetum*	2	+	29	14	3	29
Polygonum virginianum	2	+	43	16	4	32
Polystichum acrostichoides	5	++	71	15	8	60
Potentilla canadensis	1	0	14	1	0	1
Prenanthes serpentaria	1	0	14	7	1	7
Prunus avium	1	0	14	4	0	4
Prunus serotina var. *serotina*	2	0	29	2	0	2
Quercus alba	5	0	43	4	2	4
Quercus montana	3	- - - -	29	1	0	0
Quercus rubra var. *rubra*	6	+	86	10	7	20
Quercus velutina	1	- - -	14	0	0	0
Ranunculus abortivus	1	0	29	19	2	19
Ranunculus allegheniensis	1	0	14	7	1	7
Ranunculus recurvatus	1	0	29	6	1	6
Rhododendron periclymenoides	2	-	29	2	0	1
Rosa carolina	2	+	29	8	2	16
Rosa multiflora	1	0	14	7	1	7
Rubus flagellaris	2	0	43	6	1	6
Rubus occidentalis	1	0	14	5	1	5
Rubus phoenicolasius	3	+	57	18	6	35
Sanguinaria canadensis	2	+	57	33	7	65
Sanicula canadensis	2	0	86	27	6	27
Sassafras albidum	1	- -	14	0	0	0
Saxifraga virginiensis	1	0	14	7	1	7
Scutellaria elliptica	1	0	29	6	1	6

Table 31 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Sisyrinchium angustifolium	1	0	14	14	2	14
Smilax glauca	1	-	14	0	0	0
Smilax herbacea	2	+	29	11	3	23
Smilax pulverulenta	1	0	14	7	1	7
Smilax rotundifolia	2	-	43	3	1	1
Smilax tamnoides	1	0	14	14	2	14
Solidago caesia	1	-	14	1	0	0
Staphylea trifolia	5	+++	29	29	16	229
Stellaria pubera	<u>2</u>	+	<u>43</u>	<u>18</u>	<u>4</u>	<u>37</u>
Symphoricarpos orbiculatus	2	+	14	2	0	4
Taraxacum officinale ssp. *officinale*	1	0	14	3	0	3
Thalictrum thalictroides	<u>2</u>	+	<u>57</u>	<u>21</u>	<u>5</u>	<u>42</u>
Toxicodendron radicans ssp. *radicans*	<u>2</u>	0	<u>86</u>	<u>21</u>	<u>5</u>	<u>21</u>
Ulmus rubra	<u>4</u>	++	<u>57</u>	<u>25</u>	<u>11</u>	<u>102</u>
Uvularia perfoliata	<u>4</u>	++	<u>86</u>	<u>23</u>	<u>10</u>	<u>94</u>
Vaccinium fuscatum	1	- -	14	1	0	0
Verbesina alternifolia	1	0	14	7	1	7
Viburnum acerifolium	2	0	29	4	1	4
Viburnum prunifolium	2	0	29	6	1	6
Viola pubescens	1	0	14	14	2	14
Viola sororia	2	0	29	4	1	4
Viola triloba var. triloba	<u>2</u>	+	<u>43</u>	<u>16</u>	<u>4</u>	<u>32</u>
Vitis vulpina	<u>2</u>	0	<u>71</u>	<u>21</u>	<u>5</u>	<u>21</u>
Woody sp.	1	0	14	14	2	14

Table 32. Woody stem data summary for the *Liriodendron tulipifera – Quercus rubra / Asimina triloba / Lindera benzoin / Amphicarpaea bracteata –* (*Adiantum pedatum*) Forest community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for seven plots representing the type. Species with IV > 0.95 are listed in descending order of IV.

SPECIES	**Tree Density**	**Large Tree Density**	**TOTAL DENSITY**	**RELATIVE DENSITY**	**BASAL AREA**	**RELATIVE BASAL AREA**	**IV**
Liriodendron tulipifera	68	82	150	21.88	27.87	58.54	40.21
Quercus rubra var. *rubra*	7	21	29	4.76	8.31	19.36	12.06
Nyssa sylvatica	96	0	96	11.67	0.80	1.86	6.76
Carya alba	64	0	64	9.12	0.52	1.15	5.13
Fraxinus americana	43	4	46	5.71	1.40	3.95	4.83
Carya ovalis	32	7	39	5.58	1.77	3.64	4.61
Cornus florida	68	0	68	7.20	0.33	0.87	4.04
Asimina triloba	82	0	82	7.07	0.11	0.33	3.70
Cercis canadensis var. *canadensis*	32	0	32	5.91	0.18	0.45	3.18
Acer rubrum	50	0	50	4.54	0.86	1.76	3.15
Quercus alba	4	7	11	1.72	2.27	4.23	2.98
Staphylea trifolia	39	0	39	4.03	0.04	0.08	2.05
Carya cordiformis	18	0	18	1.43	0.67	2.03	1.73
Hamamelis virginiana	29	0	29	2.93	0.04	0.08	1.50
other species	71	0	71	6.46	0.67	1.67	4.06
TOTALS	**704**	**121**	**825**	**100.00**	**45.84**	**100.00**	**100.00**

Table 33. Vertical structure of woody taxa and total stratum cover in seven plots of the *Liriodendron tulipifera – Quercus rubra* / *Asimina triloba* / *Lindera benzoin* / *Amphicarpaea bracteata* – (*Adiantum pedatum*) Forest community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Acer rubrum	1	2	4	5		
Ailanthus altissima	1					
Asimina triloba	3	6	5			
Carpinus caroliniana	1	2				
Carya alba		4	4	4		
Carya cordiformis	2	2	2	4	3	
Carya ovalis	2	4	2			5
Castanea dentata		2	2			
Cercis canadensis var. *canadensis*	1	4	3			
Cornus florida	1	4	5			
Corylus americana	1	1				
Fagus grandifolia	1	3	1			
Fraxinus americana	2	3	2		2	5
Hamamelis virginiana		4	2			
Hydrangea arborescens	2					
Lindera benzoin	2	6				
Liriodendron tulipifera	2		2	2	4	8
Lonicera japonica	4					
Menispermum canadense	1					
Morus rubra		1				
Nyssa sylvatica	2	4	4	3	2	
Ostrya virginiana		2				
Parthenocissus quinquefolia	2	2				
Prunus avium	1					
Prunus serotina var. *serotina*	2					
Quercus alba	2			2	5	
Quercus montana	1				3	
Quercus rubra var. *rubra*	1	1	2		4	6
Quercus velutina	1					
Rhododendron periclymenoides	2					
Rosa carolina	2					
Rosa multiflora	1	1				
Rubus flagellaris						
Rubus occidentalis		1				
Rubus phoenicolasius	2	2				
Sassafras albidum	1	1				
Smilax glauca	1					
Smilax rotundifolia	2	2				
Smilax tamnoides	1					

Table 33 – continued

Species	<0.5m	0.5-6m	6-10m	10-20m	20-35m	>35m
Staphylea trifolia	2	5				
Symphoricarpos orbiculatus		2				
Toxicodendron radicans	2					
Ulmus rubra	2	2	2	3		
Vaccinium fuscatum		1				
Viburnum acerifolium	2					
Viburnum prunifolium	1	2				
Vitis vulpina	2	2			2	2
Total Stratum Cover (%):						
Mean: all plots in type	**59**	**54**	**28**	**19**	**18**	**79**
Mean: plots w/cover in stratum	**59**	**54**	**28**	**13**	**21**	**79**

ECOLOGICAL COMMUNITY TYPE 3.2.

Quercus montana – Quercus rubra – Carya ovalis / Desmodium nudiflorum – Dichanthelium boscii Forest

Chestnut Oak – Northern Red Oak – Red Hickory / Naked-flowered Tick-trefoil – Bosc's Panic Grass Forest

BASIC OAK – HICKORY FOREST

Habitat and Distribution: This unit has a fairly extensive distribution in the study area and forms large patches, particularly on the eastern dip slopes of the ridges. Smaller patches occur locally on the western slopes. Basic Oak-Hickory Forests appear to be strongly associated with the flaggy quartzite / muscovite schist / phyllite lithologic suite, which produces soils that are darker, deeper, and more fertile than those weathered from the massive, resistant quartzites. A few stands occur where Catoctin metabasalt may be shallowly covered by quartzite colluvium. Straight to convex slopes (mean inclination = 15˚) at middle to high topographic positions are optimal sites. East to SE aspects predominate among ten plot samples. Site moisture potential was subjectively assessed as submesic or subxeric at all sampling sites, which is consistent with intermediate TRMI values (mean = 27.2, range = 15.8 to 36.4). Only three plots had surface substrate cover ≥ 10% of bedrock or loose rocks, but most had substantial cover (mean = 8%, maximum = 20%) of exposed mineral soil. Soil samples extracted from plots are strongly to extremely acidic, with moderately high Ca, Mg, and Mn levels, and moderately low Fe concentrations (Table 34). All sites have been logged at least once and some have probably recovered from agricultural uses during the 19th century.

Composition and Physiognomy:

Constant Species (constancy ≥ 80%):
Acer rubrum, *Aristolochia serpentaria*, *Carya alba*, *Carya ovalis*, *Cornus florida*, *Desmodium nudiflorum*, *Dichanthelium boscii*, *Dioscorea quaternata*, *Fraxinus americana*, *Galium circaezans*, *Galium latifolium*, *Liriodendron tulipifera*, *Maianthemum racemosum* ssp. *racemosum*, *Parthenocissus quinquefolia*, *Polygonatum biflorum* var. *biflorum*, *Quercus montana*, *Quercus rubra* var. *rubra*, *Rubus flagellaris*, *Solidago caesia*, *Uvularia perfoliata*.

Dominant Species (mean cover ≥ 6):
Carya ovalis (7), *Quercus montana* (7), *Carya alba* (6), *Quercus rubra* var. *rubra* (6).

Diagnostic Species (fidelity = 100%):
Acalypha virginica, *Ambrosia artemisiifolia*, *Antennaria plantaginifolia* var. *parlinii*, *Apocynum cannabinum*, *Arctium minus*, *Asclepias quadrifolia*, *Aster patens* var. *patens*, *Aureolaria virginica*, *Carex aggregata*, *Carex striatula*, *Celastrus orbiculatus*, *Desmodium glutinosum*, *Desmodium paniculatum*, *Dichanthelium latifolium*, *Erigeron annuus*, *Erigeron pulchellus* var. *pulchellus*, *Erigeron strigosus*, *Eupatorium sessilifolium*, *Galium latifolium*, *Geum virginianum*, *Gnaphalium obtusifolium*, *Hedeoma pulegioides*, *Hieracium gronovii*, *Houstonia longifolia*, *Lactuca canadensis*, *Lespedeza procumbens*, *Lespedeza repens*, *Liparis liliifolia*, *Osmorhiza longistylis*, *Physalis virginiana* var. *virginiana*, *Polygonum scandens* var. *cristatum*, *Porteranthus trifoliatus*, *Pycnanthemum incanum*, *Senecio pauperculus*, *Silene stellata*, *Solidago ulmifolia* var. *ulmifolia*, *Sphenopholis nitida*, *Thalictrum dioicum*, *Thaspium barbinode*, *Triodanis perfoliata* var. *perfoliata*, *Verbascum thapsus*, *Vernonia glauca*.

Indicator Species (highest unscaled adj. IVs):
Carya ovalis, *Dichanthelium boscii*, *Ageratina altissima* var. *altissima*, *Galium latifolium*, *Solidago ulmifolia* var. *ulmifolia*, *Carya alba*, *Desmodium nudiflorum*, *Eupatorium sessilifolium*, *Aristolochia serpentaria*, *Geum virginianum*.

This community type has a mixed overstory with variable co-dominance by *Quercus montana* (chestnut oak; stems up to 58 cm [23 in] dbh), *Quercus rubra* var. *rubra* (northern red oak; stems up to 73 cm [29 in] dbh), *Carya ovalis* (red hickory; stems up to 54 cm [21 in] dbh), and *Liriodendron tulipifera* (tulip-poplar; stems up to 70 cm [28 in] dbh). Although less constant and abundant, *Quercus alba* (white oak; stems up to 69 cm [27 in] dbh) and *Quercus velutina* (black oak; stems up to 58 cm [23] dbh) are locally important in the overstory. *Carya ovalis* attains the highest IV in sampled stands and, along with *Carya alba* (mockernut hickory; stems up to 35 cm [14 in] dbh), accounts for nearly 50% of the total density of trees < 40 cm [16 in] dbh. These hickories dominate the understory tree layers, which also contain *Nyssa sylvatica* (black gum), *Fraxinus americana* (white ash), *Acer rubrum* (red maple), *Amelanchier* spp. (serviceberries), *Sassafras albidum* (sassafras), climbing lianas of *Vitis aestivalis* var. *bicolor* (silverleaf grape), and some *Quercus* spp. The shrub layer is typically composed of tree saplings (especially of *Carya* spp.), *Cornus florida* (flowering dogwood), and occasionally *Cercis canadensis* var. *canadensis* (eastern redbud). Typical stand structure consists of an open overstory (mean canopy height = 31 m [102 ft]); mean canopy cover = 74%), with very open lower layers; mean cover in each of the two lowest tree strata and shrub stratum is ≤ 28% (Table 37).

The herb layer is patchy (mean stratum cover = 38%) and contains a diverse mixture of mesophytic and xerophytic species. The one exception is plot BRM058, which is overwhelmingly dominated by a large clone of *Aralia nudicaulis* (wild sarsaparilla; Plate 3, p. xviii). The adaptability of both moist-site and dry-site species to the relatively fertile, dry-mesic habitats enhances species richness values (mean = 64, range = 44 to 88) in stands of this community type. Low patches of the deciduous heaths *Vaccinium pallidum* (early lowbush blueberry) and *Vaccinium stamineum* (deerberry) occur in 70% of plots but rarely contribute more than 5% cover. No herbaceous species attains a mean cover > 5% across all plots of the type. Herbs that occasionally cover up to 25% of an individual sample include *Ageratina altissima* var. *altissima* (white snakeroot), *Amphicarpaea bracteata* (hog-peanut), *Cimicifuga racemosa* (black bugbane), *Desmodium nudiflorum* (naked-flowered tick-trefoil), and *Dichanthelium boscii* (Bosc's panic grass). *Acalypha virginica* (Virginia three-seeded mercury) and *Hedeoma pulegioides* (American pennyroyal) are small annual herbs that often densely colonize patches of exposed soil. Relatively constant and characteristic low-cover herbs include *Agrimonia rostellata* (woodland agrimony), *Aristolochia serpentaria* (Virginia snakeroot), *Aster undulatus* (wavy-leaved aster), *Carex laxiflora* var. *laxiflora* (a sedge), *Carex pensylvanica* (a sedge), *Circaea lutetiana* ssp. *lutetiana* (enchanter's nightshade), *Eupatorium sessilifolium* (upland boneset), *Galium circaezans* (licorice bedstraw), *Galium latifolium* (purple bedstraw), *Geum virginianum* (cream avens), *Houstonia purpurea* var. *purpurea* (large summer bluets), *Maianthemum racemosum* ssp. *racemosum* (Solomon's-plume), *Muhlenbergia sobolifera* (cliff muhly), *Polygonatum biflorum* var. *biflorum* (Solomon's-seal), *Scutellaria elliptica* (hairy skullcap), *Solidago caesia* (bluestem goldenrod), *Solidago ulmifolia* var. *ulmifolia* (elm-leaf goldenrod), and *Uvularia perfoliata* (perfoliate bellwort). Herbs that are under-represented in plots despite being locally abundant include *Cynoglossum virginianum* var. *virginianum* (wild comfrey) and the spring ephemerals *Cardamine angustata* (slender toothwort), *Cardamine concatenata* (cutleaf toothwort), and *Thalictrum thalictroides* (rue-anemone).

Community Subtypes: Based on the results of quantitative analyses, two fully intergrading compositional subtypes are recognized. These units must be considered tentative because of a limited sample size, and differences between them are subtle. They are described here primarily to aid interpretation of local variation that may be apparent to observers in the field.

3.2.1. *Carya ovalis – Quercus rubra / Solidago ulmifolia – Carex pensylvanica* Subtype - This subtype tends to occur on middle slopes (mean inclination = 15°) with 10% mean substrate cover of rocks and 12% mean substrate cover of exposed soil. Soils are slightly less fertile and have higher silt content than those of Subtype 3.2.2. Habitats were subjectively considered somewhat drier than those of Subtype 3.2.2, although synthetic TRMI values do not support this assessment. Although the overall moisture potential of sites for the two units may be similar, the presence of locally thin or rocky soils in this subtype may contribute to a greater number of dry microhabitats. The overstory of this variant contains relatively little *Liriodendron tulipifera*, while *Carya ovalis*, *Quercus alba*, and *Quercus velutina* reach maximal importance. Other species that appear to be more constant and/or characteristic of this subtype include *Antennaria plantaginifolia* var. *plantaginifolia* (plantain-leaved pussytoes), *Aster undulatus*, *Carex pensylvanica*, *Danthonia spicata* (poverty oat grass), *Lespedeza intermedia* (wand bushclover), *Potentilla canadensis* (Canada cinquefoil), *Pycnanthemum incanum* (hoary mountain-mint), *Rosa carolina* (pasture rose), *Solidago ulmifolia* var. *ulmifolia*, *Sphenopholis nitida* (shiny wedge grass), *Vaccinium pallidum*, and *Vaccinium stamineum*.

3.2.2. *Quercus montana – Liriodendron tulipifera / Cimicifuga racemosa – Galium latifolium* Subtype - plot samples of this subtype are situated on convex upper slopes and crests (mean inclination = 12º) with less substrate cover of rocks and exposed soil (means = 5% and 3%), and thicker, more continuous cover of leaf litter. Soils are slightly more fertile and have higher sand content than those of Subtype 3.2.1. *Quercus montana* and *Liriodendron tulipifera* tend to be more abundant in the overstory mixtures of this subtype; *Nyssa sylvatica* and persistent sprouts of *Castanea dentata* (American chestnut) are more frequent in the understory. The herb layer tends to have a more lush, though still patchy, aspect with mesophytes such as *Cimicifuga racemosa*, *Amphicarpaea bracteata*, and *Desmodium glutinosum* (pointed-leaf tick-trefoil) prominent. Additional herbs that appear to be more constant and/or characteristic in this subtype include *Arisaema triphyllum* (jack-in-the-pulpit), *Asclepias quadrifolia* (four-leaved milkweed), *Circaea lutetiana* ssp. *canadensis*, *Galium latifolium*, and *Osmorhiza longistylis* (anise-root).

Distinguishing Features: The prominence of hickories in all strata of this community type is distinctive, as are the mixed overstory and patchy but species-rich herb layer containing both mesophytic and xerophytic species. The Basic Oak-Hickory Forest is similar to the Acidic Oak-Hickory Forest but has a much more varied and diverse herb layer, a lower cover of deciduous heaths, and a hickory component consisting mostly of *Carya ovalis* and *Carya alba* (vs. mostly *Carya glabra* in the Acidic Oak-Hickory Forest). Additionally, the Basic Oak-Hickory Forest occurs primarily on the eastern slopes while the Acidic Oak-Hickory Forest occurs primarily on western slopes. With decreasing slope position and increasing moisture, stands of Basic Oak-Hickory Forest frequently grade into the Basic Mesic Forest community type, which differs in its less mixed, *Liriodendron*-dominated overstory, shrub layer dominance by *Asimina triloba* and *Lindera benzoin*, and lush herb layer composed primarily of ferns and leafy forbs. Transitions between Basic Oak-Hickory Forest and other community types, *e.g.*, Chestnut Oak Forest, tend to be abrupt and correspond to changes in underlying bedrock and soils.

Global Conservation Rank: G3G4

State Conservation Rank: S3?

Synonymy: USNVC CEGL008514: *Quercus rubra – Quercus prinus – Carya ovalis / Cercis canadensis / Solidago caesia* Forest, *pro parte* (Fleming and Coulling 2001; Fleming 2002). USNVC CEGL008516: *Quercus prinus – Quercus rubra – Carya ovalis / Solidago* (*ulmifolia*, *arguta*) *– Galium latifolium* Forest, *pro parte* (Fleming and Coulling 2001). SAF Cover Type 52: White Oak – Black Oak – Northern Red Oak, *pro parte*.

Comments: Evidence of disturbance recorded in plots included exotic plants (8 plots), herbivory by white-tailed deer (8 plots), mortality or die-back from dogwood anthracnose (6 plots), blowdowns or crown damage from wind and ice storms (4 plots), light gypsy moth defoliation (4 plots), old chestnut wood debris (4 plots), and charcoal or fire scars (2 plots). *Symphoricarpos orbiculatus* (coralberry), a drought-tolerant shrub naturalized from the midwestern U.S., is the most frequent invasive plant, occurring in five plots. Another exotic shrub, *Rubus phoenicolasius* (wineberry; 3 plots) is also potentially problematic, as is the exotic grass *Microstegium vimineum* (Japanese stilt grass; 2 plots), which has recently become established around tip-up mounds and along trails in this community. Because of accessible habitats and floristic diversity, deer herbivory is moderate to severe over much of this community type. Damage (topped-off stems and leaves) was consistently noted on *Amphicarpaea bracteata*, *Carex* spp., *Cimicifuga racemosa*, *Cornus florida* seedlings, *Desmodium nudiflorum*, *Galium* spp., *Eupatorium sessilifolium*, *Polygonatum biflorum* var. *biflorum*, *Scutellaria elliptica*, and *Solidago* spp. (see Table 51, p. 176). Grasses and hoary or aromatic forbs such as *Cynoglossum virginianum* var. *virginianum* and *Pycnanthemum incanum* were rarely, if ever, grazed (personal observation). The impacts of browsing on woody seedlings and tree reproduction in this community need systematic investigation. A potentially serious outbreak of gypsy moth (*Lymantria dispar*) was averted in 2001 by the naturalized fungal pathogen *Entomophaga maimaiga* (Andreadis and Weseloh 1990, Hajek *et al*. 1996b), which killed thousands of caterpillars before trees had been completely defoliated.

The presence of wood debris and living root-sprouts indicate that *Castanea dentata* was once a component of forests on sites occupied by the Basic Oak-Hickory Forest. However, past logging and the apparent inability of root-sprouts to compete in mesic or submesic habitats where trees were once common (Stephenson *et al*. 1991, Fleming and Moorhead 2000) make it difficult to evaluate how important *Castanea* was on these sites. Because Allard and Leonard (1943) stressed that the area's Oak-Chestnut association was changing to an Oak-Hickory association, with hickory saplings occurring "in enormous numbers," it is plausible that *Castanea dentata* was a major tree on the area's dry-mesic slopes in mixed stands with oaks and some hickory. If that was the case, then *Carya ovalis* and *Carya alba*, along with *Liriodendron tulipifera*, must have been the principal colonizers of gaps created by the death of *Castanea* overstory trees. The gap-obligate nature of *Liriodendron* recruitment is well-documented (Orwig and Abrams 1994a, 1994b) and the replacement of *Castanea* by *Carya* spp. has been reported from both the Ridge and Valley and the Blue Ridge in Virginia (McCormick and Platt 1980, Johnson and Ware 1982).

Although many of the saplings Allard and Leonard (1943) observed have now attained much larger stature and a position of overstory co-dominance, prolific *Carya* recruitment continues to characterize these sites, even though *Carya* spp. are minor components of most other community types in the study area. While elimination of fire may have contributed to this phenomenon, a more likely explanation is an association of *Carya* abundance with base-rich, dry or dry-mesic soils. Farrell and Ware (1991) and Ware (1992) reported strong positive correlations of *Carya* importance values with high Ca, Mg, and pH in studies involving 75 upland hardwood stands in the Virginia Piedmont. Although high-base soils in these studies were confined to the northern Virginia Culpeper Basin, DCR-DNH ecologists have found this pattern to be more widespread and recurrent on soils weathered from a variety of mafic, ultramafic, intermediate metamorphic, and calcareous metasedimentary substrates throughout the Virginia Piedmont and mountains (Fleming and Coulling 2001, Fleming 2002).

The *Quercus montana – Quercus rubra – Carya ovalis* / *Desmodium nudiflorum – Dichanthelium boscii* Forest of the Bull Run Mountains is very similar to Basic Oak-Hickory Forests occurring on Catoctin metabasalt of the Watery Mountains and lower elevations of the main Blue Ridge in northern Virginia (Fleming and Coulling 2001). It also has affinities to a community type associated with Harper's Formation phyllite and metasiltstone along the western flank of the Blue Ridge (Fleming and Coulling 2001). More data collection and analysis on a regional scale is needed to clarify these relationships.

Representative Plots and Examples: This unit is represented by ten plot samples:
Subtype 3.1.1 – plots BRM021, 028, 030, 031, 039, and 069.
Subtype 3.2.2 – plots BRM044, 048, 058, 071.
The largest and most representative occurrences extend over most of the eastern slopes of High Point Mountain and the east ridge north of Hopewell Gap. See Plate 16, p. 106.

Table 34. Environmental information summary for ten plots of the *Quercus montana – Quercus rubra – Carya ovalis* / *Desmodium nudiflorum – Dichanthelium boscii* Forest community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	**MEAN**	**MIN**	**MAX**
Elevation (m / ft)	288 / 945	210 / 690	408 / 1340
Topographic Position	upper slope	lower slope	crest
Relative Slope Position (0 to 1)	0.68	0.31	0.98
SURFACE SUBSTRATE COVER (%):			
Wood	3	1	5
Bedrock	3	0	25
Boulders	1	0	3
Stones	4	0	10
Cobbles	0	0	0
Gravel	<1	0	5
Mineral Soil	8	0	20
Organic Matter	81	58	94
Water	0	0	0
Bryophytes and Lichens	7	0	30
Slope (degrees)	15	5	30
Slope Shape: Vertical	straight	straight	convex
Slope Shape: Horizontal	straight	concave	convex
Aspect (degrees [direction])	144 (SE)	0 (N)	315 (NW)
Moisture Regime	submesic	subxeric	submesic
Topographic Relative Moisture Index (0 to 60)	27.2	15.8	36.4
SOIL CHEMISTRY AND TEXTURE:			
pH	4.8	4.1	5.3
Calcium (ppm)	766	187	1973
Magnesium (ppm)	115	46	254
Iron (ppm)	144	54	424
Manganese (ppm)	129	22	236
Zinc (ppm)	4.3	2.3	7.3
Phosphorus (ppm)	74	25	308
Potassium (ppm)	90	59	128
Aluminum (ppm)	1334	658	1777
Copper (ppm)	1.12	0.76	1.89
Boron (ppm)	0.40	0.25	0.58
Sodium (ppm)	11	7	17
Soluble Sulphur (ppm)	44	35	55
% Organic Matter	9.75	5.90	14.71
Total Cation Exchange Capacity	14.05	9.44	22.76
Total Base Saturation (%)	34.57	15.14	69.80
% Clay	3	1	7
% Silt	39	23	49
% Sand	58	46	76

Table 35. Floristic composition of the *Quercus montana – Quercus rubra – Carya ovalis* / *Desmodium nudiflorum – Dichanthelium boscii* Forest community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the ten plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 64
Community Type Homoteneity = 0.656

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acalypha virginica	2	+	40	40	9	80
Acer rubrum	5	-	100	16	9	8
Adiantum pedatum	1	-	10	3	0	1
Ageratina altissima var. *altissima*	4	++	60	51	23	206
Agrimonia rostellata	2	+	40	18	4	36
Agrostis perennans var. *perennans*	2	0	50	21	5	21
Ailanthus altissima	1	0	20	13	1	13
Alliaria petiolata	1	-	10	3	0	2
Ambrosia artemisiifolia	1	0	10	10	1	10
Amelanchier arborea var. *arborea*	2	0	40	8	2	8
Amelanchier laevis	2	0	10	2	0	2
Amphicarpaea bracteata	4	0	70	23	10	23
Antennaria plantaginifolia var. *parlinii*	1	0	10	10	1	10
Antennaria plantaginifolia var. *plantaginifolia*	2	+	30	18	4	36
Apocynum cannabinum	2	+	20	20	4	40
Aralia nudicaulis	5	+	20	4	2	7
Arctium minus	1	0	10	10	1	10
Arisaema triphyllum	2	-	30	4	1	2
Aristolochia serpentaria	2	+	80	53	12	107
Asclepias quadrifolia	2	+	20	20	4	40
Asimina triloba	2	- -	20	3	1	1
Asplenium platyneuron	2	+	30	9	2	18
Aster divaricatus	2	0	20	1	0	1
Aster lateriflorus	2	0	40	8	2	8
Aster patens var. patens	1	0	10	10	1	10
Aster undulatus	2	+	70	49	11	98
Aureolaria laevigata	1	0	10	2	0	2
Aureolaria virginica	1	0	10	10	1	10
Botrychium virginianum	2	0	30	6	1	6
Bromus pubescens	1	0	10	5	1	5
Cardamine angustata	1	0	10	5	1	5
Carex aggregata	1	0	10	10	1	10
Carex albicans var. *albicans*	1	0	10	1	0	1
Carex cephalophora	2	+	20	10	2	20
Carex digitalis	2	0	70	19	4	19
Carex hirsutella	1	0	10	5	1	5
Carex laxiculmis var. *laxiculmis*	2	0	20	3	1	3

Table 35 – continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Carex laxiflora var. *laxiflora*	2	0	70	33	7	33
Carex pensylvanica	3	+	70	45	15	89
Carex platyphylla	1	0	10	5	1	5
Carex rosea	4	++	50	21	9	83
Carex striatula	1	0	10	10	1	10
Carex swanii	1	0	10	1	0	1
Carex virescens	2	+	30	13	3	26
Carya alba	6	++	100	33	22	133
Carya cordiformis	1	-	10	2	0	1
Carya glabra	3	-	30	4	1	2
Carya ovalis	7	+++	90	45	35	360
Castanea dentata	2	0	40	9	2	9
Celastrus orbiculatus	1	0	10	10	1	10
Cercis canadensis var. *canadensis*	2	0	30	11	3	11
Chamaelirium luteum	1	0	10	10	1	10
Chimaphila maculata	2	0	70	11	2	11
Chionanthus virginicus	2	0	20	4	1	4
Cimicifuga racemosa	5	++	60	20	11	80
Circaea lutetiana ssp. *canadensis*	2	0	70	21	5	21
Clitoria mariana	1	0	10	5	1	5
Collinsonia canadensis	2	0	20	3	1	3
Conopholis americana	2	+	20	5	1	10
Cornus florida	5	+	80	18	10	36
Cunila origanoides	2	+	30	15	3	30
Cynoglossum virginianum var. *virginianum*	2	+	20	13	3	27
Danthonia spicata	3	+	40	13	4	27
Desmodium glutinosum	1	0	20	20	2	20
Desmodium nudiflorum	4	++	100	31	14	125
Desmodium paniculatum	2	+	20	20	4	40
Desmodium rotundifolium	1	0	10	5	1	5
Dichanthelium boscii	4	++	80	53	24	213
Dichanthelium commutatum	2	+	20	10	2	20
Dichanthelium dichotomum	2	0	40	7	2	7
Dichanthelium latifolium	2	+	10	10	2	20
Dioscorea quaternata	2	0	80	17	4	17
Diospyros virginiana	2	0	70	31	7	31
Elymus hystrix var. hystrix	1	0	10	3	0	3
Erechtites hieraciifolia var. *hieraciifolia*	1	0	20	13	1	13
Erigeron annuus	1	0	20	20	2	20
Erigeron pulchellus var. *pulchellus*	2	+	10	10	2	20
Erigeron strigosus	1	0	10	10	1	10
Eupatorium purpureum	2	+	30	8	2	15
Eupatorium sessilifolium	2	+	60	60	13	120

Table 35 – continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Fagus grandifolia	1	- - - -	10	0	0	0
Festuca subverticillata	2	+	30	8	2	16
Fraxinus americana	3	0	80	19	6	19
Galearis spectabilis	1	0	10	3	0	3
Galium circaezans	2	0	100	38	9	38
Galium latifolium	2	+	80	80	18	160
Galium triflorum	2	0	50	11	3	11
Gaylussacia baccata	1	- - - -	10	0	0	0
Geranium maculatum	2	+	30	11	3	23
Geum virginianum	2	+	50	50	11	100
Gnaphalium obtusifolium	1	0	10	10	1	10
Goodyera pubescens	1	0	10	1	0	1
Hedeoma pulegioides	2	+	20	20	4	40
Hepatica americana	2	+	20	8	2	16
Hieracium gronovii	1	0	10	10	1	10
Hieracium paniculatum	1	0	20	8	1	8
Hieracium venosum	2	+	20	5	1	10
Houstonia longifolia	1	0	10	10	1	10
Houstonia purpurea var. *purpurea*	2	0	70	29	6	29
Hypericum hypericoides ssp. *multicaule*	2	+	30	23	5	45
Ipomoea pandurata	2	+	50	42	9	83
Juniperus virginiana var. *virginiana*	1	0	20	13	1	13
Lactuca canadensis	1	0	10	10	1	10
Lespedeza intermedia	2	+	30	23	5	45
Lespedeza procumbens	1	0	10	10	1	10
Lespedeza repens	1	0	10	10	1	10
Lindera benzoin	2	- -	40	6	1	2
Liparis liliifolia	1	0	10	10	1	10
Liriodendron tulipifera	5	-	90	17	9	8
Lobelia inflata	2	+	20	13	3	27
Lobelia spicata var. *scaposa*	1	0	10	5	1	5
Lonicera japonica	2	0	20	3	1	3
Luzula echinata	1	0	10	2	0	2
Lysimachia ciliata	1	0	10	2	0	2
Lysimachia quadrifolia	1	0	10	2	0	2
Maianthemum racemosum ssp. *racemosum*	2	0	80	15	3	15
Microstegium vimineum	2	0	20	3	1	3
Monotropa hypopithys	1	0	10	2	0	2
Monotropa uniflora	2	0	70	29	6	29
Muhlenbergia sobolifera	2	+	30	23	5	45
Muhlenbergia tenuiflora	2	+	30	23	5	45
Nyssa sylvatica	5	-	60	7	4	3
Onoclea sensibilis	1	0	10	1	0	1

Table 35 - continued

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Osmorhiza longistylis	1	0	10	10	1	10
Oxalis dillenii	2	+	20	7	1	13
Oxalis stricta	1	0	10	3	0	3
Oxalis violacea	1	-	10	3	0	2
Paronychia canadensis	2	+	20	13	3	27
Parthenocissus quinquefolia	2	0	100	24	5	24
Phegopteris hexagonoptera	1	-	10	1	0	1
Phryma leptostachya	2	+	30	8	2	15
Physalis virginiana var. *virginiana*	1	0	10	10	1	10
Pinus virginiana	1	- -	20	2	0	1
Podophyllum peltatum	1	0	10	1	0	1
Polygonatum biflorum var. *biflorum*	2	0	80	26	6	26
Polygonum caespitosum var. *longisetum*	2	+	20	10	2	20
Polygonum scandens var. *cristatum*	2	+	40	40	9	80
Polygonum virginianum	1	0	10	1	0	1
Polystichum acrostichoides	2	-	30	4	1	2
Populus grandidentata	1	0	10	5	1	5
Porteranthus trifoliatus	1	0	10	10	1	10
Potentilla canadensis	2	+	40	16	4	32
Potentilla simplex	1	0	10	3	0	3
Prenanthes trifoliolata	1	0	10	3	0	3
Prunus avium	1	0	10	3	0	3
Prunus serotina var. *serotina*	2	0	50	9	2	9
Pycnanthemum incanum	2	+	30	30	7	60
Quercus alba	5	0	60	11	6	11
Quercus coccinea	2	- -	10	1	0	0
Quercus montana	7	0	90	14	11	14
Quercus rubra var. *rubra*	6	+	90	16	11	32
Quercus velutina	5	+	70	12	6	23
Ranunculus allegheniensis	1	0	10	5	1	5
Rhododendron periclymenoides	2	-	30	2	1	1
Rosa carolina	2	+	30	13	3	26
Rubus allegheniensis var. *allegheniensis*	1	0	10	3	0	3
Rubus flagellaris	2	0	80	30	7	30
Rubus occidentalis	2	+	20	13	3	27
Rubus phoenicolasius	2	0	30	7	2	7
Sanguinaria canadensis	1	0	10	1	0	1
Sanicula canadensis	2	0	50	13	3	13
Sassafras albidum	4	+	60	8	4	16
Saxifraga virginiensis	1	0	10	5	1	5
Scutellaria elliptica	2	+	60	36	8	72
Senecio pauperculus	1	0	20	20	2	20
Silene stellata	1	0	20	20	2	20
Smilax glauca	1	-	20	1	0	1

Table 35 - continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Smilax herbacea	1	0	10	2	0	2
Smilax rotundifolia	2	-	70	11	2	5
Solidago bicolor	1	0	10	3	0	3
Solidago caesia	2	0	80	32	7	32
Solidago erecta	1	0	10	3	0	3
Solidago ulmifolia var. *ulmifolia*	2	+	70	70	16	140
Sphenopholis nitida	2	+	40	40	9	80
Symphoricarpos orbiculatus	2	+	50	36	8	71
Taraxacum officinale ssp. *officinale*	1	0	10	2	0	2
Thalictrum dioicum	1	0	10	10	1	10
Thalictrum thalictroides	2	+	30	8	2	16
Thaspium barbinode	1	0	10	10	1	10
Toxicodendron radicans ssp. *radicans*	1	-	20	2	0	1
Triodanis perfoliata var. *perfoliata*	1	0	10	10	1	10
Ulmus americana	1	0	10	5	1	5
Ulmus rubra	1	-	10	1	0	1
Uvularia perfoliata	2	0	80	29	6	29
Vaccinium corymbosum	1	0	10	3	0	3
Vaccinium pallidum	4	-	70	9	4	5
Vaccinium stamineum	2	0	70	19	4	19
Verbascum thapsus	1	0	10	10	1	10
Verbesina alternifolia	1	0	10	5	1	5
Vernonia glauca	1	0	20	20	2	20
Viburnum acerifolium	2	0	30	7	2	7
Viburnum prunifolium	2	0	20	4	1	4
Viola sororia	2	0	60	26	6	26
Viola triloba var. triloba	2	+	40	20	4	40
Vitis aestivalis var. *aestivalis*	2	0	30	13	3	13
Vitis aestivalis var. *bicolor*	2	0	50	17	4	17
Vitis vulpina	2	0	30	5	1	5

Table 36. Woody stem data summary for the *Quercus montana – Quercus rubra – Carya ovalis / Desmodium nudiflorum – Dichanthelium boscii* Forest community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for ten plots representing the type. Species with IV > 0.95 are listed in descending order of IV.

SPECIES	Tree Density	Large Tree Density	TOTAL DENSITY	RELATIVE DENSITY	BASAL AREA	RELATIVE BASAL AREA	IV
Carya ovalis	223	13	235	21.71	6.14	18.00	19.86
Quercus montana	90	28	118	12.06	7.66	25.58	18.82
Carya alba	168	0	168	17.46	2.40	7.71	12.58
Quercus rubra var. *rubra*	38	23	60	7.40	7.49	16.91	12.15
Liriodendron tulipifera	15	15	30	3.79	4.66	12.65	8.22
Quercus alba	38	10	48	4.77	3.79	8.41	6.59
Cornus florida	65	0	65	8.47	0.14	0.49	4.48
Quercus velutina	3	13	15	1.74	3.00	6.89	4.32
Acer rubrum	60	0	60	6.39	0.60	1.26	3.83
Nyssa sylvatica	55	0	55	6.41	0.34	0.80	3.61
Sassafras albidum	30	0	30	3.47	0.12	0.24	1.86
other species	63	0	63	6.31	0.35	1.05	3.68
TOTALS	**845**	**100**	**945**	**100.00**	**36.68**	**100.00**	**100.00**

Table 37. Vertical structure of woody taxa and total stratum cover in ten plots of the *Quercus montana – Quercus rubra – Carya ovalis* / *Desmodium nudiflorum – Dichanthelium boscii* Forest community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Acer rubrum	2	3	2	5		
Ailanthus altissima	1					
Amelanchier arborea	2	2	2			
Amelanchier laevis		2				
Asimina triloba	1	1				
Carya alba	2	4	5		4	
Carya cordiformis	1					
Carya glabra	1			2	2	
Carya ovalis	2	4	5	5	6	
Castanea dentata	1	2	2			
Celastrus orbiculatus	1					
Cercis canadensis var. *canadensis*	2	2	2			
Chionanthus virginicus		2				
Cornus florida	2	5	2			
Diospyros virginiana	2	2				
Fagus grandifolia	1					
Fraxinus americana	2	2	2			
Gaylussacia baccata	1					
Juniperus virginiana var. *virginiana*	1					
Lindera benzoin	2	2				
Liriodendron tulipifera	2		2	3	5	
Lonicera japonica	2	1				
Nyssa sylvatica	2	4	3	2		
Parthenocissus quinquefolia	2	2				
Pinus virginiana	1					
Populus grandidentata	1					
Prunus avium		1				
Prunus serotina var. *serotina*	2	2	2			
Quercus alba	1	2	3	3	5	
Quercus coccinea				2		
Quercus montana	2	4	4	4	6	
Quercus rubra var. *rubra*	2	2	3	2	6	
Quercus velutina	2	1			5	
Rhododendron periclymenoides	2	1				
Rosa carolina	2					
Rubus allegheniensis var. *allegheniensis*	2					
Rubus flagellaris	2					
Rubus occidentalis	2					
Rubus phoenicolasius	2					

Table 37 – continued

Species	<0.5m	0.5-6m	6-10m	10-20m	20-35m	>35m
Sassafras albidum	2	3	2			
Smilax glauca	1					
Smilax rotundifolia	2	2				
Symphoricarpos orbiculatus	2	1				
Toxicodendron radicans	1					
Ulmus americana	1					
Ulmus rubra	1					
Vaccinium corymbosum		1				
Vaccinium pallidum	4	1				
Vaccinium stamineum	2	2				
Viburnum acerifolium	2	2				
Viburnum prunifolium	2	1				
Vitis aestivalis var. *bicolor*	2	2	2	2		
Vitis vulpina	2					
Total Stratum Cover (%):						
Mean: all plots in type	**38**	**27**	**28**	**27**	**74**	
Mean: plots w/cover in stratum	**38**	**27**	**28**	**27**	**74**	

VEGETATION CLASS 4
XERIC OAK AND PINE FORESTS

Plots of this vegetation class occupy subxeric to xeric sites with infertile soils. Mean levels of soil Ca, Mg, Mn, P, K, pH, and total base saturation for the class are much lower than average for the overall dataset; mean levels of extractable Fe are much higher than average. These values are largely associated with shallow, drought-prone soils weathered in residuum from the massive, thick-bedded, quartzite that forms the area's resistant ridges. A few plots in this class are located on massive quartzite cliffs with little soil development, on highly weathered quartzite debris fields with thin colluvial soils, and on soils weathered from thin-bedded, flaggy quartzite. In aggregate, members of this class, encompassing dry oak/heath and pine-oak/heath vegetation, cover extensive areas and form the matrix of the community patch-mosaic in the Bull Run Mountains.

Thick, poorly decomposed duff layers, abundant dead wood, and high biomass of inflammable shrubs all contribute to strongly fire-prone habitats. The pine-oak/heath communities of this class can be considered pyrophytic, with the major species having evolved life histories that include production of highly flammable litter, stems, and foliage, as well as specific adaptations to ensure reproductive success in a frequently burned environment. Fire adaptations in *Pinus pungens* (table-mountain pine) include serotinous, heat-responsive cones, while *Pinus rigida* (pitch pine) exhibits both serotiny and the ability to sprout prolifically from fire-injured stems and branches. The dry-site oak forests that now prevail over much of the central Appalachian and mid-Atlantic regions developed under a regime of frequent burning, both natural and anthropogenic, that suppressed more tolerant competitors and created conditions necessary for successful oak regeneration (Abrams 1992). A dramatic reduction of fires that has marked the 20th century both in Virginia and region-wide is now leading to slow but certain changes in the structure and composition of these communities. The specific dynamics and manifestations of these changes will be examined in the community type descriptions that follow.

In addition to the pyrophytic pines, characteristic plants of the Xeric Oak and Pine Forests include *Quercus montana* (chestnut oak), *Quercus coccinea* (scarlet oak), *Quercus ilicifolia* (bear oak; very rare in the Bull Run Mountains), and a host of ericaceous (heath family) shrubs, including *Kalmia latifolia* (mountain-laurel), *Gaylussacia* spp. (huckleberries), *Rhododendron* spp. (rhododendrons and azaleas), and *Vaccinium* spp. (blueberries). Very infertile soils and dense root mats from colonial shrubs greatly limit herbaceous species. Because of lower structural diversity and fewer plant resources, the faunal diversity in communities of this class is probably lower than in more mesic forests. The northern fence lizard (*Sceloporus undulatus hyacinthinus*) and the five-lined skink (*Eumeces fasciatus*) are among the few animals that seem to prefer these dry, rocky, semi-open habitats. However, studies at other sites in western Virginia suggest that lepidopteran diversity, especially of moths, can be unexpectedly high in pine-oak/heath vegetation (C.S. Hobson, pers. comm.).

Based on cluster analysis and summary statistical analysis, three community types are recognized:

- TABLE-MOUNTAIN PINE – OAK / HEATH WOODLAND
  Pinus pungens – Quercus montana / *Kalmia latifolia – Gaylussacia baccata* Woodland
  (Table-mountain Pine – Chestnut Oak / Mountain-laurel – Black Huckleberry Woodland)

- PITCH PINE – OAK / HEATH WOODLAND
  Pinus rigida – Quercus montana – (*Pinus virginiana*) / *(Quercus marilandica)* / *Kalmia latifolia* Woodland
  (Pitch Pine – Chestnut Oak – (Virginia Pine) / (Blackjack Oak) / Mountain-laurel Woodland)

- CHESTNUT OAK FOREST
  Quercus montana – (*Quercus coccinea, Quercus velutina*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest
  (Chestnut Oak – (Scarlet Oak, Black Oak) / Mountain-laurel / Early Lowbush Blueberry Forest)

These community types separate along a moisture gradient (TRMI), with the Table-Mountain Pine – Oak / Heath Woodland (4.1) confined to the most xeric and edaphically extreme habitats on cliffs and rocky, convex summits at the highest elevations (Fig. 16). While the Table-Mountain Pine – Oak / Heath Woodland is a specialized, small-patch community type, the Pitch Pine – Oak / Heath Woodland (4.2) is more widely associated with xeric upper slopes and crests (high Relslope), forming medium to large patches. The Chestnut Oak Forest (4.3), which extends into lower slope positions with subxeric moisture regimes, is the most widespread and extensive community type in the study area. The results of cluster analysis suggest two segregates within this type. A three-dimensional ordination of plots constituting the Chestnut Oak Forest (Figs. 17 and 18) indicates that the first subtype (1) is dispersed on relatively steep slopes with higher cover of stones, boulders, bryophytes, and lichens, while the second subtype (2) occurs on gentler slopes at higher topographic positions. Surface substrate at sites occupied by the second subtype consists mostly of organic matter with few surface rocks.

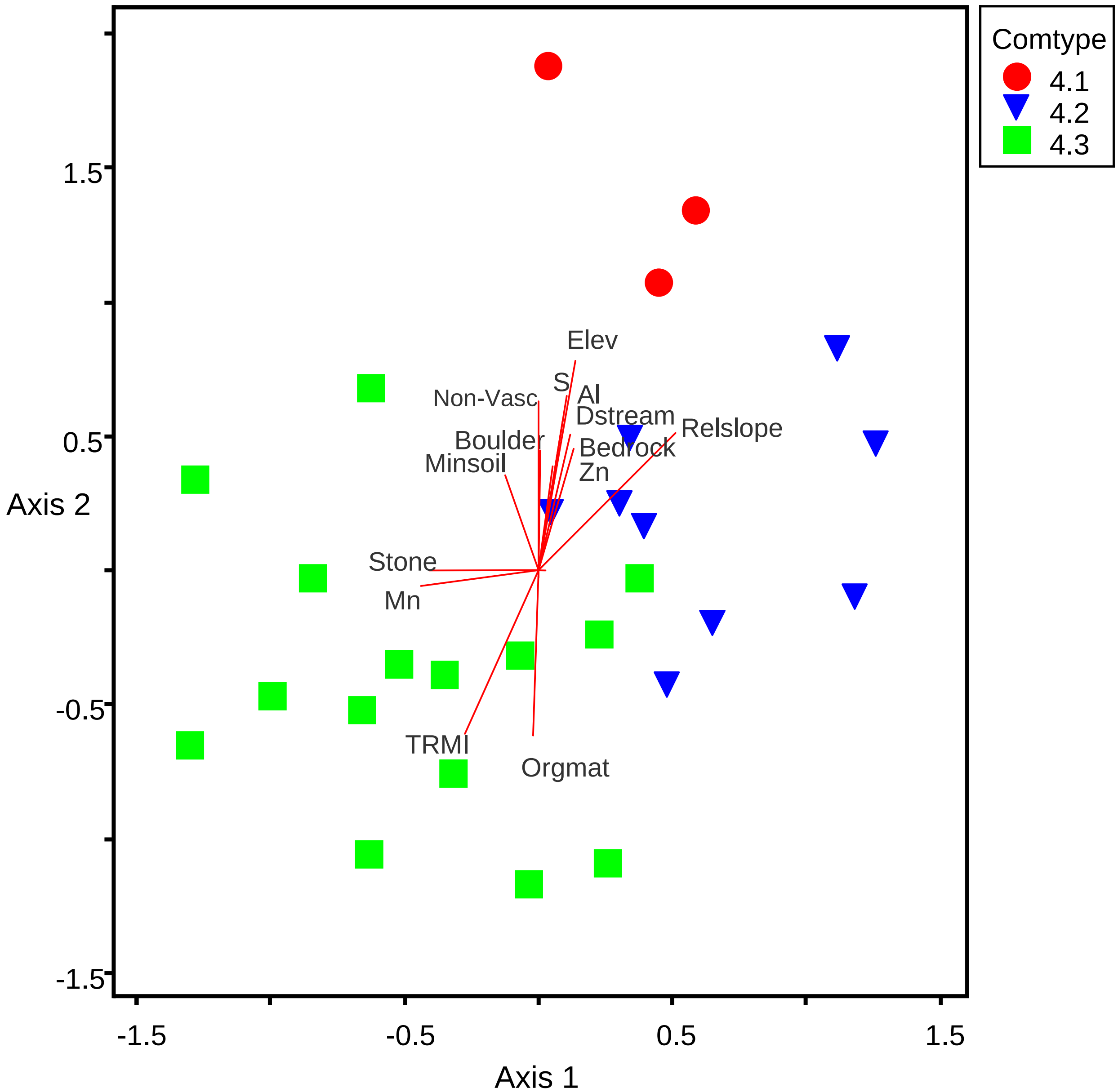


Figure 16. Scatterplot diagram for two-dimensional NMDS ordination of the XERIC OAK AND PINE FORESTS vegetation class, showing the distribution of three community types: 4.1 – Table-Mountain Pine – Oak / Heath Woodland, 4.2 – Pitch Pine – Oak / Heath Woodland, 4.3 – Chestnut Oak Forest. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients ($p = <0.020$). Bedrock = exposed bedrock surface cover. Boulder = exposed boulder surface cover. Dstream = distance to nearest stream. Elev = elevation. Minsoil = exposed mineral soil surface cover. Non-Vasc = bryophyte/lichen surface cover. Orgmat = organic matter surface cover. Relslope = relative slope position; high values correspond to higher topographic positions. Stone = exposed stone surface cover. TRMI = topographic relative moisture index; high values indicate greater site moisture potential. See pp. 20-21 for full names of soil chemistry variables.

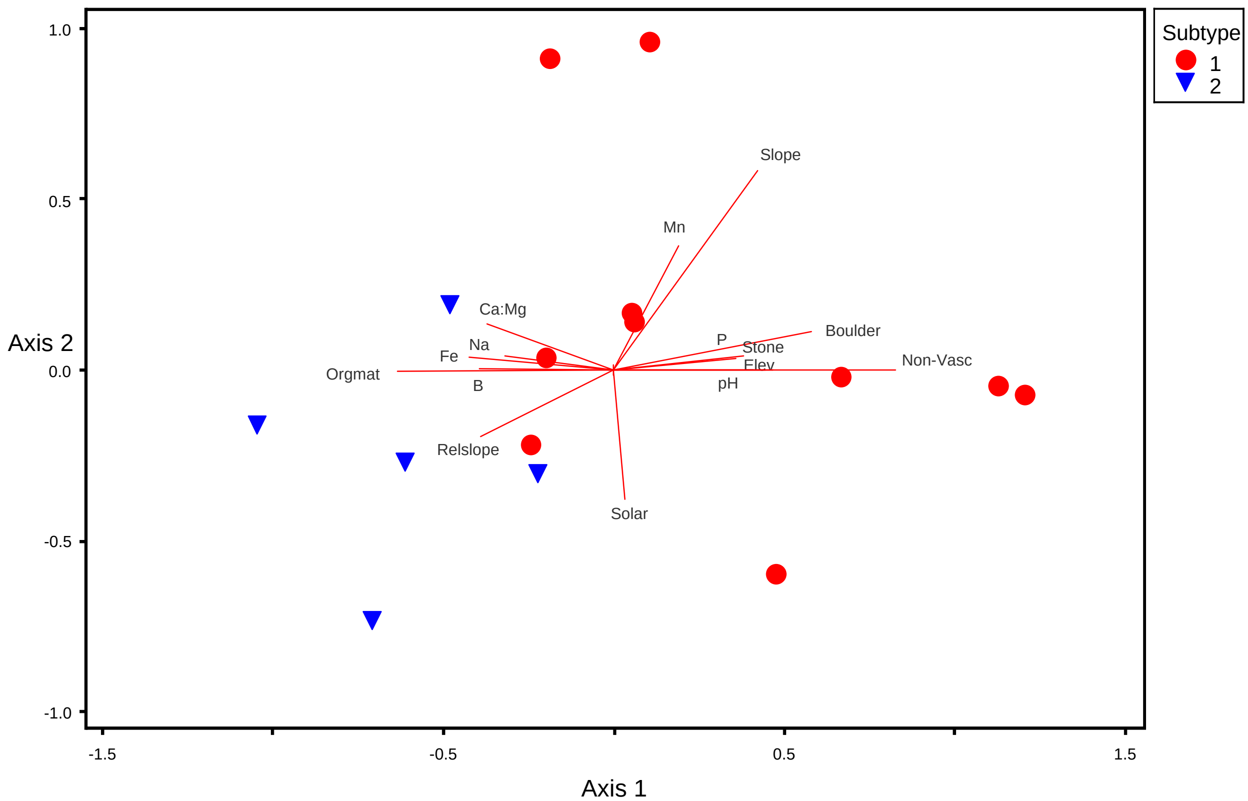


Figure 17. Scatterplot diagram for three-dimensional NMDS ordination of 15 stands of the CHESTNUT OAK FOREST community type, showing the distribution of two community subtypes on the first and second axes: 1 – *Quercus montana* – (*Quercus velutina*) / *Kalmia latifolia* Subtype, 2 – *Quercus montana* – (*Quercus coccinea*) / *Gaylussacia baccata* Subtype. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients (p = <0.100). Boulder = exposed boulder surface cover. Elev = elevation. Non-Vasc = bryophyte/lichen surface cover. Orgmat = organic matter surface cover. Relslope = relative slope position; high values indicate higher topographic positions. Solar = solar radiation index; high values indicate greater potential solar exposure. Slope = slope inclination. Stone = exposed stone surface cover. See pp. 20-21 for full names of soil chemistry variables.

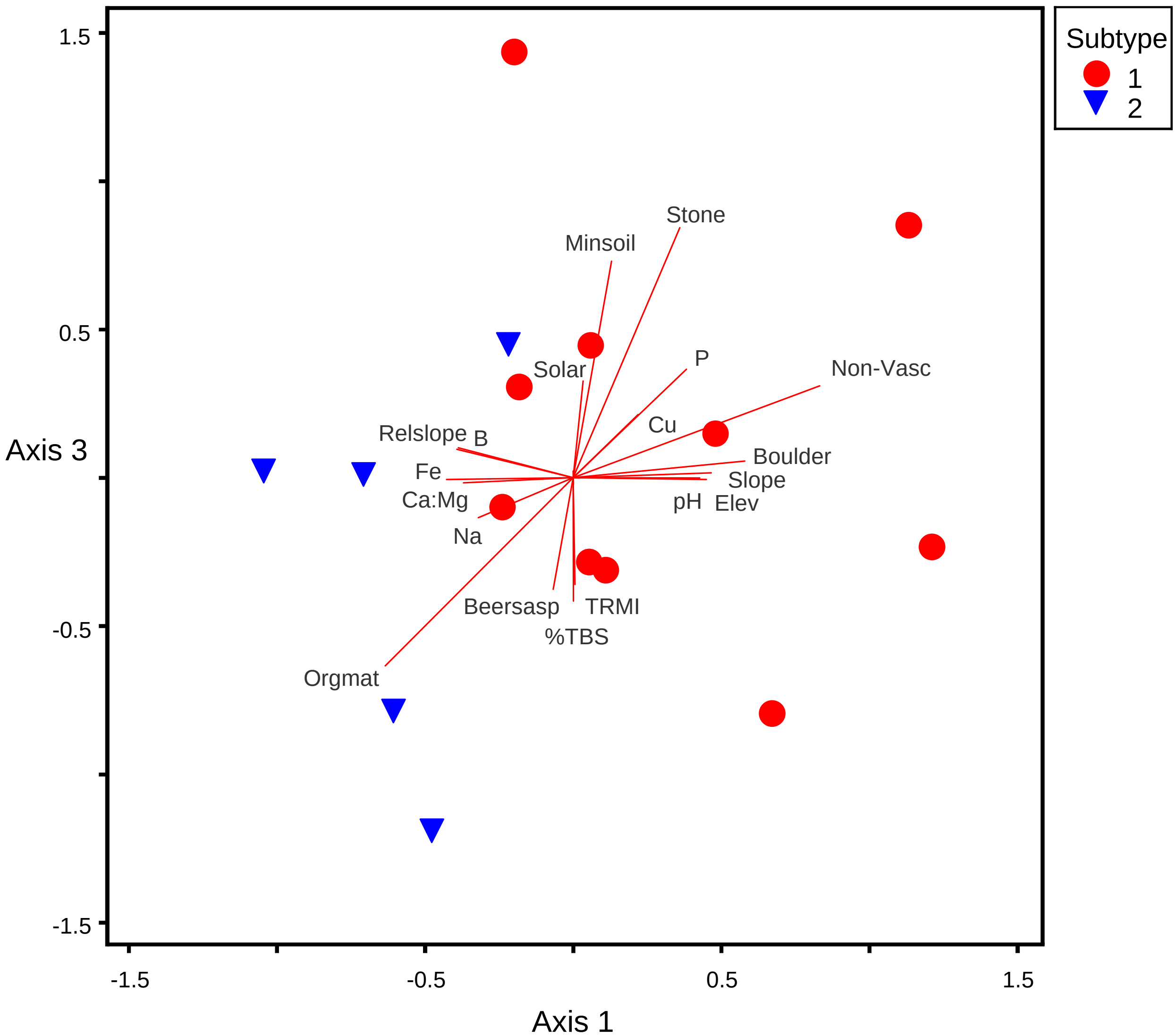


Figure 18. Scatterplot diagram for three-dimensional NMDS ordination of 15 stands of the CHESTNUT OAK FOREST community type, showing the distribution of two community subtypes on the first and third axes: 1 – *Quercus montana* – (*Quercus velutina*) / *Kalmia latifolia* Subtype, 2 – *Quercus montana* – (*Quercus coccinea*) / *Gaylussacia baccata* Subtype. Overlain joint plot vectors show significant correlations between compositional variation and environmental gradients (p = <0.100). Beersasp = Beers-transformed aspect; northeastern aspects have the highest values, southwestern aspects have the lowest values. Boulder = exposed boulder surface cover. Elev = elevation. Minsoil = exposed mineral soil surface cover. Non-Vasc = bryophyte/lichen surface cover. Orgmat = organic matter surface cover. Relslope = relative slope position; high values indicate higher topographic positions. Solar = solar radiation index; high values indicate greater potential solar exposure. Slope = slope inclination. Stone = exposed stone surface cover. TRMI = topographic relative moisture index; high values indicate greater site moisture potential. See pp. 20-21 for full names of soil chemistry variables.

Plate 17. **Pitch Pine – Oak / Heath Woodland** on High Point Mountain crest (near plot BRM022). Photo © Gary P. Fleming.

Plate 18. **Chestnut Oak Forest** on rocky, western slope of High Point Mountain. The evergreen ericad *Kalmia latifolia* (mountain-laurel) dominates the shrub layer. Photo © Gary P. Fleming.

Plate 19. DCR-DNH staff with an old-age, 108 cm (43 in) dbh *Quercus montana* (chestnut oak) below High Point cliffs. Photo: Gary P. Fleming, DCR-DNH.

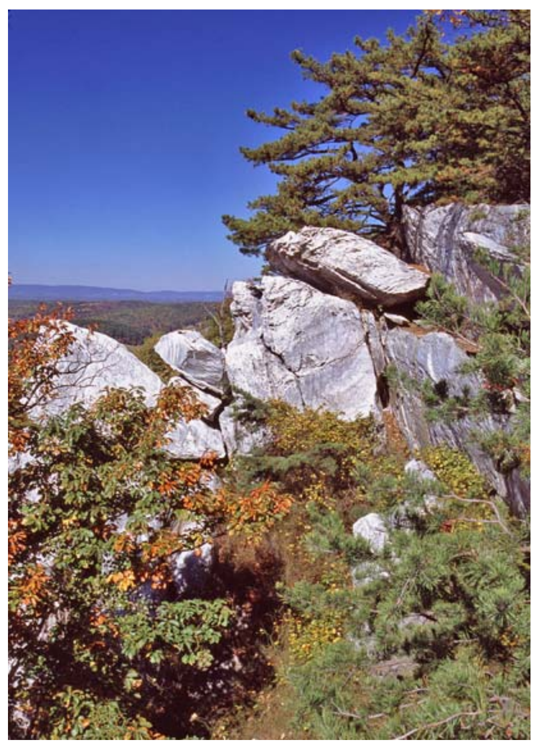


Plate 20. **Table-Mountain Pine – Oak / Heath Woodland** atop High Point cliffs (Plot BRM002). Photo © Gary P. Fleming.

ECOLOGICAL COMMUNITY TYPE 4.1

Pinus pungens – Quercus montana / Kalmia latifolia – Gaylussacia baccata Woodland

Table-mountain Pine – Chestnut Oak / Mountain-laurel – Black Huckleberry Woodland
TABLE-MOUNTAIN PINE – OAK / HEATH WOODLAND

Habitat and Distribution: This community type has a very restricted distribution in the study area. It occurs in a long, narrow, interrupted band along the upper west slope and crest of High Point Mountain, in scattered patches on High Acre Ridge, and possibly on the western flank of Signal Mountain. It is not known from the east ridge, although not all potential habitats there have been investigated. Sites supporting this vegetation are the most xeric and edaphically stressful in the study area, as indicated by exceptionally low (mean = 13.24) TMRI values (Table 38). Habitats are situated on very rocky, steep (mean slope = 24˚), dramatically convex crests (including those of secondary spurs) and upper slope / crest transition zones at high elevations (> 350 m [1160 ft]). Western aspects are most typical although plot BRM060, located on a spur of High Acre Ridge, is east-facing. At all three sample sites, the community is associated with the tops of large, massive quartzite cliffs and adjacent, more weathered outcrop complexes. Mean substrate cover of exposed bedrock and boulders is 27%, and nearly all of that is covered in turn by crustose and foliose lichens, especially *Xanthoparmelia conspersa*, *Dimelaena oreina*, *Lasallia* spp., and *Umbilicaria* spp. The remainder of the substrate consists of very shallow, infertile soils that are partly interstitial and lacking a profile, and partly weathered in place. The latter usually have a very deep (up to 24 cm [9 in] deep) and dense surface horizon of charcoal-rich duff, partly decomposed humus, and shrub roots. Mineral soils beneath the organic mantle are light, yellowish sandy loams with relatively high organic matter content (mean = 10.75%) and extremely low fertility. Samples extracted from plots had very low mean values for pH, Ca, Mg, Mn, and total base saturation, and had the highest mean values for Fe and Al among classified types (Tables 9 and 38). All documented sites for this community have a history of fires.

