Classification and Conservation Assessment of

Upland Red Spruce Communities in West Virginia

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Abstract

Upland red spruce communities in the Allegheny Mountains of West Virginia provide unique habitats for an abundance of living organisms. As part of a statewide vegetation classification effort, West Virginia Division of Natural Resources personnel used Natural Heritage methodology to assess upland red spruce habitats. Five associations were classified, peer-reviewed, and published in the U. S. National Vegetation Classification (NVC). These red spruce forest and woodland associations are all ranked as high state and global conservation priorities. Documented species occurrences in the study area include 850 animals, 211 plants, 105 fungi, and 81 slime molds. Rare taxa include 9 mammals, 16 breeding birds, 2 reptiles, 4 amphibians, 7 land snails, 3 crayfish, 17 butterflies, 10 moths, and 9 vascular plants. This report complements a recently completed assessment of high elevation wetland communities within the Allegheny Mountains of West Virginia, and together these two reports complete the NVC classification of red spruce communities in West Virginia.

Acknowledgements

This project would not have been possible without the assistance of many experts who shared their knowledge and talents with the authors. Unpublished plot data were generously contributed by Steven Stephenson, The Mountain Institute, The Nature Conservancy, and the Monongahela National Forest. Steven Stephenson also kindly contributed Myxomycetes records from West Virginia's red spruce communities. William Roody provided important additions to the fungal records associated with red spruce forests. Conversations and insights regarding disturbance regimes, stand history, and environmental processes were shared by Rodney Bartgis, Ashton Berdine, Alton Byers, Amy Cimarolli, Shane Jones, Kent Karriker, Thomas Minney, Kevin Potter, Jim Rentch, Dave Saville, and Thomas Schuler. In the field, the following people provided essential sampling skills and excellent company: Alton Byers, Amy Cimarolli, Tony Fleming, Celeste Good, Bill Grafton, Donna Mitchell, Greg Short, Rod Simmons, and Tom Vogt. Expert identification of non-vascular field specimens was done by Susan Studlar (bryophytes), Don Flenniken (lichens), and William Roody and Donna Mitchell (fungi). Jason Teets, Stephanie Connolly, and Skip Bell helped us to better understand and describe red spruce soils. Ecologists from surrounding states helped with understanding the range and ecological amplitude of community types, with particular thanks to Gary Fleming and Karen Patterson in Virginia and Mike Schafele in North Carolina. NatureServe ecologists Lesley Sneddon, Milo Pyne, Sue Gawler, and Mary Russo integrated the results of this study into the U.S. National Vegetation Classification. Review comments on various portions of the report were kindly provided by Barb Sargent, Stephanie Connolly, Michael Dougherty, Shane Jones, Walt Kordek, Donna Mitchell, William Roody, Craig Stihler, Jason Teets, and Michael Welch.

Introduction

Background and objectives

The purpose of this project was to classify, document, map, and rank occurrences of upland red spruce communities in West Virginia. The results provide a framework for assessing conservation priorities and serve as a baseline for assessing forest condition and functions related to biological diversity.

For this project, upland red spruce communities are defined as non-wetland forests and woodlands with greater than 15% cover of red spruce (*Picea rubens*) in the canopy. Although a number of excellent studies on various aspects of West Virginia's red spruce forests have been completed (*e.g.*, Murphy 1917, Lacey 1920, Korstian 1937, Pielke 1981, Stephenson and Clovis 1983, Adams and Stephenson 1984, 1989, Bills et al. 1985, Pauley 1989, Mayfield 1997, Hornbeck and Kockenderfer 1998, Adams et al. 1999, Schuler et al. 2002, Rollins 2005, Rentch et al. 2007), none have presented a comprehensive conservation assessment and classification of community types to the standard of the U.S. National Vegetation Classification (NVC) (ESA 2004, FGDC 2008). To address this need, we integrated existing data with field data collected during this project to classify and characterize the red spruce upland community types and rank individual occurrences. By collecting and analyzing plot data according to standards established for contributions to the NVC, this project also contributes to regional and national conservation assessments.

The project was supported by the West Virginia Division of Natural Resources (WVDNR) and the U.S. Fish and Wildlife Service State Wildlife Grant Program. Staffing consisted of a Project Leader and Project Assistants, working under the supervision of the WVDNR Natural Heritage Program Ecologist.

Ecological communities and conservation

Ecological communities are groups of organisms (plants, animals, fungi, and microbes) that live together in a particular physical environment. Conservation of ecological communities is important because communities maintain processes and food pathways necessary for survival of many interdependent species. Communities provide habitat for a multitude of common and poorly known organisms that are not the focus of individual species conservation efforts.

Terrestrial ecological communities are classified based on vegetation because plants are the least transient, most observable life form in these systems. Plant communities repeat across the landscape under similar environmental conditions, and comprise recognizable habitat units that can be described and mapped. The West Virginia Natural Heritage Program is developing a vegetation classification to use as the basis for tracking and ranking occurrences of all types of terrestrial ecological communities in the state. Our classification is consistent with the U.S. National Vegetation Classification, which is maintained by NatureServe, a nonprofit organization providing biodiversity information for conservation.

The West Virginia Natural Heritage Program, part of the Wildlife Resources Section of the WVDNR, conducts inventories, maps, and maintains databases on the natural biological diversity of the state, including natural ecological communities and rare plants and animals. Natural Heritage Program ecologists track occurrences of rare ecological communities as well as high quality examples of common natural communities. Rarity is determined from both state and global perspectives. The quality of an occurrence is determined by its size, environmental condition, and landscape context. Natural Heritage Program data is provided to government agencies, conservation organizations, researchers, educators, developers, and private landowners to inform and encourage conservation of biodiversity in our state.

Study area

The project scope is defined as upland red spruce forests and woodlands in West Virginia with at least 15% cover of *Picea rubens* (red spruce) in the canopy. We found stands meeting these criteria in seven counties (Grant, Greenbrier, Pendleton, Pocahontas, Randolph, Tucker, and Webster) at elevations above 875 m (2870 ft) in elevation. Nearly all stands are in the Allegheny Mountain region, with a few small outliers on the highest ridges of the Ridge and Valley region.

Ecoregional context

Red spruce grows in cool, moist climates from southeastern Canada through central New York, New England, eastern Pennsylvania, and northern New Jersey (Figure 1, left). It then extends southward along the highest ridges of the Central and Southern Appalachian Mountains as isolated "sky islands" of habitat in Maryland, West Virginia, Virginia, North Carolina, and Tennessee (Oosting and Billings 1951, Bailey and Ware 1990, Blum 1990, Cogbill and White 1991, White and Cogbill 1992, White et al. 1993, Prasad and Iverson 2003, USDA 2007). West Virginia's red spruce habitat occupies the largest high elevation area (Figure 1, right) in the northeastern United States.

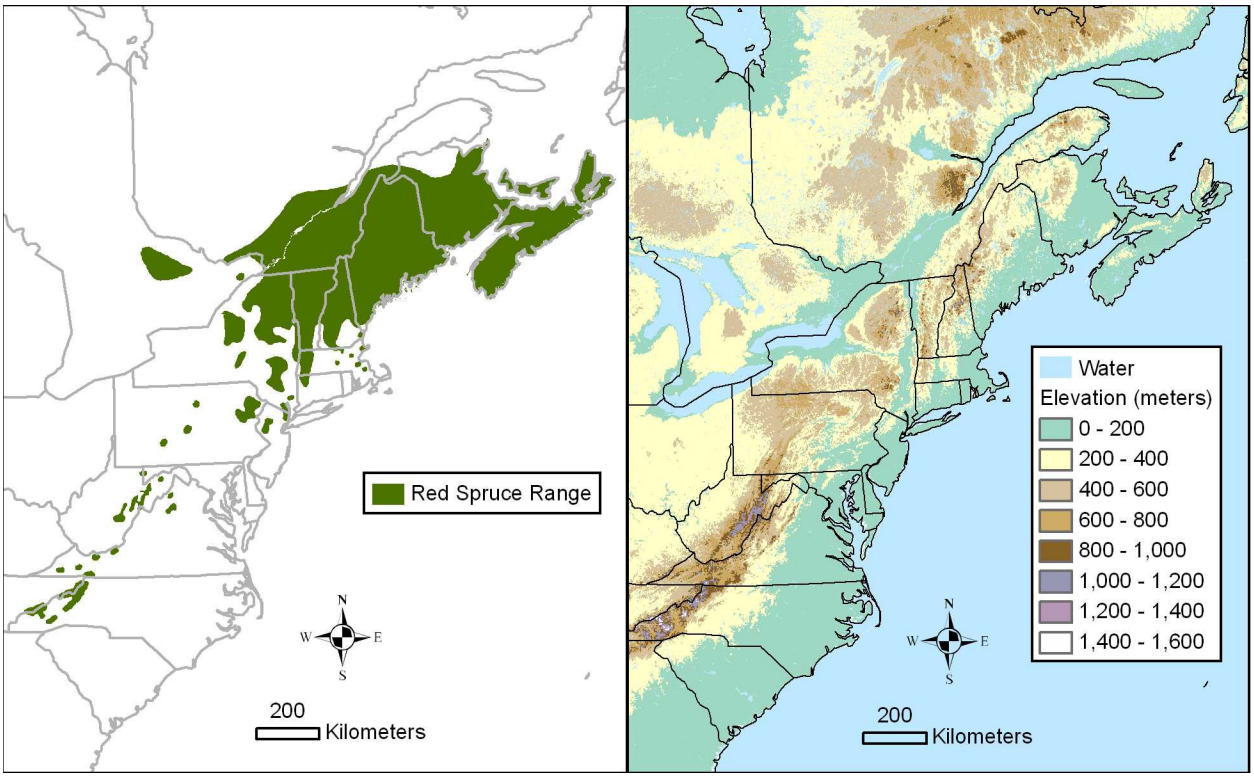


Figure 1. Left: Native range of red spruce (Little 1971); Right: Elevation map of northeastern USA (ESRI 2008).

In West Virginia, red spruce forests and woodlands grow in the Allegheny Mountain region, which contains some of the highest concentrations of globally rare plant and animal species within the northeastern states (Figure 2). The high conservation value of this region stems from several intrinsic factors, including (a) its location south of the maximum extent of Pleistocene glaciation, (b) its complex topography and geology, and (c) the relatively large remaining tracts of natural vegetation compared to adjacent areas in the northeast.

During more than one million years of Pleistocene glaciations, ice sheets more than a mile thick advanced and retreated over the much of the northern part of North America. The ground was scoured clean of all life with the possible exception of microorganisms. When the ice age ended a mere 10,000 years ago, the northern part of the continent was re-colonized by plants and animals that lived in unglaciated regions. In the unglaciated Central and Southern Appalachians, however, plants and animals had the luxury of adapting slowly to gradual fluctuations in climate over many millions of years. This long period of gradual change allowed many species to adapt, disperse and occupy a myriad of ecological niches.

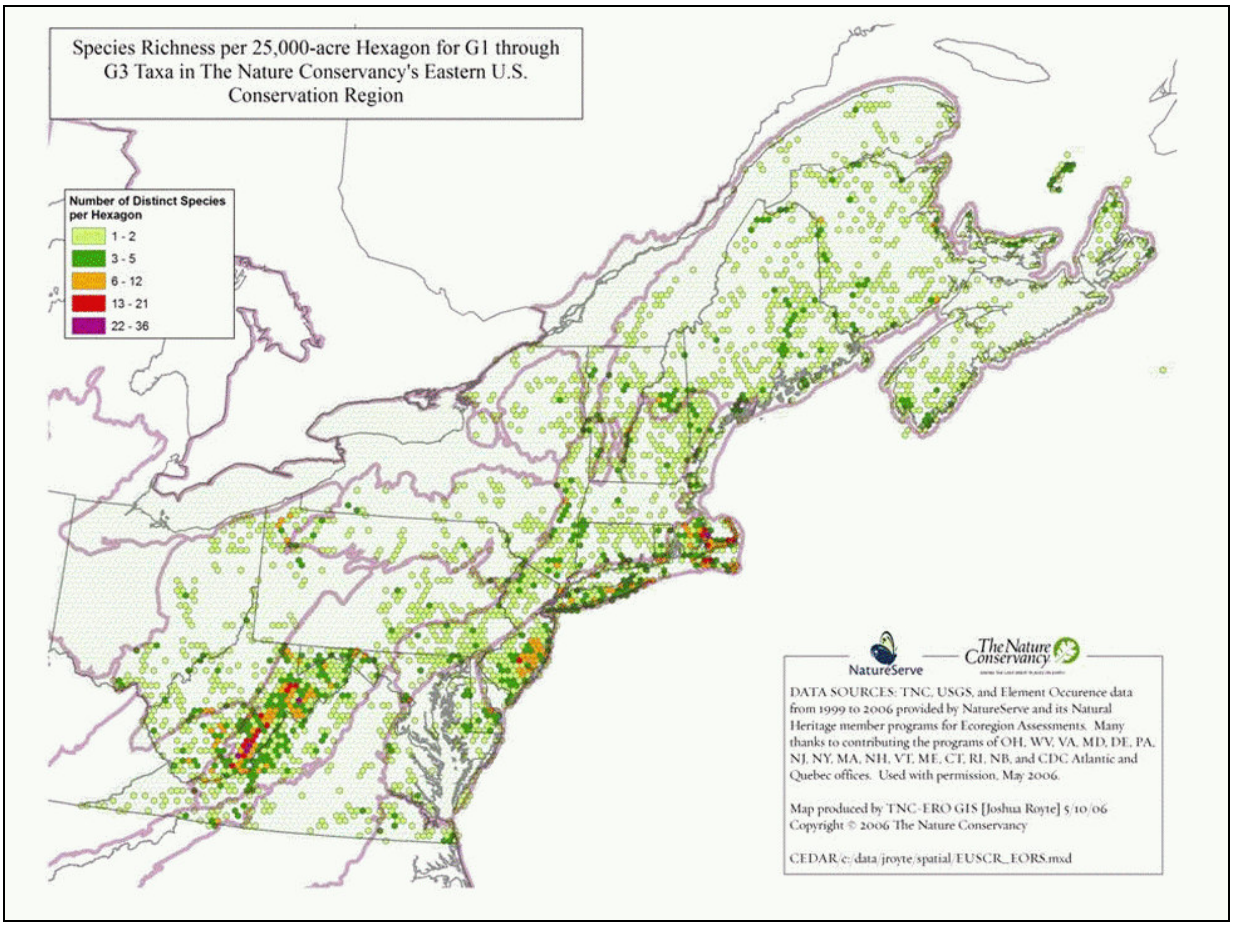


Figure 2. Rarity-weighted species richness of the northeastern states (TNC 2006)

The terrain of the Central Appalachians is topographically complex, with dissected plateaus and long ridges rising above steep river valleys. The rapid changes in elevation, slope, and aspect result in a compression of climatic zones and ecological niches, offering a profusion of habitats for potential exploitation by species with slightly differing adaptations. Adding to the diversity of habitats is the folded and jointed geologic substrate, which brings rocks of differing types to the surface in finely patterned mosaics. Each rock type has its own characteristic nutrient bank, permeability, and susceptibility to erosion. The overlay of densely juxtaposed climatic zones over differing rock types results in a complicated array of soil types and growth niches. Combining this intrinsic habitat diversity with the long period available for gradual evolution and dispersal in the region, it comes as no surprise that the Central and Southern Appalachians are a nationally significant hotspot of biodiversity.

The last piece of the "perfect storm" that gives rise to the exceptionally high conservation importance of the region is its human history. The steep slopes and relative inaccessibility of the Central Appalachians have hindered intensive human development in comparison with many of the surrounding areas. Large tracts of forested private land, and large public landholdings such as the Monongahela National Forest, have conserved relatively unfragmented natural landscapes

where native species are able to flourish. The mountains function essentially as islands of biodiversity within a sea of tamed and transformed lowlands.

West Virginia's red spruce communities comprise part of NatureServe's Central and Southern Appalachian Spruce-Fir Forest Ecological System (Comer et al. 2003), which occurs in the highest elevation zone of the Southern Blue Ridge and parts of the central Appalachians. Elevation and orographic effects make the climate cool and wet, with heavy moisture input from fog as well as high rainfall. Strong winds, extreme cold, rime ice, and other extreme weather are periodically important. This NatureServe ecological system ranges from the mountains of North Carolina and Tennessee northward to Virginia and West Virginia. Vegetation is generally dominated by *Picea rubens* (red spruce), *Abies fraseri* (Fraser fir), or *Abies balsamea* (balsam fir), or by a mixture of spruce and one of the firs. In West Virginia, *A. fraseri* does not occur naturally, and *A. balsamea* is mostly confined to wetlands.

The project area is also contained within the Central Appalachian Forest Ecoregion as defined by The Nature Conservancy (2004). U.S. Forest Service ecoregions within the study area are the Northern High Allegheny Mountains, the Southern High Allegheny Mountains, and a small section of the Western Allegheny Mountains (Keys et al. 1995). U.S. Environmental Protection Agency ecoregions that overlap the study area are the Central Appalachians: 69a Forested Hills and Mountains, 69b Uplands and Valleys of Mixed Land Use, and the Ridge and Valley: 67b Northern Shale Valleys, 67d Northern Dissected Ridges (Woods et al. 1999).

Physical characteristics

The study area covers approximately 6500 km^2 (2500 mi^2) in a southwest – northeast trending band along the summits and high plateau of the Allegheny Mountains (Figure 3).

A cool, moist climate characterizes the region (Figure 4). Rainfall in this region is the highest in the state, with 30-year averages ranging from 1220-1680 mm/yr (48-66 in/yr) (SCAS 2000). Temperatures are low and growing seasons are short compared to the rest of the state. The 30-year mean annual temperature from 1971-2000 was 6.7-9.4 ^{o}C (44-49 ^{o}F) at four stations in the project area (SRCC 2007). Mean annual soil temperature ranges from 7.2-9.4^{o}C (45-49 ^{o}F) (Prescott et al. 2006).

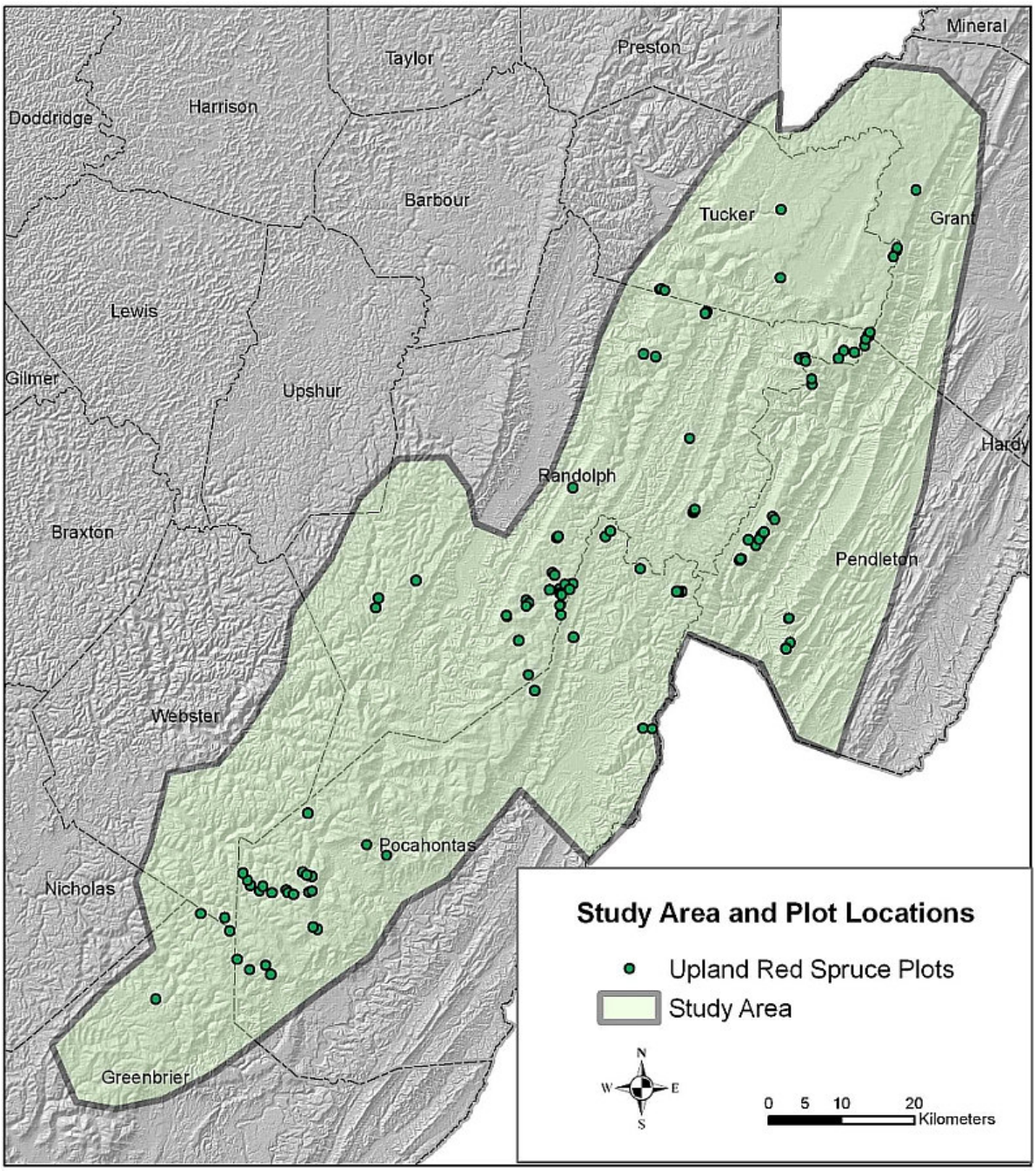


Figure 3. Study area and plot locations

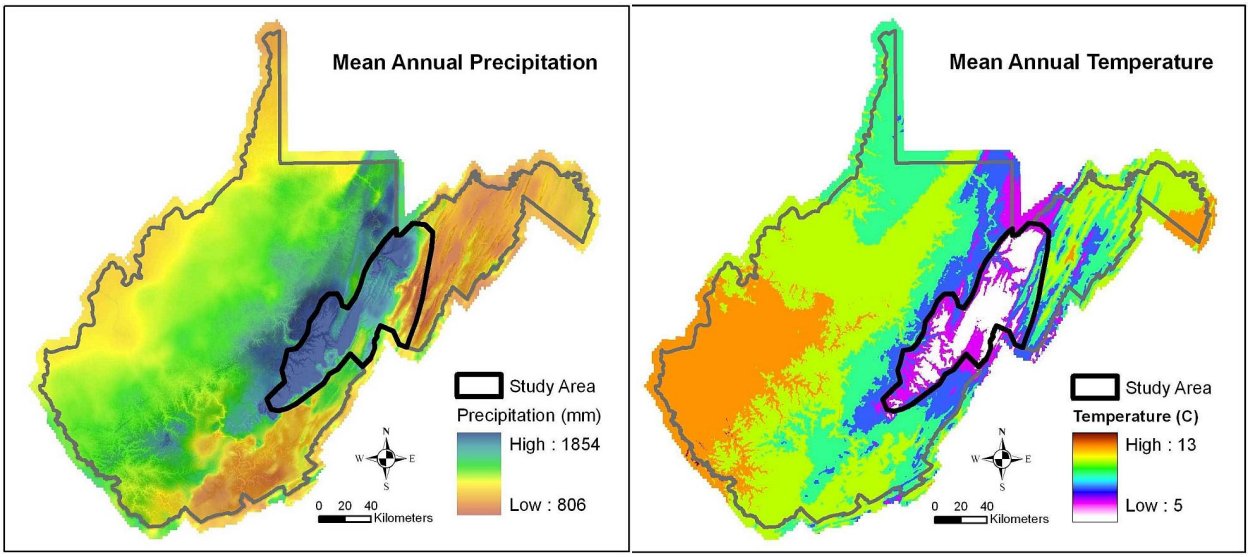


Figure 4. Mean annual precipitation and temperature

During pre-glacial time, the study area straddled the eastern continental divide between the ancient Erigan River to the north and the ancient Teays River to the west (Jezerinac et al. 1995). Today, the study area still sits on the eastern continental divide, which now lies between the Ohio and Potomac Rivers. Current drainage structures include tributaries of the Tygart and Cheat Rivers (Monongahela River basin), tributaries of the Gauley, Elk, and Greenbrier Rivers (New and Kanawha River basins), and tributaries of the Potomac River basin.

The project area lies along the high plateau of the Allegheny Mountains, immediately west of the Allegheny Front, with a few outliers in the Ridge and Valley to the east. Elevations range from 875 meters (2870 ft) to the highest point in West Virginia at the top of Spruce Knob (1482 meters or 4863 ft) (Figure 5). Topography in this part of the Appalachians is a reflection of lithology and underlying geologic structure. Sandstone tends to form resistant ridges and plateaus, whereas more erodible shale and limestone tend to occur on slopes and valley bottoms. Most of the study area is underlain by gently folded sedimentary rocks of Carboniferous and Devonian age in the Allegheny Mountains. The Allegheny Mountain region is characterized by high ridges, often with broad flat ridgetops and flat-lying headwater basins. In contrast, the Ridge and Valley region has much more precipitous topography, with narrow river valleys dividing the high ridges. The red spruce outliers in the Ridge and Valley are underlain by very steeply folded and

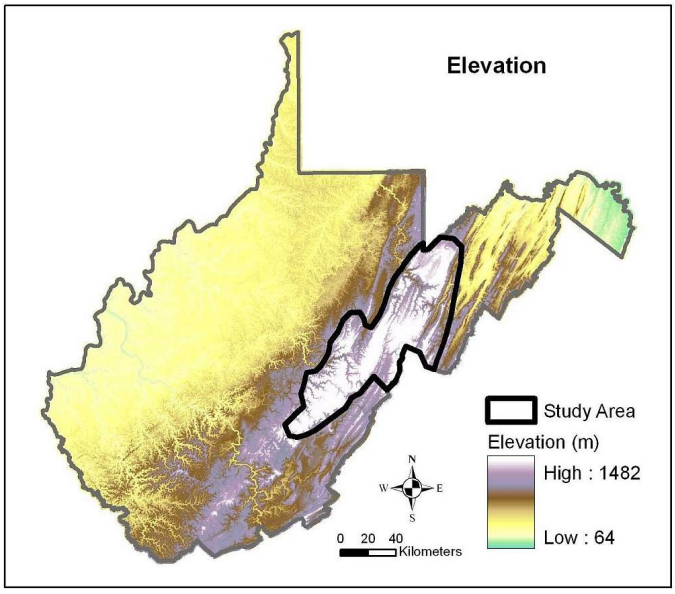


Figure 5. Elevation

faulted sedimentary rocks of Devonian, Silurian and Ordovician age (WVGES 1986).

Jenkins (2002) describes red spruce soil series occurring above 1020 m in elevation on the Allegheny Plateau of West Virginia as frigid, well and moderately-well drained spodosols. These soil series contain from 11.3 to 13.0 kg/m^2 soil organic carbon, and from 15.9 to 29.7 kg/m^2 vegetative organic carbon. Jenkins' (2002) results indicate that the high elevation forest soils of West Virginia contain significant organic carbon reserves. However, he warns that they may be among the most at-risk sites yet studied with regard to potential calcium depletion, based on the apparently very low calcium reserves, high degree of aluminum saturation of the soil series, and the amount of incident acid precipitation.

Landscape history

Pollen, plant microfossil, and radiocarbon evidence indicate that during the last ice age, treeless sedge tundra comprised the stable vegetation at higher elevations in the Central Appalachians. Tundra vegetation persisted until about 12,500 years ago, when climatic warming brought spruce, pine, and fir forests to the area. Within a few hundred years, hemlock appeared in large populations, followed by birch, ash, beech, chestnut, maple, and oak. By 10,000 years ago, the Central Appalachians supported extensive mesic forests (Darlington 1943, Cox 1968, Whitehead 1973, Watts 1979, Wieder 1985).

Natural disturbance regimes in the red spruce ecosystem include wind disturbance, ice storms, insect damage, and lightning fire, usually on a single-tree scale (White and Pickett 1985, White et al. 1985, Nicholas and Zedaker 1989). Stand-replacing fires may affect large patch sizes but occur rarely, at 300 to 1,000-year intervals and presumably in the wake of extended drought and/or widespread insect infestations; wind events are likely at more frequent intervals of 100 to 200 years (Hopkins 1899, Lorimer and White 2003, Gorman 2007).

Human history of the study area begins with Native Americans perhaps 10,000-14,000 years ago, concurrent with the retreat of the northern ice sheets and the landscape shift from tundra to early forests. The degree of landscape modification by early hunter-gatherer inhabitants is unknown, but probably consisted of localized, shifting areas of burning and clearing. Permanent settlements have not been found within the high elevation study area, but production sites, where chert and chalcedony were processed into spear points and tools, are known from the Greenbrier limestone within the project area at Spruce Knob and above Blister Swamp. These upland sites have been dated to approximately 2,000 years ago based on the style of the points. Charcoal horizons and a buried podzol in the soil profile under present-day grassland at Blister Swamp indicate localized burning and conversion of forest to grassland, presumably to enhance hunting opportunities at the production site (Krech 2000, Byers 2007, Lesser 2007).

During late Paleolithic time (1000-1200 A.D.), gardening cultures developed in West Virginia based on the "food package" of corns, beans, and squash that arrived from Mesoamerica. The development of agriculture probably led to a significant increase in

population size, with small, shifting settlements and fields concentrated along river bottoms. As in earlier times, the use of the highlands is unknown. Landscape modification probably occurred at seasonal hunting grounds and production sites. Following devastating contact with European diseases in the 16th and 17th centuries, Native American populations declined precipitously, probably 60-90%. Thus, when European settlers began to arrive in the Allegheny highlands, the native residents were few and their landscape modifications would in some cases have been reverting back to natural disturbance regimes (Diamond 1997, Krech 2000, Lesser 2007).

European settlers began to arrive in the 1700s, bringing small-scale clearing and burning impacts to the Allegheny Mountains; however, the high, cold forest regions experienced less settlement pressure than more hospitable surrounding hill regions and valley bottoms. The red spruce forest matrix, with its embedded wetlands, remained largely intact within the study area. During this period, a number of historic accounts mention habitat types in the Allegheny Mountains, including spruce forests with large-diameter trees and moss-covered deadfalls, heavily shaded streams rich in aquatic life, "impenetrable" old-growth swamps, open cranberry peatlands, and game-filled glades of bluejoint grass along headwater streams (Lewis 1746, Kennedy 1853, Strother 1853, 1872, 1873a, 1873b, Browning 1859, Selders 1917).

It was not until the logging boom of 1880-1920 that upland red spruce communities were completely altered. During this period, more than 99% of the forest was harvested or burned. Many areas burned repeatedly, consuming the organic substrate and potentially setting back natural succession by centuries. Wind and water erosion on these denuded landscapes was severe. Railroad beds were laid down along almost every high elevation stream in order to take out the timber harvest, resulting in channelization of streambeds and hydrologic alteration of surrounding floodplains (Brooks 1910, Selders 1917, Allard and Leonard 1952, Clarkson 1964).

Where degradation was severe, the landscape did not return to red spruce forest, but instead began the slow process of re-establishment of vegetation and re-building of soils. Some sites burned and eroded to bare rock with little vegetation remaining except for bracken fern. Others became grass balds or shrub barrens (Brooks 1910, Robison 1960). Many areas with moderate degradation regenerated to northern hardwood forests (Schuler et al. 2002, Fortney and Rentch 2003). Red spruce forest regenerated only in a few areas where soils remained relatively intact (Lacey 1920).