Composition and Physiognomy:

<u>Constant Species (constancy ≥ 80%):</u>
Gaylussacia baccata, *Kalmia latifolia*, *Pinus pungens*, *Quercus montana*, *Quercus rubra* var. *rubra*, *Vaccinium pallidum*.

<u>Dominant Species (mean cover ≥ 6):</u>
Gaylussacia baccata (7), *Kalmia latifolia* (7), *Pinus pungens* (7), *Quercus montana* (7), *Vaccinium pallidum* (6).

<u>Diagnostic Species (fidelity = 100%):</u>
Baptisia tinctoria, *Pinus pungens*, *Sericocarpus asteroides*, *Tephrosia virginiana*.

<u>Indicator Species (highest unscaled adj. IVs):</u>
Pinus pungens, *Baptisia tinctoria*, *Sericocarpus asteroides*, *Tephrosia virginiana*, *Gaylussacia baccata*, *Dichanthelium depauperatum*.

The vegetation is a stunted, open woodland with incomplete canopy cover (range = 33 to 50%) and little, if any, tree-layer stratification. Mean height of dominant overstory trees is only 10 m (33 ft; range 7 to 11 m [23 to 36 ft]). *Pinus pungens* (table-mountain pine; stems up to 50 cm [20 in] dbh) is the most numerous tree, attaining densities up to 850 stems/ha, and the only tree attaining diameters ≥ 40 cm (16 in). *Quercus montana* (chestnut oak; stems up to 35 cm [14 in] dbh) is less abundant but essentially co-dominant despite barely exceeding shrub stature. *Pinus virginiana* (Virginia pine; stems up to 10 cm [4 in] dbh), a very minor overstory associate in this community, is the only other tree > 6 m (20 ft) tall in plot samples; although not captured in plots, *Pinus rigida* (pitch pine) is a minor tree in a few stands on

High Point Mountain. Except where bare rock prevails, this community type has a dense shrub layer (mean stratum cover = 83%) dominated by ericaceous species and containing considerable young recruitment of *Pinus pungens* and *Quercus montana* (Table 41). The ericad component consists of a multi-tiered complex of *Kalmia latifolia* (mountain-laurel; ca. 1.5 to 2m [5 to 6.5 ft] tall), *Gaylussacia baccata* (black huckleberry; ca. 1.0 m (3 ft) tall), and *Vaccinium pallidum* (early lowbush blueberry; ca. 0.5 m (20 in) tall), with relative density and cover varying from site to site. *Sassafras albidum* (sassafras), *Amelanchier arborea* (downy serviceberry), and *Smilax glauca* (white-leaf greenbrier; a woody vine) are frequent but low-cover associates of the shrub layer. Scattered saplings of other *Quercus* spp. (oaks), *Carya* spp. (hickories), *Nyssa sylvatica* (black gum), and *Prunus serotina* var. *serotina* (black cherry) also occur, but are doubtfully persistent. The herb layer consists mostly of low clones of *Vaccinium pallidum* and *Gaylussacia baccata*, along with a few tree seedlings. Herbaceous plants are essentially absent except on some of the open ledges at High Point cliffs, where *Danthonia spicata* (poverty oat grass) and a few xerophytic forbs occur. The species richness of the High Point plot (BRM002; n = 22) is somewhat inflated by the inclusion of these herbs. Conversely, species richness of the other two plots (n = 10) may be somewhat reduced by their 200 m^2 sample sizes (see p. 18). In any case, mean overall richness (n = 14) accurately reflects the very low floristic diversity.

Distinguishing Features: This community type is unlikely to be confused with other vegetation of the study area. Distinguishing features include the extremely dry, outcrop-laden habitats on convex, high-elevation crests and upper slopes; pronounced low stature and woodland structure of the vegetation; and dominance by *Pinus pungens*, a distinctive pine which is rarely, if ever, found elsewhere in the Bull Run Mountains. The Pitch Pine – Oak / Heath Woodland, which is more generally distributed in the area on ridge crests and xeric slopes, sometimes occupies similar outcrop habitats (*e.g.*, at White Rock, upper W flank of Signal Mountain) and exhibits similar physiognomy. Generally, however, the Pitch Pine community is not associated with outcrop habitats, descends to lower elevations, and has a taller, more closed canopy. Nevertheless, while the recognition of two xerophytic pine communities appears justified in the Bull Run Mountains and even at the state level, their separation on a larger geographic scale is controversial (see "Comments" below; also Fleming and Coulling 2001).

Global Conservation Rank: G4

State Conservation Rank: S4

Synonymy: USNVC CEGL004996: *Pinus* (*pungens*, *rigida*) – *Quercus prinus* / *Quercus ilicifolia* / *Gaylussacia baccata* Woodland, *pro parte*. *Pinus pungens – Quercus prinus –* (*Quercus coccinea*) / *Kalmia latifolia – Gaylussacia baccata* Woodland (Virginia State Name; Fleming and Coulling 2001). SAF: no equivalent.

Comments: Large quantities of charcoal were found in the duff and humus layers at all three plots, along with fire scars on the trunks of *Quercus montana*, indicating severe or recurrent fires in the past. Snags of *Pinus pungens* killed by southern pine beetle (*Dendroctonus frontalis*) within the past ~10 years were present in the vicinity of both plots on High Acre Ridge. Minor *Castanea dentata* (American chestnut) wood debris was also found in these two plots.

Populations of *Pinus pungens* in the Bull Run Mountains are outliers from the species' general distribution on the main Blue Ridge and Ridge and Valley strike ridges to the west. Likewise, the Table-Mountain Pine – Oak / Heath Woodland is a montane community type with a disjunct and restricted distribution in the Piedmont. Although exclusively associated with quartzite cliffs and outcrops in the Bull Run Mountains, this community occurs on both rocky and non-rocky, xeric sites elsewhere in its range. In either case, the viability of *Pinus pungens* populations are generally considered to be reliant on periodic fires, which stimulate the opening of serotinous cones, remove litter detrimental to seedling germination, and remove competing shrubs and oaks (Barden 1979, Groeschl *et al.* 1992). In edaphically extreme, outcrop habitats, which heavily stress *Quercus montana* and other competitor oaks, it appears that *Pinus pungens* communities may persist for very long periods without fire.

Increment cores extracted from selected trees suggest that there are two cohorts of *Pinus pungens* on the main outcrops at High Point cliffs. A number of trees had ages of approximately 100 to 114 years, perhaps indicating a common origin (fire) around 1890-1900. This date also corresponds to the general age of many *Quercus montana*, including stump-sprouted trees, on the western slope of High Point Mountain, suggesting widespread logging at that time. The sizes of individual trees in this cohort are highly variable and dependent on microhabitat conditions. The smallest stem (~114 years), growing from a narrow crevice at the top of the cliff, was 20 cm (8 in) dbh and about 2.5 m tall; the largest (~110 years), growing in soil at the ecotone with *Quercus montana*-dominated forest, was 49 cm (19 in) dbh and 12 m tall. A second, much older cohort may be represented by a 41.5 cm (16 in) dbh individual that was ~200 years old and by several other trees (not cored) up to 50 cm dbh that grow or recently grew from crevices on the clifftop. Several of these large pines have died over the past 25 years, possibly from old age.

There are unresolved issues regarding the classification of this unit and its relationship to the very similar Pitch Pine – Oak / Heath Woodland. Recognition of separate vegetation types seems warranted in the Bull Run Mountains, where the two pines co-occur infrequently, occupy mostly different habitats, and exhibit somewhat different reproductive strategies (see the following section on Ecological Community Type 4.2 for details). In an analysis of 918 plots collected throughout the Virginia mountains, Fleming and Coulling (2001) identified two comparable types (see "Synonymy" above), although the nominal pines intermingled more and the pitch pine community was represented by data collected mostly at higher elevations (> 900 m [3000 ft]). *Quercus ilicifolia* (bear oak), a species known from a single historical collection in the Bull Run Mountains, was a characteristic shrub with high adjusted IVs in both units. At the regional scale represented by the U.S. National Vegetation Classification (USNVC; Grossman *et al*. 1998), these units are considered subtypes of a single association, the *Pinus* (*pungens*, *rigida*) – *Quercus prinus* / *Quercus ilicifolia* / *Gaylussacia baccata* Woodland. Additional data collection and analysis is needed to fully assess the relationship of montane and Piedmont pine-oak/heath woodlands and to determine whether the absence of *Quercus ilicifolia* from the latter is significant to classification.

Representative Plots and Examples: This unit is represented by three plot samples: BRM002, 060, and 066. The largest and most outstanding example in the study area occurs at and near the quartzite cliffs on High Point Mountain (Plates 1 and 20, pp. xvi and 138).

Table 38. Environmental information summary for three plots of the *Pinus pungens – Quercus montana / Kalmia latifolia – Gaylussacia baccata* Woodland community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	**MEAN**	**MIN**	**MAX**
Elevation (m / ft)	373 / 1223	354 / 1160	384 / 1260
Topographic Position	crest	crest	crest
Relative Slope Position (0 to 1)	0.98	0.97	0.99
SURFACE SUBSTRATE COVER (%):			
Wood	3	1	4
Bedrock	13	0	38
Boulders	14	2	30
Stones	<1	0	1
Cobbles	0	0	0
Gravel	0	0	0
Mineral Soil	2	0	5
Organic Matter	68	54	86
Water	0	0	0
Bryophytes and Lichens	24	10	33
Slope (degrees)	24	7	45
Slope Shape: Vertical	convex	convex	convex
Slope Shape: Horizontal	convex	convex	convex
Aspect (degrees [direction])	214 (SW)	83 (E)	280 (W)
Moisture Regime	xeric	xeric	xeric
Topographic Relative Moisture Index (0 to 60)	13.2	4.5	22.5
SOIL CHEMISTRY AND TEXTURE:			
pH	4.1	3.9	4.3
Calcium (ppm)	132	125	141
Magnesium (ppm)	34	29	38
Iron (ppm)	375	271	485
Manganese (ppm)	5	3	6
Zinc (ppm)	2.3	2.2	2.4
Phosphorus (ppm)	23	22	25
Potassium (ppm)	44	39	50
Aluminum (ppm)	1343	1192	1447
Copper (ppm)	0.70	0.65	0.80
Boron (ppm)	0.42	0.29	0.54
Sodium (ppm)	11	9	13
Soluble Sulphur (ppm)	56	52	61
% Organic Matter	10.75	8.54	13.77
Total Cation Exchange Capacity	22.27	19.81	24.72
Total Base Saturation (%)	5.00	4.54	5.48
% Clay	6	5	6
% Silt	44	41	47
% Sand	50	48	54

Table 39. Floristic composition of the *Pinus pungens – Quercus montana* / *Kalmia latifolia – Gaylussacia baccata* Woodland community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the three plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 14 (22 per 400 m^2, 10 per 200 m^2)

Community Type Homoteneity = 0.738

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acer rubrum	2	- - - -	67	2	0	0
Amelanchier arborea var. *arborea*	2	0	33	2	0	2
Baptisia tinctoria	2	+	33	33	7	67
Carex tonsa	2	+	33	5	1	10
Carya alba	2	- -	33	1	0	0
Carya glabra	2	- -	33	1	0	0
Chimaphila maculata	2	0	33	1	0	1
Cypripedium acaule	1	0	33	11	1	11
Danthonia spicata	4	++	33	3	1	11
Dichanthelium depauperatum	2	+	33	17	4	33
Dichanthelium dichotomum	2	0	33	1	0	1
Gaylussacia baccata	7	++	100	11	8	43
Kalmia latifolia	7	+	100	8	6	15
Nyssa sylvatica	1	- - - - -	33	1	0	0
Pinus pungens	7	++++	100	100	78	1600
Pinus virginiana	4	+	67	7	3	15
Polypodium virginianum	2	0	33	8	2	8
Prunus serotina var. *serotina*	2	0	33	1	0	1
Quercus marilandica var. *marilandica*	1	-	33	4	0	2
Quercus montana	7	0	100	5	4	5
Quercus rubra var. *rubra*	4	-	100	6	3	3
Quercus velutina	2	- -	67	3	1	1
Sassafras albidum	2	-	67	3	1	2
Sericocarpus asteroides	2	+	33	33	7	67
Smilax glauca	2	0	67	5	1	5
Solidago bicolor	2	+	33	8	2	17
Tephrosia virginiana	2	+	33	33	7	67
Vaccinium pallidum	6	+	100	6	4	12
Vitis aestivalis var. *aestivalis*	2	0	33	5	1	5

Table 40. Woody stem data summary for the *Pinus pungens* – *Quercus montana* / *Kalmia latifolia* – *Gaylussacia baccata* Woodland community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for three plots representing the type. Species with IV > 0.95 are listed in descending order of IV.

SPECIES	Tree Density	Large Tree Density	TOTAL DENSITY	RELATIVE DENSITY	BASAL AREA	RELATIVE BASAL AREA	IV
Pinus pungens	567	8	575	34.22	17.17	68.06	51.14
Quercus montana	383	0	383	25.54	7.26	26.61	26.07
Kalmia latifolia	600	0	600	27.14	0.63	2.50	14.82
Pinus virginiana	50	0	50	4.60	0.26	0.94	2.77
Sassafras albidum	25	0	25	2.94	0.29	1.08	2.01
Quercus rubra	67	0	67	3.60	0.06	0.33	1.97
other species	17	0	17	1.96	0.13	0.48	1.22
TOTALS	**1708**	**8**	**1717**	**100.00**	**25.80**	**100.00**	**100.00**

Table 41. Vertical structure of woody taxa and total stratum cover in three plots of the *Pinus pungens – Quercus montana* / *Kalmia latifolia – Gaylussacia baccata* Woodland community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Acer rubrum	2					
Amelanchier arborea		2				
Carya alba		2				
Carya glabra		2				
Gaylussacia baccata	5	7				
Kalmia latifolia		7				
Nyssa sylvatica		1				
Pinus pungens	2	5	7	5		
Pinus virginiana		4	2			
Prunus serotina var. *serotina*		2				
Quercus marilandica var. *marilandica*		1				
Quercus montana	2	6	6	6		
Quercus rubra var. *rubra*	2	4				
Quercus velutina	2	2				
Sassafras albidum		2				
Smilax glauca	2	2				
Vaccinium pallidum	6	5				
Vitis aestivalis var. *aestivalis*	2					
Total Stratum Cover (%):						
Mean: all plots in type	**27**	**83**	**44**	**28**		
Mean: plots w/cover in stratum	**27**	**83**	**44**	**41**		

ECOLOGICAL COMMUNITY TYPE 4.2.

***Pinus rigida* – *Quercus montana* – (*Pinus virginiana*) / (*Quercus marilandica*) / *Kalmia latifolia* Woodland**

Pitch Pine – Chestnut Oak – (Virginia Pine) / (Blackjack Oak) / Mountain-laurel Woodland
PITCH PINE – OAK / HEATH WOODLAND

Habitat and Distribution: Pitch Pine – Oak / Heath Woodlands are scattered on most major ridges of the Bull Run Mountains, forming small to occasionally large patches. This community type is strongly associated with dry, convex slopes with copious evidence of past fires. Subjectively, habitats appear scarcely less xeric than those of the Table-Mountain Pine – Oak / Heath Woodland, and have comparably low TRMI values (mean = 14.49). Sites include narrow to broad ridge crests, upper slopes and, less frequently, middle slopes. Westerly aspects prevail among nine plot samples. Exposed rocks constitute ≤ 2% of surface substrate at most plot-sampling sites, which are located on relatively gentle slopes (mean inclination = 11˚). However, plots BRM045 and BRM046 represent a variant occurring on cliffs, with 70-75% surface substrate of exposed, massive quartzite. Except on cliffs, soils commonly have a 7-10 cm (3-4 in) deep surface horizon of charcoal-rich duff, partly decomposed humus, and shrub roots. Mineral soils beneath the organic mantle are light, yellowish sandy loams with relatively high organic matter content (mean = 10.12%) and extremely low fertility. Samples extracted from plots had very low mean values for pH, Ca, Mg, Mn, and total base saturation, and had high mean values for Fe and Al (Table 42).

Composition and Physiognomy:

Constant Species (constancy ≥ 80%):
Gaylussacia baccata, *Kalmia latifolia*, *Pinus rigida*, *Quercus montana*, *Vaccinium pallidum*.

Dominant Species (mean cover ≥ 6):
Kalmia latifolia (7), *Pinus rigida* (7), *Quercus montana* (7), *Gaylussacia baccata* (6), *Nyssa sylvatica* (6), *Pinus virginiana* (6), *Vaccinium pallidum* (6).

Diagnostic Species (fidelity = 100%):
Epigaea repens.

Indicator Species (highest unscaled adj. IVs):
Pinus rigida, *Pinus virginiana*, *Quercus marilandica* var. *marilandica*, *Gaylussacia baccata*, *Kalmia latifolia*, *Vaccinium pallidum*, *Pteridium aquilinum* var. *latiusculum*.

Stand physiognomy varies from stunted, open woodland to nearly closed forest. Mean canopy cover ranges from 15 to 90% (mean = 58%) while mean canopy height ranges from 11 to 25 m (36 to 82 ft; mean = 18 m [59 ft]). *Pinus rigida* (pitch pine; stems up to 44 cm [17 in] dbh) and *Quercus montana* (chestnut oak; stems up to 63 cm [25 in] dbh) share overstory dominance, in aggregate contributing equal density and basal area to plot-sampled stands (Table 44). Most of the *Pinus rigida* populations consist largely of even-aged cohorts that probably regenerated following catastrophic fires; most older *Quercus montana* originated from basal sprouts. *Pinus virginiana* (Virginia pine; stems up to 43 cm [17 in] dbh) is the most frequent overstory associate, occurring in 78% of the plots. Occasional overstory associates include *Pinus strobus* (white pine; stems up to 30 cm [12 in] dbh), *Quercus velutina* (black oak; stems up to 20 cm [8 in] dbh), *Quercus coccinea* (scarlet oak; stems up to 30 cm [12 in] dbh; mostly in even-aged cohorts), *Acer rubrum* (red maple; stems up to 25 cm [10 in] dbh), and *Populus grandidentata* (bigtooth aspen; not documented in plots). Stands usually have a well-developed but open understory tree layer (mean stratum cover = 38%) that contains recruitment of the overstory species, as well as *Quercus marilandica* var. *marilandica* (blackjack oak), *Sassafras albidum* (sassafras), and *Nyssa sylvatica* (black gum).

The shrub layer is dense (mean stratum cover = 74%), with *Kalmia latifolia* (mountain-laurel) and *Gaylussacia baccata* (black huckleberry) dominating and numerous tree saplings usually present. The herb layer (< 0.5m; mean stratum cover = 38%) is dominated by patchy *Vaccinium pallidum* (early lowbush blueberry) and tree seedlings; true herbaceous plants are nearly lacking except for scattered individuals of *Pteridium aquilinum* var. *latiusculum* (northern bracken fern), *Isotria verticillata* (large whorled pogonia), *Carex tonsa* (a sedge), and *Cypripedium acaule* (pink lady's-slipper). The sub-shrubs *Chimaphila maculata* (spotted wintergreen) and *Epigaea repens* (trailing arbutus) also occur. The depauperate nature of the flora is quantified by a community-type mean species richness of 15 taxa per 400 m^2.

Distinguishing Features: Distinguishing features include xeric crest and upper-slope habitats, overstory co-dominance by *Pinus rigida*, and the somewhat open and/or stunted character of the vegetation. Examples occurring on cliffs and large outcrops may be distinguished from the Table-Mountain Pine – Oak / Heath Woodland by their dominant pine. In some situations, Pitch Pine – Oak / Heath Woodlands intergrade with stands of Chestnut Oak Forest on the landscape. Elsewhere, the boundaries between this community and co-occurring vegetation types are usually sharp.

Global Conservation Rank: G4

State Conservation Rank: S3

Synonymy: USNVC CEGL004996: *Pinus* (*pungens*, *rigida*) – *Quercus prinus* / *Quercus ilicifolia* / *Gaylussacia baccata* Woodland, *pro parte*. *Quercus prinus – Pinus rigida* / *Quercus ilicifolia – Kalmia latifolia – Gaylussacia baccata* / *Gaultheria procumbens* Woodland, *pro parte* (Virginia State Name; Fleming and Coulling 2001). SAF Cover Type 45: Pitch Pine, *pro parte*. SAF Cover Type 44: Chestnut Oak: chestnut oak – pitch pine variant, *pro parte*.

Comments: Small to large charcoal fragments were found in the duff and humus layers in all plots, and fire scars were present on larger trees in most. Snags of *Pinus rigida* killed by southern pine beetle (*Dendroctonus frontalis*) within the past ~10 years were present in or around five plots. Old wood debris and/or live sprouts of *Castanea dentata* (American chestnut) were present in four plots. Light defoliation of oaks by gypsy moth was also noted in four plots.

Populations of *Pinus rigida* and *Pinus pungens* (table-mountain pine) share a dependence on periodic fires to maintain themselves, but the reproductive strategy of *Pinus rigida* relies as much on vegetative sprouting as on recruitment of new seedlings. In addition to cone serotiny, adaptations to fire exhibited by *Pinus rigida* include an ability to sprout new growth from the trunk and branches following fire injury, or from the base of the tree if the entire stem is killed (Fowells 1965). In the absence of stand-opening fire or other disturbance, little or no recruitment of this shade-intolerant species is possible. Presumably because of dramatic reduction or exclusion of fires in the 20th century, many *Pinus rigida* woodlands appear to be undergoing canopy closure and slow but certain encroachment by *Quercus montana* and other oaks. Except for the two stands inhabiting quartzite outcrops, such a condition is characteristic of stands in the study area. A good indicator of fire suppression in the Bull Run Mountains' pitch pine woodlands is the recent establishment of *Acer rubrum* (red maple) and/or *Fagus grandifolia* (American beech) saplings in the understory at all but one of the sampling sites. These thin-barked species are shade-tolerant, very susceptible to fire and, in the case of the mesophytic *Fagus*, decidedly out of place in the high, xeric habitats.

In Virginia, the Pitch Pine – Oak / Heath Woodland is essentially a montane community type with a limited distribution in the Piedmont, mostly on foothill monadnocks. There are unresolved issues regarding the classification of this unit and its relationship to the very similar Table-Mountain Pine – Oak / Heath Woodland. Recognition of separate vegetation types seems warranted in the Bull Run Mountains, where the two pines co-occur infrequently, occupy mostly different habitats, and exhibit somewhat different reproductive strategies. In an analysis of 918 plots collected throughout the Virginia mountains, Fleming and Coulling (2001) identified two comparable types (see "Synonymy" above) although the nominal pines intermingled more and the pitch pine community was represented by data collected mostly at higher elevations (> 900 m [3000 ft]). *Quercus ilicifolia* (bear oak), a species known from a single historical collection in the Bull Run Mountains, was a characteristic shrub with high adjusted IVs in both units. Additional species characteristic of montane pitch pine communities, but not those of the Bull Run Mountains, include *Hamamelis virginiana* (witch-hazel), *Gaultheria procumbens* (wintergreen), *Melampyrum lineare* (cow-wheat), *Iris verna* (dwarf iris), and *Diphasiastrum tristachyum* (ground cedar). At the regional scale represented by the U.S. National Vegetation Classification (USNVC; Grossman *et al*. 1998), these units are considered subtypes of a single association, the *Pinus* (*pungens*, *rigida*) – *Quercus prinus* / *Quercus ilicifolia* / *Gaylussacia baccata* Woodland. Additional data collection and analysis is needed to fully assess the relationship of montane and Piedmont pine-oak/heath woodlands and to determine whether the absence of *Quercus ilicifolia* and other species from the latter is significant to classification.

Representative Plots and Examples: This unit is represented by nine plot samples: BRM022, 025, 029, 032, 035, 045, 046, 050, and 053. The largest example in the study area occurs somewhat discontinuously along the crest and western slope of the east ridge, from about 1.6 km (1 mi) NE of Hopewell Gap to the vicinity of Bull Run Mountain Estates. This occurrence, however, has been at least partly devastated by outbreaks of the southern pine beetle. One of the most recently burned and thoroughly pine-dominated stands (containing *Pinus rigida*, *Pinus virginiana*, and *Pinus strobus*) occurs on a knob of the east ridge 1.6 km (1 mi) south of Hopewell Gap. An outstanding example of the cliff/outcrop variant occurs at White Rock on Signal Mountain, NE of Hopewell Gap. Other representative stands may be seen in a narrow zone along the upper west flank of High Point Mountain between Thoroughfare Gap and the cliffs (Plate 17, p. 137).

Table 42. Environmental information summary for nine plots of the *Pinus rigida – Quercus montana –* (*Pinus virginiana*) / *(Quercus marilandica)* / *Kalmia latifolia* Woodland community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	**MEAN**	**MIN**	**MAX**
Elevation (m / ft)	309 / 1013	213 / 700	384 / 1260
Topographic Position	upper slope	middle slope	crest
Relative Slope Position (0 to 1)	0.88	0.58	1.00
SURFACE SUBSTRATE COVER (%):			
Wood	2	1	5
Bedrock	10	0	50
Boulders	6	0	30
Stones	1	0	4
Cobbles	0	0	0
Gravel	0	0	0
Mineral Soil	<1	0	1
Organic Matter	81	20	98
Water	0	0	0
Bryophytes and Lichens	13	0	60
Slope (degrees)	11	1	35
Slope Shape: Vertical	convex	straight	convex
Slope Shape: Horizontal	convex	straight	convex
Aspect (degrees [direction])	244 (WSW)	135 (SE)	311 (NW)
Moisture Regime	xeric	xeric	subxeric
Topographic Relative Moisture Index (0 to 60)	14.5	7.8	24.7
SOIL CHEMISTRY AND TEXTURE:			
pH	4.1	3.9	4.3
Calcium (ppm)	132	63	362
Magnesium (ppm)	34	24	59
Iron (ppm)	340	191	401
Manganese (ppm)	6	2	32
Zinc (ppm)	2.2	1.3	3.7
Phosphorus (ppm)	21	12	35
Potassium (ppm)	43	26	61
Aluminum (ppm)	1097	430	1533
Copper (ppm)	0.66	0.44	1.16
Boron (ppm)	0.36	0.25	0.43
Sodium (ppm)	11	6	18
Soluble Sulphur (ppm)	44	34	58
% Organic Matter	10.12	4.82	25.81
Total Cation Exchange Capacity	17.93	9.93	24.18
Total Base Saturation (%)	6.17	3.59	11.70
% Clay	4	1	7
% Silt	37	14	49
% Sand	59	46	84

Table 43. Floristic composition of the *Pinus rigida – Quercus montana* – (*Pinus virginiana*) / *(Quercus marilandica)* / *Kalmia latifolia* Woodland community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the nine plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 15

Community Type Homoteneity = 0.763

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acer rubrum	4	- -	67	6	3	2
Amelanchier arborea var. *arborea*	2	0	22	2	0	2
Carex tonsa	2	+	22	6	1	13
Carya ovalis	1	- - -	11	1	0	0
Castanea dentata	2	0	22	3	1	3
Chimaphila maculata	2	0	78	12	3	12
Cypripedium acaule	1	0	22	15	2	15
Dennstaedtia punctilobula	1	0	11	2	0	2
Diospyros virginiana	2	0	44	11	2	11
Epigaea repens	1	0	11	11	1	11
Fagus grandifolia	2	- - -	44	5	1	1
Gaylussacia baccata	6	+	89	25	17	51
Isotria verticillata	1	0	11	2	0	2
Kalmia latifolia	7	+	100	23	18	45
Nyssa sylvatica	6	0	67	7	5	7
Pinus rigida	7	++	100	75	58	300
Pinus strobus	2	0	11	6	1	6
Pinus virginiana	6	+++	78	30	20	242
Prunus serotina var. *serotina*	1	-	22	2	0	1
Pteridium aquilinum var. *latiusculum*	2	+	22	11	2	22
Quercus coccinea	4	0	56	14	6	14
Quercus marilandica var. *marilandica*	4	++	56	35	15	139
Quercus montana	7	0	100	15	12	15
Quercus rubra var. *rubra*	4	-	56	5	2	3
Quercus velutina	4	0	78	13	6	13
Rhododendron periclymenoides	2	-	44	5	1	2
Sassafras albidum	4	+	67	9	4	18
Smilax glauca	2	0	33	3	1	3
Smilax rotundifolia	2	-	44	4	1	2
Vaccinium pallidum	6	+	100	17	12	35
Vaccinium stamineum	3	+	56	11	4	21

Table 44. Woody stem data summary for the *Pinus rigida – Quercus montana* – (*Pinus virginiana*) / *(Quercus marilandica)* / *Kalmia latifolia* Woodland community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for nine plots representing the type. Species with IV > 0.95 are listed in descending order of IV.

SPECIES	Tree Density	Large Tree Density	TOTAL DENSITY	RELATIVE DENSITY	BASAL AREA	RELATIVE BASAL AREA	IV
Quercus montana	294	17	311	20.58	11.98	38.31	29.44
Pinus rigida	300	11	311	20.10	11.72	38.41	29.25
Kalmia latifolia	531	0	531	26.97	0.70	2.33	14.65
Pinus virginiana	214	3	217	12.35	3.03	9.28	10.82
Nyssa sylvatica	164	0	164	7.36	1.36	3.83	5.60
Acer rubrum	53	0	53	2.42	0.46	1.98	2.20
Sassafras albidum	50	0	50	3.27	0.23	1.03	2.15
Quercus velutina	28	0	28	1.93	0.36	1.33	1.63
Quercus rubra var. *rubra*	14	0	14	0.83	0.28	1.18	1.01
Quercus marilandica var. *marilandica*	17	0	17	1.56	0.09	0.35	0.96
other species	36	0	36	2.63	0.73	1.96	2.29
TOTALS	**1700**	**31**	**1731**	**100.00**	**30.93**	**100.00**	**100.00**

Table 45. Vertical structure of woody taxa and total stratum cover in nine plots of the *Pinus rigida – Quercus montana –* (*Pinus virginiana*) / *(Quercus marilandica)* / *Kalmia latifolia* Woodland community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	**<0.5m**	**0.5-6m**	**6-10m**	**10-20m**	**20-35m**	**>35m**
Acer rubrum	2	3	3	3		
Amelanchier arborea	1	2				
Carya ovalis	1	1				
Castanea dentata	1	2				
Diospyros virginiana	2	1				
Fagus grandifolia	2	2				
Gaylussacia baccata	4	6				
Kalmia latifolia	3	7				
Nyssa sylvatica	2	5	5	3		
Pinus rigida	2	5	5	6	6	
Pinus strobus			2	2		
Pinus virginiana		4	4	4	4	
Prunus serotina var. *serotina*	1	1				
Quercus coccinea	2	2		2	3	
Quercus marilandica var. *marilandica*	2	2	2			
Quercus montana	4	4	6	6	5	
Quercus rubra var. *rubra*	2	2	2	2	2	
Quercus velutina	2	3	3	2	2	
Rhododendron periclymenoides	2	1				
Sassafras albidum	2	3	2			
Smilax glauca	2	2				
Smilax rotundifolia	2	2				
Vaccinium pallidum	6	2				
Vaccinium stamineum	2	2				
Total Stratum Cover (%):						
Mean: all plots in type	**31**	**74**	**38**	**45**	**26**	
Mean: plots w/cover in stratum	**31**	**74**	**38**	**45**	**77**	

ECOLOGICAL COMMUNITY TYPE 4.3.

***Quercus montana* – (*Quercus coccinea, Quercus velutina*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest**

Chestnut Oak – (Scarlet Oak, Black Oak) / Mountain-laurel / Early Lowbush Blueberry Forest
CHESTNUT OAK FOREST

Habitat and Distribution: This dry oak- and ericad-dominated community is the most widespread and extensive community type in the Bull Run Mountains. It forms large patches on all of the area's ridges and occurs on all topographic positions from lower slopes to crests, but is most characteristic of middle and upper slopes. Because of bedrock stratigraphy and related patterns of soil development, this community type is probably more extensive on the western ridge flanks but also occupies sizeable areas on eastern slopes where conditions are favorable. Plot-sampling sites were subjectively considered subxeric to xeric (rarely submesic), corresponding to relatively low TRMI values (mean = 22.13; range = 5.63 to 38.25). Slope (range = 3 to 26˚) and aspect (mean = 180˚) are highly variable, while slope shape is usually convex in at least one direction. No bedrock outcrops occur in any of 15 plot samples, and surface substrate cover of loose boulders, stones, and gravel does not exceed 15% in any plot (mean = 5% loose rock cover). Soils are mostly weathered in residuum from massive or flaggy quartzite, and typically have a dense, 2-10 cm (1-4 in) deep surface horizon of duff, humus, and shrub roots. Mineral soils beneath the organic mantle are light, yellowish, sandy loams, usually containing numerous small quartzite fragments. Samples extracted from plots were extremely acidic and infertile, with cation concentrations and low total base saturation comparable to soils of the pine-oak/heath communities.

Composition and Physiognomy:

<u>Constant Species (constancy ≥ 80%):</u>
Acer rubrum, *Chimaphila maculata*, *Kalmia latifolia*, *Nyssa sylvatica*, *Quercus montana*, *Quercus velutina*, *Sassafras albidum*, *Smilax glauca*, *Vaccinium pallidum*.

<u>Dominant Species (mean cover ≥ 6):</u>
Quercus montana (8), *Kalmia latifolia* (7), *Nyssa sylvatica* (7), *Acer rubrum* (6), *Gaylussacia baccata* (6), *Quercus coccinea* (6), *Vaccinium pallidum* (6).

<u>Diagnostic Species (fidelity = 100%):</u>
Chamaelirium luteum, *Euphorbia corollata*, *Lespedeza hirta* ssp. *hirta*, *Viola sagittata* var. *sagittata*.

<u>Indicator Species (highest unscaled adj. IVs):</u>
Quercus coccinea, *Kalmia latifolia*, *Sassafras albidum*, *Vaccinium pallidum*, *Quercus montana*, *Gaylussacia baccata*, *Nyssa sylvatica*, *Quercus velutina*, *Vaccinium stamineum*.

Stands of this community type tend to have a somewhat open canopy (mean stratum cover = 73%) with trees that are shorter (mean canopy height = 27 m) than those of the area's more mesophytic forests. *Quercus montana* (chestnut oak; stems up to 107 cm [42 in] dbh, commonly 35-60 cm [14-24 in] dbh) is the overwhelming overstory dominant and accounts for 65% of the large-tree (≥ 40 cm [16 in] dbh) density in plot-sampled stands. *Quercus coccinea* (scarlet oak; stems up to 55 cm [22 in] dbh) is the most frequent overstory associate, varying from sparse to occasionally co-dominant over small areas. *Quercus velutina* (black oak; stems up to 58 cm [23 in] dbh) is a frequent but minor overstory associate. Infrequent, minor overstory species include *Quercus alba* (white oak; stems up to 59 cm [23 in] dbh), *Quercus rubra* var. *rubra* (northern red oak; stems up to 43 cm [17 in] dbh), *Pinus rigida* (pitch pine; stems up to 47 cm [19 in] dbh), *Acer rubrum* (red maple; stems up to 44 cm [17 in] dbh), *Carya glabra* (pignut hickory; stems up to 25 cm [10 in] dbh), *Liriodendron tulipifera* (tulip-poplar; stems up to 45 cm [18 in] dbh), *Fagus grandifolia* (American beech; stems up to 78 cm [31 in] dbh), and *Populus* *grandidentata* (big-tooth aspen; not captured in plots).

Acer rubrum and *Nyssa sylvatica* (black gum) dominate the understory tree layers, occasionally attaining densities as high as 850 and 750 stems/ha in an individual plot. *Quercus montana* usually has substantial cover and density in these layers as well. Occasional understory trees include *Carya alba* (mockernut hickory), *Carya glabra*, *Castanea dentata* (American chestnut; root sprouts), *Sassafras albidum* (sassafras), *Amelanchier* spp. (serviceberries), *Fagus grandifolia*, and young recruitment of associate oaks. The shrub-layer has moderate to dense cover (mean = 66%), most of it contributed by *Kalmia latifolia* (mountain-laurel), *Gaylussacia baccata* (black huckleberry), and tree saplings. Minor but relatively constant shrub-layer associates include *Vaccinium stamineum* (deerberry), *Rhododendron periclymenoides* (wild azalea), *Smilax glauca* (white-leaf greenbrier), and *Smilax rotundifolia* (common greenbrier). The herb layer (mean stratum cover = 28%) consists mostly of low colonies of *Vaccinium pallidum* (early lowbush blueberry) and seedlings of *Quercus montana*. The rocky, infertile soils, dense root mats from colonial ericads, and dense shade of *Kalmia latifolia* thickets combine to create difficult conditions for the establishment of herbs. Although the perennial sub-shrub *Chimaphila maculata* (spotted wintergreen) occurs with low cover in almost every plot, no true herbaceous species attains a constancy > 40% or a mean cover > 2 (< 1%) across all plots of the type. Nevertheless, scattered individuals of *Aureolaria laevigata* (smooth yellow false foxglove), *Dichanthelium dichotomum* (small-fruited panic grass), *Hieracium venosum* (rattlesnake weed), *Isotria verticillata* (large whorled pogonia), *Monotropa uniflora* (Indian-pipe), *Pteridium aquilinum* var. *latiusculum* (northern bracken fern), and other xerophytic herbs are characteristic. Mean species richness ranges from 16 to 33 taxa per 400 m^2 (mean = 22).

Community Subtypes: Based on the results of quantitative analyses, two fully intergrading compositional subtypes are recognized. These segregates must be regarded as tentative since they form more of a compositional continuum than two sharply delimited units. They are defined almost entirely by the relative abundances of key species, since few species are wholly restricted to either subtype. Those that are may well represent artifacts of a limited sample size. Factors influencing the compositional differences between subtypes may include differences in site conditions, fire histories, and logging histories; clarification of these factors will require additional study. Despite these constraints, formal recognition of subtypes may be useful for characterizing variation that is readily apparent in the field.

4.3.1. *Quercus montana* – (*Quercus velutina*) / *Kalmia latifolia* Subtype - the most typical expression of this subtype occurs on relatively steep (mean = 16˚) middle to upper slopes with > 5% exposed rock substrate. The overstory is dominated entirely by *Quercus montana*, often in nearly monospecific stands, beneath which *Kalmia latifolia* forms a dense (50 to 75% cover) to impenetrable (~100% cover) tall shrub layer. In some stands, however, *Kalmia* is sparse and *Vaccinium pallidum* is the dominant ericad. *Gaylussacia baccata* is present throughout, rarely contributing more than 10% cover to a plot. *Quercus velutina* is the most frequent overstory associate but never achieves the status of co-dominance, except perhaps over very small areas. *Acer rubrum* and/or *Nyssa sylvatica* heavily dominate the understory tree layers. Other species that appear to have higher fidelity to, or be more abundant in, this subtype include *Vaccinium stamineum*, *Smilax rotundifolia*, *Quercus rubra* var. *rubra*, and *Castanea dentata*. Mean species richness is 25 taxa per 400 m^2. Some stands of this subtype have clearly developed from stands formerly dominated by *Castanea dentata* (*e.g*., plot BRM064) or mixtures of *Castanea* and *Quercus montana* (*e.g*., plot BRM034).

4.3.2. *Quercus montana* – (*Quercus coccinea*) / *Gaylussacia baccata* Subtype - plot samples of this subtype occupy upper slopes and broad ridge crests with gentle slopes (mean = 8˚) and few or no surface rocks. These sites tend to have soils with deep (up to 10 cm [4 in]), densely root-matted organic horizons. Charcoal fragments are usually plentiful in the duff. The overstory is dominated by *Quercus montana* in nearly pure stands or in mixtures with *Quercus coccinea*. The latter achieves co-dominant status on some sites, but is absent or sparse on others. The ericaceous shrub layer tends to be dominated by dense colonies of *Gaylussacia baccata*, with < 25% cover of *Kalmia latifolia*. Other species apparently more characteristic of this subtype include *Pinus rigida*, *Quercus marilandica* var. *marilandica*, and *Pteridium aquilinum* var. *latiusculum*. Mean species richness is 17 taxa per 400 m^2. Overall, this subtype appears to be somewhat transitional between subtype 4.3.1. and the Pitch Pine – Oak / Heath Woodland community type.

Distinguishing Features: Diagnostic features of the Chestnut Oak Forest include strong overstory dominance of *Quercus montana*, sometimes with *Quercus coccinea*; understory dominance by *Acer rubrum* and/or *Nyssa sylvatica*; prevalence of dense ericaceous shrub colonies; and extremely low cover of herbaceous plants are. Additionally, the absence or scarcity of species important in other types, including *Carya* spp., *Liriodendron tulipifera*, and *Pinus rigida*, help distinguish stands from co-occurring communities in the field. For the most part, boundaries between stands of Chestnut Oak Forest and other community types are fairly sharp. More gradual, less distinct transitions with Pitch Pine – Oak / Heath Woodland and both oak-hickory forests occur locally.

Global Conservation Rank: G5

State Conservation Rank: S5

Synonymy: USNVC CEGL006282: *Quercus prinus* – *Quercus* (*rubra*, *velutina*) / *Gaylussacia baccata* Forest, *pro parte*. *Quercus prinus* / *Kalmia latifolia* – *Rhododendron periclymenoides* Forest (Virginia State Name; Fleming and Coulling 2001). *Quercus prinus* – (*Quercus coccinea*, *Quercus velutina*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest (Fleming 2002). SAF Cover Type 44: Chestnut Oak, including chestnut oak – scarlet oak variant.

Comments: Many stands of this community type contain a high percentage of stump-sprouted trees, indicating a history of extensive logging. While the sites supporting Chestnut Oak Forest were never suitable for agriculture, they have all been utilized for their timber resources and have been influenced by multiple disturbances. Stumps, old wood, and/or living root-sprouts of *Castanea dentata*, were recorded in 10 of the 15 plots. Fire scars and/or charcoal fragments were present in seven plots. More recent evidence of disturbance included gypsy moth (*Lymantria dispar*) caterpillars, egg masses, and/or defoliation in 11 plots, and snags of *Cornus florida* resulting from anthracnose (*Discula destructiva*) in two plots. Although major canopy gaps were avoided when choosing plot locations, large oak snags resulting from drought and gypsy moth damage in the late 1980's and early 1990's are scattered throughout the study area. Damage to tree crowns from ice or wind and visible herbivory by white-tailed deer were each documented in a single plot.

Castanea dentata was clearly an important tree on sites now occupied by Chestnut Oak Forest, but past fires and logging, especially prior to the arrival of the blight, have obscured much of the evidence necessary to estimate its former abundance on specific sites. Exceptions include the vicinity of plot BRM064, located on the northernmost segment of the middle ridge north of Hopewell Gap (historically called "Shooter's Hill"), where a virtual "chestnut graveyard" on the upper western slope indicates total past dominance by *Castanea dentata*. Moreover, before succumbing to the blight, trees on this site had escaped cutting for a long period and had attained large sizes. Some of the dead *Castanea* fell in place; others were cut in an attempted salvage operation but left to rot because of their hollow trunks. The ground in this area is now littered with numerous, large, rotting *Castanea* boles, and it is possible to determine which species filled the large gaps created when these patriarchs fell. On this site, the replacement stand consists mainly of *Quercus velutina*, *Quercus coccinea*, and *Quercus montana*. Another area on the middle ridge (vicinity of plot BRM034) harbors *Castanea dentata* stumps and stump-sprouted oaks indicative of a pre-logging stand about equally co-dominated by *Castanea* and *Quercus montana*. The replacement of *Castanea* here was largely by more mesophytic species such as *Quercus* *rubra* var. *rubra* and *Liriodendron tulipifera*. No evidence of fire was found at either middle-ridge site.

Some of the nearly monospecific stands of *Quercus montana* on more xeric sites of the study area now show little of no evidence of *Castanea dentata*. It seems plausible that *Castanea* was only a minor associate of these stands, in which *Quercus montana* may have continually dominated despite recurring disturbance (Stephenson *et al.* 1992). Even though the pre-blight distribution of *Castanea* favored mesic or submesic sites (Braun 1950, Russell 1987), Stephenson *et al.* (1991) found that persistent sprouts were most abundant on subxeric sites and conspicuously absent from the most mesic and most xeric sites. Likewise, in a study of a 1455 ha (3600 ac), never-logged site on Peters Mountain in Alleghany County, Virginia, Fleming and Moorhead (2000) found that the distribution of living sprouts did not coincide strongly with the distribution of *Castanea* logs. In this area, thousands of slowly rotting logs indicated that *Castanea* was most abundant and often dominant on submesic middle slopes and benches. By contrast, the highest mean cover of sprouts was attained on more xeric, exposed slopes dominated by *Quercus montana* and dense ericads, despite the fact that logs and old wood were widely scattered. The reasons for discrepancies between former and current *Castanea* distribution patterns are not entirely clear, but may relate to the inability of sprouts to compete in more shaded, mesic habitats that now usually support diverse forest communities.

High densities of *Acer rubrum* and *Nyssa sylvatica* in the understory of the study area's Chestnut Oak Forest are consistent with data reported from elsewhere in the central Appalachian region (Mikan *et al.* 1994, Nowacki and Abrams 1992, Rhoades 1992, Rhoades 1995, Rhoades 2002, Ruffner and Abrams 1998, Stephenson and Fortney 1998). Recent encroachment of oak forests by these species and other mesophytic trees has been correlated with widespread oak decline resulting from fire exclusion and post-logging accelerated succession (Abrams 1992, Abrams 1998, Abrams and Nowacki 1992). Chestnut Oak Forests of the Bull Run Mountains, however, do not currently exhibit the dramatic reduction of oak recruitment cited by most of these studies. Although exceeded by both *Acer rubrum* and *Nyssa sylvatica* densities, significant numbers of *Quercus montana* stems are present in all understory size classes, and often outnumber competitors in the stratum immediately below the overstory. Light gaps resulting from trees killed by drought and gypsy moth damage 10 to 15 years ago have also resulted in the recent appearance and rapid growth of huge numbers of *Quercus montana* seedlings and small saplings. The longevity and competitive persistence of *Quercus montana* makes it likely that this oak will remain a dominant or co-dominant species in this community in the foreseeable future.

Forest communities characterized by *Quercus montana* overstories are widespread on dry sites in the Virginia mountains (Adams and Stephenson 1983, Fleming and Coulling 2001, Johnson and Ware 1982, Stephenson 1974, Stephenson and Adams 1991). These communities are less common in the Piedmont, where they have been correlated with soils low in Mg and Ca, often on monadnocks (Cole and Ware 1997). Several segregate community types have been proposed, based on quantitative analysis of plot data collected throughout western Virginia and examination of data reported from elsewhere in the U.S. National Vegetation Classification (Fleming and Coulling 2001). The Chestnut Oak Forest of the Bull Run Mountains is representative of the northern type (CEGL006282; see "Synonymy" above) that lacks typical species of the southern Appalachian chestnut oak forests such as *Galax urceolata* (galax), *Leucothoe recurva* (mountain fetterbush), *Oxydendrum arboreum* (sourwood), and *Rhododendron maximum* (great rhododendron). This community type ranges from west-central Virginia and adjacent West Virginia north through the central Appalachians and more locally in the Piedmont to lower New England.

Representative Plots and Examples: This unit is represented by 15 plot samples:
Subtype 4.3.1 – plots BRM018, 019, 020, 034, 042, 047, 049, 055, 064, and 072.
Subtype 4.3.2 – plots BRM023, 024, 027, 040, and 051.
Although no single stand in this area is of exceptional quality, all stands in aggregate represent a very large occurrence for the Piedmont. Representative older stands (~90-110 years old) were noted on Pond

Mountain (Arlington Outdoor Education Association property); on the western flank and crest of High Point Mountain (Plate 18, p. 138); on the middle ridge near Jackson Hollow; on the eastern flank of the east ridge, south of Hopewell Gap; and along the ridge crest both north and south of Cold Spring Gap.

Table 46. Environmental information summary for 15 plots of the *Quercus montana* – (*Quercus coccinea, Quercus velutina*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest community type. Mean, maximum, and minimum values for measured and scalar topographic and soil variables are provided. Mean aspect is calculated as the average position along an arc defined by the range of aspect values.

Variable	**MEAN**	**MIN**	**MAX**
Elevation (m / ft)	227 / 746	146 / 480	332 / 1090
Topographic Position	upper slope	lower slope	crest
Relative Slope Position (0 to 1)	0.65	0.05	1.00
SURFACE SUBSTRATE COVER (%):			
Wood	3	1	5
Bedrock	0	0	0
Boulders	2	0	10
Stones	2	0	6
Cobbles	1	0	6
Gravel	<1	0	2
Mineral Soil	1	0	5
Organic Matter	91	80	99
Water	0	0	0
Bryophytes and Lichens	4	0	12
Slope (degrees)	13	3	26
Slope Shape: Vertical	convex	straight	convex
Slope Shape: Horizontal	convex	concave	convex
Aspect (degrees [direction])	180 (S)	5 (N)	306 (NW)
Moisture Regime	subxeric	xeric	submesic
Topographic Relative Moisture Index (0 to 60)	22.1	5.6	38.3
SOIL CHEMISTRY AND TEXTURE:			
pH	4.1	3.7	4.7
Calcium (ppm)	116	66	166
Magnesium (ppm)	42	24	56
Iron (ppm)	328	157	470
Manganese (ppm)	19	2	86
Zinc (ppm)	2.0	1.2	2.7
Phosphorus (ppm)	27	14	107
Potassium (ppm)	39	24	65
Aluminum (ppm)	898	387	1542
Copper (ppm)	0.80	0.44	2.98
Boron (ppm)	0.33	<0.20	0.49
Sodium (ppm)	10	6	15
Soluble Sulphur (ppm)	41	31	49
% Organic Matter	8.29	3.89	12.65
Total Cation Exchange Capacity	16.39	8.84	22.54
Total Base Saturation (%)	6.86	3.87	12.20
% Clay	4	1	7
% Silt	40	25	63
% Sand	56	32	74

Table 47. Floristic composition of the *Quercus montana* – (*Quercus coccinea, Quercus velutina*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest community type. Mean cover, relative cover, constancy, community type indicator value, scaled adjusted indicator value, and unscaled adjusted indicator value are given for all taxa recorded in the 15 plots representing the type. Community type homoteneity is the mean constancy of the *S* most constant species, where *S* = community type mean species richness. See pp. 25-26 for a detailed explanation of summary statistics.

Community Type Mean Species Richness = 22
Community Type Homoteneity = 0.703

Taxon	**Mean Cover**	**Rel. Cover**	**Const.**	**Comm. Type IV**	**Scaled Adj. IV**	**Unscaled Adj. IV**
Acer rubrum	6	0	100	23	16	23
Agrostis perennans var. *perennans*	1	-	7	1	0	0
Amelanchier arborea var. *arborea*	2	0	27	5	1	5
Amelanchier laevis	1	-	7	1	0	1
Aralia nudicaulis	1	- - -	7	1	0	0
Aster divaricatus	1	-	7	0	0	0
Aureolaria laevigata	1	0	20	12	1	12
Carex albicans var. *albicans*	1	0	13	4	0	4
Carex digitalis	1	-	7	0	0	0
Carex pensylvanica	2	0	7	1	0	1
Carex swanii	1	0	7	1	0	1
Carex tonsa	1	0	13	4	0	4
Carya alba	2	- -	27	4	1	1
Carya glabra	4	0	47	14	6	14
Carya ovalis	2	- -	7	0	0	0
Castanea dentata	2	0	40	14	3	14
Chamaelirium luteum	1	0	7	7	1	7
Chimaphila maculata	2	0	93	30	7	30
Cornus florida	2	- -	13	1	0	0
Danthonia spicata	1	-	13	2	0	1
Dennstaedtia punctilobula	1	0	13	5	1	5
Desmodium nudiflorum	2	0	33	5	1	5
Dichanthelium commutatum	1	0	7	2	0	2
Dichanthelium depauperatum	1	0	7	3	0	3
Dichanthelium dichotomum	2	0	40	10	2	10
Dioscorea quaternata	2	0	20	2	0	2
Diospyros virginiana	1	-	13	2	0	1
Euphorbia corollata	1	0	7	7	1	7
Fagus grandifolia	5	0	53	13	7	13
Fraxinus americana	1	- -	7	0	0	0
Gaylussacia baccata	6	+	67	24	16	48
Hieracium venosum	2	+	20	8	2	15
Houstonia purpurea var. *purpurea*	1	-	7	0	0	0
Hypericum hypericoides ssp. *multicaule*	1	0	7	2	0	2
Hypoxis hirsuta	1	0	7	2	0	2
Ipomoea pandurata	1	0	7	1	0	1
Isotria verticillata	2	+	27	15	3	30
Kalmia latifolia	7	+	100	38	29	75

Table 47 – continued

Taxon	Mean Cover	Rel. Cover	Const.	Comm. Type IV	Scaled Adj. IV	Unscaled Adj. IV
Lespedeza hirta ssp. *hirta*	1	0	7	7	1	7
Liriodendron tulipifera	4	- -	53	9	4	2
Lycopodium obscurum	1	0	7	3	0	3
Lysimachia quadrifolia	1	0	13	5	1	5
Maianthemum racemosum ssp. *racemosum*	1	-	40	6	1	3
Medeola virginiana	1	-	7	0	0	0
Monotropa hypopithys	1	0	7	1	0	1
Monotropa uniflora	2	0	27	6	1	6
Nyssa sylvatica	7	+	93	24	18	48
Pinus rigida	3	- -	20	5	2	1
Pinus virginiana	2	-	33	9	2	5
Polygonatum biflorum var. *biflorum*	1	-	13	1	0	1
Polygonum virginianum	1	0	7	1	0	1
Polypodium virginianum	1	-	7	2	0	1
Potentilla canadensis	1	0	7	1	0	1
Prunus serotina var. *serotina*	1	-	40	8	1	4
Pteridium aquilinum var. *latiusculum*	1	0	13	7	1	7
Quercus alba	4	-	67	21	9	10
Quercus coccinea	6	++	67	33	22	133
Quercus marilandica var. *marilandica*	1	-	13	3	0	2
Quercus montana	8	+	100	25	23	51
Quercus rubra var. *rubra*	4	-	33	3	1	2
Quercus velutina	5	+	80	23	13	46
Rhododendron periclymenoides	2	-	60	14	3	7
Robinia pseudoacacia	1	0	7	3	0	3
Rosa carolina	1	0	7	1	0	1
Rubus flagellaris	1	-	13	1	0	1
Sassafras albidum	4	+	100	34	15	68
Smilax glauca	2	0	80	33	7	33
Smilax rotundifolia	2	-	67	15	3	7
Solidago bicolor	1	0	7	2	0	2
Solidago caesia	1	-	13	1	0	1
Solidago erecta	1	0	7	2	0	2
Toxicodendron radicans ssp. *radicans*	1	-	7	0	0	0
Vaccinium corymbosum	2	+	7	2	0	3
Vaccinium fuscatum	2	-	13	2	0	1
Vaccinium pallidum	6	+	100	29	19	58
Vaccinium stamineum	3	+	60	21	7	42
Viburnum acerifolium	1	-	7	1	0	0
Viola sagittata var. *sagittata*	1	0	7	7	1	7
Viola sororia	1	-	7	0	0	0
Vitis aestivalis var. *aestivalis*	1	-	13	4	0	2
Vitis aestivalis var. *bicolor*	1	-	27	7	1	4

Table 48. Woody stem data summary for the *Quercus montana* – (*Quercus coccinea, Quercus velutina*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest community type. Tree density (stems ≥ 2.5 cm and < 40 cm dbh), large tree density (stems ≥ 40 cm dbh), total density (stems/ha), relative density, total basal area (m^2/ha), relative basal area, and importance value (IV; = relative density + relative basal area / 2) are averaged for 15 plots representing the type. Species with IV > 0.95 are listed in descending order of IV.

SPECIES	Tree Density	Large Tree Density	TOTAL DENSITY	RELATIVE DENSITY	BASAL AREA	RELATIVE BASAL AREA	IV
Quercus montana	192	60	252	22.73	23.01	59.65	41.19
Nyssa sylvatica	315	0	315	22.39	1.77	4.88	13.64
Acer rubrum	300	2	302	21.94	1.74	4.82	13.38
Kalmia latifolia	320	0	320	15.03	0.42	1.21	8.12
Quercus coccinea	40	12	52	3.69	4.00	10.88	7.28
Quercus velutina	18	7	25	2.03	2.33	6.57	4.30
Fagus grandifolia	27	2	28	2.26	0.97	2.46	2.36
Pinus rigida	12	2	13	1.14	1.10	3.26	2.20
Quercus alba	2	5	7	0.79	1.08	2.50	1.64
Sassafras albidum	37	0	37	2.60	0.08	0.26	1.43
Carya glabra	23	0	23	1.58	0.36	1.17	1.38
other species	47	3	50	3.83	0.89	2.33	3.08
TOTALS	**1332**	**92**	**1423**	**100.00**	**37.74**	**100.00**	**100.00**

Table 49. Vertical structure of woody taxa and total stratum cover in 15 plots of the *Quercus montana* – (*Quercus coccinea, Quercus velutina*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest community type. The height class of each stratum is measured in meters (m), and mean cover of woody taxa across all plots is represented by a cover class. Mean total percent cover (including herbaceous cover in the < 0.5 m stratum) is given for each stratum as 1) an average across all plots and 2) an average across plots containing cover in the stratum. See p. 20 for definition of cover classes.

Species	<0.5m	0.5-6m	6-10m	10-20m	20-35m	>35m
Acer rubrum	2	6	6	4	2	
Amelanchier arborea	2	2				
Amelanchier laevis		1				
Carya alba	1	2	2			
Carya glabra	2	2	2	2	3	
Carya ovalis	1	1	2			
Castanea dentata	2	2	2			
Cornus florida		2				
Diospyros virginiana	1	1				
Fagus grandifolia	2	4	3	3	4	
Fraxinus americana						
Gaylussacia baccata	4	5				
Kalmia latifolia	2	7				

Table 49 – continued

Species	<0.5m	0.5-6m	6-10m	10-20m	20-35m	>35m
Liriodendron tulipifera	2	2	2		3	
Nyssa sylvatica	2	6	6	4		
Pinus rigida		1		2	3	
Pinus virginiana	1			2		
Prunus serotina var. *serotina*	1					
Quercus alba	1	2		2	4	2
Quercus coccinea	2	2	2	3	5	
Quercus marilandica var. *marilandica*	1			1		
Quercus montana	5	5	5	6	7	
Quercus rubra var. *rubra*	2	2	2	2	3	
Quercus velutina	2	2	2	4	4	
Rhododendron periclymenoides	2	2				
Robinia pseudoacacia	1					
Rosa carolina	1					
Rubus flagellaris	1					
Sassafras albidum	2	3	3			
Smilax glauca	2	1				
Smilax rotundifolia	2	2				
Toxicodendron radicans	1					
Vaccinium corymbosum		2				
Vaccinium fuscatum		2				
Vaccinium pallidum	6	2				
Vaccinium stamineum	3	2				
Viburnum acerifolium	1	1				
Vitis aestivalis var. *aestivalis*	1					
Vitis aestivalis var. *bicolor*	2					
Total Stratum Cover (%):						
Mean: all plots in type	**28**	**66**	**34**	**32**	**63**	**1**
Mean: plots w/cover in stratum	**28**	**66**	**34**	**32**	**73**	**8**

VEGETATION TYPES NOT DOCUMENTED WITH PLOT DATA

Several additional vegetation types occur in the Bull Run Mountains but were not plot-sampled or examined in detail during this study. In the case of the Piedmont / Mountain Acidic Cliff, collection of quantitative plot data was simply not possible in such a dangerous habitat. The remaining types represent disturbed, early-successional vegetation that was not a focus of this inquiry. Because of limited data from Virginia and in the USNVC, these units are defined only at the ecological group level, if at all.

Piedmont / Mountain Acidic Cliff

A large, high-quality occurrence of this natural community occupies the exposed, massive quartzite cliffs at the summit of High Point Mountain north of Thoroughfare Gap (Plate 25, p. 255). A much smaller occurrence is located at White Rock, on the upper west flank of Signal Mountain, northwest of Hopewell Gap. As defined here, the community encompasses both the cliff faces proper and the surfaces of open, large-block talus that lies immediately below (Plate 4, p. xvix). Crustose, foliose, and umbilicate lichens are the prevalent biota. *Lasallia pensylvanica* (blackened toadskin) is the dominant lichen, with common associates of *Xanthoparmelia conspersa* (peppered rock-shield), *Dimelaena oreina* (golden moonglow lichen), and *Umbilicaria muhlenbergii* (plated rock tripe). Minor lichen associates collected by DCR-DNH ecologist Dean Walton or H.A. Allard include *Cladina rangiferina* (gray reindeer lichen), *Cladonia uncialis* (thorn cladonia), *Melanelia culbersonii* (Appalachian camouflage lichen), and *Usnea amblyoclada* (rock beard lichen). The dominance of *Lasallia pensylvanica*, a lichen usually found at higher elevations in Virginia, is unusual, especially considering that its congener, *Lasallia papulosa* (common toadskin), is more widely distributed in the study area. *Melanelia culbersonii*, an Appalachian endemic, is a rare lichen in Virginia (Townsend 2002).

Habitats for rooted vascular plants are essentially limited to crevices and a few narrow ledges with mats of organic matter. Woody vines, especially *Smilax rotundifolia* (common greenbrier), are locally common on shelves and in deeper-soiled crevices. Very stunted clumps of *Kalmia latifolia* (mountain-laurel), *Populus grandidentata* (bigtooth aspen), *Quercus montana* (chestnut oak), and *Pinus pungens* (table-mountain pine) also occur. Xerophytic herbs such as *Polypodium virginianum* (rock polypody), *Heuchera pubescens* (downy alumroot), and *Dennstaedtia punctilobula* (hayscented fern) are scattered. Allard collected the regionally rare ferns *Asplenium montanum* (mountain spleenwort) and *Asplenium pinnatifidum* (lobed spleenwort) on the High Point cliffs, but neither has been found recently despite repeated searches.

This is a poorly known community that is impossible to plot-sample and difficult to assess, but certainly very rare in the Piedmont. The large, exposed cliffs on High Point Mountain, visible from Interstate 66 and numerous vantage points to the west (Plate 6, p. 11), constitute the Bull Run Mountains' most dramatic and well-known geomorphic feature. At least one area of the cliff top at High Point has been recently degraded by a herd of feral goats. This site has also been used occasionally for rock-climbing, an activity that has proven detrimental to fragile lithophytic plants, bryophytes, and lichens at other sites (McMillan and Larson 2002).

Piedmont / Low Mountain Alluvial Forest

Degraded examples of this natural community occur within the floodplain of Broad Run in its passage through Thoroughfare Gap. The stream flows strongly through this area as it drops over a series of quartzite ledges in the vicinity of Beverley Mill. It broadens as it leaves the east side of the gap, wraps around a large abandoned quarry, and subtends high bluffs of Triassic border conglomerate at the east foot of Pond Mountain. The stream channel, floodplain, and bottomland vegetation have been severely altered by large-scale construction projects over the past 150 years, including the current mill, the quarry, the Southern Railroad line, State Route 55, and Interstate 66. Portions that are still intact support young, disturbed alluvial forests of *Fraxinus pennsylvanica* (green ash), *Platanus occidentalis* (American sycamore), *Ulmus americana* (American elm), *Acer negundo* (boxelder), *Quercus palustris* (pin oak), and *Betula nigra* (river birch). Shrubs and woody vines include *Asimina triloba* (paw-paw), *Carpinus caroliniana* (American hornbeam), *Lindera benzoin* (spicebush), *Physocarpus opulifolius* (ninebark), *Staphylea trifoliata* (bladdernut), and *Toxicodendron radicans* (poison ivy). *Asarum canadense* (wild ginger), *Erythronium americanum* ssp. *americanum* (American trout-lily), *Hydrophyllum virginianum* (Virginia waterleaf), and other native herbs of fertile, well-drained floodplains still occur in spots. However, invasive exotic plants such as *Alliaria petiolata* (garlic mustard), *Rosa multiflora* (multiflora rose), *Lonicera japonica* (Japanese honeysuckle), and *Microstegium vimineum* (Japanese stilt grass) are rampant, along with weedy natives such as *Verbesina alternifolia* (wingstem). H.A. Allard's collections from the bottomland and aquatic habitats along Broad Run include a number of species that have not been found elsewhere in the area, but it is uncertain whether any of these restricted species still occur at this much disturbed site.

Early-Successional Communities

Although systematic inventory and quantitative sampling of this group were not undertaken, it may be worthwhile to summarize existing information about early-successional patterns in the study area. This summary is based on the historical work of H.A. Allard and qualitative observations by the author over a period of years. In addition, aerial photographs of the study area from 1952, 1970, 1980, and 1997 were compared in order to detect changes in land use and vegetation cover during the last 50 years.

Ruderal Vegetation of Fields and Clearings

Most abandoned agricultural lands in the study area succeed rapidly to forests, passing through a scrub stage dominated by variable combinations of *Rubus* spp. (blackberries), *Juniperus virginiana* var. *virginiana* (eastern red cedar), *Rhus* spp. (sumac), *Cornus florida* (flowering dogwood), *Diospyros virginiana* (persimmon), *Sassafras albidum* (sassafras), *Pinus virginiana* (Virginia pine), and other woody pioneers. In some situations, however, a distinct grassland stage intervenes, dominated by the tussock-forming, warm-season species *Schizachyrium scoparium* var. *scoparium* (little bluestem) and *Andropogon virginicus* (broomsedge). In the past, the tenure of these grasslands was often prolonged by fires which eliminated the seedlings and saplings of woody invaders (Allard and Leonard 1943).

Nearly sixty years ago, there were "hundreds of acres on the lower, more cultivated slopes that have reverted to the wild grassland stage, in which *Andropogon scoparius* [= *Schizachyrium scoparium* var. *scoparium*] is an almost pure dominant" (Allard and Leonard 1944a). Today, the situation is entirely changed, with few native grasslands remaining. In the absence of fires to set back succession, most of the former grasslands have either been overtaken by young forests or have been converted to permanent cattle pastures and hay fields. The latter, while containing some indigenous species, tend to support larger numbers of exotic grasses such as *Festuca pratensis* (meadow fescue), *Poa pratensis* (Kentucky bluegrass), *Agrostis gigantea* (redtop), and *Dactylis glomerata* (orchard grass).

Currently, powerline rights-of-way that cross the ridges of the Bull Run Mountains provide optimal habitats for many native grasses, as well as forbs that prefer higher light levels than are typically available in the secondary forests. A number of herbs that Allard and Leonard (1943) described as characteristic of open pine – scrub oak woods now appear to thrive mainly on sites where powerlines cross the xeric, sandy ridge crests. Included in this group are *Comptonia peregrina* (sweet-fern), *Lechea* spp. (pinweeds), *Baptisia tinctoria* (yellow wild-indigo), *Helianthemum canadense* (Canada frostweed), and *Sericocarpus linifolius* (narrowleaf white-top aster). Apparently, areas of exposed, sandy woodland soil that once supported these species were maintained by frequent burning, but have become covered by many centimeters of dense duff and humus following decades of fire exclusion.

Certain "galled," sparsely vegetated areas in old fields on the western slope were investigated by Allard (1942) and their soils were found to be severely lacking in available phosphorus and nitrogen. The peculiar soil conditions of these barrens had evidently prevented all normal successions for a period of 20 to 25 years and supported huge colonies of lichens, particularly *Cladonia cristatella* (British soldiers) and *Cladonia cervicornis* ssp. *verticillata* (ladder lichen). A sparse herbaceous flora was dominated by *Euphorbia corollata* (flowering spurge), *Diodia teres* (buttonweed), *Calystegia spithamaea* ssp. *spithamaea* (low bindweed), and *Ipomoea pandurata* (wild potato-vine). The cause(s) of the soil deficiencies and the current disposition of these habitats are not known.

Ruderal wetland assemblages in the study area are highly variable. Where powerlines, roadsides, and other clearings intersect seeps and headwaters streams, boggy open wetlands provide the principal habitats for oligotrophic species such as *Rhynchospora capitellata* (a beaksedge), *Juncus canadensis* (Canadian rush), *Juncus scirpoides* (a rush), Juncus subcaudatus (short-tailed rush), *Dulichium arundinaceum* (three-way sedge), *Scleria triglomerata* (a nutrush), *Campanula aparinoides* (marsh bellflower), and *Lyonia ligustrina* (maleberry). Cleared floodplains and open, groundwater-controlled wetlands that have been enriched by run-off or grazing are the domain of *Alisma subcordatum* (broad-leaved water-plantain), *Carex lurida* (a sedge), *Carex scoparia* (a sedge), *Carex vulpinoidea* var. *vulpinoidea* (a sedge), *Eleocharis obtusa* (blunt spikerush), *Eupatorium fistulosum* (hollow joe-pye-weed), *Eupatorium perfoliatum* (common boneset), *Hypericum mutilum* (slender St. Johns-wort), *Juncus acuminatus* (sharp-fruited rush), *Juncus effusus* (common rush), *Leersia oryzoides* (rice cutgrass), *Ludwigia alternifolia* (seedbox), *Typha latifolia* (broad-leaved cat-tail), *Vernonia noveboracensis* (New York ironweed), and many other light- and moisture-demanding native plants. The exotic grass *Arthraxon hispidus* is a problematic invader of such habitats.

Early-Successional Forests

Allard and Leonard (1943) reported nearly pure stands of *Robinia pseudoacacia* (black locust) that had invaded abandoned pastures around old home sites in the early 1900's. The undergrowth in these forests was dominated by *Symphoricarpos orbiculatus* (coralberry), *Phytolacca americana* (common pokeweed), and *Allium vineale* ssp. *vineale* (field garlic), all weedy species that reflected mesic soils enriched by previous congregations of domestic animals and further enhanced by the nitrogen-fixing *Robinia*. While small stands of *Robinia* still occur around farms on the foot-slopes of the study area, few if any stands remain in the secondary forests of the ridges. A fast-growing, short-lived tree, *Robinia pseudoacacia* usually reaches maturity in 40 to 50 years and thereafter gives way rapidly to longer-lived, more shade-tolerant hardwoods (Fowells 1965).

Liriodendron tulipifera (tulip-poplar) is the most important tree on mesic sites undergoing secondary succession, occurring in both nearly monospecific stands and in mixtures with other shade-intolerant species such as *Robinia*, *Juglans nigra* (black walnut), *Celtis occidentalis* (hackberry), *Platanus occidentalis* (sycamore), and *Prunus serotina* var. *serotina* (black cherry). Except for thick shrub cover by *Lindera benzoin* (spicebush), the understory and herb layer of such forests tend to be dominated by invasive, shade-tolerant exotics such as *Lonicera japonica*, *Rosa multiflora* (multiflora rose), *Celastrus orbiculatus* (oriental bittersweet), *Microstegium vimineum*, *Alliaria petiolata*, and *Polygonum caespitosum* var. *longisetum* (long-bristled smartweed), making the future development of these stands into viable natural communities uncertain (see p. 109). Most of these communities are now ~50 to 70 years old.

On drier sites, especially on lower slopes along the eastern edge of the area, *Pinus virginiana* (Virginia pine) is a characteristic early-successional tree capable of forming nearly pure forests. Many discrete patches of this species are apparent on 1952 aerial photographs, cleanly following the rectangular boundaries of abandoned fields. By 1980, many of these pine forests had become mixed with emergent hardwoods. Today, most *Pinus virginiana* stands in the study area are highly decadent and nearing complete replacement, usually by oaks, hickories, and/or *Fagus grandifolia* (American beech). Like *Robinia pseudoacacia*, *Pinus virginiana* is a short-lived, early-maturing tree, but is readily adaptable to dry, eroded, or nutrient-impoverished sites. Once stands mature (~50 years), their demise is hastened by the species' susceptibility to wind-throw and breakage by wind, ice, and sleet (Fowells 1965).

DISCUSSION

Effectiveness and Regional Relationships of the Classification

An emphasis on vegetation in classifying ecological communities has many intrinsic advantages (see pp. 3-4) but was also made necessary in this study by a lack of detailed data on other biotic and abiotic community components. Furthermore, existing data on the study area's environment and biota varied greatly in their completeness, spatial scales, and overall compatibility. Published data on geologic substrate were available only at the 1:500,000 scale, and extrapolation over two orders of magnitude was necessary to identify parent material at the mapping scale for vegetation plot locations (Appendix). Although a more detailed, but very preliminary sketch of the Bull Run Mountains' bedrock geology was made available by USGS, on-site reconnaissance by USGS geologist C. Scott Southworth indicated that the stratigraphy of units, as well as some lithologies, were not fully understood in parts of the study area. An even more serious limitation of geological data was the lack of correlation at many sites between bedrock parent material and the surficial regolith, which is most influential on soil chemistry, texture, and related vegetation patterns.

Detailed soil maps existed for the study area, yet up-to-date taxonomic and nomenclatural treatments were available for only one of the three counties involved. Moreover, the fine-scale polygons on these maps had only vague correspondence with vegetation patterns and did not accurately represent the differences in soils found at multiple sampling sites. This is most likely due to the use of heterogeneous soil association complexes for mapping and the large degree of extrapolation required to delineate soils in a large, rugged landscape.

Data on the animal life of Bull Run Mountains were extremely sparse, consisting of scattered herpetological collections and studies, a study of fish diversity in Broad Run, unpublished studies of the macroinvertebrate fauna of a single drainage, a few invertebrate collections by DCR-DNH, and uncompiled records of mammal and bird sightings by a number of individuals.

Compared to other available data, vegetation composition and structure constituted the most complete, accurate, and reliably geo-referenced and ground-truthed data available for the classification. Moreover, each vegetation sample had corresponding information on soil chemistry and topographic characteristics that made possible the identification of environmental variation between community types using indirect gradient analysis. Even though vegetation provides a rich framework for the definition and description of ecological communities in the Bull Run Mountains, more comprehensive inventory of geological, soil, and faunal components would greatly enhance our understanding of the ecological dynamics at work in these systems.

One limitation of using vegetation was that with only 72 plot samples to cover a 60 km^2 (23 m^2) area, the overall robustness of the classification and replication within types were quite minimal. Additionally, cluster analysis was more successful in identifying homogeneous groups for some community types than for others. The highest homoteneity values (see p. 26) were attained by the Pitch Pine – Oak / Heath Woodland (0.763), Table-Mountain Pine / Oak – Heath Woodland (0.738), and Eastern Hemlock – Hardwood Forest (0.720). Each of these types is characterized by low species richness, and two are represented by three or fewer plots. In general, higher homoteneity values are expected for smaller groups that encompass a narrower range of compositional variation. By contrast, the most compositionally heterogeneous vegetation types are the Basic Oak – Hickory Forest (0.656) and Basic Mesic Forest (0.670), both of which are relatively species-rich and represented by larger numbers of plots. Despite these variances, homoteneity values for all ten community types fell within an acceptable range based on the results of similar studies conducted at various geographic scales (*e.g.*, Fleming 2002, Fleming and Coulling 2001, Fleming and Moorhead 2000, Coulling and Rawinski 1999).

Subjective decisions in the implementation and interpretation of cluster analysis were inevitable, given the lack of a generally accepted, optimal strategy for this method and the varied performance of different protocols with different sets of ecological data. In fact, the hierarchical classification adopted for this study was selected from a range of competing dendrograms on the basis of *a posteriori* subjective evaluation, rather than the rigorous application of objective criteria defined *a priori*. However, other lines of evidence support the present classification as fully adequate, robust, and not simply a product of arbitrary decisions and procedures. First, the results of cluster analysis are in basic agreement with the arrangement of samples in ordination diagrams. A one-dimensional display of compositional relationships in a dendrogram can scarcely summarize patterns in a complex vegetation continuum, particularly if more than one strong compositional gradient is at work. Nevertheless, the vegetation classes and community types recognized by cluster analysis are relatively discrete in their distribution in the multidimensional ordination spaces, and differences in site conditions among groups reflect the major environmental gradients implied in ordination and correlation analyses (Figs. 9-12).

Second, although differences were apparent among various procedures for cluster analyses, certain plot samples consistently clustered together regardless of the linkage method, distance measure, and relativization employed. This phenomenon suggests that the data set has a fundamental, latent structure that is largely recoverable using a variety of objective numerical techniques. That similar patterns have been observed in other data sets (Fleming 1999, Coulling and Rawinski 1999) further indicates that the phenomenon is not exclusive to this study. Experience clearly suggests that a variety of protocols in cluster analysis will recover most of the compositional patterns in a data set, and that subjective decisions concerning the optimal placement of a fraction of samples usually have relatively minor influence on the overall arrangement of stands and classification of groups. Furthermore, while it is tempting with such a small data set to focus on the particular vegetation types to which individual plots are assigned, the recognition of the types themselves is more important than individual group membership. Given that plots represent points along a continuum of vegetation composition and environmental gradation, and that cluster analysis must assign each plot to a single discrete vegetation type, nearly every data set will contain plot samples that could be assigned equally well to more than one type. While vegetation types are often appropriately considered “foci in a field of variation” (Westoff and van der Maarel 1973), rather than discrete entities, it may also be possible to identify representative samples that effectively embody the compositional and environmental distinctiveness of a community’s “average” expression, somewhat analogous to “type” specimens in taxonomy.

The landscape scale of classification in this project is sufficiently fine, and appropriate for application to future mapping, inventories, and detailed land management. Whether this classification can be extrapolated to similar areas cannot be fully evaluated at this time because of the lack of comparable studies using vegetation defined by total floristic composition. To the extent that vegetation units are strongly correlated with predictable, repeating landforms and substrates, it seems possible that the environmental and vegetation patterns documented in the Bull Run Mountains would compare well to those of similar sites along the eastern flank of the Blue Ridge anticlinorium (*e.g.*, Catoctin Mountain in Virginia and Maryland). This hypothesis will require future testing at other study sites. In any case, applicability to other sites is tangential to the primary objective of providing a workable classification for the Bull Run Mountains.

To a degree, the vegetation of the Bull Run Mountains can be evaluated in its regional context through a comparison with classification units derived from analysis of plot data collected elsewhere in Virginia and cross-referenced to the U.S. National Vegetation Classification (USNVC; Grossman *et al.* 1998) (Fleming 2002, Fleming and Coulling 2001). The biogeographic affinities of the study area’s community types are overwhelmingly Central Appalachian (Table 50). While the Southern Appalachians are considered one of the most biologically diverse temperate regions in the world and a center of endemism (Martin and Boyce 1993), the northward extension of these mountains through much of Virginia, West Virginia, Maryland, and Pennsylvania is considerably lower in average elevation and supports a smaller biota lacking many

Southern Appalachian endemics. Because it is quite distinct in the character of its landscape and natural communities, this region was recently defined by The Nature Conservancy as the "Central Appalachian Forest" for conservation planning purposes (Groves *et al*. 2000). Montane forests of the region are sometimes considered depauperate versions of the more diverse, Southern Appalachian forests or attenuated outliers of forests more prevalent to the north, but a recent study suggests that the Central Appalachians can be characterized by some degree of endemism at the community level (Fleming and Coulling 2001).

Table 50. Biogeography of community types of the Bull Run Mountains. A "(?)" indicates uncertainty about the classification of examples in that state/region.

Community Type	**Probable Range**	**Distribution within Virginia**
Mountain/Piedmont Acidic Seepage Swamp	Central Appalachians; VA, WVA, MD, PA; endemic	Ridge and Valley, northern Blue Ridge, western Piedmont
Mesic Mixed Hardwood Forest	Coastal Plain and Piedmont; NJ to VA	Piedmont, northern Coastal Plain
Acidic Oak-Hickory Forest	Central Appalachians and Piedmont; VA, WVA(?), MD(?)	western Piedmont, northern Blue Ridge(?), Ridge and Valley(?)
Eastern Hemlock-Hardwood Forest	Mid-Atlantic Piedmont; MD, VA, NC(?); endemic	Piedmont
Low-Elevation Boulderfield Forest/Woodland	Central Appalachians; VA and MD; endemic?	western Piedmont monadnocks, northern Blue Ridge (?)
Basic Mesic Forest	Central Appalachians and Piedmont; VA, MD, PA, DE	northern and western Piedmont, northern Blue Ridge
Basic Oak-Hickory Forest	Central Appalachians and Piedmont; VA and MD(?)	northern Blue Ridge, western Piedmont
Table-Mountain Pine-Oak/Heath Woodland	Central Appalachians, VA, WVA, MD, PA; endemic	Ridge and Valley, northern Blue Ridge, w. Piedmont monadnocks
Pitch Pine-Oak/Heath Woodland	Central Appalachians, VA, WVA, MD, PA; endemic	Ridge and Valley, northern Blue Ridge, w. Piedmont monadnocks
Chestnut Oak Forest	Central Appalachians and Northern Appalachians; VA and WVA to ME	Ridge and Valley, northern Blue Ridge, w. Piedmont monadnocks

In Virginia, the Central Appalachian region is typified by the Ridge and Valley province north of the New River and the Blue Ridge north of the Roanoke River. The Bull Run Mountains and other western Piedmont monadnocks are geological and biological outliers of the Central Appalachians, with vegetation patterns comparable to those of lower-elevation Blue Ridge sites. This is exemplified in the study area by the great prevalence of the Chestnut Oak Forest community type and its dominant tree, *Quercus montana*, along with the presence of the smaller-patch Pine-Oak/Heath and Acidic Seepage Swamp communities, all of which are widespread and characteristic of acidic, montane landscapes in western Virginia.

Not all communities of the Bull Run Mountains are strictly Central Appalachian. Two community types, the Basic Mesic Forest and Basic Oak-Hickory Forest, have similar ranges that are about equally divided between portions of the Piedmont and lower-elevations of the Blue Ridge. These units also have more restricted distributions that are controlled by the availability of soils with higher fertility, especially (but by no means exclusively) those weathered from Catoctin metabasalt. The Eastern Hemlock-Hardwood Forest, despite being a highly restricted, small-patch community with a superficial resemblance to montane hemlock forests, appears to be compositionally distinct and endemic to north-facing bluffs of the mid-Atlantic Piedmont. One community type, the Mesic Mixed Hardwood Forest, has a range that is co-extensive with the Piedmont and inner Coastal Plain from New Jersey to Virginia. The regional distributions of the Low-Elevation Boulderfield Forest/Woodland and Acidic Oak-Hickory Forest are poorly understood at present.

A full and comprehensive evaluation of the regional relationships of vegetation in the study area will not be achievable without the collection and analysis of much additional data over a broad region, the maturation of the USNVC, and the resolution of numerous, seemingly intractable classification issues. At the present time, the USNVC is a work-in-progress, with many gaps and discrepancies in community data across a multi-state region and no established protocols for comparing data that are available. At the same time, parts of the USNVC contain proliferations of floristically similar associations generated from landscape-scale studies in different areas. In some ways, the latter situation is analogous to the redundant classifications of newly discovered North American plants generated by a number of 17th and 18th century taxonomists working independently. These limitations notwithstanding, the significance of the Bull Run Mountains as a meeting ground of extensive but disjunct montane vegetation and more typical Piedmont communities is clear.

Fifty Years of Environmental and Vegetation Change

As H.A. Allard began his lengthy botanical survey of the Bull Run Mountains in 1934, he was confronted with a landscape in transition following a number of area-wide disturbances. Less than twenty years earlier, the introduced fungal pathogen *Cryphonectria parasitica* had infected legions of *Castanea dentata* (American chestnut) trees, resulting in the rapid elimination of one of the area's dominant overstory species. Moreover, Allard (1942) described much of the remaining forest as "cut-over woodland" and noted that "even the older stands represent successional forests following many cuttings and burnings of the original primeval forest cover" (Allard 1961). Over much of the area, even in the nearly pure ridge forests of *Quercus montana* (chestnut oak), "enormous numbers" of *Carya* (hickory) saplings had appeared, apparently indicating the ongoing replacement of the former oak-chestnut forests with an oak-hickory association (Allard and Leonard 1943). *Fagus grandifolia* (American beech), however, while present in some of the mesophytic forests, had seemed to reach a "static condition," since little or no reproduction could be found anywhere. On the higher ridges, fires "which formerly were very frequent" in the area had "so completely destroyed the vegetative cover that very xerophytic conditions obtained" (Allard and Leonard 1944a). The vegetation of these habitats was limited to a few heaths, scrub oaks, and open *Pinus rigida* (pitch pine) groves, with mosses and great lichen colonies of *Cladonia* and *Cladina* spp. (reindeer lichens) leading the revegetation of exposed, sandy soils.

The white-tailed deer (*Odocoileus virginianus*), so ubiquitous today, was absent or rare in the northern Virginia Piedmont in 1950 (Knox 1997), and even the gray squirrel (*Sciurus carolinensis*) was noticeably scarce in the forests of the Bull Run Mountains (Allard and Leonard 1943). The area's human population was also at a low ebb during this era of the Great Depression, and Allard found many homes and cabins "abandoned and left in ruins or burned" (Allard 1961). Extensive portions of the area, encompassing more fertile lower slopes and the interior valleys, had been cleared long ago and brought into cultivation. By the 1930's, however, these sites to a large extent had been abandoned and were reforesting through the usual successional stages. Some sites, probably abandoned as long ago as the Civil War, already supported pure forests of *Liriodendron tulipifera* (tulip-poplar), while "hundreds of acres" of more recently abandoned fields had reverted to scrub or grassland stages (Allard and Leonard 1944a). The overall condition of the Bull Run Mountains during Allard's tenure was perhaps best summarized by his statement that "at the present time there is probably no area in Virginia that shows more striking and beautiful stages of vegetation succession trending toward the climax forest than does this area" (Allard and Leonard 1943).

Data collected during the present study provide an interesting contrast to these historical observations and demonstrate that environmental and biotic changes have continued to exert a profound influence on the area's landscape and vegetation during the five decades since Allard made his final collections. Factors or processes that can be clearly identified as catalysts of ongoing change fall into five interacting categories.

Forest Succession and Maturation
The varied successional communities encountered by Allard have for the most part continued to advance and mature. Scrutiny of aerial photographs indicates that between 1952 and 1997, most mountain-slope fields became forested and extensive old-field stands of *Pinus virginiana* (Virginia pine) became decadent and were replaced by hardwoods. A few new fields, as well as clearings for new houses, were created during this period but, on the whole, the Bull Run Mountains proper are more completely wooded than in 1952. Very few timber harvests have taken place in the last 50 years, and some sizeable hardwood stands have been undisturbed for ~100-110 years. Many stands are now 70-80 years old, having been cut during the period when salvage of dying chestnut trees was underway. Exceptions include large tracts just north of and just south of Hopewell Gap that were clear-cut within the past ~30 years.

In the older, mesophytic successional forests occupying long-abandoned clearings, *Liriodendron tulipifera* trees that in the 1930's were "at least 50 feet tall" now generally exceed 35 m (115 ft) tall with diameters commonly 50 to 70 cm (20 to 28 in) dbh. The pulse of hickory saplings reported by Allard has matured and many have taken a position of canopy co-dominance with oaks and *Liriodendron* on the more fertile, dry-mesic slopes of the area (see p. 122). On slopes where intermediate moisture conditions prevail, it appears that *Carya ovalis* (red hickory), *Liriodendron*, and mixed oaks made up most of the overstory replacement for *Castanea dentata* and now form the Basic Oak-Hickory Forest of the current classification. On the more xeric slopes dominated by nearly pure stands of *Quercus montana* (chestnut oak), however, oaks (mostly *Quercus montana*) made up most of the replacement stand; the hickory reproduction that was "making more headway than the chestnut oak itself in some situations" (Allard and Leonard 1943) either did not survive or failed to reach the overstory, as hickories are very minor trees with low cover and density in the current Chestnut Oak Forest community type (Tables 47, 48, and 49).

Far from being reproductively "static," *Fagus grandifolia* now dominates every stratum of Mesic Mixed Hardwood Forests in acidic ravines and also has abundantly invaded the understories of dry-mesic oak and oak-hickory stands in some parts of the area. *Fagus* densities up to 500 stems/ha were documented during this study, and this prolific recruitment has even reached some of the most xeric ridge crests, where scattered *Fagus* saplings have appeared in stands of *Quercus montana* and *Pinus rigida*. Similarly, *Acer rubrum* (red maple), which was listed as "frequent" by Allard and Leonard (1943), has become the leading understory species, along with *Nyssa sylvatica* (black gum), on all dry, acidic slopes. These species have attained densities as high as 850 and 750 stems/ha, respectively, in some stands of Chestnut Oak Forest despite rarely occurring in the overstory. However, both species are conspicuously less important in the Basic Oak-Hickory Forest, where hickory (*Carya ovalis* and *Carya alba*) recruitment continues to dominate the understory layers.

By contrast, recruitment of oaks in this area is very uneven. *Quercus alba* (white oak), *Quercus rubra* var. *rubra* (northern red oak), *Quercus velutina* (black oak), and *Quercus coccinea* (scarlet oak) show little recruitment in any community type, especially in the taller understory layers. Only *Quercus montana* appears to be successfully recruiting in various age-classes, although at densities lower than that of *Acer rubrum* and *Nyssa* in most stands. These trends toward decreased oak recruitment and increased importance of shade-tolerant mesophytic species such as *Fagus* and *Acer rubrum* in oak forests are consistent with a larger regional trend of oak decline occurring throughout the Central Appalachians and the Mid-Atlantic Piedmont and Coastal Plain.

Fire Suppression
Over the past twenty years, an impressive body of ecological research has implicated the exclusion or reduction of wildfires as a major contributor to oak decline and the invasion of most oak understories by later-successional trees. Among upland hardwoods, oaks are particularly well adapted to periodically burned habitats because of their thick bark, prolific sprouting abilities, moderate to low shade tolerance, and seedbed requirements for successful acorn germination. At the same time, *Acer* spp. (maples), *Fagus grandifolia* (American beech), and other shade-tolerant, potential successors to oaks tend to have thin,

fire-sensitive bark and other ecological requirements that work against their persistence on frequently burned sites. Based on paleoecological evidence, development of widespread oak forests in the eastern United States during the Holocene coincided with a warming climate and recurring fires (Abrams 1992, Watts 1980). In the Central Appalachian and Mid-Atlantic regions, routine burning by American Indians probably increased fire frequencies far and above those that would have resulted from lightning alone (Abrams 1992, Van Lear and Waldrop 1989). Following European settlement, oak forests of these regions were perpetuated by a regime of repeated logging and burning associated with the charcoal iron industry and other activities (Nowacki and Abrams 1992, Orwig and Abrams 1994b).

The 20th century has been a period of increasing fire reduction and exclusion, in large measure driven by changing land uses, population growth, and a massive campaign by the U.S. Forest Service to suppress wildfires. Orwig and Abrams (1994b) determined that in Virginia, the total area burned annually and the average size of individual fires decreased by 95% and 98% respectively from 1925 to 1991. This dramatic scale of fire reduction has occurred region-wide (Abrams and Nowacki 1992) and has been correlated with a widespread lack of oak recruitment and the development of extensive *Acer rubrum* (red maple)-dominated understories in both Piedmont and montane oak forests (Abrams 1998, Lorimer 1984, McDonald *et al.* 2002). Apparent ongoing successional replacement of oaks by *Acer saccharum* (sugar maple), *Betula alleghaniensis* (yellow birch), *Betula lenta* (sweet birch), *Fagus grandifolia*, *Nyssa sylvatica* (black gum), *Prunus serotina* (black cherry), and other mesophytic hardwoods has also been documented at various sites in the region (Abrams and Copenheaver 1999, Abrams and Downs 1990, Abrams *et al*. 1997, Mikan *et al.* 1994, Ruffner and Abrams 1998).

Other stand-opening disturbances (*e.g*., logging, chestnut blight, gypsy moths) in fire-suppressed oak forests have facilitated the establishment and advance of later-successional hardwoods, as well as less tolerant oak competitors such as *Liriodendron tulipifera* (tulip-poplar) and *Carya* ssp. (hickory). Increasingly, cutting of the oak overstory in stands with little or no oak recruitment and an abundance of potential oak successors has led to accelerated succession and rapid attainment of overstory dominance by oak-replacement species (Nowacki and Abrams 1992). Exceptions to these trends may occur on the most xeric sites, where mesophytic competitors are at a distinct disadvantage to drought-tolerant oaks (Abrams *et al.* 1997).

Charcoal and/or fire scars were found in 32% of the plots sampled in the Bull Run Mountains. While details of the area's fire history are not known, evidence indicates that the historical trend here has been consistent with the regional reduction of fires during the 20th century. In 1930, a fire burned about 80 ha (200 ac) of the east ridge south of Cold Spring Gap (Dr. F.T. Reuter, pers. comm.) and a few other limited fires are known to have occurred in recent decades (*e.g*., High Point Mountain in 1988-1989). It would appear, however, that these were small in magnitude compared to earlier burns on the ridges that left huge amounts of charcoal in the duff and "so completely destroyed the vegetative cover that very xerophytic conditions obtained" (Allard and Leonard 1944a). The current abundance of *Acer rubrum* and young *Fagus grandifolia*, contrasting sharply with Allard and Leonard's (1943) assessment of these species, is also consistent with regional trends. An apparent expansion of *Asimina triloba* (paw-paw) out of its typical stream-bottom and ravine habitats may also be related to fire exclusion, as well as to this species' virtual immunity to deer browsing (Liang and Seagle 2002). Discrete clones of the distinctly mesophytic *Asimina* have recently become established in middle-slope, dry-mesic oak-hickory stands and even in a few dry, rocky forests of *Quercus montana* (chestnut oak) and heaths. While the enlargement of existing clones in mesic habitats may be primarily a product of selective grazing, fire exclusion seems to offer the most likely explanation of new clones in atypically dry, forage-poor habitats.

Although both *Acer rubrum* and *Nyssa sylvatica* are present in high densities, Chestnut Oak Forests of the Bull Run Mountains still exhibit significant levels of oak recruitment, with *Quercus montana* present in all understory size classes, and often more abundant than competitors in the stratum immediately below the overstory. Huge numbers of *Quercus montana* seedlings and small saplings dominate the herb and/or shrub layers of many stands, in some cases responding to light gaps resulting from trees killed by drought and gypsy moth damage 10 to 15 years ago. The superior competitive ability of *Quercus montana* on the Bull Run Mountain ridges is obvious and makes it likely that this oak will remain a dominant or co-dominant species over large areas in the foreseeable future. On the other hand, little recruitment of other upland oaks (*Quercus alba*, *Q. coccinea*, *Q. rubra*, *Q. velutina*) is evident over most of the area. It seems possible that these species were relatively minor components of the pre-blight landscape dominated by chestnut oak and American chestnut, and may have benefited, at least temporarily, from the dying-off of chestnut. With conditions now poor for reproduction, these oaks may be returning to pre-blight levels of abundance. The absence of intense, stand-opening fires on the most xeric ridges has eliminated all recruitment of *Pinus rigida* (pitch pine) in most of the area's Pitch Pine – Oak / Heath Woodlands, which appear to be undergoing canopy closure and slow but certain encroachment by *Quercus montana*. Except for the two stands inhabiting quartzite outcrops, the pitch pine community type in this area will gradually disappear, or at least be reduced to small, fragmentary stands, if current trends continue.

It is difficult if not impossible to separate the potential influences of a wholly "natural" fire regime from anthropogenic fire, or to determine what constitutes a "natural" fire return interval, in the Bull Run Mountains' landscape. While the xeric ridges and their pyrophytic vegetation are no doubt susceptible to occasional lighting-ignited wildfires, it appears likely that much of the intense pre-settlement and early post-settlement burning throughout the region was in fact caused by native Americans and later by various human disturbances such as the charcoal iron industry and logging. Although the subject is controversial, the general dominance of oaks over much of the eastern United States during the Holocene may largely represent (except on xeric sites) the maintenance of an early or mid-successional stage of forest development by recurring anthropogenic disturbances (Abrams 1992). If this well-supported hypothesis is accepted, then the current successional advance by mesophytic, late-successional trees in oak forests is a natural consequence of the cessation of those disturbances. Given that the contemporary Piedmont landscape is too fragmented and too populated to support the kind of frequent, large burns that characterized the pre-settlement/early post-settlement era, the ongoing trend of oak decline and replacement by mixed mesophytic species in the Bull Run Mountains seems inevitable. It may be possible to initiate a program of targeted prescribed fire at certain sites, but the feasibility and logistics of such a program will be very difficult. However, the consequences of not maintaining some kind of prescribed burning regime on the study area ridges include the accumulation of huge fuel loads and increased risk that any wildfire that does start could quickly burn out of control and threaten houses and people, particularly on the rapidly developing eastern slope.

Insect and Fungal Pathogens

Although none has been as devastating as the chestnut blight, biological pathogens have continued to plague the Bull Run Mountains' forests in recent decades. Foremost among these are the exotic lepidopteran gypsy moth (*Lymantria dispar*) and the fungal agent *Discula destructiva* (dogwood anthracnose). The indigenous southern pine beetle (*Dendroctonus frontalis*), the exotic hemlock woolly adelgid (*Adelges tsugae*), and the fungal agent *Sirococcus clavigignenti-juglandacearum* (butternut canker) are also present and very destructive. Presumably, Dutch Elm Disease (*Ceratocycstis ulmi*) and an obscure mulberry die-back disease are responsible for the low numbers of tree-sized *Ulmus americana* (American elm), *Ulmus rubra* (slippery elm), and *Morus rubra* (red mulberry) in the area, but are difficult to assess since none of these species was very common historically (Allard and Leonard 1943).

Gypsy moth poses the most serious threat to the compositional and biotic integrity of study area forests due to its caterpillars' preferential feeding on oaks. Unchecked infestations frequently result in total defoliation of oaks and other preferred trees and shrubs. Trees weakened by successive years of defoliation become highly vulnerable to mortality from secondary agents, including other insects, disease organisms, and drought stress (Reardon 1996, Schweitzer 1987). Moreover, removal of leaf canopies during late spring and early summer may impact forest understories by increasing insolation, soil drying, and the establishment of light-demanding weeds. Long-term impacts of repeated gypsy moth infestations are less clear, but probably reinforce ongoing patterns of oak decline and successional advances by species less favorable or toxic to gypsy moth (*e.g*., *Liriodendron tulipifera*).

The initial outbreak of gypsy moth in the Bull Run Mountains and surrounding region occurred in the late 1980's and early 1990's. Widespread spraying with chemical agents (primarily Bt [*Bacillus thuringiensis*] and diflubenzuron [Dimilin]) partially controlled the infestation, although some oak mortality resulted (L. Grayson, pers. comm.; personal observation). After a low ebb in the population cycle lasting several years, the moth reached outbreak levels again in 2000-2001. A potentially devastating defoliation of oaks was averted during the summer of 2001 by the naturalized fungal pathogen *Entomophaga maimaiga* (Andreadis and Weseloh 1990, Hajek *et al*. 1996b), which, in a matter of days, killed many thousands of fully grown caterpillars before they had completely defoliated the trees. Caterpillars (alive or dead), egg masses, and/or minor damage to foliage caused by gypsy moth was recorded in 35% of the vegetation plots sampled in 2001. Defoliation was more severe, and *Entomophaga*-induced caterpillar mortality much lower, in 2002 (M. Kieffer, pers. comm.). Among available control methods, Bt and Dimilin are undesirable in natural areas managed for biodiversity because of their toxicity to all lepidopterans and, in the case of Dimilin, crustaceans. Gypcheck, a product derived from an introduced nucleopolyhedrosis virus, and Disrupt II (Hercon Environmental), a mating disruptant pheromone, apparently have limited or no non-target toxicity and may be more suitable for application in natural areas with dense gypsy moth populations (Reardon 1996). *Entomophaga maimaiga* is a powerful control agent that can deplete gypsy moth populations in as little as two years with low impact on non-target lepidopterans in nature (Hajek *et al*. 1996a, Webb *et al*. 1999). This fungus, however, is somewhat unpredictable and requires cool, moist conditions during the winter and at critical times during the vernal emergence of caterpillars for optimal effectiveness in reducing gypsy moth populations (Weseloh and Andreadis 1992; Weseloh *et al.* 1993).

The southern pine beetle (*Dendroctonus frontalis*) is a stressor of pines throughout the southeastern United States, north to New Jersey and Pennsylvania. This tiny beetle attacks trees in mass, boring through the bark and creating galleries in phloem tissue where eggs are laid and young develop. The beetles also introduce a fungus that eventually inhibits water flow in the sapwood (Day 1997). In Virginia, beetle populations seem to remain at low levels for years, with periodic outbreaks lasting two or three years and causing extensive pine mortality. One such outbreak occurred in the northern Virginia mountains and western Piedmont in the early 1990's. Snags and downed wood from beetle-killed pines recorded in seven plots and observed elsewhere in the Bull Run Mountains date from that outbreak. No active southern pine beetle activity was observed in 2001, but this pest can be expected to cause periodic damage to the area's Pine-Oak/Heath Woodlands in the future. At present, there is no effective control at the stand level, other than quickly spotting outbreaks and cutting and removing infested trees.

All three populations of *Tsuga canadensis* (eastern hemlock) known in the Bull Run Mountains are infested with the hemlock woolly adelgid (*Adelges tsugae*), an Asiatic insect that was first reported in Virginia in 1954. Populations remained at low ebb for decades, but beginning in the 1980's, a major outbreak of this pest devastated hemlock forests throughout the Ridge and Valley, northern Blue Ridge, and northern Piedmont areas of the state. Because of its small numbers and highly localized distribution in the Bull Run Mountains, *Tsuga canadensis* is vulnerable to complete extirpation from the area. The adelgid is a tiny insect that assumes several growth forms during its life. Both immature nymphs and adults damage trees by depleting the sap from twigs, causing premature defoliation and eventually the death of the tree (Day 1996). The adelgid can be controlled on individual trees by intensive application of insecticides, but no proven, practical control method is available for treatment of forest stands (Morisawa 2000). A predatory ladybeetle (*Pseudoscymnus tsugae*) that feeds exclusively on hemlock woolly adelgid in Japan was discovered in 1992. Following laboratory and field tests, *Pseudoscymnus tsugae* were released in Connecticut and Virginia from 1995 to 1997. The effectiveness of this control agent has yet to be determined. Non-target effects of *Pseudoscymnus tsugae* include larval and adult feeding on other exotic and indigenous adelgids, but no harmful effects have been documented on any other hemlock arthropods to date (Morisawa 2000).

The symptoms of what is now known to be dogwood anthracnose fungus (*Discula destructiva*) began to be noticeable in northern Virginia forests in the mid-1980's (personal observation). Since then, rampant infection of forest stands in all parts of the Commonwealth has probably resulted in the mortality of millions of individual *Cornus florida* (flowering dogwood) trees. The ecological consequences of this calamity are potentially severe, as *Cornus florida* is (or was) a dominant understory species in many community types and one of the most important sources of food for songbirds and other wildlife (Anderson *et al.* 1993). The origins of dogwood anthracnose, which was only named at the species level in 1991, are not known but its sudden appearance and epidemic spread have led many to suspect that it is an introduced exotic (Anderson *et al.* 1993). Fungal infections appear to be most severe in shaded, cool, humid habitats, and may be encouraged by dense *Acer rubrum* understories in fire-suppressed oak forests. More than one-third (36%) of the vegetation plots sampled in the Bull Run Mountains contained dead or dying *Cornus florida*, and sites where this species was formerly dominant (*e.g*., in oak-hickory forests) are typically littered with snags and downed wood from anthracnose-killed trees. Sadly, we are now witnessing the rapid disappearance of *Cornus florida* from the area's forests, although this tree will most likely persist along borders and in sunny locations where the fungus does not thrive as well.

Another suspected exotic fungal pathogen, butternut canker (*Sirococcus clavigignenti-juglandacearum*) has caused extensive, range-wide mortality of *Juglans cinerea* (butternut) trees since it was first reported from Wisconsin in 1967. The devastation to populations of this tree have been so severe that the species has become rare in some states and has been listed as a "Species of Concern" by the U.S. Fish and Wildlife Service (Anderson 1996). In the Watery Mountains, a Piedmont monadnock situated about 12 km SW of the Bull Run Mountains, *Juglans cinerea* was frequent and widely distributed on rocky slopes and boulderfields in the mid-1970's but nearly all overstory trees had succumbed to the canker by the early 1990's (personal observation). The status of the species and the historical course of fungal infection are poorly known in the Bull Run Mountains. No mature trees of *Juglans cinerea* have been found recently, but several apparently healthy young trees were noted on boulderfields at High Point Mountain and Jackson Hollow. *Juglans cinerea* may never have been a frequent tree in the area; Allard and Leonard (1943) describe its distribution as "at foot of High Point Cliffs, and elsewhere on moist wooded ridges; infrequent."

As virulent and ecologically disruptive as they are, current pathogenic disturbances pale in comparison to the chestnut blight (*Cryphonectria parasitica*), which entirely removed one of the most abundant, broadly distributed, and economically important trees from the overstory of Appalachian forests. In the study area, *Castanea dentata* (American chestnut) was probably second in abundance only to *Quercus montana* (chestnut oak) and distributed across the full range of habitats from moist ravines to xeric ridge crests. Although interspecific patterns of competition have adjusted and the forest has largely recovered from this overwhelming disturbance, the legacy of *Castanea dentata* lives on in the form of root-sprouts that persist because the fungus cannot survive underground. Living sprouts were recorded in 24% of the vegetation plots sampled during this study, while old chestnut wood debris was recorded in 36%. Occasionally, sprouts reach 6 m (20 ft) or more in height and bear fruit before again succumbing to the blight and dying back to the ground (personal observation). On some sites in the Central Appalachians, chestnut root-sprouts have increased dramatically while other sites have experienced a precipitous decline, apparently as a result of drought or other stochastic events (Rhoades 1992, Parker *et al.* 1993). A major effort to restore the American chestnut through successive backcrossing of native chestnuts with blight-resistant Asian species was initiated by the USDA and is being carried on by the American Chestnut Foundation (http://chestnut.acf.org). Another group, the American Chestnut Cooperators' Foundation (headquartered at Virginia Tech; http://www.ppws.vt.edu/griffin/accf.html), is working toward the same goal by successive breeding of grafted, indigenous, blight-resistant stock inoculated with hypovirulent strains of the fungus (Griffin 2000, Griffin 1999, Dierauf *et al*. 1997, Robbins and Griffin 1999). Limited successes by both groups and potential advances in genetic engineering of hypovirulent strains of the fungus keep hope alive that American chestnut will eventually regain a role in the region's forests.

Herbivory

Indirect evidence of major herbivory impacts by white-tailed deer (*Odocoileus virginianus*) abounds in the Bull Run Mountains and includes:

- open understories with lack of structural diversity and sparse representation of tree saplings;
- complete absence of tree seedlings on some sites;
- sparse herb layers, even on some fertile, mesic sites;
- strong patch-dominance by shrubs and herbs unpalatable or rarely eaten by deer, *e.g*., *Asimina triloba* (paw-paw), *Amphicarpaea bracteata* (hog-peanut), *Polystichum acrostichoides* (Christmas Fern), and *Cynoglossum virginianum* var. *virginianum* (wild comfrey);
- widespread populations of herbaceous species that show below-average size and vigor, and consisting of vegetative individuals that do not flower;
- populations of normally robust (> 1m tall and leafy) herbaceous species (*e.g*., *Cimicifuga racemosa*, black bugbane) that are "dwarfed," *i.e*., reduced to tiny individuals scarcely a few cm tall;
- areas of extensive, visible browse damage to plants, *i.e*., topped-off stems and leaves.

These manifestations are uneven across the study area, varying with different vegetation types and between sites. Nearly all of this evidence is somewhat circumstantial since rarely have deer actually been observed in the act of browsing or grazing specific species. Nevertheless, the prevalence of such evidence combined with other signs of deer activity (*e.g*., numerous tracks and scat), historical data on deer populations in this area, and widespread reports (both scientific and anecdotal) of excessive herbivory in natural areas, clearly suggest that the relationship of this species to its environment is not in equilibrium.

The white-tailed deer was nearly extirpated in the mountain and Piedmont provinces of Virginia by 1900. Restocking, initiated in the western counties in 1926, and hunting regulations designed to promote maximal reproductive success have led to a spectacular recovery. According to Knox (1997), the specific recent history of deer populations in the vicinity of the Bull Run Mountains is as follows:

- 1938 – absent;
- 1950 – absent or rare;
- 1970 – population level below environmental capacity;
- 1980 – population level equals environmental capacity;
- 1988 > 12 deer km^2.

In a quantitative study of deer impacts in a protected Massachusetts oak forest, Healy (1997) reported that deer densities > 10 per km^2 were not compatible with normal forest development, while densities of 3-6 deer per km^2 had negligible impact. Feeding by dense deer populations (10-17 per km^2) at this site interrupted stand development and oak regeneration, progressively leading to an open understory dominated by unpalatable grasses and shrubs. Since deer preferred acorns to most other foods in this forest, variations in yearly mast production were correlated with fall and winter browse impacts on lower woody plants (Healy 1997).

Other studies focusing on mesic and bottomland sites have documented selective grazing impacts in forest understories, particularly increased abundance of the entirely unpalatable *Asimina triloba* (paw-paw; Lea and Simmons 2002, Liang and Seagle 2002, Rheinhardt *et al*. 2000). The ecological consequences of deer populations that exceed the carrying capacity of a site extend to other members of the faunal community. Decreased structural diversity and density in the understory of eastern forests reduces resources for other animals and may contribute to sharp declines in breeding bird abundances (McShea and Rappole 1997). Several studies have emphasized the impact of over-populous deer on endangered species and have promoted the use of herbaceous plant population characteristics as warning indicators of over-browsing (Balgooyen and Waller 1995, Miller *et al.* 1992, Noy-Meier 1981). Although such methods are promising as tools for gauging whether deer are negatively affecting the biodiversity of a site, implementation is difficult because too little is now known about what indicator status should be assigned to specific herbaceous species (McShea and Rappole 1997).

A well-designed research program will be required to fully quantify deer population densities and ecosystem impacts in the Bull Run Mountains. However, in order to at least obtain a crude indication of current impacts at the community level, visible herbivory (if any) was recorded by species in each vegetation plot sampled for this project (Table 51). Evidence of herbivory was recorded in 31% of plots and on 41 species (8 woody, 33 herbaceous). The most frequently grazed species in this sample were *Polygonatum biflorum* var. *biflorum* (Solomon's-seal; 10 plots), *Carex laxiflora* var. *laxiflora* (a sedge; 10 plots), *Desmodium nudiflorum* (naked-flowered tick-trefoil; 9 plots), *Aster divaricatus* (white wood aster; 9 plots), and *Cornus florida* (flowering dogwood; 8 plots). Almost no herbivory was observed in plots of the Chestnut Oak Forest and the two Pine-Oak/Heath Woodlands, probably because these dry, species-poor vegetation types contain few palatable resources for deer. The community types that exhibited by far the highest frequencies of herbivory and the highest number of grazed species-populations were the Basic Oak-Hickory Forest and the Acidic Oak-Hickory Forest. These open, dry-mesic forest communities are relatively species-rich, contain a variety of browse resources, periodically produce heavy mast crops, and have few physical impediments to deer (*e.g.*, dense shrubs, boulderfields).

Exotic Plants

Exotic plants were recorded in 44% of the plots in this study (Table 52), despite the fact that sampling sites were selected to avoid disturbed and/or early-successional habitats where invasive exotics typically thrive. The Basic Mesic Forest, Basic Oak-Hickory Forest, and Mountain/Piedmont Acidic Seepage Swamp communities generally had the highest mean numbers of exotics per plot as well as the individual plots containing the highest diversity and mean cover of exotics. Not coincidentally, these three community types are also associated with the most fertile soils of the study area, as well as sites with generous supplies of soil moisture. On the other hand, no exotic plants were recorded in any plot of the extensive Chestnut Oak Forest community type or either Pine-Oak/Heath Woodland. It would appear that the subxeric to xeric, extremely acidic, and nutrient-poor soils occupied by these vegetation types are simply too stressful for most exotics, which show strong preferences for mesic, fertile substrates (Table 53). Allard and Leonard (1943) reported that seedlings of *Paulownia tomentosa* (royal paulownia) and *Ailanthus altissima* (tree-of-heaven) had appeared on burned-over, sandy ridge crests, but these populations apparently did not persist long.

Although difficult to quantify, the past fifty years have seen the expanded influence of naturalized exotics in the vegetation composition and ecological dynamics of the study area and the region as a whole. *Lonicera japonica* (Japanese honeysuckle) was the only exotic plant that Allard and Leonard (1943) recognized as a serious threat to native vegetation some sixty years ago. Today, the situation is entirely different. *Microstegium vimineum* (Japanese stilt grass), arguably the most abundant, problematic, and rapidly increasing exotic in the study area, was first documented in the Bull Run Mountains in 1986 (C.E. Stevens no. 19918 at Longwood College herbarium). Also absent from Allard and Leonard's (1943) flora are such familiar exotics as *Arthraxon hispidus* (jointed grass), *Elaeagnus umbellata* var. *parvifolia* (autumn olive), *Ligustrum obtusifolium* (border privet), *Polygonum caespitosum* var. *longisetum* (long-bristled smartweed), *Polygonum perfoliatum* (mile-a-minute), and *Tussilago farfara* (coltsfoot). In fact, the percentage of exotics increased from 15% in Allard and Leonard's (1943) flora to 20% in the updated flora prepared in this report (Section II) despite the fact that current study area is considerably smaller and more wooded than the area covered by Allard's collecting (see p. 183).

Table 51. Herbivory damage to species documented in vegetation plots.

	COMMUNITY TYPE							
Species	**1.1**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**4.3**	**No. of Plots**
WOODY SPECIES:								
Carya glabra							1	**1**
Carya ovalis						1		**1**
Carya sp.					1			**1**
Cornus florida			3		1	4		**8**
Hamamelis virginiana		1		1				**2**
Lindera benzoin		1	1		2	3		**7**
Rhododendron periclymenoides			1	1	1		1	**4**
Viburnum acerifolium			1					**1**
HERBACEOUS SPECIES:								
Amphicarpaea bracteata						2		**2**
Aristolochia serpentaria						1		**1**
Aster divaricatus	1	1	4	1	1			**8**
Aster lateriflorus		1	3			1		**5**
Aster patens var. patens						1		**1**
Carex amphibola var. *turgida*		1						**1**
Carex cephalophora			1					**1**
Carex digitalis			2			3		**5**
Carex laxiculmis var. *laxiculmis*		2	1					**3**
Carex laxiflora var. *laxiflora*			4		1	5		**10**
Carex prasina	1	1						**2**
Carex sp.				1	1			**2**
Chelone glabra	3							**3**
Cimicifuga racemosa		2			1	4		**7**
Circaea lutetiana ssp. canadensis					1	1		**2**
Desmodium glutinosum						1		**1**
Desmodium nudiflorum			5			4		**9**
Eupatorium purpureum	1					2		**3**
Eupatorium sessilifolium						2		**2**
Galium circaezans			1		1	4		**6**
Galium latifolium						3		**3**
Galium triflorum						3		**3**
Geranium maculatum			1		1	1		**3**
Hieracium venosum							1	**1**
Hypoxis hirsuta							1	**1**
Maianthemum racemosum ssp. *racemosum*			1					**1**
Osmunda cinnamomea	1							**1**
Polygonatum biflorum var. *biflorum*			5			5		**10**
Phryma leptostachya					1	2		**3**
Scutellaria elliptica						3		**3**
Solidago caesia			3			3		**6**
Solidago ulmifolia						3		**3**
Viola palmata var. *triloba*						2		**2**
No. of grazed/browsed species populations	**7**	**10**	**37**	**4**	**13**	**64**	**4**	
% of plots with herbivory impacts	**33**	**40**	**71**	**50**	**29**	**80**	**7**	

Table 52. Numbers of exotic plant species recorded in 72 vegetation plots.

	NO. OF PLOTS:		NO. OF EXOTICS IN PLOT:			
Community Type	**Total**	**w/exotics**	**Mean**	**Max**	**Min**	**Most abundant spp. (# plots)**
M/P Acidic Seepage Swamp	9	6	1.8	6	0	*Microstegium vimineum* (4), *Lonicera japonica* (4)
Mesic Mixed Hardwood Forest	5	4	1.2	2	0	*Microstegium vimineum* (2), *Lonicera japonica* (2)
Acidic Oak-Hickory Forest	7	4	0.7	2	0	*Rubus phoenicolasius* (2)
Eastern Hemlock-Hardwood Forest	2	1	0.5	1	0	n.a.
L-E Boulderfield Forest/Woodland	5	2	1.2	4	0	*Rubus phoenicolasius* (2)
Basic Mesic Forest	7	7	3.0	8	1	*Microstegium vimineum* (5), *Rubus phoenicolasius* (4), *Lonicera japonica* (3), *Alliaria petiolata* (2)
Basic Oak-Hickory Forest	10	8	2.2	4	0	*Symphoricarpos orbiculatus* (5), *Rubus phoenicolasius* (3)
Table-Mt Pine-Oak/Heath Woodland	3	0	0	0	0	-
Pitch Pine-Oak/Heath Woodland	9	0	0	0	0	-
Chestnut Oak Forest	15	0	0	0	0	-
Totals	72	32	1.1	8	0	*Microstegium vimineum* (14), *Rubus phoenicolasius* (13), *Lonicera japonica* (12)

Aside from the higher absolute number of exotic taxa, many exotics that have been established in the study area for a considerable time now occur in greater numbers than previously. For instance, *Alliaria petiolata* (garlic-mustard), now abundant in floodplains and mesic, fertile forests throughout the area, was reported by Allard and Leonard (1943) as "infrequent" around old house sites on High Point Mountain. Other exotics now common or abundant in suitable habitats but reported by Allard and Leonard (1943, 1952) as "infrequent" or "local" include *Ailanthus altissima*, *Celastrus orbiculatus* (Asiatic bittersweet), *Lespedeza cuneata* (sericea bushclover), *Rosa multiflora* (multiflora rose), and *Rubus phoenicolasius* (wineberry). Because of a strong bias in sampling site selection towards relatively undisturbed habitats and late-successional forest vegetation, the record of exotics recorded in plots (Tables 52 and 53) cannot provide a realistic picture of the extent to which these species have overtaken some habitats of the study area. Young successional forests on mesic fertile sites, for example, are so dominated in the lower layers by rampantly invasive populations of exotics that their future viability as "natural" communities has been compromised (see pp. 109 and 164).

What the statistics from vegetation plots do provide, however, is a general indication of which species are capable of becoming problematic in the more undisturbed forest communities. The three most frequently recorded species – *Microstegium vimineum* (15 plots; Tu 2000), *Rubus phoenicolasius* (13 plots), and *Lonicera japonica* (12 plots; Nuzzo 1997) – are particularly troublesome because of their shade tolerance and aggressive growth habits. These species are often opportunistic invaders of the older, more intact forest communities, getting a foothold where mineral soil has been disturbed by roads, trails, tip-up mounds, downfalls, and other gap-disturbances. Once established, colonies are able to more easily expand or spread into nearby microhabitats. Although recorded in only three plots, *Alliaria petiolata* (Nuzzo 2000) poses a significant threat to the compositional integrity of the Basic Mesic Forest community due to its high shade-tolerance and ability to naturalize in undisturbed forests with suitably fertile soils. Currently, this species is more common in disturbed forests of the Bull Run Mountains, but appears to be spreading rapidly.

Table 53. Important exotic plant species in the Bull Run Mountains. List includes all exotics recorded in vegetation sample plots and other species exhibiting invasive tendencies in natural areas. Invasiveness, shade tolerance, and moisture ratings are adopted from Heffernan *et al.* (2001).

TAXON	**COMMON NAME**	**Total Freq (# plots)**	**Total Mean Cover**	**Invasiveness**	**Estimated Shade Tolerance**	**Optimal Moisture Range**
RECORDED IN PLOTS:						
Ailanthus altissima	tree-of-heaven	3	1	High	Low	Mesic
Alliaria petiolata	garlic-mustard	3	2	High	High	Mesic
Arctium minus	lesser burdock	1	1	not ranked	Low	Mesic
Celastrus orbiculatus	Asiatic bittersweet	1	1	High	Medium	Mesic
Glechoma hederacea	ground-ivy	2	1	Medium	Medium	Mesic
Ligustrum obtusifolium	border privet	1	1	Medium	High	Mesic
Lonicera japonica	Japanese honeysuckle	12	2	High	High	Mesic
Microstegium vimineum	Japanese stilt grass	14	2	High	High	Mesic-Hydric
Poa trivialis	rough bluegrass	2	1	Medium	High	Mesic-Hydric
Polygonum caespitosum var. *longisetum*	long-bristled smartweed	4	1	Medium	High	Mesic-Hydric
Prunus avium	sweet cherry	4	1	not ranked	Medium	Mesic
Rosa multiflora	multiflora rose	2	1	High	Medium	Mesic
Rubus phoenicolasius	wineberry	13	2	High	Medium	Mesic
Rumex crispus	curly dock	1	1	Medium	Low	Mesic-Xeric
Symphoricarpos orbiculatus	coralberry	7	1	not ranked	Medium	Mesic-Xeric
Taraxacum officinale	common dandelion	5	1	not ranked	Low	Mesic
Verbascum thapsus	great mullein	1	1	not ranked	Low	Mesic-Xeric
Total Exotic Occurrences in plots		**76**				
Percent of Total Dataset Richness		**0.0255**				
NOT RECORDED IN PLOTS:						
Allium vineale	field garlic			medium	medium	mesic-hydric
Arthraxon hispidus	jointed grass			medium	medium	mesic-hydric
Berberis thunbergii	Japanese barberry			medium	high	mesic
Centaurea nigrescens	Tyrol knapweed			high	low	mesic-xeric
Elaeagnus umbellata var. parvifolia	autumn-olive			high	medium	mesic
Lespedeza cuneata	sericea bushclover			high	medium	mesic
Lysimachia nummularia	moneywort			medium	high	mesic-hydric
Lythrum salicaria	purple loosestrife			high	low	hydric
Paulownia tomentosa	royal paulownia			medium	low	mesic
Poa compressa	flat-stemmed bluegrass			medium	medium	xeric
Polygonum perfoliatum	mile-a-minute			high	medium	mesic-hydric
Stellaria media	common chickweed			medium	high	mesic-hydric
Tussilago farfara	coltsfoot			not ranked	high	mesic-hydric

Based on observations and plot data collected elsewhere in the region, four species that were not sampled or had very low frequency in plots are also potentially invasive and require careful monitoring. Three of them, *Ailanthus altissima* (Hoshovsky 1988), *Celastrus orbiculatus* (Dreyer 1994), and *Elaeagnus umbellata* var. *parvifolia* (Sather and Eckhardt 1987), have long exhibited invasive tendencies in open habitats, but have been appearing with alarming frequency in shaded forest understories throughout the northern Piedmont and Blue Ridge provinces. In the case of *Celastrus* and *Elaeagnus*, plants have exhibited a surprising shade-tolerance that is not generally ascribed to these species or expected based on their abundance in ruderal vegetation assemblages. The invasive strategy of *Ailanthus*, which is clearly intolerant of shade, involves the wind-dispersal of huge numbers of seeds that appear frequently and repeatedly in mesic and dry-mesic forests. Most of these seedlings die, but logging and gap-creating disturbances such as mortality following gypsy moth outbreaks have allowed mass releases of *Ailanthus* at several northern Virginia sites observed by the author. Once established in a disturbed forest, *Ailanthus* is a fierce, difficult-to-eradicate competitor with allelopathic foliage and a prolific ability to reproduce by seed and vegetatively from root-sprouts.

The fourth species, *Polygonum perfoliatum* (mile-a-minute; Mountain 1989) is a relative newcomer that has become established in northern Virginia only within the past twenty-five years. The first record for the Bull Run Mountains was discovered in 2001 on the north slope of High Acre Ridge, where this pernicious annual vine covered the scrubby regeneration in an approximately one hectare clearcut. *Polygonum perfoliatum* is shade-intolerant but should be regarded as a potentially destructive invader of mesic gap-disturbances. In such habitats, this species typically produces dense tangles of spiny vines that grow up to 15 cm (6 in) a day and quickly smother all competing vegetation.

Even though continuing expansion of exotic populations seems inevitable, one redeeming character of the Bull Run Mountains is that large areas on the ridges appear to be too dry and infertile to support persistent populations of the exotics that now occur in the area. Barring the arrival of some new, xerophytic invasive, it seems likely that the most common forest community of the area will remain free of this unwanted disturbance.

Summary and Recommendations

This report examines the vegetation ecology of the Bull Run Mountains, a 60 km^2 (23 m^2) Piedmont monadnock in Fauquier, Prince William, and Loudoun Counties, Virginia. The goals of the study were to classify the major, landscape-scale ecological communities of the area, to investigate relationships among biotic and abiotic components, and to inform future conservation actions and ecosystem-based management by private landowners and stewards of a new 1,000 ha (2,500 ac) state Natural Area Preserve. Following a review of existing information, quantitative data on vegetation structure, floristics, and site conditions were collected from 72 relatively undisturbed forest stands distributed across the study area to capture the full range of environmental settings. Cluster analysis using the Flexible-Beta linkage method and Bray-Curtis coefficient of community was employed to generate a hierarchical community classification of four vegetation classes representing groups with broad environmental and floristic similarities, and ten community types characterized by consistent floristic composition, structure, and habitat affiliation. Although vegetation provides the primary basis for delineating community types, these units integrate information on the environmental conditions that underlie community composition. Indirect gradient analysis using non-metric multidimensional scaling (NMDS) ordination indicates that soil fertility, topographic position, slope shape, site moisture potential, and geologic substrate are the most important environmental factors influencing the composition and distribution of vegetation types in the study area.

Evidence from historical plat maps, aerial photographs, and published reports indicates that large parts of the area that were cleared in the 19^{th} and early 20^{th} century have become reforested. The Bull Run Mountains now comprise one of the largest areas of relatively unfragmented forest cover in the northern Virginia Piedmont. Most of the area's community types are closely affiliated with Central Appalachian forests of the main Blue Ridge and Ridge and Valley provinces, although several more typical Piedmont community types also occur. The most extensive community type in the area, covering the dry, nutrient-poor ridges, is a forest dominated by *Quercus montana* (chestnut oak) and ericaceous (heath-family) shrubs. A community type dominated by hickories, mixed oaks, and *Liriodendron tulipifera* (tulip-poplar) is also widespread on dry-mesic slopes with soils of higher fertility. Both communities replaced former forests dominated by mixtures of oaks and *Castanea dentata* (American chestnut) following the arrival of chestnut blight around 1915. A palustrine forest occurring along headwater stream bottoms with abundant groundwater seepage, and two xerophytic woodlands dominated by *Pinus pungens* (table-mountain pine) and *Pinus rigida* (pitch pine), respectively, represent distinctly montane community types that are rare and isolated in the Piedmont.

When compared with historical evidence, data collected during the present study indicate that profound environmental and biotic changes have continued to influence the composition and distribution of natural communities during the past fifty years. Catalysts for change have included a reduction in timber harvests, a pronounced reduction of wildfires, a dramatic increase of white-tailed deer and associated herbivory, the arrival of several new biological pathogens such as gypsy moth (*Lymantria dispar*) and dogwood anthracnose (*Discula destructiva*), and the establishment or spread of several shade-tolerant, invasive exotic plants. General trends that can be considered manifestations of change include the increased physical maturity of the area's forests; increased prevalence of mesophytic, shade-tolerant trees along with a decline of most oaks, pines, and dogwood; increased cover of colonial heaths and build-up of dense organic soil horizons on the formerly much-burned ridge crests; and decreased cover of herbaceous plants generally, with a tendency in some community types toward patch-dominance by species unpalatable to deer.

The information generated by this study provides a detailed framework for ecological land management, conservation planning, and research. It also highlights a number of "data gaps," or areas where additional data collection and research might greatly enhance and refine our understanding of ecological processes. The 48 plots that were permanently marked during this project provide an opportunity for future monitoring and re-sampling that should help quantify new and ongoing biotic changes. Other potential work that would complement the current study and benefit conservation in the Bull Run Mountains includes:

- Comprehensive inventory of major animal groups: mammals, birds, reptiles, amphibians, invertebrates.

- Detailed survey and mapping of bedrock and surficial geology.

- Hydrological studies, including determination of groundwater chemistry in various localities.

- Survey and mapping of soils with a consistent taxonomy and scale for all three counties.

- Mapping of vegetation types.

- Study to reconstruct at least the historical fire history of the area in greater detail.

- Studies utilizing exclosures and non-exclosed plots to better quantify the impact of herbivory on the reproduction of woody plants and the distribution/abundance of herbaceous plants.

- Monitoring studies to quantify the impact of selective exotic species and experimental research to determine ecologically sound, effective treatments for their reduction or eradication.

- Census of living American chestnut sprouts and feasibility assessment of the applicability to the study area (if any) of current research on chestnut restoration, especially that being conducted by the American Chestnut Cooperators' Foundation at Virginia Tech.