Ecosystem recovery in the cool climate of the Allegheny Mountains is very slow, but red spruce is gradually growing back on some of its former range. A period of decline in red spruce growth rates and vigor occurred beginning in the 1980s and lasted for more than a decade (Adams et al. 1985, McLaughlin et al. 1987, Adams and Stephenson 1989, Silver et al. 1991, Eager and Adams 1992, Schutt 1993, Battles and Fahey 2000). More recently, red spruce appears to have stabilized and is actively expanding into portions of its former range (Schuler et al. 2002, Rollins 2005, Rentch et al. 2007).

Today, many of the forests, woodlands, and wetlands in the high Allegheny Mountain region enjoy some degree of protection under public ownership or private stewardship. Dougherty and Byers (2008) calculated landscape integrity values on a 30-meter grid for the state of West Virginia based on distance from weighted landscape disturbance features including

mining and other industries, residential and urban development, transportation corridors, and agriculture (Figure 6). Publicly-owned lands stand out as having high landscape integrity. The large acreage of the Monongahela National Forest, home to most of the red spruce forests in the state, is among the least fragmented areas in the state.

Upland red spruce communities nevertheless face a host of serious new threats, as discussed in the "Results" section of this report. Understanding the dynamics and diversity of these natural communities is critical to conserving West Virginia's extraordinarily rich natural heritage.

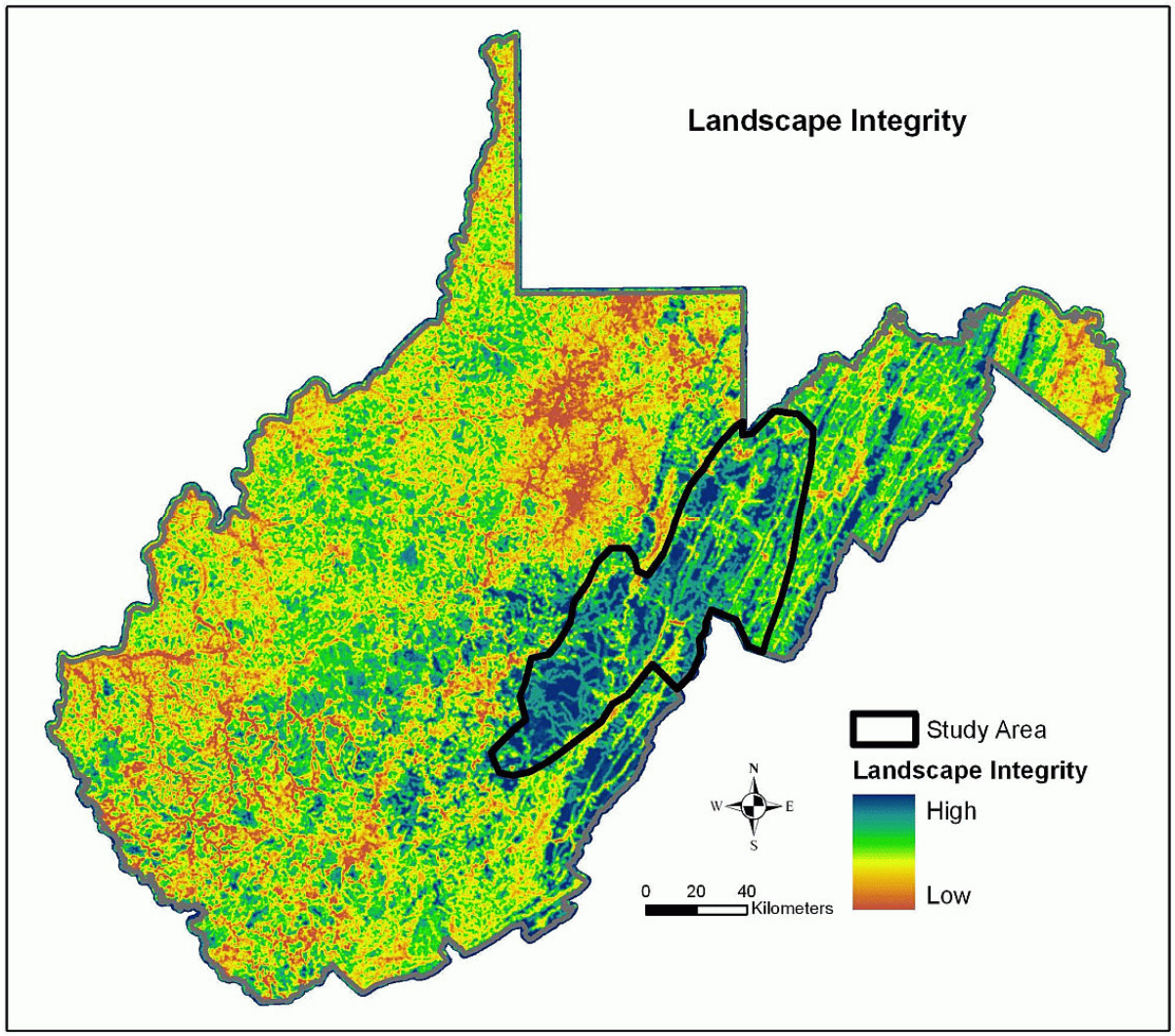


Figure 6. Landscape integrity (Dougherty and Byers 2008)

Methodology

Sampling plan

Prior to field sampling, we collected existing quantitative vegetation plot data and assessed its suitability for classification purposes. Data sets were screened to determine whether they could be combined with the WV Natural Heritage Program standard plot data for multivariate statistical analyses. The Natural Heritage database contained an initial 43 plots, including plots sampled by WVDNR staff and data contributed by the Monongahela National Forest, The Mountain Institute, and The Nature Conservancy. Steve Stephenson and Harold Adams generously contributed unpublished plot data from old growth red spruce stands at Turkey Run, Shavers Mountain, and Gaudineer Knob.

Based on our review of literature and data sources, we determined which communities or areas were already adequately sampled and which required additional sampling. Additional sources for identifying target stands included interviews with experienced surveyors and biologists, USGS topographic maps, 1997 infrared aerial photography, 2003 true-color aerial photography, NRCS soil survey maps, WV Geological Survey maps of bedrock lithology, Monongahela National Forest stand data, and Natural Heritage rare species records.

Plot locations were stratified to sample the diversity of red spruce upland community types across their range in the state. We did not sample every community occurrence at every stand, but rather a large enough subset to develop a comprehensive classification, document abundance and variation of individual community types across their range in the state, and assess relative quality of individual occurrences. Red spruce forests in West Virginia are largely on public land including the Monongahela National Forest, the Canaan Valley National Wildlife Refuge, Canaan Valley State Park, and Blackwater Falls State Park. Additional high quality forests are owned by The Nature Conservancy, corporations and private individuals. We obtained all needed permissions and permits before conducting surveys. The results of this project should yield benefits for all of these cooperators, in terms of better understanding of the natural communities present on their land, the quality and rarity of these communities, and the ecological processes that maintain them.

After an area was chosen for field inventory, we reviewed aerial photography, maps, and written sources of information to identify the presence and distribution of individual stands as indicated by photographic signatures and environmental, physiognomic, and floristic patterns. During the project, 72 plots were field sampled, with particular emphasis on gaps in the existing data set. A total of 118 quantitative plot samples were thus assembled.

Animal records were drawn from published literature, unpublished reports, and databases available at the WVDNR. Animal data were compiled based on habitat information when it was available, and otherwise based on locations that were known to be within the red spruce ecosystem. Since many animal species use both forested and open habitats during various parts of their life cycles, the criteria for including species in this section is broader than for the floristic descriptions. Faunal records are included from red spruce forests, mixed red spruce-northern hardwood forests, and high elevation wetlands embedded within the red spruce ecosystem.

Field methods

We sampled red spruce communities in compliance with standards for vegetation field plots established by the Ecological Society of America (2004) for describing and classifying associations in the U.S. National Vegetation Classification. Specific sampling protocols are described by Sneddon (1994). Plot locations were carefully selected in the field to be relatively homogenous and representative of their stand. Most plots measured 20 x 20 meters, but in one case a rectangular plot (18 x 22m) was used to capture a narrow woodland. Coordinates for the center of each plot were collected using a Trimble GeoExplorer Global Positioning System (GPS).

Seventy-two plots were sampled during June-September of 2006. A sample plot data collection form is included as Appendix A. Three types of data were collected: metadata, environmental data, and vegetation data. Metadata documented the plot identifiers, surveyors' names, sampling date and time, photographic record, location information, and GPS data.

Environmental data included hydrologic descriptors, aspect, elevation, slope, slope shape, landform, Cowardin system (Cowardin et al. 1979), surficial geology, topographic position, and stand size. Soil information included a profile description, texture determined by hand in the field, pH determined in the field, horizon, color, stoniness, and depth of organic soil. Our soil sampling protocol is to collect the top 10 cm of the mineral horizon for chemical analysis in the lab; however, in many spruce plots the organic surface soils were deep, and the chemical analysis indicates that samples reflect organic, not mineral, horizons. Each soil sample was composited from four locations in the plot. We also made a qualitative written evaluation detailing whether the plot was representative of the community as a whole, the overall environmental condition of the plot, and its landscape context. Both natural and anthropogenic disturbances and threats were noted, and an overall quality rank was assigned to each stand. We made a brief note of any signs of animal use such as scat, game trails, or browsed vegetation.

Vegetation data included information on physiognomy (structure) and species composition. Dominant leaf type, leaf phenology, and physiognomic class were noted, along with the height and total cover in each stratum (canopy, subcanopy, tall shrub, short shrub, herbaceous, and nonvascular). Percent cover in each stratum and total cover by each vascular plant species in a plot was determined by ocular estimation. We recorded the diameter at breast height (dbh) for all woody species with dbh of 7 cm or greater. A few trees were cored in each plot to help determine stand age and growth rates. Bryophytes and lichens were recorded for species having greater than 1% cover. Unknown plant and lichen taxa were collected for identification in the herbarium or by specialists.

Analysis methods

Collections and data management

Vascular plants that could not be identified in the field were collected and later identified in the WVDNR herbarium. Bryophyte specimens were identified by Susan M. Studlar of West Virginia University. Lichens were identified by Don G. Flenniken. Fungi were identified by William Roody and Donna Mitchell at WVDNR.

Brookside Labs analyzed the chemistry of soil samples from each plot. Tests were made for the following parameters: aluminum, boron, calcium, copper, estimated nitrogen release, hydrogen ions, iron, magnesium, manganese, organic matter, pH, phosphorus, potassium, SMP buffer, sodium, soluble sulphur, total exchange capacity, and zinc.

We entered all community plot data collected during this project and any legacy data deemed compatible for classification purposes in the Natural Heritage community ecology plots database, known as Plots2-WV, which is based on the Plots Database System of the National Park Service Vegetation Mapping Program (USGS 2002). The Plots2-WV database meets standards established by the Ecological Society of America (2004), facilitates import and export of plot data, and is used for all of West Virginia's Natural Heritage Program community classification projects.

Species names were standardized following Harmon et al. (2006) for vascular plants, Studlar et al. (2002) for bryophytes, Esslinger (2009) for lichens, and the Index Fungorum (2008) for fungi. Environmental variables (units and categories) were also standardized across the data set. Two WVDNR biologists checked all data for errors, comparing recitation from the database with visual checking of original plot sheets.

Statistical analysis

Classification of communities was based primarily on vegetation. We performed multivariate statistical analyses using PC-Ord software (McCune and Mefford 1999) to develop a classification of upland forest and woodland communities within the study area. Sample results showing graphical outputs at various stages in the iterative statistical process are included as Appendix B.

The analysis began with 202 upland plots, all of which contained some red spruce, of which 118 plots contained at least 15% red spruce in the canopy layer. The plots with a minor red spruce component (<15% canopy cover in a northern hardwood forest) were included in the initial statistical analysis in order to delineate the "edges" of the upland red spruce ecological system.

The first step in preparing plot data for analysis was to reconcile differing levels of species identification. For example, some immature taxa were identified to genus rather than

species. Also, varieties and subspecies were noted by some researchers but not by all. When the ecological amplitudes at the different levels of taxonomic identification were closely similar (*e.g.*, *Photinia* spp. or *Lasallia* spp.), the specific or infraspecific data were lumped. When the level of taxonomic identification was too broad (*e.g.*, most genera) to be meaningful in terms of ecological amplitude, the data were deleted from the analysis.

Data preparation continued with the development of different analysis scenarios based on the quality and distribution of the plot data. For example, analysis sets were compiled for plots with and without bryophyte data, or with differing physiognomies (*e.g.*, forest or woodland).

The next part of scenario development was to choose a data transformation that made ecological sense. Ecological reasons to use data transformations include (a) making statistical distance measures work better, (b) altering the relative importance of common and rare species, and (c) emphasizing informative species at the expense of uninformative species. Transformations also improve assumptions of normality, linearity, and homogeneity of variance (McCune and Grace 2002). Based on the authors' experience with West Virginia forest stand data, a square root transformation was preferred. Brief experimentation with log transformation, relativization by plot maximum, relativization by species maximum, and double relativization did not change this preference, *i.e.*, the results that consistently made the most sense in terms of matching the researchers' understanding of natural groupings and outliers were derived from the square root transformation scenarios. This is a commonly used transformation for ecological data, which typically have a positively skewed distribution. The square root transformation also makes ecological sense in terms of the type of plot samples used in this study, since it slightly damps the influence of dominant species (which might have higher cover in individual plots than in the community as a whole), and slightly enhances the influence of rare species (which might be under-sampled in plots compared to the community as a whole).

Continuing with scenario development, we experimented with deleting species that occur in only a small number of plots, in order to reduce statistical noise in the data and enhance relationships between communities. McCune and Grace (2002) recommend deleting species that occur in up to 5% of the sample units. The optimum number to delete can be estimated by comparing correlation coefficients against the number of species retained. We found the highest correlations and most meaningful groupings when we deleted all species that occurred in only one plot.

We began the evaluation of each scenario by examining statistical summaries of rows (plots) and columns (species) and outlier analysis. Univariate and bivariate plot outliers were identified and carefully evaluated. Some outlier plots were retained if they appeared to represent important but underrepresented community types. Other outlier plots were excluded from subsequent classification runs, either because of placement on an ecotone, excessive anthropogenic disturbance, lack of bryophyte data (in bryophyte-rich communities), or incomplete floristics. These plots still contained much useful information and were set aside for eventual use in determining the range of classified vegetation types.

Hierarchical, polythetic, agglomerative cluster analysis was applied to the various scenarios to iteratively define groupings of plots. We used the Sorensen (Bray-Curtis) distance

measure with the compatible, space-conserving flexible beta group linkage. Flexible beta was initially set equal to -0.25, but in multiple classification runs this number was varied (as low as -0.5) to "stress" the clusters, *i.e.*, to see if the clusters were robust. Clusters were examined to ensure that excessive chaining did not occur.

Indicator species analysis was used to help choose the optimum number of groups, and to characterize community types. Using an iterative process, the numbers of groups were compared with the number of significant indicator species for each scenario. Scenarios with large numbers of significant indicators were selected as robust groupings. Indicator species are also important descriptors to help differentiate between community types, and are reported in the text of the community descriptions. We calculated indicator values using the method of Dufrene and Legendre (1997). The Monte Carlo significance test of observed maximum indicator value for groups used 4999 permutations for each analysis, with a random number seed based on the time of day. Significance (*p*-values) less than 0.05 were used to define indicators.

Once we identified major groups through the clustering process, nonmetric multidimensional scaling (NMS) was used to help understand the relationships between groups, to seek out patterns, and to identify environmental gradients (Kruskal 1964, Mather 1976). NMS is currently considered to be the most effective ordination method for ecological community data (McCune and Grace 2002), allowing interactive views into multi-dimensional "species space." We used the Sorenson (Bray-Curtis) distance measure with a random starting configuration. For each scenario, we specified 250 runs with real and randomized data, respectively, in two- to six-dimensional configurations. We evaluated the quality of results through stress levels, which at 13-16 were typical of community ecology data, instability levels (generally <0.0001), and the number of iterations (generally <130) required to reach a solution. Scenarios with lowest stress, instability and number of iterations represented the most interpretable solutions. Results were viewed in 2-dimensional charts and 3-dimensional rotating "clouds", allowing us to discern community grouping patterns and their relationships to floristic axes. The linear relationship between the ordination scores and each species in the analysis was evaluated using Pearson's *r* (Pearson 1901), and the rank relationship was evaluated using Kendall's *tau* (Kendal 1975). Strongly correlated species helped us to conceptualize the floristic axes of the ordination in relation to community types.

The hypothesis of no difference between classified communities was tested using nonparametric multi-response permutation procedures (Mielke 1984, Mielke and Berry 2001). A Euclidean (Pythagorean) distance measure was used. The chance-corrected within-group agreement (*A*) results ranged from 0.17-2.0, with *p*-values = 0.00000000, which indicates high confidence that the heterogeneity within groups is less than would be expected by chance, *i.e.*, that there are indeed differences between classified communities.

Environmental factors were analyzed to determine correlations with floristic ordination axes using correlation coefficients and joint plots. The linear relationship between the ordination scores and each quantitative environmental variable in the analysis was evaluated using Pearson's *r*, and the rank relationship was evaluated using Kendall's *tau*. Joint plots show the relationship between environmental variables and ordination scores as a diagram of radiating lines. The angle and length of each line indicates the direction and strength of the relationship

(McCune and Grace 2002). We specified a cutoff value of Pearson's r^2 >= 0.2, or a combination of r^2 > 0.1 combined with absolute values of Kendall's *tau* > 0.2 for correlations described in the text. This method gives information about the full range of values for each community, but is restricted to environmental variables that have strong correlations with floristic axes. In some cases where communities lie between floristic axes, strong correlations can be missed by this method.

A second, non-standard method was used to extract additional information about environmental gradients. Quantitative environmental variables were input to PC-Ord as "pseudo-species". A second matrix assigned these variables to classified communities based on their plot codes. Indicator species analysis was used to determine the indicator value and significance ($p < 0.05$) of each environmental variable relative to defined community types. This method is flawed in that indicator values combine both frequency and abundance, and in this case frequency is 100% for all variables, so the calculated "indicator value" represents only abundance. However, the technique is useful in highlighting environmental variables that have significantly higher abundance in specific communities. It does not give information on low and intermediate values. Environmental variables with significant ($p<0.05$) values of high abundance in a classified community are reported in the text.

Integration into the U.S. National Vegetation Classification

The final classification is based on the West Virginia data but is constructed within the hierarchy and context of the U.S. National Vegetation Classification (NVC) (Grossman et al. 1998). Community types are classified and described at the association level. Five associations were identified in West Virginia, which were classified, described, peer-reviewed, and published in the NVC as a result of this project. The crosswalk to the NVC was done in coordination with NatureServe partners including the Northeastern and Southeastern NatureServe Ecology staff and state ecologists from Virginia and North Carolina.

NVC descriptions of each community include floristic data (composition, indicator species, rare species), environmental data, soils data, distribution data, ecological process information, and references from the literature. Rangewide descriptions of each NVC community are available on the NatureServe Explorer website (NatureServe 2010). The descriptions in this report are specific to West Virginia.

Conservation ranking

Each community type was given a global and state conservation rank based on ecological integrity, rarity, current status, threats, and short- and long-term trends. These factors are summarized and expressed as a brief code, following NatureServe standards (Faber-Langendoen et al. 2009). Global ranks, beginning with "G", reflect an assessment of the condition of the ecological community across its entire range. Ranks beginning with "S" reflect the state rank, *i.e.*, the conservation priority within West Virginia. Conservation ranks can provide a basis for prioritizing management and conservation decisions by public and private land managers. Definitions of conservation status ranks are given in Table 1.

Table 1. NatureServe conservation status rank definitions

Rank	Definition
G1 **S1**	**Critically Imperiled**—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2 **S2**	**Imperiled**—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
G3 **S3**	**Vulnerable**—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
G4 **S4**	**Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5 **S5**	**Secure**—Common; widespread and abundant.
G#G# **S#S#**	**Range Rank**—A numeric range rank (*e.g.*, G2G3) is used to indicate the range of uncertainty in the status of a species or community. A G2G3 rank would indicate that there is a roughly equal chance of G2 or G3 and other ranks are much less likely.
GNR **SNR**	**Unranked**—Rank not yet assessed.
G#? **S#?**	**Inexact Numeric Rank**—Denotes some uncertainty about the numeric rank (*e.g.* G3? - Believed most likely a G3, but some chance of either G2 or G4).

In addition to ranking the conservation status of each community as a whole, sampled stands were also assessed in terms of their quality at the specific sampling site. Each sampled stand, also called a community occurrence, was rated using NatureServe standard criteria of size, condition, and landscape context. The highest quality occurrences of each natural community type are the reference or benchmark to which all degraded or impacted communities should be compared.

Mapping and modeling

Red spruce forests have not been comprehensively mapped to date in West Virginia. As part of this assessment, we mapped sampled occurrences of rare and exemplary upland red spruce communities in Biotics (NatureServe 2007, WVDNR 2010a), a georeferenced database developed and maintained by NatureServe and the network of Natural Heritage Programs. Biotics utilizes both spatial and tabular data to document natural ecological communities and rare, threatened, and endangered species. The mapped communities are linked to representative plot samples and comprise only a small portion of the total red spruce forests in West Virginia.

We also modeled habitat suitability for red spruce upland and wetland communities in the state, using MaxEnt Version 3.1.0 software (Phillips et al. 2004, 2006). Michael Dougherty, GIS Analyst at WVDNR, was the lead for this modeling project (Dougherty 2008). The MaxEnt software uses maximum-entropy techniques, *i.e.*, sequential-update algorithms that can handle a very large number of features, to model species geographic distributions with presence-only data. The model input consists of a set of georeferenced occurrence locations and a set of layers or environmental variables, and the output is a model of the probable range of the species. The model expresses the suitability of each grid cell in a landscape as a function of the environmental variables at that grid cell. A high value of the function at a particular grid cell indicates that the grid cell is predicted to have suitable conditions for that species. The computed model is a probability distribution over all the grid cells. The distribution chosen is the one that has

maximum entropy and the same expectation for each feature (derived from the environmental layers) as the average over sample locations.

Input data for the distribution models included 114 upland plots and 169 wetland plots. Each plot was characterized by at least 15% cover of red spruce in the canopy. Plots were screened for locational accuracy, with most plots accurate to less than 3 meters. A few plots with locational uncertainty as high as100 meters were allowed in the analysis when air photo verification indicated that this uncertainty level would still place the plot within the same stand. Plot data were modeled against 58 quantitative variables and 7 categorical variables related to temperature, precipitation, elevation, aspect, slope, topographic position, geology, and land use. The plot records were used for training the model and then 10,000 background points were added to determine the maximum entropy distribution. The algorithm was run for 500 iterations. More information about these model results is available on request to WVDNR.

Dissemination of results

Results have been shared through meetings, presentations, and data exchanges with government and civil society partners including Appalachian Joint Venture, Canaan Valley Institute, Canaan Valley National Wildlife Refuge, Monongahela National Forest, Natural Resources Conservation Service, NatureServe, The Nature Conservancy, West Virginia Academy of Sciences, West Virginia Division of Forestry, West Virginia Highlands Conservancy, West Virginia University, private timber companies, and private landowners. The project leader is an active member of the Central Appalachian Spruce Restoration Initiative, a multi-organizational partnership to restore the red spruce ecosystem on public and private land.

The project leader has communicated results to the public through the Blackwater Falls Wildflower Pilgrimage, Brooks Bird Club, Davis & Elkins College, Maryland Native Plant Society, Randolph County Outdoor Program, Virginia Native Plant Society, West Virginia Master Naturalist Program, West Virginia Native Plant Society, and West Virginia Public Radio.

Results and Discussion

The upland red spruce associations in West Virginia along with their environmental characteristics, vegetation, distribution, and conservation status are described in this section. A description of the fauna, flora, extent, and vulnerability of red spruce forests and woodlands is also included.

Upland red spruce communities

Five upland red spruce associations were classified, peer-reviewed, and published in the U.S. National Vegetation Classification (NVC). All five of the associations have high global and state conservation priority. The communities described in this study include four upland forest types and one upland woodland type. Wetland associations within the red spruce zone in West Virginia are described separately in Byers et al. (2007). The common and scientific names of the associations, with their corresponding state and global conservation ranks, are listed in Table 2.

Table 2. Red spruce upland communities and conservation ranks

Common Name	NVC Code and State Scientific Name	Global Rank	State Rank
FOREST			
Red Spruce – Southern Mountain Cranberry Forest	CEGL007131: *Picea rubens / Vaccinium erythrocarpum / Dryopteris campyloptera* Forest	G2	S1
Red Spruce – Yellow Birch Forest	CEGL008501: *Picea rubens – Betula alleghaniensis* var. *alleghaniensis / Bazzania trilobata* Forest	G2	S2
Red Spruce – Rhododendron Forest	CEGL006152: *Picea rubens / Rhododendron maximum* Forest	G2G3	S2
Red Spruce – Hemlock – Beech Forest	CEGL006029: *Picea rubens – Tsuga canadensis – Fagus grandifolia* / Dryopteris *intermedia* Forest	G3	S3
WOODLAND			
Red Spruce – Heath Rocky Woodland	CEGL006254: *Picea rubens / Kalmia latifolia - Vaccinium angustifolium* Rocky Woodland	G2	S1

A dichotomous floristic key to the upland red spruce communities (Appendix C) was developed to assist practitioners in identifying the red spruce communities discussed in this report. Together with the key to red spruce wetlands in Byers et al (2007), the floristic keys should allow identification of all U.S. National Vegetation Classification units within the red spruce ecosystem in West Virginia. In addition, an approximate key based solely on environmental characteristics such as elevation and geology was developed to guide restoration activities within the red spruce ecosystem (Appendix C).

Each of these five upland communities has its own ecological niche. Figure 7 shows the approximate altitudinal range in feet above sea level and the approximate relative abundance (width of the diamond) of the five types.

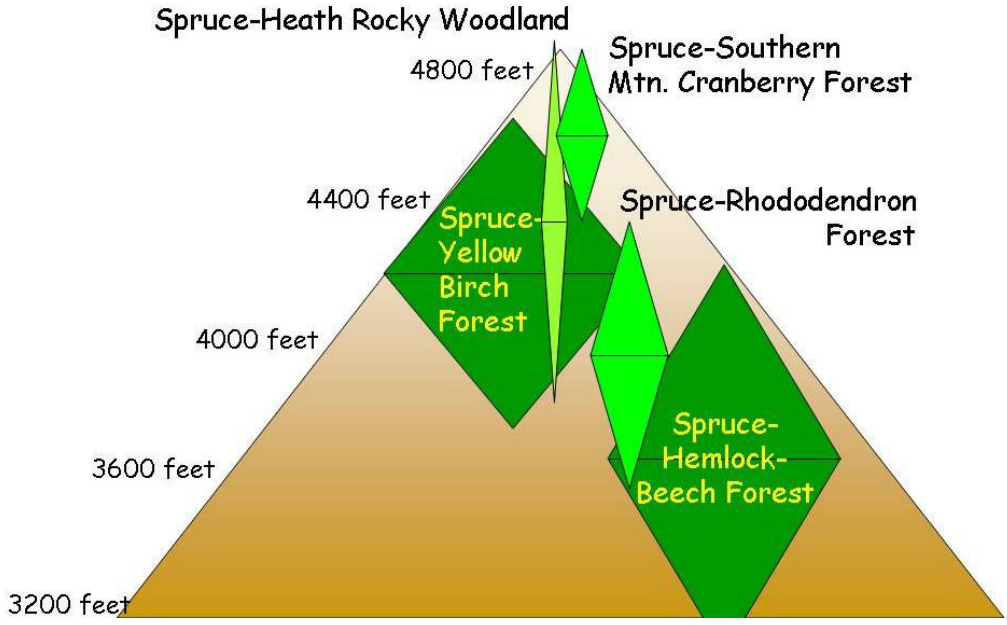


Figure 7. Altitudinal range and relative abundance of red spruce communities

In West Virginia, upland red spruce forests and woodlands occupy the highest, coldest, and wettest environments in the state, topping the ridges and knobs of the Allegheny Mountain region at elevations above 1000 meters (3300 feet). The red spruce-southern mountain cranberry forest is found in the highest and wettest topographic positions, while the red spruce-heath rocky woodland may be just as high in elevation, but is restricted to drier summits along the Allegheny Front. Throughout the middle and upper elevations, the red spruce-yellow birch forest is the most commonly encountered association. Red spruce-rhododendron forest is generally found in sheltered locations at middle and lower elevations within the spruce zone. At lower elevations and grading into northern hardwood forests, red spruce-hemlock-beech forest is found. In frost pockets or on cool northern aspects, occasional stands of red spruce-hemlock-beech forest may extend to elevations as low as 875 meters (2870 feet). All of the red spruce forest and woodland types are characterized by relatively gentle slopes and less disturbed landscapes, as compared to other forest types in the state (Table 3).

Table 3. Topographic and disturbance indices

	Statistic	Red spruce-sou. mtn. cranberry forest	Red spruce-yellow birch forest	Red spruce-rhodo-dendron forest	Red spruce-hemlock-beech forest	Red spruce-heath rocky woodland	All upland spruce types	Statewide mean
Number of plots	*N*	*13*	*37*	*15*	*23*	*10*	*118*	
Elevation (m)	Mean	**1387**	1248	**1183**	**1183**[1]	1245	1242	505
	StdDev	80	86	118	124	134	123	259
	Min	1142	1076	959	875	1014	875	64
	Max	1455	1384	1364	1357	1479	1479	1482
Slope (degrees)	Mean	9.7	5.9	8.1	**12.0**	**5.1**	7.7	26
	StdDev	9.6	5.4	8.1	8.0	4.7	7.4	16
Topographic roughness index	Mean	155	100	109	**167**	**66**	121	203
	StdDev	94	51	69	94	60	80	114
Landscape integrity index (Fig. 6)	Mean	**827**	818	818	813	**805**	817	693
	StdDev	31	36	52	51	37	44	96

Upland red spruce communities are characterized a short growing season, low temperatures, high precipitation, high relative humidity, and low evapotranspiration rates. Solar radiation is high (Table 4). As would be expected, the coldest temperatures and highest precipitation are found in the high elevation red spruce-southern mountain cranberry forest. The warmest temperatures are experienced by the lower elevation red spruce-hemlock-beech forest. Temperature extremes, including frost and summer heat, are greatest in the red spruce-heath rocky woodland that occurs on the exposed summits of the Allegheny Front. Climate data is drawn from 400-meter resolution grids created using the Parameter-elevation Regressions on Independent Slopes Model (PRISM) climate mapping system (PRISM Climate Group 2009) of daily, monthly, and annual measurements from the National Weather Service Cooperative Network, USDA Snow Telemetry, US Forest Service Remote Automatic Weather Stations, and other networks (Climate Source 2008).

[1] Bold values in the five red spruce community columns indicate strong correlations with communities or significantly ($p<0.05$) higher values from communities within the red spruce ecosystem.