Finally, it is worth noting that the vegetation and natural communities of the Bull Run Mountains are likely to continue changing in the future, possibly in ways that are now difficult to imagine. The ecological shifts of the past 50 or 100 years are trivial when compared to regional changes in composition during the late Pleistocene and Holocene Epochs. Eighteen thousand years ago, at the peak of the last continental glaciation, the climate of northern Virginia was boreal due to the southward extension of the Laurentide Ice Sheet to northern Pennsylvania. A boreal forest dominated by spruce, along with tundra on the higher Appalachians, covered the landscape, slowly giving way to a mixed conifer-northern hardwoods vegetation over the next several millennia as the ice retreated northward (Delcourt and Delcourt 1993). Only about 9,000 to 10,000 years ago, a mere snapshot in geological time, did the boreal-northern forests begin to collapse and shift toward the oak and chestnut dominance that has characterized the Holocene (Delcourt and Delcourt 1993, Craig 1969). Even in 1952, following the catastrophic loss of chestnut and the end of an era of incessant burning, who could have predicted the decline of oaks and pines, the dramatic increases of red maple and beech, the devastation of *Tsuga canadensis* and *Cornus florida* by pathogens, the strong influence of white-tailed deer, or the emerging dominance of an Asiatic grass that would follow in the decades ahead? Ongoing global climate change and the contemporary loss of barriers to the worldwide migration of plants, animals, and other organisms make predictions about future conditions perilous and the value of comprehensive baseline data for natural areas obvious.

II.

VASCULAR FLORA AND LICHENS OF THE BULL RUN MOUNTAINS

Changes and Additions to the Bull Run Mountains' Flora since 1952

Few discrete landscapes in Virginia have received the kind of intensive botanical scrutiny that H.A. Allard gave the Bull Run Mountains from 1934 to 1952. In addition to permanently documenting the area's vascular flora and lichens with more than 15,000 specimens now housed mainly at the Smithsonian's U.S. National Herbarium (US), Allard published the results of this study in a series of papers (Allard 1940, 1942, 1944a, 1961; Allard and Leonard 1943, 1944a, 1944b, 1952). The total vascular flora represented by Allard's specimens approaches 1,100 taxa, which is exceptional for any site of this size in the Piedmont, and the published accounts are replete with distribution and habitat information for each taxon, as well as valuable insights concerning the ecology of the area. For a number of reasons, however, this remarkable flora is now considerably out of date. First, many new taxa, including both exotic species that have become established in the area since 1952 and indigenous species that must have been overlooked by Allard, have been documented by other botanists. Secondly, the within-site distributions and relative abundances of some plants have changed over the past 50 years as a result of ongoing successional processes and disturbance impacts (see DISCUSSION section, p. 168).

Completion of the current vegetation ecology study based on extensive, field-collected data makes this an appropriate time to produce an updated version of the Bull Run Mountains' flora. The primary objective of this exercise is to generate a current botanical database that can serve as a baseline for future inventory, research, and land management. Completion of this task was made considerably easier by the Smithsonian's on-line resources. Most specimens from the Bull Run Mountains are housed in the D.C. (District of Columbia) Herbarium, which is maintained within the U.S. National Herbarium as a separate collection covering the greater Washington-Baltimore area. This collection now has a website that allows a complete database of specimens to be queried and the label data for individual specimens to be viewed on-line (http://www.nmnh.si.edu/botany/projects/dcflora/dcherbarium.html). This resource permits access to a more complete and accurate summary of distribution data than can be obtained from the published papers alone. Additional work will be required before a formal update of the Bull Run Mountains' flora can be published. Not all of the new records are vouchered by specimens and at least a few historical collections need systematic review. Several errors of identification in the original flora have since been corrected by reviewers and these corrections are incorporated into the updated list.

The updated flora differs from the original in one important respect. Allard used roads to bound his study area, which thus included portions of both the Culpeper Basin to the east and the rolling area underlain by metabasalt to the west. This delimitation allowed some plants exclusive to these distinctive areas to be included in the original flora and greatly increased the amount of open pastures and abandoned fields in the study area. Moreover, in the original flora and especially its two addenda, species collected even outside the road-bounded area in the Culpeper Basin were included. Although its boundaries are more indefinite by nature, the study area for the updated flora is restricted to the highland area and extends only to the base of the Bull Run Mountains proper. The floodplain of Broad Run from the vicinity of the historical Broad Run Railroad Station west of Thoroughfare Gap to the bluffs at the east foot of Pond Mountain about 1.2 km (0.75 mi) SE of Thoroughfare Gap is included. After reviewing collection data for all taxa of the historical flora, those that were not clearly documented from the new, more strictly defined study area were dropped from the current treatment.

Although the updated flora is much more taxonomically conservative and represents an area of approximately 60 km^2 (23 m^2) versus 85 km^2 (33 m^2) for Allard's study area, it contains nearly as many taxa as the original flora and its two addenda. Of 1,020 taxa now included, 818 are native and 202 (20%) are introduced. Eighty-six (86) new taxa, 23 of them exotics, have been added to the flora, based on relatively recent work by Charles E. Stevens, F. Raymond Fosberg, and the current author, as well as a few historical records by Allard and Hubert Penson that were never included in the published accounts.

Phytogeography of the Bull Run Mountains

No botanical treatment of the Bull Run Mountains would be complete without at least a cursory overview of the geographic distribution patterns represented by the flora. While many of the area's native species are generally distributed in the eastern United States and throughout Virginia, others form coherent groups of more regionally restricted taxa. To a great extent, these groups reflect the influences of two larger biogeographic floras: that of the northern North American and Appalachian region, and that of the southeastern Atlantic and Gulf slopes and coastal plains. Plants characteristic of each region are well represented in the study area, which is situated at a latitude where these great floras intermingle and in a very narrow part of the Piedmont Plateau close to both the Coastal Plain and the Appalachian Mountains. Because of the Bull Run Mountains' status as a geological and biological outlier of the Central Appalachians (see p. 167), the area's flora has more affinities to the northern / Appalachian region. Thus, it contains a sizeable group of species that are widely distributed in the mountains and Piedmont of Virginia but are uncommon, localized, or rare in the Coastal Plain. A second group contains species that are more strongly affiliated with the mountains and even more irregularly distributed or localized (but often locally common) in the Piedmont. Yet the Bull Run Mountains also harbor a number of plants that are most abundant and widespread in the Coastal Plain and Piedmont provinces of Virginia, occurring more irregularly in suitable habitats of the mountains. A very small but interesting group consists of species with distributions centered in and mostly confined to the Piedmont. Examples of species belonging to each of these phytogeographic groups include:

1. *Widely distributed in the mountains and Piedmont; uncommon, localized, or rare in the Coastal Plain*: *Arabis canadensis* (sicklepod), *Asclepias quadrifolia* (four-leaved milkweed), *Aureolaria laevigata* (smooth yellow false foxglove), *Bromus pubescens* (common eastern brome grass), *Carex prasina* (a sedge), *Collinsonia canadensis* (horse-balm), *Conopholis americana* (squawroot), *Deparia acrostichoides* (silvery spleenwort), *Elymus hystrix* var. *hystrix* (bottlebrush grass), *Eupatorium sessilifolium* (upland boneset), *Hieracium paniculatum* (panicled hawkweed), *Hydrocotyle americana* (American water-pennywort), *Hydrophyllum virginianum* (Virginia waterleaf), *Lactuca biennis* (tall blue lettuce), *Laportea canadensis* (wood nettle), *Muhlenbergia tenuiflora* (woodland muhly), *Osmunda claytoniana* (interrupted fern), *Physocarpus opulifolius* (ninebark), *Polypodium virginianum* (rock polypody), *Rubus allegheniensis* var. *allegheniensis* (Allegheny blackberry), *Senecio obovatus* (round-leaved ragwort), *Schoenoplectus purshianus* (a bulrush), *Solidago ulmifolia* (elm-leaf goldenrod), *Staphylea trifolia* (bladdernut).

2. *Most common and characteristic of the mountains; more localized eastward in the Piedmont and/or Coastal Plain*: *Amelanchier laevis* (smooth serviceberry), *Aralia nudicaulis* (wild sarsaparilla), *Betula lenta* (sweet birch), *Chrysosplenium americanum* (American golden-saxifrage), *Desmodium glutinosum* (pointed-leaf tick-trefoil), *Dichanthelium linearifolium* (narrow-leaved panic grass), *Muhlenbergia sobolifera* (cliff muhly), *Paronychia canadensis* (smooth forked nailwort), *Paronychia fastigiata* (hairy forked nailwort), *Parietaria pensylvanica* (Pennsylvania pellitory), *Pinus rigida* (pitch pine), *Tilia americana* var. *americana* (American basswood), *Tsuga canadensis* (eastern hemlock).

3. *Most common and characteristic of the Piedmont and Coastal Plain; more irregularly and locally distributed at low elevations in mountains*: *Betula nigra* (river birch), *Dulichium arundinaceum* (three-way sedge), *Elephantopus carolinianus* (Carolina elephant's-foot), *Eupatorium rotundifolium* ssp. *ovatum* (round-leaved thoroughwort), *Euthamia graminifolia* var. *graminifolia* (flat-top goldenrod), *Galium obtusum* var. *obtusum* (bluntleaf bedstraw), *Houstonia purpurea* var. *purpurea* (large summer bluets), *Juncus scirpoides* (a rush), *Juncus subcaudatus* (short-tailed rush), *Quercus falcata* (southern red oak), *Rhynchospora capitellata* (a beakrush), *Vaccinium fuscatum* (hairy highbush blueberry).

4. *Distribution strongly centered in the Piedmont*: *Cardamine angustata* (slender toothwort), *Clematis ochroleuca* (curly-heads), *Corallorhiza wisteriana* (spring coralroot), *Liatris squarrosa* (scaly blazing-star).

Most interesting are groups of species that are close to their eastern or western range limits at this latitude (Table 53). As a rule, these species are strongly characteristic of either the mountains or the Coastal Plain-Piedmont provinces of Virginia, with rare occurrences outside these regions in special, localized habitats. For example, montane species are usually confined to disjunct, microclimatically cool habitats on Piedmont monadnocks or north-facing bluffs. Likewise, lowland species may have disjunct populations in isolated wetlands and other coastal plain-like habitats of the Ridge and Valley region.

Table 54. Selected plant species at or near their regional east-west range limits in the Bull Run Mountains. Only species recently documented are listed. Refer to Harvill *et al*. (1992) for maps of species ranges in Virginia.

Species	**Common Name**	**Primary VA Range**	**Habitat in Bull Run Mts.**
Andropogon gyrans var. *gyrans*	beardgrass	coastal-piedmont	fields, clearings
Apocynum androsaemifolium	spreading dogbane	mountains	wooded ridges
Asplenium montanum	mountain spleenwort	mountains	sheltered rock crevices
Carex atlantica ssp. *capillacea*	a sedge	coastal-piedmont	seepage swamps
Carex hirtifolia	a sedge	mountains	rich wooded slope
Comptonia peregrina	sweet-fern	mountains	xeric clearings, ridge crests
Cornus alternifolia	alternate-leaved dogwood	mountains	rocky forests, seeps
Cuscuta compacta	compact dodder	coastal-piedmont	seepage swamps
Dichanthelium latifolium	broad-leaved panic grass	mountains	wooded ridges
Dichanthelium scoparium	velvet panic grass	coastal-piedmont	fields, clearings
Dryopteris celsa	log fern	coastal-piedmont	seepage swamps
Dryopteris goldiana	Goldie's wood fern	mountains	seepage swamps
Fraxinus nigra	black ash	mountains	seepage swamps
Galium latifolium	purple bedstraw	mountains	basic wooded slopes
Glyceria melicaria	slender mannagrass	mountains	seepage swamps
Helianthemum canadense	Canada frostweed	coastal-piedmont	xeric clearings, ridge crests
Ilex opaca var. *opaca*	American holly	coastal-piedmont	acidic wooded slopes
Juncus canadensis	Canadian Rush	coastal-piedmont	boggy seeps, clearings
Krigia dandelion	potato dwarf-dandelion	coastal-piedmont	floodplains, stream bottoms
Lycopodium clavatum	staghorn clubmoss	mountains	damp acidic clearings
Maianthemum canadense	Canada mayflower	mountains	seepage swamps
Mikania scandens	climbing hempweed	coastal-piedmont	seepage swamps, wet clearings
Mitella diphylla	two-leaved miterwort	mountains	rocky stream bottoms
Phoradendron leucarpum	American mistletoe	coastal-piedmont	on trees at low elevations
Pinus pungens	table-mountain pine	mountains	cliffs and rocky ridges
Platanthera orbiculata	round-leaf orchid	mountains	acidic wooded ravine
Quercus phellos	willow oak	coastal-piedmont	floodplains, low forests
Ranunculus allegheniensis	Allegheny buttercup	mountains	basic wooded slopes
Rhododendron maximum	great rhododendron	mountains	acidic wooded ravine
Rubus odoratus	purple flowering raspberry	mountains	boulderfield forest
Spiraea betulifolia var. *corymbosa*	dwarf spiraea	mountains	wooded ridges
Toxicodendron vernix	poison sumac	coastal-piedmont	seepage swamps
Trientalis borealis ssp. *borealis*	northern starflower	mountains	seepage swamp
Trillium cernuum	nodding trillium	mountains	seepage swamps
Veratrum viride	American false hellebore	mountains	seepage swamps
Woodwardia areolata	netted chain fern	coastal-piedmont	seepage swamps, springs

The relatively large number of plants occurring as disjuncts or at the peripheries of their ranges in the Bull Run Mountains is a reflection both of the area's transitional physiography and of the habitat diversity that results from its sharp relief. The seepage swamps, in particular, constitute habitats suitable for unusual species of different biogeographic affinities. In Jackson Hollow, for instance, one swamp features the typical Coastal Plain-lower Piedmont species *Toxicodendron vernix*, *Woodwardia areolata*, and *Carex seorsa* growing alongside the mountain disjuncts *Glyceria melicaria*, *Maianthemum canadense*, and *Veratrum viride*. It is doubtful that this peculiar and anomalous mingling of species could be found elsewhere in Virginia.

Rare Vascular Plants of the Bull Run Mountains

Twenty-six occurrences of 18 state-rare plant species monitored by DCR-DNH have been documented in the Bull Run Mountains (Table 54; Townsend 2002). Most of these populations have not been seen in more than 25 years and are now considered historical. None of the species in question are globally rare; most are state-rare by virtue of Virginia being situated at the edge of their overall ranges. Nevertheless, this is an impressive assemblage for the Virginia Piedmont, which has far fewer potential habitats for rare plants than either the higher Appalachians or the Coastal Plain. More intensive and systematic botanical inventory is needed to determine the current status of historical rarities and to ensure that populations of other rare species have not been missed.

Perhaps the most noteworthy rare plant of the study area is *Stachys eplingii* J. Nelson (Epling's hedgenettle), a mint family member with a scattered, sporadic distribution in the central and southern Appalachians and Ozark Mountains. The treatment of this species as *Stachys eplingii* is relatively recent (Nelson and Fairey 1979), as the name *Stachys nuttallii* Shuttlw., which correctly belongs to a more common southern Appalachian species, had been misapplied to the initial collections. The earliest known collections of *Stachys eplingii* were made by H.A. Allard (8985) on 29 June 1941 from a "swale on west slope of Pond Mountain just south of Thoroughfare Gap." As a result, a specimen from this collection at the New York Botanical Garden was designated as the holotype of this taxon, with duplicate isotypes at Field Museum of Natural History, Gray Herbarium (Harvard University), U.S. National Herbarium, and Virginia Tech (Nelson 1981). In 1992, J.B. Nelson and the author investigated the status of the population at they type locality and found it to be extant but heavily impacted by cattle grazing.

Ten additional plant species considered uncommon to rare in Virginia and maintained on a "watch list" by DCR-DNH have also been documented in the study area (Table 54; Townsend 2002).

Table 55. State-rare and “watch list” (uncommon) plant species documented, at least historically, in the Bull Run Mountains. The current status, localities, date(s) last seen, and habitat(s) for each species are listed. See Townsend (2002) for ranking criteria.

Species	**Common Name**	**G/S Ranks**	**Status**	**Locality (last seen)**	**Habitat**
Asclepias purpurascens	purple milkweed	G4G5S2	historical	near Broad Run Station (1949)	floodplain swales
Botrychium oneidense	blunt-lobed grape fern	G4QS2	historical	Bartons Creek (1974)	wooded bank
Buchnera americana	blue-hearts	G5?S1S2	historical	W slope Pond Mt (1951)	old pasture
Crataegus calpodendron	pear hawthorn	G5S1	historical	ridge of Pond Mountain (1941) just N of Hopewell Gap (1951)	? by stream
Crataegus pruinosa	a hawthorn	G5S2	historical	N of Antioch (1935), S of Aldie (1936), Hopewell Gap (1936), S of Hopewell Gap (1938)	?
Crataegus succulenta	fleshy hawthorn	G5S1	historical	N of Hopewell Gap (1942)	?
Filipendula rubra	queen-of-the-prairie	G4G5S2	historical	W foot Pond Mt (1946)	swale
Gnaphalium helleri	catfoot	G4G5S1	historical	E of High Point ridge (1941)	old field
Muhlenbergia glomerata	marsh muhly	G5S2	historical	W slope High Point Mt (1973)	?
Penstemon hirsutus	hairy beardtongue	G5S2	historical	N of Hopewell Gap (1935) near Antioch (1939) Pond Mountain (1945)	woods ? pasture
Platanthera peramoena	purple fringeless orchid	G5S2	historical	W foot Pond Mt (1946?)	swale
Populus tremuloides	quaking aspen	G5S2	extant?	near White Rock (1989)	wooded slope
Pyrola elliptica	shinleaf	G5S2	historical	~1 mi N of Hopewell Gap (1936) 2 mi. N of Hopewell Gap (1936)	moist rich woods
Ranunculus aquatilis var. *diffusus*	white water crowfoot	G5T5S1	historical	Broad Run W of Bev. Mill (1941)	shallow water
Rosa setigera var. *tomentosa*	prairie rose	G5S1	historical	Rt 628 near Hopewell Gap (1940)	roadside thicket
Spiranthes ochroleuca	yellow nodding ladies'-tresses	G4S1	historical	E slope below High Point (1937)	?
Stachys eplingii	Epling's hedgenettle	G5S1	extant?	W foot Pond Mt (1992)	wet meadow
Trillium cernuum	nodding trillium	G5S2	extant? extant	near White Rock Spring (1982) W foot High Acre Ridge (2001)	seepage swamps
WATCH LIST:					
Carex bushii	a sedge	G4S3	extant?	W foot Pond Mt (1992)	wet meadow
Carex hirtifolia	a sedge	G5S3	extant	E foot Pond Mt (2001)	rich wooded bluff
Corallorhiza wisteriana	spring coralroot	G5S3	historical	N of Hopewell Gap (1937), W of Hopewell Gap (1940), Pond Mountain (1942), Roland Farm (1967)	moist wooded slopes
Desmodium fernaldii	Fernald's tick-trefoil	G4S3	historical	near High Point (1935)	dry wooded ridge
Fraxinus nigra	black ash	G5S3	extant	various (2001)	seepage swamps
Iris versicolor	blueflag	G4S3	historical	0.5 mi S of Thoroughfare Gap (1946)	swale
Juglans cinerea	butternut	G3G4S3?	extant	various (2001)	boulderfield forests
Oenothera nutans	nodding evening-primrose	G4S3	historical	W slope below High Point (1939) near Beverley Mill (1943)	? along railroad
Panax quinquefolius	American ginseng	G3G4S4	extant?	Hungry Run (1986)	wooded slope
Paspalum boscianum	bull paspalum	G5S3	extent?	W foot of High Point Mt (1989)	around stables

ANNOTATED LIST OF
VASCULAR PLANTS OF THE BULL RUN MOUNTAINS, VIRGINIA

In the following annotated list, 1,016 vascular plant taxa documented in the Bull Run Mountains proper are organized in the following order of major groups:

- Pteridophytes (Fern and Fern Allies)
- Spermatophytes (Flowering Plants): Gymnosperms
- Spermatophytes: Angiosperms – Monocots
- Spermatophytes: Angiosperms – Dicots

Within each major group, families, genera, and species are listed alphabetically. Nomenclature generally follows the Flora of North America where completed (Flora of North America Editorial Committee 1993, 1997, 2000) and otherwise Kartesz (1999) or Gleason and Cronquist (1991). Synonymy with Allard and Leonard (1943, 1944a, 1952) and with names on specimen labels at US is provided. Common names, when available, are compiled from various sources by DCR-DNH. If a taxon occurred in vegetation plots sampled during the ecological study, the number of plots is given. Species considered to be exotics are indicated as such in the annotations. Taxa representing new records for the Bull Run Mountains (*i.e.*, not previously included in publications) are indicated by a double asterisk (**) following the name. The collector (or observer, in the case of unvouchered records) and collection number(s) for new records are also provided. Collections of G.P. Fleming are located at the herbaria of George Mason University (GMUF) and the College of William and Mary (WILLI); those of F.R. Fosberg are at the U.S. National Herbarium (US); and those of C.E. Stevens are at the Longwood College Herbarium (FARM).

Data on distribution, habitats, and abundance is based on the current author's field experiences or synthesized from specimen labels and annotations in Allard and Leonard (1943, 1944a, 1952). There are many cases where the characterization of a species' distribution or abundance given here varies from that given in Allard and Leonard's papers. One likely reason for such discrepancies is that Allard's study area included a much greater area of open habitats, and thus larger populations of ruderal species. Another reason is that habitat conditions and species-populations in the area have changed because of diseases, herbivory, invasive exotics, and the reduction of logging and fires. A third potential reason is simply that one of the assessments is inaccurate. This is a large study area and even with 18 years of field work, Allard obviously missed some important species and was probably biased by his interest in certain species and habitats. My own experience with this area is much more limited time-wise, and largely focused on forested habitats and older successional communities. As a result, there are many taxa collected by Allard that I have not seen here. Thus, despite the magnitude of collective botanical work by Allard and others who followed, the status of a number of taxa remains sketchy, and annotations in the following list should be regarded as a rough guide and the starting point for future studies. Finally, the term "fertile" is used in a relative sense in the following annotations, since the base status of the better soils in this area is only moderately high on an absolute scale.

For consistency with previously published accounts of the study area's flora, terms used by Allard and Leonard (1943) to indicate distribution and abundance have been adopted here with a few minor modifications to their definitions:

Abundant: occurring in large numbers in suitable habitats.
Common: plentiful throughout the area.
Frequent: evenly distributed over the area (in suitable habitats) but not plentiful.
Infrequent: unevenly or irregularly distributed in the area; occasional.
Rare: one to few small populations known in the area.
Local: restricted to a particular habitat.

PTERIDOPHYTES. FERNS AND FERN ALLIES

ASPLENIACEAE. SPLEENWORT FAMILY

***Asplenium montanum* Willd.** Mountain Spleenwort. Shaded quartzite outcrops on north-facing hemlock bluff along Little River, just S of Aldie (G.P. Fleming 15264); also collected by Allard at High Point cliffs, but not found there recently despite intensive searches. Rare, local.

***Asplenium pinnatifidum* Nutt.** Lobed Spleenwort. Collected by Allard on High Point cliffs; not found recently despite intensive searches. Rare, local.

***Asplenium platyneuron* (L.) B.S.P.** Ebony Spleenwort. Rock outcrops, rocky wooded slopes, wood road banks, and old fields. Frequent (10 plots).

***Asplenium rhizophyllum* L.** Walking Fern. *Camptosorus rhizophyllus* (L.) Link. On flat, mossy, quartzite shelves of wooded boulderfield in Jackson Hollow, just E of Rt. 629; also collected by Allard on rock shelves, NE slope of "Round Knob" (= the northernmost knob of High Acre Ridge). Rare, local (1 plot). The occurrence of this typically calciphilic species on quartzite is somewhat unusual.

***Asplenium trichomanes* L. ssp. *trichomanes*.** Maidenhair Spleenwort. On outcrops of calcareous Triassic conglomerate on wooded bluff along Broad Run, 1.2 km (0.75 mi) SE of Thoroughfare Gap at E foot of the Pond Mountains. Rare, local.

BLECHNACEAE. CHAIN FERN FAMILY

***Woodwardia areolata* (L.) T. Moore.** Netted Chain Fern. *Lorinseria areolata* (L.) Presl. Seepage swamp in Jackson Hollow and around Spouting Spring on slope above railroad just W of Thoroughfare Gap; also collected by Allard in swampy woods on the eastern slope N of Antioch. Infrequent, local. A fern most characteristic of the Coastal Plain and lower Piedmont.

DENNSTAEDTIACEAE. BRACKEN FERN FAMILY

***Dennstaedtia punctilobula* (Michx.) T. Moore.** Hay-Scented Fern. Clearings, wooded slopes, and rock outcrops. Frequent (5 plots).

***Pteridium aquilinum* (L.) Kuhn var. *latiusculum* (Desv.) Underwood *ex* Heller.** Northern Bracken Fern. *Pteridium latiusculum* (Desv.) Hieron. Dry, infertile soils of clearings and wooded slopes, particularly those with a history of fire; most common in powerlines, chestnut oak forests, and pine-oak/heath woodlands. Frequent (4 plots).

DRYOPTERIDACEAE. WOOD FERN FAMILY

Allard and Leonard (1943) reported the hybrid *Dryopteris* x *uliginosa* (A. Braun *ex* Dowell) Druce (*Dryopteris carthusiana* x *cristata*), while *Dryopteris celsa* x *cristata* was collected by C.E. Stevens.

***Athyrium filix-femina* (L.) Roth *ex* Mert. var. *asplenioides* (Michx.) Farw.** Southern Lady Fern. *Athyrium asplenioides*. Moist wooded slopes, stream bottoms, and seepage swamp hummocks. Common (16 plots).

Cystopteris protrusa* (Weatherby) Blasdell.* Lowland Brittle Fern. Locally abundant on rich wooded bluff along Broad Run at E foot of the Pond Mountains, SE of Thoroughfare Gap (G.P. Fleming, field observation); the only known station in the area (1 plot).

***Deparia acrostichoides* (Sw.) M. Kato.** Silvery Spleenwort. *Athyrium thelypterioides* (Michx.) Desv. On moist, fertile, wooded slopes and hummocks of seepage swamps; sometimes a patch-dominant herb in basic mesic forests. Frequent (6 plots).

Diplazium pycnocarpon* (Spreng.) Broun.* Glade Fern. *Athyrium pycnocarpon* (Spreng.) Tidestrom. Large colony around seepage area in rich forest at NW end of Pond Mountain, Thoroughfare Gap, elev. 162 m (530 ft) (C.E. Stevens 9461, 31 July 1974); the only record. Attempts to relocate this colony in 2001 were unsuccessful.

***Dryopteris carthusiana* (Vill.) H.P. Fuchs.** Spinulose Wood Fern. *Dryopteris spinulosa* (O.F. Muell.) Sw. Seepage swamps and moist, cool crevices of wooded boulderfields; infrequent (4 plots).

Dryopteris celsa* (Wm. Palmer) Knowlt., Palmer & Pollard *ex* Small.* Log Fern. Probably *Dryopteris clintoniana* (D.C. Eat.) Dowell of Allard and Leonard (1943). Rocky seepage swamps; W foot of High Point Mountain, 2.1 km (1.3 mi) N of Thoroughfare Gap and 0.2 km (0.1 mi) E of Rt. 628, elev. 158 m (520 ft) (C.E. Stevens 9280, 14586, 19927); Jackson Hollow, on E side of Rt. 629, 0.5 km (0.3 mi) SE of White Rock Spring and 2.4 km (1.5 mi) N of Hopewell Gap, elev. 277 m (910 ft) (C.E. Stevens 19908, 24646) . Allard's specimen at US labeled *D. clintoniana* was collected "one mile N of Hopewell Gap." A fern most characteristic of lowland swamps in the Coastal Plain and lower Piedmont.

Dryopteris cristata* (L.) Gray.* Crested Fern. Seepage swamps; W foot of High Point Mountain (C.E. Stevens 9281), Little Bull Run (C.E. Stevens 9306), Jackson Hollow (G.P. Fleming 3989, 14451), Bartons Creek (G.P. Fleming, field observation). Infrequent (3 plots).

***Dryopteris goldiana* (Hook. *ex* Goldie) Gray.** Goldie's Wood Fern. Seepage swamps in bouldery ravine bottoms, W foot of High Acre Ridge and W foot of High Point Mountain. Rare, local (2 plots). Apparently collected by Allard from these same localities in the 1930's. A mountain species of rare occurrence east of the main Blue Ridge.

***Dryopteris intermedia* (Muhl. *ex* Willd.) Gray.** Evergreen Wood Fern. Rocky streamsides and hummocks of seepage swamps; Jackson Hollow and Catletts Branch. Infrequent.

***Dryopteris marginalis* (L.) Gray.** Marginal Wood Fern. On rocky wooded slopes, boulderfields, and shaded cliffs. Frequent to common (5 plots).

***Onoclea sensibilis* L.** Sensitive Fern. Seepage swamps, floodplains, and wet, disturbed habitats; occasionally on moist wooded slopes. Frequent (7 plots).

***Polystichum acrostichoides* (Michx.) Schott.** Christmas Fern. On moist or fertile wooded slopes and seepage swamp hummocks throughout; most characteristic of mesic mixed hardwood and acidic oak-hickory forests. Common (24 plots).

***Woodsia obtusa* (Spreng.) Torr. ssp. *obtusa*.** Blunt-Lobed Woodsia. Rocky wooded slopes and shaded outcrops. Infrequent.

EQUISETACEAE. HORSETAIL FAMILY

***Equisetum arvense* L.** Field Horsetail. Damp, wooded stream bottoms, wet clearings, and ditches. Infrequent.

ISOETACEAE. QUILLWORT FAMILY

Isoetes caroliniana* (A.A. Eat.) N. Luebke.* Carolina Quillwort. In *Sphagnum* of seepage swamp, Jackson Hollow, 0.5 km (0.3 mi) SSE of Rt 629 bridge over Catharpin Creek (G.P. Fleming 14454, 14653). Apparently rare and local (1 plot).

LYCOPODIACEAE. CLUB-MOSS FAMILY

***Diphasiastrum digitatum* (Dill.*ex* A. Braun) Holub.** Common Running-Pine. *Lycopodium complanatum* L. var. *flabelliforme* Fern. Moist, usually early-successional forests. Locally abundant.

***Diphasiastrum tristachyum* (Pursh) Holub.** Ground-Cedar. *Lycopodium tristachyum* Pursh. A single collection by Allard from a dry wooded slope N of Hopewell Gap. Rare. A mountain species.

***Huperzia lucidula* (Michx.) Trevisan.** Shining Clubmoss. *Lycopodium lucidulum* Michx. On moist, infertile wooded slopes, rocky streambanks, and seepage swamp hummocks. Infrequent (1 plot).

Lycopodiella appressa* (Chapm.) Cranfill.* Southern Bog Clubmoss. *Lycopodium appressum* (Chapm.) Lloyd & Underw. Sandy wet places in a quarry W of Antioch (H. Penson s.n., 30 May 1952, at US); the only record.

Lycopodium clavatum* L.* Staghorn Clubmoss. Seeping, sandy bank at edge of beaver pond in lower part of Jackson Hollow (G.P. Fleming 14456, 14659) and on mossy road cut along State Rt 55 at N end of Pond Mountain, where locally abundant (G.P. Fleming 15258). Infrequent. Low-elevation, Piedmont occurrences in the Bull Run Mountains and a few other localities are noteworthy, as this species is most common in middle- to high-elevation habitats of the mountains.

***Lycopodium obscurum* L.** Common Tree Clubmoss. On moist, low, infertile wooded slopes, stream bottoms and seepage swamp hummocks. Infrequent, locally abundant (2 plots).

OPHIOGLOSSACEAE. ADDER'S-TONGUE FAMILY

***Botrychium dissectum* Spreng.** Cut-Leaf Grape Fern. Incl. *Botrychium obliquum* Muhl., a common form with less dissected fronds. Moist secondary forests and openly wooded slopes. Frequent.

Botrychium oneidense* (Gilbert) House.* Blunt-Lobed Grape Fern. Wooded bank along Rt 629 near head of Bartons Creek, elev. 259 m (850 ft) (C.E. Stevens 9386, 21 July 1974, verified by W.H. Wagner). Apparently rare.

***Botrychium virginianum* (L.) Sw.** Rattlesnake Fern. On moist or fertile wooded slopes and seepage swamp hummocks; most abundant in basic mesic forests. Frequent to common (16 plots).

***Ophioglossum vulgatum* L.** Southern Adder's-Tongue. Damp, wooded stream bottoms and old fields. Infrequent.

OSMUNDACEAE. ROYAL FERN FAMILY

***Osmunda cinnamomea* L.** Cinnamon Fern. Seepage swamps, damp wooded stream bottoms, and springy clearings. Locally abundant throughout (11 plots; Plate 9, p. 47).

***Osmunda claytoniana* L.** Interrupted Fern. On moist, fertile wooded slopes; in basic mesic forests. Infrequent (2 plots).

***Osmunda regalis* L. var. *spectabilis* (Willd.) Gray.** Royal Fern. Seepage swamps. Frequent (6 plots).

POLYPODIACEAE. POLYPODY FERN FAMILY

***Polypodium virginianum* L.** Rock Polypody. *Polypodium vulgare* L. Shelves and crevices of wooded cliffs, ledges, and boulderfields. Frequent (4 plots).

PTERIDACEAE. MAIDENHAIR FERN FAMILY

***Adiantum pedatum* L.** Northern Maidenhair Fern. On moist, fertile wooded slopes; characteristic of basic mesic forests. Frequent to locally abundant (4 plots; Plate 15, p. 105).

***Pellaea atropurpurea* (L.) Link.** Misidentified as *Pellaea glabella* Mett. in Allard and Leonard (1944b). Collected by Allard from Triassic conglomerate outcrops on bluff along Broad Run, 1.2 km (0.75 mi) SE of Thoroughfare Gap at E foot of Pond Mountain; the only record in the area. Rare.

THELYPTERIDACEAE. MAIDEN FERN FAMILY

***Phegopteris hexagonoptera* (Michx.) Fée.** Broad Beech Fern. *Dryopteris hexagonoptera* (Michx.) C.Chr.; incl. *Dryopteris phegopteris* (L.) C.Chr. (= *Phegopteris connectilis* (Michx.) Watt) of Allard and Leonard (1943), a misidentification. On moist or fertile wooded slopes; most abundant in basic mesic forests. Frequent (7 plots).

***Thelypteris noveboracensis* (L.) Nieuwl.** New York Fern. *Dryopteris noveboracensis* (L.) A.Gray. Moist, infertile wooded slopes, stream bottoms, and seepage swamp hummocks. Common (12 plots).

***Thelypteris palustris* Schott var. *pubescens* (Lawson) Fern.** Marsh Fern. *Dryopteris thelypteris* (L.) A. Gray var. *pubescens* (Laws.) Prince. Seepage swamps. Infrequent (2 plots).

SPERMATOPHYTES. FLOWERING PLANTS

GYMNOSPERMS

CUPRESSACEAE. CYPRESS FAMILY

***Juniperus virginiana* L. var. *virginiana*.** Eastern Red-Cedar. *Juniperus virginiana* L. var. *crebra* Fern. & Grisc. In fencerow thickets and brushy old fields; occasional seedlings and small trees occur on wooded slopes. Frequent (3 plots).

PINACEAE. PINE FAMILY

***Pinus echinata* P. Mill.** Shortleaf Pine. With *Pinus virginiana* in a reforesting old field at the foot of the eastern slope, just N of Hopewell Gap. Very infrequent in the area.

***Pinus pungens* Lamb.** Table-Mountain Pine. On exposed cliffs and xeric, rocky ridges of High Point Mountain, Signal Mountain, and High Acre Ridge; the characteristic tree of the table-mountain pine-oak/heath woodland community type. Infrequent, locally common (3 plots). Local occurrences of this pine east of the Blue Ridge are outliers of its main Appalachian distribution (Plates 1 and 20, pp. xvi and 138).

***Pinus rigida* P. Mill.** Pitch Pine. On xeric, infertile, thinly wooded upper slopes, ridge crests, and exposed cliffs with a history of fire; the characteristic tree of the pitch pine-oak/heath woodland community type. Frequent to locally common (12 plots; Plate 17, p. 137). The southern pine beetle (*Dendroctonus frontalis*) has infested some stands of this tree during the past decade, but damage has not been as severe as in many other parts of the region.

***Pinus strobus* L.** Eastern White Pine. On moist or dry wooded slopes, always on infertile sites. Infrequent but widely scattered throughout (2 plots).

***Pinus virginiana* P. Mill.** Virginia Pine. An invader of abandoned fields and an associate of *Pinus rigida* and *Pinus pungens* on exposed cliffs and formerly burned, xeric slopes; most of the pure stands of this pine that formerly occupied old fields have become decadent and largely replaced by hardwoods. Frequent, locally common (18 plots).

Tsuga canadensis* (L.) Carr* Eastern Hemlock. Abundant on steep, rocky NW-facing bluff along the Little River just S of Aldie; a few trees on a rocky slope in the lower part of Jackson Hollow and in a moist, N-facing ravine on the east ridge, 1.7 km (1.0 mi) SSE of Hopewell Gap. Very local in the area (2 plots; Plate 12, p. 64). All three populations are infested with the exotic insect pathogen *Adelges tsugae* (hemlock woolly adelgid).

ANGIOSPERMS: MONOCOTS

ALISMATACEAE. WATER-PLANTAIN FAMILY

***Alisma subcordatum* Raf.** Broad-Leaved Water-plantain. Old beaver ponds on the eastern slope at Hopewell Gap and in the lower part of Jackson Hollow. Infrequent, local.

***Sagittaria australis* (J.G. Sm.) Small.** Long-Beaked Arrowhead. *Sagittaria brevirostra* Mackenzie & Bush of Allard and Leonard (1943). Collected by Allard "in mud on Broad Run near Broad Run Station." The only record.

***Sagittaria latifolia* Willd.** Broad-leaf Arrowhead. *Sagittaria pubescens* Muhl. Wet, open or thinly wooded habitats in seepage swamps, stream channels, ditches, and clearings. Very infrequent (1 plot).

ACORACEAE. CALAMUS FAMILY

***Acorus calamus* L.** Sweetflag. Collected by Allard from wet soil at Hopewell Gap. The only record.

ARACEAE. ARUM FAMILY

Arisaema triphyllum* (L.) Schott ssp. *triphyllum. Jack-in-the-Pulpit. Seepage swamps, moist or fertile wooded slopes, and cool shaded boulderfields. Common (24 plots).

***Symplocarpus foetidus* (L.) Salisb. *ex* Nutt.** Skunk-cabbage. Seepage swamps. Locally abundant throughout (11 plots; Plates 9 and 10, pp. 47-48).

COMMELINACEAE. SPIDERWORT FAMILY

***Commelina communis* L.** Asiatic Dayflower. Moist, weedy habitats. Frequent. Naturalized exotic.

***Commelina erecta* L.** Slender Dayflower. Collected by Allard from a dry railroad embankment at Beverley Mill in Thoroughfare Gap, and an unspecified locality in the Pond Mountains; the only records. Infrequent or rare.

CYPERACEAE. SEDGE FAMILY

***Bulbostylis capillaris* (L.) Kunth *ex* C.B. Clarke.** Common Hair Sedge. Thin soil on shelves of High Point cliffs; local, infrequent.

Carex aggregata* Mackenzie.* Mostly in open, disturbed ground of powerline clearings and roadsides; on quartzite piles in abandoned quarry 0.5 km (0.3 mi) S of Hopewell Gap (C.E. Stevens s.n.). Infrequent (1 plot).

***Carex albicans* Willd. *ex* Spreng. var. *albicans*.** *Carex artitecta* Mackenz. On moist to dry wooded slopes. Frequent (7 plots).

***Carex albicans* Willd. *ex* Spreng. var. *emmonsii* (Dewey *ex* Torr.) Rettig.** *Carex emmonsii* Dewey. Collected by Allard "below Beverley Mill" (Thoroughfare Gap) and near White Rock. Evidently infrequent.

***Carex albolutescens* Schwein**.** Collected by Allard (1401, 10 May 1936) from the headwaters of Chestnut Lick, on the eastern slope N of Hopewell Gap, but not reported in Allard and Leonard (1943) or its two supplements.

***Carex amphibola* Steud.** Collected by Allard in "low ground 1½ miles north of Hopewell Gap."

***Carex annectens* (Bickn.) Bickn.** Powerline clearings, roadsides, and other open habitats. Infrequent.

***Carex appalachica* Webber & Ball.** *Carex radiata* (Wahl.) Dewey of Allard and Leonard (1943). Moist wooded slopes.

***Carex atlantica* Bailey ssp. *atlantica*.** *Carex incomperta* Bickn. Seepage swamps. Infrequent, local (4 plots).

***Carex atlantica* Bailey ssp. *capillacea* (Bailey) Reznicek.** *Carex howeii* Mackenz. Seepage swamp in Jackson Hollow. Rare. A species most typical of boggy wetlands on the Coastal Plain.

***Carex blanda* Dewey.** On moist or fertile wooded slopes and stream bottoms. Frequent (5 plots).

***Carex bushii* Mackenzie.** Swale at W foot of the Pond Mountains, 0.4 km (0.25 mi) WSW of Thoroughfare Gap. Reported by Allard and Leonard (1943) from "open low ground; frequent."

***Carex caroliniana* Schwein.** Collected by Allard along Broad Run above Beverley Mill. The only record.

***Carex cephalophora* Muhl. *ex* Willd.** On moist or fertile wooded slopes; in basic mesic and basic oak-hickory forests. Frequent (4 plots).

***Carex communis* Bailey.** On steep, rocky, NW-facing hemlock bluff along the Little River just S of Aldie; also collected by Allard from a wooded ravine on the western slope, S of Hopewell Gap. Very infrequent in the area.

Carex debilis* Michx. var. *debilis. Seepage swamps and low, damp forests along streams. Frequent (5 plots).

***Carex debilis* Michx. var. *pubera* Gray.** *Carex allegheniensis* Mackenz. Reported by Allard and Leonard (1943) from "wet soil in open woods; one collection."

***Carex digitalis* Willd.** On moist to dry wooded slopes; a characteristic sedge in most upland community types except chestnut oak forest and pine-oak/heath woodlands. Common (26 plots).

***Carex festucacea* Schkuhr *ex* Willd.** Collected by Allard from swale along Broad Run near Broad Run Station. The only record.

***Carex frankii* Kunth.** Wet open habitats and low roadsides. Infrequent.

***Carex glaucodea* Tuckerm. *ex* Olney.** *Carex flaccosperma* Dewey var. *glaucodea* (Tuckerm. *ex* Olney) Kukenth. Oak-hickory forest on east ridge above Catletts Branch, 2.1 km (1.3 mi) N of Thoroughfare Gap (G.P. Fleming, field observation); collected by Allard only in the Culpeper Basin near Antioch. Evidently very infrequent in the Bull Run Mountains proper (1 plot).

***Carex gracilescens* Steud.** Moist wooded slopes. Infrequent.

Carex gracillima* Schwein.* Rocky wooded stream bottoms and seepage swamp hummocks; Catletts Branch, Little Bull Run, Bartons Creek, Jackson Hollow (G.P. Fleming 3981). Infrequent (4 plots).

***Carex grisea* Wahl.** *Carex amphibola* Steud. var. *turgida* Fern. Moist wooded slopes and Broad Run floodplain. Frequent (2 plots).

***Carex gynandra* Schwein.** Seepage swamps and wet open habitats in clearings and powerlines. Frequent (4 plots).

***Carex hirsutella* Mackenz.** *Carex complanata* Torr. & Hook. var. *hirsuta* (Bailey) Gl. On moist or dry wooded slopes. Frequent (2 plots).

Carex hirtifolia* Mackenz.* Moist, fertile, wooded slope at top of Triassic conglomerate bluff along Broad Run, 1.2 km (0.75 mi) SE of Thoroughfare Gap at E foot of the Pond Mountains (G.P. Fleming 15255). A species most characteristic of limestone forests in the Ridge and Valley province of western Virginia.

***Carex intumescens* Rudge.** Seepage swamps and springy clearings in powerlines. Frequent (4 plots).

***Carex laevivaginata* (Kukenth.) Mackenz.** Seepage swamps and wet open habitats. Infrequent.

***Carex laxiculmis* Schwein. var. *laxiculmis*.** On moist wooded slopes and seepage swamp hummocks; a very characteristic plant of the mesic mixed hardwood forest community type. Frequent (12 plots).

Carex laxiflora* Lam. var. *laxiflora. On moist or dry, fertile wooded slopes; very characteristic of the Basic Mesic and Basic Oak-Hickory Forest community types (15 plots). Common. This broad-leaved sedge is frequently grazed by deer.

***Carex leavenworthii* Dewey.** Several collections by Allard: Broad Run below Thoroughfare Gap; Pond Mountains; and N of Hopewell Gap. Evidently infrequent.

***Carex leptalea* Wahl.** Incl. *Carex leptalea* ssp. *harperi* (Fern.) W. Stone. Seepage swamps, usually growing in *Sphagnum* or other mosses. Infrequent, local (5 plots).

***Carex lurida* Wahl.** Wet open habitats, ditches, and around ponds. Frequent.

***Carex muehlenbergii* Schkuhr var. *enervis* Boott.** On dry, rocky wooded slopes; chestnut oak and oak-hickory forests. Infrequent.

***Carex muehlenbergii* Schkuhr var. *muehlenbergii*.** Collected by Allard from "S of Rt. 55, Pond Mts., W slope of Bull Run Mts."

***Carex nigromarginata* Schwein.** On moist or dry wooded slopes; very early maturing. Infrequent. (1 plot)

***Carex normalis* Mackenz.** Collected by Allard "near Hopewell" and "north of Broad Run Station;" a species of damp open habitats.

***Carex pensylvanica* Lam.** On dry wooded slopes; characteristic of the drier oak-hickory forests. Frequent (11 plots).

***Carex platyphylla* Carey.** On moist or fertile wooded slopes and rocky streambanks. Infrequent (2 plots).

***Carex prasina* Wahl.** Seepage swamps. Frequent, locally abundant (9 plots).

***Carex radiata* (Wahl.) Small.** *Carex rosea* Schkuhr. of Allard and Leonard (1943). Seepage swamps, damp streamsides, and Broad Run floodplain. Frequent (7 plots).

***Carex retroflexa* Muhl. *ex* Willd.** On moist or dry, fertile wooded slopes; apparently limited to the basic mesic forest and basic oak-hickory forest community types. Infrequent (1 plot).

***Carex rosea* Schkuhr *ex* Willd.** *Carex convoluta* Mackenz. Wooded slopes; most common in the basic mesic forest and basic oak-hickory forest community types. Frequent (12 plots).

***Carex scabrata* Schwein.** Collected by Allard from "damp soil on wood roads north of Beverley Mill" (Thoroughfare Gap); the only record. A mountain species that is extremely rare east of the Blue Ridge; characteristic of seepage swamps in the mountains but not found in any of the swamps here to date.

***Carex scoparia* Schkuhr *ex* Willd. var. *scoparia*.** Damp or wet, open habitats. Infrequent.

Carex seorsa* Howe.* Seepage swamps in Jackson Hollow, downstream from Rt. 629 (G.P. Fleming 14448). Infrequent, local (1 plot). A sedge most characteristic of Coastal Plain swamps.

***Carex shortiana* Dewey.** Collected by Allard from "roadside near Beverley Mill, Thoroughfare Gap" and "Broad Run below Thoroughfare Gap, Pond Mountain." The only records.

Carex sparganioides* Muhl. *ex* Willd.*. On moist, fertile wooded slopes; vouchered by H. Penson (s.n., 30 May 1952 at US) near Antioch. Infrequent (1 plot).

***Carex squarrosa* L.** Broad Run floodplain. Infrequent.

***Carex stipata* Muhl. *ex* Willd. var. stipata.** Seepage swamps and boggy clearings. Infrequent (2 plots).

***Carex striatula* Michx.** On moist or fertile wooded slopes. Infrequent (1 plot).

***Carex styloflexa* Buckl.** Seepage swamps and streambanks. Frequent (2 plots).

***Carex swanii* (Fern.) Mackenz.** On wooded slopes generally, but especially common in the mesic mixed hardwood forest community type. Frequent (7 plots).

***Carex tonsa* (Fern.) Bickn.** Incl. *Carex rugosperma.* On dry wooded slopes, ridge crests, and thin soils of cliffs and outcrop shelves. Frequent (7 plots).

***Carex tribuloides* Wahlenb. var. *tribuloides*.** Wooded floodplain along Broad Run above Beverley Mill. Local, infrequent.

***Carex virescens* Muhl. *ex* Willd.** On moist or dry, rocky wooded slopes. Frequent (7 plots).

***Carex vulpinoidea* Michx. var. *vulpinoidea*.** Damp or wet, open habitats, clearings, and roadsides. Frequent.

Carex willdenowii* Schkuhr *ex* Willd.* Thin, rocky soil in oak forest on N slope of Signal Mountain, elev. 351 m (1150 ft) (C.E. Stevens s.n.); infrequent.

***Cyperus bipartitus* Torr.** *Cyperus rivularis* Kunth. Three collections by Allard from "swales and low ground." Evidently infrequent.

***Cyperus echinatus* (L.) Wood.** *Cyperus ovularis* (Michx.) Torr. Fields, roadsides, other weedy habitats. Frequent.

Cyperus esculentus* L.* Collected by Allard (9654, 21 Sept. 1941) from "South of Route 55, Pond Mountains." Probably frequent in weedy habitats. Naturalized exotic.

***Cyperus flavescens* L.** Incl. *Cyperus flavescens* var. *poaeformis* (Pursh) Fern. Four collections by Allard from Thoroughfare and Hopewell Gaps; a species of open, seasonally flooded ditches and ponds.

Cyperus lancastriensis* Porter *ex* Gray.* Collected by Allard (5408, 7 Aug. 1938) along the railroad at Beverley Mill in Thoroughfare Gap, but never reported.

***Cyperus lupulinus* (Spreng.) Marcks ssp. *lupulinus*.** *Cyperus filiculmis* Vahl. Six collections by Allard from dry pastures and old fields dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem).

***Cyperus odoratus* L.** *Cyperus ferruginescens* Boeckl. Reported by Allard and Leonard (1943) from "old field 1 mile south of highway 55, west slope of Pond Mountain; infrequent." No specimens at US.

***Cyperus strigosus* L.** Damp open habitats, low roadsides, and clearings. Infrequent.

Dulichium arundinaceum* (L.) Britt.* Three-Way Sedge. Seepage area in pasture at W foot of Pond Mountain, just S of Thoroughfare Gap (G.P. Fleming 6836); in old impoundment and beaver ponds in Jackson Hollow, downstream from Rt. 629 (G.P. Fleming 14656). Infrequent, locally abundant.

***Eleocharis acicularis* (L.) Roemer & Schultes.** A single collection by Allard from "muddy soil along Broad Run near Broad Run Station." Evidently rare.

***Eleocharis engelmannii* Steud.** Three collections by Allard from wet soil at Hopewell Gap.

***Eleocharis obtusa* (Willd.) Schultes.** Blunt Spikerush. Wet open habitats in fields, ditches, and powerline clearings. Infrequent but locally common.

***Eleocharis tenuis* (Willd.) Schultes var. *tenuis*.** Slender Spikerush. Wet open habitats in fields, ditches, and powerline clearings. Infrequent, local.

***Fimbristylis autumnalis* (L.) Roemer & Schultes.** Incl. *Fimbristylis autumnalis* var. *mucronulata* (Michx.) Fern. Two collections by Allard from open wet ground, "north of Beverley Mill" (Thoroughfare Gap) and "north of Round Knob" (= northernmost knob of High Acre Ridge).

***Rhynchospora capitellata* (Michx.) Vahl.** Springy open habitats in powerline clearings and roadsides. Infrequent.

Schoenoplectus purshianus **(Fern.) M.T. Strong.**** *Scirpus purshianus* Fern. Seasonally flooded soil in old impoundment and beaver ponds in lower part of Jackson Hollow, downstream from Rt. 629 (G.P. Fleming 14655). Infrequent, local.

Schoenoplectus tabernaemontani **(K.C. Gmel.) Palla.** *Scirpus tabernaemontani* K.C. Gmel. *Scirpus validus* Vahl. Five collections by Allard from the vicinity of Broad Run at and W of Thoroughfare Gap; also Roland Farm (F.R. Fosberg) and S of Aldie (Allard). A species of wet, open habitats; evidently infrequent and local.

Scirpus atrovirens **Willd.** Common Bulrush. Wet open habitats of fields, roadsides, and powerline clearings. Frequent.

Scirpus cyperinus **(L.) Kunth.** Woolgrass. Incl. *Scirpus rubricosus* Fern. Wet open habitats in floodplains, meadows, and old ponds. Infrequent, local.

Scirpus georgianus **Harper.** *Scirpus atrovirens* var. *georgianus* (Harper) Fern. Reported by Allard and Leonard (1943) from "open wet soil by brooks and springs." No specimens at US.

Scirpus polyphyllus **Vahl.** Leafy Bulrush. Seepage swamps and wooded floodplain of Broad Run above Beverley Mill. Locally frequent (2 plots).

Scleria pauciflora **Muhl. *ex* Willd. var. *pauciflora*.** Two collections by Allard; "old fields and pastures." Evidently infrequent.

Scleria triglomerata **Michx.** In boggy powerline clearing near the headwaters of Catletts Branch, just S of Hopewell Gap; also collected by Allard "on crest of open wooded ridge at High Point Cliffs." Very infrequent in this area.

Trichophorum planifolium **(Spreng.) Palla.** *Scirpus planifolius* Muhl., *Scirpus verecundus* Fern. Rocky wooded slopes; Pond Mountain, High Point Mountain, Signal Mountain, Jackson Hollow. Infrequent (2 plots).

DIOSCOREACEAE. YAM FAMILY

Dioscorea oppositifolia **L.** *D. batatas* Dcne. Chinese Yam. Weedy thicket along railroad W of Beverley Mill in Thoroughfare Gap. Infrequent. Naturalized exotic.

Dioscorea quaternata **J.F. Gmel.** Whorled Wild Yam. Incl. *Dioscorea glauca* Muhl. and *Dioscorea villosa* L. of Allard and Leonard (1943). On wooded slopes generally, although less frequent in xeric habitats. Common (37 plots).

HYDROCHARITACEAE. TAPE-GRASS FAMILY

Elodea canadensis **Michx.** Canadian Waterweed. *Anacharis canadensis* (Michx.) Planch. Collected by Allard in Broad Run near Beverley Mill. An aquatic species.

Elodea nuttallii **(Planch.) St. John.** Western Waterweed. *Anacharis occidentalis* (Pursh) Vict. Collected by Allard in Broad Run near Beverley Mill. An aquatic species.

IRIDACEAE. IRIS FAMILY

Belamcanda chinensis **(L.) DC.** Blackberry-Lily. Collected by both Allard (in pastures and clearings) and F.R. Fosberg (Saddleback Cottage). A naturalized escape from cultivation.

Iris versicolor **L.** Blueflag. Collected by Allard in "swale near Broad Run ½ mi. south of Thoroughfare Gap;" the only record from the area. Rare.

***Sisyrinchium angustifolium* P. Mill.** Narrow-Leaved Blue-Eyed-Grass. Moist forests and clearings. Frequent (1 plot).

JUNCACEAE. RUSH FAMILY

***Juncus acuminatus* Michx.** Sharp-fruited Rush. Open wet habitats, ditches, and muddy streamsides; old impoundment and beaver ponds in Jackson Hollow. Locally common.

***Juncus anthelatus* (Wieg.) Brooks.** *Juncus macer* f. *anthelatus* (Wieg.) Hermann. Muddy bed of old impoundment in lower part of Jackson Hollow; locally common.

***Juncus canadensis* J. Gay *ex* Laharpe.** Canadian Rush. Seeping edges of an old beaver pond in lower part of Jackson Hollow; infrequent, local. A species more typical of the Coastal Plain.

Juncus diffusissimus* Buckl.* Shaded, mossy edge of Hungry Run, near its headwaters (C.E. Stevens 19920). Evidently rare in the area.

***Juncus effusus* L.** Common Rush. Incl. *Juncus effusus* var. *solutus* Fern. & Wieg. In seepage swamps and various damp to wet, open habitats. Frequent (2 plots).

***Juncus marginatus* Rostk.** Grass-leaved Rush. Six collections by Allard from Thoroughfare Gap, Hopewell Gap, and in Bartons Creek headwaters area; a species of wet, open, often seasonally flooded habitats. Evidently infrequent.

***Juncus scirpoides* Lam.** Seeping edges of an old beaver pond in lower part of Jackson Hollow; infrequent, local.

***Juncus secundus* Beauv. *ex* Poir.** Eight collections by Allard from "pastures and old fields."

***Juncus subcaudatus* (Engelm.) Coville & Blake.** Short-Tailed Rush. Seepage swamps, and boggy clearings; beaver ponds in lower part of Jackson Hollow. Infrequent.

***Juncus tenuis* Willd.** Path Rush. *Juncus macer* S.F. Gray. Various habitats in moist to wet soil; often along trail edges. Frequent.

***Luzula bulbosa* (Wood) Smyth & Smyth.** Bulbous Wood-Rush. *Luzula multiflora* var. *bulbosa* (Wood) Hermann. Collected by Allard from the vicinity of Beverley Mill in Thoroughfare Gap.

***Luzula echinata* (Small) F.J. Herm.** Spreading Wood-Rush. On moist or dry wooded slopes; especially common on mossy wood road banks and streambanks. Frequent (6 plots).

***Luzula multiflora* (Ehrh.) Lej. ssp *multiflora*.** Common Wood-Rush. Collected by Allard from Broad Run below Beverley Mill.

LEMNACEAE. DUCKWEED FAMILY

Lemna minor* L. * Lesser Duckweed. Abundant in old quarry pool on east ridge, 2.1 km (1.3 mi) N of Thoroughfare Gap (G.P. Fleming 15263). The only record to date.

LILIACEAE. LILY FAMILY

***Aletris farinosa* L.** White Colicroot. Collected by Allard in old pastures N of Hopewell Gap.

***Allium canadense* L. var. *canadense*.** Meadow Onion. Collected by Allard along Broad Run below Beverley Mill.

***Allium vineale* L. ssp. *vineale*.** Field Garlic. Fields, roadsides, and moist secondary forests. Common. Naturalized exotic.

***Asparagus officinalis* L.** Asparagus. Fields and roadsides. Infrequent. Naturalized exotic.

Chamaelirium luteum* (L.) Gray.* Devil's-Bit. In dense *Kalmia latifolia* (mountain-laurel) thicket in chestnut oak forest on middle ridge, 2.1 km (1.3 mi) N of Hopewell Gap (G.P. Fleming, field observation); collected "SW of Antioch" by H. Penson (s.n., 30 May 1952, at US). Evidently infrequent or rare (1 plot).

Erythronium americanum* Ker-Gawl. ssp. *americanum. American Trout-Lily. Broad Run floodplain, Thoroughfare Gap. Locally abundant.

***Hemerocallis fulva* (L.) L.** Orange Day-Lily. On roadsides and weedy floodplain along Broad Run. Infrequent. Naturalized exotic.

***Hypoxis hirsuta* (L.) Cov.** Eastern Yellow Star-Grass. Dry wooded slopes, wood road banks, and powerline clearings. Frequent (3 plots).

***Lilium canadense* L. ssp. *editorum* (Fern.) Wherry.** Canada Lily. Collected by Allard from a wet meadow at Hopewell Gap; the only record. Rare here and elsewhere east of the Blue Ridge.

***Maianthemum canadense* Desf.** Canada Mayflower. Seepage swamps and damp wooded streamsides; mostly in the Catharpin Creek/Jackson Hollow drainage but also seen along the headwaters of Little Bull Run and at the W foot of High Point Mountain. Infrequent, locally abundant (3 plots). A northern and mountain species.

Maianthemum racemosum* (L.) Link ssp. *racemosum. Solomon's-Plume. *Smilacina racemosa* (L.) Desf.,, *S. racemosa* var. *cylindrica* Fern. On moist to dry wooded slopes throughout. Common (42 plots). Many populations consist of stunted, non-flowering individuals, presumably the result of repeated grazing by deer.

***Medeola virginiana* L.** Indian Cucumber-Root. Moist to moderately dry, infertile wooded slopes and hummocks of seepage swamps. Common (21 plots).

***Melanthium virginicum* L.** Virginia Bunchflower. Collected by Allard from a "wet, rocky wooded ravine on west slope 2 miles north of Hopewell Gap," the sole record for the area. Rare. Attempts to relocate this population have not been successful.

Muscari botryoides* (L.) Mill.* Collected by Allard (9838) along Broad Run below Beverley Mill but never reported. Naturalized exotic.

***Muscari neglectum* Guss. *ex* Ten.** Grape-Hyacinth. *Muscari racemosum* (L.) Mill. Collected by Allard along Broad Run and on roadside N of Hopewell Gap. Naturalized exotic.

***Narcissus pseudonarcissus* L.** Common Daffodil. Open forests around old house sites. Infrequent. Naturalized exotic.

***Ornithogalum umbellatum* L.** Common Star-of-Bethlehem. Collected by Allard, vicinity of Beverley Mill in Thoroughfare Gap. Naturalized exotic.

Polygonatum biflorum* (Walt.) Ell. var. *biflorum. Solomon's-Seal. Moist to dry wooded slopes; most characteristic of moderately dry oak-hickory forests. Frequent (25 plots). One of the forest herbs most frequently grazed by deer.

***Trillium cernuum* L.** Nodding Trillium. *Trillium cernuum* var. *macranthum* Eames & Wieg. A single plant in swampy forest at W foot of High Acre Ridge (C.E. Stevens, G.P. Fleming *et al*., field observation, 10 Aug 2001); several dozen plants in seepage area 100-150 m below White Rock Spring, Jackson Hollow (C.E. Stevens 14206, 30 April 1977). Rare. The first Virginia record for this state-rare northern species was collected by Allard (4544, 27 April 1938), evidently at the station near White Rock Spring (*i.e*., "cold woodland swamp in Jackson Hollow, 2 miles north of Hopewell Gap, Harris Place." Although other populations have been found on the Blue Ridge, the Bull Run Mountains remain the only Piedmont locality for the species in Virginia.

***Uvularia perfoliata* L.** Perfoliate Bellwort. On moist or fertile wooded slopes; most characteristic of the basic mesic forest and basic oak-hickory forest community types. Common (22 plots).

***Uvularia sessilifolia* L.** Sessile-Leaf Bellwort. On moist, infertile wooded slopes, stream bottoms, and seepage swamp hummocks. Frequent (8 plots).

***Veratrum viride* Ait.** American False Hellebore. Seepage swamps; in all interior drainages N of Hopewell Gap. Locally abundant throughout (6 plots; Plate 9, p. 47). The Bull Run Mountains support one of the largest populations of this northern species east of the main Blue Ridge in Virginia.

NAJADACEAE. WATER-NYMPH FAMILY

Najas gracillima* (A.Br. *ex* Engelm.) Magnus.* Slender Water-Nymph. Shallow water of pond at Roland Farm, W foot of High Point Mountain (F.R. Fosberg 55980). An aquatic species, evidently rare and local in this area.

ORCHIDACEAE. ORCHID FAMILY

***Aplectrum hyemale* (Muhl. *ex* Willd.) Torr.** Putty-Root. Moist, fertile wooded slopes; basic mesic forests. Infrequent.

***Corallorhiza odontorhiza* (Willd.) Poir.** Autumn Coralroot. Moist to dry wooded slopes; usually under oaks or beech. Frequent.

***Corallorhiza wisteriana* Conrad.** Spring Coralroot. Collected by Allard from several localities, "on slopes in moist, rich woods." An uncommon species in Virginia, with an unusual distribution strongly centered in the Piedmont.

***Cypripedium acaule* Ait.** Pink Lady's-Slipper. On dry, infertile wooded slopes and ridge crests; characteristic of chestnut oak forests and pine-oak/heath woodlands. Frequent (3 plots).

***Cypripedium parviflorum* Salisb. var. *pubescens* (Willd.) Knight.** Yellow Lady's-Slipper. Incl. *Cypripedium parviflorum* of Allard and Leonard (1943). Moist to moderately dry, fertile wooded slopes; restricted to the basic mesic forest and basic oak-hickory forest community types. Infrequent (1 plot).