Table 4. Mean annual climate variables 1971-2000

	Statistic	Red spruce-sou. mtn. cranberry forest	Red spruce-yellow birch forest	Red spruce-rhodo-dendron forest	Red spruce-hemlock-beech forest	Red spruce-heath rocky woodland	All upland spruce types	Statewide mean
No. of plots	*N*	13	37	15	23	10	118	
Days below 32°F	Mean	**157**[2]	153	155	**151**	153	153	129
	StdDev	5	5	4	7	2	5	13
Evapotrans-piration (1/10 mm)	Mean	**15**	16	**17**	16	16	16	20
	StdDev	1.2	1.0	1.1	1.4	0.8	1.2	2
Frost-free days	Mean	125	132	129	**134**	**124**	130	156
	StdDev	12.1	7.7	10.1	7.9	9.0	9	13
Growing degree-days >50°F	Mean	**1948**	2041	2040	2069	**2103**	2040	3067
	StdDev	75	113	153	144	51	125	471
Precipi-tation (mm)	Mean	**1452**	1425	**1443**	1434	**1210**	1411	1154
	StdDev	131	107	120	170	42	141	136
Relative humidity (%)	Mean	77	77	**76**	77	**76**	77	71
	StdDev	1.7	1.7	2.0	2.3	1.7	1.9	3
Solar radiation (kw/m^2/day)	Mean	1443	1485	1460	**1407**	1480	1458	1295
	StdDev	120	65	83	87	71	87	98
Solar rad. in growing season (kw/m^2/day)	Mean	902	915	901	**877**	**916**	903	809
	StdDev	47	25	29	34	30	35	43
Mean monthly temperature (°C)	Mean	**6.1**	6.4	**6.8**	**6.8**	6.6	6.5	10.8
	StdDev	0.4	0.5	0.6	0.9	0.4	0.6	1.3
Maximum monthly temperature (°C)	Mean	**12.0**	12.3	**12.8**	12.7	12.7	12.5	17.3
	StdDev	0.2	0.5	0.8	1.0	0.6	0.7	1.5
Minimum monthly temperature (°C)	Mean	**0.4**	0.7	**0.9**	**1.0**	0.7	0.7	4.5
	StdDev	0.7	0.8	0.6	0.9	0.2	0.8	1.2

Dominant species with constancy >60% and cover >9% in upland red spruce communities are *Picea rubens* (red spruce), *Betula alleghaniensis* var. *alleghaniensis* (yellow birch), and *Bazzania trilobata* (common bazzania liverwort). Other important species, with slightly lower constancy and/or cover, are *Acer rubrum* (red maple), *Tsuga canadensis* (eastern hemlock), *Ilex montana* (mountain holly), *Rhododendron maximum* (great rhododendron),

[2] Bold values in the five red spruce community columns indicate strong correlations with communities or significantly ($p<0.05$) higher values from communities within the red spruce ecosystem.

Vaccinium erythrocarpum (southern mountain cranberry), *Dryopteris intermedia* (intermediate woodfern), *Hypnum imponens* (flat fern moss), and *Dicranum scoparium* (broom fork moss).

The most common and characteristic tree species in the study area is the foundation species *Picea rubens* (red spruce). Red spruce is a shade-tolerant species that can persist in the understory for long periods and quickly respond to canopy gaps. Adams and Stephenson (1989) documented three old-growth red spruce stands in West Virginia with stand ages of approximately 200 years and oldest trees ranging from 274 to 368 years. We cored a few trees in most plots to get an idea of the stand age and history; however, we did not core any trees in old-growth stands whose stand ages were available in the literature. The oldest red spruce tree (spruce 22a in Figure 8) that we cored had 301 annual growth rings at breast height, and had been released about the year 1910. Other trees in that stand were released at the same time, presumably when the stand was logged at the turn of the century. This particular old tree had attained a diameter of only 13 centimeters during its first two hundred years of understory growth. In 2006, after 100 years of release, it had grown to a diameter of 41 cm. Similar patterns of long (more than 100 years) of understory growth prior to release were found in stands throughout the upland red spruce communities.

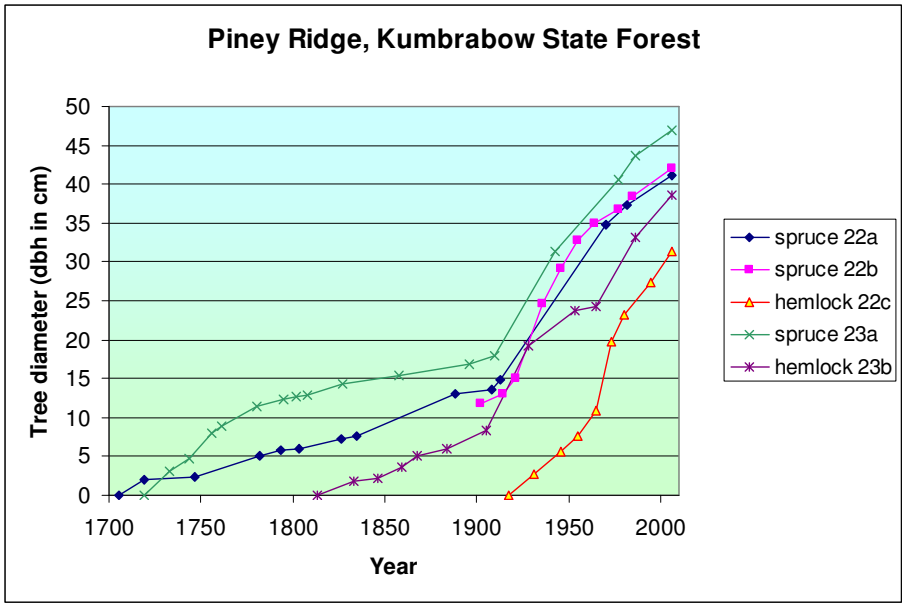


Figure 8. Growth-release pattern of red spruce stand at Kumbrabow State Forest

Red spruce is most competitive with other species in West Virginia's coldest and wettest habitats. Canopy cover by red spruce is highest in the red spruce-southern mountain cranberry forest, with decreasing canopy cover as elevations decrease. Red spruce-hemlock-beech forest, which occurs at lower elevations within the range of red spruce, has the lowest percentage of red spruce in the canopy. Red spruce-heath rocky woodland, at high elevations but on drier sites, is strongly dominated by red spruce in the canopy, but because of its more open woodland physiognomy, the percentage of red spruce is only moderate (Figure 9).

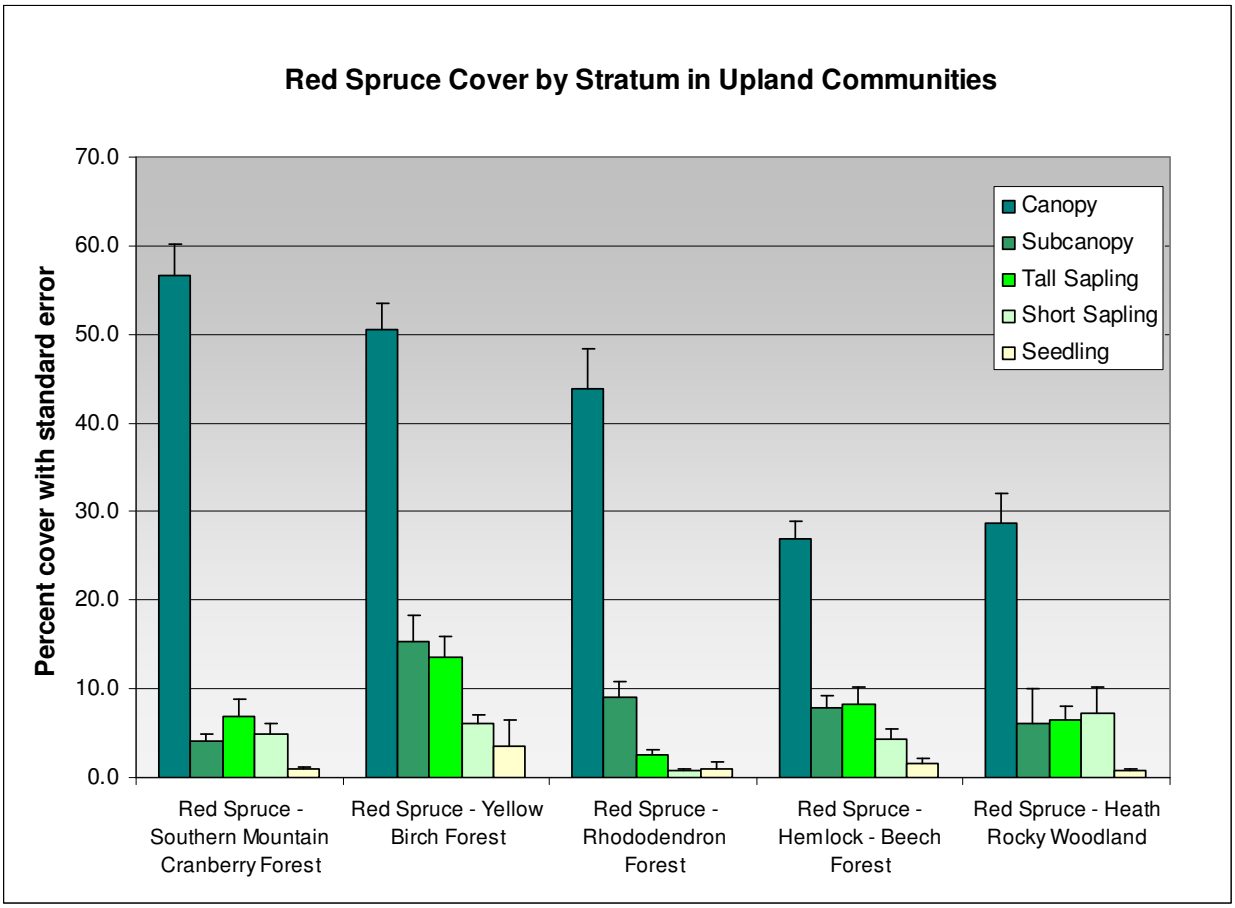


Figure 9. Red spruce cover by stratum in upland communities

The successional state (80-120 years post-logging) of most mature spruce stands in West Virginia tends to obscure environmental gradients and community types. Very few old growth red spruce stands remain in the state, and those that do remain are small enough that edge effects are important. It is not feasible to write completely accurate descriptions of spruce forest characteristics prior to European settlement descriptions based on existing vegetation; however, where soils were not eroded or burned and forests have regenerated naturally, existing vegetation is probably a relatively faithful reflection of the pre-settlement floristic composition. Tree ages and diameters are younger and smaller today than they would have been in pre-settlement times, and most stands are lacking in important habitat elements such as standing snags and abundant coarse woody debris. The natural interspersion of early successional openings and forest matrix has changed as well. While many natural wetland openings remain intact, only a few natural openings created by windthrow exist today. Instead, the forest matrix is fragmented by weedy anthropogenic openings including roads, utility lines, railbeds, timber cuts, structures, maintained pastures, abandoned farms, and strip mines.

We observed deep organic surface horizons in soils under mature red spruce stands, particularly where there was no evidence of soil damage from the widespread destructive fires

that occurred during the logging boom of 1880-1920. The Natural Resources Conservation Service has tentatively classified these soils as having folistic epipedons, *i.e.*, soils with an organic horizon that is at least 15 cm thick (NRCS 1999). Our limited number of observations indicates that red spruce forests and woodlands at high elevations on flats or on boulderfields are often underlain by folists, which have an organic horizon that is at least 30 cm thick. We hypothesize that for soil surfaces occurring in burned areas, or at lower elevations where the red spruce dominance cedes to northern hardwoods, this organic soil surface horizon is much diminished.

Our soil sampling protocol for laboratory analysis is to collect and composite the top 10 cm of mineral soil from four shallow "cat-holes" inside the 20 x 20 meter plot. However, the organic soils in most of our spruce plots were either (a) deep, or (b) extended to rock layers that we did not penetrate with our simple "cat-hole" procedure. The litter/duff layer extended from 1-20 cm depth (average 6 cm). Beneath this was organic-rich silty or sandy material with low color value and chroma to a depth of 5-34 cm (average 16 cm). This is the layer that was primarily sampled for laboratory analysis. Beneath this layer we encountered rock, continued organic-rich material, or mineral soil of a variety of textures. The laboratory results for our soil samples average 44% organic matter, indicating that the sampled horizons were organic soils, not mineral soils.

The samples are characterized by very high organic matter, high cation exchange capacity, low pH, and a high percentage of the acid cation hydrogen. In comparison with soil data from Natural Heritage plots statewide, spruce soils are generally low in base saturation and low in macro- and micronutrients. The exception is the primary nutrient nitrogen, which is available in normal and sometimes abundant supply. Phosphorus is low to normal. Potassium is low, as are calcium and magnesium. Micronutrients are also low, particularly copper, manganese, boron, and iron. Non-nutrient aluminum (acid) and sodium (base) cations are low as well (Table 5). These results are consistent with Jenkins (2002) soil series description of frigid, well and moderately-well drained spodosols, containing significant organic carbon reserves, but at high risk with regard to potential calcium depletion.

Table 5. Soil chemistry results

Soil chemistry variable	Statistic	Red spruce-sou. mtn. cranberry forest	Red spruce-yellow birch forest	Red spruce-rhodo-dendron forest	Red spruce-hemlock-beech forest	Red spruce-heath rocky woodland	All upland spruce	State-wide upland forest (excluding spruce)
	N (plots)	6	24	7	15	5	57	744
pH	Mean	3.6	3.6	3.6	3.6	3.7	3.6	4.5
	StdDev	0.25	0.16	0.18	0.24	0.33	0.22	0.78
SMP buffer pH	Mean	4.3	4.3	4.2	4.2	4.5	4.3	5.8
	StdDev	0.31	0.31	0.85	0.31	0.45	0.41	0.80
% base saturation	Mean	32	33	34	36	39	34	69
ENR (estimated nitrogen release)	Mean	126	128	123	128	130	127	108
	StdDev	5.8	5.0	17.8	4.0	0.0	7.4	22.5
% organic matter	Mean	35	42	52	40	**57**	44	13
	StdDev	33	29	25	27	24	27	16
TEC (total exchange capacity)	Mean	34	35	35	35	32	35	19
	StdDev	4.0	4.1	10.6	4.2	4.9	5.2	9.1
Al (ppm)	Mean	520	431	333	598	215	453	769
	StdDev	281	234	88	412	80	294	355
B (ppm)	Mean	0.3	0.3	0.3	0.4	0.3	0.31	0.49
	StdDev	0.1	0.1	0.2	0.2	0.1	0.14	0.29
Ca (ppm)	Mean	245	239	263	302	**307**[3]	264	776
	StdDev	167	102	161	177	121	135	1163
Cu (ppm)	Mean	0.38	0.41	0.51	0.42	0.31	0.42	1.12
	StdDev	0.12	0.32	0.38	0.23	0.11	0.28	1.58
Fe (ppm)	Mean	204	177	121	**240**	**82**	181	217
	StdDev	150	128	24	171	23	136	112
H (pct)	Mean	95	95	94	94	93	94	69
	StdDev	2.2	1.5	2.4	2.5	3.3	2.2	30.5
K (ppm)	Mean	52	54	51	59	**78**	56	79
	StdDev	24	20	26	33	21	25	47
Mg (ppm)	Mean	37	46	47	49	**55**	46	85
	StdDev	11	15	21	14	12	15	76
Mn (ppm)	Mean	5.5	7.7	7.0	10.1	**20.6**	9.1	129
	StdDev	4.2	6.9	4.5	8.3	32.7	11.5	157
Na (ppm)	Mean	13	15	18	15	15	15	20
	StdDev	1.8	3.1	3.8	4.0	5.1	3.6	7.3
P (ppm)	Mean	26	20	17	24	11	20	27
	StdDev	15.2	10.1	7.5	11.2	1.8	10.7	27
Sol. Sulfur	Mean	25	23	30	**37**	**19**	28	31
	StdDev	5.2	4.2	11.0	19.2	3.7	12.5	18.6
Zn (ppm)	Mean	2.5	3.8	6.4	3.1	4.9	4.0	4.5
	StdDev	1.4	2.6	5.9	1.8	1.7	2.9	17.1

[3] Bold values in the five red spruce association columns indicate strong correlations with associations or significantly higher abundance ($p<0.05$) values than other spruce associations.

Red Spruce – Southern Mountain Cranberry Forest

West Virginia Scientific Name: *Picea rubens / Vaccinium erythrocarpum / Dryopteris campyloptera* Forest

NVC Code: CEGL007131

NVC Name: *Picea rubens - (Abies fraseri) / Vaccinium erythrocarpum / Oxalis montana - Dryopteris campyloptera / Hylocomium splendens* Forest

NatureServe Conservation Status: G2 (Imperiled Globally); S1 (Critically Imperiled in West Virginia). This community is restricted to the highest mountain systems of the Southern Appalachians in eastern Tennessee, western North Carolina, and southwestern Virginia, with northern outliers in the highest elevations in the Allegheny Mountains of West Virginia. It has a naturally restricted distribution and was subject to major acreage reduction during the early part of the 20th century. Modern threats include atmospheric pollution deposition and climate change. Well-developed, undisturbed examples of this community are extremely rare.

West Virginia Description: This forest type is restricted to the highest elevations and coldest climate niche within the red spruce zone in West Virginia, occurring primarily on ridgetops at elevations above 1350 m (4400 feet). It is characterized by a dense canopy of *Picea rubens* (red spruce), with a sparse to dense understory of *Vaccinium erythrocarpum* (southern mountain cranberry), on a luxuriant carpet of liverworts and mosses. Dominant species, with high constancy and cover are *Picea rubens* (red spruce), *Betula alleghaniensis* var. *alleghaniensis* (yellow birch), *Vaccinium erythrocarpum* (southern mountain cranberry), *Bazzania trilobata* (common bazzania liverwort), and *Hypnum imponens* (flat fern moss). Diagnostic species, which combine significant indicator value ($p<0.05$) within West Virginia's red spruce forest types with relatively high constancy and cover, include *Vaccinium erythrocarpum* (southern mountain cranberry), *Ilex montana* (mountain holly), *Dryopteris campyloptera* (mountain woodfern), *Clintonia borealis* (yellow bluebead-lily), and *Trillium undulatum* (painted trillium). Species richness is 19 per 400 m^2 plot, which is typical of red spruce forests in West Virginia.

Natural disturbances in this community include wind disturbance, ice storms, insect damage, and lightning fire, usually on a single-tree scale (White and Pickett 1985, Nicholas and Zedaker 1989). Stand-replacing fires may affect large patch sizes but occur rarely, at 300 to 1,000-year intervals; wind events are likely at more frequent intervals of 100 to 200 years (Gorman 2007). Human-initiated disturbances have included logging, slash fires, and livestock grazing. Recent stresses include deposition of atmospheric pollutants, browsing damage by high deer populations, and land conversion for roads and recreation. This community is highly susceptible to climate change stress.

This spruce forest type has a dense canopy (70% cover) that is strongly dominated by *Picea rubens* (red spruce), with much lower cover by *Betula alleghaniensis* var. *alleghaniensis* (yellow birch) and *Acer rubrum* (red maple). *Prunus serotina* var. *serotina* (black cherry) and *Sorbus americana* (American mountain-ash) are occasionally present in the canopy. The subcanopy (20% cover) is much less dense with *Betula alleghaniensis* var. *alleghaniensis* (yellow birch), *Picea rubens* (red spruce), and *Acer rubrum* (red maple) as co-dominants, and occasional low cover by *Sorbus americana* (American mountain-ash) or *Fagus grandifolia* (American beech).

The tall and short shrub strata are dominated by *Vaccinium erythrocarpum* (southern mountain cranberry), which generally grows as a short shrub but can reach heights of more than 2 meters where growing conditions are favorable. The tall shrub layer averages 20% cover and may also include *Ilex montana* (mountain holly), *Acer pensylvanicum* (striped maple), and regenerating canopy saplings. Occasionally, *Menziesia pilosa* (minniebush), *Rhododendron maximum* (great rhododendron), *Rhododendron prinophyllum* (early azalea), and *Viburnum lantanoides* (hobblebush) may be present in the tall shrub stratum. The short shrub stratum averages 18% cover, with species distribution very similar to the tall shrub layer, including occasional trace amounts of *Vaccinium angustifolium* (northern lowbush blueberry).

The herbaceous layer is sparse, averaging only 7% cover. Herbaceous species with constancy >50% include *Dryopteris intermedia* (intermediate woodfern), *Dryopteris campyloptera* (mountain woodfern), *Maianthemum canadense* (Canada mayflower), *Oxalis montana* (mountain wood sorrel), *Clintonia borealis* (yellow bluebead-lily), and *Trillium undulatum* (painted

trillium). Less common herbaceous species include *Dennstaedtia punctilobula* (eastern hay-scented fern), *Lycopodium dendroideum* (tree clubmoss), *Polypodium appalachianum* (Appalachian rockcap fern), *Lycopodium clavatum* (running clubmoss), *Lycopodium obscurum* (princess-pine), *Oclemena acuminata* (whorled wood aster), and *Osmunda cinnamomea* (cinnamon fern). Bryophytes and lichens make up a considerable percent of the vegetative coverage in this community, occurring on the surface of the soil, trees, and fallen logs. Non-vascular cover is high (averaging 54%) in this forest type, with *Bazzania trilobata* (common bazzania liverwort) dominant, followed by *Hypnum imponens* (flat fern moss), *Dicranum scoparium* (broom fork moss), and *Brotherella recurvans* (shiny fern moss). Other common non-vascular plants include *Leucobryum glaucum* (common white cushion moss), *Cladonia furcata* (many-forked cladonia), *Polytrichum pallidisetum* (mountain hair cap moss), and *Dicranodontium denudatum* (naked windblown moss).

The moisture regime of this community is mesic to wet due to high rainfall, abundant cloud cover, fog deposition, and low temperatures. From 1971-2000, it experienced the lowest mean, maximum, and minimum temperatures, the fewest number of growing degree-days >50^{o}F, and the lowest potential evapotranspiration of the upland red spruce communities. Precipitation is moderate to comparatively high for the spruce zone (Climate Source 2008).

Soils are typical of the red spruce zone, with high organic matter and nitrogen, low pH, and generally low micronutrient nutrient status. Pennsylvanian sandstones of the Pottsville Group, often forming a resistant caprock on the ridges, underlie this community at most sites. At two sites (Green Knob and First Fork of the Upper Shavers) the community extends onto the adjacent Mississippian Mauch Chunk shale.

The community has been sampled at 13 plots (5 element occurrences) on the summits and north-facing uppermost slopes of Mt. Porte Crayon, Green Knob, Spruce Knob, Black Mountain, and in one slightly lower elevation upland-riparian transitional setting along First Fork of the Upper Shavers Fork. The plots in this type do not cluster tightly together in hierarchical agglomerative cluster analysis, but rather intermix with the more common red spruce-yellow birch forest type (CEGL008501) in West Virginia; however, in three-dimensional species space, they ordinate clearly together in the high elevation portion of CEGL008501. They are clearly related to elevation and temperature gradients and floristically distinct in the field due to the characteristic dominance of *Vaccinium erythrocarpum* (southern mountain cranberry).

Red Spruce – Yellow Birch Forest

West Virginia Scientific Name: *Picea rubens – Betula alleghaniensis* var*. alleghaniensis / Bazzania trilobata* Forest

NVC Code: CEGL008501

NVC Name: *Picea rubens / Betula alleghaniensis / Bazzania trilobata* Forest

NatureServe Conservation Status: G2 (Imperiled Globally); S2 (Imperiled in West Virginia). This community is geographically and environmentally restricted, occurring primarily in the Allegheny Mountains of West Virginia (Greenbrier, Pendleton, Pocahontas, Randolph, and Tucker Counties) and in scattered stands in Virginia (Highland and Rockingham Counties) (Stevens 1969) in the Alleghenies and adjacent Ridge and Valley region. Its former extent has been reduced to more-or-less isolated, small patches by logging and subsequent fires (Allard and Leonard 1952, Clarkson 1964, Pielke 1981, Stephenson and Clovis 1983). Despite good short-term viability, healthy regeneration, and protected status of many stands, this type is restricted to the highest elevations of the Central Appalachians and is highly vulnerable to climate change.

West Virginia description: This is the typical forest encountered in the heart of red spruce habitat in West Virginia, with widespread distribution in the middle and upper elevations (1070-1400 m [3500-4600 feet]) of the red spruce zone in the state. The community occurs on both gentle slopes bordering high-elevation valley floors and on more exposed ridge crests and rocky summits. The canopy typically has strong dominance by *Picea rubens* (red spruce), with *Betula alleghaniensis* var. *alleghaniensis* (yellow birch) next in importance. Shrub cover is sparse to moderate, herbs are sparse, and the forest floor is often a luxuriant green with the liverwort *Bazzania trilobata*. In West Virginia, two common floristic variants of this community occur. In one variant, shrubs and herbs are almost entirely absent, and the dense canopy shades a carpet of green liverwort. Another variant is characterized by post-burning increases in the shrub *Kalmia latifolia* (mountain laurel), which locally dominates the shrub layer.

The local invasion of young *Picea rubens* (red spruce) into northern hardwood understories on middle-slope positions suggests that this association once occupied, or will in the future occupy, a wider variety of habitats in the region (Fleming and Moorhead 1996). Natural disturbances in this community are characterized by frequent windthrow of individual trees. Stand-replacing lightning-ignited fires may affect large patch sizes but occur rarely, at 300 to 1,000-year intervals; large-scale wind events are likely at more frequent intervals of 100 to 200 years (Gorman 2007). Human-initiated disturbances have included strip mines, logging, slash fires, and livestock grazing. Recent stresses include deposition of atmospheric pollutants, browsing damage by high deer populations, and land conversion for second homes and wind power. This community is highly susceptible to climate change stress.

Dominant species, with high constancy and cover are *Picea rubens* (red spruce), *Betula alleghaniensis* var. *alleghaniensis* (yellow birch), and *Bazzania trilobata* (common bazzania liverwort). Species richness averages 17 taxa per 400 m^2 plot. Within the narrowly defined ecology of the red spruce zone in West Virginia, this community has a relatively broad ecological amplitude, and as a result it has no indicator species that differentiate it from other upland red spruce communities. Instead, the other four upland red spruce communities differentiate themselves from this community through their diagnostic species, which reflect their own particular niches along environmental gradients within the red spruce zone.

The canopy averages 61% cover and is strongly dominated by *Picea rubens* (red spruce), with lower cover of *Betula alleghaniensis* var. *alleghaniensis* (yellow birch) and *Acer rubrum* (red maple). Other trees that occasionally occur with low cover in the canopy include *Tsuga canadensis* (eastern hemlock), *Betula lenta* (sweet birch), *Acer pensylvanicum* (striped maple), *Pinus strobus* (white pine), *Sorbus americana* (American mountain-ash), *Amelanchier laevis* (Allegheny serviceberry), and *Quercus rubra* (red oak). The subcanopy averages 28% cover and is very similar in dominance and composition to the canopy, with the occasional addition of *Magnolia fraseri* (Fraser magnolia), *Acer spicatum* (mountain maple), *Amelanchier arborea* var. *arborea* (common serviceberry), and *Fagus grandifolia* (American beech).

The tall shrub stratum averages 23% cover and is strongly dominated by saplings of the regenerating canopy species, especially *Picea rubens* (red spruce) and *Betula alleghaniensis* var. *alleghaniensis* (yellow birch). *Ilex montana* (mountain holly), *Kalmia latifolia* (mountain laurel), and *Rhododendron maximum* (great rhododendron) occur frequently in the tall shrub

layer. Rarely, a small amount of *Hamamelis virginiana* (witch hazel), *Menziesia pilosa* (minniebush), or *Nemopanthus mucronatus* (catberry) may be present. The short shrub stratum averages only 8% cover, again dominated by regenerating canopy species, with *Ilex montana* (mountain holly), *Vaccinium erythrocarpum* (southern mountain cranberry), *Kalmia latifolia* (mountain laurel), and *Rhododendron maximum* (great rhododendron). Occasional very low cover of *Menziesia pilosa* (minniebush), *Vaccinium angustifolium* (northern lowbush blueberry), *Vaccinium myrtilloides* (velvetleaf blueberry), *Gaylussacia baccata* (black huckleberry), *Smilax rotundifolia* (roundleaf greenbrier), and *Viburnum lantanoides* (hobblebush) may be present.

The herbaceous stratum averages 6% cover and often includes *Dryopteris intermedia* (intermediate woodfern), *Oxalis montana* (mountain wood sorrel), and *Dennstaedtia punctilobula* (eastern hay-scented fern). Less common are *Trillium undulatum* (painted trillium), *Maianthemum canadense* (Canada mayflower), *Dryopteris campyloptera* (mountain woodfern), *Lycopodium obscurum* (princess-pine), *Monotropa uniflora* (Indian-pipe), *Carex debilis* var. *rudgei* (white-edge sedge), *Mitchella repens* (partridgeberry), and *Oclemena acuminata* (whorled wood aster). The non-vascular stratum averages 53% cover and is strongly dominated by *Bazzania trilobata* (common bazzania liverwort), with lesser amounts of *Hypnum imponens* (flat fern moss), *Dicranum scoparium* (broom fork moss), *Polytrichum pallidisetum* (mountain hair cap moss), *Brotherella recurvans* (shiny fern moss), and *Leucobryum glaucum* (common white cushion moss).

Sites range from mesic to submesic and are characterized by the climate conditions common to all red spruce types in West Virginia: cold winter microclimates, low mean annual temperature, short growing seasons, frequent fog, and high annual precipitation, high relative humidity, and low evapotranspiration rates. Soils are typical of the red spruce zone, characterized as acidic, infertile, frigid silt or sandy loams with thick surficial duff accumulations. They typically have high organic matter, high cation-exchange capacity, high exchangeable nitrogen, and generally low micronutrient status. Pennsylvanian sandstones of the Pottsville Group underlie this community at almost all sites. Outliers occur on older sandstone ridges to the east: the Ordovician Juniata sandstone at Kile Knob and Silurian Tuscarora sandstone at Panther Knob. Rarely, the community may extend slightly onto adjacent Mississippian Mauch Chunk shale, as at the headwaters of John's Camp Run on Shavers Mountain.

The community has been sampled at 37 plots (20 element occurrences) at Barlow Top, Barton Knob, Black Mountain, Canaan Mountain, Cheat Mountain, Flatrock Plains, Gaudineer Knob, Kile Knob, McGowan Mountain, Panther Knob, Shavers Mountain, Spruce Mountain, Stuart Knob, Top of Allegheny, and Yew Mountains. Statistically, the plots in this type mix with the high elevation red spruce-southern mountain cranberry type (CEGL007131) in hierarchical agglomerative clustering, but they ordinate distinctly from CEGL007131 in three-dimensional species space. Ordination shows the plots in this group as the broad floristic centroid of red spruce plots in West Virginia.

Red Spruce – Rhododendron Forest

West Virginia Scientific Name: *Picea rubens / Rhododendron maximum* Forest

NVC Code: CEGL006152

NVC Name: *Picea rubens - (Tsuga canadensis) / Rhododendron maximum* Forest

NatureServe Conservation Status: G2G3 (Imperiled Globally); S2 (Imperiled in West Virginia). This association ranges sporadically at appropriate elevations from the Great Smoky Mountains in the Southern Blue Ridge of North Carolina and Tennessee, north to the Central Appalachians in West Virginia. In Virginia, limited patches of this association occur at the highest elevations of Clinch Mountain in the Ridge and Valley and also on Mount Rogers and Whitetop in the Southern Blue Ridge. This vegetation type is environmentally restricted within a somewhat geographically restricted range. Their former extent has been reduced to more-or-less isolated, small patches by logging and subsequent fires (Allard and Leonard 1952, Clarkson 1964, Pielke 1981, Stephenson and Clovis 1983).

West Virginia Description: This species-poor forest type occurs primarily at low and middle elevations within the red spruce zone of West Virginia. It generally grows on moist,

protected landforms and can include slope forests, boulderfields, ravines, and occasional ridges. This community has the lowest species richness, at 12 species per 400 m^2 plot, of the West Virginia red spruce forest types. It has the highest cover of tall shrubs, almost exclusively *Rhododendron maximum* (great rhododendron), and the lowest cover of herbaceous species. Dominant species, with constancy >60% and cover >9% are *Picea rubens* (red spruce), *Betula alleghaniensis* var. *alleghaniensis* (yellow birch), *Rhododendron maximum* (great rhododendron), and *Bazzania trilobata* (common bazzania liverwort). The diagnostic species, which combines significant indicator value ($p<0.05$) within West Virginia's red spruce forest types with relatively high constancy and cover, is *Rhododendron maximum* (great rhododendron).

Natural disturbances in this community include frequent windthrow and rare (300-1000 year rotation) stand-replacing catastrophic events related to windstorms, ice storms, and lightning fires (Lorimer and White 2003, Gorman 2007). Human-initiated disturbances have included strip mines, logging, slash fires, and livestock grazing. Recent stresses include deposition of atmospheric pollutants, browsing damage by high deer populations, and land conversion for second homes and industrial wind power. This community is susceptible to climate change stress.

Rhododendron maximum (great rhododendron) has been proposed as an ecological driver in Appalachian forest communities, in terms of its potential to inhibit successful recruitment of canopy tree seedlings (Monk et al. 1985, Chastain and Townsend 2008, Horton et al. 2009). Heavy shading of the ground surface, rapid accumulation of litter and humus with a high carbon-nitrogen ratio, and reduced nutrient availability are cited by Horton et al. (2009) as contributing factors. Our plot samples exhibit low seedling/sapling numbers in this community compared to other red spruce forest types (Figure 9), and are potentially consistent with this theory. It is noteworthy, however, that areas of rhododendron dominance are generally sheltered from temperature extremes and drought by a healthy tree canopy. Rhododendron is known to be sensitive to stem hydraulic conductivity damage from winter freeze-thaw cycles and summer drought (Lipp and Nilsen 1997, Cordero and Nilsen 2002). It is possible that seedling recruitment for canopy species may occur cyclically after rhododendron die-back during severe drought, or locally after windthrow treefall which opens the canopy and exposes rhododendron to more extreme temperatures.

The canopy layer averages 58% cover and is dominated by *Picea rubens* (red spruce) with lower cover by *Tsuga canadensis* (eastern hemlock), *Acer rubrum* (red maple), and *Betula alleghaniensis* var. *alleghaniensis* (yellow birch). Occasionally *Betula lenta* (sweet birch) and *Amelanchier arborea* var. *arborea* (common serviceberry) are also present in the canopy. The subcanopy averages 35% cover and is dominated by *Betula alleghaniensis* var. *alleghaniensis* (yellow birch) and *Picea rubens* (red spruce), with lower cover of *Tsuga canadensis* (eastern hemlock) and *Acer rubrum* (red maple). Other subcanopy trees may include *Sorbus americana* (American mountain-ash), *Amelanchier arborea* var. *arborea* (common serviceberry), *Betula lenta* (sweet birch), and *Magnolia fraseri* (Fraser magnolia).

The tall shrub layer is dense, averaging 63% cover and strongly dominated by *Rhododendron maximum* (great rhododendron). Low cover of *Ilex montana* (mountain holly)

and various tree seedlings may intermix, and occasionally a few shrubs of *Kalmia latifolia* (mountain laurel) or *Rhododendron catawbiense* (Catawba rhododendron) occur. The short shrub layer is much less dense, averaging 13% cover and with the same dominance and species distribution as the tall shrubs. Occasional low cover of *Vaccinium erythrocarpum* (southern mountain cranberry), *Menziesia pilosa* (minniebush), and *Vaccinium angustifolium* (northern lowbush blueberry) may occur in the short shrub stratum.

The herbaceous layer is extremely sparse, averaging only 1% cover. There are no herbaceous species other than tree seedlings that have constancy >20%. Those that do occur with low constancy and cover include *Dryopteris intermedia* (intermediate woodfern), *Dryopteris campyloptera* (mountain woodfern), *Oclemena acuminata* (whorled wood aster), *Oxalis montana* (mountain wood sorrel), and *Polypodium appalachianum* (Appalachian rockcap fern). The bryophyte layer averages 28% cover and is strongly dominated by *Bazzania trilobata* (common bazzania liverwort), with much lower cover of *Hypnum imponens* (flat fern moss), *Leucobryum glaucum* (common white cushion moss), *Brotherella recurvans* (shiny fern moss), and *Dicranum scoparium* (broom fork moss).

Temperatures are moderate to high compared to other red spruce types, as measured by mean, maximum, and minimum temperatures from 1971-2000. Seasonal temperature variations are relatively small, with warm winter days and cool summer days, as indicated by extreme maximum daily temperatures, degree-days above 65^{o}F, and growing degree-days above 50^{o}F. Potential evapotranspiration is fairly high and precipitation is high compared to other spruce habitats (Climate Source 2008). This climate profile is consistent with other studies which indicate that summer drought and winter freeze-thaw are limiting factors in the growth of *Rhododendron maximum* (great rhododendron) (Lipp and Nilsen 1997, Cordero and Nilsen 2002).

Soils are typical of the red spruce zone, with high organic matter and nitrogen, low pH, and generally low micronutrient nutrient status. Pennsylvanian sandstones of the Pottsville Group underlie this community at most sites. At two sites (Hills Creek and the Upper Shavers Fork) the community extends onto the adjacent Mississippian Mauch Chunk shale.

The community has been sampled at 15 plots (11 element occurrences) at Back Allegheny Mountain, Blackwater Falls, Hills Creek, McGowan Mountain (old growth), Red Creek Plains, Roaring Plains, Shavers Mountain (old growth), Sugar Creek Mountain, Turkey Run, Upper Shavers Fork, and Yew Mountain. Statistically, the plots in this type cluster strongly together and ordinate together in three-dimensional species space.

Red Spruce – Hemlock – Beech Forest

West Virginia Scientific Name: *Picea rubens – Tsuga canadensis – Fagus grandifolia / Dryopteris intermedia* Forest

NVC Code: CEGL006029

NVC Name: *Picea rubens - Tsuga canadensis - Fagus grandifolia / Dryopteris intermedia* Forest

NatureServe Conservation Status: G3 (Vulnerable Globally); S3 (Vulnerable in West Virginia). This community occurs in the Allegheny Mountain region of West Virginia, at elevations above 850 m (2800 feet), with additional stands in the Allegheny Mountain region of Maryland and possibly in Pennsylvania. It is restricted to the upper elevations of the Central Appalachians, and will be under stress to track a diminishing climate envelope up the mountaintops and ridges as the climate warms. Northward migration of the community is unlikely because of the low-elevation barrier in Pennsylvania.

West Virginia Description: This forest type occupies relatively warmer, lower elevations within the red spruce zone in West Virginia. At the lower elevation margin of this

community type, the forest grades into adjacent northern hardwoods forest, with steadily decreasing spruce components. Red spruce-hemlock-beech forest is characterized by a mixed canopy of *Picea rubens* (red spruce) (>15% cover), *Tsuga canadensis* (eastern hemlock), and deciduous trees, with a dense subcanopy, generally sparse shrub layer, and relatively diverse, fern-dominated herb layer. A less common variant of this type extends into the middle and upper elevations of the spruce zone along slightly richer substrates underlain by shale and limestone. Floristically, the richer variant has less hemlock but is otherwise quite similar to the lower elevation red spruce-hemlock-beech community. The similarities are probably due to a slight amelioration of environmental stresses at lower elevations and/or on richer substrates, which allows other species to compete successfully with the red spruce. The richer substrates are more erodible than the typical sandstone bedrock underlying most red spruce communities, which results in slightly higher slopes and higher topographic roughness index.

Natural disturbances in this community include frequent windthrow and rare (>500-year rotation) stand-replacing catastrophic events related to windstorms, ice storms, and lightning fires (Lorimer and White 2003). Human-initiated disturbances have included strip mines, logging, logging slash fires, and livestock grazing. Recent stresses include deposition of atmospheric pollutants, browsing damage by high deer populations, and land conversion for second homes and industrial wind power. This community is susceptible to climate change stress.

Dominant species, with constancy >60% and cover >9% are *Picea rubens* (red spruce), *Tsuga canadensis* (eastern hemlock), *Betula alleghaniensis* var. *alleghaniensis* (yellow birch), *Acer rubrum* (red maple), *Dryopteris intermedia* (intermediate woodfern) and *Bazzania trilobata* (common bazzania liverwort). Diagnostic species, which combine significant indicator value ($p<0.05$) within West Virginia's red spruce forest types with relatively high constancy and cover, are *Fagus grandifolia* (American beech), *Tsuga canadensis* (eastern hemlock), *Prunus serotina* var. *serotina* (black cherry), *Acer saccharum* var. *saccharum* (sugar maple), *Betula lenta* (sweet birch), *Magnolia fraseri* (Fraser magnolia), *Acer pensylvanicum* (striped maple), *Smilax rotundifolia* (roundleaf greenbrier), *Dryopteris intermedia* (intermediate woodfern), *Maianthemum canadense* (Canada mayflower), *Oxalis montana* (mountain wood sorrel), and *Mitchella repens* (partridgeberry). Species richness is relatively high for the red spruce system, averaging 23 taxa per 400 m^2 plot, with the highest values on shale and limestone substrates.

The canopy averages 62% cover and is dominated by *Picea rubens* (red spruce) with *Tsuga canadensis* (eastern hemlock), *Betula alleghaniensis* var. *alleghaniensis* (yellow birch), and *Acer rubrum* (red maple). Less common are *Fagus grandifolia* (American beech), *Prunus serotina* var. *serotina* (black cherry), and *Betula lenta* (sweet birch), and occasional canopy species include *Acer saccharum* var. *saccharum* (sugar maple), *Magnolia fraseri* (Fraser magnolia), *Liriodendron tulipifera* (tuliptree), and *Magnolia acuminata* (cucumber-tree). The subcanopy is relatively lush, with average 38% cover, and exhibits co-dominance by several species including *Picea rubens* (red spruce), *Betula alleghaniensis* var. *alleghaniensis* (yellow birch), *Tsuga canadensis* (eastern hemlock), *Acer pensylvanicum* (striped maple), *Acer rubrum* (red maple), *Fagus grandifolia* (American beech), and *Acer saccharum* var. *saccharum* (sugar maple). Less common subcanopy species are *Magnolia acuminata* (cucumber-tree), *Betula lenta* (sweet birch), *Magnolia fraseri* (Fraser magnolia), *Prunus serotina* var. *serotina* (black cherry),

Crataegus spp. (hawthorn), *Amelanchier laevis* (Allegheny serviceberry), *Fraxinus americana* (white ash), and *Tilia americana* (American basswood).

The shrub layers are relatively sparse in this community compared to other upland spruce communities. The tall shrub layer, averaging 16% cover, is dominated by regenerating tree saplings, especially *Picea rubens* (red spruce), *Fagus grandifolia* (American beech), *Tsuga canadensis* (eastern hemlock), and *Acer pensylvanicum* (striped maple). Shrubs that are occasionally present include *Ilex montana* (mountain holly), *Rhododendron maximum* (great rhododendron), *Kalmia latifolia* (mountain laurel), and *Viburnum lantanoides* (hobblebush). The short shrub layer is sparse at 5% cover and consists largely of regenerating tree species, with occasional presence of *Vaccinium erythrocarpum* (southern mountain cranberry), *Ilex montana* (mountain holly), *Smilax rotundifolia* (roundleaf greenbrier), *Kalmia latifolia* (mountain laurel), and *Menziesia pilosa* (minniebush).

This community has the richest herbaceous layer of any of the upland spruce communities in West Virginia. Averaging 23% cover, it is strongly dominated by *Dryopteris intermedia* (intermediate woodfern). Other common species include *Maianthemum canadense* (Canada mayflower), *Oxalis montana* (mountain wood sorrel), *Mitchella repens* (partridgeberry), *Dennstaedtia punctilobula* (eastern hay-scented fern), *Trillium undulatum* (painted trillium), *Medeola virginiana* (Indian cucumber-root), *Oclemena acuminata* (whorled wood aster), *Dryopteris campyloptera* (mountain woodfern), *Anemone quinquefolia* (nightcaps), *Lycopodium dendroideum* (tree clubmoss), *Arisaema triphyllum* (jack-in-the-pulpit), *Carex debilis* var. *rudgei* (white-edge sedge), *Danthonia compressa* (flattened oatgrass), *Galium triflorum* (sweet-scent bedstraw), *Huperzia lucidula* (shining clubmoss), *Lycopodium clavatum* (running clubmoss), *Lycopodium obscurum* (princess-pine), *Platanthera orbiculata* (large round-leaved orchid), *Polypodium appalachianum* (Appalachian rockcap fern), and *Tiarella cordifolia* (heartleaf foamflower). The non-vascular stratum averages 20% cover, the lowest bryophyte cover among upland red spruce communities in West Virginia. *Bazzania trilobata* (common bazzania liverwort) and *Hypnum imponens* (flat fern moss) are the dominant species, followed by *Dicranum scoparium* (broom fork moss), *Thuidium delicatulum* (delicate fern moss), *Brotherella recurvans* (shining fern moss), and *Dicranodontium denudatum* (naked windblown moss).

Relatively mild climate conditions characterize this red spruce community. It experienced the highest mean, maximum, and minimum temperatures, the largest number of growing degree-days > 50^{o}F, the highest median length of freeze-free period, and the highest potential evapotranspiration. Precipitation is moderate to comparatively high for the spruce zone (Climate Source 2008). As would be expected in the higher elevation variant of this type, which occurs on shale rather than sandstone substrates, temperatures are cooler and relative humidity is higher, similar to the mean values for the red spruce zone.

Soils are typical of the red spruce zone, with high organic matter and nitrogen, low pH, and generally low micronutrient nutrient status. This community has high concentrations of the macronutrient sulphur and the micronutrient iron. A variety of geologic formations underlie this community type, including Pennsylvanian Pottsville sandstone, Mississippian Mauch Chunk shale and Greenbrier limestone, Devonian Hampshire shale, and Silurian Tuscarora sandstone.

The community has been sampled at 23 plots (15 element occurrences) at Cheat Mountain, Gaudineer Knob, Haystack Knob, Lost Flat, Panther Knob, Pharis Knob, Piney Ridge, Red Spruce Knob, Rich Mountain (Kumbrabow), Spruce Knob, Top of Allegheny, West Fork of the Greenbrier River, and Yew Mountain. Statistically, the plots in this type cluster strongly together and ordinate in a loose but definite grouping in three-dimensional species space using non-metric multidimensional scaling.

Red Spruce – Heath Rocky Woodland

West Virginia Scientific Name: *Picea rubens / Kalmia latifolia - Vaccinium angustifolium* Rocky Woodland

NVC Code: CEGL006254

NVC Name: *Picea rubens / Kalmia latifolia – Menziesia pilosa* Woodland

NatureServe Conservation Status: G2 (Imperiled Globally); S1 (Critically Imperiled in West Virginia). This community is restricted to a 50-kilometer linear band along the Allegheny Front in West Virginia. This association has a limited habitat on exposed acidic bedrock and talus, within the restricted cool, moist climate of the red spruce zone. The total area of occupancy is

about 5 square km. The potential range of this community has been well-surveyed in West Virginia, where four large occurrences are known, three of which are on public land and reasonably well-protected. Threats include vacation home development on these highly scenic rocky ridgetops, industrial wind development along the Allegheny Front, strip mining, fire management (poorly understood fire dynamics could lead to damage by either fire suppression or prescribed burning), and climate change which is likely to push the narrow climate envelope of the community off the ridgetops.

West Virginia Description: This red spruce rocky woodland occupies high elevations in the drier northeastern part of the red spruce range in West Virginia, along the Allegheny Front. The community is characterized by a stunted, open canopy of *Picea rubens* (red spruce), with abundant heath shrubs and lichens. Large seasonal temperature variations characterize this habitat. In some areas, this community may have been impacted by fire (for blueberry production) in the period following European settlement. Native Americans may also have practiced burning in this community. A lightning-ignited fire occurred at Bear Rocks in the summer of 1999. Fire is likely to convert this community to the more common Central Appalachian Blueberry Shrubland (CEGL003958 *Vaccinium* (*angustifolium, myrtilloides, pallidum*) Central Appalachian Dwarf-shrubland). Following the extensive logging and slash fires of 1885-1920, this community expanded to cover previously forested areas along the Allegheny Front. Soils are slowly accumulating again in the absence of widespread fires, with both in-situ organic matter deposition and windblown soil deposits as likely mechanisms. In more sheltered areas this community is following a slow successional pathway back to red spruce forest. Shallow, infertile, and sometimes waterlogged soils and acidic bedrock outcrops appear to maintain this community in more exposed areas even in the absence of fire. In 1746, Thomas Lewis surveyed across one present location of this community and wrote: "When we had gained the summit there was a level as far as we could see to right and left clear of timber about a quarter of a mile wide, covered with large flat rocks and marshy" (Lewis 1746). Along the Allegheny Front at Red Creek Plains and Helmick Run, a variant of the community occurs with a taller *Picea rubens* (red spruce) canopy mixed with *Pinus rigida* (pitch pine). The *Pinus rigida* appears to have expanded outward from adjacent *Pinus rigida*-heath peatlands during severe fire episodes from 1900-1920.

Natural disturbances in this community include frequent windthrow and rare (probably >200-year rotation) stand-replacing catastrophic events related to windstorms, ice storms, and lightning fires (Lorimer and White 2003). Human-initiated disturbances have included strip mines, logging, livestock grazing, slash fires, and fires to maintain blueberry production. Recent stresses include deposition of atmospheric pollutants, browsing damage by high deer populations, and land conversion for second homes and industrial wind power. This community has little natural buffering of temperature extremes and is highly susceptible to climate change stress.

Dominant species, with high constancy and cover, are *Picea rubens* (red spruce) and *Kalmia latifolia* (mountain laurel). Diagnostic species, which combine significant indicator value ($p<0.05$) within West Virginia's red spruce forest types with relatively high constancy and cover, include *Kalmia latifolia* (mountain laurel), *Pinus rigida* (pitch pine), *Amelanchier laevis* (Allegheny serviceberry), *Nemopanthus mucronatus* (catberry), *Vaccinium angustifolium*

(northern lowbush blueberry), *Menziesia pilosa* (minniebush), *Gaylussacia baccata* (black huckleberry), *Nemopanthus mucronatus* (catberry), *Photinia melanocarpa* (black chokeberry), *Ribes rotundifolium* (Appalachian gooseberry), *Prunus pensylvanica* var. *pensylvanica* (fire cherry), *Gaultheria procumbens* (wintergreen), *Pteridium aquilinum* (bracken fern), *Polypodium appalachianum* (Appalachian rockcap fern), *Cladonia rangiferina* (grey reindeer lichen), and *Umbilicaria muehlenbergii* (lesser rocktripe). Species richness averages 24 species per 400 m^2 plot, which is the highest value within the upland red spruce forest and woodland types. Most of the diversity is in the shrub strata.

This upland spruce type has a low, stunted, open woodland canopy averaging 41% cover. The canopy is strongly dominated by *Picea rubens* (red spruce), with much lower cover of *Pinus rigida* (pitch pine), *Acer rubrum* (red maple), *Betula alleghaniensis* var. *alleghaniensis* (yellow birch), *Amelanchier laevis* (Allegheny serviceberry), *Sorbus americana* (American mountain-ash), and *Tsuga canadensis* (eastern hemlock).

The tall shrub layer averages 43% cover and is dominated by *Kalmia latifolia* (mountain laurel) with *Nemopanthus mucronatus* (catberry), *Rhododendron maximum* (great rhododendron), and regenerating tree saplings. The short shrub layer is diverse, averaging 35% cover, and often includes *Vaccinium angustifolium* (northern lowbush blueberry), *Menziesia pilosa* (minniebush), *Gaylussacia baccata* (black huckleberry), *Nemopanthus mucronatus* (catberry), *Photinia melanocarpa* (black chokeberry), *Rhododendron maximum* (great rhododendron), and *Vaccinium erythrocarpum* (southern mountain cranberry). Occasional shrubs include *Ribes rotundifolium* (Appalachian gooseberry), *Prunus pensylvanica* var. *pensylvanica* (fire cherry), *Gaultheria procumbens* (wintergreen), *Ribes glandulosum* (skunk currant), *Vaccinium myrtilloides* (velvetleaf blueberry), *Ilex montana* (mountain holly), *Acer pensylvanicum* (striped maple), *Acer spicatum* (mountain maple), *Hamamelis virginiana* (witch hazel), *Rhododendron prinophyllum* (early azalea), and *Viburnum nudum* var. *cassinoides* (northern wild raisin).

The herbaceous layer is sparse, with only 3% average cover. *Maianthemum canadense* (Canada mayflower), *Pteridium aquilinum* (bracken fern), and *Polypodium appalachianum* (Appalachian rockcap fern) have constancy >40%. Additional herbaceous species may include *Deschampsia flexuosa* var. *flexuosa* (crinkled hairgrass), *Aralia nudicaulis* (wild sarsaparilla), *Epigaea repens* (trailing arbutus), and *Carex brunnescens* (brown sedge). The non-vascular stratum has significant diversity, much of which occurs as abundant crustose lichens on the rocky substrate. The crustose lichens have not been thoroughly documented for this type. Non-vascular cover averages 21% and in addition to crustose lichens, often includes *Cladonia rangiferina* (grey reindeer lichen), *Umbilicaria muehlenbergii* (lesser rocktripe), *Hypnum imponens* (flat fern moss), *Leucobryum glaucum* (common white cushion moss), *Pleurozium schreberi* (redstem feather moss) and *Lasallia papulosa* (toadskin lichen).

This spruce habitat is characterized by large seasonal temperature variations, with relatively cold winter days and hot summer days, as indicated by extreme maximum daily temperatures, degree-days above 65°F, degree-days below 65°F, and growing degree-days above 50°F. It also experiences the most mean annual freezing days <32°F and very hot days >90°F. From 1971-2000, it experienced low to moderate mean, maximum, and minimum temperatures

compared to other red spruce habitat types. Potential evapotranspiration is relatively low and precipitation is the lowest in the spruce zone (Climate Source 2008).

Soil is sparse in this rocky woodland, generally occurring in cracks and pore spaces between rocks. Some of the soil may be residual, sheltered from major fires in the last century. Soil samples were collected from crevices between rocks in this community. Soil chemistry characteristics include the highest values for organic matter within the red spruce zone. Macronutrients potassium and magnesium and the micronutrient manganese are high compared to other upland spruce communities, although they are low compared to soils statewide. Sulphur and iron are very low. Geologically, Pennsylvanian sandstones of the Pottsville Group underlie this community.

The community has been sampled at 10 plots (4 element occurrences) along the Allegheny Front at Spruce Knob, Dolly Sods, Bear Rocks, Red Creek Plains, and Helmick Run. The plots in this type cluster and ordinate strongly together in species space. Statistically, this is the most distinct of the red spruce upland communities, with a large number of indicator species. This is not surprising since it is the only woodland type among the red spruce forests, and it is restricted geographically to the drier, more exposed sites of the Allegheny Front.

Flora, fungi, and slime molds

The flora of upland red spruce communities is characterized by a generally northern affiliation. A few of the species whose largest distributions occur to the north of West Virginia include the foundation species *Picea rubens* (red spruce), as well as *Coptis trifolia* (goldthread), *Dalibarda repens* (robin-run-away), *Oxalis montana* (mountain woodsorrel), *Trillium undulatum* (painted trillium) and *Vaccinium angustifolium* (northern lowbush blueberry). Mixed with the northern-affiliated species, and giving a unique character to the study area, are several characteristic central and southern Appalachian species such as *Aconitum reclinatum* (white monkshood), *Hypericum mitchellianum* (Blue Ridge St. Johnswort), *Menziesia pilosa* (minniebush), and *Vaccinium erythrocarpum* (southern mountain cranberry).

A large number of globally rare and state rare plants have been documented within the red spruce ecosystem, nearly all of which are associated with wetland or riparian habitats. Wetland and riparian communities are discussed in Byers et al. (2007). Two globally vulnerable plants that may be encountered within upland red spruce forests are often associated with small forested seeps. They are *Aconitum reclinatum* (white monkshood) and *Hypericum mitchellianum* (Blue Ridge St. Johnswort). A third globally vulnerable plant, *Scutellaria saxatilis* (rock skullcap), is found in rocky forests in a variety of forest types, including red spruce. Seven additional globally rare species are associated with red spruce wetland habitats (Byers et al. 2007).

State-rare vascular plants are generally associated with moist uplands. They include the imperiled Canadian bunchberry (*Cornus canadensis*) and summer sedge (*Carex aestivalis*) and the vulnerable species robin-run-away (*Dalibarda repens*), threeleaf goldthread (*Coptis trifolia*),

and Fraser's sedge (*Cymophyllus fraserianus*). Red spruce wetland habitats harbor an additional 133 state-rare species (Byers et al. 2007).

Myxomycetes, or slime molds, have been documented in the red spruce ecosystem in West Virginia by Stephenson (2010). He notes that five species are possibly restricted to spruce and spruce-fir forests. One of these, *Diderma simplex*, is also a rare species. *Colloderma oculatum* and *Diderma roanense* are occasional, and *Barbeyella minutissima* and *Lepidoderma tigrinum* are abundant.

One hundred sixty-six vascular plant species, 45 bryophyte species, and 105 fungi were documented within the upland red spruce vegetation plots during this assessment. In addition, 81 species of myxomycetes (slime molds) have been documented within red spruce forests by Stephenson (2010) (Appendix D). The breakdown of documented plant, fungi, and slime mold species by kingdom and division is shown in Table 6.

Table 6. Plant, fungal, and slime mold species by division

Plants	**# species**	**Fungi**	**# species**
Bryophyta	38	Ascomycota	36
Lycopodiophyta	6	Basidiomycota	69
Magnoliophyta	140	**Amoebozoa**	
Marchantiophyta	7	Myxomycota	81
Pinophyta	4		
Polypodiophyta	16		

Floristic summaries of each forest or woodland type are included in the community descriptions in the previous section. Floristic constancy-cover tables for each community type are presented in Appendix E.

Fauna

The high elevation red spruce forests of West Virginia provide important habitat for many wildlife species, including some that are dependent on this habitat and essentially restricted to it within the state. Examples are the Cheat Mountain Salamander, West Virginia Northern Flying Squirrel, and Northern Saw-whet Owl. Twenty species have been identified by the West Virginia Wildlife Conservation Action Plan (WVDNR 2006) as being in greatest need of conservation within red spruce forests, although not all of them are restricted to this habitat type (Table 7). Ten additional species of the red spruce forest with vulnerable or imperiled populations were identified during this assessment, and are listed in Table 8.

Since many animal species use both forested and open habitats during various parts of their life cycles, the criteria for including species in this section is broader than for the floristic descriptions. Faunal records are included from red spruce forests, mixed red spruce-northern hardwood forests, and high elevation wetlands embedded within the red spruce ecosystem. High elevation wetland species are discussed in greater detail in Byers et al. (2007).

TABLE 7. SPECIES IN GREATEST NEED OF CONSERVATION RED SPRUCE FOREST (WVDNR 2006)

Scientific Name	Common Name	Global Rank	State Rank
Plethodon nettingi	Cheat Mountain Salamander	G2	S2
Glaucomys sabrinus fuscus	West Virginia Northern Flying Squirrel	G5T2	S2
Sorex palustris punctulatus	Southern Water Shrew	G5T3	S1
Microtus chrotorrhinus carolinensis	Southern Rock Vole	G4T3	S2
Neotoma magister	Allegheny Woodrat	G3G4	S3
Virginia valeriae pulchra	Mountain Earthsnake	G5T3T4	S2
Contopus cooperi	Olive-Sided Flycatcher	G4	S1B
Sorex dispar	Long-Tailed Shrew	G4	S2S3
Sylvilagus obscurus	Appalachian Cottontail	G4	S3
Sorex hoyi winnemana	Southern Pygmy Shrew	G5T4	S2S3
Accipiter gentilis	Northern Goshawk	G5	S1B,S1N
Sphyrapicus varius	Yellow-Bellied Sapsucker	G5	S1B,S3N
Aegolius acadicus	Northern Saw-Whet Owl	G5	S2B,S1N
Seiurus noveboracensis	Northern Waterthrush	G5	S2B
Carduelis pinus	Pine Siskin	G5	S2B,S4N
Cambarus monongalensis	Monongahela Crayfish	G5	S3
Catharus ustulatus	Swainson's Thrush	G5	S3B
Dendroica fusca	Blackburnian Warbler	G5	S3B
Dendroica coronata	Yellow-Rumped Warbler	G5	S3B,S3N
Certhia americana	Brown Creeper	G5	S3B,S4N

TABLE 8. VULNERABLE OR IMPERILED SPECIES OF RED SPRUCE COMMUNITIES IDENTIFIED DURING THIS ASSESSMENT

Scientific Name	Common Name	Global Rank	State Rank
Stenotrema simile	Bear Creek Slitmouth Snail	G2	SNR
Triodopsis picea	Spruce Knob Threetooth Snail	G3	S2
Glyphyalinia picea	Rust Glyph Snail	G3	SNR
Mesodon andrewsae	Balsam Globe Snail	G3	SNR
Colias interior	Pink-edged Sulphur	G5T1T2	S1S2
Polygonia faunus smythi	Smyth's Green Comma	G5T3	S1
Empidonax flaviventris	Yellow-bellied Flycatcher	G5	S1B
Synagrapha rectangular	Salt & Pepper Looper Moth	G5	S1
Discus catskillensis	Angular Disc	G5Q	S1
Catharus guttatus	Hermit Thrush	G5	S3B, S4N

Mammals

Relatively few mammals within the study area are considered to be dependent on upland red spruce communities, although many species benefit from the habitat. Rare mammals that have been recorded within the red spruce ecosystem, and a few common species that are typical of this habitat, are described below. Fifty-two species of mammals have been recorded within the red spruce ecosystem. Mammals known from the project area, with habitat and distribution information, are listed in Appendix F.

The West Virginia Northern Flying Squirrel (*Glaucomys sabrinus fuscus*) is imperiled throughout its range was a federally endangered species until it was de-listed in 2008. The WV Northern Flying Squirrel is endemic to West Virginia and Virginia, where it lives in red spruce forests and northern hardwood forests associated with nearby spruce. It is generally found in moist forest stands with widely spaced mature trees, well-developed understory, an abundance of snags, and abundant lichens and mosses (Loeb et al. 2000, Ford et al. 2004, WVDNR 2006, WVDNR 2010a, NatureServe 2010).

The Southern Water Shrew (*Sorex palustris punctulatus*) is vulnerable to extinction throughout its range, and critically imperiled within West Virginia. Southern Water Shrews often occupy the shoreline of shaded, rocky, mountain streams within red spruce and northern hardwood forests. They can also live in sphagnum swamps and peatlands bordering beaver meadows or marshes at high elevations (Merritt 1987, Handley 1991, WVDNR 2006, WVDNR 2010a).

Southern Rock Vole (*Microtus chrotorrhinus carolinensis*) populations are vulnerable to extinction throughout their range, and imperiled within West Virginia. This short-tailed brown mouse typically occurs in moist talus or among mossy rocks and logs in spruce and northern hardwood forests, often near flowing water (WVDNR 2006, NatureServe 2010).