***Galearis spectabilis* (L.) Raf.** Showy Orchid. *Orchis spectabilis* L. Moist, fertile wooded slopes; mostly associated with the basic mesic forest community type. Frequent (4 plots).

***Goodyera pubescens* (Willd.) R. Br. *ex* Ait. f.** Downy Rattlesnake-Plantain. Moist or dry, infertile wooded slopes. Frequent (9 plots).

Isotria verticillata* Raf.* Large Whorled Pogonia. On moist or dry, infertile wooded slopes (C.E. Stevens 9349, 9366; G.P. Fleming 3972); one of the few herbs that often grows under *Kalmia latifolia* (mountain-laurel). Frequent (7 plots).

***Liparis liliifolia* (L.) L.C. Rich. *ex* Ker-Gawl.** Large Twayblade. Incl. *Liparis loeselii* (L.) Rich. of Allard and Leonard (1952), a misidentification. Moist to moderately dry, fertile wooded slopes; in basic mesic forest and basic oak-hickory community types. Infrequent (1 plot).

***Malaxis unifolia* Michx.** Green Adder's-Mouth. Three collection by Allard from "moist woodland," N and S of Hopewell Gap, and near Beverley Mill in Thoroughfare Gap. Evidently infrequent.

***Platanthera clavellata* (Michx.) Luer.** Small Green Wood Orchid. *Habenaria clavellata* (Michx.) Spreng. Seepage swamps, usually on wet mossy hummocks. Local, frequent (5 plots).

***Platanthera lacera* (Michx.) G. Don.** Ragged Fringed Orchid. *Habenaria lacera* (Michx.) Lodd. Seepage swamps. Infrequent or rare (1 plot).

Platanthera orbiculata* (Pursh) Lindl.* Round-Leaf Orchid. A single plant in a moist, wooded, acidic ravine bottom 0.8 km (0.5 mi) N of Thoroughfare Gap (G.P. Fleming, field observation). Rare. A northern and mountain species.

***Platanthera peramoena* (Gray) Gray.** Purple Fringeless Orchid. Collected by Allard from swale on W slope of Pond Mountain just S of Thoroughfare Gap; attempt to relocate this population in 1992 were unsuccessful. Evidently rare in the area.

***Spiranthes cernua* (L.) L.C. Rich.** Nodding Ladies'-Tresses. Around springs on wooded slopes and powerline clearings. Infrequent, local.

***Spiranthes lacera* (Raf.) Raf. var. *gracilis* (Bigelow) Luer.** Slender Ladies'-Tresses. *Spiranthes gracilis* (Bigel.) Beck. Fields and moist clearings. Infrequent.

Spiranthes ochroleuca* (Rydb.) Rydb.* Yellow Nodding Ladies'-Tresses. Collected by Allard on eastern slope of High Point Mountain, "below High Point;" the specific habitat is unclear. A rare species here and elsewhere in Virginia.

***POACEAE*. GRASS FAMILY**

***Agrostis gigantea* Roth.** Redtop. *Agrostis alba* L. Moist fields, roadsides, and other weedy habitats. Frequent. Naturalized exotic.

***Agrostis hyemalis* (Walt.) BSP.** Winter Bentgrass. Reported by Allard and Leonard (1943) from "open woods on tops of ridges and in pastures." Apparently infrequent.

***Agrostis perennans* (Walt.) Tuckerm. var. *perennans*.** Autumn Bentgrass. Moist or dry wooded slopes; especially common in mesic mixed hardwood and oak-hickory forests. Frequent (12 plots).

***Andropogon gerardii* Vitman.** Big Bluestem. *Andropogon furcatus* Muhl. Collected (twice) by Allard from "wet open ground near Broad Run Station," the only records.

***Andropogon gyrans* Ashe var. *gyrans*.** Beardgrass. *Andropogon elliottii* Chapm. Reported by Allard and Leonard (1943) from "old fields and pastures; infrequent." No specimens at US. A Coastal Plain-Piedmont species that is very rare west of the Culpeper Basin in northern Virginia.

***Andropogon virginicus* L. var. *virginicus*.** Broomsedge. Fields, roadsides, powerline clearings; occasional in dry open forests along wood roads. Frequent to locally common.
.

***Anthoxanthum odoratum* L. ssp. *odoratum*.** Sweet Vernal Grass. Fields, roadsides, and other weedy habitats. Frequent. Naturalized exotic.

***Aristida dichotoma* Michx. var. *curtisii* Gray *ex* S. Wats. & Coult.** Curtis' Three-Awn Grass. *Aristida curtisii* (A. Gray) Nash. Collected by Allard on roadside bank near Catletts Branch, N of Thoroughfare Gap; the only record.

***Aristida dichotoma* Michx. var. *dichotoma*.** Forked Three-Awn Grass. Thin soil on shelf at High Point cliffs and barren, gravelly waste ground at old quarry near Broad Run at E foot of the Pond Mountains, just ESE of Thoroughfare Gap; a plant of dry, sterile habitats. Infrequent, locally abundant.

***Aristida longispica* Poir.** Long-Spiked Three-Awn Grass. Reported by Allard and Leonard (1943) from "clearing in Jackson Hollow." No specimens at US.

***Aristida oligantha* Michx.** Prairie Three-Awn Grass. Barren, gravelly waste ground at old quarry near Broad Run at E foot of the Pond Mountains, just ESE of Thoroughfare Gap; a plant of dry, sterile habitats. Infrequent or rare.

***Arrhenatherum elatius* (L.) Beauv. *ex* J. & S. Presl. var. *elatius*.** Tall Oat Grass. Roadside thickets and young secondary forest along Rt. 628 at W foot of High Point Mountain. Infrequent. Naturalized exotic.

Arthraxon hispidus* (Thunb.) Makino.* Jointed Grass. Damp to wet, open habitats of fields, roadsides, and clearings; vouchered by F.R. Fosberg (66208). Frequent, locally abundant. Naturalized exotic; invasive in open, already disturbed habitats.

Brachyelytrum erectum* (Schreb. *ex* Spreng.) Beauv. var. *erectum*.* Common Shorthusk. On moist wooded slopes and hummocks of seepage swamps; vouchered by C.E. Stevens (9288). Frequent (7 plots).

***Bromus commutatus* Schrad.** Hairy Brome Grass. Fields, roadsides, and other weedy habitats. Frequent. Naturalized exotic.

***Bromus inermis* Leyss. ssp. *inermis*.** Awnless Brome Grass. Roadsides, often shaded. Infrequent, locally common. Naturalized exotic.

***Bromus japonicus* Thunb. *ex* Murr.** Japanese Brome Grass. Fields, roadsides, and other weedy habitats. Naturalized exotic.

***Bromus pubescens* Muhl. *ex* Willd.** Common Eastern Brome Grass. *Bromus purgans* L. On moist or fertile wooded slopes; most numerous in basic oak-hickory forests. Frequent (2 plots).

***Bromus tectorum* L.** Cheat Grass. Collected by Allard from Beverley Mill (Thoroughfare Gap) and Broad Run Station. A naturalized exotic of weedy, open habitats.

***Cinna arundinacea* L.** Wood Reed Grass. Seepage swamps and floodplain forests along Broad Run. Frequent (7 plots).

***Cynodon dactylon* (L.) Pers.** Bermuda Grass. Lawns and dry, weedy places. Frequent to locally abundant. Naturalized exotic.

***Dactylis glomerata* L.** Orchard Grass. Open weedy habitats. Frequent. Naturalized exotic.

***Danthonia compressa* Austin *ex* Peck.** Mountain Oat Grass. Collected by Allard, "W of High Point." A mountain species of open forests and old fields.

***Danthonia spicata* (L) Beauv. *ex* Roemer & Schultes.** Poverty Oat Grass. Dry wooded slopes, powerline clearings, and fields. Common (12 plots).

***Dichanthelium acuminatum* (Sw.) Gould & Clark. var. *fasciculatum* (Torr.) Freckman.** Woolly Panic Grass. *Panicum huachucae* Ashe, *P. huachucae* var. *fasciculatum* (Torr.) F.T. Hubb., *P. tennesseense* Ashe. Dry wooded slopes, powerlines, and other clearings. Frequent.

***Dichanthelium acuminatum* (Sw.) Gould & Clark var. *lindheimeri* (Nash) Gould & Clark.** Lindheimer's Panic Grass. *Panicum lindheimeri* Nash. Reported by Allard and Leonard (1943) as frequent in "barren fields and pastures."

***Dichanthelium boscii* (Poir.) Gould & Clark.** Bosc's Panic Grass. *Panicum boscii* Poir., *P. boscii* var. *molle* (Vasey) Hitchc. & Chase. On moderately moist to dry wooded slopes; most characteristic of the basic oak-hickory forest community type. Frequent to common (12 plots).

***Dichanthelium clandestinum* (L.) Gould.** Deer-Tongue Grass. *Panicum clandestinum* L. Moist or damp open forests, clearings, and low meadows. Frequent (4 plots).

***Dichanthelium commutatum* (Schultes) Gould.** Variable Panic Grass. *Panicum ashei* Pearson, *P. commutatum* Schult. On moderately moist to dry wooded slopes. Frequent (4 plots).

***Dichanthelium depauperatum* (Muhl.) Gould.** Starved Panic Grass. *Panicum depauperatum* Muhl. On dry, thinly wooded slopes, ridge crests, sandy outcrop shelves, and wood road banks. Frequent (2 plots).

Dichanthelium dichotomum **(L.) Gould var. *dichotomum*.** Small-Fruited Panic Grass. *Panicum barbulatum* Michx., *P. dichotomum* L., *P. nitidum* Lam. On dry wooded slopes, and thinly wooded ridges. Frequent (23 plots).

Dichanthelium dichotomum **(L.) Gould var. *ramulosum* (Torr.) R.J. LeBlond.** *Panicum microcarpon* Muhl. Moist wooded slopes and hummocks of seepage swamps. Frequent.

Dichanthelium latifolium **(L.) Gould & Clark.** Broad-Leaved Panic Grass. *Panicum latifolium* L. Oak-hickory forest on steep wooded slope at N end of High Point Mountain ridge. Very infrequent or rare (1 plot). A mountain species.

Dichanthelium linearifolium **(Scribn. *ex* Nash) Gould.** Narrow-Leaved Panic Grass. *Panicum linearifolium* Scribn. Collected by Allard from railroad bank above Beverley Mill in Thoroughfare Gap, and two localities near Hopewell Gap; a species most typical of basic soils.

Dichanthelium lucidum **(Ashe) R.J. LeBlond.** Shining Panic Grass. *Panicum lucidum* Ashe. Boggy seepage area in powerline clearing along Rt 629, Jackson Hollow; also collected by Allard. Infrequent, local. A species more characteristic of Coastal Plain wetlands.

Dichanthelium meridionale **(Ashe) Freckman.** *Panicum meridionale* Ashe. Reported by Allard and Leonard (1943) from “old field north of Hopewell Gap.”

Dichanthelium oligosanthes **(Schultes) Gould var. *scribnerianum* (Nash) Gould.** Scribner’s Panic Grass. *Panicum scribnerianum* Nash. Collected by Allard in pasture W of High Point; perhaps not within the study area as defined here.

Dichanthelium sabulorum **(Lam.) Gould & Clark var. *patulum* (Scribn. & Merr.) Gould.** *Panicum tsugetorum* Nash. Collected by Allard on cliffs at High Point, S of Hopewell Gap, and White Rock (Signal Mountain), N of Hopewell Gap.

Dichanthelium sabulorum **(Lam.) Gould & Clark var. *thinium* (Hitchc. & Chase) Gould & Clark.** *Panicum columbianum* Scribn. Collected by Allard from wet soil by roadside on eastern slope at Hopewell Gap.

Dichanthelium scoparium **(Lam.) Gould.** Velvet Panic Grass. *Panicum scoparium* Lam. Boggy seepage area in powerline clearing along Rt 629, Jackson Hollow; also collected by Allard. Infrequent. A species characteristic of the Coastal Plain and Piedmont lowlands.

Dichanthelium sphaerocarpon **(Ell.) Gould var. *isophyllum* (Scribn.) Gould & Clark.** Round-Fruited Panic Grass. *Panicum polyanthes* Schult. Seepage swamps, damp secondary forests, and clearings. Infrequent.

Dichanthelium sphaerocarpon **(Ell.) Gould var. *sphaerocarpon*.** *Panicum sphaerocarpon* Ell. Several collections by Allard, most from the vicinity of Beverley Mill in Thoroughfare Gap.

Dichanthelium villosissimum **(Nash) Freckmann var. *villosissimum*.** *Panicum villosissimum* Nash. Reported by Allard and Leonard from “roadway in woods; infrequent.” No specimens at US.

Dichanthelium yadkinense **(Ashe) Mohlenbr.** Yadkin Panic Grass. *Panicum yadkinense* Ashe., under *D. dichotomum* at US. Collected by Allard on cliffs on Pond Mountain, “two miles south of highway 55.”

Digitaria filiformis **(L.) Koel.** Slender Crabgrass. Dry, sandy powerline clearing on east ridge, S of Hopewell Gap. Apparently infrequent.

Digitaria ischaemum **(Schreb.) Schreb. *ex* Muhl.** Smooth Crabgrass. Open weedy habitats. Frequent. Naturalized exotic.

Digitaria sanguinalis **(L.) Scop.** Hairy Crabgrass. Open weedy habitats. Frequent. Naturalized exotic.

***Echinochloa crus-galli* (L.) Beauv.** Barnyard Grass. Damp weedy habitats. Infrequent. Naturalized exotic.

***Echinochloa muricata* (Beauv.) Fern. var. *microstachya* Wieg.** Rough Barnyard Grass. *Echinochloa crus-galli* var. *mitis* (Pursh) Peterm. Collected by Allard on roadside below Beverley Mill in Thoroughfare Gap, and N of Hopewell Gap.

***Eleusine indica* (L.) Gaertn.** India Goosegrass. Open weedy habitats. Infrequent. Naturalized exotic.

***Elymus hystrix* L. var. *hystrix*.** Bottlebrush Grass. *Hystrix patula* Moench. Moist to moderately dry wooded slopes. Most characteristic of the basic mesic forest and basic oak-hickory forest community types. Frequent (3 plots).

***Elymus repens* (L.) Gould.** Quackgrass. *Agropyron repens* (L.) Beauv. Open weedy habitats. Infrequent, locally abundant. Naturalized exotic.

***Elymus riparius* Wieg.** River Wild Rye. Reported by Allard and Leonard (Allard and Leonard 1943) from "along highway near Broad Run Station." No specimens at US.

***Elymus villosus* Muhl. *ex* Willd.** Slender Wild Rye. Moist wooded slopes and stream bottoms. Infrequent.

***Elymus virginicus* L. var. *virginicus*.** Virginia Wild Rye. Incl. *Elymus virginicus* var. *intermedius* (Vasey) Bush. Wooded floodplain of Broad Run above Beverley Mill. Local.

***Eragrostis capillaris* (L.) Nees.** Lacegrass. Dry soils of powerline clearings and around rock outcrops and old quarries. Infrequent.

***Eragrostis pectinacea* (Michx.) Nees *ex* Steud. var. *pectinacea*.** Western Lovegrass. Weedy open habitats.

***Eragrostis spectabilis* (Pursh) Steud.** Purple Lovegrass. Fields, roadsides, clearings. Infrequent.

***Festuca pratensis* Huds.** Meadow Fescue. *Festuca elatior* L. Fields, clearings, and other disturbed, open habitats. Frequent to locally abundant. Naturalized exotic.

Festuca rubra* L. ssp. *rubra*.* Red Fescue. Collected by F.R. Fosberg (65454) at Roland Farm, W foot of High Point Mountain. Native to certain regions of Virginia, but probably introduced here.

***Festuca subverticillata* (Pers.) Alexeev.** Nodding Fescue. *Festuca obtusa* Spreng. On moist or fertile wooded slopes. Frequent (11 plots).

***Glyceria melicaria* (Michx.) Hubbard.** Slender Mannagrass. Seepage swamps, Jackson Hollow and Hungry Run headwaters. Infrequent, local (1 plot). A species normally found at higher elevations of the Appalachians and not known elsewhere in the Virginia Piedmont.

***Glyceria striata* (Lam.) Hitchc.** Fowl Mannagrass. Seepage swamps and other wet habitats. Frequent (5 plots).

***Holcus lanatus* L.** Common Velvet Grass. Moist to damp fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Leersia oryzoides* (L.) Sw.** Rice Cutgrass. Damp to wet clearings, floodplains. Locally abundant.

***Leersia virginica* Willd.** Virginia Cutgrass. Seepage swamps, stream bottoms, floodplains. Frequent (6 plots).

***Lolium perenne* L. ssp. *perenne*.** Perennial Ryegrass. Collected by Allard from Thoroughfare Gap, "on Rt. 55 above Broad Run." Naturalized exotic.

Microstegium vimineum* (Trin.) A. Camus.* Japanese Stilt Grass. Moist forests, old-field thickets, shaded roadsides, stream bottoms, and floodplains throughout (C.E. Stevens 19918, F.R. Fosberg 65918). Abundant (14 plots). A recently established (first collection in 1986), naturalized exotic that has spread rampantly throughout the area in a very short period of time.

Muhlenbergia glomerata* (Willd.) Trin.* Marsh Muhly. Collected by F.R. Fosberg (55099, 26 Aug. 1973) from Roland Farm, W slope of High Point Mountain, on "lower mountain slope, common locally." This northern grass is a rare species in Virginia, and normally associated with calcareous fens or basic rock outcrops with ephemeral seepage in the mountains. This is a rather remarkable record and an attempt should be made to relocate the population.

***Muhlenbergia schreberi* J.F. Gmel.** Nimble-Will. Incl. *Muhlenbergia schreberi* var. *palustris* (Scribn.) Scribn. Moist open habitats and along wood roads. Frequent.

***Muhlenbergia sobolifera* (Muhl. *ex* Willd.) Trin.** Cliff Muhly. On dry wooded slopes, almost always in oak-hickory forests. Frequent (4 plots).

***Muhlenbergia tenuiflora* (Willd.) B.S.P.** Woodland Muhly. Moist or fertile wooded slopes, in basic mesic and basic oak-hickory forests. Frequent (4 plots).

***Panicum anceps* Michx.** Beaked Panic Grass. Moist fields and clearings. Frequent.

***Panicum capillare* L.** Witch Grass. In disturbed soil by railroad tracks in Thoroughfare Gap.

***Panicum dichotomiflorum* Michx. var. *dichotomiflorum*.** Fall Witch Grass. Barren roadsides. Infrequent.

***Panicum flexile* (Gatt.) Scribn.** Wiry Panic Grass. Several collections by Allard in old fields and pastures on W slope of the Pond Mountains. Normally a species of basic or calcareous soils, perhaps occurring here in soils derived from Catoctin metabasalt.

***Panicum gattingeri* Nash.** Gattinger's Panic Grass. Collected by Allard in "old broomsedge field" and "corn field" S of Hopewell Gap.

***Panicum philadelphicum* Bernh. *ex* Trin.** Philadelphia Panic Grass. Dry, barren soil of powerline clearing, and on roadsides.

***Panicum rigidulum* Bosc *ex* Nees var. *elongatum* (Pursh) Lelong.** Redtop Panic Grass. *Panicum stipitatum* Nash. Wet meadow along Bull Run at foot of eastern slope near Cold Spring Gap. Local.

***Panicum rigidulum* Bosc *ex* Nees var. *rigidulum*.** Tall Flat Panic Grass. *Panicum agrostoides* Spreng. Collected by Allard in "wet open ground."

Paspalum boscianum* Fluegge.* Bull Paspalum. Two collections by F.R. Fosberg (55122, 65781) from Roland Farm, one of them from "grassy corral around unused stable." The identity of these specimens needs verification, since the Bull Run Mountains are somewhat out of the normal, Coastal Plain range of this southeastern species.

***Paspalum setaceum* Michx.** Slender Paspalum. *Paspalum pubescens* Muhl. Fields, clearings, and roadsides. Probably frequent.

***Phleum pratense* L.** Meadow Timothy. Fields, clearings, roadsides. Frequent. Naturalized exotic.

***Poa annua* L.** Annual Bluegrass. Barren, weedy habitats; parking lots, lawns, etc. Infrequent. Naturalized exotic.

***Poa compressa* L.** Flat-Stemmed Bluegrass. Dry soil of fields, clearings, roadsides, and rocky forests. Frequent. Naturalized exotic.

***Poa cuspidata* Nutt.** Short-Leaved Bluegrass. On moist, usually rocky wooded slopes; Catletts Branch; hemlock bluff on Little River just S of Aldie; and Triassic conglomerate bluffs along Broad Run SSE of Thoroughfare Gap. Infrequent (1 plot).

***Poa pratensis* L. ssp. *pratensis*.** Kentucky Bluegrass. Fields, clearings, and roadsides. Common. Native to certain regions of Virginia, but probably introduced here.

***Poa trivialis* L.** Rough Bluegrass. Seepage swamps, damp shaded streamsides, and Broad Run floodplain. Frequent. Naturalized exotic (2 plots).

***Schizachyrium scoparium* (Michx.) Nash. var. *scoparium*.** Little Bluestem. *Andropogon scoparius* Michx. Formerly abundant in old fields and pastures but few of these habitats now remain; in powerlines and other clearings on wooded slopes. Frequent to locally abundant.

***Setaria faberi* Herrm.** Nodding Foxtail. Weedy open habitats. Frequent. Naturalized exotic.

***Setaria pumila* (Poir.) Roemer & Schultes ssp. *pumila*.** Yellow Foxtail. *Setaria lutescens* (Weigel) F.T. Hubb. Weedy open habitats. Naturalized exotic.

***Setaria viridis* (L.) Beauv. var. *viridis*.** Green Foxtail. Weedy open habitats. Naturalized exotic.

***Sorghastrum nutans* (L.) Nash.** Indian Grass. Powerline clearings on wooded slopes. Infrequent.

***Sorghum halepense* (L.) Pers.** Johnson Grass. Weedy roadsides; a locally abundant invader of corn fields outside the study area. Naturalized exotic.

***Sphenopholis intermedia* (Rydb.) Rydb.** Intermediate Wedge Grass. Incl. *Sphenopholis filiformis* (Chapm.) Scribn. of Allard and Leonard (1943), a misidentification. Several collections by Allard from wooded slopes.

***Sphenopholis nitida* (Biehl.) Scribn.** Shiny Wedge Grass. Dry wooded slopes, usually in basic oak-hickory forests (4 plots).

***Sphenopholis obtusata* (Michx.) Scribn.** Prairie Wedge Grass. Powerline clearing on east ridge, S of Hopewell Gap. Apparently infrequent.

***Sphenopholis pensylvanica* (L.) Hitchc.** Swamp Wedge Grass. *Trisetum pensylvanicum* (L.) Beauv. Seepage swamps. Frequent, local (2 plots).

***Tridens flavus* (L.) Hitchc. var. flavus.** Purpletop. *Triodia flava* (L.) Smyth. Fields, clearings, and roadsides. Frequent to locally abundant.

***Vulpia octoflora* (Walt.) Rydb. var. *octoflora*.** Slender Fescue. *Festuca octoflora* Walt. Dry, sandy powerline clearings on wooded slopes and ridge crests. Infrequent.

POTAMOGETONACEAE. PONDWEED FAMILY

***Potamogeton diversifolius* Raf.** Waterthread Pondweed. Collected by Allard from mud and shallow water in Broad Run near Broad Run Station; collected by Fosberg from a shallow pond at Roland Farm, W foot of High Point Mountain. Local.

Potamogeton foliosus* Raf. ssp. *foliosus*.* Leafy Pondweed. Collected by F.R. Fosberg (55979) from Roland Farm. An aquatic species probably inhabiting a farm pond.

***SMILACACEAE*. GREENBRIER FAMILY**

***Smilax glauca* Walt.** White-Leaf Greenbrier. Incl. *Smilax glauca* var. *genuina* Blake and *S. glauca* var. *leurophylla* Blake. Hummocks of seepage swamps and on dry, rocky wooded slopes and ridge crests; a species preferring acidic, infertile soils. Common (29 plots).

***Smilax herbacea* L.** Common Carrion-Flower. Moist or fertile wooded slopes and seepage swamp hummocks. Frequent (5 plots).

***Smilax pulverulenta* Michx.** Hairy Carrion-Flower. Moist wooded slopes. Infrequent (2 plots).

***Smilax rotundifolia* L.** Common Greenbrier. Seepage swamps and on wooded slopes throughout; occurs in a very wide range of habitats and community types. Common; locally abundant in dense tangles in some seepage swamps and on cliffs (45 plots).

***Smilax tamnoides* L.** Bristly Greenbrier. *Smilax hispida* Muhl. Moist wooded slopes. Infrequent (1 plot).

***SPARGANIACEAE*. BURR-REED FAMILY**

***Sparganium americanum* Nutt.** American Burr-Reed. *Sparganium androcladum* (Engelm.) Morong of Allard and Leonard (1943). Collected by Allard from "swale on Broad Run near Broad Run Station." The only record.

***TYPHACEAE*. CAT-TAIL FAMILY**

***Typha latifolia* L.** Broad-Leaved Cat-Tail. Ditches, ponds, and floodplain swales along Broad Run. Infrequent.

***XYRIDACEAE*. YELLOW-EYED-GRASS FAMILY**

***Xyris torta* Sm.** Twisted Yellow-Eyed-Grass. Collected by Allard from "Allen's Spring," on eastern slope, N of Hopewell Gap; the only record. Rare and local.

ANGIOSPERMS: DICOTS

***ACANTHACEAE*. ACANTHUS FAMILY**

***Justicia americana* (L.) Vahl.** Common Water-Willow. Rocky edge of Broad Run above Beverley Mill; also collected in the same general vicinity by Allard. Local.

***Ruellia caroliniensis* (J.F. Gmel.) Steud. ssp. *caroliniensis*.** Carolina Wild Petunia. *Ruellia caroliniensis* var. *membranacea* Fern. Moist clearings and forests, especially on disturbed sites undergoing secondary succession. Infrequent.

***ACERACEAE*. MAPLE FAMILY**

***Acer negundo* L. var. *negundo*.** Boxelder. In floodplain forests and thickets along Broad Run, and in disturbed secondary forests on the lower slopes. Infrequent.

***Acer rubrum* L.** Red Maple. A characteristic overstory tree in seepage swamps and the most abundant understory tree on wooded slopes throughout, especially in chestnut oak and acidic oak-hickory forests; somewhat less abundant in fertile soils of basic mesic and basic oak-hickory forests (64 plots).

***Acer saccharinum* L.** Silver Maple. Near old house sites. Native in large-stream floodplains of the region, but apparently spread from plantings here.

AMARANTHACEAE. AMARANTH FAMILY

***Amaranthus hybridus* L.** Smooth Amaranth. Collected by Allard near Beverley Mill in Thoroughfare Gap; a weedy species of cultivated and freshly disturbed ground. Naturalized exotic.

***Amaranthus spinosus* L.** Spiny Amaranth. Collected by Allard near Hopewell Gap and Beverley Mill in Thoroughfare Gap; a weedy of cultivated and freshly disturbed ground. Naturalized exotic.

ANACARDIACEAE. SUMAC FAMILY

***Rhus aromatica* Ait. var. *aromatica*.** Aromatic Sumac. A single collection by Allard from "ledges on crest of ridge of Pond Mountain, "2-2½ mi. S of Thorofare [sic] Gap." Evidently rare in this area; a shrub strongly associated with calcareous and basic soils. The collection locality appears to be the same as that for *Quercus muhlenbergii* Engelm. (chinkapin oak), a similarly calciphilic species.

***Rhus copallinum* L.** Winged Sumac. Fields and roadside thickets. Infrequent.

***Rhus glabra* L.** Smooth Sumac. Fields and roadside thickets. Infrequent.

***Rhus typhina* L.** Staghorn Sumac. A single collection by Allard from "low moist woodland" near Beverley Mill in Thoroughfare Gap. Rare in this area.

***Toxicodendron pubescens* Mill.** Poison Oak. *Rhus toxicodendron* L. On thinly wooded quartzite cliffs and outcrops along the crest of Pond Mountain, S of Thoroughfare Gap. Infrequent (1 plot).

***Toxicodendron radicans* (L.) Kuntze ssp. *radicans*.** Poison Ivy. *Rhus radicans* L.; incl. *R. radicans* var. *rydbergii* (Small) Rehd. of Allard and Leonard (1943), a misidentification. Wooded slopes, floodplains, scrubby old fields, and roadside thickets throughout; usually in moist or fertile soils; also abundant on shaded boulderfields. Common (25 plots).

***Toxicodendron vernix* (L.) Kuntze.** *Rhus vernix* L. Poison Sumac. Seepage swamps. Infrequent, but scattered throughout the Little Bull Run, Carthapin Creek/Jackson Hollow, Bartons Creek, and Hungry Run drainages N of Hopewell Gap (1 plot). Occurrences here are noteworthy since this typical Coastal Plain-lower Piedmont tree is rather rare in the Virginia mountains.

ANNONACEAE. CUSTARD-APPLE FAMILY

***Asimina triloba* (L.) Dunal.** Paw-Paw. On moist to moderately dry, fertile wooded slopes, sheltered boulderfields, and wooded floodplains along Broad Run and Little River; a dominant understory species in the basic mesic forest community type. Frequent to locally abundant throughout (15 plots). This tree appears to be more widespread and abundant than it was 60 years ago (Allard and Leonard 1943), and is now spreading far beyond its usual habitats in mesic ravines and floodplains. Discrete clones of paw-paw have recently become established in the drier oak-hickory forests and even in dry, rocky chestnut oak forests. The reasons for this expansion are not entirely clear but are probably related to fire exclusion and the immunity of this species to deer browsing.

APIACEAE. CARROT FAMILY

***Angelica venenosa* (Greenw.) Fern.** Hairy Angelica. *Angelica villosa* (Walt.) B.S.P. On moist, or occasionally dry, wooded slopes. Infrequent (1 plot).

***Bupleurum rotundifolium* L.** Hare's-Ear. A single collection by Allard in "groves of *Robinia pseudoacacia* [black locust] on the west slope below High Point cliffs." Naturalized exotic.

***Cicuta maculata* L. var. *maculata*.** Spotted Water-Hemlock. Seepage swamps, wet clearings, and floodplains. Infrequent.

***Cryptotaenia canadensis* (L.) DC.** Honewort. Moist, fertile wooded slopes, floodplain forests, and seepage swamp hummocks. Frequent (4 plots).

***Daucus carota* L.** Queen Anne's Lace. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Hydrocotyle americana* L.** American Water-Pennywort. Seepage swamps, spring seeps, and stream banks. Infrequent, locally abundant (1 plot).

Osmorhiza claytonii* (Michx.) C.B. Clarke.* Sweet-Cicely. Two collections by F.R. Fosberg (55518, 65821) from Roland Farm, W foot of High Point Mountain. A species of mesic, fertile, mostly montane forests.

***Osmorhiza longistylis* (Torr.) DC.** Anise-Root. Incl. *Osmorhiza longistylis* var. *brachycoma* Blake, *O. longistylis* var. *villicaulis* Fern. On moist or fertile wooded slopes. Frequent (1 plot).

***Oxypolis rigidior* (L.) Raf.** Cowbane. Seepage swamps. Infrequent, local (6 plots).

***Pastinaca sativa* L.** Wild Parsnip. Roadsides along Rt 628 and elsewhere. Infrequent. Naturalized exotic.

***Sanicula canadensis* L.** Black Snakeroot. On wooded slopes throughout; in all community types except the dry, sterile chestnut oak forest and pine-oak/heath woodlands. Common (19 plots).

***Sanicula odorata* (Raf.) Pryer & Phillippe.** Clustered Snakeroot. *Sanicula gregaria* Bickn. Collected by Allard in "moist woods along brook, west slope, north of Hopewell 1½ miles" and by F.R. Fosberg from Roland Farm (W slope of High Point Mountain). Allard and Leonard (1943) reported this species as "frequent," but no specimens have been found anywhere in the area in recent years.

***Taenidia integerrima* (L.) Drude.** Yellow Pimpernel. A single collection by Allard from "moist soil in lowland woods, several miles N of Antioch, eastern slope of the Bull Run Mountains." It is unclear whether this record is actually from the mountain slopes or from the Culpeper Basin, where soils are more favorable for this base-loving species.

***Thaspium barbinode* (Michx.) Nutt.** Hairy-Jointed Meadow Parsnip. On moderately moist, fertile wooded slopes; in basic oak-hickory forests. Infrequent (1 plot).

***Zizia aptera* (Gray) Fern.** Heart-Leaved Golden-Alexanders. On dry, fertile wooded slopes; in basic oak-hickory forests. Infrequent.

***Zizia aurea* (L.) Koch.** Golden-Alexanders. Seepage swamps. Infrequent, local.

***APOCYNACEAE*. DOGBANE FAMILY**

***Apocynum androsaemifolium* L.** Spreading Dogbane. *Apocynum androsaemifolium* var. *incanum* A.DC. Two collections by Allard from "crests of ridges and on open wooded slopes 2 miles north of Hopewell Gap." A mountain species of rare occurrence east of the main Blue Ridge in Virginia.

***Apocynum cannabinum* L.** Indian Hemp. Incl. *Apocynum cannabinum* var. *pubescens* (Mitchell) A.DC. Fields, roadsides, and dry, fertile wooded slopes. Frequent (2 plots).

***Vinca minor* L.** Lesser Periwinkle. Disturbed secondary forests in Thoroughfare Gap and around old home sites. Locally abundant. Naturalized exotic.

***AQUIFOLIACEAE*. HOLLY FAMILY**

***Ilex opaca* Ait. var. *opaca*.** American Holly. A few small plants seen in young mesic forests on the east ridge, S of Hopewell Gap. Rare in this area; increasingly common eastward in the Piedmont and Coastal Plain.

***Ilex verticillata* (L.) Gray.** Winterberry. Incl. *Ilex verticillata* var. *padifolia* (Willd.) T.& G. Seepage swamps. Frequent. (10 plots)

ARALIACEAE. GINSENG FAMILY

***Aralia nudicaulis* L.** Wild Sarsaparilla. On moist or dry, rocky wooded slopes and outcrops; especially abundant on sheltered, wooded boulderfields. Frequent to locally abundant throughout, forming dense colonies up to about one ha in extent (11 plots; Plate 3, p. xviii).

***Aralia racemosa* L. var. *racemosa*.** American Spikenard. Moist, fertile, wooded ravine at N end of High Point Mountain; collected by Fosberg at Roland Farm, W slope of High Point Mountain. Very infrequent or rare.

***Aralia spinosa* L.** Devil's Walkingstick. On exposed cliff shelf at summit of High Point Mountain. Rare.

***Hedera helix* L.** English Ivy. Locally abundant and covering trees in disturbed secondary forests in Thoroughfare Gap. Naturalized exotic.

Panax quinquefolius* L.* American Ginseng. Moderately rich, N-facing hardwood slope near head of Hungry Run (C.E. Stevens 19919). Rare.

ARISTOLOCHIACEAE. BIRTHWORT FAMILY

Aristolochia serpentaria* L.* Virginia Snakeroot. Moderately dry wooded slopes, characteristic of both the basic oak-hickory forest and acidic oak-hickory forest community types; vouchered by F.R. Fosberg (60914). Frequent (12 plots).

***Asarum canadense* L.** Wild Ginger. Incl. *Asarum reflexum* Bickn. Moist, fertile wooded slopes and floodplain of Broad Run near Beverley Mill. Infrequent but locally abundant (1 plot).

ASCLEPIADACEAE. MILKWEED FAMILY

***Asclepias exaltata* L.** Poke Milkweed. *Asclepias phytolaccoides* Pursh. Two collections by Allard from "rocky wooded west slope 2½ miles north of Hopewell Gap." A mountain species not otherwise known east of the main Blue Ridge in northern Virginia.

***Asclepias incarnata* L. ssp. *pulchra* (Ehrh. *ex* Willd.) Woods.** Swamp Milkweed. *Asclepias pulchra* Ehrh. Wet clearings and floodplains. Infrequent.

***Asclepias purpurascens* L.** Purple Milkweed. Collected by Allard "in lowland swales along the flood plain of Broad Run near Broad Run Station; local."

***Asclepias quadrifolia* Jacq.** Four-Leaved Milkweed. On moderately moist or dry, fertile wooded slopes; strongly associated with the basic oak-hickory community type. Infrequent (2 plots).

***Asclepias syriaca* L.** Common Milkweed. Fields, roadsides, and clearings. Frequent.

***Asclepias tuberosa* L. ssp. *tuberosa*.** Butterfly-Weed. Dry fields and powerline clearings. Infrequent.

***Asclepias variegata* L.** White Milkweed. On moist or dry, fertile wooded slopes; in basic oak-hickory forests. Infrequent.

***Asclepias viridiflora* Raf.** Green Milkweed. In powerline clearings. Infrequent.

ASTERACEAE. ASTER FAMILY

The putative hybrid *Solidago bicolor* x *erecta* was reported by Allard and Leonard (1943).

***Achillea millefolium* L. var. *occidentalis* DC.** Common Yarrow. Fields, clearings, and open forests. Frequent.

***Ageratina altissima* (L.) King & Robins. var. *altissima*.** White Snakeroot. *Eupatorium rugosum* Houtt. On moist to dry, fertile wooded slopes; strongly (but not exclusively) associated with the basic oak-hickory community type (7 plots).

***Ageratina aromatica* (L.) Spach var. *aromatica*.** Small-Leaved White Snakeroot. *Eupatorium aromaticum* L. Collected by Allard; reported by Allard and Leonard (1943) as frequent in thin open pine woods and field edges.

***Ambrosia artemisiifolia* L.** Common Ragweed. Fields, clearings, roadsides, and open forests. Frequent (1 plot).

***Ambrosia trifida* L. var. *trifida*.** Great Ragweed. Incl. *Ambrosia trifida* var. *integrifolia* (Muhl.) T.& G. In Broad Run floodplain and elsewhere in low, damp, shaded habitats. Frequent.

***Antennaria neglecta* ssp. *neglecta*.** Field Pussytoes. Dry fields and powerline clearings. Locally abundant.

***Antennaria neglecta* Greene var. *neodioica* (Greene.) Cronq.** Small Pussytoes. *Antennaria neodioica* Greene. Collected by Allard in old fields and pastures N and S of Hopewell Gap; reported to be especially abundant in "galled," sparsely vegetated areas with soils severely lacking in available phosphorus and nitrogen (see Allard 1942).

***Antennaria plantaginifolia* (L.) Rich. var. *ambigens* (Greene) Cronq.** *Antennaria fallax* Greene. Reported by Allard and Leonard (1943) as frequent in open woods and pastures; similar to *A. plantaginifolia* var. *plantaginifolia* and not separated at US.

***Antennaria plantaginifolia* (L.) Rich. var. *parlinii* (Fern.) Cronq.** Parlin's Pussytoes. *Antennaria parlinii* Fern. On dry wooded slopes and sterile road banks. Infrequent (1 plot).

***Antennaria plantaginifolia* (L.) Rich. var. *plantaginifolia*.** Plantain-Leaved Pussytoes. In exposed, often rocky mineral soil on dry wooded slopes; most characteristic in the drier oak-hickory forests and on wood road banks. Frequent (5 plots).

***Antennaria virginica* Stebbins.** Shale-Barren Pussytoes. A single collection by Allard from "along a wood road on a dry ridge one mile north of Hopewell Gap."

***Anthemis arvensis* L.** Corn Chamomile. Incl. *Anthemis arvensis* var. *agrestis* (Wallr.) DC. Fields and roadsides. Naturalized exotic.

***Anthemis cotula* L.** Mayweed. Collected by Allard several times around old house sites and along the railroad at Beverley Mill in Thoroughfare Gap. Naturalized exotic.

***Arctium minus* Bernh.** Lesser Burdock. Weedy open habitats; occasional around tip-up mounds and other disturbances on wooded slopes (1 plot). Naturalized exotic

***Arnoglossum atriplicifolium* (L.) Robins.** Pale Indian-Plantain. *Cacalia atriplicifolia* L. On dry, fertile wooded slopes; oak-hickory forests. Infrequent.

***Artemisia annua* L.** Annual Wormwood. Alluvial waste ground near old quarry along Broad Run, just SE of Thoroughfare Gap; collected by Allard around an old cabin on Catletts Branch 3.2 km (2 mi) N of Thoroughfare Gap. Very infrequent. Naturalized exotic.

***Aster cordifolius* L.** Heart-Leaved Aster. On moist or fertile wooded slopes and sheltered boulderfields. Infrequent.

***Aster divaricatus* L.** White Wood Aster. On moist to rather dry wooded slopes and seepage swamp hummocks; most abundant in acidic, infertile soils. Common (27 plots). This species is commonly top-grazed by white-tailed deer; as a result, many populations consist of vegetative individuals that rarely flower.

***Aster infirmus* Michx.** Cornel-Leaved Aster. On dry, wooded slopes; oak-hickory and chestnut oak forests. Infrequent.

***Aster lanceolatus* Willd. var. *simplex* (Willd.) A.G. Jones.** Panicled Aster. *Aster paniculatus* Lam. Wooded floodplains and damp meadows along streams around the foot of the mountain. Frequent.

***Aster lateriflorus* (L.) Britt.** Calico Aster. On moist to moderately dry wooded slopes throughout. Common (21 plots). Frequently stunted by repeated deer grazing.

***Aster novae-angliae* L.** New England Aster. Collected by Allard on roadside bank on W slope of High Point Mountain near Broad Run Station; possibly an escape from cultivation here.

***Aster oblongifolius* Nutt.** Aromatic Aster. Collected by Allard from a single locality in an old field on the W slope of High Point Mountain, S of Hopewell Gap. This record is significantly disjunct from the species' main distribution on shale barrens and limestone outcrops of the Ridge and Valley province.

***Aster patens* Ait. var. *patens*.** Late Purple Aster. On dry wooded slopes. Infrequent (1 plot).

Aster patens* Ait. var. *phlogifolius* (Muhl. *ex* Willd.) Nees.* Phlox-Leaved Aster. Collected by Allard several times but never reported: "wooded ridge N of Beverley Mill" (972, 29 Sept 1935), "wooded ridge, High Point vicinity" (3814, 3 Oct 1937), and "woods below High Point" (5682, 9 Oct 1938).

***Aster pilosus* Willd. var. *demotus* Blake.** White Heath Aster. Fields, roadsides, and clearings. Frequent.

***Aster pilosus* Willd. var. *pilosus*.** Incl. *Aster pilosus* var. *platyphyllus* (T.& G.) Blake. In habitats similar to those of var. *demotus*; not as frequent.

***Aster prenanthoides* Muhl. *ex* Willd.** Crooked-Stem Aster. Wooded, rocky floodplain of Broad Run above Beverley Mill; also collected by Allard from a streamside in Jackson Hollow. Infrequent.

***Aster puniceus* L.** Swamp Aster. Damp open habitats in floodplains and fields along streams around the foot of the mountain.

***Aster schreberi* Nees.** Schreber's Aster. Seepage swamp in Jackson Hollow. Rare, local.

***Aster tataricus* L.f.** Tartarian Aster. Shaded roadside along Rt. 55 at N end of Pond Mountain in Thoroughfare Gap; collected here by Allard in 1942 and by G.P. Fleming in 1989. Naturalized exotic.

***Aster umbellatus* Mill.** Flat-Top White Aster. Collected several times by Allard in Prince William Co. N of Hopewell Gap; typically a species of seepage swamps and wet clearings.

***Aster undulatus* L.** Wavy-Leaved Aster. Incl. *Aster undulatus* var. *loriformis* Burgess. On dry wooded slopes; strongly associated with both the acidic oak-hickory forest and basic oak-hickory forest community types. Frequent (10 plots).

***Bidens aristosa* (Michx.) Britt.** Tickseed Sunflower. Incl. *Bidens aristosa* var. *fritcheyi* Fern., *B. aristosa* var. *mutica* (A.Gray) Gatt., *B. polylepis* Blake. Fields, roadsides, and clearings around the foot of the mountain. Frequent to locally common, especially along the edge of the Culpeper Basin (Plate 7, p. 11).

***Bidens bipinnata* L.** Spanish-Needles. On thinly wooded quartzite outcrops along the crest of Pond Mountain and in clearings on dry wooded slopes. Infrequent (1 plot).

***Bidens cernua* L.** Nodding Beggarticks. Old impoundment and beaver ponds in lower part of Jackson Hollow; reported by Allard and Leonard (1943) as "frequent" in moist clearings, swales, and along brooks.

***Bidens connata* Muhl. *ex* Willd.** Purple-Stem Beggarticks. Collected by Allard in "moist, springy soil in a pasture near Catletts Branch."

***Bidens frondosa* L.** Devil's Beggarticks. Seepage swamps, floodplains, and wet clearings (1 plot).

***Bidens tripartita* L.** Three-Lobed Beggarticks. *Bidens comosa* (Gray) Wieg. Gravel bars in Broad Run above Beverley Mill. Infrequent.

***Bidens vulgata* Greene.** Tall Beggarticks. Collected by Allard N of Hopewell Gap and above Broad Run Station; reported as "frequent" in wet soils of roadsides and pastures (Allard and Leonard 1943).

Carduus nutans* L. ssp. *macrolepis* (Peterm.) Kazmi.* Fields, roadsides, and clearings; vouchered by F.R. Fosberg (59075). Frequent. Naturalized exotic.

***Centaurea maculosa* Lam.** Spotted Knapweed. Dry roadsides, clearings, and railroad embankments. Locally common. Naturalized exotic.

***Centaurea nigrescens* Willd.** Tyrol Knapweed. *Centaurea vochinensis* Bernh. Fields and roadsides. Locally common at the foot of the western slope. Naturalized exotic.

***Chondrilla juncea* L.** Skeleton-Weed. Collected by Allard in old pastures near Hopewell Gap and Broad Run Station. Naturalized exotic.

***Chrysopsis mariana* (L.) Ell.** Maryland Golden-Aster. Incl. *Chrysopsis mariana* var. *macradenia* Fern. On dry embankments along the railroad in Thoroughfare Gap and in dry powerline clearings on wooded slopes. Infrequent.

***Cichorium intybus* L.** Chicory. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Cirsium arvense* (L.) Scop.** Canada Thistle. Fields and roadsides. Locally abundant. Naturalized exotic.

***Cirsium discolor* (Muhl. *ex* Willd.) Spreng.** Field Thistle. Moist open forests, fencerow thickets, and floodplains. Frequent.

***Cirsium pumilum* (Nutt.) Spreng.** Pasture Thistle. Fields and powerline clearings. Infrequent.

***Cirsium vulgare* (Savi) Tenore.** Bull Thistle. Weedy open habitats. Frequent. Naturalized exotic.

***Conoclinium coelestinum* (L.) DC.** Mist-Flower. *Eupatorium coelestinum* L. Moist clearings and floodplains. Infrequent.

***Conyza canadensis* (L.) Cronq.** Horseweed. *Erigeron canadensis* L. A weed of open disturbed habitats, barren powerline clearings, and cultivated ground. Frequent.

***Coreopsis tripteris* L.** Tall Tickseed. Several collections by Allard: old pasture S of Thoroughfare Gap, thicket N of Hopewell Gap, and open woods near Beverley Mill. Evidently infrequent.

***Eclipta prostrata* (L.) L.** False Daisy. *Eclipta alba* (L.) Hassk. Collected twice by Allard from weedy habitats.

***Elephantopus carolinianus* Raeusch.** Carolina Elephant's-Foot. Moist or dry, fertile wooded slopes, clearings, and floodplains. Frequent (1 plot).

***Erechtites hieraciifolia* (L.) Raf. *ex* DC. var. *hieraciifolia*.** Pilewort. A temporary invader of freshly disturbed soils in fields and open habitats; on wooded slopes, it may appear abundantly in areas severely disturbed by gypsy moth, around tip-up mounds, and (formerly) on burned-over sites. Frequent (3 plots).

***Erigeron annuus* (L.) Pers.** Annual Fleabane. Fields, roadsides, and clearings; occasionally in open forests and along wood roads. Frequent to locally abundant (2 plots). Populations of this annual vary tremendously in size from year to year.

Erigeron philadelphicus* L.* Philadelphia Fleabane. Moist clearings and disturbed secondary forests; vouchered by F.R. Fosberg (65431). Infrequent.

***Erigeron pulchellus* Michx. var. *pulchellus*.** Robin's-Plantain. On dry, fertile wooded slope in a diverse basic oak-hickory forest, on the east ridge S of Hopewell Gap. Very infrequent or rare (1 plot).

***Erigeron strigosus* Muhl. *ex* Willd. var. *strigosus*.** Daisy Fleabane. Incl. *Erigeron strigosus* var. *discoideus* Robbins. Fields, roadsides, and clearings; occasional in open forests and along wood roads. Frequent to locally common (1 plot).

***Eupatorium album* L. var. *album*.** White Thoroughwort. Incl. *Eupatorium album* var. *monardifolium* Fern. Several collections by Allard: dry wooded ridge (High Point Mountain) opposite Broad Run Station; dry sterile wooded ridge N of Beverley Mill (Thoroughfare Gap); and thicket on W slope of Pond Mountains S of Thoroughfare Gap. Reported as “frequent” by Allard and Leonard (1943) but not seen anywhere recently despite repeated searches.

***Eupatorium altissimum* L.** Tall Thoroughwort. A single collection from a dry pasture on W slope of the Pond Mountains S of Thoroughfare Gap. Evidently rare.

***Eupatorium fistulosum* Barratt.** Hollow Joe-Pye-Weed. In open low forests, damp clearings, and floodplains. Frequent.

***Eupatorium hyssopifolium* L. var. *calcaratum* Fern. & Schub.** A single collection by Allard from an old pasture N of Hopewell Gap.

***Eupatorium hyssopifolium* L. var. *hyssopifolium*.** Hyssop-Leaved Thoroughwort. Several collections by Allard from old fields and thickets on the eastern slope N of Hopewell Gap. Infrequent or rare; much more common in the Culpeper Basin just east of the study area.

***Eupatorium perfoliatum* L.** Common Boneset. Damp or wet clearings, streamsides, and floodplains. Frequent.

***Eupatorium purpureum* L.** Purple Joe-Pye-Weed. On moist or fertile wooded slopes and seepage swamp hummocks. Frequent (12 plots).

***Eupatorium rotundifolium* L. var. *ovatum* (Bigel.) Torr.** Round-Leaved Thoroughwort. *Eupatorium pubescens* Muhl. On dry embankments along the railroad in Thoroughfare Gap and in dry powerline clearings on wooded slopes. Infrequent.

***Eupatorium sessilifolium* L.** Upland Boneset. On dry, fertile wooded slopes; strongly, if not exclusively associated with the basic oak-hickory forest community type. Frequent (6 plots).

***Euthamia graminifolia* (L.) Greene var. *graminifolia*.** Flat-Top Goldenrod. *Solidago graminifolia* (L.) Salisb., incl. *S. graminifolia* var. *nuttallii* (Greene) Fern. Moist or dry powerline clearings on wooded slopes. Frequent.

***Galinsoga quadriradiata* Cav.** Fringed Quickweed. *Galinsoga ciliata* (Raf.) Blake. Weedy roadsides and disturbed soil along railroad tracks in Thoroughfare Gap; probably frequent in similar habitats throughout. Naturalized exotic.

***Gamochaeta purpurea* (L.) Cabrera.** Purple Cudweed. *Gnaphalium purpureum* L. Sterile powerline clearings and wood road banks. Infrequent.

***Gnaphalium helleri* Britt.** Catfoot. *Gnaphalium obtusifolium* var. *micradenium* Weath. Collected by Allard in an old field in valley (Catletts Branch?) E of High Point ridge. Apparently rare.

***Gnaphalium obtusifolium* L.** Sweet Everlasting. Dry fields, clearings, and open forests. Frequent (1 plot).

***Helianthus decapetalus* L.** Thin-Leaved Sunflower. Damp thicket along Broad Run in Thoroughfare Gap. Local, infrequent.

***Helianthus divaricatus* L.** Woodland Sunflower. On dry wooded slopes (mostly in oak-hickory forests) and powerline clearings. Frequent.

***Helianthus giganteus* L.** Tall Sunflower. Collected by Allard from wet swales and pastures near Broad Run Station; near Beverley Mill in Thoroughfare Gap; Pond Mountains; and N of Hopewell Gap.

***Helianthus strumosus* L.** Pale-Leaved Sunflower. Moist secondary forest at W foot of High Point Mountain; collected by Allard from several other localities. Infrequent.

***Heliopsis helianthoides* (L.) Sweet var. *helianthoides*.** Oxeye. Incl. *Heliopsis scabra* Dunal of Allard and Leonard (1943). Wet pasture along Trapp Run at W foot of the Pond Mountains, just WSW of Thoroughfare Gap; collected by Allard from several additional localities. Infrequent.

***Hieracium caespitosum* Dum.** Meadow Hawkweed. *Hieracium pratense* Tausch. Fields, clearings, and roadsides. Frequent, locally common. Naturalized exotic.

***Hieracium gronovii* L.** Hairy Hawkweed. Dry wooded slopes and clearings. Frequent (1 plot).

***Hieracium paniculatum* L.** Panicled Hawkweed. Moist or dry wooded slopes. Frequent (5 plots).

***Hieracium scabrum* Michx.** Rough Hawkweed. Moist or fertile wooded slopes. Infrequent.

***Hieracium venosum* L.** Rattlesnake-Weed. *Hieracium venosum* var. *nudicaule* (Michx.) Farw. On dry wooded slopes and clearings; in oak-hickory and chestnut oak forests. Frequent (8 plots).

***Ionactis linariifolius* (L.) Greene.** Stiff Aster. Collected by Allard; reported from "dry, sterile, rocky, sandy soil on banks and crests of ridges; infrequent" (Allard and Leonard 1943).

***Krigia dandelion* (L.) Nutt.** Potato Dwarf-Dandelion. Wooded floodplain of Broad Run above Beverley Mill. This species is fairly common in flatwoods of the Culpeper Basin but apparently does not occur west of the Bull Run Mountains.

***Krigia virginica* (L.) Willd.** Dwarf-Dandelion. Dry powerline clearings and open forests. Infrequent.

***Lactuca biennis* (Moench) Fern.** Tall Blue Lettuce. *Lactuca spicata* (Lam.) Hitchc., incl. *L. spicata* var. *integrifolia* (A. Gray) Britt. Low, moist forests in Thoroughfare Gap, along Rt. 629, and elsewhere. Frequent.

***Lactuca canadensis* L.** Wild Lettuce. Incl. *Lactuca canadensis* var. *latifolia* Kuntze, *L. canadensis* var. *obovata* Wieg. Fields, roadsides, clearings, and open forests. Frequent (1 plot).

***Lactuca floridana* (L.) Gaertn. var. *floridana*.** Florida Blue Lettuce. Moist, fertile wooded slopes, disturbed secondary forests, and floodplains. Frequent.

***Lactuca floridana* (L.) Gaertn. var. *villosa* (Jacq.) Cronq.** *Lactuca villosa* Jacq. Collected by Allard in floodplain of Broad Run below Beverley Mill and by Fosberg along trail in woods at Roland Farm, W slope of High Point Mountain; a variety of dubious taxonomic distinction.

***Lactuca saligna* L.** Willow-Leaf Lettuce. Collected by Allard in "waste ground," Jackson Hollow. Naturalized exotic.

***Lactuca serriola* L.** Prickly Lettuce. A weed of cultivated and recently disturbed soil; along railroad in Thoroughfare Gap. Naturalized exotic.

***Leucanthemum vulgare* Lam.** Oxeye Daisy. *Chrysanthemum leucanthemum* L. var. *pinnatifidum* Lecoq. & Lamotte. Fields, roadsides, and clearings. Frequent to common. Naturalized exotic.

***Liatris squarrosa* (L.) Michx. var. *squarrosa*.** Scaly Blazing-Star. A single collection by Allard from "low ground" in Thoroughfare Gap. A species nearly endemic to the Piedmont; in northern Virginia, it is common in the Culpeper Basin but rare from the Bull Run Mountains westward.

***Mikania scandens* (L.) Willd.** Climbing Hempweed. Seepage swamps and roadside spring seeps; Jackson Hollow, Little Bull Run headwaters, and W foot of High Point Mountain. Infrequent, local (3 plots). The Bull Run Mountains are close to a western range limit of this Coastal Plain-Piedmont species.

***Prenanthes alba* L.** White Rattlesnake-Root. Three collections by Allard from "moist open woods in and near Jackson Hollow" and "beyond High Point cliffs" S of Hopewell Gap; also collected by F.R. Fosberg along trail in woods at Roland Farm, W slope of High Point Mountain. Evidently infrequent. Sterile basal leaves seen in one or two places along Catharpin Creek in Jackson Hollow during the 2001 field work may belong to this species.

***Prenanthes altissima* L.** Tall Rattlesnake-Root. On moist wooded slopes and seepage swamp hummocks. Frequent (6 plots).

***Prenanthes serpentaria* Pursh.** Lion's-Foot. Dry wooded slopes and clearings; oak-hickory forests. Frequent (2 plots).

***Prenanthes trifoliolata* (Cass.) Fern.** Three-Leaved Rattlesnake-Root. On moist or dry wooded slopes. Frequent (3 plots).

***Rudbeckia hirta* L. var. *hirta*.** Black-Eyed Susan. Incl. *Rudbeckia monticola* Small. Reported by Allard and Leonard (1943) based on a single collection near Catletts Branch. See comments under *R. hirta* var. *pulcherrima* below.

***Rudbeckia hirta* L. var. *pulcherrima* Farw.** *Rudbeckia serotina* Nutt., incl. *R. serotina* var. *sericea* (T.V. Moore) Fern. & Schub. Field, roadsides, and clearings. Frequent. Probably introduced from the western U.S. The distinction between the two vars. of this species is not always sharp and may have become obscured by introgression between the native var. *hirta* and the aggressive var. *pulcherrima*, which expanded its range eastward following widespread post-settlement disturbances and land clearing.

***Rudbeckia laciniata* L. var. *laciniata*.** Cut-Leaved Coneflower. Seepage swamps and floodplains. Infrequent (1 plot).

***Senecio anonymus* Wood.** Small's Ragwort. *Senecio smallii* Britt. Fields and powerline clearings, particularly on the eastern slope. Frequent.

***Senecio aureus* L.** Golden Ragwort. Seepage swamps in Jackson Hollow. Infrequent, local.

Senecio obovatus* Muhl. *ex* Willd.* Round-Leaved Ragwort. On wooded quartzite cliff ca. 0.24 km (0.15 mi) N of FAA tower at summit of Signal Mountain and 2.3 (1.4 mi) N of Hopewell Gap, elev. 396 m (1300 ft) (G.P. Fleming 3921). Evidently rare in the area.

Senecio pauperculus* Michx.* Balsam Ragwort. On fertile, rocky wooded slopes; evidently confined to the basic oak-hickory forest community type (G.P. Fleming, field observation). Infrequent (2 plots).

***Sericocarpus asteroides* (L.) B.S.P.** Toothed White-Top Aster. Dry, openly wooded slopes, ridge crests, and powerline clearings; one of the few herbs characteristic (though sparse) in xeric chestnut oak forests and pine-oak/heath woodlands. Frequent (1 plot).

***Sericocarpus linifolius* (L.) B.S.P.** Narrowleaf White-Top Aster. Dry, barren powerline clearing on the east ridge; dry, rocky ledge of quartzite cliff above railroad in Thoroughfare Gap. Infrequent, local.

***Silphium trifoliatum* L. var. *trifoliatum*.** Whorled Rosin-Weed. Dry forest borders along Rt 629 and in powerline clearing on W side of Cold Spring Gap; reported by Allard and Leonard (1943) as "frequent" in old fields and clearings. Infrequent.

***Solidago altissima* L.** Tall Goldenrod. Fields, roadsides, and clearings. Frequent to locally common.

***Solidago bicolor* L.** White Goldenrod. Dry wooded slopes and clearings. Frequent (4 plots).

***Solidago caesia* L.** Bluestem Goldenrod. On moist or fertile wooded slopes; occurs in several community types, but most abundantly in acidic and basic oak-hickory forests. Common (20 plots). One of the forest herbs most commonly grazed by deer.

***Solidago erecta* Pursh.** Slender Goldenrod. Dry wooded slopes; mostly in acidic oak-hickory and chestnut oak forests. Infrequent (3 plots).

***Solidago gigantea* Ait.** Smooth Goldenrod. Incl. *Solidago gigantea* var. *leiophylla* Fern. Low, damp forest along road to abandoned quarry just ESE of Thoroughfare Gap. Probably frequent in similar habitats throughout.

***Solidago juncea* Ait.** Early Goldenrod. Fields, roadsides, and clearings. Frequent.

***Solidago nemoralis* Ait. var. *nemoralis*.** Gray Goldenrod. Dry, sterile soil in fields, road banks, and powerline clearings. Frequent.

***Solidago rugosa* Mill. ssp. *rugosa*.** Rough-Leaved Goldenrod. Seepage swamps, damp secondary forests, and floodplains. Frequent.

***Solidago ulmifolia* Muhl. *ex* Willd. var. *ulmifolia*.** Elm-Leaf Goldenrod. Dry, fertile wooded slopes; strongly, if not exclusively associated with the basic oak-hickory forest community type. Frequent (7 plots). Often top-grazed by deer.

***Sonchus arvensis* L. ssp. *uliginosus* (Bieb.) Nyman.** Field Sow-Thistle. *Sonchus arvensis* var. *glabrescens* Guenth., Wimm. & Grab. Collected by Allard along railroad at Beverley Mill in Thoroughfare Gap; a very uncommon weed in Virginia. Naturalized exotic.

***Sonchus asper* (L.) Hill.** Spiny-Leaf Sow-Thistle. Collected by Allard; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Sonchus oleraceus* L.** Common Sow-Thistle. Collected by Allard; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Taraxacum laevigatum* (Willd.) DC.** Red-Seeded Dandelion. Collected several times by Allard: Spouting Spring along railroad W of Thoroughfare Gap; S of Aldie; and near Chestnut Lick on eastern slope N of Antioch. Similar to *T. officinale* but much less common everywhere. Naturalized exotic.

***Taraxacum officinale* Weber *ex* Wigg. ssp. *officinale*.** Common Dandelion. *Taraxacum palustre* (Lyons) Lam. & DC. var. *vulgare* (Lam.) Fern. Common in fields, roadsides, and clearings; appears frequently in wooded habitats but probably does not persist (5 plots). Naturalized exotic

Tussilago farfara* L.* Coltsfoot. Damp soil along woodland roadsides and rocky stream bottoms (G.P. Fleming, field observation). Frequent. Naturalized exotic.

***Verbesina alternifolia* (L.) Britt *ex* Kearney.** Wingstem. *Actinomeris alternifolia* (L.) DC. Floodplain forests, low secondary forests, and damp clearings; occasional on moist, fertile wooded slopes. Frequent, locally abundant (2 plots).

***Vernonia glauca* (L.) Willd.** Broad-Leaved Ironweed. Dry, fertile wooded slopes (mostly in basic oak-hickory forests) and clearings. Infrequent (2 plots).

***Vernonia noveboracensis* (L.) Michx.** New York Ironweed. Damp powerline clearings, low fields, and floodplains. Frequent.

***Xanthium strumarium* L. var. *canadense* (Mill.) Torr. & Gray.** Cocklebur. *Xanthium saccharatum* Wallr. Collected by Allard; typically a weed of damp open sites disturbed by cultivation or livestock.

***Xanthium strumarium* L. var. *glabratum* (DC.) Cronq.** Smooth Cocklebur. *Xanthium pungens* Wallr. Collected by Allard; typically a weed of damp open sites disturbed by cultivation or livestock.

BALSAMINACEAE. TOUCH-ME-NOT FAMILY

***Impatiens capensis* Meerb.** Spotted Jewelweed. *Impatiens biflora* Walt. Seepage swamps and other wet, open or shaded habitats. Frequent to locally common (11 plots).

***Impatiens pallida* Nutt.** Yellow Jewelweed. Reported by Allard and Leonard (1943) from "rocky wooded slope of High Knob [= Signal Mountain] near Jackson Hollow." No specimens at US.

BERBERIDACEAE. BARBERRY FAMILY

Berberis thunbergii* DC.* Japanese Barberry. Moist forests, especially in formerly disturbed sites undergoing secondary succession; vouchered by F.R. Fosberg (65403). Frequent. Naturalized exotic.