Allegheny Woodrat (*Neotoma magister*) populations are considered vulnerable throughout their range, including West Virginia. They are found almost exclusively in rocky areas such as caves, deep crevices and large boulder fields at higher elevations. These areas are generally located in or around mast-bearing hardwood forests. The Allegheny Woodrat is also known to occur in oak-pine forests and red spruce - northern hardwood forests (WVDNR 2006, NatureServe 2010).

Long-Tailed Shrews (*Sorex dispar*) are uncommon throughout their range and imperiled within West Virginia. They live in wooded talus and boulderfields within coniferous or deciduous mountain forests, at medium to high elevations (WVDNR 2006, NatureServe 2010).

Appalachian Cottontails (*Sylvilagus obscurus*) and Southern Pygmy Shrews (*Sorex hoyi winnemana*) are uncommon throughout their range and vulnerable within West Virginia. The Appalachian Cottontail is restricted to areas with dense cover such as woods and shrubby/brushy areas. It is most often found at higher elevations, and is often associated with red spruce and heaths, such as mountain laurel (*Kalmia latifolia*) and *Vaccinium* species. Southern Pygmy Shrews prefer woodlands with abundant leaf litter and decaying wood, and may occur in moist to relatively dry habitats statewide (Merritt 1987, Whitaker and Hamilton 1998, WVDNR 2006, WVDNR 2010a).

Two species that are common rangewide but imperiled in West Virginia have been recorded in the red spruce ecosystem. They include the Star-nosed Mole (*Condylura cristata*) and Southern Bog Lemming (*Synaptomys cooperi*). The Star-nosed Mole prefers wet and mucky habitats in the eastern part of state, mostly in the mountains. Southern Bog Lemmings are found in wetlands, especially those with abundant graminoids, and also in old fields and forest

openings. They are known from 28 counties, with half of the records from high elevations in the Alleghenies (Merritt 1987, WVDNR 2010a).

Several species that are not tracked by the West Virginia Natural Heritage Program are of interest because of their affinity for the red spruce ecosystem. Fisher (*Martes pennanti*) are found in large, heavily wooded areas consisting of spruce or mixed hardwood trees. They also inhabit forested peatlands and swamps. During the 1800s, Fisher were recorded as abundant in red spruce forests at higher elevations. This species was rare or extirpated in West Virginia by 1912, and was reintroduced in 1969 to Canaan Valley and Cranberry Glades (Rogers 2010). Fisher are currently known from 28 counties with about half the records from higher elevations in the Alleghenies (WVDNR 2010b). The Snowshoe Hare (*Lepus americanus virginianus*) is a typical mammal of brushy environments in the red spruce ecosystem, especially where forests or swamps have a dense understory of rhododendron (*Rhododendron maximum*), mountain laurel (*Kalmia latifolia*), or red spruce. It is known from Randolph, Pocahontas, and Tucker counties. The Southern Red-Backed Vole (*Myodes gapperi*) is found in moist, cool forest with abundant mosses and ferns. Most records are from the eastern part of state, especially in the mountains. The Woodland Jumping Mouse (*Napaeozapus insignis*) prefers cool moist mixed forests and swamps in the mountains. It can be found statewide, but about half of the collections come from high elevations in the Allegheny Mountain counties. The Smoky Shrew (*Sorex fumeus*) is a common species of moist, cool conifer or hardwood forests and swamps. Although it is known from 35 counties statewide, one-third of the collections are from high elevations in the Alleghenies (Merritt 1987, Whitaker and Hamilton 1998, Linzey and Brecht 2003, WVDNR 2010b).

Four common species with statewide distributions that are likely to be encountered in red spruce communities are the Deer Mouse (*Peromyscus maniculatus*), Northern Short-Tailed Shrew (*Blarina brevicauda*), Eastern Chipmunk (*Tamias striatus*), and Red Squirrel (*Tamiasciurus hudsonicus*). The Deer Mouse is found in conifer forest, mixed woods and diverse habitats; it has a broad distribution with many records from high elevation sites in the Allegheny mountain counties. The Northern Short-Tailed Shrew prefers moist habitats with well-developed layer of leaf litter or humus. The Eastern Chipmunk is found in a variety of wooded habitats while the Red Squirrel prefers mature, closed-canopy conifer forests and mixed or deciduous forests (Marshall U. 1994, TNC 2001, Francl et al. 2003, CVNWR 2007, WVDNR 2010b).

Birds

The relatively undisturbed nature of the red spruce ecosystem provides high quality breeding habitat for many bird species. Although 125 species of breeding birds have been recorded in this ecosystem, only 24 species appear to have a particular affinity for the red spruce forests and their embedded high elevation wetlands. These spruce-affiliated species are described briefly below. All of the breeding bird species that have been recorded within the project area, with habitat and distribution information, are listed in Appendix F.

Olive-sided Flycatchers (*Contopus cooperi*) are uncommon throughout their range and critically imperiled in West Virginia, where they are known only from Pocahontas and Randolph

counties. This rare neotropical migrant is declining throughout its range, and was once more widely distributed in the mountain counties of West Virginia. It favors high elevation bogs, old beaver meadows, and other openings in red spruce forest, especially where dead standing trees provide singing and feeding perches (Buckelew and Hall 1994, WVPIF 2006, WVDNR 2006, NatureServe 2010).

The bird species described below are all considered secure and abundant within their global range. Many of them are northern species, and all are ranked as uncommon or rare within West Virginia. Five species whose breeding populations are critically imperiled in the state are the Yellow-bellied Flycatcher (*Empidonax flaviventris*), Yellow-bellied Sapsucker (*Sphyrapicus varius*), Northern Goshawk (*Accipiter gentilis*), Nashville Warbler (*Vermivora ruficapilla*), and White-throated Sparrow (*Zonotrichia albicollis*). The Yellow-bellied Flycatcher is known only from Pocahontas County, where it was recorded in red spruce forest with moss-carpeted forest floor. The Yellow-bellied Sapsucker is found in remote, mixed hardwood-spruce forests. Northern Goshawks nest in mature deciduous or conifer forests. Nests are generally restricted to large, undisturbed tracts of forest, which are found in the red spruce and northern hardwood forests of the Monongahela National Forest. Two wetland species, the Nashville Warbler in Grant and Tucker counties and White-throated Sparrow in Pocahontas County, are found in high elevation bogs and thickets on the edge of spruce or spruce-hardwood forests. The Nashville Warbler reaches its southernmost breeding extent in the mountains of West Virginia (Buckelew and Hall 1994, TNC 2001, WVPIF 2006, WVDNR 2006, NatureServe 2010).

Three species with globally secure but state-imperiled breeding populations in the red spruce ecosystem are the Northern Saw-whet Owl (*Aegolius acadicus*), Pine Siskin (*Carduelis pinus*), and the Northern Waterthrush (*Seiurus noveboracensis*). The Northern Saw-whet Owl breeds in red spruce and spruce-hardwood forests, particularly in association with wetland areas. Most records are from high elevations in the red spruce zone. Breeding records in West Virginia for the Pine Siskin are far to the south of the usual breeding range of this boreal forest species. It has been recorded in red spruce forests, pine plantations, and ornamental conifers. The Northern Waterthrush has its southernmost breeding population in West Virginia, where it is found in cool riparian areas, wooded swamps, bog thickets, and shrub swamps above 1000 meters elevation in the Allegheny Mountains (Buckelew and Hall 1994, Eaton 1995, WVPIF 2006, WVDNR 2006, NatureServe 2010).

Globally secure but state-vulnerable breeding populations in the red spruce ecosystem include seven species: Yellow-rumped Warbler (*Dendroica coronata*), Blackburnian Warbler (*Dendroica fusca*), Brown Creeper (*Certhia americana*), Swainson's Thrush (*Catharus ustulatus*), Hermit Thrush (*Catharus guttatus*), Alder Flycatcher (*Empidonax alnorum*), and Swamp Sparrow (*Melospiza georgiana*). The Yellow-rumped Warbler is known from Pendleton, Pocahontas, Randolph, and Tucker counties, where it breeds in red spruce woodlands or forest and mixed spruce-hardwood forest. The Blackburnian Warbler is found in red spruce and northern hardwood forests, with most records above 900 m in the Allegheny Mountains, along with smaller numbers as low at 600 m in oak-hickory-pine forest in the eastern panhandle. Most records for the Brown Creeper are from red spruce forests of the Allegheny Mountains, although it sometimes nests at lower elevations where dead or dying trees offer overhanging slabs of bark for nesting habitat. Swainson's Thrush populations are disjunct from their northern

range and found in red spruce forest and northern hardwood-spruce forest at high elevation sites in the Allegheny Mountains. Hermit Thrushes are found in northern hardwood and red spruce forests. They are most numerous above 1200 m along the higher ridges of the Alleghenies. Two wetland species, the Alder Flycatcher and Swamp Sparrow, prefer alder swamps and other wetlands with low bushes or trees, primarily in the high elevations of the Allegheny Mountains (Buckelew and Hall 1994, WVPIF 2006, WVDNR 2006, NatureServe 2010).

Eight uncommon but apparently stable species include the Red-breasted Nuthatch (*Sitta canadensis*), Golden-crowned Kinglet (*Regulus satrapa*), Purple Finch (*Carpodacus purpureus*), Magnolia Warbler (*Dendroica magnolia*), Black-throated Blue Warbler (*Dendroica caerulescens*), Canada Warbler (*Wilsonia canadensis*), Winter Wren (*Troglodytes troglodytes*), and Veery (*Catharus fuscescens*). The Red-breasted Nuthatch Red is known from spruce and spruce-hardwood forests in the higher elevations of eight Allegheny Mountain counties. The Golden-crowned Kinglet nests in mature red spruce forests in Pendleton, Pocahontas, Preston, Randolph, and Tucker counties. Purple Finches are found on the edges of spruce forests and in successional spruce habitats. Most records are from the higher ridges of the Allegheny Mountains, with a few scattered lowland outliers. Magnolia Warblers favor red spruce and spruce-hardwood forests, with lesser numbers in northern hardwoods. Their breeding range is limited to the Allegheny Mountains above 900 m elevation. Black-throated Blue Warblers nest in red spruce, northern hardwoods-spruce, and hemlock stands, typically with rhododendron present. Most records are from above 600 m elevation in the Allegheny Mountains, with an additional population in the higher elevation northern hardwood forest of the southern Western Hills region of the state. Canada Warblers prefer the undergrowth of spruce-hardwood forests, open woodlands, and wetland margins. They are usually found above 650 m elevation and are restricted to the Allegheny Mountains. Winter Wrens are known from red spruce, spruce-hardwood, and hemlock-hardwood forests. Most records are from high elevations in eight Allegheny Mountain counties. The Veery is typical of the high elevation transition zone between hardwood and spruce, where it nests in mixed spruce-northern hardwood, hemlock-hardwood, and northern hardwood forests (Buckelew and Hall 1994, WVPIF 2006, WVDNR 2006, NatureServe 2010).

Amphibians and reptiles

Rare amphibians and reptiles that have been recorded within the red spruce ecosystem, and a few common species that are typical of this habitat, are described below. Thirty-five species have been recorded within the red spruce ecosystem. Amphibians and reptiles known from the project area, with habitat and distribution information, are listed in Appendix F.

The Cheat Mountain Salamander (*Plethodon nettingi*) is a federally threatened species that is endemic to West Virginia and imperiled in the state. It is found primarily in cool, moist red spruce-yellow birch forests, but is occasionally collected in mixed deciduous hardwoods. Its habitat usually includes a ground cover including the liverwort Bazzania and an abundance of leaf litter, fallen logs and decaying woody debris (Brooks 1945, 1948; Clovis 1979; Green and Pauley 1987). It is known from high elevations in Grant, Pendleton, Pocahontas, Randolph, and Tucker counties.

The Mountain Earthsnake (*Virginia valeriae puchra*) is known from only four central Appalachian states. It is ranked as vulnerable throughout its range and imperiled in West Virginia. This snake prefers moist rocky deciduous forest or wooded hillsides, occasionally with a red spruce component, often on slopes with flat sandstone rocks and open vegetation (Green and Pauley 1987, WVDNR 2006, PA Herp Atlas 2009). It is known from high elevation sites in Pendleton, Pocahontas, Preston, and Randolph counties.

The Timber Rattlesnake (*Crotalus horridus*) and Jefferson's Salamander (*Ambystoma jeffersonianum*) are both uncommon throughout their range and vulnerable in West Virginia. The Timber Rattlesnake prefers rough, rocky mountainous habitats and has been observed in the red spruce-heath rocky woodland community. It is known from 27 counties in the Allegheny Mountains and the eastern and southern parts of the state. Jefferson's Salamander has a statewide distribution, living underground or in stacks of wet leaves in forests and wetlands (Green and Pauley 1987, Pauley 2006, WVDNR 2006). The Northern Red Salamander (*Pseudotriton ruber ruber*) is vulnerable with a statewide distribution, occurring in springs, small streams, fens, and caves (Green and Pauley 1987, Francl 2003, Pauley 2004, Pauley 2006).

Four relatively common species of amphibians and reptiles are often found in the red spruce ecosystem. Wehrle's Salamander (*Plethodon wehrlei*) has a bimodal distribution in the state, occurring in red spruce-yellow birch forests at high elevations and mixed deciduous woodlands at lower elevations. The Mountain Dusky Salamander (*Desmognathus ochrophaeus*) is found mainly in the mountains from Preston to McDowell counties, where it lives in red spruce and hardwood forests, springs, seeps, and streams. The Four-toed Salamander (*Hemidactylium scutatum*) is found in Sphagnum peatlands and hardwood forests. Most records of this species are from the mountainous and eastern counties, although it may be found statewide. The Red-bellied Snake (*Storeria o. occipitomaculata*) prefers wooded areas; it is found statewide with a preference for mountainous terrain (Green and Pauley 1987, TNC 2001, Pauley 2004, Green et al. 2006, Pauley 2006, CVNWR 2007).

Invertebrates

Land snails, crayfish, moths, and butterflies of the red spruce ecosystem, including both upland and wetland species, are described below. Additional information on invertebrates that are associated with wetlands within the red spruce ecosystem including dragonflies, damselflies, insects, springtails, spiders, and harvestmen is available in Byers et al. (2007).

Land snails

Land snails are found throughout West Virginia. Most land snails live in the upper leaf litter of forests, old fields, and wetlands, but they are also found in more disturbed habitats. A few species are restricted to high elevation red spruce and spruce-hardwood forests, but most have a broader distribution. Land snails play an important role in micronutrient cycling and provide critical calcium carbonate to the ecosystem, including nutritional benefits to other invertebrates, small mammals, salamanders, frogs, turtles, passerine birds (especially ground-foragers), and bats (Hotopp and Pearce 2008, Dourson 2010). Fifty-one species of land snail have been recorded within the red spruce ecosystem, including several rare species. Land snails known from the project area, with habitat and distribution information, are listed in Appendix F.

The Bear Creek Slitmouth (*Stenotrema simile*) is imperiled throughout its range but has not yet been ranked in West Virginia. Its habitat consists of logs and leaf litter on rocky wooded hillsides. It is known from higher elevations in Nicholas, Pocahontas, Randolph, and Webster counties. The Spruce Knob Threetooth (*Triodopsis picea*) is vulnerable to extinction throughout its range and imperiled in West Virginia. It is possible that this species has been under-collected and further research may indicate that populations are more abundant. It lives under leaf litter in alder swamps, cool ravines, and wet areas of red spruce and spruce-northern hardwood forest, and is often associated with calcium-poor soils. It has been collected from high elevation sites in Greenbrier, Nicholas, Pendleton, Pocahontas, Randolph, and Webster counties. Two other land snails, the Rust Glyph (*Glyphyalinia picea*) and Balsam Globe (*Mesodon andrewsae*), are vulnerable throughout their range but have not yet been ranked in West Virginia. The Rust Glyph is found in moist leaf litter on wooded hillsides. It is known from high elevation sites in Pendleton, Pocahontas, Preston, and Randolph counties. The Balsam Globe has been found at high elevation sites including red spruce forest in Pocahontas and Randolph counties (TNC 2001, FMNH 2006, Hotopp and Pearce 2008, Dourson 2010).

The Angular Disc (*Discus catskillensis*) and Striped Whitelip (*Webbhelix multilineata*) are critically imperiled in West Virginia. The Angular Disc lives in leaf litter and decaying logs in high elevation woods. West Virginia's only two known collections of this northern species are at sites within the red spruce ecosystem in Pocahontas and Tucker counties. The Striped Whitelip is found in wetlands and riparian zones, primarily along the Ohio River Islands. It has been found at Cranesville Swamp, which brings it just into the red spruce wetland ecosystem. The Eastern Glass-snail (*Vitrina limpida*), which has a northern distribution, was recorded on a limestone outcrop in Canaan Valley, Tucker County in 2008 (Dourson 2010) and should be considered critically imperiled in the state. The Atlantic Threetooth (*Triodopsis juxtidens*) is also ranked as critically imperiled in the state, but recent collections may indicate that it is more abundant than previously thought. It lives under leaf litter, logs, and rocks on wooded hillsides, ravines, and disturbed areas, and although it has been recorded at high elevations, it is not restricted to any one ecosystem in West Virginia (Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008, TNC 2001, Dourson 2010).

Three land snails that are uncommon throughout their range, but which have not yet been ranked in West Virginia, are typically found at high elevation sites. They are the Brown-spotted Mantleslug (*Philomycus venustus*), Golden Dome (*Ventridens arcellus*), and Temperate Coil (*Helicodiscus shimeki*). The Golden Dome was listed as extirpated in the state but was recently re-discovered (Hotopp and Pearce 2008). Its habitat is leaf litter in hardwood or mixed forests above 3000 feet (914 m) elevation. Three common leaf litter species that are typically found at higher elevations are Ribbed Striate (*Striatura exigua*), Black Striate (*Striatura ferrea*), and Median Striate (*Striatura meridionalis*) (Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008, Dourson 2010).

Crayfish

Crayfish species distribution in the Central Appalachians is related to both pre-Pleistocene and Pleistocene river basin configurations (Crandall and Templeton 1999, Jezerinac et al. 1995). The headwater streams of the study area have straddled the eastern continental

divide since pre-Pleistocene time, allowing for a diversity of crayfish species. Nine species of crayfish are known from the study area. The Elk River Crayfish (*Cambarus elkensis*) is globally imperiled and endemic to West Virginia. It occurs in relatively undisturbed tributaries and mainstem sections of the upper Elk River, where it burrows through loose cobble and under rock slabs (Loughman 2009, Loughman and Welsh 2010). The Monongahela Crayfish (*Cambarus monongalensis*) is found in the Allegheny Mountain region and northern panhandle. It is considered stable globally but populations are vulnerable within West Virginia. It is a primary burrower and constructs burrows in seeps, springs, and roadside ditches in deciduous woods. The New River Crayfish (*Cambarus chasmodactylus*) is confined to the New River system and is also ranked as vulnerable within West Virginia. Within the study area, it occurs in the East and West Forks of the Greenbrier River. This species seems to prefer rocky pools in clean, high gradient larger streams (Jezerinac et al. 1995, WVDNR 2010b).

Two species of crayfish are commonly found in the project area. They are the rock crayfish (*Cambarus carinirostris*) and the Allegheny crayfish (*Orconectes obscurus*). The rock crayfish occupies the Allegheny Mountain region and northern panhandle of West Virginia, where it inhabits small rocky headwater streams, intermittent streams, and seeps. The Allegheny crayfish lives in small rocky headwater streams that are not affected by acid mine drainage or clear-cutting in the northern portion of the state (Jezerinac et al. 1995, WVDNR 2010b).

Four additional species are found only on the periphery of the study area, where their broader ranges overlap slightly with the red spruce ecosystem. These include the Teays River crayfish (*Cambarus sciotensis*) in Little Clear Creek, Cranberry River, and Williams River; the Sanborn crayfish (*Orconectes sanbornii*) in Little Clear Creek, the big water crayfish (*Cambarus robustus*) in the East and West Forks of the Greenbrier, and the Appalachian brook crayfish (*Cambarus bartonii bartonii*) in headwater streams of the Potomac River (TNC 2001, WVDNR 2010b). Crayfish species known from the red spruce ecosystem are listed in Appendix F.

Butterflies and moths

The red spruce-northern hardwood forest and its mosaic of embedded wetlands in the study area provide a rich diversity of habitats for butterfly and moth species. While there are very few species associated with red spruce trees directly, an abundance of native nectar and larval host plants occur in the study area, and the juxtaposition of open and shaded habitats provides excellent habitat for many Lepidoptera. Rare butterfly and moth species that have been recorded within the red spruce ecosystem, and a few common species that may be typical of this habitat, are described below. A total of 579 species of Lepidoptera have been recorded in the study area. They are listed in Appendix F.

Smyth's Green Comma (*Polygonia faunus smythii*) is vulnerable to extinction throughout its range, and critically imperiled in West Virginia. This subspecies occurs along streams or small openings in cool coniferous forested areas, often at high altitude and usually with some spruce present. The Pink-edged Sulphur (*Colias interior*) is a northern species with disjunct and critically imperiled populations in the high Alleghenies of West Virginia. The Pink-edged Sulphur is found in open areas and bogs within the red spruce ecosystem. Blueberry species are its larval host plant, with a preference for lowbush blueberry (*Vaccinium angustifolium*). Three

other northern disjunct species have populations that are imperiled in the state. They are Harris' Checkerspot (*Chlosyne harrisii*), Bog Copper (*Lycaena epixanthe*), and Black Dash (*Euphyes conspicua*). Harris' Checkerspot is found in wet meadows of the high Alleghenies that support good populations of flat-topped white aster (*Doellingeria umbellata*), its larval host plant. The Bog Copper has a disjunct population at Cranesville swamp, where it is confined to acidic cranberry peat bogs. Allen (1997) writes that the Cranesville population was probably established during the latest glacial period. Large and small cranberry (*Vaccinium macrocarpon, Vaccinium oxycoccos*) serve as the only larval host plants in West Virginia. The Black Dash is also known only from Cranesville Swamp, although it may occur in other high elevation wetland sites. It inhabits wet meadows and fens, particularly where its preferred larval host, tussock sedge (*Carex stricta*), is abundant (Allen 1997, TNC 2001, NatureServe 2010).

Butterflies with populations that are vulnerable in West Virginia and which show some affinity for the red spruce ecosystem include the Atlantis Fritillary (*Speyeria atlantis*) and the Silver-bordered Fritillary (*Boloria selene myrina*). The Atlantis Fritillary is northern disjunct that is found in open meadows, bogs, and woodland edges of the high Alleghenies. The Silver-bordered Fritillary is found in wet meadows and shrub swamps, often in the high Alleghenies, preferring sites with taller vegetation. Both species of fritillary select woodland violets (*Viola* spp.) as larval host plants (Allen 1997, TNC 2001, NatureServe 2010).

Ten additional rare species of butterfly have been recorded in the red spruce ecosystem, but these species all have broader distributions and are not particularly associated with spruce forests or their embedded wetlands in West Virginia. They include the West Virginia White (*Pieris virginiensis*), Diana Fritillary (*Speyeria diana*), Early Hairstreak (*Erora laeta*), Bronze Copper (*Lycaena hyllus*), White M Hairstreak (*Parrhasius m-album*), Pepper & Salt Skipper (*Amblyscirtes hegon*), Gray Comma (*Polygonia progne*), Appalachian Brown (*Satyrodes a. appalachia*), Baltimore Checkerspot (*Euphydryas phaeton*), and Leonard's Skipper (*Hesperia l. leonardus*) (Allen 1997, TNC 2001, WVDNR 2010b).

Three rare species of moth may have some affinity for the red spruce ecosystem. The Salt & Pepper Looper Moth (*Syngrapha rectangula*), which is critically imperiled in the state, is a northern species that ranges south along moist montane coniferous forests of the Appalachians. Larvae feed on needles of red spruce, balsam fir, and eastern hemlock. The Willow Dart (*Cerastis salicarum*), also critically imperiled in the state, is a northern species that presumably feeds on willow. The Summer Hyppa (*Hyppa contrasta*) is not ranked in the state, but it is ranked as vulnerable throughout its (mostly northern and montane) range (Opler et al. 2010, WVDNR 2010b).

Seven additional rare species of moth have been recorded in the red spruce ecosystem, but these species either have broader distributions or their distributions are poorly known. They are all ranked as critically imperiled in West Virginia. They include a Looper Moth (*Euchlaena effecta*), two Noctuid Moths (*Aplectoides condita* and *Lithophane oriunda*), the Bicolor Moth (*Eilema bicolor*), the Common Ringlet (*Coenonympha tullia*), the Similar Black Noctuid (*Melanchra assimilis*), and the Spotted Tussock Moth (*Lophocampa maculata*) (Wagner et al. 2001, Opler et al. 2010, WVDNR 2010b).

The thirty-eight common species of moths and butterflies listed below may possibly have an affinity for the red spruce ecosystem, based on current data (Table 9). Most existing records for these species in West Virginia are from the red spruce ecosystem; however, these apparent distributional trends may not be significant. The sample sizes are in many cases too small, or are drawn from only a few collecting sites, to allow confidence in the species' distributions.

Table 9. Common Lepidoptera recorded predominantly in the red spruce ecosystem (WVDNR 2010b)

Common Name	*Species*	Number of Records	% in Spruce Ecosystem
Olive-and-black Carpet	*Acasis viridata*	1	100
Fall Cankerworm Moth	*Alsophila pometaria*	40	78
A Noctuid Moth	*Anaplectoides brunneomedia*	8	100
A Noctuid Moth	*Apamea nigrior*	2	100
A Noctuid Moth	*Apamea verbascoides*	9	100
Four-lined Cream Moth	*Cabera quadrifasciaria*	10	80
A Noctuid Moth	*Capis curvata*	3	100
Sleepy Underwing	*Catocala concumbens*	3	100
Praeclara Underwing	*Catocala praeclara*	7	86
Inornate Common Ringlet	*Coenonympha tullia inornata*	31	100
A Noctuid Moth	*Ctenucha virginica*	21	95
Dark-spotted Looper Moth	*Diachrysia aeroides*	9	100
Rubifera Dart	*Diarsia rubifera*	24	83
Dark Marbled Carpet	*Dysstroma truncata*	30	97
Pointed Sallow	*Epiglaea apiata*	1	100
A Noctuid Moth	*Eucoptocnemis fimbriaris*	1	100
A Noctuid Moth	*Eueretagrotis perattenta*	4	100
Soothsayer Dart	*Graphiphora haruspica*	7	86
A Noctuid Moth	*Harrisimemna trisignata*	2	100
A Noctuid Moth	*Hormisa absorptalis*	2	100
A Noctuid Moth	*Lithacodia bellicula*	16	100
A Noctuid Moth	*Lithomoia solidaginis*	4	100
Nameless Pinion	*Lithophane innominata*	5	80
A Noctuid Moth	*Meropleon diversicolor*	8	88
A Noctuid Moth	*Morrisonia mucens*	1	100
A Geometrid Moth	*Nemoria pistaciaria*	1	100
Common Petrophora	*Petrophora divisata*	8	88
Speckled Rustic	*Platyperigea multifera*	9	78
Purple Arches	*Polia purpurissata*	5	100
A Noctuid Moth	*Protagrotis obscura*	6	83
Virgin Moth	*Protitame virginalis*	1	100
Wild Cherry Sphinx	*Sphinx drupiferarum*	1	100
Pale Alder Moth	*Tacparia detersata*	16	94
A Noctuid Moth	*Xestia atrata*	2	100
Gray Sword Grass Moth	*Xylena cineritia*	3	100
Dot-and-dash Sword Grass Moth	*Xylena curvimacula*	3	100
A Noctuid Moth	*Zanclognatha inconspicualis*	9	78

Extent of the red spruce ecosystem

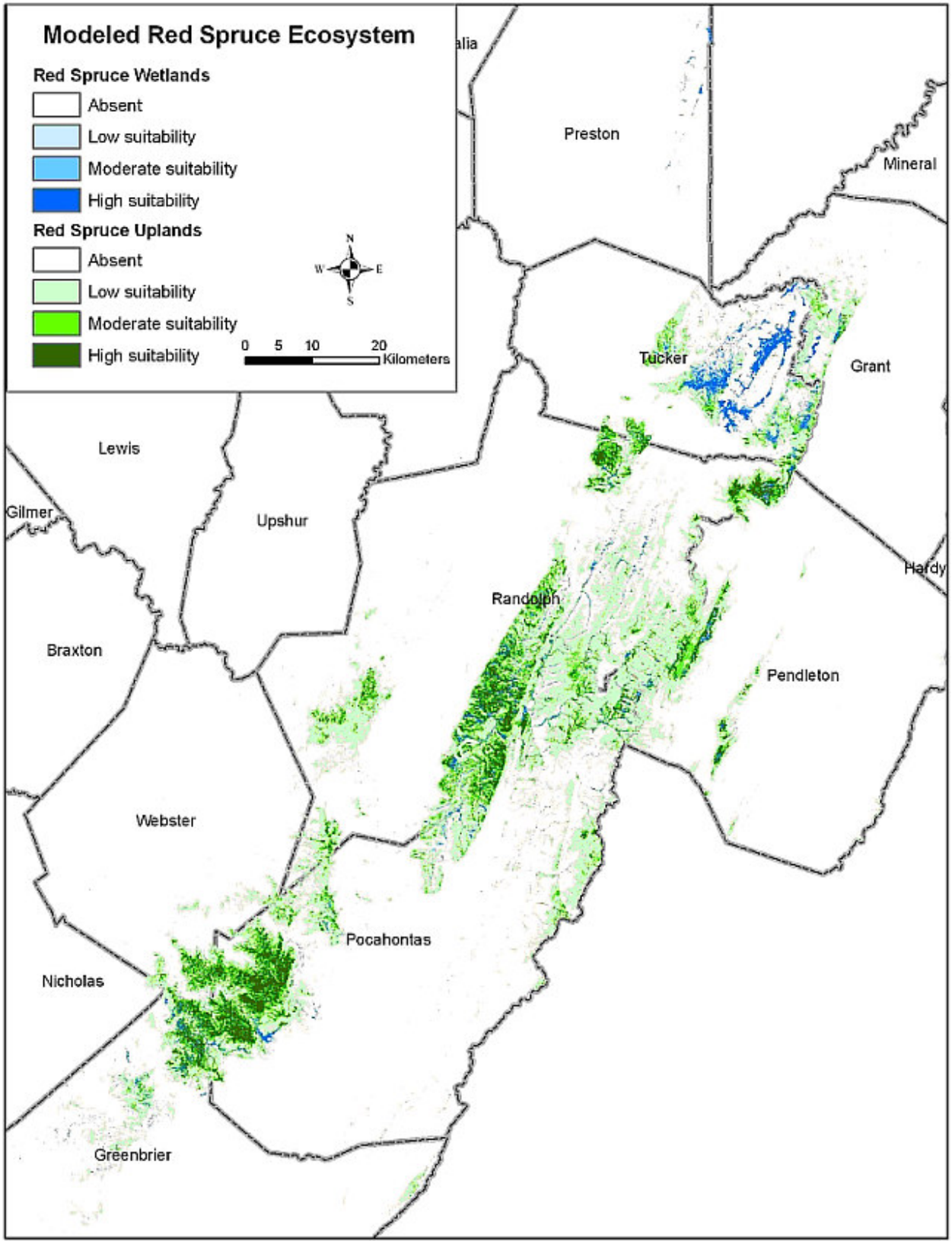
The current extent of the red spruce ecosystem has not been accurately measured. The U.S. Forest Service estimates that only 24,000 ha of red spruce forests remain in West Virginia, representing perhaps a 90% decrease in area compared to the late nineteenth century (USFS 2000).

We conducted maximum entropy habitat suitability modeling to estimate the extent of potentially restorable red spruce habitat in West Virginia (Dougherty 2008). Input data for the distribution models included 114 upland and 169 wetland spruce plots. Plot data were modeled against 58 quantitative variables and 7 categorical variables related to temperature, precipitation, elevation, aspect, slope, topographic position, geology, and land use. The resulting area under the receiver operating characteristic curve was 0.999 for both upland and wetland models, indicating a strong "fit" of the model to the training data. This result should not be over-interpreted, however, since species with narrow ranges relative to the area described by the environmental data (West Virginia) tend to have high values for this statistic (Phillips 2010). The largest training gains and relative contributions to the models came from temperature, elevation, and land use variables. Results are shown in Figure 10. This map shows one prediction of the probable extent of the red spruce ecosystem in West Virginia prior to extensive logging from 1880-1920. The predicted extent of 206,000 hectares may be compared to other estimates of the area formerly covered by red spruce forests in the state (Table 10), which range from 200,000 to 600,000 hectares.

Table 10. Estimated extent of the red spruce ecosystem in West Virginia prior to 1880.

Source	Estimated extent (ha)
Hopkins 1899 (cited in Rentch et al. 2007)	600,000
Korstian 1937	200,000
Menzel et al. 2006	224,000
This assessment	206,000

Figure 10. Habitat suitability model of red spruce uplands and wetlands



Vulnerability to climate change and other threats

Climate change is one of the newest and least understood threats to upland red spruce communities. West Virginia is predicted to warm approximately 5 degrees Fahrenheit by mid-century under medium emissions scenarios (Gervitz et al. 2009). Precipitation is predicted to increase from 5% to 8% in the same time period. The increased precipitation is not, however, enough to offset increased evapotranspiration as habitats warm. Overall, habitats are predicted to experience net drying throughout the state, especially during summer and early fall (Gervitz et al. 2009, Young et al. 2010). Extreme events, including floods, droughts, and severe storms are expected to increase as well (Pachauri and Reisinger 2007). These coming changes will have significant but as yet poorly understood impacts on species and communities. Some species and communities are likely to be resilient, and some are at risk. Upland red spruce communities occupy the highest and coldest climate niche in the state, and are clearly at risk due to climate change. USDA's Climate Change Tree Atlas (USDA 2007) shows red spruce disappearing from West Virginia, even under low emissions scenarios (Figure 11). This model, however, may have overly pessimistic initial conditions in that it does not take into account the current expansion of red spruce into portions of its former range.

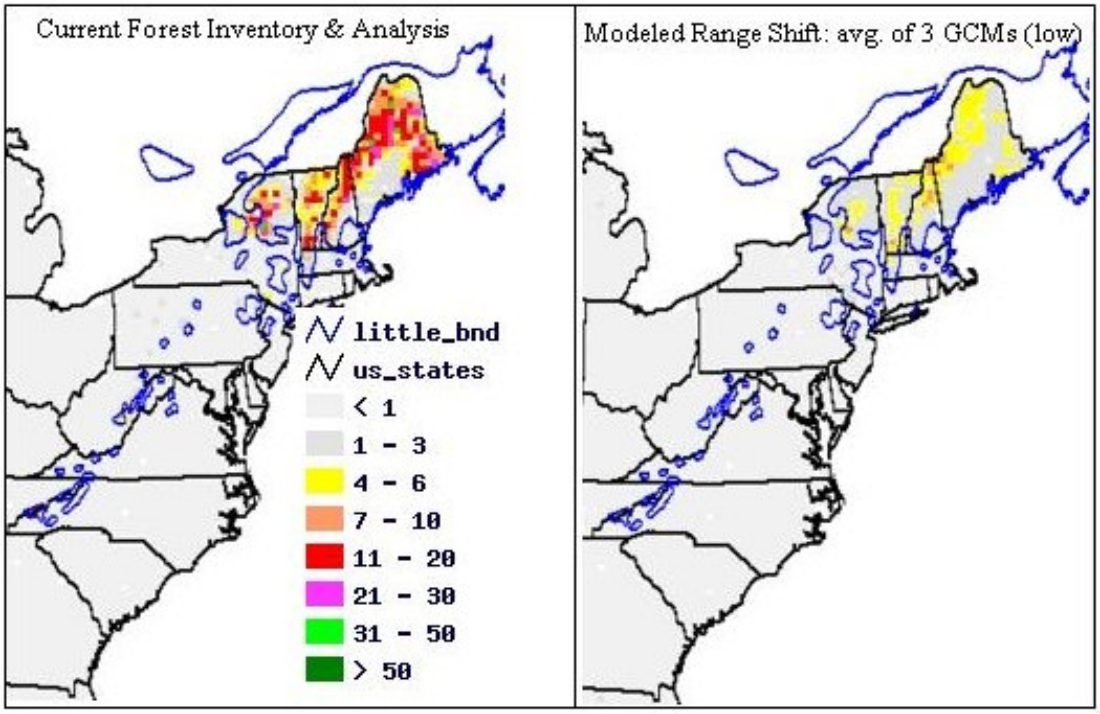


Figure 11. Red spruce range contraction under climate change (USDA 2007)

NatureServe has developed a Climate Change Vulnerability Index (Young et al. 2010) to assess the relative risk of local extirpation of plant and animal species due to climate change. Red spruce was assessed using this methodology and scores as "Highly Vulnerable" to climate change due to several factors including its topographic location on the highest mountaintops, geographic (low elevation) barriers to dispersal, moderately poor dispersal ability, and fairly

narrow temperature and precipitation tolerances. This method also predicts that red spruce will shift its range northward and disappear from West Virginia.

In addition to the coming threat from climate change, it is important to remember other serious on-going threats to upland red spruce communities. Despite protection of many areas, red spruce communities still face significant habitat loss and hydrologic alteration from mining activities, second home development, industrial wind corridors, fragmentation and loss of buffer from road construction and logging, invasive species and aggressive new pathogens, excessive deer herbivory which is eradicating palatable species, airborne pollution, ozone damage, and acid deposition.

On the positive side, upland red spruce communities have several key characteristics that are likely to impart resiliency in the face of climate stress and other stresses. They occur on large tracts of relatively well-connected landscapes in the largest high-elevation area in the northeastern United States. The red spruce ecosystem as a whole, including both upland and imbedded wetland communities, contains high levels of biodiversity, which means that even with some extinctions, there may be enough connected threads of the ecosystem left to function. The southwest to northeast orientation of the mountains, and the connectivity of natural habitats between low and high elevations, may allow some rapidly dispersing species to migrate northward or upward as the climate envelope shifts. Regardless of what happens to the individual species in the red spruce ecosystem, the landscape itself is highly likely to continue to support important conservation targets for the foreseeable future.

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APPENDIX A: West Virginia Natural Heritage Program, Vegetation Plot Form (woody version)

Identifiers

Revised Aug 2008

Plot code _____ Location name _____

County name _____ Sublocation_____ Quad name _____

Dominant vegetation _____

Survey date _____ Time: _____ Surveyors _____

Plot directions:

X dimension (m) _____ Y dimension (m) _____ Plot shape _____

GPS file _____ GPS feature _____ ❑ corrected ❑ raw ❑ map dot

Field UTM x _____ Field UTM y _____

Corrected UTM x _____ Corrected UTM y _____ Datum _____

❑ **Photos** Camera _____

Photographer _____

Roll # _____ Frame # _____

Environmental data

Hydrology evidence
❑ hydrophytes ❑ standing water ❑ saturated soil ❑ flood scour ❑ flotsam ❑ soil features ❑ other: e.g. crayfish holes

Hydrologic regime
❑ permanently flooded ❑ semi-permanenty flooded ❑ seasonally flooded ❑ temporarily flooded ❑ intermittently flooded ❑ saturated ❑ moist ❑ somewhat moist ❑ dry ❑ very dry ❑ extremely dry ❑ unknown

Elevation (m) _____

Slope (°) _____ **Aspect** (°): _____

Slope shape-vert.: *concave straight convex undulating*

Slope shape-horiz.: *concave straight convex undul.*

Landform: _____

Cowardin system: *U P R L*

Geologic unit: _____

Surficial geology: _____

Topographic sketch

Rosgen stream type
A B C D DA E F G
1 2 3 4 5 6 a+ a b c c-

Hummocks ___%___% hollow
height (cm):____ ❑ peat
❑ tussocks ❑ roots
❑ tip mounds ❑ down wood
❑ woody stem clusters

Topographic position
❑ interfluve ❑ backslope ❑ low level
❑ high slope ❑ step in slop ❑ channel wall
❑ high level ❑ lowslope ❑ channel bed
❑ midslope ❑ toeslope ❑ basin floor

Unvegetated surface (%)
____ bedrock ____lg rocks >10 cm ____sm rocks .2-10 cm ____sand .1-2 mm ____litter/duff ____wood >1 cm ____water ____bare soil ____other:

Stoniness
❑ <.1% ❑ .1-3% ❑ 3-15% ❑ 15-50% ❑ 50-90% ❑ >90%

Soil drainage
❑ rapid ❑ well ❑ moderate ❑ mod-poor ❑ poor ❑ very poor

Soil Depth to water table (cm):_____

Texture (mineral soil):_____

pH (mineral soil):_____

Depth of organic soil (cm): _____

Depth to mottling (cm):_____

Pore water pH: _____

Pore water EC: _____

Pore water T (°C) _____

Soil map unit:_____

Soil profile: *indicate depth, horizon, texture, matrix & mottle colors, redoximorphic features, peat decomposition, comments* ⇨

Hydric indicators: _____

❑ Soil sample collected for lab analysis

Estimated stand size (ha): _____

Representativeness:

Environmental condition:

Landscape context:

Ranking: size:_____
condition: _____
context: _____
composite: _____

Disturbance: ❑ fire ❑ exotic plants ❑ trails/roads ❑ deer trails ❑ clearing ❑ insects ❑ grazing ❑ wind-ice damage ❑ other ❑ logging ❑ disease ❑ browsing ❑ ditching/hydro alteration
Comments:

Animal use evidence:
❑ insects collected

Plot code ______________	**Leaf phenology**	**Physiognomic class**	*Height class (m)*	**Stratum**	Height (m)	% cover
Leaf type	❑ evergreen	❑ forest		T1 emergent tree		
❑ broad leaf	❑ cold-deciduous	❑ woodland	*<.5 35-50*	T2 tree canopy		
❑ needle leaf	❑ mixed evergreen-deciduous	❑ shrubland	*.6-1 >50*	T3 tree sub-canopy		
❑ mixed broad/needle	❑ annual herb	❑ dwarf shrubland	*1.1-2 float*	S1 tall shrub		
❑ graminoid	❑ perennial herb	❑ herbaceous	*2.1-5 subm*	S2 short shrub		
❑ broad-leaf herbaceous	❑ drought-deactivated	❑ non-vascular	*5.1-10*	H herbaceous		
❑ pteridophyte		❑ floating aquatic	*10.1-15*	N non-vascular		
❑ byrophyte	❑ **Floristically complete?**	❑ submerged aquatic	*15.1-20*	A1 floating		
		❑ sparse vegetation	*20.1-35*	A2 submerged		

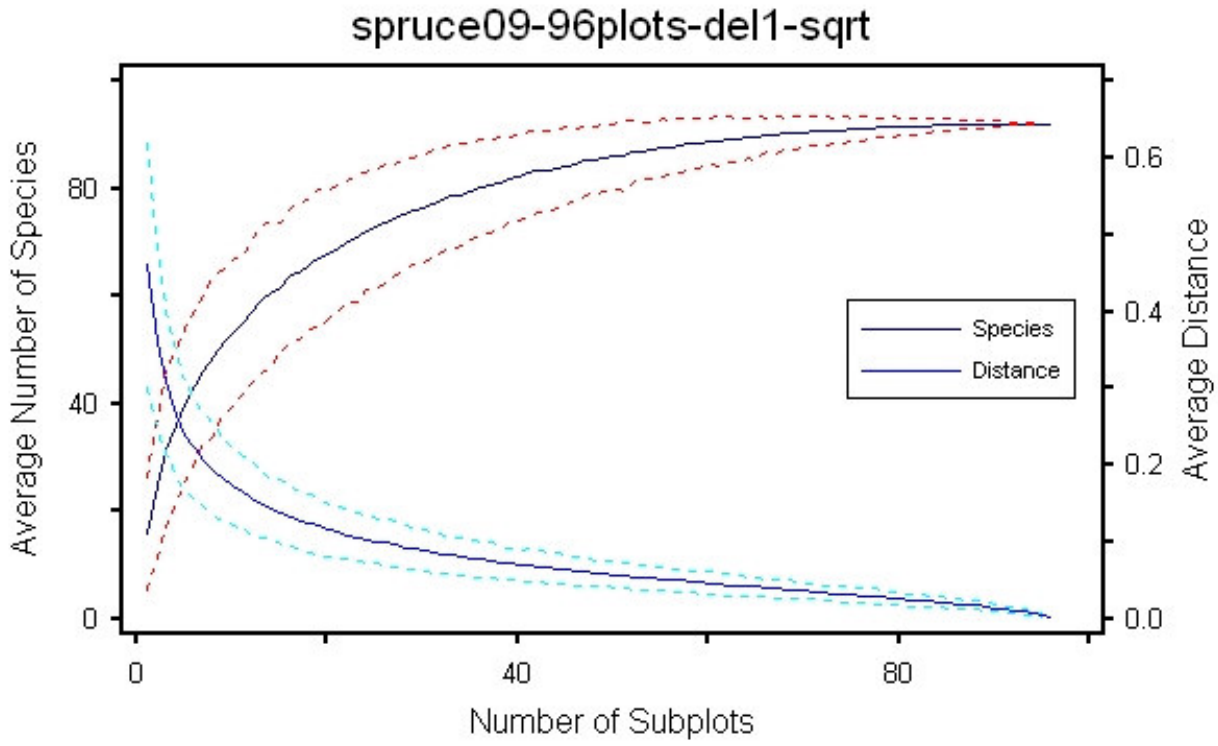
Start with uppermost stratum. Note 'cf.' for uncertain taxa, © for collection (add # when available). Phenology codes (fr), (fl), (v).

Woody species	**T1**	**T2**	**T3**	**S1**	**S2**	**H**	**%TC**	**DBH** *(note stratum; include age data if available)*

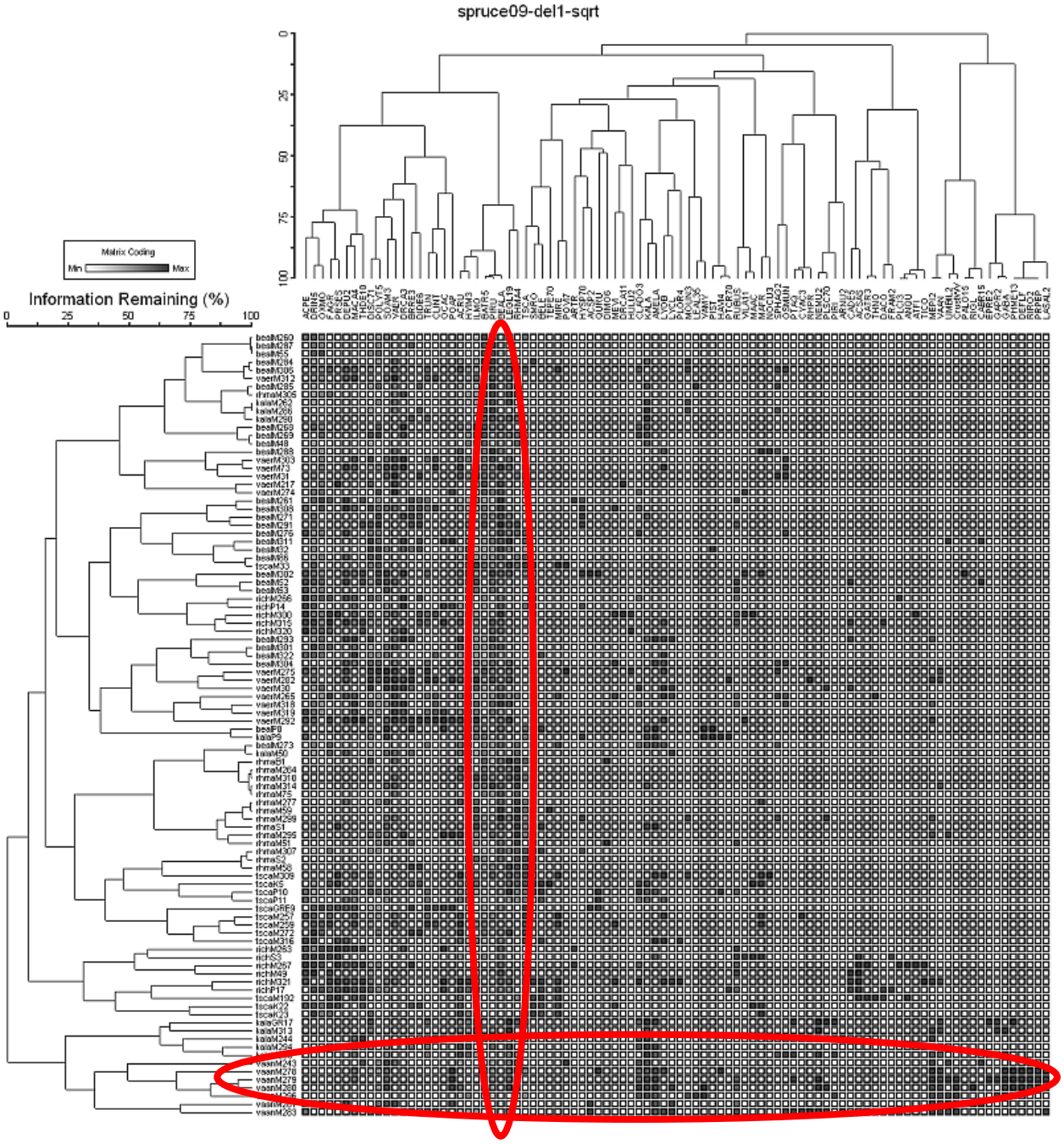
Species name	% cover		

Appendix B: Sample Statistical Results

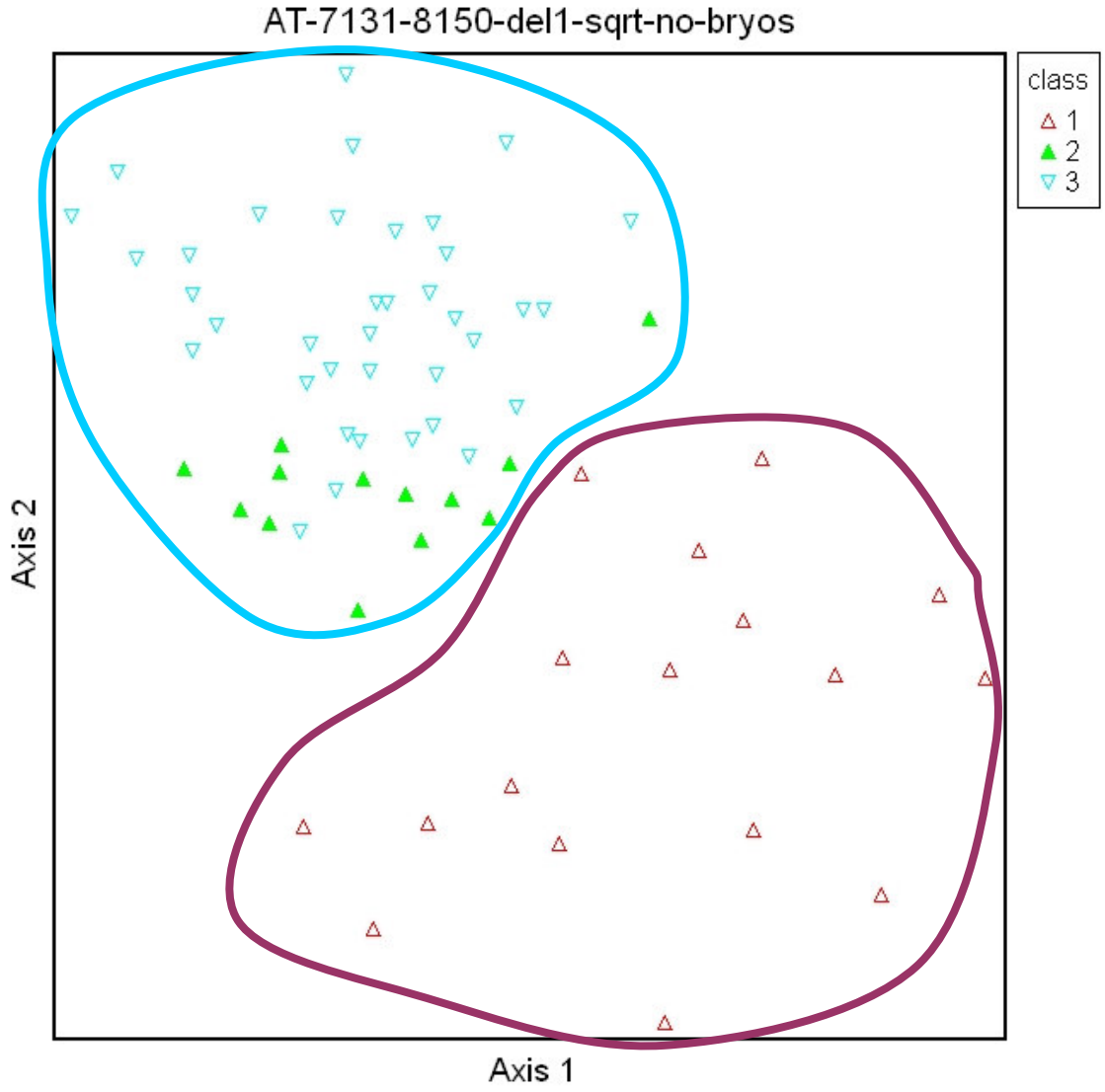
Sample #1. Species-area curve to assess sample adequacy. Dotted lines represent +- 1 standard deviation. The distance curve (blue line) describes the average Sorenson (Bray-Curtis) distance between the subsamples and the whole sample, as a function of subsample size.



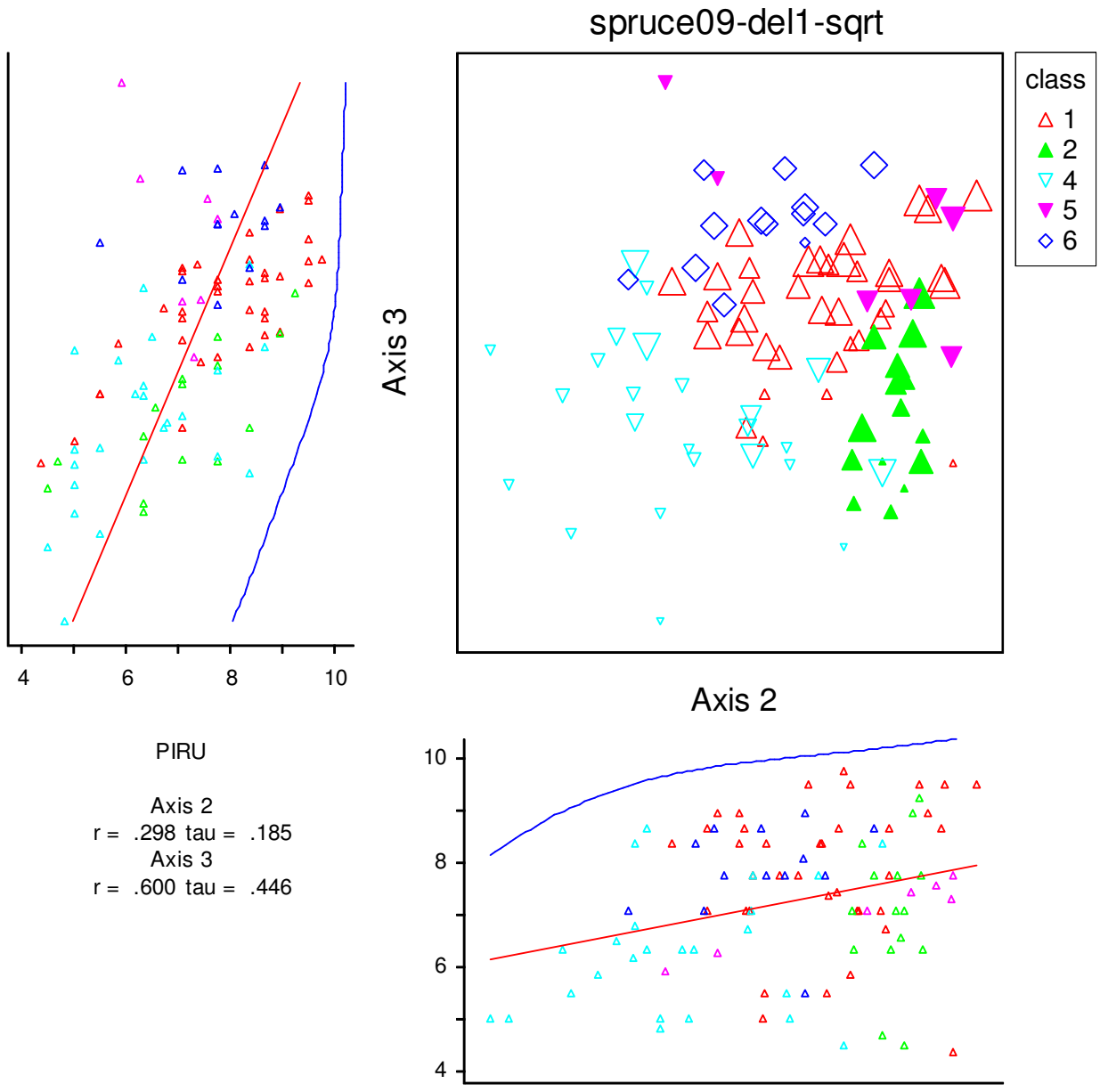
Sample #2. Two-way hierarchical agglomerative cluster analysis, sample result showing (a) vertical species cluster of *Picea rubens, Betula alleghaniensis, Bazzania trilobata, Ilex montana,* and *Hypnum imponens*, and (b) horizontal plot cluster of Red spruce – heath rocky woodland plots. Multiple iterations of cluster analysis and ordination based on different data scenarios were examined to determine the final classification groupings.



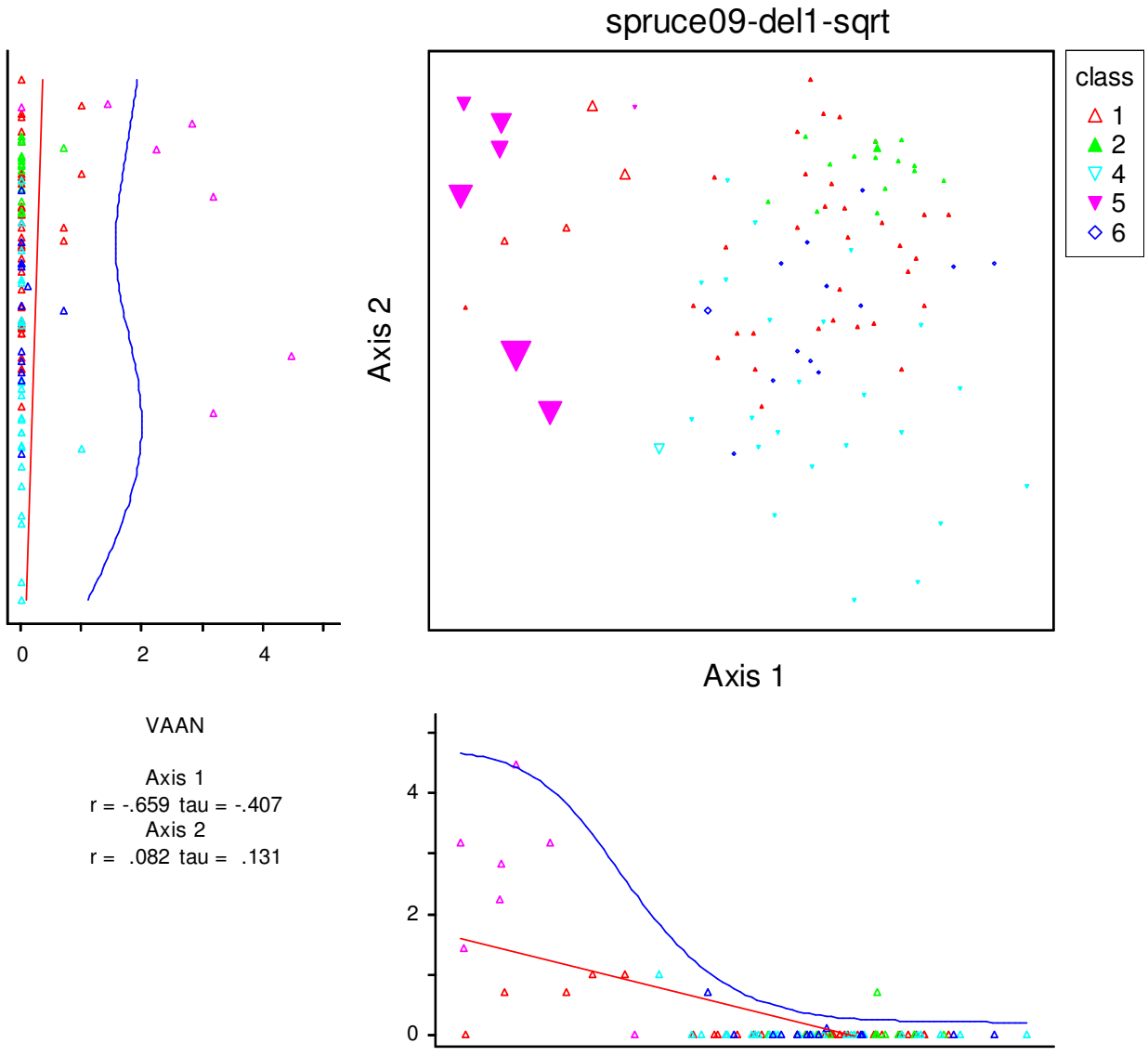
Sample #3. Ordination (non-metric multi-dimensional scaling). Red spruce-yellow birch forest plots are outlined in blue, with two floristic variants plotted as blue and green triangles. Red spruce-southern mountain cranberry forest plots are outlined in brown. The plots are shown in species space. Multiple iterations of cluster analysis and ordination based on different data scenarios were examined to determine the final classification groupings.