***Podophyllum peltatum* L.** May-Apple. On moist wooded slopes and seepage swamp hummocks. Frequent to locally abundant (10 plots). Populations of highly stunted individuals are frequently encountered but it is uncertain whether condition is a result of repeated grazing since no actual herbivory was observed on this species.

BETULACEAE. BIRCH FAMILY

***Alnus serrulata* (Ait.) Willd.** Smooth Alder. *Alnus rugosa* (Ehrh.) Spreng. of Allard and Leonard (1943). (10 plots). Seepage swamps, stream bottoms, and Broad Run floodplain. Frequent to locally common (10 plots).

***Betula lenta* L.** Sweet Birch. On wooded slopes, usually north-facing; ravine at W foot of High Acre Ridge (G.P. Fleming 14663); N slope of High Point Mountain; middle ridge 1.3 km (0.8 mi) N of Hopewell Gap; and N end of Pond Mountain at Thoroughfare Gap. Infrequent (1 plot). Although characteristic of boulderfields in the Blue Ridge and Ridge and Valley provinces, this tree has not yet been found in boulderfield habitats of the Bull Run Mountains.

***Betula nigra* L.** River Birch. Broad Run floodplain below Beverley Mill. Locally abundant. A species most characteristic of the Coastal Plain and Piedmont lowlands.

***Carpinus caroliniana* Walt.** American Hornbeam. Moist wooded slopes, stream bottoms, and Broad Run floodplain. Frequent (8 plots). Many of the area's plants appear to be the northern ssp. *virginiana* (Walt.) Furlow, but the situation is somewhat muddled here and elsewhere in Virginia by intermediates with the southern var. *caroliniana*.

***Corylus americana* Walt.** American Hazelnut. Moist wooded slopes, sheltered boulderfields, seepage swamp hummocks, and floodplain thickets. Frequent (5 plots).

Ostrya virginiana* (Mill.) K.Koch.* Eastern Hophornbeam. On wooded, Triassic conglomerate bluff along Broad Run, 1.2 km (0.75 mi) SE of Thoroughfare Gap at E foot of the Pond Mountains (G.P. Fleming, field observation); also collected by F.R. Fosberg (65295) at Roland Farm, W foot of High Point Mountain. Apparently rare in the area (1 plot). This species prefers base-rich substrates and is one of the most abundant understory trees in the Watery Mountains, a greenstone monadnock located only a few km SW of the Bull Run Mountains in Fauquier County.

***BIGNONIACEAE*. BIGNONIA FAMILY.**

***Campsis radicans* (L.) Seem. *ex* Bureau.** Trumpet-Creeper. Floodplains, fencerows, and low secondary forests; occasionally on cliffs. Infrequent.

***Catalpa bignonioides* Walt.** Southern Catalpa. An occasional escape from cultivation on roadside in Hopewell Gap, along railroad in Thoroughfare Gap, and probably elsewhere; Allard and Leonard (1943) reported that small trees appeared in burned-over areas on the sandy ridge crests. Naturalized from the south-central U.S.

***BORAGINACEAE*. BORAGE FAMILY**

***Anchusa arvense* (L.) Bieb.** Small Bugloss. *Lithospermum arvense* L. Collected by Allard; a weed of fields and roadsides. Naturalized exotic.

***Cynoglossum virginianum* L. var. *virginianum*.** Wild Comfrey. On moist to moderately dry, fertile wooded slopes; associated with basic mesic and basic oak-hickory forests. Frequent, locally abundant (3 plots).

***Echium vulgare* L.** Common Viper's-Bugloss. Dry fields and road banks. Infrequent. Naturalized exotic.

***Hackelia virginiana* (L.) I.M. Johnston.** Virginia Stickseed. Moist wooded slopes, disturbed successional forests, and floodplains. Frequent (1 plot).

***Mertensia virginica* (L.) Pers. *ex* Link.** Virginia Bluebells. Broad Run floodplain below Beverley Mill, the only known locality in the area.

***Myosotis laxa* Lehm.** Small Forget-Me-Not. Collected by Allard in wet soil at the old Broad Run Station; the only record.

***Myosotis verna* Nutt.** Spring Forget-Me-Not. *Myosotis virginica* (L.) B.S.P. Collected by Allard from "open ground north of Beverley Mill; infrequent."

***BRASSICACEAE*. MUSTARD FAMILY**

***Alliaria petiolata* (Bieb.) Cav. & Grande.** Garlic-Mustard. *Alliaria officinalis* Andrz. Moist, fertile soils of wooded slopes and ravines, floodplains, disturbed secondary forests, and old fields. Frequent, locally abundant (3 plots). Naturalized exotic. Because of its shade tolerance, this species is a serious threat to the compositional integrity of the basic mesic forest and basic oak-hickory forest community types.

***Arabidopsis thaliana* (L.) Heynh.** Mouse-Ear Cress. *Sisymbrium thalianum* (L.) Gay. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Arabis canadensis* L.** Sicklepod. On moist to dry, fertile wooded slopes; associated with the basic mesic forest and basic oak-hickory forest community types. Infrequent.

***Barbarea verna* (Mill.) Aschers.** Early Winter-Cress. Fields, roadsides, and clearings; usually in moist soil. Naturalized exotic.

***Barbarea vulgaris* Ait.f.** Common Winter-Cress. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Brassica juncea* (L.) Czern.** Chinese Mustard. Collected by Allard; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Brassica nigra* (L.) W.D.J. Koch.** Black Mustard. Collected by Allard; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Camelina microcarpa* DC.** Little-Seed False Flax. Collected by Allard along railroad in Thoroughfare Gap; a weed of dry, barren soils. Naturalized exotic.

***Capsella bursa-pastoris* (L.) Medik.** Shepherd's-Purse. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Cardamine angustata* O.E. Schulz.** Slender Toothwort. *Dentaria heterophylla* Nutt. On fertile wooded slopes and stream bottoms; mostly associated with basic mesic and basic oak-hickory forests. Frequent (2 plots); a spring ephemeral that is under-represented in plots due to its early maturation and evanescence.

***Cardamine bulbosa* (Schreb. *ex* Muhl.) B.S.P.** Spring Cress. Collected by Allard in Broad Run floodplain, both above and below Thoroughfare Gap. Evidently infrequent and local.

***Cardamine concatenata* (Michx.) Sw.** Cutleaf Toothwort. *Dentaria laciniata* Muhl. On fertile wooded slopes, in basic mesic and basic oak-hickory forests. Frequent (4 plots); a spring ephemeral that is under-represented in plots due to its early maturation and evanescence.

***Cardamine hirsuta* L.** Hairy Bittercress. Fields, roadsides, and clearings. Common. Naturalized exotic.

Cardamine parviflora* L. var. *arenicola* (Britt.) Schulz.* Small-Flowered Bittercress. Collected by Allard (4417, 10765) but misidentified or never reported: Pond Mountains; N of Hopewell Gap; and Broad Run below Beverley Mill. This species usually grows in wet or dry sand or in thin soil and moss on exposed outcrops.

***Cardamine pensylvanica* Muhl. *ex* Willd.** Pennsylvania Bittercress. Seepage swamps and wet open ground. Infrequent (1 plot).

***Draba verna* L.** Whitlow-Grass. Collected by Allard; a weed of dry, barren soils. Naturalized exotic.

***Hesperia matronalis* L.** Dame's Rocket. Along Broad Run in Thoroughfare Gap and probably elsewhere. Naturalized exotic; often cultivated and escaped.

***Lepidium campestre* (L.) Ait.f.** Field Pepper-Grass. Collected by Allard; a common weed of fields, roadsides, and cultivated ground. Naturalized exotic.

***Lepidium virginicum* L. var. *virginicum*.** Poor-Man's Pepper-Grass. Fields, roadsides, and clearings. Frequent.

***Rorippa nasturtium-aquaticum* (L.) Hayek.** Watercress. *Nasturtium officinale* R.Br. Collected by Allard from “overflow of spring on west slope of Pond Mountain, 1½ miles below Thorofare [sic] Gap;” the only record from this area. Naturalized exotic.

***Rorippa palustris* (L.) Bess. ssp. *fernaldiana* (Butters & Abbe) Jonsell.** Marsh Yellow-Cress. *Rorippa islandica* (Murr.) Borb. var. *fernaldiana* Butters & Abbe. Collected by Allard along old mill race in Broad Run floodplain above Beverley Mill; not found there recently.

***Sinapis arvensis* L.** Charlock. Collected by Allard; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Sisymbrium officinale* (L.) Scop.** Hedge Mustard. *Sisymbrium officinale* var. *leiocarpum* DC. Collected by Allard; a weed of fields, roadsides, and cultivated ground. Naturalized exotic.

***Thlaspi arvense* L.** Field pennycress. Disturbed soil along railroad in Thoroughfare Gap. Naturalized exotic.

Thlaspi perfoliatum* L.* Perfoliate Pennycress. Collected by F.R. Fosberg (64454, 65449) at Roland Farm. A naturalized exotic of weedy open habitats.

CALLITRICHACEAE. WATER-STARWORT FAMILY

***Callitriche heterophylla* Pursh ssp. *heterophylla*.** Northern Water-Starwort. *Callitriche palustris* L. of Allard and Leonard (1943, 1952).

CAMPANULACEAE. BELLFLOWER FAMILY

***Campanula aparinoides* Pursh.** Marsh Bellflower. In rocky seepage swamp at W foot of High Point Mountain; in old impoundment and beaver ponds in the lower part of Jackson Hollow, where locally abundant. Infrequent (1 plot).

***Lobelia cardinalis* L.** Cardinal Flower. Seepage swamps and damp streamsides. Infrequent (2 plots).

***Lobelia inflata* L.** Indian-Tobacco. Dry open forests, wood road banks, powerlines, and other clearings. Frequent (3 plots).

***Lobelia puberula* Michx. var. *puberula*.** Downy Lobelia. A single collection by Allard "above Allen's spring" on the eastern slope N of Antioch. Apparently rare.

***Lobelia siphilitica* L. var. *siphilitica*.** Great Blue Lobelia. Floodplains, wooded stream bottoms, and damp clearings. Frequent.

***Lobelia spicata* Lam. var. *scaposa* McVaugh.** Spiked Lobelia. Dry wooded slopes (mostly in oak-hickory forests) and powerline clearings. Frequent (2 plots).

***Triodanis perfoliata* (L.) Nieuwl. var. *perfoliata*.** Venus' Looking-Glass. *Specularia perfoliata* (L.) A.DC. Dry powerline clearings and exposed soil in open oak-hickory forests. Frequent (1 plot).

CANNABACEAE. HEMP FAMILY

***Humulus lupulus* L. var. *lupuloides* E. Small.** Common Hops. *Humulus americanus* Nutt. Several collections by Allard from Thoroughfare Gap.

CAPRIFOLIACEAE. HONEYSUCKLE FAMILY

***Lonicera japonica* Thunb.** Japanese Honeysuckle. Moist or fertile wooded slopes, seepage swamp hummocks, disturbed secondary forests, old fields, and fencerows. Common to abundant (12 plots). Naturalized exotic. This species is a serious threat to natural communities of the Bull Run Mountains, but its status does not appear to have changed much during the past 60 years (Allard and Leonard 1943).

***Sambucus canadensis* L.** Common Elderberry. Seepage swamps, damp stream bottoms, and floodplains. Frequent (7 plots).

***Symphoricarpos orbiculatus* Moench.** Coralberry. Fields, clearings, disturbed secondary forests, and dry, fertile oak-hickory forests on wooded slopes. Common (7 plots). Naturalized from the midwestern U.S. This species is a problematic introduction that can become very invasive in drier, fertile soils of native forests and woodlands. Most of its occurrences in plots were in the basic oak-hickory forest community type.

***Triosteum perfoliatum* L.** Perfoliate Tinker's-Weed. Three collections by Allard: wooded slope (High Point Mountain) near Broad Run Station; thin woods N of Hopewell Gap; and W slope of Pond Mountains S of Thoroughfare Gap. Evidently infrequent; a species usually associated with base-rich soils.

***Viburnum acerifolium* L.** Maple-Leaved Viburnum. On moist to dry wooded slopes throughout. Although frequent to common (13 plots), a lack of shrub-sized specimens and prevalence of small (< 20 cm tall) sprouts is characteristic of most populations. This condition is presumed to be the result of repeated deer browsing.

***Viburnum dentatum* L. var. *dentatum*.** Southern Arrow-Wood. *Viburnum scabrellum* (T.& G.) Chapm. Collected by Allard from "swampy woods on Catharpin Creek in Jackson Hollow." The morphological distinction between this and var. *lucidum* (see below) is not always clear, especially in areas where the two taxa co-occur.

***Viburnum dentatum* L. var. *lucidum* Ait.** Northern Arrow-Wood. *Viburnum recognitum* Fern. Seepage swamps. Infrequent (5 plots).

***Viburnum prunifolium* L.** Smooth Black-Haw. In old fields, disturbed secondary forests, and moist to rather dry wooded slopes. Frequent to common (9 plots).

CARYOPHYLLACEAE. PINK FAMILY

***Agrostemma githago* L.** Common Corncockle. Collected by Allard; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Arenaria serpyllifolia* L.** Thyme-Leaved Sandwort. Collected by Allard along the railroad in Thoroughfare Gap; a weed of dry, barren soils. Naturalized exotic.

***Cerastium fontanum* Baumg. ssp. *vulgare* (Hartm.) Greut. & Burdet.** Common Mouse-Ear Chickweed. *Cerastium vulgatum L. var. hirsutum Fries.* Fields, lawns, and roadsides. Frequent. Naturalized exotic.

***Cerastium glomeratum* Thuill.** Sticky Mouse-Ear Chickweed. *Cerastium viscosum* L. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Cerastium nutans* Raf.** Nodding Mouse-Ear Chickweed. Collected by Allard from floodplain forests along Broad Run below Thoroughfare Gap and from upland fields N of Beverley Mill. Evidently infrequent. This species is usually associated with base-rich soils.

***Dianthus armeria* L.** Deptford Pink. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Paronychia canadensis* (L.) Wood.** Smooth Forked Nailwort. Exposed mineral soil on dry wooded slopes, ridge crests, wood road banks, and powerline clearings. Frequent (3 plots).

***Paronychia fastigiata* (Raf.) Fern. var. *fastigiata*.** Hairy Forked Nailwort. In sandy, sterile powerline clearings on the east ridge S of Hopewell Gap and near Cold Spring Gap; several collections by Allard from similar habitats. Infrequent.

***Petrorhagia prolifera* (L.) Ball & Heywood.** Childing Pink. *Dianthus prolifer* L. Collected by Allard from "grassy lane and pasture just south of Thorofare [sic] Gap, west of Pond Mountain." Naturalized exotic.

***Sagina decumbens* (Ell.) Torr. & Gray ssp. *decumbens*.** Trailing Pearlwort. Collected by Allard; a weed of dry, barren soils, cracks in pavement or sidewalks, etc.

***Saponaria officinalis* L.** Bouncing-Bet. Moist fields and roadsides. Infrequent. Naturalized exotic.

***Silene antirrhina* L.** Sleepy Catchfly. Collected by Allard; usually a species of dry, barren or rocky soils.

***Silene caroliniana* Walt. ssp. *pensylvanica* (Michx.) Clausen.** Wild Pink. On dry, rocky wooded slopes and wood road banks. Infrequent.

***Silene dioica* (L.) Clairv.** Red Catchfly. *Lychnis dioica* L. Collected by Allard from a corn field on W slope of the Pond Mountains. Naturalized exotic.

***Silene latifolia* Poir. ssp. *alba* (Mill.) Greut. & Burdet.** White Campion. *Lychnis alba* Mill. Collected by Allard on E slope of the Pond Mountains and by Fosberg at Roland Farm; a weed of fields, roadsides, and clearings. Naturalized exotic.

***Silene stellata* (L.) Ait.f.** Starry Campion. *Silene stellata* var. *scabrella* Nieuwl. On fertile wooded slopes; appears to be mostly associated with basic oak-hickory forests. Infrequent (2 plots).

***Silene vulgaris* (Moench) Garcke.** Bladder Campion. *Silene cucubalus* Wibel. Collected by Allard; a weed of fields, roadsides, and clearings. Naturalized exotic.

***Stellaria graminea* L.** Grass-Leaved Stitchwort. Collected by Allard from a grassy field S of Aldie and by Fosberg at Roland Farm. Naturalized exotic.

***Stellaria longifolia* Muhl. *ex* Willd. var. *longifolia*.** Long-Leaved Stitchwort. Collected by Allard in floodplain along Broad Run above Beverley Mill in Thoroughfare Gap, and near Hopewell. Evidently infrequent. In this region, it is a species characteristic of shaded, alluvial soils.

***Stellaria media* (L.) Vill. ssp. *media*.** Common Chickweed. Floodplain forests, disturbed secondary forests, moist wooded slopes, and weedy open habitats. Frequent to locally abundant. Naturalized exotic.

***Stellaria pubera* Michx.** Star Chickweed. On moist wooded slopes, in both fertile and infertile soils. Frequent (7 plots).

CELASTRACEAE. BITTERSWEET FAMILY

***Celastrus orbiculatus* Thunb.** Asiatic Bittersweet. Fencerows, disturbed secondary forests, and moist or fertile wooded slopes. Frequent (1 plot). Naturalized exotic. This vine has long exhibited invasive tendencies in open habitats, but has increasingly invaded shaded forest understories throughout the northern Piedmont and Blue Ridge in recent decades.

***Celastrus scandens* L.** Climbing Bittersweet. Two collections by Allard from N of Hopewell Gap; reported to grow "along fences and walls on ridges" (Allard and Leonard 1943). This species is generally outcompeted by its introduced congener and is much less common in the region.

CERATOPHYLLACEAE. HORNWORT FAMILY

***Ceratophyllum demersum* L.** Coon's-Tail. Reported by Allard and Leonard (1943) as submersed in Broad Run W of Beverley Mill in Thoroughfare Gap. No specimens at US.

CHENOPODIACEAE. GOOSEFOOT FAMILY

***Chenopodium album* L. var. *album*.** White Lamb's-Quarters. Disturbed roadside and railroad grade in Thoroughfare Gap; undoubtedly found throughout in similar habitats. Naturalized exotic.

***Chenopodium ambrosioides* L. var. *ambrosioides*.** Mexican Tea. *Chenopodium ambrosioides* ssp. *euambrosioides* Aellen. Collected by Allard; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

CISTACEAE. ROCK-ROSE FAMILY

***Helianthemum canadense* (L.) Michx.** Canada Frostweed. On rocky ledge of quartzite cliff above railroad in Thoroughfare Gap; several collections by Allard from "dry, thinly wooded rocky ridges." Rare. A species most characteristic of dry clearings and sandhills of the Coastal Plain, but occurring as scattered, disjunct populations on xeric, sandy ridges in the mountains.

***Lechea pulchella* Raf. var. *pulchella*.** Leggett's Pinweed. *Lechea leggettii* Britt. & Holl. var. *typica* Hodgdon. On rocky ledge of quartzite cliff above railroad in Thoroughfare Gap and in barren, sandy powerline clearings. Infrequent.

***Lechea racemulosa* Michx.** Pinweed. Dry, sterile powerline clearings and road banks on wooded slopes and crests. Infrequent.

CLUSIACEAE. ST. JOHNS-WORT FAMILY

***Hypericum hypericoides* (L.) Crantz spp. *multicaule* (Michx. *ex* Willd.) Robson.** St. Andrew's Cross. *Ascyrum hypericoides* L. var. *multicaule* (Michx.) Fern. Exposed mineral soil on dry wooded slopes and ridge crests. Frequent (4 plots).

***Hypericum densiflorum* Pursh.** Bushy St. Johns-Wort. A single collection by Allard from "swale on west slope of Pond Mountain south of highway 55." Very rare everywhere in northern Virginia.

***Hypericum gentianoides* (L.) B.S.P.** Orange-Grass. Dry, sterile powerline clearings on wooded ridges. Infrequent.

***Hypericum mutilum* L.** Slender St. John's-Wort. Wet, springy clearings and ditch along railroad W of Thoroughfare Gap. Infrequent.

***Hypericum perforatum* L.** Common St. John's-Wort. Fields, roadsides, and clearings. Probably frequent. Naturalized exotic.

***Hypericum prolificum* L.** Shrubby St. John's-Wort. Forest borders and powerline clearings; E slope of High Point Mountain and N end of High Acre Ridge. Infrequent.

***Hypericum punctatum* Lam.** Spotted St. John's-Wort. Moist fields and clearings. Frequent.

CONVOLVULACEAE. MORNING GLORY FAMILY

***Calystegia sepium* (L.) R.Br.** Hedge Bindweed. *Convolvulus sepium* L. var. *communis* Tryon, *C. sepium* var. *repens* (L.) A.Gray. Fields, roadsides, and cultivated ground.

***Calystegia spithamaea* (L.) Pursh ssp. *spithamaea*.** Low Bindweed. *Convolvulus spithamaeus* L. Several collections by Allard from old fields and banks; reported to be one of the characteristic species of "galled," sparsely vegetated areas with soils severely lacking in available phosphorus and nitrogen (see Allard 1942).

***Ipomoea coccinea* L.** Red Morning-Glory. *Quamoclit coccinea* (L.) Moench. Collected by Allard in an "old broomsedge field" near Jackson Hollow and a corn field on E slope of the Pond Mountains. Naturalized exotic.

***Ipomoea hederacea* Jacq.** Ivy-Leaved Morning-Glory. Collected by Allard and Fosberg; usually a weed of cultivated ground. Naturalized exotic.

***Ipomoea lacunosa* L.** Small-Flowered White Morning Glory. Collected by Allard and Fosberg; a weed of fields and clearings.

***Ipomoea pandurata* (L.) G.W.F. Meyer.** Wild Potato-Vine. Dry wooded slopes, in oak-hickory and chestnut oak forests; reported by Allard and Leonard (1943) as common in old fields and pastures. Frequent (6 plots).

***Ipomoea purpurea* (L.) Roth.** Common Morning-Glory. Collected by Allard and Fosberg; usually a weed of cultivated ground. Naturalized exotic.

CORNACEAE. DOGWOOD FAMILY

Cornus alternifolia* L.f.* Alternate-Leaved Dogwood. Cool, wooded boulderfields and rocky streamside thickets (C.E. Stevens 9315); three known occurrences, all in the Cartharpin Creek/Jackson Hollow drainage. Rare (1 plot). Occurrences east of the main Blue Ridge in Virginia are few and far between.

***Cornus amomum* Mill.** Silky Dogwood. Floodplain thickets and forests. Infrequent.

***Cornus florida* L.** Flowering Dogwood. On wooded slopes throughout, formerly an abundant and dominant understory tree in the basic mesic forest, basic oak-hickory forest, and acidic oak-hickory forest community types. Still common (36 plots), but greatly reduced by dogwood anthracnose (*Discula destructiva*), a fungal pathogen that appeared in the early 1980's and has caused extensive mortality of dogwoods in shaded forest habitats. Compounding this problem, the species is heavily browsed by white-tailed deer.

***Nyssa sylvatica* Marsh.** Black Gum. Incl. *Nyssa sylvatica* var. *caroliniana* (Poir.) Fern. An occasional overstory tree and a dominant understory tree in seepage swamps and on wooded slopes throughout. Abundant (55 plots).

CRASSULACEAE. STONECROP FAMILY

***Penthorum sedoides* L.** Ditch Stonecrop. Collected by Allard in wet open ground near Broad Run Station and N of Hopewell Gap. Infrequent, local.

***Sedum telephium* L.** Garden Stonecrop. Collected by Allard on wood road banks near Hopewell Gap and N of Thoroughfare Gap, and in “heavy oak-chestnut woods” on E slope of High Point Mountain. Live collections were greenhouse reared and induced to flower by extended artificial lighting in order to determine this taxon to species. Adventive exotic, persisting or escaped from cultivation. See Allard (1940) for a detailed account of this species in the Bull Run Mountains.

CUSCUTACEAE. DODDER FAMILY

***Cuscuta compacta* Juss. *ex* Choisy var. *compacta*.** Compact Dodder. Attached to *Alnus serrulata* in seepage swamp, Jackson Hollow; collected by Allard on the western slope of High Point Mountain, 1.6 km (1 mi) N of Thoroughfare Gap. Infrequent or rare. A species most typical of Coastal Plain swamps; host plants are usually woody shrubs.

***Cuscuta gronovii* Willd. *ex* J.A. Schultes var. *gronovii*.** Gronovius' Dodder. Attached to other plants in floodplains, seepage swamps and on moist or fertile wooded slopes; commonly on *Impatiens capensis*; other host plants recorded by Allard and Fleming include *Ageratina altissima*, *Agrimonia* sp., *Amphicarpaea bracteata*, *Aster lanceolatus*, *Aster lateriflorus*, *Aster puniceus*, *Ceanothus americanus*, *Desmodium nudiflorum*, *Lactuca* sp., *Polygonum* spp., and *Rubus argutus*. Frequent.

***Cuscuta pentagona* Engelm. var. *pentagona*.** Field Dodder. Many collections by Allard; a weed of fields, roadsides, and cultivated soils; reported by Allard and Leonard (1943) to be especially common on *Kummerowia stipulacea* (=*Lespedeza stipulacea*).

DIPSACACEAE. TEASEL FAMILY

***Dipsacus fullonum* L.** Teasel. *Dipsacus sylvestris* Huds. Fields and roadsides. Infrequent. Naturalized exotic.

EBENACEAE. EBONY FAMILY

***Diospyros virginiana* L.** Persimmon. A tree in fencerows and old fields; seedlings and saplings are commonly found on dry-mesic to dry wooded slopes and ridge crests throughout. Frequent to common (16 plots).

ELAEAGNACEAE. OLEASTER FAMILY

Elaeagnus umbellata* Thunb. var. *parvifolia* (Royle) Schneid.* Autumn-Olive. Spread from plantings into fields, fencerows, roadsides, and clearings. Naturalized exotic. This shrub has long exhibited invasive tendencies in open habitats, but has been appearing with alarming frequency in shaded forest understories throughout Virginia in recent years.

ERICACEAE. HEATH FAMILY

***Epigaea repens* L.** Trailing Arbutus. Exposed, sterile, acidic soil of wooded slopes and ridge crests; usually associated with the chestnut oak forest and pitch pine-oak/heath woodland community types. Frequent (2 plots).

***Gaultheria procumbens* L.** Wintergreen. In moist, infertile, N-facing wooded ravine on the east ridge, 1.7 km (1.0 mi) SSE of Hopewell Gap; one collection by Allard at Thoroughfare Gap. Evidently rare in this area (1 plot).

***Gaylussacia baccata* (Wang.) K. Koch.** Black Huckleberry. On dry, infertile, openly wooded slopes and ridge crests. Abundant (28 plots).

***Kalmia latifolia* L.** Mountain-Laurel. On moist to dry, infertile wooded slopes and ridge crests; dominates the shrub layer of many chestnut oak forests and pine-oak/heath woodlands with impenetrably dense stands. Abundant (40 plots).

***Lyonia ligustrina* (L.) DC. var. *ligustrina*.** Maleberry. Moist, acidic powerline clearing near the head of Catletts Branch and on the east ridge. Infrequent.

Rhododendron maximum* L.* Great Rhododendron. Under mixed oak-hemlock-white pine forest in deep, N-facing ravine on the east ridge, 1.7 km (1.0 mi) SSE of Hopewell Gap (G.P. Fleming 15249, 15253). Rare but locally abundant (1 plot). This mountain species was planted in Cold Spring Gap around 1930, but there is every indication that the east ridge population is indigenous (see p. 87). The status of another small colony, occurring in a dense oak/heath forest on the mountain crest in Bull Run Mountain Estates, is unknown.

***Rhododendron periclymenoides* (Michx.) Shinners.** Wild Azalea. *Rhododendron nudiflorum* (L.) Torr., incl. *R. nudiflorum* var. *album* Sweet and *R. nudiflorum* var. *glandiferum* (Porter) Rehd. Seepage swamps and moist or dry, usually infertile wooded slopes. Common (38 plots). Very large, robust shrubs of this species occur throughout in seepage swamps and occasionally on moist slopes; in the dry, sterile chestnut oak forests, however, this species is common but usually reduced by repeated deer browsing to colonies of sprouts < 20 cm tall.

***Vaccinium corymbosum* L.** Highbush Blueberry. Moist to moderately moist, infertile wooded slopes; scattered in mesic mixed hardwood forests, acidic oak-hickory forests, and the more mesic chestnut oak forests. Infrequent (4 plots).

***Vaccinium fuscatum* Ait.** Hairy Highbush Blueberry. *Vaccinium corymbosum* var. *atrococcum* A. Gray. Seepage swamps. Frequent, locally common (13 plots).

***Vaccinium pallidum* Ait.** Early Lowbush Blueberry. *Vaccinium vacillans* Kalm., incl. *V. vacillans* var. *crinitum* Fern. On dry, or occasionally moist, infertile wooded slopes and ridge crests throughout; dominant low shrub in acidic oak-hickory forests, chestnut oak forests, and pine-oak/heath woodlands. Abundant (52 plots).

***Vaccinium stamineum* L.** Deerberry. On dry, infertile wooded slopes and ridge crests throughout. Common (26 plots).

***EUPHORBIACEAE*. SPURGE FAMILY**

***Acalypha gracilens* Gray.** Slender Three-Seeded Mercury. In powerline clearings and exposed mineral soil on dry, fertile wooded slopes. Infrequent.

Acalypha rhomboidea* Raf.* Common Three-Seeded Mercury. Floodplain forest along Broad Run and in weedy, usually moist, open habitats; vouchered by Allard (10492) and F.R. Fosberg (55178, 55146). Frequent.

***Acalypha virginica* L.** Virginia Three-Seeded Mercury. Exposed mineral soil on dry, fertile wooded slopes; strongly, if not exclusively associated with the basic oak-hickory forest community type. Frequent (4 plots).

***Chamaesyce maculata* (L.) Small.** Spotted Spurge. *Euphorbia supina* Raf. Barren, gravelly waste ground at old quarry near Broad Run just ESE of Thoroughfare Gap, in parking lot of Post Office at Thoroughfare Gap, and on road shoulders. Local.

***Chamaesyce nutans* (Lag.) Small.** Eyebane. *Euphorbia maculata* L. Fields and roadsides. Frequent.

Croton capitatus* Michx. var. *capitatus*.* Woolly Croton. Barren, gravelly waste ground at old quarry near Broad Run at E foot of Pond Mountain, just ESE of Thoroughfare Gap (G.P. Fleming 15254); also at edge of field at foot of the eastern slope near Cold Spring Gap. Infrequent. Probably naturalized from farther west.

***Croton glandulosus* L. var. *septentrionalis* Muell.-Arg.** Northern Croton. Barren, gravelly waste ground at old quarry near Broad Run at E foot of Pond Mountain, just ESE of Thoroughfare Gap; collected by Allard along railroad near Beverley Mill in Thoroughfare Gap. Infrequent.

***Euphorbia corollata* L.** Flowering Spurge. Incl. *Euphorbia arundelana* Bartlett. Dry fields, powerline clearings, and sterile exposed soil on wooded slopes. Frequent (1 plot).

***Euphorbia dentata* Michx.** Wild Poinsettia. In cinders of railroad bed in Thoroughfare Gap. Local.

***Euphorbia spathulata* Lam.** Warty Spurge. *Euphorbia obtusata* Pursh. Collected by Allard from Broad Run floodplain above and below Beverley Mill in Thoroughfare Gap.

FABACEAE. PEA FAMILY

Albizia julibrissin* Durazz.* Silktree; Mimosa. Roadside thicket in Thoroughfare Gap, E of Beverley Mill (G.P. Fleming, field observation). Naturalized exotic.

***Amphicarpaea bracteata* (L.) Fern.** Hog-Peanut. Incl. *Amphicarpaea bracteata* var. *comosa* (L.) Fern. On moist or fertile wooded slopes and seepage swamp hummocks; a patch-dominant herb in the basic mesic forest community type; also characteristic in basic oak-hickory forests. Common to abundant (21 plots).

***Apios americana* Medik.** American Groundnut. Seepage swamps. Very infrequent, local (1 plot).

***Baptisia tinctoria* (L.) R.Br. *ex* Ait.** Yellow Wild-Indigo. *Baptisia tinctoria* var. *crebra* Fern. In powerline clearings and exposed, sterile soil on dry wooded slopes and ridge crests. Frequent (1 plot).

***Cercis canadensis* L. var. *canadensis*.** Eastern Redbud. Fertile soils of fencerows, moist secondary forests, and wooded slopes; most numerous in young *Liriodendron tulipifera* (tulip-poplar)-dominated forests on rich abandoned fields; among the older successional communities, it is most often associated with the basic mesic forest and basic oak-hickory forest community types. Frequent to locally common (8 plots).

***Chamaecrista fasciculata* (Michx.) Greene var. *fasciculata*.** Partridge-Pea. *Cassia fasciculata* Michx. Roadsides and powerline clearings, particularly on the eastern slope bordering the Culpeper Basin. Infrequent.

***Chamaecrista nictitans* (L.) Moench ssp. *nictitans*.** Wild Sensitive-Plant. *Cassia nictitans* L. Dry, barren soils of powerlines, road banks, and other clearings. Frequent.

***Clitoria mariana* L.** Maryland Butterfly-Pea. Dry wooded slopes, mostly in the drier oak-hickory forests. Infrequent (2 plots).

***Crotalaria sagittalis* L.** Rattlebox. In dry, sandy powerline clearing at crest of the east ridge S of Hopewell Gap. Infrequent.

***Desmodium ciliare* (Muhl. *ex* Willd.) DC.** Hairy Small-Leaved Tick-Trefoil. Dry, sterile powerline clearings and road banks. Infrequent.

***Desmodium fernaldii* Schub.** Fernald's Tick-Trefoil. *Desmodium rhombifolium* DC. A single collection by Allard from wooded ridge crest near High Point cliffs. A species of dry, sandy Coastal Plain habitats; the identity of the specimen at US needs verification.

***Desmodium glabellum* (Michx.) DC.** Dillen's Tick-Trefoil. *Desmodium dillenii* Darl. Fields, clearings, wooded roadsides, and open forests. Frequent.

***Desmodium glutinosum* (Muhl. *ex* Willd.) Wood.** Pointed-Leaf Tick-Trefoil. *Desmodium acuminatum* (Michx.) DC. On fertile wooded slopes; more or less restricted to the basic mesic forest and basic oak-hickory forest community types. Frequent (2 plots).

***Desmodium laevigatum* (Nutt.) DC.** Smooth Tick-Trefoil. Several collections by Allard; reported from "open, second growth woods in old pastures" (Allard and Leonard 1943). Very common in dry clearings of the Culpeper Basin just east of the Bull Run Mountains.

Desmodium marilandicum* (L.) DC.* Smooth Small-Leaved Tick-Trefoil. Collected by F.R. Fosberg (55100) at Roland Farm. Typically a species of dry, open forests and clearings.

***Desmodium nudiflorum* (L.) DC.** Naked-Flowered Tick-Trefoil. On wooded slopes throughout; occurs in most community types but is especially characteristic and abundant in basic oak-hickory forests. Common (32 plots). Allard and Leonard (1943) describe *Desmodium nudiflorum* as one of the two most abundant herbs on the better soils of the area; it is still very numerous but is so heavily grazed by white-tailed deer that many populations consist of non-flowering, vegetative individuals.

***Desmodium paniculatum* (L.) DC.** Narrow-Leaved Tick-Trefoil. Moist or dry clearings and open forests. Frequent (2 plots).

***Desmodium rotundifolium* DC.** Prostrate Tick-Trefoil. Dry wooded slopes, mostly in the drier oak-hickory forests. Infrequent (2 plots).

***Desmodium viridifolium* (L.) DC.** Velvet-Leaved Tick-Trefoil. Two collections by Allard, from N and W of Hopewell Gap; reported from "thin open pine woods on dry pasture slopes" (Allard and Leonard 1943). Very common in dry clearings of the Culpeper Basin just east of the Bull Run Mountains.

***Galactia volubilis* (L.) Britt.** Downy Milk-Pea. A single collection by Allard from an "old broomsedge field" S of Hopewell Gap; the only record.

***Gleditsia triacanthos* L.** Honey-Locust. Fields, fencerows, and floodplains; seedlings occasional on wooded slopes. Infrequent (1 plot).

***Kummerowia stipulacea* (Maxim.) Makino.** Korean Bushclover. *Lespedeza stipulacea* Maxim. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Kummerowia striata* (Thunb.) Schindl.** Japanese Bushclover. *Lespedeza striata* (Thunb.) H. & A. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Lespedeza cuneata* (Dum.-Cours.) G. Don.** Sericea Bushclover. Fields, roadsides, and powerline clearings. Frequent to locally abundant. Naturalized exotic.

***Lespedeza hirta* (L.) Hornem. ssp. *hirta*.** Hairy Bushclover. On dry, infertile wooded slopes and crests; in chestnut oak forests and pine-oak/heath woodlands. Infrequent (1 plot).

***Lespedeza intermedia* (S. Wats.) Britt.** Wand Bushclover. On moderately dry wooded slopes; associated with both acidic and basic oak-hickory forests. Frequent (4 plots).

***Lespedeza* x *nuttalii* Darl.** Nuttall's Bushclover. Reported by Allard and Leonard (1943) as occasional in old broomsedge fields. Usually considered a hybrid of *L. hirta* x *L. intermedia*.

***Lespedeza procumbens* Michx.** Trailing Bushclover. Dry wooded slopes and powerline clearings. Frequent (1 plot).

***Lespedeza repens* (L.) W. Bart.** Creeping Bushclover. Dry wooded slopes and powerline clearings. Frequent (1 plot).

***Lespedeza violacea* (L.) Pers.** Violet Bushclover. Three collections by Allard, two from High Point Mountain and one from N of “Round Knob” (= northernmost knob of High Acre Ridge). These specimens need critical evaluation since *L. violacea* is a regionally uncommon species that is usually associated with calcareous soils and that can easily be confused with forms of *L. intermedia* or *L. repens*.

***Lespedeza virginica* (L.) Britt.** Slender Bushclover. Dry wooded slopes and powerline clearings. Frequent.

***Lupinus perennis* L. ssp. *perennis*.** Wild Lupine. Collected by Allard from the dry, wooded crest of High Point Mountain and a dry, rocky slope at Spouting Spring along railroad W of Thoroughfare Gap. Not seen recently at either locality.

***Medicago lupulina* L.** Black Medic. Weedy open habitats. Naturalized exotic.

***Melilotus alba* Medik.** White Sweetclover. Fields, roadsides, and other weedy habitats. Frequent. Naturalized exotic.

***Melilotus officinalis* (L.) Lam.** Yellow Sweetclover. Fields, roadsides, and other weedy habitats. Frequent. Naturalized exotic.

***Phaseolus polystachyos* (L.) B.S.P.** Wild Kidney Bean. Two collections by Allard from “rich, moist wooded slopes” N of Hopewell Gap. Infrequent or rare in this area.

***Robinia pseudoacacia* L.** Black Locust. In secondary forests on old fields; saplings are invaders in powerline clearings and gap disturbances on dry wooded slopes. Frequent (2 plots). Allard and Leonard (1943) reported pure stands of this tree in abandoned pastures around old home sites, but these stands apparently have been replaced in the natural course of succession.

***Senna hebecarpa* (Fern.) Irwin & Barneby.** Northern Wild Senna. A few collections by Allard from moist open habitats around the foot of the mountains. Infrequent.

***Senna marilandica* (L.) Link.** Maryland Wild Senna. Dry oak-hickory forests on W slope of the east ridge above Jackson Hollow, and on E slope of the Pond Mountains, S of Thoroughfare Gap. Infrequent.

***Strophostyles helvula* (L.) Ell.** Trailing Wild Bean. A single collection by Allard at US; reported as frequent in old fields and pastures (Allard and Leonard 1943).

***Stylosanthes biflora* (L.) B.S.P.** Pencil-Flower. Incl. *Stylosanthes riparia* Kearney. Dry, sterile powerline clearings, banks, and thinly wooded ridge crests. Infrequent.

***Tephrosia virginiana* (L.) Pers.** Goat's-Rue. Incl. *Tephrosia virginiana* var. *holosericea* (Nutt.) Torr. & Gray. Dry, sandy, infertile soil of powerline clearings and thinly wooded ridge crests. Infrequent (1 plot).

***Trifolium arvense* L.** Rabbit's-Foot Clover. Dry fields and clearings. Frequent. Naturalized exotic.

***Trifolium aureum* Pollich.** Yellow Clover. *Trifolium agrarium* L. Collected by Allard; a weed of fields and roadsides. Naturalized exotic.

***Trifolium campestre* Schreb.** Low Hop Clover. *Trifolium procumbens* L. Weedy, open habitats. Naturalized exotic.

***Trifolium hybridum* L.** Alsike Clover. Incl. *Trifolium hybridum* var. *elegans* (Savi) Boiss. Reported by Allard and Leonard (1943), but no specimens at US; an uncommon weed of fields and cultivated soils. Naturalized exotic.

***Trifolium pratense* L.** Red Clover. Fields, roadsides, and clearings. Frequent. Naturalized exotic.

***Trifolium repens* L.** White Clover. Fields, roadsides, lawns, and clearings. Frequent, locally abundant. Naturalized exotic.

Trifolium resupinatum* L.* Collected by F.R. Fosberg (65441) at Roland Farm. The specimen was verified by Mark T. Strong (US) and represents the first record of this species in Virginia. Naturalized exotic.

***Vicia caroliniana* Walt.** Wood Vetch. Oak-hickory forests on dry wooded slopes and on wood road banks. Infrequent.

***Vicia sativa* L. ssp. *nigra* (L.) Erhr.** Narrow-Leaved Vetch. *Vicia angustifolia* (L.) Reich. Fields, roadsides, and other weedy habitats. Naturalized exotic.

***Vicia villosa* Roth ssp. *villosa*.** Hairy-Fruited Vetch. A single collection by Allard from a pasture on W slope of the Pond Mountains. Naturalized exotic.

***FAGACEAE*. BEECH FAMILY**

Hybrids reported somewhat tentatively by Allard and Leonard (1943) include *Quercus* x *saulii* Schneid. (*Q. alba* x *montana*), *Quercus alba* x *stellata*, and *Quercus marilandica* x *stellata*.

***Castanea dentata* (Marsh.) Borkh.** American Chestnut. Formerly an abundant overstory tree on wooded slopes throughout; now reduced to persistent root sprouts by an exotic fungal pathogen, *Cryphonectria parasitica*; specimens occasionally reach 6 m (20 ft) tall and bear fruit before again succumbing to the blight. Frequent (17 plots).

***Castanea pumila* (L.) P. Mill. var. *pumila*.** Allegheny Chinkapin. Moist or dry wooded slopes, always in acidic, infertile soils; reported by Allard as locally abundant in old fields and clearings, but few of these habitats now remain. Infrequent (1 plot).

***Fagus grandifolia* Ehrh.** American Beech. Moist to moderately dry, infertile soils of wooded slopes and ravines. Overstory trees frequent to common, saplings common to abundant (33 plots; Plate 11, p. 63). This species has increased dramatically in the area, based on Allard and Leonard's (1943) assessment that "little or no reproduction" of beech could be found anywhere.

***Quercus alba* L.** White Oak. On wooded slopes throughout, but most important in oak-hickory forests on sites of intermediate moisture and fertility. Common, but young regeneration usually sparse (32 plots).

***Quercus bicolor* Willd.** Swamp White Oak. Broad Run floodplain; also collected by Allard in "low ground on the west slope" below White Rock (Signal Mountain). Rare here; abundant in floodplains and flatwoods depressions of the Culpeper Basin to the east.

***Quercus coccinea* Muenchh. var. *coccinea*.** Scarlet Oak. On dry, infertile, wooded slopes and crests with *Quercus montana* and heaths. Frequent to locally common (20 plots).

***Quercus falcata* Michx.** Southern Red Oak. On dry wooded slopes; S end of High Point Mountain near Thoroughfare Gap and on the eastern slope bordering the Culpeper Basin. Infrequent.

***Quercus ilicifolia* Wangenh.** Bear Oak. A single collection by Allard from "dry, sandy ridge north of Beverley Mill .... represented by only a few specimens." Rare here and elsewhere east of the mountains in Virginia. Repeated recent searches have failed to relocate this population.

***Quercus marilandica* Muenchh. var. *marilandica*.** Blackjack Oak. Thinly wooded, xeric ridge crests and upper slopes, especially on sites with a history of fire; most common in pitch pine-oak/heath woodlands. Frequent (8 plots).

***Quercus montana* Willd.** Chestnut Oak. *Quercus prinus* L. On wooded slopes throughout, completely dominating dry, infertile sites. The most abundant tree in the area (59 plots; Plate 19, p. 138), and co-dominant or dominant in all upland community types except the basic mesic forest.

***Quercus muhlenbergii* Engelm.** Chinkapin Oak. Collected by Allard from cliffs at crest of Pond Mountain S of Thoroughfare Gap; Allard and Leonard (1943) report this locality as "1½ miles S of Thorofare [sic] Gap" while the specimen label states "2.75 mi. S of Rt. 55." Evidently rare in this area; a tree strongly associated with calcareous and basic soils.

***Quercus palustris* Muenchh.** Pin Oak. Low forests and thickets in and just E of Thoroughfare Gap, along Broad Run, and along streams at the foot of the eastern slope. Infrequent here; abundant in floodplains and flatwoods depressions of the Culpeper Basin to the east.

***Quercus phellos* L.** Willow Oak. A few small trees seen in young secondary forests in and near Thoroughfare Gap. Very infrequent or rare here; abundant in floodplains and flatwoods depressions of the Culpeper Basin to the east. The Bull Run Mountains represent a western range limit of this typical Coastal Plain-lower Piedmont tree.

***Quercus rubra* L. var. *rubra*.** Northern Red Oak. On wooded slopes throughout, most important (often a co-dominant overstory tree) in basic mesic forests and basic oak-hickory forests. Common, but young regeneration usually sparse (51 plots).

***Quercus stellata* Wangenh.** Post Oak. On dry wooded slopes; S end of High Point Mountain near Thoroughfare Gap and on the eastern slope bordering the Culpeper Basin. Infrequent.

***Quercus velutina* Lam.** Black Oak. On wooded slopes throughout, most important in chestnut oak and oak-hickory forests. Common (42 plots).

FUMARIACEAE. FUMITORY FAMILY

***Corydalis flavula* (Raf.) DC.** Yellow Corydalis. Moist, fertile soils in floodplain forests, and on wooded slopes. Infrequent.

***Corydalis sempervirens* (L.) Pers.** Pink Corydalis. A single 1939 collection by Allard from a "rocky, exposed shelf at High Point Cliffs; not found elsewhere; very rare in the area." The population may have been extirpated since many searches of this locality in recent years have failed to relocate it. This northern and mountain species also grows on exposed metabasalt outcrops in the Watery Mountains in Fauquier Co., but reaches (or reached) its easternmost limits at High Point.

GENTIANACEAE. GENTIAN FAMILY

***Bartonia virginica* (L.) B.S.P.** Yellow Screwstem. Reportedly collected by F.J. Hermann (9905) "in damp woods north of Hopewell Gap in Jackson Hollow" (Allard and Leonard 1943). No specimens at US.

***Gentiana clausa* Raf.** Closed Gentian. Seepage swamp at W foot of High Point Mountain. Rare, local.

***Gentiana villosa* L.** Striped Gentian. In moist, sandy powerline clearing near old quarry on E slope of High Point Mountain, just S of Hopewell Gap; several collections by Allard from dry forests. Infrequent.

***Obolaria virginica* L.** Virginia Pennywort. On moist, fertile wooded slopes; strongly associated with the basic mesic forest community type. Frequent (3 plots).

***Sabatia angularis* (L.) Pursh.** Rose-Pink. Damp clearings and roadsides. Infrequent.

GERANIACEAE. GERANIUM FAMILY

***Geranium carolinianum* L.** Carolina Crane's-Bill. *Geranium carolinianum* var. *confertiflorum* Fern. Collected by Allard; a common weed of dry fields and clearings.

***Geranium columbinum* L.** Long-Stalked Crane's-Bill. Collected by Allard and Fosberg; a weed of fields and roadsides. Naturalized exotic.

***Geranium maculatum* L.** Wild Geranium. On moist to dry, fertile wooded slopes; strongly associated with the basic mesic forest and basic oak-hickory forest community types. Frequent (8 plots).

GROSSULARIACEAE. CURRANT FAMILY

Ribes rubrum* L.* Garden Red Current. *Ribes sativum* Syme. W side of rock wall near old cemetery in secondary forest 0.8 km (0.5 mi) N of Hopewell Gap, elev. 296 m (970 ft) (C.E. Stevens 9465). Naturalized or adventive exotic.

HAMAMELIDACEAE. WITCH-HAZEL FAMILY

***Hamamelis virginiana* L.** Witch-Hazel. Seepage swamps and moist wooded slopes; mostly in acidic, infertile soils. Common (11 plots)

HYDRANGEACEAE. HYDRANGEA FAMILY

***Hydrangea arborescens* L.** Wild Hydrangea. Moist, rocky wooded slopes, shaded boulderfields, and outcrops. Frequent (12 plots; Plate 12, p. 64).

HYDROPHYLLACEAE. WATERLEAF FAMILY

***Hydrophyllum virginianum* L.** Virginia Waterleaf. Moist, fertile wooded slopes at foot of the Pond Mountains at and SE of Thoroughfare Gap; wooded floodplain along Broad Run above Beverley Mill. Infrequent (2 plots).

JUGLANDACEAE. WALNUT FAMILY

***Carya alba* (L.) Nutt. *ex* Ell.** Mockernut Hickory. *Carya tomentosa* (Lam.) Nutt. On wooded slopes throughout; most numerous in Basic Oak-Hickory Forests. Common to abundant, especially as an understory tree (30 plots).

***Carya cordiformis* (Wangenh.) K. Koch.** Bitternut Hickory. On moist wooded slopes and in floodplain forests along Broad Run; seedlings and saplings are more numerous than trees in much of the area. Infrequent (5 plots).

***Carya glabra* (P. Mill.) Sweet.** Pignut Hickory. On wooded slopes throughout; most important in acidic oak-hickory forests and, as a scattered understory tree, in chestnut oak forests. Common (24 plots).

Carya ovalis* (Wangenh.) Sarg.* Red Hickory. Undoubtedly included in *C. glabra* (P. Mill) Sweet by Allard and Leonard (1943). On wooded slopes throughout, favoring the more fertile sites; a co-dominant overstory tree in basic oak-hickory forests. Common to abundant (18 plots).

***Juglans cinerea* L.** Butternut. On the more mesic, sheltered, openly wooded boulderfields; Jackson Hollow just E of Rt. 629 and along the foot of High Point cliffs. Infrequent (1 plot). During the past forty years, this species has been seriously reduced over its entire range by a virulent fungal pathogen (*Sirococcus clavigignenti-juglandacearum*, butternut canker).

***Juglans nigra* L.** Black Walnut. Moist wooded slopes, stream bottoms, and floodplains, especially in disturbed sites undergoing secondary succession. Frequent (2 plots).

LAMIACEAE. MINT FAMILY

***Agastache nepetoides* (L.) Kuntze.** Yellow Giant Hyssop. Collected twice by Allard: Pond Mountains and the western slope N of Hopewell Gap; a species of moist, fertile, open forests and clearings. Infrequent or rare.

***Clinopodium vulgare* L.** Wild Basil. *Satureja vulgaris* (L.) Fritsch. Dry fields, clearings, and open forests. Frequent.

***Collinsonia canadensis* L.** Horse-Balm. On moist wooded slopes and seepage swamp hummocks. Frequent (14 plots).

***Cunila origanoides* (L.) Britt.** Dittany. On dry wooded slopes and ridge crests. Frequent (6 plots).

***Glechoma hederacea* L.** Ground-Ivy. *Glecoma hederacea* var. *parviflora* (Beth.) House. Seepage swamp hummocks, floodplains, and old house sites. Frequent, locally abundant (2 plots). Naturalized exotic.

***Hedeoma pulegioides* (L.) Pers.** American Pennyroyal. Exposed mineral soil on dry, fertile wooded slopes and in powerline clearings; often associated with the basic oak-hickory forest community type. Frequent (2 plots)

***Lamium amplexicaule* L.** Henbit. Fields, roadsides, and cultivated soil. Frequent. Naturalized exotic.

***Lamium purpureum* L.** Purple Deadnettle. Fields, roadsides, and cultivated soil. Frequent. Naturalized exotic.

***Leonurus cardiaca* L. ssp. *cardiaca*.** Motherwort. Several collections by Allard from around old house sites and Beverley Mill. Naturalized exotic.

***Lycopus americanus* Muhl. *ex* Bart.** American Bugleweed. Old impoundment in lower part of Jackson Hollow; collected by Allard along Broad Run and N of Beverley Mill. Infrequent.

***Lycopus virginicus* L.** Virginia Bugleweed. Seepage swamps, wet clearings, and floodplains. Frequent (9 plots).

***Mentha arvensis* L.** American Wild Mint. *Mentha arvensis* var. *sativa* Benth. Floodplain forest along Broad Run above Beverley Mill in Thoroughfare Gap. Infrequent, local.

***Mentha* x *gracilis* Sole.** *Mentha cardiaca* (S.F. Gray) Gerarde *ex* Baker. Collected by Allard from “swale near Broad Run Station on Broad Run flood plain; local.” Naturalized exotic.

***Mentha* x *piperita* L.** Peppermint. Open springy clearings in powerlines and along Rt. 629 N of Hopewell Gap. Infrequent. Naturalized exotic.

***Mentha spicata* L.** Spearmint. Collected by Allard from “swale on highway 628 south of Hopewell Gap; local.” Naturalized exotic.

***Monarda fistulosa* L. ssp. *fistulosa*.** Wild Bergamot. Incl. *Monarda fistulosa* var. *mollis* (L.) Benth. Dry fields and roadsides. Infrequent.

***Nepeta cataria* L.** Catnip. Weedy roadsides and clearings. Infrequent. Naturalized exotic.

***Perilla frutescens* (L.) Britt.** Beef-Steak Plant. Low, moist, shaded habitats in floodplains, secondary forests, and clearings. Frequent, locally common. Naturalized exotic.

***Prunella vulgaris* L. ssp. *vulgaris*.** Self-Heal. Fields, clearings, and open forests. Frequent (but see note under ssp. *lanceolata* below). Naturalized exotic.

***Prunella vulgaris* L. ssp. *lanceolata* (Bart) Hulten.** American Self-Heal. Fields, clearings, and open forests. Frequent. Introgression between our native ssp. *lanceolata* and the introduced ssp. *vulgaris* has obscured the subspecific identity of many populations.

***Pycnanthemum incanum* (L.) Michx. var. *incanum*.** Hoary Mountain-Mint. Dry soil in fields, powerline clearings, and open oak-hickory forests. Frequent (3 plots).

***Pycnanthemum loomisii* Nutt.** Loomis' Mountain-Mint. Reported by Allard and Leonard (1943) as frequent on wooded slopes throughout, but not separated from *P. incanum* at US. Doubtfully distinct from *P. incanum*, at least at the species level, but further taxonomic investigation is needed.

***Pycnanthemum tenuifolium* Schrad.** Narrow-Leaved Mountain-Mint. *Pycnanthemum flexuosum* (Walt.) B.S.P. of Allard and Leonard (1943). Moist fields, clearings, and roadsides at low elevations. Infrequent. More common in the Culpeper Basin just east of the Bull Run Mountains.

***Salvia lyrata* L.** Lyre-Leaf Sage. Rocky floodplain of Broad Run above Beverley Mill and in woodland clearings on High Acre Ridge and near Cold Spring Gap. Infrequent.

***Scutellaria elliptica* Muhl. *ex* Spreng.** Hairy Skullcap. *Scutellaria ovalifolia* Pers. ssp. *mollis* Epl. On moderately dry wooded slopes, in both acidic and basic oak-hickory forests. Frequent (10 plots). This species is commonly top-grazed by deer.

***Scutellaria integrifolia* L.** Hyssop Skullcap. Moist fields and clearings at low elevations. Infrequent.

***Scutellaria lateriflora* L.** Mad Dog Skullcap. Seepage swamps, wooded streamsides, and floodplains. Infrequent (1 plot).

***Scutellaria serrata* Andr.** Showy Skullcap. Moist, fertile wooded slope at N end of Pond Mountain just S of Thoroughfare Gap; also collected by Fosberg at Roland Farm, W slope of High Point Mountain. Very infrequent and local.

***Stachys eplingii* J. Nelson.** Epling's Hedgenettle. *Stachys nuttallii* Shuttlw. of Allard and Leonard (1943). In pasture swale at W foot of Pond Mountain, 0.4 km (0.25 mi) WSW of Thoroughfare Gap, where first collected by Allard in 1941; also apparently collected by Allard in a swale on the E slope of Pond Mountain (19940, 01 July 1951). Rare and local. The 1941 station is the type locality for *S. eplingii* (see p. 186).

Stachys hispida* Pursh.* Bristly Hedgenettle. With *Stachys eplingii* in pasture swale at W foot of Pond Mountain, 0.4 km (0.25 mi) WSW of Thoroughfare Gap (G.P. Fleming 6835). Infrequent or rare.

***Teucrium canadense* L. var. *canadense*.** Germander. Incl. *Teucrium canadense* var. *virginicum* (L.) Eat. Wet fields and floodplains; along Broad Run and in gap of the Pond Mountains 2.1 km (1.3 mi) SSW of Thoroughfare Gap. Infrequent.

***Trichostema dichotomum* L.** Blue-Curls. Dry, sterile powerline clearings. Infrequent.

LAURACEAE. LAUREL FAMILY

***Lindera benzoin* (L.) Blume.** Spicebush. Seepage swamps and moist or fertile wooded slopes; the dominant shrub of basic mesic forests and characteristic of several other community types. Common to locally abundant (26 plots). Frequent browsing by deer seems to have little impact on large populations; on sites where this shrub is sparse, however, populations are often reduced to struggling root-sprouts a few cm tall.

***Sassafras albidum* (Nutt.) Nees.** Sassafras. Incl. *Sassafras albidum* var. *molle* (Raf.) Fern. In secondary forests of old fields and on dry wooded slopes throughout. Common (44 plots).

LINACEAE. FLAX FAMILY

***Linum medium* (Planch.) Britt. var. *texanum* (Planch.) Fern.** Stiff Yellow Flax. Dry fields and clearings. Infrequent.

***Linum striatum* Walt.** Ridged Yellow Flax. Springy open wetland around beaver pond in lower part of Jackson Hollow. Local.

***Linum virginianum* L.** Yellow Flax. Dry powerline clearings, wood road banks, and openly wooded slopes. Frequent.

LYTHRACEAE. LOOSESTRIFE FAMILY

***Cuphea viscosissima* Jacq.** Blue Waxweed. In powerline clearing, E slope of High Point Mountain; according to Allard and Leonard (1943), this species was “common” in dry open woods and pastures.

Lythrum salicaria* L.* Purple Loosestrife. Open floodplain and wet meadows along Broad Run and State Rt. 55 on the E side of Thoroughfare Gap (C.E. Stevens 9374; F.R. Fosberg 55574). Despite the construction of Interstate 66 and other disturbances, this population has persisted and expanded since the early 1970’s. Naturalized exotic.

MAGNOLIACEAE. MAGNOLIA FAMILY

***Liriodendron tulipifera* L.** Tulip-Poplar. On moist to moderately dry, wooded slopes throughout; forms nearly pure stands in mesophytic old-field succession and is a dominant or co-dominant tree in the acidic seepage swamp, mesic mixed hardwood forest, basic mesic forest, acidic oak-hickory forest, and basic oak-hickory forest community types. Abundant (49 plots).

MALVACEAE. MALLOW FAMILY

***Abutilon theophrasti* Medik.** Velvetleaf. Collected by Allard; a weed of cultivated soil. Naturalized exotic.

***Malva neglecta* Wallr.** Common Mallow. Collected by Allard and Fosberg; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

Malva rotundifolia* L.* Dwarf Mallow. Collected by Allard (2805) "one mile N of Hopewell Gap;" a rare weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Sida spinosa* L.** Prickly Mallow. Collected by Allard and Fosberg; a weed of cultivated ground and dry, barren, disturbed soil. Naturalized exotic.

MELASTOMATACEAE. MELASTOME FAMILY

Rhexia mariana* L. var. *mariana*.* Maryland Meadow-Beauty. Collected by Allard (12003, 14 July 1946) but never reported: Fauquier County, Thoroughfare Gap, western slope, damp soil by roadside.

MENISPERMACEAE. MOONSEED FAMILY

***Menispermum canadense* L.** Canada Moonseed. On moist, fertile wooded slopes. Infrequent (2 plots).

MOLLUGINACEAE. CARPETWEED FAMILY

***Mollugo verticillata* L.** Green Carpetweed. Collected by Allard; a weed of cultivated, freshly disturbed, and barren soils. Naturalized exotic.

MONOTROPACEAE. INDIAN-PIPE FAMILY

***Monotropa hypopithys* L.** Pinesap. Incl. *Monotropa hypopithys* var. *americana* (DC.) Farw. and *M. hypopithys* var. *rubra* (Torr.) Farw. Wooded slopes, usually in acidic oak-hickory or chestnut oak forests. Infrequent (5 plots).

***Monotropa uniflora* L.** Indian-Pipe. Moderately moist to dry wooded slopes; mostly in oak-hickory and chestnut oak forests. Frequent (17 plots).

MORACEAE. MULBERRY FAMILY

***Broussonetia papyrifera* (L.) L'Hér. *ex* Vent.** Paper Mulberry. Disturbed secondary woodland in Thoroughfare Gap and elsewhere near old home sites. Naturalized exotic.

***Maclura pomifera* (Raf.) Schneid.** Osage-Orange. Collected by Fosberg at Roland Farm; reported from around old home sites elsewhere (Allard and Leonard 1943). Naturalized from the south-central U.S.

Morus rubra* L. var. *rubra. Red Mulberry. Fencerow thickets and moist wooded slopes. Very infrequent (1 plot). Large specimens of red mulberry have become rare everywhere in recent years due to a die-back disease that is poorly understood.

MYRICACEAE. BAYBERRY FAMILY

***Comptonia peregrina* (L.) Coult.** Sweet-Fern. Dry, sandy powerline clearing on crest of the east ridge S of Hopewell Gap; collected by Allard on sterile, sandy ridge N of Beverley Mill, but not found there recently. Very local and infrequent. In the mountains, this is a fairly common species of open pine-oak/heath woodlands with a history of fire, but is rarely found east of the Blue Ridge in Virginia.

NYMPHAEACEAE. WATER-LILY FAMILY

***Nuphar advena* Ait.** Spatterdock. Collected by Allard in Broad Run at Broad Run Station W of Thoroughfare Gap; the only record in the area for this aquatic species.

OLEACEAE. OLIVE FAMILY

***Chionanthus virginicus* L.** Fringetree. Mostly in seepage swamps; occasionally in oak-hickory forests on dry wooded slopes. Frequent (10 plots).

***Fraxinus americana* L.** White Ash. Seepage swamps, moist to moderately dry wooded slopes, and sheltered boulderfields. Common in seedling, sapling and understory tree sizes; large trees infrequent (33 plots).

Fraxinus nigra* Marsh.* Black Ash. Seepage swamps (C.E. Stevens 9298, 9379, 19926; G.P. Fleming 3987). Infrequent, but scattered in all interior drainages of the area (2 plots). A northern tree that reaches its southern limits in the Virginia mountains. The populations in the Bull Run Mountains are the only ones documented E of the main Blue Ridge and were evidently missed by Allard. Ironically, Allard (1944b) published a paper railing against then-unverified accounts of the species in Virginia.

***Fraxinus pennsylvanica* Marsh.** Green Ash. Incl. *Fraxinus lanceolata* Borkh. Floodplains; Broad Run above and below Beverley Mill, and Little River just S of Aldie. Infrequent, locally common.

***Ligustrum amurense* Carr.** Amur Privet. Collected by Allard from near Beverley Mill in Thoroughfare Gap. Naturalized or adventive exotic.

Ligustrum obtusifolium* Sieb. & Zucc.* Border Privet. Fencerows, disturbed secondary forests; occasional seedlings on wooded slopes. Frequent. Naturalized exotic. (1 plot).

Ligustrum sinense* Lour.* Chinese Privet. Collected by Allard from Thoroughfare Gap. Naturalized exotic.