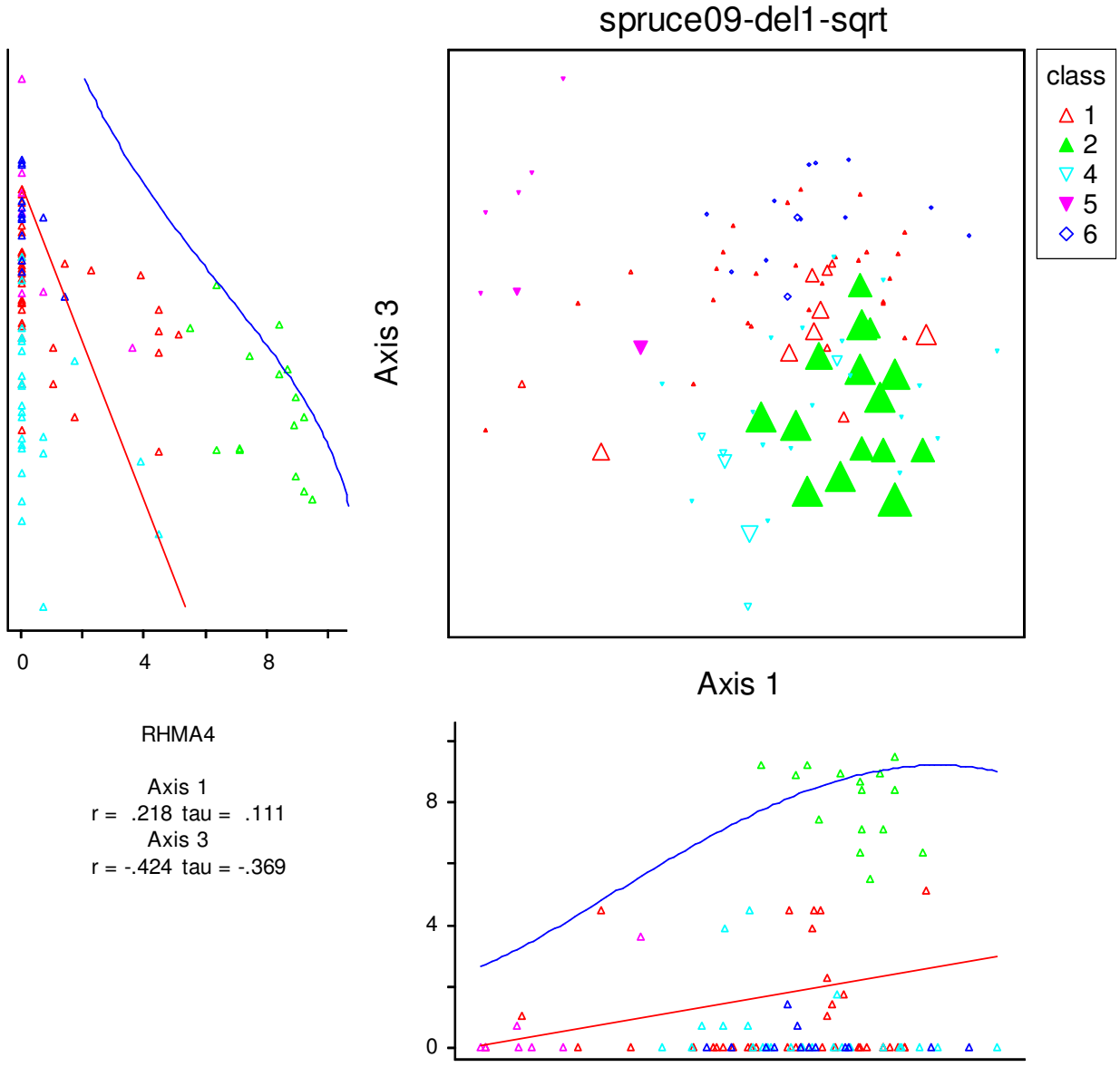
Sample #4. Ordination, showing correlation between selected species, communities, and ordination axes. "Class" indicates the community type of each plot sample, as follows: 1. Red spruce-yellow birch forest, 2. Red spruce-rhododendron forest, 4. Red spruce-hemlock-beech forest, 5. Red spruce-heath rocky woodland, and 6. Red spruce-southern mountain cranberry forest. Correlations (Pearson's r and Kendall's tau) are shown between the species PIRU (*Picea rubens,* red spruce) and floristic ordination axes. The abundance of red spruce in each plot sample is indicated by the size of the "class" symbol.



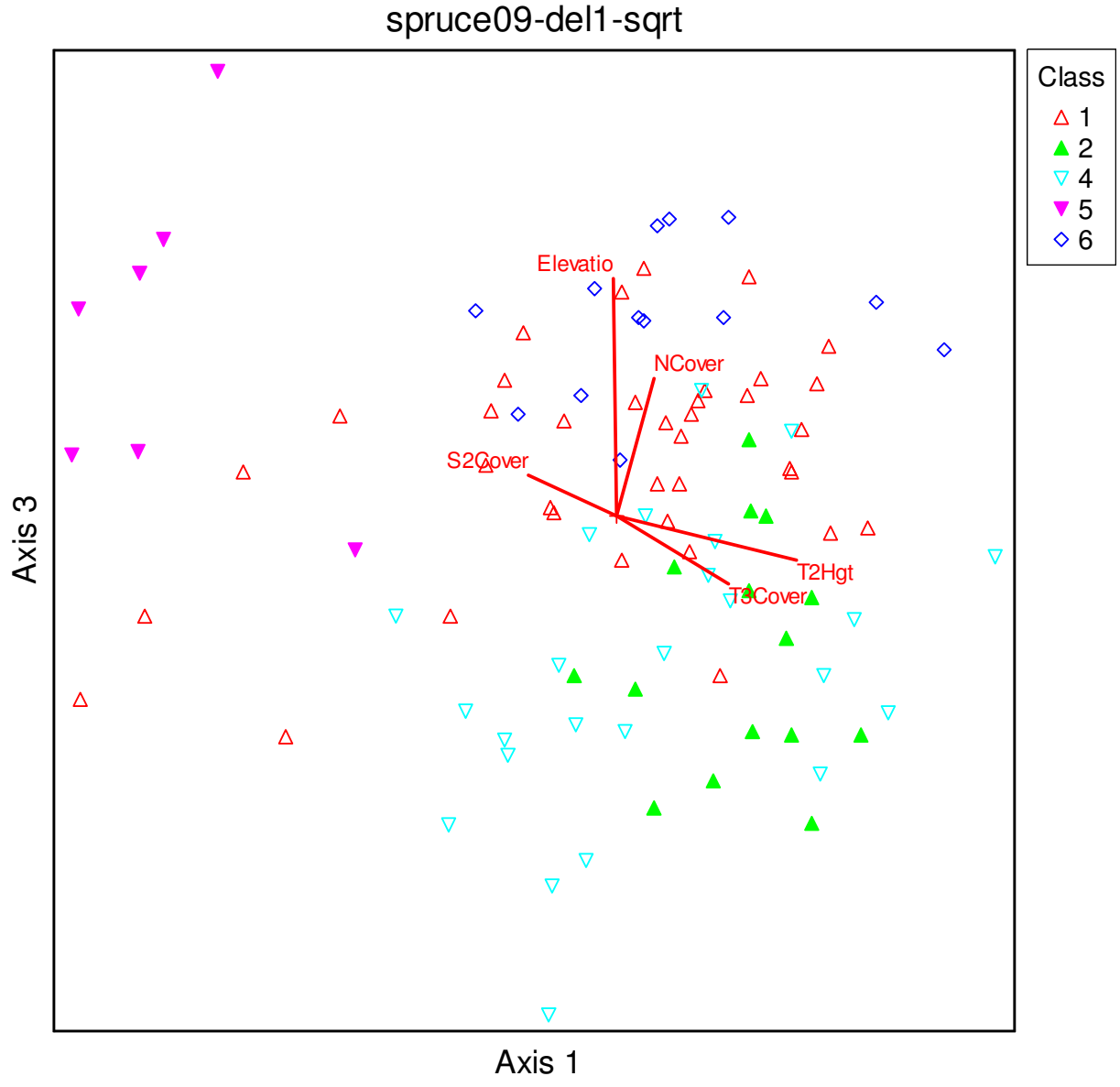
Sample #5. Ordination, showing correlation between selected species, communities, and ordination axes. "Class" indicates the community type of each plot sample, as follows: 1. Red spruce-yellow birch forest, 2. Red spruce-rhododendron forest, 4. Red spruce-hemlock-beech forest, 5. Red spruce-heath rocky woodland, and 6. Red spruce-southern mountain cranberry forest. Correlations (Pearson's r and Kendall's tau) are shown between the species VAAN (*Vaccinium angustifolium,* northern lowbush blueberry) and floristic ordination axes. The abundance of northern lowbush blueberry in each plot sample is indicated by the size of the "class" symbol.



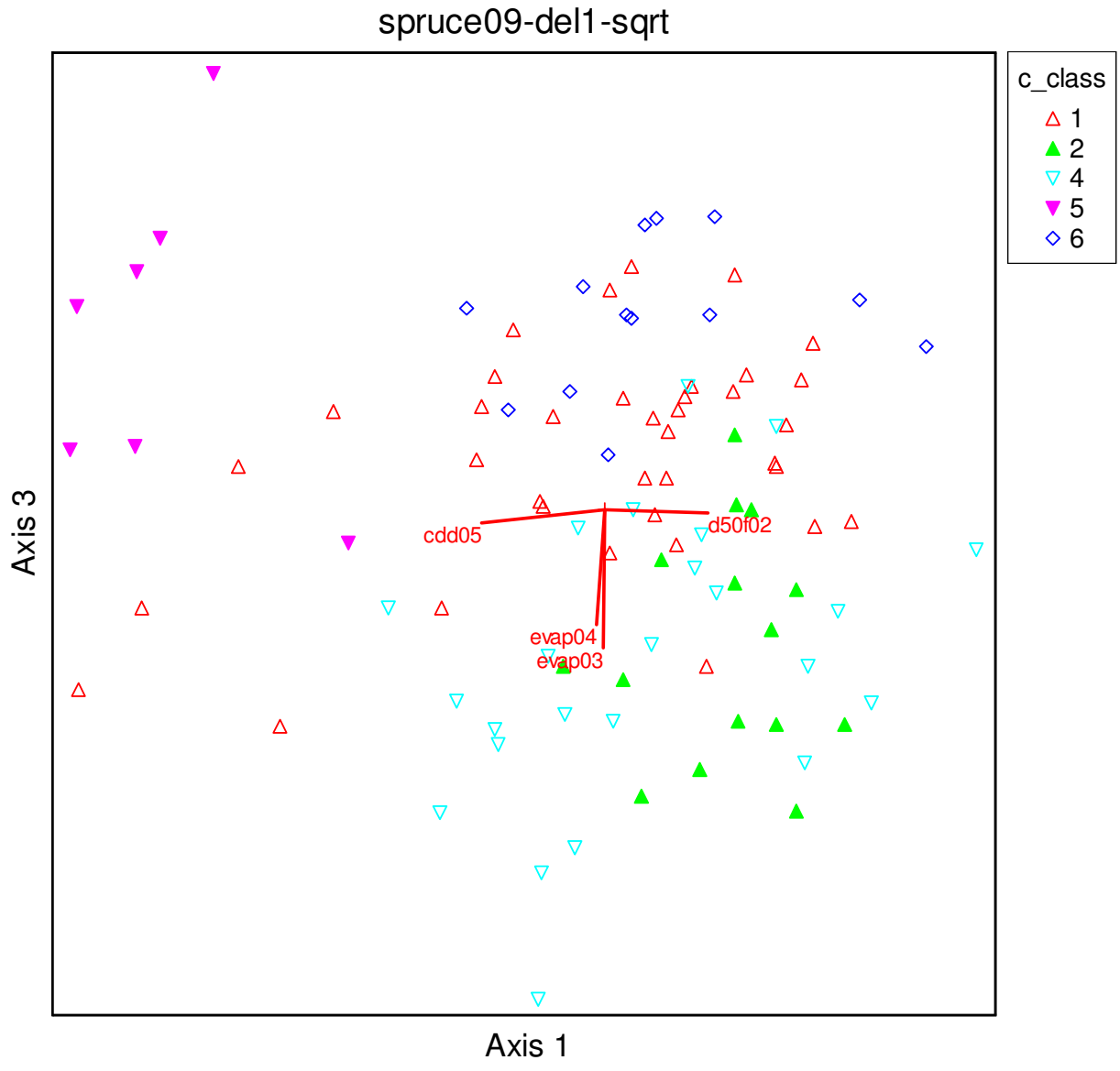
Sample #6. Ordination, showing correlation between selected species, communities, and ordination axes. "Class" indicates the community type of each plot sample, as follows: 1. Red spruce-yellow birch forest, 2. Red spruce-rhododendron forest, 4. Red spruce-hemlock-beech forest, 5. Red spruce-heath rocky woodland, and 6. Red spruce-southern mountain cranberry forest. Correlations (Pearson's r and Kendall's tau) are shown between the species RHMA4 (*Rhododendron maximum,* great rhododendron) and floristic ordination axes. The abundance of rhododendron each plot sample is indicated by the size of the "class" symbol.



Sample #7. Ordination and joint plot, showing correlation between selected environmental variables, communities, and ordination axes. "Class" indicates the community type of each plot sample, as follows: 1. Red spruce-yellow birch forest, 2. Red spruce-rhododendron forest, 4. Red spruce-hemlock-beech forest, 5. Red spruce-heath rocky woodland, and 6. Red spruce-southern mountain cranberry forest. Environmental variables shown are correlated with the ordination axes with Pearson's $r^2 > 0.2$. Environmental variables shown are: elevation, N: percent non-vascular cover, S2: percent short shrub cover, T3: percent subcanopy cover, and T2Hgt: height of the canopy.



Sample #8. Ordination and joint plot, showing correlation between selected environmental variables, communities, and ordination axes. "Class" indicates the community type of each plot sample, as follows: 1. Red spruce-yellow birch forest, 2. Red spruce-rhododendron forest, 4. Red spruce-hemlock-beech forest, 5. Red spruce-heath rocky woodland, and 6. Red spruce-southern mountain cranberry forest. Environmental variables shown are correlated with the ordination axes with Pearson's $r^2 > 0.2$. Environmental variables shown are: cdd05 cooling degree-days in May; d50f02 growing degree-days in February; evap03-04 mean monthly evapotranspiration in April and May.



Appendix B *in* Byers, E. A., J. P. Vanderhorst, and B. P. Streets. 2010. **Classification and Conservation Assessment of Upland Red Spruce Communities in West Virginia**. West Virginia Natural Heritage Program, WVDNR. Elkins, WV.

Appendix C. Dichotomous Keys to Red Spruce Communities

Floristic Key to Upland Red Spruce Associations in West Virginia

(>15% canopy cover by *Picea rubens*)

1. Woodland physiognomy: total cover by trees <60%. Rocky woodland with at least 1% cover of *Vaccinium angustifolium* and *Menziesia pilosa*. Lichens, especially *Umbilicaria muehlenbergii*, present on rocks. Occurs on west-facing slopes along the Allegheny Front. **= *Picea rubens / Kalmia latifolia - Vaccinium angustifolium* Rocky Woodland** (red spruce – heath rocky woodland)

1. Forest physiognomy: total cover by trees >60%. **2**

2. Shrub layer has >30% cover of *Rhododendron maximum*. **= *Picea rubens / Rhododendron maximum* Forest** (red spruce – rhododendron forest)

2. Shrub layer has <30% cover of *Rhododendron maximum.* **3**

3. Shrub layer has >10% cover of *Vaccinium erythrocarpum.* This type is restricted to the highest elevations in the red spruce zone. **= *Picea rubens / Vaccinium erythrocarpum / Dryopteris campyloptera* Forest** (red spruce – southern mountain cranberry forest)

3. Shrub layer has <10% cover of *Vaccinium erythrocarpum.* **4**

4. *Picea rubens* accounts for half or more of the total canopy/subcanopy cover; however, if *Betula alleghaniensis* is the only other canopy/subcanopy species, *Picea rubens* cover may be as low as one-third of total canopy/subcanopy. Herbaceous cover generally <15% and bryophyte cover generally >30%. This is the most common red spruce type above 3600 ft (1100 m) elevation in West Virginia. **= *Picea rubens / Betula alleghaniensis* var. *alleghaniensis / Bazzania trilobata* Forest** (red spruce – yellow birch forest)

4. *Picea rubens* cover accounts for less than half of the total canopy/subcanopy. Herbaceous cover generally >15% and bryophyte cover generally <30%. This is a transitional type between red spruce and northern hardwoods, sometimes with red spruce coming up in the understory. It occurs at lower elevations in the red spruce zone, and also on richer shale substrates at high elevations. **= *Picea rubens – Tsuga canadensis – Fagus grandifolia / Dryopteris intermedia* Forest** (red spruce – hemlock – beech forest)

Approximate Environmental Key to Upland and Wetland Red Spruce Associations

Or, how do I choose an NVC reference unit for my red spruce restoration project?

Use the rough key below to determine which National Vegetation Classification (NVC) unit is likely to fit your project area. If you are not sure based on the key, you may wish to choose the "Red spruce – yellow birch" type, which is the most common and widespread of our red spruce forests in West Virginia. You can also read the detailed descriptions of the associations in the main section of the report or in Byers et al. (2007) to verify your choice. If you have intact red spruce communities adjacent to and in the same environmental setting as your site, then you can use the floristic keys to make a more accurate choice regarding the best NVC unit to use as a restoration target. The West Virginia Natural Heritage Program at WVDNR can provide assistance as needed.

1. My project is on an upland site. **2**
1. My project is in a wetland. **8**

Uplands

2. My site is at an elevation below 850 m (2800 ft): (stop here: you are probably too low for an upland red spruce forest to grow)
2. My site is at an elevation above 850 m (2800 ft) **3**

3. The bedrock at my site is shale or limestone: **Red spruce – hemlock – beech forest**
3. The bedrock at my site is sandstone **4**

4. My site is on exposed rock or talus along the Allegheny Front: **Red spruce – heath rocky woodland**
4. My site is not on exposed rock or talus along the Allegheny Front **5**

5. My site is at an elevation above 1340 m (4400 feet): **Red spruce – southern mountain cranberry forest**
5. My site is at an elevation below 1340 m (4400 feet) **6**

6. My site is at an elevation above 1180 m (3870 ft): **Red spruce – yellow birch forest**
6. My site is at an elevation below 1180 m (3870 ft) **7**

7. My site is in a sheltered, moist cove: **Red spruce – rhododendron forest**
7. My site is not in a sheltered, moist cove: **Red spruce – hemlock – beech forest**

Wetlands

8. My site is a peatland (stop here: peatlands are rare habitats with many sensitive species and should be assessed by a conservation ecologist prior to any restoration work)
8. My site is not a peatland **9**

9. My site is at an elevation below 770 m (2800 ft): (stop here: you are probably too low for a red spruce wetland to grow)
9. My site is at an elevation above 770 m (2800 ft) **10**

10. The bedrock at my site is shale or limestone AND my site is either in Canaan Valley, Gandy Creek headwaters, the headwaters of the East Fork of the Greenbrier, or near Blister Run on the Upper Shavers Fork **11**
10. The bedrock at my site is sandstone, or my site is not in the places listed above **13**

11. The bedrock at my site is limestone, or the soil pH > 5.0: **Balsam fir – black ash swamp**
11. The bedrock at my site is shale, or the soil pH is between 4.0-5.0 **12**
    12. My site is dry enough that my feet don't get wet in regular hiking boots. White-edge sedge, clubmosses, partridgeberry, and bracken fern may be abundant: **Balsam fir – oatgrass swamp**
    12. My site is wetter, with some obligate wetland sedges or grasses present: **Balsam fir – winterberry swamp**
13. My site is at an elevation above 1140 m (3740 feet): **Red spruce – southern mountain cranberry swamp**
13. My site is at an elevation below 1140 m (3740 feet) **14**
    14. The soil pH at my site is greater than 4.0: **Red spruce – yellow birch – mannagrass swamp**
    14. The soil pH at my site is less than 4.0: **Red spruce – hemlock – rhododendron swamp**

Appendix C *in* Byers, E. A., J. P. Vanderhorst, and B. P. Streets. 2010. **Classification and Conservation Assessment of Upland Red Spruce Communities in West Virginia**. West Virginia Natural Heritage Program, WVDNR. Elkins, WV.

Appendix D. Documented Flora, Fungi, and Slime Molds of Upland Red Spruce Communities

Vascular Plants

Scientific Name	Common Name	State Rank	Global Rank
Acer pensylvanicum L.	Striped Maple		
Acer rubrum L.	Red Maple		
Acer saccharum Marsh. *var. saccharum*	Sugar Maple		
Acer spicatum Lam.	Mountain Maple		
Aconitum reclinatum Gray	White Monkshood	S3	G3
Ageratina altissima (L.) King & H.E. Robins.	White Snakeroot		
Agrostis perennans (Walt.) Tuckerman	Upland Bentgrass		
Amelanchier arborea (Michx. f.) Fern. var. *arborea*	Common Serviceberry		
Amelanchier laevis Wieg.	Allegheny Serviceberry		
Anemone quinquefolia L.	Nightcaps		
Angelica triquinata Michx.	Filmy Angelica		
Aralia nudicaulis L.	Wild Sarsaparilla		
Arisaema triphyllum (L.) Schott ssp. *stewardsonii* (Britt.) Huttleston	Bog Jack-In-The-Pulpit, Indian Turnip, Jack-In-The-Pulpit		
Arisaema triphyllum (L.) Schott ssp. *triphyllum*	Jack-In-The-Pulpit		
Asplenium ruta-muraria L.	Wall-Rue		
Athyrium filix-femina (L.) Roth	Common Ladyfern		
Betula alleghaniensis Britt. var. *alleghaniensis*	Yellow Birch		
Betula lenta L.	Sweet Birch		
Brachyelytrum erectum (Schreb. ex Spreng.) Beauv.	Bearded Shorthusk		
Brachyelytrum septentrionale (Babel) G. Tucker	Northern Shorthusk		
Cardamine diphylla (Michx.) Wood	Crinkleroot		
Carex aestivalis M.A. Curtis ex Gray	Summer Sedge	S3	G4
Carex amphibola Steud.	Eastern Narrowleaf Sedge		
Carex argyrantha Tuckerman	Hay Sedge		
Carex brunnescens (Pers.) Poir.	Brown Sedge		
Carex crinita Lam.	Fringed Sedge		
Carex debilis Michx.	White-Edge Sedge		
Carex debilis Michx. var. *rudgei* Bailey	White-Edge Sedge		
Carex digitalis Willd. var. *digitalis*	Slender Woodland Sedge		
Carex intumescens Rudge	Greater Bladder Sedge		
Carex laxiculmis Schwein. var. *laxiculmis*	Spreading Sedge		
Carex leptonervia (Fern.) Fern.	Nerveless Woodland Sedge	S3	G4
Carex plantaginea Lam.	Plantainleaf Sedge		
Carex scoparia Schkuhr ex Willd. var. *scoparia*	Broom Sedge		
Carex trisperma Dewey var. *trisperma*	Three-Seeded Sedge		
Carpinus caroliniana Walt. ssp. *virginiana* (Marsh.) Furlow	Muscletree, American Hornbeam, Blue Beech, Water Beech		
Chamaecrista fasciculata (Michx.) Greene var. *fasciculata*	Partridge Pea		

Chamerion angustifolium (L.) Holub	Fireweed		
Cinna latifolia (Trev. ex Goepp.) Griseb.	Slender Woodreed		
Claytonia caroliniana Michx.	Carolina Springbeauty		
Clematis virginiana L.	Virgin's-Bower		
Clintonia borealis (Ait.) Raf.	Yellow Bluebead-Lily		
Clintonia umbellulata (Michx.) Morong	White Bluebead-Lily		
Coptis trifolia (L.) Salisb.	Threeleaf Goldthread	S3	G5
Cornus canadensis L.	Canadian Bunchberry	S2	G5
Crataegus L.	Hawthorn		
Cymophyllus fraserianus (Ker-Gawl.) Kartesz & Gandhi	Fraser's Sedge	S3	G4
Cypripedium acaule Ait.	Pink Lady's-Slipper		
Dalibarda repens L.	Robin-Run-Away	S3	G5
Danthonia compressa Austin ex Peck	Flattened Oatgrass		
Dennstaedtia punctilobula (Michx.) T. Moore	Eastern Hay-Scented Fern		
Deparia acrostichoides (Sw.) M. Kato	Silver False Spleenwort		
Deschampsia flexuosa (L.) Trin. var. *flexuosa*	Crinkled Hairgrass		
Dicentra eximia (Ker-Gawl.) Torr.	Appalachian Bleeding-Heart		
Dichanthelium clandestinum (L.) Gould	Deer-Tongue Witchgrass		
Dioscorea quaternata J.F. Gmel.	Fourleaf Yam		
Dryopteris campyloptera Clarkson	Mountain Woodfern		
Dryopteris carthusiana (Vill.) H.P. Fuchs	Spinulose Woodfern		
Dryopteris intermedia (Muhl. ex Willd.) Gray	Intermediate Woodfern		
Dryopteris marginalis (L.) Gray	Marginal Woodfern		
Epigaea repens L.	Trailing Arbutus		
Erythronium americanum Ker-Gawl. ssp. *americanum*	Yellow Trout-Lily		
Fagus grandifolia Ehrh.	American Beech		
Festuca subverticillata (Pers.) Alexeev	Nodding Fescue		
Fraxinus americana L.	White Ash		
Galearis spectabilis (L.) Raf.	Showy Orchid		
Galium aparine L.	Sticky Willy		
Galium lanceolatum Torr.	Lanceleaf Wild Licorice		
Galium triflorum Michx.	Sweet-Scent Bedstraw		
Gaultheria procumbens L.	Wintergreen		
Gaylussacia baccata (Wangenh.) K. Koch	Black Huckleberry		
Geranium maculatum L.	Spotted Geranium		
Hamamelis virginiana L.	American Witch-Hazel		
Heuchera americana L.	Common Alumroot		
Huperzia lucidula (Michx.) Trevisan	Shining Clubmoss		
Hydrophyllum virginianum L.	Shawnee Salad		
Hypericum mitchellianum Rydb.	Blue Ridge St. John's-Wort	S1	G3
Ilex montana Torr. & Gray ex Gray	Mountain Holly		
Impatiens capensis Meerb.	Orange Jewelweed		
Ipomoea pandurata (L.) G.F.W. Mey.	Man-Of-The-Earth		
Juncus effusus L.	Soft Rush		
Kalmia latifolia L.	Mountain Laurel		
Laportea canadensis (L.) Weddell	Canadian Wood-Nettle		
Lepidium virginicum L. var. *virginicum*	Wild Peppergrass		

Liriodendron tulipifera L.	Tuliptree		
Lycopodium annotinum L.	Stiff Clubmoss		
Lycopodium clavatum L.	Running Clubmoss		
Lycopodium dendroideum Michx.	Tree Clubmoss		
Lycopodium digitatum Dill. ex A. Braun	Fan Clubmoss		
Lycopodium obscurum L.	Princess-Pine		
Magnolia acuminata (L.) L.	Cucumber-Tree		
Magnolia fraseri Walt.	Fraser Magnolia		
Maianthemum canadense Desf.	Canada Mayflower		
Medeola virginiana L.	Indian Cucumber-Root		
Menziesia pilosa (Michx. ex Lam.) Juss. ex Pers.	Minniebush		
Mitchella repens L.	Partridgeberry		
Monarda didyma L.	Scarlet Beebalm		
Monotropa uniflora L.	Indian-Pipe		
Nemopanthus mucronatus (L.) Loes.	Catberry		
Oclemena acuminata (Michx.) Greene	Whorled Wood Aster		
Onoclea sensibilis L.	Sensitive Fern		
Osmunda cinnamomea L.	Cinnamon Fern		
Osmunda claytoniana L.	Interrupted Fern		
Oxalis montana Raf.	Mountain Wood Sorrel		
Oxalis violacea L.	Violet Wood Sorrel		
Packera aurea (L.) A.& D. Löve	Golden Ragwort		
Panicum dichotomiflorum Michx. ssp. *dichotomiflorum*	Fall Panicgrass		
Photinia melanocarpa (Michx.) Robertson & Phipps	Black Chokeberry		
Picea rubens Sarg.	Red Spruce		
Pinus rigida P. Mill.	Pitch Pine		
Pinus strobus L.	Eastern White Pine		
Platanthera orbiculata (Pursh) Lindl.	Large Round-Leaved Orchid		
Podophyllum peltatum L.	Mayapple		
Polygonatum pubescens (Willd.) Pursh	Hairy Solomon's-Seal		
Polygonum scandens L.	Climbing False Buckwheat		
Polypodium appalachianum Haufler & Windham	Appalachian Rockcap Fern		
Polypodium virginianum L.	Rock Polypody		
Polystichum acrostichoides (Michx.) Schott	Christmas Fern		
Prenanthes L.	Rattlesnake-Root		
Prosartes lanuginosa (Michx.) D. Don	Yellow Fairybells		
Prunus pensylvanica L. f. var. *pensylvanica*	Pin Cherry, Bird Cherry, Fire Cherry		
Prunus serotina Ehrh. var. *serotina*	Black Cherry		
Pteridium aquilinum (L.) Kuhn	Bracken Fern		
Quercus rubra L.	Northern Red Oak		
Ranunculus abortivus L.	Kidneyleaf Buttercup		
Rhododendron catawbiense Michx.	Catawba Rhododendron		
Rhododendron maximum L.	Great Laurel		
Rhododendron prinophyllum (Small) Millais	Early Azalea		
Ribes glandulosum Grauer	Skunk Currant		
Ribes rotundifolium Michx.	Appalachian Gooseberry		

Rubus hispidus L.	Bristly Dewberry		
Rubus L.	Blackberry		
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli	Black Elderberry, Common Elder		
Sassafras albidum (Nutt.) Nees	Sassafras		
Saxifraga micranthidifolia (Haw.) Steud.	Branch-Lettuce		
Scutellaria saxatilis Riddell	Rock Skullcap	S2	G3
Smilax ecirrata (Engelm. ex Kunth) S. Wats.	Upright Greenbrier		
Smilax glauca Walt.	Whiteleaf Greenbrier		
Smilax rotundifolia L.	Roundleaf Greenbrier		
Smilax tamnoides L.	Chinaroot		
Solidago canadensis L.	Canada Goldenrod		
Solidago flexicaulis L.	Zigzag Goldenrod		
Solidago rugosa P. Mill.	Wrinkleleaf Goldenrod		
Sorbus americana Marsh.	American Mountain-Ash		
Streptopus lanceolatus (Ait.) Reveal var. *roseus* (Michx.) Reveal	Rosy Twisted-Stalk		
Symphyotrichum divaricatum (Nutt.) Nesom	Lawn American-Aster		
Symphyotrichum pilosum (Willd.) Nesom	White Oldfield American-Aster		
Symphyotrichum prenanthoides (Muhl. ex Willd.) Nesom	Crooked-Stem Aster		
Thalictrum pubescens Pursh	King-Of-The-Meadow		
Thelypteris noveboracensis (L.) Nieuwl.	New York Fern		
Tiarella cordifolia L.	Heartleaf Foamflower		
Tilia americana L.	American Basswood		
Trientalis borealis Raf. ssp. *borealis*	Star Flower		
Trillium erectum L.	Stinking Benjamin		
Trillium undulatum Willd.	Painted Wakerobin		
Tsuga canadensis (L.) Carr.	Eastern Hemlock		
Vaccinium angustifolium Ait.	Northern Lowbush Blueberry		
Vaccinium erythrocarpum Michx.	Highbush Cranberry		
Vaccinium myrtilloides Michx.	Velvetleaf Blueberry		
Veratrum viride Ait.	American False Hellebore		
Viburnum acerifolium L.	Mapleleaf Viburnum		
Viburnum lantanoides Michx.	Hobblebush		
Viburnum nudum L. var. *cassinoides* (L.) Torr. & Gray	Northern Wild Raisin		
Viola cucullata Ait.	Marsh Blue Violet		
Viola hastata Michx.	Halberd-Leaf Yellow Violet		
Viola sororia Willd.	Common Blue Violet		

Bryophytes

Scientific Name	Common Name
Amblystegium Schimp. in B.S.G.	Conecap Moss
Andreaea rupestris Hedw.	Stone Lantern Moss
Bazzania trilobata (L.) Gray	Common Bazzania Liverwort
Brachythecium Schimp. in B.S.G.	Mat Moss
Brotherella recurvans (Michx.) Fleisch.	Shiny Fern Moss
Calypogeia fissa (L.) Raddi ssp. *neogaea* R. M. Schust.	Notched Sack Liverwort