ONAGRACEAE. EVENING-PRIMROSE FAMILY

***Circaea lutetiana* L. ssp. *canadensis* (L.) Aschers. & Magnus.** Enchanter's Nightshade. *Circaea quadrisulcata* (Maxim.) Franch. & Sav. var. *canadensis* (L.) Hara. On moist or fertile wooded slopes, seepage swamp hummocks, and humus-covered shelves of sheltered boulderfields. Common (23 plots).

***Chamerion angustifolium* (L.) Holub ssp. *circumvagum* (Mosq.) Kartesz.** Fireweed. *Epilobium angustifolium* L. Two collections by Allard: along railroad near Beverley Mill in Thoroughfare Gap, and on burns 3.2 km (2 mi) N of Hopewell Gap. These are the only records for this showy species east of the mountains in Virginia, and it has not been found anywhere in the area recently. As its common name implies, the species frequently thrives on sites that have recently burned.

***Epilobium coloratum* Biehl.** Purple-Leaved Willow-Herb. Incl. *Epilobium adenocaulon* of Allard and Leonard (1952). Wet, springy powerline clearings and low roadsides. Frequent.

***Gaura biennis* L.** Biennial Gaura. Collected by Allard in open alluvial habitats along Broad Run and on a dry roadside bank in Thoroughfare Gap. Evidently infrequent in this area.

***Ludwigia alternifolia* L.** Seedbox. Floodplains, pond edges, and ditches; collected by Allard in damp pastures and swales throughout. Frequent.

***Ludwigia palustris* (L.) Ell.** Marsh Seedbox. *Ludwigia palustris* var. *americana* (DC.) Fern. & Grisc. Drawn-down bed of old impoundment in the lower part of Jackson Hollow; probably in similar habitats elsewhere in the area. Local.

***Oenothera biennis* L.** Common Evening-Primrose. *Oenothera pycnocarpa* Atkins. & Bartl. Fields, roadsides, and clearings. Frequent.

***Oenothera fruticosa* L. ssp. *fruticosa*.** Narrow-Leaved Sundrops. *Oenothera fruticosa* var. *vera* Hook., *O. fruticosa* var. *linearis* (Michx.) S. Wats. Moist fields and clearings; in gap of the Pond Mountains 2.1 km (1.3 mi) SSW of Thoroughfare Gap, and along Rt 629 N of Hopewell Gap. Infrequent. Much more common in the Culpeper Basin just east of the study area.

***Oenothera nutans* Atkins. & Bartl.** Nodding Evening-Primrose. Similar to O. biennis. Two collections by Allard: along railroad above Beverley Mill in Thoroughfare Gap, and W slope of High Point Mountain S of Hopewell Gap. According to Allard and Leonard (1943), it was “rather general” in the area.

Oenothera parviflora* L.* Northern Evening-Primrose. Collected by Allard (1149, 10 Nov 1935) “1 mi. N of Hopewell Gap” but never reported.

Oenothera perennis* L.* Small Sundrops. Collected by Allard (19631, 20 June 1950) in wet soil on the western slope but never reported.

OROBANCHACEAE. BROOM-RAPE FAMILY

***Conopholis americana* (L.) Wallr.f.** Squawroot. On moist to moderately dry wooded slopes; a root-parasite of *Quercus* spp. (oaks). Frequent (8 plots).

***Epifagus virginiana* (L.) Bart.** Beechdrops. A root-parasite of *Fagus grandifolia* (American beech); in mesic mixed hardwood forests and elsewhere under beech throughout. Frequent (3 plots).

***Orobanche uniflora* L.** One-Flowered Cancer-Root. A single collection by Allard from “dry woods on E slope of High Point ridge 1½ -2 mi. north of Thorofare [sic] Gap;” a root-parasite of various plants. Infrequent or rare in the area.

OXALIDACEAE. WOOD-SORREL FAMILY

***Oxalis dillenii* Jacq.** Slender Yellow Wood-Sorrel. *Oxalis filipes* Small, *Oxalis stricta* L. of Allard and Leonard (1943). Dry wooded slopes and clearings. Frequent (6 plots).

***Oxalis stricta* L.** Upright Yellow Wood-Sorrel. *Oxalis europaea* Jordan. Fields, clearings, and moist open forests. Frequent (3 plots).

***Oxalis violacea* L.** Violet Wood-Sorrel. On moist, usually fertile wooded slopes. Frequent (3 plots).

PAPAVERACEAE. POPPY FAMILY

***Papaver dubium* L.** Long-Pod Poppy. Roadsides and along railroad in Thoroughfare Gap. Infrequent. Naturalized exotic.

***Sanguinaria canadensis* L.** Bloodroot. On moist to moderately dry, fertile slopes; primarily associated with the basic mesic forest and basic oak-hickory forest community types. Frequent (7 plots).

PHYTOLACCACEAE. POKEWEED FAMILY

***Phytolacca americana* L.** Common Pokeweed. Fields, fencerows, other weedy habitats; seeds dropped by birds on wooded slopes persist for years and sprout readily in gap disturbances caused by gypsy moth infestations or around tip-up mounds. Frequent (1 plot).

PLANTAGINACEAE. PLANTAIN FAMILY

***Plantago aristata* Michx.** Large-Bracted Plantain. In sterile powerline clearings, along railroad in Thoroughfare Gap, and elsewhere in dry, barren, open soils. Frequent. Naturalized from the midwestern U.S.

***Plantago lanceolata* L.** English Plantain. Fields, roadsides, clearings, lawns, and cultivated soils. Frequent, locally abundant. Naturalized exotic.

***Plantago major* L.** Great Plantain. A single collection by Allard from "waste ground at Beverley Mill," Thoroughfare Gap. Naturalized exotic.

***Plantago rugelii* Dcne.** American Plantain. Fields, roadsides, lawns, and cultivated ground. Frequent, locally abundant.

***Plantago virginica* L.** Virginia Plantain. Dry fields, powerline clearings, and road banks. Frequent.

PLATANACEAE. SYCAMORE FAMILY

***Platanus occidentalis* L.** American Sycamore. Floodplains and moist, secondary forests on the lower slopes. Frequent.

PODOSTEMONACEAE. RIVERWEED FAMILY

***Podostemon ceratophyllum* Michx.** Horn-Leaf Riverweed. Collected by Allard; an aquatic species attached to submerged rocks in Broad Run, above and below Beverley Mill. Very local.

POLEMONIACEAE. PHLOX FAMILY

***Phlox paniculata* L.** Fall Phlox. Eight collections by Allard, most in low, damp soils along streams, and most from the Pond Mountains and Jackson Hollow area N of Hopewell Gap.

POLYGALACEAE. MILKWORT FAMILY

***Polygala ambigua* Nutt.** Dry, barren soil in powerline clearings. Infrequent, local.

***Polygala incarnata* L.** Pink Milkwort. A single collection by Allard in pastures near Allen's spring, on the eastern slope 1.6 km (1 mi) N of Hopewell Gap. Evidently rare here; more frequent in the Culpeper Basin just east of the study area.

***Polygala senega* L.** Seneca Snakeroot. Two collections from the W slope of High Point Mountain: clearing on slope above Broad Run Station (Allard 118, 29 May 1934) and at Roland Farm (F.R. Fosberg 55496, 55512, 05 May 1974, 26 May 1974). Evidently rare in this area; a species characteristic of dry, basic or calcareous soils and perhaps associated with underlying Catoctin metabasalt at the High Point Mountain localities.

***Polygala verticillata* L. var. *isocycla* Fern.** Whorled Milkwort. Collected by Allard; reported as infrequent "in old fields and pastures, sandy clearings, and dry, wooded roadsides."

POLYGONACEAE. BUCKWHEAT FAMILY

***Polygonum arifolium* L.** Halberd-Leaf Tearthumb. Incl. *Polygonum arifolium* var. *lentiforme* Fern. & Grisc. Seepage swamps. Frequent (2 plots).

***Polygonum aviculare* L.** Knotweed. Incl. *Polygonum monspeliense* Pers., *P. neglectum* Bess. of Allard and Leonard (1943). In cultivated ground and dry, often barren, disturbed soil of old quarries, railroad grades, and roadsides. Frequent.

Polygonum caespitosum* Blume var. *longisetum* (DeBr.) Steward.* Long-Bristled Smartweed. Moist or fertile wooded slopes, seepage swamps, disturbed secondary forests, and old fields; vouchered by F.R. Fosberg (55128, 55145, 57740, 65780, 66212). Common (4 plots). Naturalized exotic. A very shade tolerant, annual herb capable of establishing itself abundantly in relatively undisturbed, mesic forests.

***Polygonum convolvulus* L.** Black Bindweed. Collected by Allard; a weed of fields, roadsides, and cultivated soil. Naturalized exotic.

***Polygonum erectum* L.** Erect Knotweed. Collected by Allard several times at Beverley Mill in Thoroughfare Gap, and along Broad Run. A native, weedy species often found in disturbed alluvial soil.

***Polygonum hydropiper* L.** Mild Water-Pepper. Incl. *Polygonum hydropiper* var. *projectum* Sanf. Damp soil in clearings, roadsides, and along old roadways. Infrequent.

***Polygonum orientale* L.** Asiatic Smartweed. Collected by Allard; reported as an escape from cultivation near an old house site on Catletts Branch, N of Thoroughfare Gap (Allard and Leonard 1943). Naturalized or adventive exotic.

***Polygonum pensylvanicum* L.** Pennsylvania Smartweed. Incl. *Polygonum pensylvanicum* var. *laevigatum* Fern., *P. pensylvanicum* var. *rosaeflorum* Norton. Moist, low clearings, disturbed floodplains, and roadsides. Infrequent.

Polygonum perfoliatum* L.* Mile-a-Minute, Asiatic Tearthumb. A very extensive colony covering a scrubby clearcut on the NE slope of High Acre Ridge (G.P. Fleming, field observation). A rapidly spreading, naturalized exotic that is potentially very invasive in natural areas.

***Polygonum persicaria* L.** Lady's-Thumb. Collected by Allard in waste ground at Hopewell Gap; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Polygonum punctatum* Ell. var. *punctatum*.** Dotted Smartweed. Floodplain forest along Broad Run, in old impoundment in lower part of Jackson Hollow, and in wet meadows along Bull Run at foot of the eastern slope near Cold Spring Gap. Frequent in wet open forests, clearings, and meadows.

***Polygonum sagittatum* L.** Arrow-Leaf Tearthumb. Seepage swamps, wet clearings, and floodplain meadows along Rt. 628. Frequent (3 plots).

***Polygonum scandens* L. var. *cristatum* (Engelm. & Gray) Gleason.** Crested False Buckwheat. *Polygonum dumetorum* L. of Allard and Leonard (1943). Exposed mineral soil on dry, fertile wooded slopes; strongly, if not exclusively associated with the basic oak-hickory forest community type. Frequent (4 plots).

***Polygonum scandens* L. var. *scandens*.** Climbing False Buckwheat. Damp brushy forest along road to abandoned quarry just ESE of Thoroughfare Gap; collected by Allard from various localities. Probably frequent in low forests along streams throughout.

***Polygonum tenue* Michx.** Slender Knotweed. A single collection by Allard from a dry pasture on W slope of the Pond Mountains, 1.6 km (1 mi) S of Thoroughfare Gap. A species usually associated with dry, basic rock outcrops and rocky soils. Rare in the area.

***Polygonum virginianum* L.** Virginia Knotweed. Moist wooded slopes, seepage swamp hummocks, and wooded floodplains. Frequent (8 plots)

***Rumex acetosella* L.** Sheep-Sorrel. Fields, roadsides, clearings, and cultivated ground. Frequent. Naturalized exotic.

***Rumex crispus* L.** Curly Dock. A weed of fields and cultivated ground; rarely on wooded slopes around tip-up mounds and other disturbances. Frequent (1 plot). Naturalized exotic.

***Rumex obtusifolius* L.** Bitter Dock. Collected by Allard; a common weed of cultivated ground and various disturbed weedy habitats. Naturalized exotic.

PORTULACACEAE. PURSLANE FAMILY

***Claytonia virginica* L. var. *virginica*.** Spring-Beauty. On moist or fertile wooded slopes and floodplains. Frequent. Not captured in plots because of its very early maturation and evanescence.

***Portulaca oleracea* L.** Common Purslane. Collected by Allard and Fosberg; a weed of soils disturbed by cultivation or livestock. Naturalized exotic.

PRIMULACEAE. PRIMROSE FAMILY

***Anagalis arvensis* L.** Scarlet Pimpernel. Collected by Allard; a weed of cultivated and barren soils. Naturalized exotic.

***Lysimachia ciliata* L.** Fringed Yellow Loosestrife. Moist wooded slopes, seepage swamp hummocks, and wooded floodplains. Frequent (5 plots).

***Lysimachia nummularia* L.** Moneywort. Wooded floodplain of Broad Run above Beverley Mill. Naturalized exotic. A very invasive species in floodplain habitats.

***Lysimachia quadrifolia* L.** Whorled Yellow Loosestrife. Moderately dry to dry wooded slopes, ridge crests, and powerline clearings; usually in acidic, infertile soils. Frequent (5 plots).

***Lysimachia terrestris* (L.) B.S.P.** Swamp-Candles. Collected by Allard from floodplain swale near Broad Run Station; at Thoroughfare Gap; and an unspecified locality in the Pond Mountains. A species of open, marshy wetlands.

Trientalis borealis* Raf. ssp. *borealis*.* Northern Starflower. In a narrow, mossy-rocky seepage swamp near the headwaters of Hungry Run, elev. 274 m (900 ft) (C.E. Stevens 19922, 7 Sept 1986; G.P. Fleming 14458); scores of plants were seen here on 27 May 1998 and 21 June 2001. Rare and local (1 plot). A remarkable occurrence of this northern species, which in Virginia is normally confined to higher elevations in the mountains.

PYROLACEAE. WINTERGREEN FAMILY

***Chimaphila maculata* (L.) Pursh.** Spotted Wintergreen. On wooded slopes throughout, in every community type except the basic mesic forest; most characteristic of dry, infertile soils. Frequent everywhere, but never very numerous (44 plots).

***Chimaphila umbellata* (L.) Bart. var. *cisatlantica* (Blake) Hulten.** Pipsissewa. Dry chestnut oak forest on middle ridge between the headwaters of Bartons Creek and Hungry Run; collected only twice by Allard. Infrequent or rare.

***Pyrola americana* Sweet.** American Pyrola. *Pyrola rotundifolia* L. var. *americana* (Sweet) Fern. Several collections by Allard, one from "below High Point," the others from N of Hopewell Gap; reported as local in "moist, rich woods" (Allard and Leonard 1943).

***Pyrola elliptica* Nutt.** Shinleaf. Six collections by Allard, all from N of Hopewell Gap; reported by Allard and Leonard (1943) as local in “moist rich woods 3 miles north of Hopewell Gap”; the label for one collection specifies “2 mi. N of Hopewell Gap.” These are very noteworthy records, constituting the only reports of this state-rare species east of the Blue Ridge in Virginia.

RANUNCULACEAE. BUTTERCUP FAMILY

***Aquilegia canadensis* L.** Wild Columbine. On Triassic conglomerate outcrops on wooded bluff above Broad Run, 1.2 km (0.75 mi) SE of Thoroughfare Gap at E foot of the Pond Mountains. Rare, local.

***Anemone quinquefolia* L. var. *quinquefolia*.** Wood Anemone. Seepage swamps in Jackson Hollow; also collected by Allard along Broad Run near Beverley Mill. Infrequent, local (1 plot).

***Anemone virginiana* L. var. *virginiana*.** Thimbleweed. Moist secondary forests, clearings, and dry, fertile oak-hickory forests. Frequent.

Caltha palustris* L.* Marsh Marigold. Seepage swamps; along headwaters of Bartons Creek by Rt 629 and in a shallow ravine head on N slope of High Acre Ridge, 4.8 km (3.0 mi) N of Hopewell Gap (G.P. Fleming 3888, 3891).

***Cimicifuga racemosa* (L.) Nutt.** Black Bugbane. On moist to moderately dry, usually fertile wooded slopes; a patch-dominant herb in the basic mesic forest and basic oak-hickory forest community types; occasional elsewhere. Common (18 plots). Despite the fact that it is reputed to have insecticidal and medicinal properties, this species is frequently grazed by deer. As a result, except in protected habitats such as boulderfields, flowering and vigor of individual plants has been greatly reduced. Local populations of dwarfed individuals only a few cm tall are not uncommon.

***Clematis ochroleuca* Ait.** Curly-Heads. A single individual on a flat quartzite boulder in dry oak forest on W slope of High Point Mountain; also collected by Allard near Spouting Spring along railroad W of Thoroughfare Gap and on Pond Mountain. Rare (1 plot). This species is nearly endemic to the mid- and south-Atlantic Piedmont. It is usually found in dry, basic soils and is frequent in diabase areas of the Culpeper Basin just east of the Bull Run Mountains.

Clematis virginiana* L.* Virgin's-Bower. Hummocks of seepage swamps; headwaters of Bartons Creek, Jackson Hollow, and Little Bull Run N of Hopewell Gap (G.P. Fleming, field observations). Infrequent (3 plots).

***Hepatica americana* (DC.) Ker-Gawl.** Round-Lobe Hepatica. On moist or fertile wooded slopes and seepage swamp hummocks. Frequent (5 plots).

***Ranunculus abortivus* L.** Kidneyleaf Buttercup. On moist wooded slopes, seepage swamp hummocks, and floodplains. Frequent (3 plots).

***Ranunculus allegheniensis* Britt.** Allegheny Buttercup. On moist to moderately dry, fertile wooded slopes; in basic mesic and basic oak-hickory forests. Frequent (2 plots). A mountain species, occurring as an outlier and reaching its eastern range limits here.

Ranunculus aquatilis* L. var. *diffusus* With.* White Water Crowfoot. Collected by Allard (8892, 08 June 1941) but never reported: submersed in Broad Run W of Beverley Mill in Thoroughfare Gap. Rare, local.

***Ranunculus bulbosus* L.** Bulbous Buttercup. Fields, roadsides, and clearings. Frequent, locally abundant. Naturalized exotic.

***Ranunculus hispidus* Michx. var. *hispidus*.** Bristly Buttercup. On moist or dry, fertile wooded slopes. Frequent.

***Ranunculus recurvatus* Poir.** Hooked Buttercup. Wooded floodplains, seepage swamps, and moist wooded slopes. Frequent (9 plots).

***Thalictrum coriaceum* (Britt.) Small.** Appalachian Meadowrue. *Thalictrum caulophylloides* Small. One collection by Allard from "a single small colony below High Point Cliffs in woods on west slope constituting the sole record; rare." A mountain species rarely found east of the Blue Ridge. Recent attempts to relocate the population have not been successful.

***Thalictrum dioicum* L.** Early Meadowrue. On moist, often rocky wooded slopes. Frequent (1 plot).

***Thalictrum pubescens* Pursh.** Tall Meadowrue. *Thalictrum perelegans* Greene. Seepage swamps, wet clearings, and floodplains. Frequent (9 plots).

***Thalictrum thalictroides* (L.) Eames & Boiv.** Rue-Anemone. On moist to moderately dry wooded slopes, usually in relatively fertile soils. Common (11 plots). This spring ephemeral is under-represented in plots due to its early maturation and evanescence.

RHAMNACEAE. BUCKTHORN FAMILY

***Ceanothus americanus* L.** New Jersey Tea. Dry wooded slopes and powerline clearings. Frequent.

ROSACEAE. ROSE FAMILY

***Agrimonia gryposepala* Wallr.** Tall Hairy Agrimony. Moist, low forest in Jackson Hollow along Rt. 629; collected by Allard from several localities N of Hopewell Gap and by Fosberg at Roland Farm. Infrequent.

***Agrimonia microcarpa* Wallr.** Low Agrimony.** Collected by F.R. Fosberg at Roland Farm (55094) and Thoroughfare Gap, E of Broad Run P.O. (65925A).

***Agrimonia parviflora* Ait.** Small-Flowered Agrimony. Damp habitats in fields, clearings, and open secondary forests. Frequent.

***Agrimonia pubescens* Wallr.** Downy Agrimony. Moist, fertile wooded slopes and disturbed secondary forests. Infrequent (1 plot).

***Agrimonia rostellata* Wallr.** Woodland Agrimony. On moist, fertile wooded slopes; usually associated with the basic mesic forest and basic oak-hickory forest community types. Frequent (9 plots).

***Amelanchier arborea* (Michx.f.) Fern. var. *arborea*.** Downy Serviceberry. On wooded slopes throughout, most commonly in acidic, infertile soils. Common (21 plots).

***Amelanchier laevis* Wieg.** Smooth Serviceberry. On wooded slopes and rocky ridge crests; mostly at higher elevations. Frequent (5 plots).

***Aronia arbutifolia* (L.) Pers.** Red Chokeberry. Seepage swamps. Infrequent (3 plots).

***Aronia melanocarpa* (Michx.) Ell.** Black Chokeberry. Reported by Allard and Leonard (1943) from "moist, wooded slope north of Hopewell Gap." No specimens at US.

***Aronia* x *prunifolia* (Marsh.) Rehd.** Purple Chokeberry. Reported by Allard and Leonard (1943) from "boggy ground in Jackson Hollow 2 miles north of Hopewell Gap." No specimens at US.

***Aruncus dioicus* (Walt.) Fern.** Goatsbeard. *Aruncus allegheniensis* Rydb. On moist, fertile wooded slopes; N end of Pond Mountain at Thoroughfare Gap. Infrequent.

***Crataegus calpodendron* (Ehrh.) Medik.** Pear Hawthorn. Collected by Allard "on ridge of Pond Mountain and in moist soil along brook at foot of west slope just north of Hopewell Gap." A rare tree in Virginia.

***Crataegus crus-galli* L.** Cockspur Hawthorn. Fencerows, thickets, and forest edges.

Crataegus intricata* Lange.* Collected by Allard (7469, 04 Oct 1939) S of Hopewell Gap but never reported.

***Crataegus margarettiae* Ashe.** Collected several times by Allard S of Hopewell Gap; reported as frequent "in broomsedge pastures" (Allard and Leonard 1943).

***Crataegus pruinosa* (Wendl.f.) K. Koch.** Incl. *Crataegus rugosa* Ashe. Several collections by Allard: Hopewell Gap; S of Hopewell Gap; Rt. 628 SW of Hopewell Gap; and S of Aldie.

Crataegus succulenta* Schrad. *ex* Link.* Fleshy Hawthorn. Two collections by Allard (9310, 27 July 1941; 9927, 10 May 1942) from the western slope, N of Hopewell Gap.

***Crataegus viridis* L. var. viridis.** Green Hawthorn. Reported by Allard and Leonard (1943) from an "old broomsedge pasture south of Hopewell Gap." No specimens at US.

***Filipendula rubra* (Hill) Robins.** Queen-of-the-Prairie. Collected by Allard from "swale on west slope of Pond Mountain just south of Thorofare [sic] Gap." Attempts to relocate this population in 1992 were unsuccessful.

***Fragaria virginiana* Duchesne ssp. *virginiana*.** Wild Strawberry. Fields, secondary forests, and clearings. Frequent.

***Geum canadense* Jacq. White Avens.** Incl. *Geum meyerianum* Rydb. Moist wooded slopes, disturbed secondary forests, seepage swamp hummocks, and floodplains. Frequent (4 plots).

Geum vernum* (Raf.) Torr. & Gray.* Spring Avens. Moist soil along wood roads on W slope of High Point Mountain; vouchered by F.R. Fosberg (55503, 65435). Infrequent.

***Geum virginianum* L.** Cream Avens. On moderately moist to moderately dry, fertile wooded slopes; appears to be associated almost exclusively with the basic oak-hickory forest community type. Frequent (5 plots).

***Malus coronaria* (L.) Mill.** Sweet Crabapple. *Malus lancifolia* Rehd. Two collections by Allard from the western slope "west of High Point."

Malus prunifolia* (Willd.) Borkh.* Pear-Leaf Crabapple. Collected by Allard N of Beverley Mill in Thoroughfare Gap (1055, 13 Oct. 1935) and N of Hopewell Gap (2324, 27 Sept. 1936), but never reported. Presumably persisting or escaped from cultivation. Adventive exotic.

***Malus pumila* Mill.** Common Apple. *Malus sylvestris* P. Mill. Commonly planted and occasionally escaped to fencerows and old fields. Naturalized or adventive exotic.

***Physocarpus opulifolius* (L.) Maxim. var. *opulifolius*.** Ninebark. Rocky streamsides; Broad Run floodplain above Beverley Mill; also reported from the Pond Mountains (C. Blair, pers. comm.). Infrequent, local.

***Porteranthus trifoliatus* (L.) Britt.** Bowman's-Root. *Gillenia trifoliata* (L.) Moench. On moderately dry to dry wooded slopes. Infrequent (1 plot).

***Potentilla canadensis* L.** Canada Cinquefoil. Exposed, barren soil on wooded slopes, wood road banks, and powerline clearings. Frequent to common (10 plots).

***Potentilla norvegica* L. ssp. *monspeliensis* (L.) Aschers. & Graebn.** Rough Cinquefoil. *Potentilla norvegica* var. *hirsuta* (Michx.) Lehm. Several collections by Allard; a species of disturbed alluvial soils and moist clearings.

***Potentilla recta* L.** Upright Cinquefoil. Dry fields and roadsides. Naturalized exotic.

***Potentilla simplex* Michx.** Common Cinquefoil. On moist to moderately dry wooded slopes and in clearings; often in oak-hickory forests. Frequent (3 plots).

***Prunus americana* Marsh.** American Wild Plum. In fencerows, thickets, and forest edges. Infrequent.

***Prunus angustifolia* Marsh. var. *angustifolia*.** Chickasaw Plum. Collected by Allard from "open woods on west slope below High Point" and N of Hopewell Gap. Very infrequent and possibly persisting or spread from cultivation here.

***Prunus avium* (L.) L.** Sweet Cherry. Moist or fertile wooded slopes, sheltered boulderfields, disturbed secondary forests, and fencerows. Frequent (4 plots). Naturalized exotic. This Eurasian tree appears perfectly adapted to mesic, often rocky forests of the Virginia mountains and Piedmont; it generally occurs in small numbers and is not invasive.

***Prunus munsoniana* Wight & Hedrick.** Wild Goose Plum. Collected by Allard near an old house site in Jackson Hollow; a cultivated escape. Introduced from the midwestern U.S.

***Prunus persica* (L.) Batsch.** Peach. Collected by Allard; an occasional escape from cultivation. Naturalized or adventive exotic.

***Prunus serotina* Ehrh. var. *serotina*.** Wild Black Cherry. A tree in fencerows and secondary old-field forests; seedling and saplings are widespread on moist to dry wooded slopes, in every community type. Common (29 plots).

***Pyrus communis* L.** Common Pear. Collected by Allard from the vicinity of Thoroughfare Gap; an occasional escape from cultivation. Naturalized or adventive exotic.

***Rosa blanda* Ait.** Smooth Rose. Collected by Allard at vicinity of jct. Rtes. 601 and 629 in Hopewell Gap: "a single record in old field." This is a very distinctive rose, native to rocky clearings and shores of the northern U.S., S to Pennsylvania and Maryland. The specimen was verified by Mark T. Strong (US) and represents a new record for the Virginia flora.

***Rosa carolina* L.** Pasture Rose. Dry wooded slopes and powerline clearings. Frequent (7 plots).

***Rosa eglanteria* L.** Sweetbrier. Incl. *Rosa rubiginosa* L. Two collections by Allard from the Pond Mountains. Naturalized exotic.

***Rosa multiflora* Thunb. *ex* Murr.** Multiflora Rose. Fields, clearings, roadsides, fencerows, and disturbed secondary forests; occasionally in undisturbed forests. Frequent to common (2 plots). Naturalized exotic. A serious invader of disturbed habitats that smothers competition and pre-empts natural successional processes.

***Rosa palustris* Marsh.** Swamp Rose. Seepage swamps and damp, low forest near Beverley Mill in Thoroughfare Gap. Infrequent.

***Rosa setigera* Michx. var. *tomentosa* Torr. & Gray.** Prairie Rose. A single collection by Allard from a roadside thicket along Rt. 628 SW of Hopewell Gap. Rare.

***Rubus allegheniensis* Porter var. *allegheniensis*.** Allegheny Blackberry. Incl. *Rubus alumnus* Bailey, *R.. apianus* Bailey. Openly wooded slopes, powerline clearings, shaded outcrops. Frequent (3 plots).

***Rubus argutus* Link.** Prickly Blackberry. Incl. *Rubus floridus* Tratt. Fields, clearings, roadside thickets, and open disturbed forests. Common (1 plot).

***Rubus flagellaris* Willd.** Northern Dewberry. Moist to dry wooded slopes, seepage swamp hummocks, and powerline clearings. Common (21 plots).

***Rubus pensilvanicus* Poir.** Pennsylvania Blackberry. *Rubus frondosus* Bigel. Several collections by Allard, most from the Pond Mountains and near Hopewell Gap. Reported as common in pastures and roadside thickets (Allard and Leonard 1943).

***Rubus hispidus* L.** Bristly Dewberry. Seepage swamps along the headwaters of Hungry Run, where locally common. Very infrequent in the area (1 plot).

***Rubus occidentalis* L.** Black Raspberry. Moist to dry fertile wooded slopes, cliffs and boulderfields, and disturbed secondary forests. Frequent to common (3 plots).

Rubus odoratus* L. ssp. *odoratus*.* Purple Flowering Raspberry. Wooded, N-facing boulderfield on slope of Jackson Hollow, just E of Rt. 629 (G.P. Fleming 15252). Rare, local (1 plot). A mountain species rarely found east of the Blue Ridge in Virginia.

***Rubus phoenicolasius* Maxim.** Wineberry. On moist or fertile wooded slopes, boulderfields, seepage swamp hummocks, and in disturbed secondary forests of old fields and clearings. Common (13 plots). Naturalized exotic. One of the most frequent exotics of relatively undisturbed, forest habitats in the Bull Run Mountains and elsewhere; very problematic because of its unusually great (among *Rubus* spp.) shade tolerance and aggressive tendencies on suitable, mesic or fertile sites.

***Spiraea alba* Du Roi var. *alba*.** Narrow-Leaved Meadowsweet. Collected by Allard from swales on E and W slopes of the Pond Mountains, just S of Thoroughfare Gap. Evidently rare and local.

***Spiraea alba* Du Roi var. *latifolia* (Ait.) Dippel.** Broad-Leaved Meadowsweet. *Spiraea latifolia* (Ait.) Borkh. Collected by Allard from "swale along Broad Run near Broad Run Station," where it was limited to a few plants. Rare.

***Spiraea betulifolia* Pall. var. *corymbosa* (Raf.) Maxim.** Dwarf Spiraea. *Spiraea corymbosa* Raf. Dry chestnut oak/heath forests on upper slope of the east ridge S of Hopewell Gap and near Bull Run Mountain estates; collected by Allard from a similar habitat N of Hopewell Gap. Very infrequent. A mountain species, occurring as an outlier and reaching its eastern range limits here.

***Spiraea prunifolia* Sieb. & Zucc.** Bridle-Wreath. *Spiraea prunifolia* var. *plena* Schneid. Collected by Allard in woods around an old house site near Hopewell Gap; spread from cultivation. Naturalized exotic.

RUBIACEAE. MADDER FAMILY

***Cephalanthus occidentalis* L.** Buttonbush. Along wet spring runs in secondary forest near Beverley Mill; in old impoundment and beaver ponds in lower part of Jackson Hollow. Infrequent, local.

***Diodia teres* Walt.** Buttonweed. *Diodia teres* var. *setifera* Fern. & Grisc. Dry, sterile powerline clearings and barren roadsides. Infrequent.

***Galium aparine* L.** Cleavers. Moist wooded slopes, floodplain forests, and disturbed secondary woodlands. Frequent to common; under-represented by plots due to its early maturation and evanescence (1 plot).

***Galium asprellum* Michx.** Rough Bedstraw. Forming tangles in old impoundment in lower part of Jackson Hollow; also collected by Allard near Beverley Mill. Infrequent.

***Galium circaezans* Michx. var. *circaezans*.** Licorice Bedstraw. On moist to moderately dry wooded slopes throughout. Common (26 plots). Repeated top-grazing by deer often results in stunted populations of this and other *Galium* spp. See note under *G. circaezans* var. *hypomalacum* below.

***Galium circaezans* Michx. var. *hypomalacum* Fern.** Seven collections by Allard at US are considered to be this variety, while five are treated as the typical variety. Additional research is needed to determine how robust the morphological, environmental, and distributional differences are between these putative taxa in the study area.

***Galium latifolium* Michx.** Purple Bedstraw. On moderately moist to moderately dry, fertile wooded slopes; appears to be strongly, if not exclusively associated with the basic oak-hickory forest community type. Frequent to common (8 plots). A mountain species, occurring as an outlier and reaching its eastern range limits here.

***Galium obtusum* Bigel. var. *obtusum*.** Bluntleaf Bedstraw. Seepage swamps in Jackson Hollow. Infrequent (1 plot).

***Galium pilosum* Ait.** Hairy Bedstraw. Dry wooded slopes and clearings. Frequent.

***Galium tinctorium* (L.) Scop.** Stiff Marsh Bedstraw. Wet pasture at W foot of Pond Mountain, just S of Thoroughfare Gap, and in old impoundment in lower part of Jackson Hollow; several collections by Allard from similar habitats. Infrequent, locally common.

***Galium triflorum* Michx.** Sweet-Scented Bedstraw. On moist or fertile wooded slopes and seepage swamp hummocks. Common (22 plots).

***Houstonia caerulea* L.** Quaker-Ladies. Mossy wood road banks, and moist clearings. Frequent.

Houstonia longifolia* Gaertn.* Longleaf Bluets. On rocky wooded slope at N end of High Point ridge (G.P. Fleming, field observation). Apparently rare in this area (1 plot).

***Houstonia purpurea* L. var. *purpurea*.** Large Summer Bluets. Incl. *Houstonia purpurea* var. *pubescens* Britt. On moist to dry wooded slopes and clearings throughout; usually in patches of exposed mineral soil and around tree bases. Common (17 plots).

***Mitchella repens* L.** Partridge-Berry. Moist wooded slopes, stream bottoms, and mossy seepage swamp hummocks; scattered throughout in moist or damp, acidic soils. Frequent (1 plot); this species is certainly not "rare" as claimed by Allard and Leonard (1943), although perhaps it was less frequent in the area 60 years ago.

SANTALACEAE. SANDALWOOD FAMILY

***Comandra umbellata* (L.) Nutt. ssp. *umbellata*.** Bastard-Toadflax. Dry, sandy, sterile soil in powerline clearings and open chestnut oak or oak-pine forests on ridges; almost always associated with colonies of the deciduous ericads *Vaccinium pallidum* (early lowbush blueberry) and *Gaylussacia baccata* (black huckleberry). Infrequent.

SALICACEAE. WILLOW FAMILY

***Populus alba* L.** White Poplar. A large colony in an abandoned field near Hopewell Gap; a colonial tree frequently spread from cultivation. Naturalized exotic.

***Populus grandidentata* Michx.** Bigtooth Aspen. On dry, infertile wooded slopes and ridge crests with a history of fire, and on cliffs; an associate tree of the chestnut oak forests and pine-oak/heath woodlands. Frequent (2 plots). This species is under-represented in plots.

***Populus tremuloides* Michx.** Quaking Aspen. On formerly burned slope above White Rock, Signal Mountain in chestnut oak forest with some *Pinus rigida* (pitch pine) and *Populus grandidentata* (bigtooth aspen); one or two trees seen here in 1989; also collected by Allard in this vicinity in 1935 and 1941. Very rare in the area.

***Salix humilis* Marsh. var. *humilis*.** Prairie Willow. Incl. *Salix humilis* var. *rigidiuscula* (Anderss.) Robins. & Fern. Numerous collections by Allard; reported as frequent in “old broomsedge fields and pastures” (Allard and Leonard 1943).

***Salix humilis* Marsh. var. *tristis* (Ait.) Griggs.** Prairie Willow. *Salix tristis* Ait. Three collections by Allard from a damp pasture in Jackson Hollow, 3.2 km (2 mi) N of Hopewell Gap.

***Salix nigra* Marsh.** Black Willow. Open floodplains, streambanks, and around ponds and springs at the foot of the mountain. Infrequent.

***Salix sericea* Marsh.** Silky Willow. Seepage swamps, damp streamsides, and springy clearings. Infrequent.

SAXIFRAGACEAE. SAXIFRAGE FAMILY

***Chrysosplenium americanum* Schwein. *ex* Hook.** American Golden-Saxifrage. Seepage swamps, usually growing in shallow water and wet rills or depressions. Frequent, local (3 plots).

***Heuchera americana* L.** American Alumroot. Rocky wooded slopes and shaded outcrops. Frequent (2 plots).

***Heuchera pubescens* Pursh.** Downy Alumroot. Incl. *Heuchera pubescens* var. *brachyandra* Rosend., Butters & Lakela. Exposed to thinly shaded quartzite outcrops at High Point cliffs and White Rock (Signal Mountain). Infrequent, local. A mountain species.

Mitella diphylla* L.* Two-Leaved Miterwort. Misidentified as *Tiarella cordifolia* in Allard and Leonard (1943). Rocky wooded streamsides along Catharpin Creek, above and below Rt. 629 (C.E. Stevens 9321, G.P. Fleming 3973, 14447). Infrequent. Occurrences of this species east of the main Blue Ridge in Virginia are rare and localized.

***Saxifraga pensylvanica* L.** Swamp Saxifrage. *Saxifraga pensylvanica* ssp. *eupensylvanica* Burns. A single collection by Allard from a "wooded swamp on W slope of Pond Mountain ½ mile south of Thoroughfare Gap." Rare and local everywhere east of the Blue Ridge in Virginia. Attempts by C.E. Stevens to relocate this population have not been successful.

***Saxifraga virginiensis* Michx.** Early Saxifrage. On rocky wooded slopes and outcrops. Frequent (2 plots).

SCROPHULARIACEAE. FIGWORT FAMILY

***Agalinis purpurea* (L.) Pennell.** Purple False Foxglove. Collected by Allard from wet swales near Broad Run Station and on W slope of the Pond Mountains S of Thoroughfare Gap. Evidently infrequent to rare here; much more abundant in open habitats of the Culpeper Basin to the east.

***Agalinis tenuifolia* (Vahl) Raf. var. *tenuifolia*.** Slender False Foxglove. Dry, sandy powerline clearing on ridge in Cold Spring Gap; several collections by Allard in similar habitats. Infrequent and local here; much more abundant in the Culpeper Basin to the east.

***Aureolaria flava* (L.) Farw. var. *flava*.** Yellow False Foxglove. Dry, infertile wooded slopes; in chestnut oak forest near High Point cliffs. Infrequent to rare.

***Aureolaria laevigata* (Raf.) Raf.** Smooth Yellow False Foxglove. On dry, infertile wooded slopes; one of the few herbs that is most common in chestnut oak forests. Frequent (5 plots).

***Aureolaria pedicularia* (L.) Raf.** var. *pedicularia*. Fern-Leaved Yellow False Foxglove. Four collections by Allard from dry oak woods and thinly wooded banks. Infrequent.

***Aureolaria virginica* (L.) Pennell.** Downy Yellow False Foxglove. On dry wooded slopes, in oak-hickory and chestnut oak forests. Infrequent (1 plot).

***Buchnera americana* L.** Blue-Hearts. A single collection by Allard from "a small colony in old pasture on west slope of Pond Mountain 2-2½ mi. south of Thorofare [sic] Gap." Very rare here, and elsewhere in Virginia.

***Chelone glabra* L.** White Turtlehead. Incl. *Chelone glabra* var. *elatior* Raf. Seepage swamps and wet clearings. Frequent (10 plots). Often top-grazed by deer.

***Gratiola neglecta* Torr**. Clammy Hedge-Hyssop. A single collection by Allard from a muddy brook E of Rt. 600 just S of Thoroughfare Gap. Probably in similar habitats elsewhere in the area.

***Linaria vulgaris* Mill.** Butter-and-Eggs. Roadsides and open disturbed ground. Infrequent. Naturalized exotic.

***Lindernia dubia* (L.) Pennell var. *dubia*.** *Lindernia dubia* ssp. *major* (Pursh) Pennell. Muddy streams and pond shores; lower part of Jackson Hollow. Infrequent, local.

***Mimulus alatus* Ait.** Winged Monkey-Flower. Seepage swamps, usually in muck-filled channels or depressions. Infrequent (1 plot).

***Mimulus ringens* L. var. *ringens*.** Monkey-Flower. Wet open habitats in floodplains, swales, and around ponds. Infrequent, local.

***Paulownia tomentosa* (Thunb.) Sieb. & Zucc. *ex* Steud.** Royal Paulownia. Roadsides and young secondary forests; Allard and Leonard (1943) reported that seedlings frequently appeared in burns on the summits of dry ridges. Naturalized exotic.

***Pedicularis canadensis* L.** Eastern Lousewort. Reported by Allard and Leonard (1943) "in dry soil on a wood road north of Hopewell Gap." No specimens at US.

***Penstemon digitalis* Nutt. ex Sims.** Foxglove Beardtongue. Collected by F.R. Fosberg (55557, 08 June 1974) at Roland Farm, W slope of High Point Mountain. A midwestern species now naturalized in fields and roadsides throughout the region.

***Penstemon hirsutus* (L.) Willd.** Hairy Beardtongue. Several collections by Allard: woods N of Hopewell Gap; pasture S of Thoroughfare Gap; and near Antioch. Rare here; frequent in the Culpeper Basin east of the study area.

***Penstemon laevigatus* Ait.** Smooth Beardtongue. Several scattered collections by Allard from meadows, swales, and road banks. Very infrequent.

***Scrophularia lanceolata* Pursh.** American Figwort. Collected by Allard on wooded slopes at Beverley Mill in Thoroughfare Gap, and on wooded ridge N of Antioch. Rare; primarily a mountain species in Virginia.

***Scrophularia marilandica* L.** Eastern Figwort. Low, damp forest along road to abandoned quarry just ESE of Thoroughfare Gap. Infrequent or rare.

***Verbascum blattaria* L.** Moth Mullein. Fields, roadsides, and other disturbed habitats. Naturalized exotic.

Verbascum phlomoides* L.* Orange Mullein. Rocky banks and cinders along railroad just W of Thoroughfare Gap (G.P. Fleming 15265). Naturalized exotic.

***Verbascum thapsus* L.** Great Mullein. Fields and other dry, weedy open habitats; a spontaneous weed in exposed soil around tip-up mounds on wooded slopes. Frequent (1 plot). Naturalized exotic.

***Veronica anagallis-aquatica* L.** Water Speedwell. Collected by Allard "in mud and water along railroad just above Beverley Mill" in Thoroughfare Gap; the only record in the area. Naturalized exotic.

***Veronica arvensis* L.** Corn Speedwell. Fields, roadsides, lawns, and clearings. Common. Naturalized exotic.

***Veronica officinalis* L.** Common Speedwell. Fields, roadsides, and open forests. Frequent.

***Veronica peregrina* L.** Purslane Speedwell. Collected by Allard and Fosberg; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Veronica serpyllifolia* L.** Thyme-Leaved Speedwell. Fields, roadsides, lawns, and disturbed secondary forests. Frequent. Naturalized exotic.

***Veronicastrum virginicum* (L.) Farw.** Culver's-Root. A single collection by Allard in an old pasture on the western slope, 6.4 to 8 km (4 to 5 mi) S of Aldie. Rare.

SIMAROUBACEAE. QUASSIA-WOOD FAMILY

***Ailanthus altissima* (Mill.) Swing.** Tree-of-Heaven. Roadsides, fencerows, old quarries, and other disturbed habitats; seedlings become established temporarily but repeatedly on wooded slopes (see p. 179). Frequent (3 plots). Naturalized exotic.

SOLANACEAE. NIGHTSHADE FAMILY

***Datura stramonium* L.** Jimsonweed. Collected by Allard; a weed of cultivated and freshly disturbed soils. Naturalized exotic.

***Lycium barbarum* L.** Matrimony Vine. *Lycium halimifolium* Mill. Collected by Allard at old house sites N of Hopewell Gap and S of Aldie; persisting and spread from cultivation. Naturalized exotic.

***Physalis heterophylla* Nees.** Clammy Ground-Cherry. Incl. *Physalis heterophylla* var. *ambigua* (A. Gray) Rydb. Old fields and open forests. Very infrequent.

***Physalis longifolia* Nutt. var. *subglabrata* (Mackenz. & Bush) Cronq.** Smooth Ground-Cherry. *Physalis subglabrata* Mackenz. & Bush. Collected by Allard; a native weed of fields and cultivated soil. Apparently very infrequent.

***Physalis philadelphica* Lam. var. *immaculata* Waterfall.** Mexican Ground-Cherry. *Physalis ixocarpa* Brot. Reported by Allard and Leonard (1943) from an old field on the western slope below High Point; a cultivated escape. No specimens at US. Adventive exotic.

***Physalis virginiana* Mill. var. *virginiana*.** Virginia Ground-Cherry. *Physalis lanceolata* Michx. On dry, fertile wooded slopes and wood road banks. Infrequent (1 plot).

***Solanum carolinense* L.** Horse-Nettle. Fields, roadsides, and cultivated soils. Frequent.

***Solanum dulcamara* L. var. *dulcamara*.** Climbing Nightshade. Collected by Allard near an old house site in Jackson Hollow, probably escaped from cultivation. Naturalized exotic.

***Solanum ptychanthum* Dunal.** Eastern Black Nightshade. *Solanum nigrum* L. of Allard and Leonard (1943). Along wood roads and areas heavily disturbed by gypsy moth on fertile wooded slopes. Infrequent.

STAPHYLEACEAE. BLADDERNUT FAMILY

***Staphylea trifolia* L.** Bladdernut. Moist, fertile forests; bluffs and floodplains along Broad Run; rocky slope at N end of the Pond Mountains; and alluvial banks of the Little River just S of Aldie. Infrequent, locally abundant (2 plots).

TILIACEAE. LINDEN FAMILY

Tilia americana* L. var. *americana*.* American Basswood. Numerous trees in wooded, bouldery stream bottom along Catharpin Creek in Jackson Hollow, downstream from Rt. 629 (G.P. Fleming 14446). Not known elsewhere in the Bull Run Mountains (1 plot).

ULMACEAE. ELM FAMILY

***Celtis occidentalis* L.** Common Hackberry. Incl. *Celtis occidentalis* var. *canina* (Raf.) Sarg. and *C. occidentalis* var. *crassifolia* (Lam.) A.Gray. A tree in fencerows, disturbed secondary forests, and floodplains; seedlings and saplings are scattered on moist or fertile wooded slopes. Frequent (2 plots).

***Ulmus americana* L.** American Elm. In seepage swamps, floodplains, and low secondary forests. Infrequent (2 plots). See comments concerning Dutch Elm Disease under *Ulmus rubra* below.

Ulmus parvifolia* Jacq.* Chinese Elm. Escaped from cultivation into roadside thickets in Thoroughfare Gap, E of Beverley Mill (G.P. Fleming 15266). Naturalized exotic.

***Ulmus rubra* Muhl.** Slippery Elm. On moist to dry, fertile wooded slopes and sheltered boulderfields. Frequent (9 plots). Although seedlings and saplings are often encountered, few trees of this species have been seen here recently, presumably because of mortality from Dutch Elm Disease (*Ceratocycstis ulmi*). In the Watery Mountains, 12 km SW of the study area, the most abundant die-off of elm trees occurred in the 1970's (personal observation).

URTICACEAE. NETTLE FAMILY

***Boehmeria cylindrica* (L.) Sw.** False Nettle. Incl. *Boehmeria cylindrica* var. *drummondiana* Wedd. Seepage swamps, wet clearings, and floodplains. Frequent (9 plots).

***Laportea canadensis* (L.) Wedd.** Wood Nettle. Moist wooded stream bottoms along Catharpin Creek and tributaries in Jackson Hollow, where locally common. Infrequent.

***Parietaria pensylvanica* Muhl. *ex* Willd.** Pennsylvania Pellitory. Moist, fertile, rocky wooded slope on E flank of High Acre Ridge, and on Triassic conglomerate bluff along Broad Run 1.2 km (0.75 mi) SE of Thoroughfare Gap at E foot of the Pond Mountains; also collected by F.R. Fosberg at Roland Farm, W slope of High Point Mountain. Infrequent.

***Pilea pumila* (L.) Gray var. *pumila*.** Clearweed. Seepage swamps, moist wooded slopes, and floodplains. Frequent (4 plots).

VERBENACEAE. VERBENA FAMILY

***Phryma leptostachya* L.** Lopseed. On moist or dry, fertile wooded slopes; strongly associated with the basic mesic forest and basic oak-hickory forest community types. Frequent (12 plots). Often top-grazed by deer.

***Verbena hastata* L. var. *hastata*.** Blue Vervain. Collected by Allard only from the open floodplain of Broad Run near Broad Run Station. Local, infrequent or rare.

***Verbena simplex* Lehm.** Narrow-Leaved Vervain. Several collections by Allard; a species of dry, usually basic soils in open habitats. Infrequent.

***Verbena urticifolia* L.** White Vervain. Fields, clearings, floodplains, and moist open forests. Frequent.

VIOLACEAE. VIOLET FAMILY

Allard and Leonard (1943) reported two putative hybrids: *Viola sagittata* var. *ovata* x *sororia* and *Viola triloba* var. *triloba* x *sagittata* var. *sagittata* or *hirsutula*.

***Viola bicolor* Pursh.** Field Pansy. *Viola kitaibeliana* Roemer & Schultes var. *rafinesquii* (Greene) Fern. Dry fields, clearings, and road banks. Probably frequent.

Viola blanda* Willd. var. *blanda*.* Sweet White Violet. Damp wooded stream bottom along Catletts Branch, NW of Thoroughfare Gap (G.P. Fleming, field observation). Very infrequent to rare (1 plot).

***Viola cucullata* Ait.** Marsh Blue Violet. Seepage swamps, wet clearings, floodplains. Frequent to locally abundant (12 plots).

Viola hirsutula* Brainerd.* Southern Wood Violet. Wooded slope of ravine at W foot of High Acre Ridge (G.P. Fleming, field observation). Infrequent or rare (1 plot).

***Viola pedata* L.** Bird's-Foot Violet. Incl. *Viola pedata* var. *lineariloba* DC. Dry, sterile soil of powerline clearings, road banks, and openly wooded ridge crests. Frequent.

Viola pubescens **Ait. var. *pubescens*.** Downy Yellow Violet. Incl. *Viola pensylvanica* Michx. On moist, fertile wooded slopes; in basic mesic forests. Infrequent (1 plot).

Viola pubescens **Ait. var. *scabriuscula* Schwein. *ex* Torr. & Gray.** Smooth Yellow Violet. *Viola pensylvanica* var. *leiocarpa* Fern. & Wieg. Collected by Allard from a "rich wooded slope 2 miles north of Hopewell Gap."

Viola sagittata **Ait. var. *sagittata*.** Arrow-Leaved Violet. Sterile, exposed soils of dry, thinly wooded slopes, ridge crests, and powerline clearings. Infrequent (1 plot).

Viola sagittata **Ait. var. *ovata* (Nutt.) Torr. & Gray.** Northern Downy Violet. Dry, openly wooded slopes and clearings. Frequent.

Viola septentrionalis **Greene.** Northern Blue Violet. Collected by Allard from "thinly wooded hillside on west slope of Pond Mountain about 1 mile south of Thoroughfare Gap." Under *V. sororia* at US.

Viola sororia **Willd.** Common Blue Violet. Incl. *Viola papilionacea* Pursh. Moist or fertile wooded slopes, disturbed secondary forests, clearings, and weedy habitats. Common (14 plots).

Viola triloba **Schwein. var. *dilitata* (Ell.) Brainerd.** One collection by Allard from the "Harris Place," near White Rock Spring in Jackson Hollow; it is uncertain whether three additional collections from "north of Antioch" are actually from the mountain slopes or from the Culpeper Basin. Evidently an infrequent to rare taxon here; more common in base-rich soils of the Piedmont lowlands.

Viola triloba **Schwein. var. *triloba*.** Three-Lobed Violet. On moist or dry, fertile wooded slopes; mostly associated with the basic mesic forest and basic oak-hickory forest community types. Frequent (8 plots).

VISCACEAE. CHRISTMAS MISTLETOE FAMILY

Phoradendron leucarpum **(Raf.) Reveal & M.C. Johnston.** American Mistletoe. *Phoradendron flavescens* (Pursh.) Nutt. On *Quercus rubra* var. *rubra* (northern red oak) and *Acer rubrum* (red maple) along Rt. 600 at E foot of the Pond Mountains; numerous clumps on a large *Ulmus americana* (American elm) opposite the Mountain House in Thoroughfare Gap; Allard and Leonard (1943) reported a single staminate plant on *Acer rubrum* just N of Hopewell Gap. Very infrequent to rare in this area. Mistletoe is much more common and characteristic of the Coastal Plain in Virginia.

VITACEAE. GRAPE FAMILY

Ampelopsis brevipedunculata **(Maxim.) Trautv.** Amur Peppervine. A single collection by Allard from "along old wood road in Jackson Hollow 2½ mi. north of Hopewell Gap;" the only record from the area. Naturalized exotic.

Parthenocissus quinquefolia **(L.) Planch.** Virginia Creeper. On moist to dry wooded slopes, boulderfields, cliffs, and outcrops. Common (42 plots).

Vitis aestivalis **Michx. var. *aestivalis*.** Summer Grape. On dry wooded slopes, cliffs, and outcrops. Frequent (7 plots).

Vitis aestivalis **Michx. var. *bicolor* Deam.** Silverleaf Grape. *Vitis aestivalis* var. *argentifolia* (Muns.) Fern. On dry wooded slopes and boulderfields throughout. Common (15 plots).

Vitis cinerea **(Engelm.) Millard var. *floridana* Munson.** Graybark Grape. Collected twice by Allard: "in valley on west slope 2 miles north of Hopewell Gap" and "south of Thorofare [sic] Gap."

Vitis labrusca **L. Fox Grape.** Incl. *Vitis labrusca* var. *subedentata* Fern. Seepage swamps, wet clearings, and floodplains. Frequent (6 plots).

Vitis vulpina **L.** Winter Grape. Moist or fertile wooded slopes, shaded boulderfields, and floodplain forests. Frequent to common (17 plots).

Lichen Ecology and Distribution in the Bull Run Mountains

Although most of H.A. Allard's published work on the Bull Run Mountains addresses the area's vascular flora, one paper (Allard and Leonard 1944a) presents an annotated list of collections in the lichen family *Cladoniae*. Further examination of a database of Virginia lichen collections at the Smithsonian Institution's U.S. National Herbarium (US) reveals that during the 1930's and 1940's, more than 2200 specimens representing more than 100 species of lichens in various families were collected in the Bull Run Mountains, primarily by Allard. This level of effort in documenting lichens in a relatively small geographic area, with extensive replication and very detailed records of habitat for each specimen, is exceptional in Virginia.

Lichens are ubiquitous in natural areas, but often overlooked. In the Bull Run Mountains, exposed rock surfaces, tree bark, logs and wood debris, and patches of mineral soil are often abundantly covered by a multitude of species. Ecologically, lichens are equally underappreciated, but provide nesting material for many birds and forage for a wide range of animals from mammals to invertebrates. Human cultures have used lichens in medicine, for dyes, as clothing, and even as food. Perhaps most importantly, lichens are pioneering organisms in the early development of soil on bare rock and decaying wood and in the replenishment and stabilization of soil following erosion (Purvis 2000). Soil-inhabiting lichens also contribute heavily to the general nitrogen cycle, which benefits higher plants.

Although they are often informally grouped with mosses and liverworts as cryptograms or non-vascular plants, lichens cannot be neatly classified in any of the conventional categories of plants. A lichen is actually a symbiotic association between a fungus and one or more species of algae or blue-green algae (cyanobacteria) capable of producing food by photosynthesis. While ultimately mutually beneficial, the symbiosis in most lichens is complex, to some extent involving an invasion of the photosynthetic partner, or photobiont, by the fungal partner. The relationship varies from mild parasitism to rampant disease, but in all cases reproduction of the photobiont cells exceeds their destruction, ensuring the organism's survival. On the other hand, the enveloping fungus provides the photobiont with a protective habitat and moisture supply, while some carbohydrates produced by the photobiont are absorbed by the fungus.

As a convenience to aid identification, lichen species are often divided into several groups based on their growth strategies (Plates 21-24). These groups are quite distinctive but not based on genetic relationships:

- **crustose lichens** adhere closely to, and are difficult or impossible to separate from, a substrate; crustose lichens abundantly cover most exposed rock outcrops.

- **foliose lichens** typically lie flush to a substrate, but are removable such that the lower surface is visible; foliose lichens are often attached to rocks and other substrates by numerous fine structures called rhizines;

- **fruticose lichens** grow erect or pendent, with thalli that have no clearly distinguishable upper and lower surfaces; this group includes species that are branched and shrubby, as well as those that form unbranched stalks.

- **umbilicate lichens** are leaf-like and attached to rocks by a single cord; lichens of this group, especially those of the genus *Umbilicaria*, are often referred to as "rock tripes."

In the Bull Run Mountains, lichens inhabit several characteristic substrates, including tree bark, decaying wood, mosses and dead vegetation, rock, and soil. Many species are found entirely or primarily on one of these substrates, although a few are more flexible in their habitat preferences.

Some lichen species are extremely sensitive to airborne pollutants and one of the most important contemporary lichen uses is for monitoring air quality. Lichens readily absorb sulphur dioxide as well as many other chemicals and heavy metals from air and rainwater, which in some cases readily destroys the symbiotic lichen partnership. Because of the range of sensitivities of lichen species to pollutants, comparisons of populations in or near urban areas with populations in more pristine sites of the same region can provide a good indication of air quality differences within a region. Similarly, long-term monitoring of a site's lichen populations can reveal changes in air quality over time. In some instances, the most sensitive species may already be extirpated, as has happened in many industrialized areas (Garcia and Nash 2000).

In order to consolidate available information on lichens of the Bull Run Mountains, an annotated list of all lichens collected historically has been compiled, updated to contemporary nomenclatural standards, and supplemented with additional records based on collections by DCR-DNH ecologist Dean P. Walton in 2001. Additional inventory of lichens, especially of crustose taxa, is likely to result in many additions to the list. On the other hand, more detailed inventory could also reveal that some species found historically in this area are no longer extant. The recently published book *Lichens of North America* (Brodo *et al*. 2001), which is lavishly illustrated with spectacular photographs, is highly recommended as an accessible resource to aid the study and appreciation of lichens. Most (89 out of 112) species recorded from the study area are treated and illustrated by this book.

Lichens are important components of several ecological communities treated in the first section of this report, especially the Low-Elevation Boulderfield Forest/Woodland (p. 92), the Table-Mountain Pine-Oak/Heath Woodland (p. 139), and Piedmont/Mountain Acidic Cliff (p.162), where they are the dominant biota (Plate 25). The assemblage of lichens at High Point cliffs, in particular, is extraordinary for the Piedmont. *Lasallia pensylvanica* (blackened toadskin), a species usually found at higher elevations in Virginia, is the dominant lichen in the community, which also contains several other regionally uncommon species, *e.g*., *Umbilicaria muhlenbergii* (plated rock tripe), *Cladina rangiferina* (gray reindeer lichen), *Melanelia culbersonii* (Appalachian camouflage lichen; rare in Virginia), and *Usnea amblyoclada* (rock beard lichen).

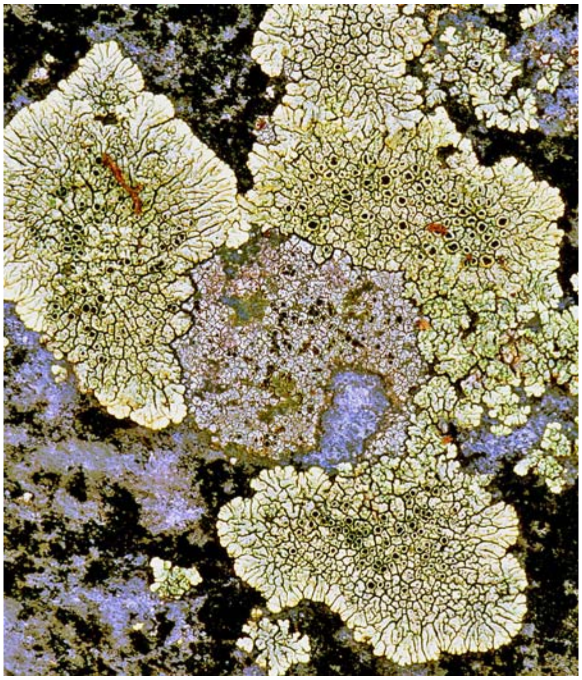


Plate 21. **Crustose Lichen**: *Dimelaena oreina* (golden moonglow lichen). Photo © Gary P. Fleming.

Plate 22. **Foliose Lichen**: *Flavoparmelia baltimorensis* (rock greenshield lichen). Photo © Gary P. Fleming.

Plate 23. **Fruticose Lichen**: *Cladonia cristatella* (British soldiers). Photo © Gary P. Fleming.

Plate 24. **Umbilicate Lichen**: *Umbilicaria mamulata* (smooth rock tripe). Photo © Gary P. Fleming.

Plate 25. **Piedmont/Mountain Acidic Cliff** community at High Point cliffs. Dominated by the umbilicate lichen *Lasallia pensylvanica* (blackened toadskin). Photo © Gary P. Fleming.

ANNOTATED LIST OF
LICHENS OF THE BULL RUN MOUNTAINS, VIRGINIA

In the following treatment, 112 lichens that have been collected in the Bull Run Mountains are listed alphabetically by genera and species. Nomenclature follows Esslinger (1997). Synonymy with Allard and Leonard (1944a, 1952) and with names on specimen labels at US is provided. Common names, when available, follow Brodo *et al*. (2001). Habitat descriptions are synthesized from specimen labels, annotations in Allard and Leonard (1944a, 1952), and in some cases from field observations by DCR-DNH ecologists. Collections made in July 2001 by DCR-DNH ecologist Dean P. Walton and representing new records for the Bull Run Mountains are so indicated; otherwise statements about collections refer to those made by H.A. Allard, and to a much lesser extent E.C. Leonard, in the 1930's and 1940's. Refer to Brodo *et al.* (2001) for detailed descriptions, range maps, and superb photographs of most of the listed taxa.

The status of five species allegedly represented by specimens at US needs further investigation and these taxa are not included in the following list: *Cladonia borbonica* (not listed in Esslinger 1997), *Cladonia scoparius* (not listed in Esslinger 1997), *Cladonia vulcanica* (not known to be present in North America), *Ochrolechia pallescens* (not known to be present in North America), and *Xanthoparmelia isidiigera* (not listed in Esslinger 1997). Two putative specimens of *Sticta weigellii*, also unknown from North America, probably represent misidentifications of *S. beauvoisii*, since they were collected from the same locality. A specimen misidentified as *Nephroma laevigatum* Ach., a boreal, maritime lichen, is probably *Peltigera canina* (L.) Willd. (P. Depriest, US, pers. comm.). Another specimen, originally labeled *Ramalina farinacea* (L.) Ach. and redetermined as *Cetraria cucullata* (Bellardi) Ach. (=*Flavocetraria cucullata* (Bellardi) Kärnefelt & Thell), was almost certainly misidentified, as both *Ramalina farinacea* and *Flavocetraria cucullata* are boreal lichens not mapped south of New York and New England by Brodo *et al*. (2001).

***Allocetraria oakesiana* (Tuck.) Randlane & Thell.** Yellow Ribbon Lichen. *Tuckermannopsis oakesiana* (Tuck.) Hale. On bark of *Quercus rubra* var. *rubra* (northern red oak) and *Kalmia latifolia* (mountain-laurel), old chestnut rail fences, and other wood; seven collections.

***Anaptychia palmulata* (Michx.) Vainio.** Shaggy-Fringe Lichen. Mostly on bark of *Quercus montana* (chestnut oak), *Carya* spp. (hickory), *Pinus* spp. (pine); occasionally on rocks; many collections.

***Bacidia schweinitzii* (Fr. *ex* E. Michener) A. Schneider.** Surprise Lichen. On bark of deciduous trees. Collected by D.P. Walton, July 2001.

***Bacidia trachona* (Ach.) Lettau.** On soil; grassy meadow N of Hopewell Gap; one collection.

***Bryoria furcellata* (Fr.) Brodo & D. Hawksw.** Burred Horsehair Lichen. On rocks, High Point Mountain; one collection. The typical habitat of this species is reported to be conifer branches, not rocks (Brodo *et al*. 2001).

***Caloplaca microphyllina* (Tuck.) Hasse.** On bark of *Carya* spp. (hickory), *Quercus montana* (chestnut oak), and *Juniperus virginiana* var. *virginiana* (eastern red cedar); many collections.

***Candelariella efflorescens* R.C. Harris & B.C. Buck.** Powdery Goldspeck Lichen. On bark of deciduous trees. Collected by D.P. Walton, July 2001.

***Canoparmelia caroliniana* (Nyl.) Elix & Hale.** Carolina Shield Lichen. Wooded slope below High Point; one collection. Although the specimen label does not specify a habitat, this species typically occurs on tree bark substrates.

***Cladina arbuscula* (Wallr.) Hale and Culb.** Reindeer Lichen. *Cladonia sylvatica* (L.) Hoffm. On dry, sterile soils of thinly wooded ridge crests and old pastures; nine collections; "more of less abundant" throughout the area (Allard and Leonard 1944a).

***Cladina rangiferina* (L.) Nyl.** Gray Reindeer Lichen. *Cladonia rangiferina* (L.) Web. On dry, sterile soils of thinly wooded ridge crests and high, exposed outcrop shelves, *e.g*., at High Point cliffs. "Uncommon" and occurring in small colonies (Allard and Leonard 1944a).

***Cladina subtenuis* (Abbayes) Hale and Culb.** Dixie Reindeer Lichen. Including *Cladonia tenuis* (Flörke) Harm. of Allard and Leonard (1944a). On dry, thin soils of open oak forests and pine-oak woodlands, outcrop shelves, wood road banks, and old fields; evidently common; Allard and Leonard, singly and together, made more than 100 collections of this species from the Bull Run Mountains.

***Cladonia apodocarpa* Robbins.** Stalkless Cladonia. On exposed soil in open forests and old fields; many collections.

***Cladonia caespiticia* (Pers.) Flörke.** Stubby-Stalked Cladonia. On exposed forest soils, stumps, logs, rock shelves, and outcrops; extensive collections; "widespread," according to Allard and Leonard.

***Cladonia caroliniana* Tuck.** Granite Thorn Cladonia. On bare soil in dry, scrubby oak forest, western slope of Pond Mountain, 3.5 mi. S of Thoroughfare Gap; the only record.

***Cladonia cervicornis* (Ach.) Flotow. ssp. *verticillata* (Hoffm) Ahti.** Ladder Lichen. *Cladonia verticillata* (Hoffm.) Schaerer. Exposed soil, mostly in old fields dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem); also on wood road banks and in dry, open pine-oak woodlands; extensive collections.

***Cladonia chlorophaea* (Flörke *ex* Sommerf.) Spreng.** Mealy Pixie-cup. On soil and humic matter, rotten logs, and stumps in forests, open woodlands, and old fields; many collections; apparently common.

***Cladonia coniocraea* (Flörke) Spreng.** Common Powderhorn. On dead wood, bark, logs, stumps, rock ledges, and exposed soil in dry oak forests and thin pine-oak woodlands; extensive collections; apparently common.

***Cladonia conista* A. Evans.** On exposed soil of a wood road 3.5 mi. S of Aldie and open woods on western slope S of Hopewell Gap; the only records.

***Cladonia cristatella* Tuck.** British Soldiers (Plate 23, p. 254). On exposed soil and dead wood in forests, woodlands, and old fields throughout; Allard and Leonard, singly and together, collected 300 specimens of this species in the Bull Run Mountains.

***Cladonia cryptochlorophaea* Asah.** On exposed soil of oak forests, thin pine-oak woodlands, and outcrop shelves; many collections.

***Cladonia cylindrica* (A. Evans) A. Evans.** On exposed soil and rocks; represented in the Bull Run Mountains by a few scattered collections.

***Cladonia didyma* (Fee) Vainio.** Southern Soldiers. On rotting logs, stumps, other dead wood; many collections.

***Cladonia floerkeana* (Fr.) Flörke.** Gritty British Soldiers. A single collection by E.C. Leonard on a ledge E of White Rock, N of Hopewell Gap.

***Cladonia furcata* (Hudson) Schrader.** Many-Forked Cladonia. On exposed soil in forests and forest edges; represented by a few scattered collections.

***Cladonia grayi* G. Merr. *ex* Sandst.** On exposed soil, moss, rotting wood, and humus-covered rock shelves in oak forests, thin pine-oak woodlands, and old fields dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem); very extensive (> 170) collections made by Allard.

***Cladonia incrassata* Flörke.** Powder-Foot British Soldiers. On soil and rotting wood in forests and thin woodlands; represented by a few scattered collections.

***Cladonia macilenta* Hoffm. var. *macilenta*.** Lipstick Powderhorn. On soil in oak forests, thin pine-oak woodlands, and on cliffs; many collections.

***Cladonia macilenta* Hoffm. var. *bacillaris* (Genth.) Schaerer.** Pin Lichen. *Cladonia bacillaris* Nyl. On dead wood and exposed soil of oak forests and thin pine-oak woodlands; many collections.

***Cladonia mateocyatha* Robbins.** Mixed-Up Pixie-Cup. On woodland soils and rotten wood; represented by a few scattered collections.

***Cladonia ochrochlora* Flörke.** Smooth-Footed Powderhorn. Two collections: thin soil on wooded rock ledge 5 mi S of Aldie and on roadside bank in Thoroughfare Gap. The typical habitat of this species is reported to be decaying wood, rarely soil (Brodo *et al*. 2001).

***Cladonia parasitica* (Hoffm.) Hoffm.** Fence Rail Cladonia. *Cladonia delicata* (Ehrh.) Flörke. On rotting wood; four collections, all on the western slope below High Point cliffs.

***Cladonia peziziformis* (With.) J. R. Laundon.** Turban Lichen. Mostly on soil, occasionally on rotting wood or rocks, in open forests and old fields dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem); extensive collections.

***Cladonia piedmontensis* G. Merr.** Mostly on soil in old fields dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem); occasionally on soil and rotting wood of dry forests and thin pine-oak woodlands; extensive collections.

***Cladonia pleurota* (Flörke) Schaerer.** Red-Fruited Pixie-Cup. On soil of open forests, dry pine-oak woodlands, rock shelves, and old fields dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem); extensive collections.

***Cladonia pyxidata* (L.) Hoffm.** Pebbled Pixie-Cup. A single record on soil in an old field S of Hopewell Gap.

***Cladonia ramulosa* (With.) J.R. Laundon.** On rotting wood and stumps in forests and thin woodlands; represented by relatively few (12) collections.

***Cladonia rappii* A. Evans.** Slender Ladder Lichen. A single locality on soil in "oak-chestnut woods," E slope of High Point ridge, 0.5 mi. S of Hopewell Gap.

***Cladonia sobolescens* Nyl. *ex* Vainio.** Peg Lichen. Mostly on soil among heath shrubs in dry, open chestnut oak forests and thin pine-oak woodlands; occasionally on rocks and in old fields; many collections.

***Cladonia squamosa* Hoffm.** Dragon Cladonia. On thin soil (occasionally on rotting wood) of rock outcrops, wood-road banks, and dry forests or woodlands; a number of collections were made on seeping or seasonally moist rocks; extensive collections.

***Cladonia strepsilis* (Ach.) Grognot.** Olive Cladonia. On soil of dry oak forests, open pine-oak woodlands, and wood road banks; extensive collections.

Cladonia subcariosa Nyl. Peg Lichen. Including *Cladonia polycarpoides* Nyl. On soil of dry oak forests, thin pine-oak woodlands, rock shelves, pastures, and old fields dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem); very extensive collections.

***Cladonia uncialis* (L.) F.H. Wigg.** Thorn Cladonia. On thin soil of cliff shelves and ledges; High Point cliffs and middle ridge N of Hopewell Gap; apparently local.

***Collema auriforme* (With.) Coppins & J.R. Laundon.** On rocks and dead wood, western slope below High Point; three collections.

***Collema callibotrys* Tuck.** On bark of *Quercus montana* (chestnut oak); two collections.

***Collema fuscovirens* (With.) J.R. Laundon.** On rocks; western slope below High Point cliffs; two collections

***Collema limosum* (Ach.) Ach.** On flat rocks in "heavy oak-chestnut woods," western slope S of Hopewell Gap; one collection

***Collema ryssoleum* (Tuck.) A. Schneider.** On flat rocks below High Point cliffs; one collection

***Collema subflacidum* Degel.** True Jelly Lichen. On bark of *Juglans cinerea* (butternut) at base of talus slope below High Point cliffs. Collected by D.P. Walton, July 2001.

***Dermatocarpon luridum* (With.) J.R. Laundon.** Brook Lichen. Wet or submerged rocks along streams; Broad Run, Jackson Hollow; apparently not common

***Dermatocarpon miniatum* (L.) W. Mann.** Common Stippleback. Wet to dry rocks in various habitats; scattered collections. This species is more characteristic of calcareous rocks, especially limestone.

***Dibaeis baeomyces* (L.f.) Rambold & Hertel.** Pink Earth Lichen. *Baeomyces roseus* Pers. On soil of dry forests, wood road banks, and old fields dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem).

***Dimelaena oreina* (Ach.) Norman.** Golden Moonglow Lichen (Plate 21, p. 254). Open and thinly shaded outcrops and boulders throughout; frequent. Collected by D.P. Walton 2001.

***Flavoparmelia baltimorensis* (Gyelnick & Foriss) Hale.** Rock Greenshield Lichen (Plate 22, p. 254). On shaded outcrops and boulders; common.

***Flavoparmelia caperata* (L.) Hale.** Common Greenshield Lichen. On bark of various tree species throughout; common.

***Graphis elegans* (Borrer *ex* Sm.) Ach.** On bark of *Quercus montana* (chestnut oak) in forest below High Point; one collection.

***Graphis scripta* (L.) Ach.** Common Script Lichen. On bark of *Carya ovalis* (red hickory) and *Juglans cinerea* (butternut). Collected by D.P. Walton, July 2001.

***Heterodermia galactophylla* (Tuck.) Culb.** On bark of *Quercus rubra* var. *rubra* (northern red oak), western slope S of Hopewell Gap; one collection.

***Heterodermia hypoleuca* (Muhl.) Trev.** Cupped Fringe Lichen. On bark of *Quercus montana* (chestnut oak), western slope 5 miles S of Aldie, and on old walnut logs near Beverley Mill in Thoroughfare Gap; two collections.

***Heterodermia speciosa* (Wuflen) Trev.** Powdered Fringe Lichen. On bark of *Quercus rubra* var. *rubra* (northern red oak) and *Carya* sp. (hickory); also on "flat rock;" several collections from High Point Mountain.

***Hyperphyscia adglutinata* (Flörke) H. Mayrh & Poelt.** Grainy Shadow-Crust Lichen. On *Carya* sp. (hickory) bark, western slope S of Hopewell Gap; one collection.

***Hypotrachyna livida* (Taylor) Hale.** Wrinkled Loop Lichen. High Point cliffs; one collection. Although the specimen label does not specify a habitat, this species typically occurs on tree bark.

***Imshaugia aleurites* (Ach.) S.F. Meyer.** Salted Starburst Lichen. On bark of *Pinus rigida* (pitch pine), crest of High Point Mountain; apparently common in similar habitats throughout. Collected by D.P. Walton, July 2001.

***Lasallia papulosa* (Ach.) Llano.** Common Toadskin. On shaded to exposed outcrops and boulders on the higher ridges throughout; common.

***Lasallia pensylvanica* (Hoffm) Llano.** Blackened Toadskin. Locally abundant on rocks at High Point cliffs (Plate 25, p. 255) and White Rock (Signal Mountain). In Virginia, this lichen is primarily a species of the higher mountains; its occurrences in the Bull Run Mountains are notable for their low-elevation habitats.

***Lecanora miculata* Ach.** On old *Castanea dentata* (American chestnut) logs, western slope near Aldie; one collection.

***Leproloma membranaceum* (Dickson) Vainio.** *Lepraria membranacea* (Dickson) Vainio. On dead sticks and woodland soil; two collections. The habitats on Allard's specimen labels are atypical for this lichen, which is usually associated with shaded, humid rock outcrops (Brodo *et al.* 2001).

***Leptogium appalachense* Nyl.** On bark of *Quercus rubra* var. *rubra* (northern red oak), middle ridge, 2.4 km (1.5 mi) N of Hopewell Gap; one collection.

***Leptogium chloromelum* (Sw. *ex* Ach.) Nyl.** Ruffled Jellyskin. On *Quercus montana* (chestnut oak) bark and woodland soil; two collections from one locality.

***Leptogium corticola* (Taylor) Tuck.** Blistered Jellyskin. On *Quercus montana* (chestnut oak) bark; one collection.

***Leptogium cyanescens* (Rabenh.) Korber.** Blue Jellyskin. On bark of *Quercus rubra* var. *rubra* (northern red oak), middle ridge, 2.4 km (1.5 mi) N of Hopewell Gap; one collection.

***Lobaria pulmonaria* (L.) Hoffm.** Lungwort. On bark of *Quercus rubra* var. *rubra* (northern red oak), middle ridge, 2.4 km (1.5 mi) N of Hopewell Gap; two collections.

***Melanelia culbersonii* (Hale) Thell.** Appalachian Camouflage Lichen. On exposed rocks near base of High Point cliffs; one collection (Walton 2001); considered a rare lichen in Virginia, and perhaps globally (G2G4S2?; Townsend 2002).

***Myelochroa aurulenta* (Tuck.) Elix & Hale.** Powdery Axil-Bristle Lichen. Mostly on shaded rocks, but one collection from *Carya* sp. (hickory) bark; High Point Mountain, Pond Mountain, Hopewell Gap; six collections.

***Myelochroa galbina* (Ach.) Elix & Hale.** Smooth Axil-Bristle Lichen. On bark of *Quercus montana* (chestnut oak) and *Sassafras albidum* (sassafras); three collections.

***Normandina pulchella* (Borrer) Nyl.** Elf-Ear Lichen. On *Quercus montana* (chestnut oak) bark, western slope S of Hopewell Gap; one collection. This species is reported to grow commonly on other lichens and mosses (Brodo *et al*. 2001).

***Parmelia saxatilis* (L.) Hale.** Salted Shield Lichen. Mostly on bark of *Quercus montana* (chestnut oak) and *Quercus rubra* var. *rubra* (northern red oak), but one collection from soil of exposed rock shelf; six collections.

***Parmelia squarrosa* Hale.** Bottlebrush Shield Lichen. On "wood", High Point cliffs; one collection. This species typically grows on tree bark or mossy rocks.

***Parmelina quercina* (Willd.) Hale.** Fringed Shield Lichen. On bark of *Quercus rubra* var. *rubra* (northern red oak), *Sassafras albidum* (sassafras), and other unspecified trees; also on old *Juglans nigra* (black walnut) logs near Beverley Mill in Thoroughfare Gap; several collections.

***Parmotrema chinense* (Osbeck) Hale and Ahti.** Powdered Ruffle Lichen. On rocks, western slope below High Point; one collection.

***Parmotrema perforatum* (Jacq.) A. Massal.** Perforated Ruffle Lichen. On bark of *Prunus serotina* var. *serotina* (black cherry), White Rock ridge (Signal Mountain) 2 mi. N of Hopewell Gap, and on old *Juglans nigra* (black walnut) logs near Beverley Mill in Thoroughfare Gap; two collections.

***Peltigera canina* (L.) Willd.** Dog-Lichen. On shaded, often damp woodland soil and rocks; apparently frequent. A specimen originally determined as *Nephroma laevigatum* Ach. (Mustard Kidney Lichen), collected from thin soil on a rock outcrop, ridge E of High Point, is probably this species (P. Depriest, US, pers. comm.). *Nephroma laevigatum* is a boreal, maritime lichen not mapped S of coastal Maine (Brodo *et al*. 2001).

***Peltigera polydactylon* (Necker) Hoffm.** Many-Fruited Pelt. On woodland soil and rocks; seven collections. Determinations of these specimens need critical evaluation, since this species is not mapped in Virginia (Brodo *et al.* 2001).

***Peltigera rufescens* (Weiss) Humb.** Field Dog-Lichen. On soil in forests and pastures; 12 collections.

***Pertusaria pustulata* (Ach.) Duby.** On soil in "oak-chestnut woods," eastern slope near High Point; one collection.

***Pertusaria velata* (Turner) Nyl.** Rimmed Wart Lichen. On *Quercus montana* (chestnut oak) bark, High Point cliffs; one collection.

***Phaeophyscia adiastola* (Essl.) Essl.** Powder-Tipped Shadow Lichen. On base of *Quercus montana*, western slope of High Point Mountain below cliffs. Collected by D.P. Walton, July 2001.

***Phaeophyscia ciliata* (Hoffm.) Moberg.** Smooth Shadow Lichen. On *Carya* sp. (hickory) bark and "rock in woods;" two collections on western slope.

***Phaeophyscia orbicularis* (Necker) Moberg.** Mealy Shadow Lichen. On *Carya* sp. (hickory) bark, western slope S of Hopewell Gap; three collections from one locality.

***Phaeophyscia pusilloides* (Zahlbr.) Essl.** Pompon Shadow Lichen. On *Carya* sp. (hickory) bark, Pond Mountain, and "at base of small tree," S of Hopewell Gap; two collections.

***Phaeophyscia rubropulchra* (Degel.) Essl.** Orange-Colored Shadow Lichen. On bark of *Carya* sp. (hickory), *Quercus montana* (chestnut oak), and other unspecified trees; eight collections.

***Physcia aipolia* (Ehrh. *ex* Humb.) Fürnr.** Hoary Rosette Lichen. On *Carya* sp. (hickory) bark, western slope S of Hopewell Gap; one collection. The specimen needs critical examination to determine varietal status.

Physcia millegrana Degel. Mealy Rosette Lichen. On bark of *Juniperus virginiana* var. *virginiana* (eastern red cedar) in fields and woods, western slope below High Point; one collection.

***Physcia stellaris* (L.) Nyl.** Star Rosette Lichen. On *Diospyros virginiana* (persimmon) bark in old pasture, western slope below High Point; one collection.

***Physcia subtilis* Degel.** Slender Rosette Lichen. On quartzite. Collected by D.P. Walton, July 2001.

***Porpidia albocaerulescens* (Wilfen) Hertel & Knoph.** Smoky-Eye Boulder Lichen. On quartzite boulder, E slope of High Point Mountain along old road. Collected by D.P. Walton, July 2001.

***Punctelia rudecta* (Ach.) Krog.** Rough Speckled Shield Lichen. On bark of *Carya* spp. (hickory), *Quercus rubra* var. *rubra* (northern red oak), *Juniperus virginiana* var. *virginiana* (eastern red cedar), *Prunus serotina* var. *serotina* (black cherry), and *Fraxinus americana* (white ash); also on logs, stumps, and rock; many collections.

***Punctelia subrudecta* (Ach.) Krog.** Powdered Speckled Shield Lichen. On bark of various tree species throughout; common. Collected by D.P. Walton, July 2001.

***Pycnothelia papillaria* Dufour.** Nipple Lichen. On dry, thin soils of oak forests and pine-oak woodlands throughout; also in old fields dominated by *Schizachyrium scoparium* var. *scoparium* (little bluestem); many collections.

***Pyxine sorediata* (Ach.) Mont.** Mustard Lichen. On bark of *Quercus montana* (chestnut oak), *Nyssa sylvatica* (black gum), and other unspecified trees; also on logs and stumps; nine collections.

***Ramalina intermedia* (Delise *ex* Nyl.) Nyl.** Rock Ramalina. On exposed outcrop ledge at White Rock; two collections from one station.

***Rimelia reticulata* (Taylor) Hale & Fletcher.** High Point cliffs; one collection. Although the specimen label does not specify a habitat, this species typically grows on tree bark.

***Sticta beauvoisii* Delise.** Fringed Moon Lichen. Rocks in forest, western slope below High Point; one collection. Two specimens labeled *Sticta weigelii* (Ach.) Vainio, a species not known to occur in North America, are probably this species since they were collected from the same locality.

***Tuckermannopsis ciliaris* (Ach.) Gyelnik.** On "wood," S of Hopewell Gap; one collection.

***Umbilicaria mamulata* (Ach.) Tuck.** Smooth Rock Tripe (Plate 24, p. 254). Dry, shaded cliffs, outcrops, and boulders on the higher ridges throughout.

***Umbilicaria muhlenbergii* (Ach.) Tuck.** Plated Rock Tripe. Exposed rocks at High Point cliffs. Collected by D.P. Walton 2001.

***Usnea amblyoclada* (Müll. Arg.) Zahlbra (Clerc & Herrera-Campos 1997).** Rock Beard Lichen. On quartzite talus below High Point cliffs. Collected by D.P. Walton, July 2001.

***Usnea florida* (L.) F.H. Wigg.** On rocks, western slope near High Point; one collection.

***Usnea pensylvanica* Mot.** On vertical rock face at White Rock; one collection.

***Usnea subfusca* Stirton.** On cliffs, ridge N of Thoroughfare Gap; one collection.

***Xanthoparmelia angustiphylla* (Gyelnick) Hale.** On rock; one collection.

***Xanthoparmelia conspersa* (Ehrh. *ex* Ach.) Hale.** Peppered Rock-Shield. Open and thinly shaded outcrops and boulders throughout. Common.

***Xanthoparmelia somloensis* (Gyelnick) Hale.** Shingled Rock-Shield. On rock; one collection.

LITERATURE CITED

Abbott Associates. 1972. Preliminary master plan for Bull Run Mountains State Park. Unpublished report and maps prepared for the Virginia Department of Conservation and Economic Development.

Abrams, M.D. 1992. Fire and the development of oak forests. BioScience 42: 346-353.

Abrams, M.D. 1998. The red maple paradox. BioScience 48: 355-364.

Abrams, M. D. and C.A. Copenheaver. 1999. Temporal variation in species recruitment and dendroecology of an old-growth white oak forest in the Virginia Piedmont, USA. Forest Ecol. and Managem. 124: 275-284.

Abrams, M.D. and J.A. Downs. 1990. Successional replacement of old-growth white oak by mixed mesophytic hardwoods in southwestern Pennsylvania. Can. J. For. Res. 20: 1864-1870.

Abrams, M.D. and G.J. Nowacki. 1992. Historical variation in fire, oak recruitment, and post-logging accelerated succession in central Pennsylvania. Bull. Torrey Bot. Club 119: 19-28.

Abrams, M.D., D.A. Orwig, and M.J. Dockry. 1997. Dendroecology and successional status of two contrasting old-growth oak forests in the Blue Ridge Mountains, U.S.A. Can. J. For. Res. 27: 994-1002.

Abrams, M.D., C.M. Ruffner, and T.E. DeMeo. 1998. Dendroecology and species co-existence in an old-growth *Quercus-Acer-Tilia* talus slope forest in the central Appalachians, USA. For. Ecol. and Managem. 106: 9-18.

Adams, H.S. and S.L. Stephenson. 1991. A description of the vegetation on the south slopes of Peters Mountain, southwestern Virginia. Bull. Torrey Bot. Club 110: 18-22.

Allard, H.A. 1940. *Sedum telephium* L. in the Bull Run Mountain area, Virginia. Castanea 5: 17-19.

Allard, H.A. 1942. Lack of available phosphorus preventing normal succession on small areas on Bull Run Mountain in Virginia. Ecology 23: 345-353.

Allard, H.A. 1944a. An analysis of the flora of the Bull Run Mountain region of Virginia using Raunkiaer's "life-form" method. J. Washington Acad. Sciences 34: 112-119.

Allard, H.A. 1944b. *Fraxinus nigra* in the District of Columbia and in Virginia. Castanea 10: 82-87.

Allard, H.A. 1961. The Bull Run Mountains. Potomac Appalachian Trail Club Bulletin 1:3-10.

Allard, H.A. and E.C. Leonard. 1943. The vegetation and floristics of Bull Run Mountain, Virginia. Castanea 8: 1-64.

Allard, H.A. and E.C. Leonard. 1944a. The *Cladoniae* of Bull Run Mountain, Virginia. Castanea 9: 81-100.

Allard, H.A. and E.C. Leonard. 1944b. Additions to the Flora of Bull Run Mountain, Virginia. Castanea 9: 130-134.

Allard, H.A. and E.C. Leonard. 1952. The vegetation and floristics of Bull Run Mountain, Virginia. Castanea 17: 145-153.

Anderson, R.L. 1996. Butternut canker. Proceedings of the Southern Appalachian Biological Control Initiative, Sept. 26-27, 1996. Asheville, N.C. USGS Biological Resource Division and the Southern Appalachian Man and Biosphere Project. 4 pp.

Anderson, R.L., J.L. Knighten, M. Windham, K. Langdon, F. Hedrix, and R. Roncardori. 1993. Dogwood anthracnose and its spread in the south. USDA Forest Service Southern Region, Forest Health Protection, Atlanta, GA. 13 pp.

Andreadis, T.G. and R.M. Weseloh. 1990. Discovery of *Entomophaga maimaiga* in North American gypsy moth, *Lymantria dispar*. Proc. Natl. Acad. Sci. USA 87: 2461-2465.

Balgooyen, C.P. and D.W. Waller. 1995. The use of *Clintonia borealis* and other indicators to gauge impacts of white-tailed deer on plant communities in northern Wisconsin, USA. Natural Areas Journal 15: 308-318.

Barbour, MG., J.H. Burk, and W.D. Pitts. 1987. Terrestrial plant ecology. The Benjamin/Cummings Publishing Co., Inc., Menlo Park, CA. 634 pp.

Barden, L.S. 1979. Serotiny and seed viability of *Pinus pungens* in the southern Appalachians. Castanea 44: 44-47.

Beals, E.W. 1984. Bray-Curtis ordination: an effective strategy for analysis of multivariate ecological data. Advances in Ecological Research 14: 1-55.

Beers, T.W., P.E. Dress, and L.C. Wensel. 1966. Aspect transformation in site productivity research. Journal of Forestry 64: 691-692.

Bleil, D.F. and G.B. Shea. Field study of Bull Run Mountain Natural Area for designation as a potential National Landmark. Unpublished report submitted to National Landmarks Program office, Philadelphia, PA by Western Eco-Systems Technology, Inc., Laurel, Maryland.

Braun, E.L. 1950. Deciduous forests of eastern North America. Macmillan Publishing Co., New York. 596 pp.

Bray, J.R. and J.T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecological Monographs 27: 325-349.

Brodo, I.M., S.D. Sharnoff, and S. Sharnoff. 2001. Lichens of North America. Yale University Press, New Haven. 795 pp.

Brown, H. 2000. Wildland burning by American Indians in Virginia. Fire Management Today 60:3. USDA Forest Service, Washington, D.C.

Buckner, E. and W. McCracken. 1978. Yellow-poplar: a component of climax forests? J. Forestry 76: 421-423.

Busing, R.T. 1995. Disturbance and population dynamics of *Liriodendron tulipifera*: simulations with a spatial model of forest succession. Journal of Ecology 83: 4.

Canham, C.D. 1990. Suppression and release during canopy recruitment in *Fagus grandifolia*. Bull. Torrey Bot. Club 117: 1-7.

Clarkson, R.B. 1964. Tumult on the mountains: lumbering in West Virginia – 1770-1920. McClain Printing Co., Parsons, WVA. 410 pp.

Cole, A.M. and S.A. Ware. 1997. Forest vegetation, edaphic factors, and successional direction in the central Piedmont of Virginia. Castanea 62: 100-111.

Commission on Outdoor Recreation of the Commonwealth of Virginia. 1979. Virginia Outdoor Plan. Unpublished report.

Coulling, P.P. 1999. Eastern hemlock inventory and assessment for Prince William Forest Park, Virginia. Nat. Heritage Tech. Rep. 99-08. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. 68 pp. plus appendices.

Coulling, P.P. and T.J. Rawinski. 1999. Classification of vegetation and ecological land units of the Piney River and Mt. Pleasant Area, Pedlar Ranger District, George Washington and Jefferson National Forests, Virginia. Nat. Heritage Tech. Rep. 99-03, Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond. 135 pp. plus appendices.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service. FWS/OBS-79/31. 103 pp.

Craig, A.J. 1969. Vegetational history of the Shenandoah Valley, Virginia. Geological Society of America Special Paper 123: 283-296.

Curtis, J.T. 1959. The vegetation of Wisconsin: an ordination of plant communities. University of Wisconsin Press, Madison, WI. 657 pp.

Davis, M.B. 1993. Old growth in the east: a survey. The Cenezoic Society, Richmond, Vermont.

Day, E. 1996. Hemlock woolly adelgid. Entomology Publication 444-244, Virginia Cooperative Extension. Virginia Tech, Blacksburg, VA. 2 pp.

Day, E. 1997. Southern pine beetle: *Dendroctonus frontalis* Zimmerman (*Coleoptera*: *Scolytidae*). Entomology Publication 444-243, Virginia Cooperative Extension. Virginia Tech, Blacksburg, VA. 4 pp.

Delcourt, P.A. and H.R. Delcourt. 1993. Paleoclimates, paleovegetation, and paleofloras during the late Quaternary. Pages 71-94 in Flora of North America. Volume 1. Introduction. Oxford University Press, New York.

Dierauf, T., J. Artman, J. R. Elkins, S. L. Griffin and G. J. Griffin. 1997. High level of chestnut blight control on grafted American chestnut trees inoculated with hypovirulent strains. J. of Arboriculture 23: 87-88.

Dreyer, G.D. 1994. Element stewardship abstract for *Celastrus orbiculatus* Thunb. (*Celastrus articulatus*), Asiatic bittersweet. The Natural Conservancy, Arlington, Virginia. 9 pp.

Earth Design Associates, Inc. 1997. Thoroughfare Gap to Aldie – the Bull Run Mountain Preserve: past, present, future. Unpublished report submitted to the Virginia Outdoors Foundation. 73 pp.

Elder, J.H. 1989. Soil survey of Prince William County, Virginia. U.S.D.A. Soil Conservation Service in cooperation with Virginia Polytechnic Institute and State University. U.S. Government Printing Office, Washington, D.C. 245 pp. plus maps.

Environmental Systems Research Institute, Inc. 1999. ArcView GIS, Version 3.2. ESRI, Redlands, CA.

Environmental Timber Management. 2000. Forest management plan for Montpelier. Unpublished report. 86 pp,

Espenshade, G.H. 1970. Geology of the northern part of the Blue Ridge Anticlinorium. Pages 199-211 *in* Fisher, G.W. *et al.* (eds.). Appalachian geology. Interscience Publishers, New York.

Esslinger, T. L. 1997. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm (First Posted 1 December 1997, Most Recent Update 26 February 2001), Fargo, North Dakota.

Eyre, F.H., ed. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, D.C. 148 pp.

Fauquier County Bicentennial Committee. 1959. Fauquier County, Virginia: 1759-1959. Virginia Publishing, Warrenton, Virginia. 323 pp.

Farrell, J.D. and S. Ware. 1991. Edaphic factors and forest vegetation in the Piedmont of Virginia. Bull. Torrey Bot. Club 118: 161-169.

Fenneman, N.M. 1938. Physiography of the eastern United States. McGraw-Hill Book Company, New York. 714 pp.

Fleming, G.P. 1999. Plant communities of limestone, dolomite, and other calcareous substrates in the George Washington and Jefferson National Forests, Virginia. Nat. Heritage Tech. Rep. 99-4, Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 218 pp. plus appendices.

Fleming, G.P. 2002. Preliminary classification of Piedmont and inner Coastal Plain vegetation types in Virginia. Nat. Heritage Tech. Rep. 02-14. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 28 pp.

Fleming, G.P., A.C. Chazal, K.M. McCoy, and C.S. Hobson. 1999. A Natural Heritage inventory of Virginia Outdoors Foundation properties on Bull Run Mountain, Virginia. Nat. Heritage Tech. Rep. 99-05. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 32 pp. plus appendix.

Fleming, G.P. and P.P. Coulling. 2001. Ecological communities of the George Washington and Jefferson National Forests, Virginia: preliminary classification and description of vegetation types. Nat. Heritage Tech. Rep. 01-14. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 372 pp.

Fleming, G.P. and W.H. Moorhead III. 2000. Plant communities and ecological land units of the Peters Mountain area, James River Ranger District, George Washington and Jefferson National Forests, Virginia. Nat. Heritage Tech. Rep. 00-07, Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond. 195 pp. plus appendices.

Fleming, G.P. and N.E. Van Alstine. 1999. Plant communities and floristic features of sinkhole ponds and seepage wetlands in southeastern Augusta County, Virginia. Banisteria 13: 67-94.

Fleming, G.P., P.P. Coulling, D.P. Walton, K.M McCoy, and M.R. Parrish. 2001. The natural communities of Virginia: classification of ecological community groups. First Approximation. Nat. Heritage Tech. Rep. 01-1. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 76 pp.

Flora of North America Editorial Committee. 1993. Flora of North America. Volume 2. Pteridophytes and gymnosperms. Oxford University Press, New York. 475 pp.

Flora of North America Editorial Committee. 1997. Flora of North America. Volume 3. *Magnoliophyta*: *Magnoliidae* and *Hamamelidae*. Oxford University Press, New York. 590 pp.

Flora of North America Editorial Committee. 2000. Flora of North America. Volume 22. *Magnoliophyta*: *Alismatidae*, *Arecidae*, *Commelinidae* (in part), and *Zingiberidae*. Oxford University Press, New York. 352 pp.

Fowells, H.A., ed. 1965. Silvics of the forest trees of the United States. Agriculture handbook No. 271, USDA Forest Service, Washington, D.C. 762 pp.

Frank, E.C. and R. Lee. 1966. Potential solar beam irradiation on slopes: tables for 30º to 50º latitude. U.S. Forest Service Research Paper RM-18. Rocky Mountain Forest and Range Experiment Station. 116 pp.

Garcia, A.Z. and T.H. Nash III. 2000. Lichen decline in Desierto de los Leones (Mexico City). The Bryologist 103: 428-441.

Gauch, H.G. 1982. Multivariate analysis in community ecology. Cambridge University Press, Cambridge. 298 pp.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and Canada. New York Botanical Garden, Bronx, NY. 910 pp.

Godfrey, M.A. 1980. A Sierra Club naturalist's guide to the Piedmont. Sierra Club Books, San Francisco. 499 pp.

Golet, F.C., A.J.K. Calhoun, W.R. DeRagon, D.J. Lowry, and A.J. Gold. 1993. Ecology of red maple swamps in the glaciated northeast: a community profile. Biological Report 12, U.S. Dept. of the Interior, Fish and Wildlife Service, Washington, D.C. 151 pp.

Griffin, G. J. 2000. Blight Control and Restoration of the American Chestnut. Journal of Forestry. February, 98 (2): 22-27.

Griffin, G. J. 1999. Frequencies and spatial patterns of white hypovirulent and pigmented strains of *Cryphonectria parasitica* within blight-controlled cankers on grafted American chestnut trees15-16 years after inoculation. European Journal of Forest Pathology. December, 29: 377-390.

Groeschl, D.A., Johnson, J.E., and D.W. Smith. 1992. Early vegetative response to wildfire in a table-mountain pine – pitch pine forest. International Journal of Wildland Fire 2: 177-184.

Grossman, D.H., D. Faber-Langendoen, A.S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume I. The national vegetation classification system: development, status, and applications. The Nature Conservancy, Arlington, Virginia. 126 pp.

Groves, C., L. Valutis, D. Vosick, B. Neely, K. Wheaton, J. Touval, and B. Runnels. 2000. Designing a geography of hope: a practitioner's handbook for ecoregional conservation planning. Volume II. Second Edition. The Nature Conservancy, Arlington, Virginia.

Hajek, A.E., L. Butler, S.R.A. Walsh, J.C. Silver, F.P. Hain, F.L. Hastings, T.M. O'Dell, and D.R. Smitley. 1996a. Host range of the gypsy moth (*Lepidoptera*: *Lymantriidae*) pathogen *Entomophaga maimaiga* (*Zygomycetes*: *Entomophthorales*) in the field versus laboratory. Environ. Entomol. 25: 709-721.

Hajek, A.E., J.S. Elkinton, and J.J. Witcosky. 1996b. Introduction and spread of the fungal pathogen, *Entomophaga maimaiga* (*Zygomycetes*: *Entomophthorales*) along the leading edge of gypsy moth (*Lepidoptera*: *Lymantriidae*) spread. Environ. Entomol. 25: 1235-1247.

Harvill, A.M., Jr., T.R. Bradley, C.E. Stevens, T.F. Wieboldt, D.M.E. Ware, D.W. Ogle, G.W. Ramsey, and G.P. Fleming. 1992. Atlas of the Virginia Flora III. Virginia Botanical Associates, Burkeville, Virginia. 144 pp.

Healy, W.M. 1997. Influence of deer on the structure and composition of oak forests in central Massachusetts. Pages 249-266 *in* W.J. McShea, H.B. Underwood, and J.H. Rappole, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C. 402 pp.

Heffernan, K.E., P.P. Coulling, J.F. Townsend, and C.J. Hutto. 2001. Ranking invasive exotic plant species in Virginia. Nat. Heritage Tech. Rep. 01-13. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond. 27 pp. plus appendices.

Hitchcock, A.S. and P.C. Standley. 1919. Flora of the District of Columbia and vicinity. Contributions from the United States National Herbarium 21. Smithsonian Institution. U.S. Government Printing Office, Washington, D.C. 351 pp.

Hoshovsky, M.C. 1988. Element stewardship abstract for *Ailanthus altissima*, tree-of-heaven. The Nature Conservancy, Arlington, Virginia. 10 pp.

JMP, Version 3.2.6. 1999. Statistical Discovery Software. SAS Institute, Inc. Cary, N.C.

Johnson, G.G. and S. Ware. 1982. Post-chestnut forests in the central Blue Ridge of Virginia. Castanea 47: 329-343.

Kartesz, J.T. 1999. A Synonymized Checklist and Atlas with Biological Attributes for the Vascular Flora of the United States, Canada, and Greenland. First Edition. *in*: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

Knox, W.M. 1997. Historical changes in the abundance and distribution of deer in Virginia. Pages 27-36 *in* W.J. McShea, H.B. Underwood, and J.H. Rappole, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C. 402 pp.

Kruskal, J.B. 1964. Nonmetric multidimensional scaling: a numerical method. Psychometrika 29: 115-129.

Küchler, A.W. 1964. Potential natural vegetation of the conterminous United States. American Geographical Society Special Publication 36.

Lance, G.N. and W.T. Williams. 1966. A generalized sorting strategy for computer classifications. Nature 212: 218.

Lance, G.N. and W.T. Williams. 1967. A general theory of classification sorting strategies. I. Hierarchical systems. Computer Journal 9: 373-380.

Lea, C. and R. Simmons. 2002. Vegetation classification of the Gold Mine Tract, C&O Canal National Historical Park. USGS/NPS Vegetation Mapping Program. Unpublished report submitted to the National Park Service and The Nature Conservancy. 68 pp.

LeBlond, R.J. 2001. Taxonomy of the *Dichotoma* group of *Dichanthelium* (*Poaceae*). Sida 19: 821-837.

Liang, S.Y. and S.W. Seagle. 2002. Browsing and microhabitat effects on riparian forest woody seedling demography. Ecology 83: 212-217.

Lipscomb, M.V., and E.T. Nilson. 1990a. Environmental and physiological factors influencing the natural distribution of evergreen and deciduous Ericaceous shrubs on northeast- and southwest-facing slopes of the southern Appalachian mountains. I. Irridiance tolerance. American Journal of Botany 77: 108-115.

Lipscomb, M.V., and E.T. Nilson. 1990b. Environmental and physiological factors influencing the natural distribution of evergreen and deciduous Ericaceous shrubs on northeast- and southwest-facing slopes of the southern Appalachian mountains. II. Water relations. American Journal of Botany 77: 517-526.

Lorimer, C.G. 1984. Development of the red maple understory in northeastern oak forests. For. Science 30: 3-22.

Magurran, A.E. 1988. Ecological diversity and its measurement. Princeton University Press, Princeton, NJ. 179 pp.

Martin, W.H. and S.G. Boyce. 1993. Introduction: the Southeastern setting. Pages 1-46 in W.H. Martin, S.G. Boyce, and A.C. Echternacht, eds. Biodiversity of the Southeastern United States: lowland terrestrial communities. John Wiley & Sons, New York.

Maxwell, H. 1910. The use and abuse of forests by the Virginia Indians. William and Mary College Quarterly Historical Magazine XIX: 73-103.

McCormick, J.F. and R.B. Platt. 1980. Recovery of an Appalachian forest following the chestnut blight, or Catherine Keever – you were right! American Midland Naturalist 104: 264-273.

McCune, B. and M.J. Mefford. 1999. PC-ORD. Multivariate analysis of ecological data. Version 4.16. MjM Software Design, Gleneden Beach, CA.

McDonald, R.I., R.K. Peet, and D.L. Urban. 2002. Environmental correlates of oak decline and red maple increase in the North Carolina Piedmont. Castanea 67: 84-95.

McMillan, M.A. and D.W. Larson. 2002. Effects of rock climbing on the vegetation of the Niagra Escarpment in southern Ontario, Canada. Conservation Biology 16: 389-398.

McShea, W.J. and J.H. Rappole. 1997. Herbivores and the ecology of forest understory birds. Pages 298-309 *in* W.J. McShea, H.B. Underwood, and J.H. Rappole, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C. 402 pp.

Mehlich, A. 1984. Mehlich III soil test extraction modification of Mehlich II extractant. Communications in Soil Science and Plant Analysis 15: 1409-1416.

Mikan, C.J., D.A. Orwig, and M.D. Abrams. 1994. Age structure and successional dynamics of a presettlement-origin chestnut oak forest in the Pennsylvania Piedmont. Bull. Torrey Bot. Club 121: 13-23.

Miller, S.G., J.B. Dunning, Jr. and J. Hadidan. 1992. Impacts of white-tailed deer on endangered and threatened vascular plants. Natural Areas Journal 12: 67-75.

Minchin, P.R. 1987. An evaluation of the relative robustness of techniques for ecological ordination. Vegetatio 69: 89-107.

Morisawa, T. 2000. Hemlock woolly adelgid: *Adelges tsugae* Annand. The Nature Conservancy, Wildlands Invasive Species Program, Arlington, Virginia. 2 pp.

Mountain, W.L. 1989. Mile-a-minute update – distribution, biology and control suggestions. Regulatory Horticulture 15: 21-24.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley & Sons, Inc., New York. 574 pp.

National Park Service. 1965. Outdoor recreation in the National Capital Region. National Capital Open Space Program Tech. Rep. No. 3. Prepared by Dept. of the Interior, National Park Service, National Capital Region, Washington, D.C. 40 pp.

Nelson, J.B. 1981. *Stachys* (Labiatae) in the southeastern United States. Sida 9: 104-123.

Nelson, J.B. and J.E. Fairey III. 1979. Misapplication of the name *Stachys nuttallii* to a new southeastern species. Brittonia 31: 491-494.

Nemeth, J.C. 1973. A mountain disjunct hemlock stand in the piedmont of Virginia. Castanea 38: 171-175.

Newell, C. L., and R. K. Peet. 1996. Plant species richness of southern Appalachian forests (abstract). Bull. Ecol. Soc. of America 77 (suppl.): 324.

Nowacki, G.J. and M.D. Abrams. 1992. Community, edaphic, and historical analysis of mixed oak forests of the Ridge and Valley Province in central Pennsylvania. Can. J. For. Res. 22: 790-800.

Noy-Meier, I. 1981. Responses of vegetation to the abundance of mammalian herbivores. Pages 233-246 in P.A. Jewell and S. Holt, eds. Problems in management of locally abundant wild mammals. Academic Press, New York.

Nuzzo, V. 2000. Element stewardship abstract for *Alliaria petiolata* (*Alliaria officinalis*), garlic mustard. The Nature Conservancy, Arlington, Virginia. 19 pp.

Nuzzo, V. 1997. Element stewardship abstract for *Lonicera japonica*, Japanese honeysuckle. The Nature Conservancy, Arlington, Virginia. 23 pp.

Oksanen, L. 1976. On the use of the Scandanavian type class system in cover estimation. Ann. Bot. Fenn. 13: 149-153.

Orwig, D.A. and M.D. Abrams. 1994a. Contrasting radical growth and canopy recruitment patterns in *Liriodendron tulipifera* and *Nyssa sylvatica*: gap-obligate versus gap-facultative tree species. Can. J. For. Res. 24: 2141-2149.

Orwig, D.A. and M.D. Abrams. 1994b. Land-use history (1720-1992), composition, and dynamics of oak-pine forests within the Piedmont and Coastal Plain of northern Virginia. Can. J. For. Res. 24: 1216-1225.

Palmer, M.W. 1993. Putting things in even better order: the advantages of canonical correspondence analysis. Ecology 74: 2215-2230.

Parker, A.J. 1982. The topographic relative moisture index: an approach to soil-moisture assessment in mountain terrain. Physical Geography 3: 160-168.

Parker, G.C., S.M. Hill, and L.A. Kuehnel. 1993. Decline of understory American Chestnut (*Castanea dentata*) in a southern Appalachian forest. Can. Jour. of Forest Res. 23: 259-265.

Patrick, W.H. 1958. Modification of method of particle size analysis. Soil Sci. Soc. Amer. Proc. 22: 366-367.

Peet, R.K. 1988. Herb diversity in forests and woodlands of the Southeastern United States (abstract). Bull. Ecol. Soc. of America 79 (supplement).

Peet, R.K., T.R. Wentworth, and P.S. White. 1998. A flexible, multipurpose method for recording vegetation composition and structure. Castanea 63: 262-274.

Petro, J.H. 1956. Soil survey of Fauquier County, Virginia. U.S.D.A. Series 1944, No. 7. U.S.D.A. Soil Conservation Service in cooperation with Virginia Agricultural Experiment Station. U.S. Government Printing Office, Washington, D.C. 231 pp. plus maps.

Porter, H.C. 1960. Soil survey of Loudoun County, Virginia. U.S.D.A. Soil Conservation Service in cooperation with Virginia Agricultural Experiment Station. U.S. Government Printing Office, Washington, D.C. 117 pp. plus maps.

Prentice, I.C., P.J. Bartlein, and T. Webb III. 1991. Vegetation and climate change in eastern North America since the last glacial maximum. Ecology 72: 2038-2056.

Purvis, W. 2000. Lichens. Smithsonian Institution Press, Washington, D.C. 112 pp.

Racine, C.H. 1978. Evaluation of Bull Run Mountain Natural Area in Fauquier County, Virginia for eligibility as a natural landmark. Unpublished report submitted to the National Park Service, Mid-Atlantic Regional Office, Philadelphia, Pa. 13 pp.

Rader, E.K. and N.H. Evans. 1993. Geologic map of Virginia – expanded explanation. Virginia Division of Mineral Resources, Charlottesville, Virginia. 80 pp.

Radford, A.E. and D.L. Martin. 1975. Potential ecological landmarks: Piedmont region, eastern United States. Unpublished report prepared for the National Park Service, University of North Carolina, Chapel Hill. 215 pp. plus appendices.

Reardon, R.C. 1996. Biological control of the gypsy moth: an overview. Proceedings of the Southern Appalachian Biological Control Initiative, Sept. 26-27, 1996. Asheville, N.C. USGS Biological Resource Division and the Southern Appalachian Man and Biosphere Project. 7 pp.

Rheinhardt, R., D. Whigham, H. Khan, and M. Brinson. 2000. Vegetation of headwater wetlands in the inner Coastal Plain of Virginia and Maryland. Castanea 65: 21-35.

Rhoades, R.W. 1992. Compositional changes in an oak forest in southwestern Virginia after twenty years. Castanea 57: 252-263.

Rhoades, R.W. 1995. Succession in a mature oak forest in southwest Virginia. Castanea 60: 98-106.

Rhoades, R.W. 2002. Post-disturbance changes in the understory of an oak forest in southwestern Virginia. Castanea 67: 96-103.

Robbins, N. and G.J. Griffin. 1999. Spread of white hypovirulent strains of *Cryphonectria parasitica* on grafted American chestnut trees exhibiting a high level of blight control. Eur. J. For. Path. 29:51-64.

Ruffner, C.M. and M.D. Abrams. 1998. Relating land-use history and climate to the dendroecology of a 326-year-old *Quercus prinus* talus slope forest. Can. J. For. Res. 28: 347-358.

Russell, E.W.B. 1987. Pre-blight distribution of *Castanea dentata* (Marsh.) Borkh. Bull. Torrey Bot. Club 114: 183-190.

SAS Institute Inc. 1996. SAS Version 6.11. SAS Institute Inc., Cary North Carolina.

Sather, N. and N. Eckardt 1987. Element stewardship abstract for *Elaeagnus umbellata*, autumn olive. The Nature Conservancy, Arlington, Virginia. 4 pp.

Schweitzer, D.F. 1987. Element stewardship abstract for *Lymantria dispar*, gypsy moth. The Nature Conservancy, Boston, Massachusetts. 17 pp.

Southeast Regional Climate Center. 2002. http://water.dnr.state.sc.us/water/climate/sercc/products/historical/historical_va.html

Southworth, S., W.C. Burton, J.S. Schindler, and A.J. Froelich. 1999. Introduction: geologic map of Loudoun County, Virginia. U.S. Geological Survey Map 99-150. U.S. Dept. of the Interior, USGS, Reston, VA. http://geology.er.usgs.gov/eespteam/GISLab/search/Virginia/loudoun/LOUDOUN.HTM.

SPSS for Windows, Release 7.5.3. 1997. SPSS Inc., Chicago.

Stephenson, S.L. 1974. Ecological composition of some former oak-chestnut communities in western Virginia. Castanea 39: 278-286.

Stephenson, S.L. and H.S. Adams. 1991. Upland oak forests of the Ridge and Valley province in southwestern Virginia. Virginia Journal of Science 42: 371-380.

Stephenson, S.L. and R.H. Fortney. 1998. Changes in forest overstory composition on the southwest slope of Beanfield Mountain in southwestern Virginia. Castanea 63: 482-488.

Stephenson, S.L., H.S. Adams, and M.L. Lipford. 1991. The present distribution of chestnut in the upland forest communities of Virginia. Bull. Torrey Bot. Club 118: 24-32.

Stephenson, S.L., H.S. Adams, and M.L. Lipford. 1992. The impact of human activities on the upland forests of western Virginia. Virginia Journal of Science 43: 121-131.

Stephenson, S.L., A.N. Ash, and D.F. Stauffer. 1993. Appalachian oak forests. Pages 255-303 *in* W.H. Martin, S.G. Boyce, and A.C. Echternacht (eds.). Biodiversity of the Southeastern United States: upland terrestrial communities. John Wiley & Sons, Inc., New York.

Stovall, A.D. 1980. Bull Run Mountains Natural Area: a feasibility study. Unpublished report submitted to the Virginia Outdoors Foundation. 60 pp.

Teels, B.M. and T.J. Danielson. 2001. Using a regional index of biotic integrity (IBI) to characterize the condition of northern Virginia streams, with emphasis on the Occoquan watershed. WLI Case Study. U.S. Dept. of Agriculture, Natural Resources Conservation Service, Wetland Science Institution, Laurel, Maryland. 92 pp.

ter Braak, C.J.F. and C.W.N. Looman. 1995. Regression. Pages 29-77 in R.H.G. Jongman, C.J.F. ter Braak, and O.F.R. van Tongeren (eds.). Data analysis in community and landscape ecology. Cambridge University Press, Cambridge.

Townsend, J. F. 2002. Natural heritage resources of Virginia: rare plants. Nat. Heritage Tech. Rep. 02-13. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 48 pp. plus appendices.

Tu, M. 2000. Element stewardship abstract for *Microstegium vimineum*: Japanese stilt grass, Nepalese browntop, Chinese packing grass. The Nature Conservancy, Wildland Invasive Species Program, Arlington, VA. 8 pp.

Van Lear, D.H. and T.A. Waldrop. 1989. History, uses, and effects of fire in the Appalachians. USDA Forest Service General Tech. Rep. SE-54. Southeastern Forest Experiment Station, Clemson, S.C. 20 pp.

Van Tongeren, O.F.R. 1995. Cluster analysis. Pages 174-212 in R.H.G. Jongman, C.J.F. ter Braak, and O.F.R. Van Tongeren (eds.). Data analysis in community and landscape ecology. Cambridge University Press, Cambridge.

Virginia Department of Conservation and Recreation. 1996. The 1996 Virginia outdoors plan. Unpublished report, Virginia Dept. of Conservation and Recreation, Division of Planning and Recreation Resources, Richmond, VA. 360 pp.

Virginia Division of State Planning and Community Affairs. 1972. Critical environmental areas. Unpublished report. 90 pp. plus appendix.

Virginia Outdoor Recreation Study Commission. 1965. Virginia's common wealth: a study of Virginia's outdoor recreational resources and the Virginia outdoors plan for conserving and developing them for lasting public benefit. Unpublished report.

Ward, J.H. 1963. Hierarchical groupings to optimise an objective function. Jour. Amer. Statistical Assoc. 58: 236-244.

Ware, S. 1992. Where are all the hickories in the Piedmont oak-hickory forest? Castanea 57: 4-12.

Watts, W.A. 1980. Late Quaternary vegetation of the central Appalachians and the New Jersey coastal plain. Ecol. Monogr. 49: 427-469.

Webb, D.A. 1954. Is the classification of plant communities either possible or desirable? Bot. Tidsskr. 51: 362-370.

Webb, R.E., G.B. White, K.W. Thorpe, and S.E. Talley. 1999. Quantitative analysis of a pathogen-induced premature collapse of a "leading edge" gypsy moth (*Lepidoptera*: *Lymantriidae*) population in Virginia. J. Entomol. Sci. 34: 84-100.

Weseloh, R.M. and T.G. Andreadis. 1992. Mechanisms of transmission of the gypsy moth (*Lepidoptera*: *Lymantriidae*) fungus, *Entomophaga maimaiga* (*Entomophthorales*: *Entomophthoraceae*) and effects of site conditions on its prevalence. Environ. Entomol. 21: 901-906.

Weseloh, R.M., T.G. Andreadis, and D.W. Onstad. 1993. Modeling the influence of rainfall and temperature on the phenology of infection of gypsy moth, *Lymantria dispar*, larvae by the fungus *Entomophaga maimaiga*. Biological Control 3: 311-318.

Westoff, V. and E. van der Maarel. 1973. The Braun-Blanquet approach. Pages 617-726 in R.H. Whittaker (ed.), Handbook of vegetation science, Part V: ordination and classification of communities, Junk, The Hague.

Wirth, Theodore J. and Associates. 1965. A proposal for the establishment of the Bull Run Conservancy, Bull Run Mountain, Virginia. Unpublished report.

Woodward, S.L. and Hoffman, R.L. 1991. The nature of Virginia. Pages 23-50 *in* McDonald, J.N. and T. Skware, eds. Virginia's endangered species: proceedings of a symposium, coord. by Karen Terwilliger. The McDonald and Woodward Publishing Co., Blacksburg, Virginia.

APPENDIX.

VEGETATION PLOT METADATA, FORMS, AND LOCATION MAPS

Table 56. Metadata for vegetation plots in the Bull Run Mountains.

PLOT	DATE	SURVEY SITE	COUNTY	USGS QUADRANGLE	UTME	UTMN	SIZE (m2)	MARKER
BRM001	5/26/98	Jackson Hollow	Prince William	Middleburg	266744	4307618	400	n.a.
BRM002	5/27/98	High Point Mountain – cliffs	Fauquier	Thoroughfare Gap	264336	4303792	400	n.a.
BRM003	6/7/00	Bartons Creek headwaters	Fauquier	Middleburg	266715	4310208	400	n.a.
BRM004	6/7/00	Middle Ridge North – W slope	Fauquier	Middleburg	266728	4308908	400	n.a.
BRM005	6/7/00	Catletts Branch	Prince William	Thoroughfare Gap	265135	4301827	400	n.a.
BRM006	6/7/00	Catletts Branch	Prince William	Thoroughfare Gap	265110	4301637	400	n.a.
BRM007	5/23/01	Thoroughfare Gap – Fern Hollow	Prince William	Thoroughfare Gap	264548	4301218	400	Tag #979
BRM008	5/24/01	High Point Mtn. / Roland Farm	Fauquier	Thoroughfare Gap	263934	4303478	400	n.a.
BRM009	5/24/01	High Point Mtn. / Roland Farm	Fauquier	Thoroughfare Gap	263648	4303646	400	n.a.
BRM010	6/5/01	Bartons Creek headwaters	Fauquier	Middleburg	266704	4309683	400	n.a.
BRM011	6/5/01	Upper Catletts Branch	Fauquier	Thoroughfare Gap	265119	4304347	400	Tag #978
BRM012	6/7/01	Jackson Hollow	Fauquier	Middleburg	266001	4307066	400	Tag #977
BRM013	6/7/01	Bartons Creek headwaters	Fauquier	Middleburg	266624	4309877	400	n.a.
BRM014	6/7/01	Little Bull Run headwaters	Fauquier	Middleburg	265698	4306404	400	Tag #976
BRM015	6/21/01	Hungry Run headwaters	Fauquier	Middleburg	267326	4309144	400	Tag #975
BRM016	6/21/01	Middle Ridge North – W slope	Fauquier	Middleburg	266903	4309290	400	Tag #974
BRM017	6/21/01	Middle Ridge North – W slope	Fauquier	Middleburg	266430	4307892	400	Tag #973
BRM018	6/22/01	Upper Catletts Branch	Fauquier	Thoroughfare Gap	265221	4304619	400	Tag #972
BRM019	6/22/01	Upper Catletts Branch	Fauquier	Thoroughfare Gap	265237	4304761	400	Tag #971
BRM020	6/22/01	Thoroughfare Gap	Prince William	Thoroughfare Gap	264980	4300961	400	Tag #970
BRM021	7/11/01	High Point Mountain. – E slope	Prince William	Thoroughfare Gap	264512	4302518	400	Tag #969
BRM022	7/11/01	High Point Mountain – crest	Fauquier	Thoroughfare Gap	264275	4302767	400	Tag #968
BRM023	7/11/01	High Point Mountain – E slope	Prince William	Thoroughfare Gap	264636	4301696	400	Tag #967
BRM024	7/11/01	Thoroughfare Gap	Prince William	Thoroughfare Gap	264707	4301234	400	Tag #966
BRM025	7/12/01	East Ridge South – crest	Prince William	Thoroughfare Gap	265699	4303457	400	Tag #965
BRM026	7/12/01	East Ridge South – E slope	Prince William	Thoroughfare Gap	265710	4303717	400	Tag #964
BRM027	7/12/01	East Ridge South – E slope	Prince William	Thoroughfare Gap	265612	4303555	400	Tag #996
BRM028	7/12/01	East Ridge South – W slope	Fauquier	Thoroughfare Gap	265326	4303774	400	n.a.
BRM029	7/17/01	East Ridge North – W slope	Prince William	Middleburg	267099	4307086	400	Tag #901
BRM030	7/17/01	East Ridge North – E slope	Prince William	Middleburg	267495	4307759	400	Tag #902
BRM031	7/17/01	East Ridge North – E slope	Prince William	Middleburg	267683	4308239	400	Tag #903
BRM032	7/17/01	East Ridge North – W slope	Prince William	Middleburg	267643	4308833	400	Tag #1000
BRM033	7/18/01	Little River – Aldie	Loudoun	Middleburg	271057	4316961	400	n.a.
BRM034	7/18/01	Middle Ridge North – W slope	Fauquier	Middleburg	266099	4306954	400	Tag #999
BRM035	7/19/01	East Ridge North – W slope	Fauquier	Middleburg	267129	4308544	400	Tag #998
BRM036	7/19/01	Jackson Hollow	Fauquier	Middleburg	266735	4307935	400	Tag #997
BRM037	7/19/01	Middle Ridge North	Fauquier	Middleburg	266551	4307864	400	Tag #963
BRM038	7/19/01	East Ridge South – W slope	Fauquier	Thoroughfare Gap	265332	4303596	400	Tag #962
BRM039	7/20/01	Pond Mountains – W slope	Fauquier	Thoroughfare Gap	263527	4298405	400	n.a.
BRM040	7/20/01	Pond Mountains – E slope	Fauquier	Thoroughfare Gap	264150	4298165	400	n.a.

Table 56 – continued

PLOT	DATE	SURVEY SITE	COUNTY	USGS QUADRANGLE	UTME	UTMN	SIZE (m2)	MARKER
BRM041	7/20/01	Pond Mountains – E slope	Fauquier	Thoroughfare Gap	263897	4298714	400	n.a.
BRM042	7/24/01	High Point Mountain – W slope	Fauquier	Thoroughfare Gap	264284	4303710	400	Tag #961
BRM043	7/24/01	High Point Mountain – W slope	Fauquier	Thoroughfare Gap	264361	4304033	400	Tag #960
BRM044	7/24/01	High Point Mountain – E slope	Fauquier	Thoroughfare Gap	264903	4304783	400	Tag #959
BRM045	7/25/01	Signal Mountain / White Rock	Fauquier	Middleburg	265400	4307332	400	n.a.
BRM046	7/25/01	Middle Ridge North – crest	Prince William	Thoroughfare Gap	265919	4306170	400	Tag #958
BRM047	7/25/01	Middle Ridge North – E slope	Fauquier	Middleburg	266615	4307862	400	Tag #957
BRM048	7/25/01	High Acre Ridge – crest	Fauquier	Middleburg	265939	4309094	400	Tag #956
BRM049	7/26/01	Catletts Branch	Prince William	Thoroughfare Gap	264786	4302510	400	Tag #955
BRM050	7/26/01	East Ridge South – crest	Prince William	Thoroughfare Gap	265259	4302321	400	Tag #954
BRM051	7/26/01	East Ridge South – crest	Prince William	Thoroughfare Gap	265259	4301946	400	Tag #953
BRM052	7/26/01	East Ridge South – W slope	Prince William	Thoroughfare Gap	264923	4302780	400	Tag #952
BRM053	7/31/01	Aldie Ridge – crest	Loudoun	Middleburg	271180	4316266	400	n.a.
BRM054	7/31/01	Aldie Ridge – W slope	Loudoun	Middleburg	270919	4316181	400	n.a.
BRM055	7/31/01	Aldie Ridge – W slope	Loudoun	Middleburg	270791	4316331	400	n.a.
BRM056	7/31/01	Aldie Ridge – W slope	Loudoun	Middleburg	270725	4316170	400	n.a.
BRM057	8/1/01	Cold Spring Gap – W slope	Fauquier	Middleburg	269578	4313655	400	n.a.
BRM058	8/7/01	High Point Mountain – N end	Fauquier	Thoroughfare Gap	264627	4304747	400	Tag #904
BRM059	8/7/01	High Point Mountain – N end	Fauquier	Thoroughfare Gap	264596	4304931	400	Tag #906
BRM060	8/7/01	High Acre Ridge – E slope	Fauquier	Middleburg	266265	4309192	200	Tag #905
BRM061	8/8/01	Pond Mountains – crest	Fauquier	Thoroughfare Gap	264002	4299795	400	n.a.
BRM062	8/8/01	Pond Mountains – E slope	Fauquier	Thoroughfare Gap	265239	4299624	400	n.a.
BRM063	8/8/01	Pond Mountains – N end	Fauquier	Thoroughfare Gap	264109	4300761	400	n.a.
BRM064	8/8/01	Middle Ridge North – W slope	Fauquier	Middleburg	266822	4309726	400	Tag #907
BRM065	8/10/01	High Acre Ridge – W slope	Fauquier	Middleburg	265630	4308512	400	Tag #908
BRM066	8/10/01	High Acre Ridge - crest	Fauquier	Middleburg	265998	4309437	200	Tag #909
BRM067	8/15/01	High Acre Ridge – W slope	Fauquier	Middleburg	265637	4308467	400	Tag #910
BRM068	8/15/01	High Point Mtn. / Roland Farm	Fauquier	Thoroughfare Gap	263784	4302903	400	Tag #911
BRM069	8/15/01	High Point Mountain – W slope	Fauquier	Thoroughfare Gap	264070	4302939	400	Tag #912
BRM070	8/15/01	High Point Mountain – W slope	Fauquier	Thoroughfare Gap	264221	4302434	400	Tag #913
BRM071	8/16/01	High Point Mountain – E slope	Fauquier	Thoroughfare Gap	264323	4301480	400	Tag #950
BRM072	8/16/01	High Point Mountain – crest	Fauquier	Thoroughfare Gap	264268	4301434	400	Tag #951