*Dicranella heteromalla (*Hedw.*)* Schimp.	Silky Fork Moss
Dicranodontium denudatum (Brid.) Britt. in Williams	Naked Windblown Moss
Dicranum flagellare Hedw.	Broodbranch Fork Moss
Dicranum fuscescens Turn.	Dusky Fork Moss
Dicranum montanum Hedw.	Mountain Fork Moss
Dicranum scoparium Hedw.	Broom Fork Moss
Frullania asagrayana Mont.	Bronze Cup Liverwort
*Hedwigia ciliata (*Hedw.) P. Beauv.	Hedwig's White Tip Moss
*Hylocomium splendens (*Hedw.*)* Schimp. in B.S.G.	Splendid Stairstep Moss
Hypnum fertile Sendtn.	Fertile Fern Moss
Hypnum imponens Hedw.	Flat Fern Moss
*Hypnum pallescens (*Hedw.*)* P. Beauv.	Snaky Fern Moss
Lepidozia reptans (L.) Dumort.	Big Claw Liverwort
Leucobryum albidum (Brid. ex P. Beauv.) Lindb.	Small White Cushion Moss
*Leucobryum glaucum (*Hedw.*)* Ångstr. in Fries	Common White Cushion Moss
Nowellia curvifolia (Dicks.) Mitt.	Red Crescent Liverwort
Pallavicinia lyellii (Hook.) Carruth.	Wavy Ribbon Liverwort
*Paraleucobryum longifolium (*Hedw.*)* Loeske	Pale Windblown Moss
Plagiomnium ciliare (C. Müll.) T. Kop.	American Woodsy Mnium Moss
Pleurozium schreberi (Brid.) Mitt.	Redstem Feather Moss
Polytrichum commune Hedw.	Common Hair Cap Moss
Polytrichum pallidisetum Funck	Mountain Hair Cap Moss
Polytrichum strictum Brid.	Woolly Hair Cap Moss
Pseudotaxiphyllum distichaceum (Mitt.) Iwats.	Spreading Wing Moss
Ptilium crista-castrensis (Hedw.) De Not.	Knight's Plume Moss
Pylaisiadelpha tenuirostris (Bruch & Schimp. ex Sull.) Buck	Slender Fern Moss
Rhizomnium appalachianum T. Kop.	Woolly Largeleaf Mnium Moss
Rhytidiadelphus subpinnatus (Lindb.) T. Kop.	Square Goose Neck Moss
Scapania nemorea (L.) Grolle	Toothy Mitten Liverwort
Sphagnum capillifolium var. *capillifolium* (Ehrh.) Hedw.	Pompom Hair Peatmoss
Sphagnum fimbriatum Wils. in Wils. & Hook. f. in Hook. f.	Ragged Hair Peatmoss
Sphagnum girgensohnii Russ.	Star Hair Peatmoss
Sphagnum palustre L.	Common Spoon Peat Moss
Sphagnum quinquefarium (Lindb. ex Braithw.) Warnst.	Spike Hair Peatmoss
Sphagnum recurvum P. Beauv.	Curvy Longleaf Peatmoss
Sphagnum rubellum Wils.	Red Hair Peatmoss
Sphagnum russowii Warnst.	Russow's Peatmoss
Tetraphis pellucida Hedw.	Four Tooth Moss
*Thuidium delicatulum (*Hedw.*)* Schimp. in B.S.G.	Delicate Fern Moss

Fungi and Lichens

Scientific Name	Common Name
Allocetraria oaksiana (Tuck.) Randlane & Thell	Lichen
Amanita abrupta Peck	Abrupt-bulbed Amanita
Amanita ceceliae (Berk. & Broome) Bas	Strangulated Amanita Mushroom
Amanita flavoconia G.F. Atk.	Yellow Patches Mushroom

Amanita fulva (Schaeff.) Fr.	Orange-Brown Ringless Amanita Mushroom
Amanita sp.	Amanita Mushroom
Apiosporina morbosa (Schwein.) Arx	Black Knot
Boletus badius Fr.	Bay Bolete
Boletus subvelutipes Peck	Red-pored Bolete
Caloscypha fulgens (Pers.) Boud.	Caloscypha (cup fungus)
Cantharellus cibarius Fr.	Golden Chanterelle
Chlorociboria aeruginascens (Nyl. Kanouse ex Ramamurthi, Korf & L. R. Batra	Chlorociboria (cup fungus)
Cladonia arbuscula (Wallr.) Flotow	Reindeer Lichen
Cladonia coniocraea auct.	Cup Lichen
Cladonia digitata (L.) Hoffm.	Finger Cup Lichen
Cladonia furcata (Hudson) Schrader	Many-Forked Cladonia
Cladonia gracilis (L.) Willd.	Cup Lichen
Cladonia grayi G. Merr. ex Sandst.	Gray's Cup Lichen
Cladonia ochrochlora Florke	Cup Lichen
Cladonia petrophila R.C. Harris	Cladonia Lichen
Cladonia rangiferina (L.) F. H. Wigg.	Grey Reindeer Lichen
Cladonia rappii A. Evans	Rapp's Cup Lichen
Cladonia squamosa Hoffm.	Dragon Cladonia
Clavulina cristata (Holmsk.) J. Schroet.	Crested Coral Mushroom
Clavulinopsis fusiformis (Sowerby) Corner	Yellow Spindle Coral Mushroom
Clitocybe sp.	Clitocybe (gilled mushroom)
Cortinarius sp.	Cortinarius (gilled mushroom)
Craterellus tubaeformis (Schaeff.) Quél.	Funnel Chanterelle
Crepidotus applanatus (Pers)K, Fü. Pi (Z) var. *applanatus*	Crepidotus (gilled mushroom)
Crepidotus variabilis (Pers.) P. Kumm.	Crepidotus (gilled mushroom)
Cyptotrama chrysopeplum (Berk. & M. A. Curtis) Singer	Cyptotrama (gilled mushroom)
Cystoderma amianthinum (Scop.:Fr.) Fayod	Cystoderma (gilled mushroom)
Dacrymyces chrysospermus Berk. & M.A. Curtis	Orange Yellow Jelly
Elaphocordyceps ophioglossoides (Ehrh.) G.H. Sung, J.M. Sung & Spatafora	Snaketongue Truffleclub
Elaphomyces granulatus Fr.	Deer Truffle
Flavoparmelia caperata (*L.) Hale*	Lichen
Fomes fomentarius (L.) J.J. Kickx	Tinder Fungus; Amadou
Fomitopsis cajanderi (P. Karst.) Kotlaba & Pouzar	Bracket Fungus
Fomitopsis pinicola (Sw.) P. Karst.	Red Banded Polypore
Fuscidea recensa (Stirton) Hertel, V. Wirth & Vezda	Fuscidea Lichen
Galerina sp.	Galerina (gilled mushroom)
Ganoderma applanatum (Pers.) Pat.	Ganoderma (bracket fungus)
Ganoderma lucidum (Curtis) P. Karst.	Varnish Shelf Mushroom
Gloeophyllum sepiarium (Wulfen) P. Karst.	Bracket Fungus
Gymnopilus sp.	Gymnopilus (gilled mushroom)
Gymnopus acervatus (Fr.) Murrill	Gymnopus (gilled mushroom)
Gymnopus alkalivirens (Singer) Halling	Gymnopus (gilled mushroom)
Gymnopus dichrous (Berk. & M. A. Curtis) Halling	Gymnopus (gilled mushroom)
Gymnopus dryophilus (Bull.) Murrill	Oak-loving Collybia

Gyrodon merulioides (Schwein.) Singer	Ash Tree Bolete
Helvella elastica Bull.	Elastic Saddle
Hygrocybe miniata (Fr.) P. Kumm.	Vermilion Waxcap
Hygrophoropsis aurantiaca (Wulfen) Maire	False Chanterelle
Inocybe sp.	Inocybe (gilled mushroom)
Laccaria laccata (Scop.) Fr.	Laccaria (gilled mushroom)
Lachnum virgineum (Batsch) P. Karst	Lachnum (cup fungus)
Lactarius deceptivus Peck	Deceptive Lactarius
Lactarius deterrimus Gröger	False Saffron Milk-cap
Lactarius gerardii var. *gerardii* Peck	Gerard's Lactarius
Lactarius lignyotellus A.H. Sm. & Hesler	Sooty Spruce Lactarius Mushroom
Lactarius oculatus (Peck) Burl.	Lactarius (gilled mushroom)
Lasallia papulosa (Ach.) Llano	Toadskin Lichen
Leotia viscosa Fr.	Green-headed Jelly Club
Lepraria caesioalba (de Lesd.) J. R. Laundon	Dust Lichen
Lepraria incana (L.) Ach.	Dust Lichen
Lycoperdon perlatum Pers.	Gem-studded Puffball
Marasmiellus opacus (Berk. & M. A. Curtis) Singer	Marasmiellus (gilled mushroom)
Marasmius androsaceus (L.) Fr.	Marasmius (gilled mushroom)
Marasmius rotula (Scop.) Fr.	Pinwheel Marasmius; Little Wheel
Megacollybia platyphylla (Pers.) Kotl. & Pouzar	Platterfull
Miriquidica Hertel & Rambold	Miriquidica
Mycena sanguinolenta (Alb. & Schwein.) P. Kumm.	Smaller Bleeding Mycena
Mycena sp.	Mycena (gilled mushroom)
Paxillus involutus (Batsch) Fr.	Brown Roll-rim, Poison Pax
Phaeocalicium polyporaeum (Nyl.) Tibell	Phaeocalicium Fungus
Pholiota malicola (Kauffman) A.H. Sm.	Pholiota Mushroom
Pleurocybella porrigens (Pers.) Singer	Angel Wings
Pleurotus ostreatus (Jacq.:Fr.) P. Kumm.	Oyster Mushroom
Pluteus atricapillus (Batsch) Fayod	Deer Mushroom; Fawn Pluteus
Postia caesia (Schrad.) P. Karst.	Conifer Bluing Bracket
Pseudevernia consocians (Vainio) Hale & Culb.	Light And Dark Lichen
Rhizocarpon eupetraeum (Nyl.) Arnold	Map Lichen
Rickenella fibula (Bull.) Raithelh.	Rickenella (gilled mushroom)
Russula compacta Frost	Firm Russula
Russula crassitunicata Singer	Rubber-skin Russula
Russula dissimulans Shaffer	Red and Black Russula
Russula granulata Peck	Granulated Russula
Russula modesta Peck	Modest Russula Mushroom
Russula peckii Singer	Russula (gilled mushroom)
Sarcogyne privigna (Ach.) A. Massal.	Sarcogyne Lichen
Sarcoscypha occidentalis (Schwein.) Sacc.	Stalked Scarlet Cup
Scleroderma citrinum Pers.	Poison Pigskin Puffball
Stropharia hornemannii (Fr.) S. Lundell & Nannf. *Tapesia fusca* (Pers.) Fuckel	Lacerated Stropharia Tapesia Fungus
Trametes versicolor (L.) Lloyd	Turkey Tail; Many-zoned Polypore
Trichaptum abietinum (Dickson:Fr.) Ryvarden	Trichaptum (bracket fungus)
Trichaptum biforme (Fr.) Ryvarden	Violet-toothed Polypore

Tricholoma vaccinum (Pers.) Fr.	Russet Scaly Tricholoma
Tricholomopsis decora (Fr.) Singer	Tricholomopsis (gilled mushroom)
Tylopilus fellus (Bull.:Fr.) P. Karst.	Bitter Bolete Mushroom
Umbilicaria mammulata (Ach.) Tuck.	Common Rocktripe
Umbilicaria muehlenbergii (Ach.) Tuck.	Lesser Rocktripe
Ustulina deusta (Hoffm.:Fr.) Lind	Carbon Cushion
Xanthoconium affine var. *affine* (Peck) Singer	Xanthoconium Mushroom
Xylaria hypoxylon (L.) Grev.	Candlesnuff Fungus

Slime Molds

Myxomycetes Recorded from Spruce and Spruce-Fir Forests in West Virginia

Data contributed by Dr. Steven L. Stephenson, Department of Biological Sciences, University of Arkansas, Fayetteville, Arkansas 72701, 3 March 2010.

Note: Bold font indicates a species that is possibly restricted to spruce and spruce-fir forests

Arcyria cinerea (Bull.) Pers.	Abundant
Arcyria denudata (L.) Wettst.	Occasional
Arcyria ferruginea Saut.	Occasional
Arcyria incarnata (Pers. ex J.F.Gmel.) Pers.	Rare
Arcyria obvelata (Oeder) Onsberg	Occasional
Arcyria stipata (Schwein.) Lister	Rare
Badhamia goniospora Meyl.	Rare
Badhamia utricularis (Bull.) Berk.	Rare
***Barbeyella minutissima* Meyl.**	**Abundant**
Ceratiomyxa fruticulosa (O.F.Müll.) T.Macbr.	Abundant
Clastoderma debaryanum A.Blytt	Occasional
Collaria arcyrionema (Rostaf.) Nann.-Bremek. ex Lado	Common
Collaria lurida (Lister) Nann.-Bremek.	Occasional
***Colloderma oculatum* (C.Lippert) G.Lister**	**Occasional**
Comatricha laxa Rostaf.	Occasional
Comatricha nigra (Pers. ex J.F.Gmel.) J.Schröt.	Common
Cribraria argillacea (Pers. ex J.F.Gmel.) Pers.	Common
Cribraria cancellata (Batsch) Nann.-Bremek.	Common
Cribraria confusa Nann.-Bremek. & Y.Yamam.	Occasional
Cribraria ferruginea Meyl.	Rare
Cribraria intricata Schrad.	Occasional
Cribraria microcarpa (Schrad.) Pers.	Occasional
Cribraria cf. oregano H.C.Gilbert	Rare
Cribraria purpurea Schrad.	Occasional
Cribraria rufa (Roth) Rostaf.	Occasional
Dianema corticatum Lister	Rare
Diderma effusum (Schwein.) Morgan	Occasional
***Diderma roanense* (*Rex*) T.Macbr.**	**Occasional**
***Diderma simplex* (J.Schröt.) G.Lister**	**Rare**
Diderma testaceum (Schrad.) Pers.	Occasional
Didymium difforme (Pers.) Gray	Rare
Didymium melanospermum (Pers.) T.Macbr.	Occasional
Echinostelium minutum de Bary	Rare
Enerthenema papillatum (Pers.) Rostaf.	Occasional
Fuligo septica (L.) F.H.Wigg.	Common
Hemitrichia calyculata (Speg.) M.L.Farr	Occasional
Hemitrichia clavata (Pers.) Rostaf.	Occasional

Hemitrichia serpula (*Scop.*) Rostaf. ex Lister	Occasional
Lamproderma columbinum (Pers.) Rostaf.	Occasional
Leocarpus fragilis (Dicks.) Rostaf.	Occasional
***Lepidoderma tigrinum* (Schrad.) Rostaf.**	**Abundant**
Licea kleistobolus G.W.Martin	Rare
Licea minima Fr.	Occasional
Licea parasítica (Zukal) G.W.Martin	Rare
Licea pusilla Schrad.	Rare
Lindbladia tubulina Fr.	Rare
Listerella paradoxa E.Jahn	Occasional
Lycogala epidendrum (L.) Fr.	Abundant
Lycogala exiguum Morgan	Rare
Metatrichia floriformis (Schwein.) Nann.-Bremek.	Occasional
Metatrichia vesparia (Batsch) Nann.-Bremek. ex G.W.Martin & Alexop.	Rare
Mucilago crustacea F.H.Wigg.	Rare
Paradiacheopsis solitaria (Nann.-Bremek.) Nann.-Bremek.	Rare
Perichaena chrysosperma (Curr.) Lister	Rare
Perichaena pedata (Lister & G.Lister) Lister ex E.Jahn	Rare
Physarum album (Bull.) Chevall.	Occasional
Physarum bivalve Pers.	Rare
Physarum confertum T.Macbr.	Common
Physarum globuliferum (Bull.) Pers.	Rare
Physarum pulcherripes Peck	Occasional
Physarum viride (Bull.) Pers.	Abundant
Reticularia splendens Morgan	Occasional
Stemonitis axifera (Bull.) T.Macbr.	Abundant
Stemonitis flavogenita E.Jahn	Rare
Stemonitis fusca Roth	Occasional
Stemonitis fusca var. *nigrescens* (Rex) Torrend	Rare
Stemonitis smithii T.Macbr.	Occasional
Stemonitis virginiensis Rex	Rare
Stemonitopsis aequalis (Peck) Y.Yamam.	Abundant
Stemonitopsis hyperopta (Meyl.) Nann.-Bremek.	Occasional
Stemonitopsis typhina (F.H.Wigg.) Nann.-Bremek.	Rare
Trabrooksia applanata H. W. Keller	Rare
Trichia botrytis (J.F.Gmel.) Pers.	Occasional
Trichia contorta (Ditmar) Rostaf.	Rare
Trichia decipiens (Pers.) T.Macbr.	Abundant
Trichia erecta Rex	Common
Trichia favoginea (Batsch) Pers.	Abundant
Trichia subfusca Rex	Abundant
Trichia varia (Pers. ex J.F.Gmel.) Pers.	Rare
Tubifera casparyi (Rostaf.) T.Macbr.	Occasional
Tubifera ferruginosa (Batsch) J.F.Gmel.	Abundant

Data Sources

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Appendix D *in* Byers, E. A., J. P. Vanderhorst, and B. P. Streets. 2010. **Classification and Conservation Assessment of Upland Red Spruce Communities in West Virginia**. West Virginia Natural Heritage Program, WVDNR. Elkins, WV.

Appendix E. Floristic Cover-Constancy Tables by Community Type

Table of Contents

Picea rubens / Vaccinium erythrocarpum / Dryopteris campyloptera Forest (CEGL007131)

Stratum	Scientific Name	Average	Min	Max	Constancy
T2	Picea rubens	56.54	30	75	100
T2	Acer rubrum	6.67	0.01	10	69
T2	Betula alleghaniensis var. alleghaniensis	13.33	5	30	46
T2	Sorbus americana	20.00	20	20	8
T2	Prunus serotina var. serotina	10.00	10	10	8
T3	Betula alleghaniensis var. alleghaniensis	15.80	0.01	50	77
T3	Picea rubens	4.10	1	10	77
T3	Acer rubrum	4.20	1	10	38
T3	Sorbus americana	12.67	1	32	23
T3	Fagus grandifolia	3.50	3	4	15
S1	Ilex montana	7.30	0.01	20	77
S1	Picea rubens	6.90	1	20	77
S1	Vaccinium erythrocarpum	12.21	0.5	50	54
S1	Betula alleghaniensis var. alleghaniensis	2.75	0.5	5	46
S1	Acer pensylvanicum	3.83	0.5	10	23
S1	Fagus grandifolia	1.75	0.5	3	15
S1	Menziesia pilosa	2.00	2	2	8
S1	Rhododendron maximum	2.00	2	2	8
S1	Rhododendron prinophyllum	0.50	0.5	0.5	8
S1	Viburnum lantanoides	0.50	0.5	0.5	8
S2	Vaccinium erythrocarpum	13.92	2	40	92
S2	Picea rubens	4.92	0.5	10	92
S2	Ilex montana	0.60	0.01	1	38
S2	Betula alleghaniensis var. alleghaniensis	0.88	0.01	2	31
S2	Sorbus americana	0.38	0.01	0.5	31
S2	Viburnum lantanoides	0.51	0.01	1	15
S2	Menziesia pilosa	0.26	0.01	0.5	15
S2	Vaccinium angustifolium	0.26	0.01	0.5	15
S2	Fagus grandifolia	1.00	1	1	8
S2	Rhododendron maximum	0.50	0.5	0.5	8
S2	Rhododendron prinophyllum	0.50	0.5	0.5	8
S2	Viburnum acerifolium	0.01	0.01	0.01	8
H	Picea rubens	0.89	0.01	5	100
H	Dryopteris intermedia	1.11	0.01	2	69
H	Dryopteris campyloptera	3.50	0.01	8	54

H	Maianthemum canadense	1.64	0.5	5	54
H	Oxalis montana	0.29	0.01	1	54
H	Clintonia	0.22	0.01	0.5	54
H	Trillium undulatum	0.22	0.01	0.5	54
H	Dennstaedtia punctilobula	1.67	0.01	3	46
H	Betula alleghaniensis var. alleghaniensis	0.11	0.01	0.5	38
H	Sorbus americana	0.50	0.01	1	31
H	Vaccinium erythrocarpum	0.26	0.01	0.5	31
H	Lycopodium dendroideum	0.50	0.01	1	23
H	Osmunda	0.17	0.01	0.5	23
H	Acer rubrum	0.01	0.01	0.01	23
H	Polypodium appalachianum	0.01	0.01	0.01	23
H	Oclemena acuminata	1.51	0.01	3	15
H	Osmunda cinnamomea	1.00	1	1	15
H	Lycopodium obscurum	0.75	0.5	1	15
H	Oxalis	0.75	0.5	1	15
H	Ilex montana	0.26	0.01	0.5	15
H	Lycopodium clavatum	0.26	0.01	0.5	15
H	Rhododendron maximum	0.26	0.01	0.5	15
H	Rubus	0.01	0.01	0.01	15
H	Clintonia umbellulata	3.00	3	3	8
H	Aster	0.50	0.5	0.5	8
H	Dryopteris carthusiana	0.50	0.5	0.5	8
H	Carex debilis var. rudgei	0.01	0.01	0.01	8
H	Fagus grandifolia	0.01	0.01	0.01	8
H	Huperzia lucidula	0.01	0.01	0.01	8
H	Medeola virginiana	0.01	0.01	0.01	8
H	Mitchella repens	0.01	0.01	0.01	8
H	Polypodium virginianum	0.01	0.01	0.01	8
H	Thelypteris noveboracensis	0.01	0.01	0.01	8
N	Bazzania trilobata	33.50	0.5	95	100
N	Hypnum imponens	11.10	1	40	77
N	Dicranum scoparium	4.57	0.01	10	54
N	Leucobryum glaucum	0.50	0.01	1	46
N	Dicranum	8.60	0.01	40	38
N	Brotherella recurvans	6.38	0.5	10	31
N	Polytrichum	0.13	0.01	0.5	31
N	Polytrichum pallidisetum	5.33	1	10	23
N	Cladonia furcata	2.00	0.5	5	23
N	Dicranodontium denudatum	5.00	5	5	15
N	Leucobryum	0.26	0.01	0.5	15
N	Cladonia	0.01	0.01	0.01	15
N	Sphagnum capillifolium var. capillifolium	5.00	5	5	8
N	Thuidium delicatulum	5.00	5	5	8
N	Hypnum	3.00	3	3	8
N	Cladonia squamosa	1.00	1	1	8
N	Cladonia petrophila	0.50	0.5	0.5	8
N	Cladonia rappii	0.50	0.5	0.5	8
N	Clavalina cristata	0.50	0.5	0.5	8
N	Pleurozium schreberi	0.50	0.5	0.5	8

N	Sphagnum	0.50	0.5	0.5	8
N	Sphagnum russowii	0.50	0.5	0.5	8
N	Cladonia arbuscula	0.25	0.25	0.25	8
N	Lactarius lignyotellus	0.01	0.01	0.01	8
N	Mycena sp.	0.01	0.01	0.01	8
N	Ptilium crista-castrensis	0.01	0.01	0.01	8

Picea rubens / Kalmia latifolia - Vaccinium angustifolium Rocky Woodland (CEGL006254)

Stratum	Scientific Name	Average	Min	Max	Constancy
T2	Picea rubens	29.60	15	50	100
T2	Pinus rigida	11.33	3	21	30
T2	Acer rubrum	8.83	0.5	21	30
T2	Tsuga canadensis	1.67	1	2	30
T2	Betula alleghaniensis var. alleghaniensis	1.00	0.5	2	30
T2	Sorbus americana	1.50	1	2	20
T3	Picea rubens	6.00	2	10	20
T3	Acer rubrum	2.00	1	3	20
T3	Betula alleghaniensis var. alleghaniensis	2.00	1	3	20
T3	Amelanchier laevis	1.25	0.5	2	20
T3	Pinus rigida	20.00	20	20	10
S1	Picea rubens	4.70	1	10	100
S1	Kalmia latifolia	17.43	2	45	70
S1	Nemopanthus mucronatus	6.58	0.5	15	60
S1	Betula alleghaniensis var. alleghaniensis	1.50	0.5	5	60
S1	Amelanchier laevis	1.10	0.5	3	50
S1	Acer rubrum	19.13	0.5	70	40
S1	Rhododendron maximum	7.88	0.5	20	40
S1	Sorbus americana	2.50	0.5	5	30
S1	Pinus rigida	1.17	0.5	2	30
S1	Prunus pensylvanica var. pensylvanica	1.17	0.5	2	30
S1	Menziesia pilosa	30.00	30	30	20
S1	Vaccinium erythrocarpum	7.50	5	10	20
S1	Tsuga canadensis	0.50	0.5	0.5	20
S1	Ilex montana	1.00	1	1	10
S1	Rhododendron prinophyllum	1.00	1	1	10
S1	Viburnum nudum var. cassinoides	1.00	1	1	10
S1	Acer pensylvanicum	0.50	0.5	0.5	10
S1	Gaylussacia baccata	0.50	0.5	0.5	10
S1	Hamamelis virginiana	0.50	0.5	0.5	10
S1	Acer spicatum	0.01	0.01	0.01	10
S2	Picea rubens	7.30	0.5	30	100
S2	Vaccinium angustifolium	7.06	0.5	20	80
S2	Menziesia pilosa	4.19	0.5	8	80
S2	Kalmia latifolia	16.29	2	45	70
S2	Gaylussacia baccata	6.00	1	10	50
S2	Acer rubrum	0.50	0.01	1	50

S2	Sorbus americana	0.21	0.01	0.5	50
S2	Photinia melanocarpa	3.50	0.01	8	40
S2	Nemopanthus mucronatus	0.88	0.01	3	40
S2	Rhododendron maximum	2.00	1	3	30
S2	Vaccinium erythrocarpum	1.50	0.5	3	30
S2	Amelanchier laevis	1.33	1	2	30
S2	Ribes rotundifolium	0.01	0.01	0.01	30
S2	Vaccinium myrtilloides	3.00	1	5	20
S2	Ilex montana	0.51	0.01	1	20
S2	Ribes glandulosum	0.51	0.01	1	20
S2	Prunus pensylvanica var. pensylvanica	0.50	0.5	0.5	20
S2	Rubus	0.26	0.01	0.5	20
S2	Betula alleghaniensis var. alleghaniensis	0.50	0.5	0.5	10
S2	Tsuga canadensis	0.50	0.5	0.5	10
S2	Viburnum nudum var. cassinoides	0.50	0.5	0.5	10
S2	Acer pensylvanicum	0.01	0.01	0.01	10
S2	Acer spicatum	0.01	0.01	0.01	10
S2	Ribes	0.01	0.01	0.01	10
H	Maianthemum canadense	0.30	0.01	0.5	50
H	Kalmia latifolia	0.21	0.01	0.5	50
H	Polypodium appalachianum	0.38	0.01	1	40
H	Pteridium aquilinum	0.38	0.01	1	40
H	Lycopodium clavatum	0.50	0.01	1	30
H	Gaultheria procumbens	0.34	0.01	0.5	30
H	Menziesia pilosa	0.17	0.01	0.5	30
H	Deschampsia flexuosa var. flexuosa	0.01	0.01	0.01	30
H	Trillium undulatum	0.01	0.01	0.01	30
H	Osmunda cinnamomea	1.50	1	2	20
H	Acer rubrum	0.26	0.01	0.5	20
H	Aralia nudicaulis	0.26	0.01	0.5	20
H	Carex brunnescens	0.26	0.01	0.5	20
H	Epigaea repens	0.26	0.01	0.5	20
H	Lycopodium dendroideum	0.26	0.01	0.5	20
H	Gaylussacia baccata	0.01	0.01	0.01	20
H	Photinia melanocarpa	0.01	0.01	0.01	20
H	Rubus	0.01	0.01	0.01	20
H	Vaccinium angustifolium	0.01	0.01	0.01	20
H	Dennstaedtia punctilobula	8.00	8	8	10
H	Cornus canadensis	3.00	3	3	10
H	Betula alleghaniensis var. alleghaniensis	0.50	0.5	0.5	10
H	Chamerion angustifolium	0.50	0.5	0.5	10
H	Cypripedium acaule	0.50	0.5	0.5	10
H	Dicentra eximia	0.50	0.5	0.5	10
H	Polypodium virginianum	0.50	0.5	0.5	10
H	Rhododendron maximum	0.50	0.5	0.5	10
H	Carex argyrantha	0.01	0.01	0.01	10
H	Carex trisperma var. trisperma	0.01	0.01	0.01	10
H	Clintonia	0.01	0.01	0.01	10
H	Coptis trifolia	0.01	0.01	0.01	10
H	Monotropa uniflora	0.01	0.01	0.01	10

H	Nemopanthus mucronatus	0.01	0.01	0.01	10
H	Quercus rubra	0.01	0.01	0.01	10
H	Rubus hispidus	0.01	0.01	0.01	10
N	Hypnum imponens	6.61	0.5	20	90
N	Cladonia	0.19	0.01	0.5	80
N	Umbilicaria muehlenbergii	5.30	0.5	12	50
N	Leucobryum glaucum	0.90	0.5	2	50
N	Cladonia rangiferina	20.37	0.1	60	30
N	Pleurozium schreberi	2.33	1	5	30
N	Thuidium delicatulum	8.00	1	15	20
N	Lasallia papulosa	4.50	1	8	20
N	Dicranum	2.51	0.01	5	20
N	Umbilicaria	1.50	1	2	20
N	Bazzania trilobata	1.01	0.01	2	20
N	Lasallia	0.51	0.01	1	20
N	Cladina	0.50	0.5	0.5	20
N	Leucobryum	0.50	0.5	0.5	20
N	Polytrichum	0.01	0.01	0.01	20
N	Sarcogyne privigna	0.01	0.01	0.01	20
N	Hypnum fertile	6.00	6	6	10
N	Dicranum scoparium	1.00	1	1	10
N	Hedwigia ciliata	1.00	1	1	10
N	Paraleucobryum longifolium	1.00	1	1	10
N	Polytrichum pallidisetum	1.00	1	1	10
N	Leucobryum albidum	0.50	0.5	0.5	10
N	Polytrichum strictum	0.50	0.5	0.5	10
N	Cladonia furcata	0.10	0.1	0.1	10
N	Fuscidea recensa	0.01	0.01	0.01	10
N	Lepraria caesioalba	0.01	0.01	0.01	10
N	Lepraria incana	0.01	0.01	0.01	10
N	Miriquidica sp.	0.01	0.01	0.01	10
N	Rhizocarpon eupetraeum	0.01	0.01	0.01	10
N	Sphagnum	0.01	0.01	0.01	10

Picea rubens – Betula alleghaniensis var. alleghaniensis / Bazzania trilobata Forest (CEGL008501)

Stratum	Scientific Name	Average	Min	Max	Constancy
T2	Picea rubens	49.62	1	80	100
T2	Betula alleghaniensis var. alleghaniensis	11.61	0.01	40	49
T2	Acer rubrum	7.62	2	25	35
T2	Tsuga canadensis	11.86	4	40	19
T2	Betula lenta	3.33	2	5	8
T2	Acer pensylvanicum	3.00	3	3	5
T2	Pinus strobus	1.50	1	2	5
T2	Sorbus americana	1.00	1	1	5
T2	Amelanchier laevis	5.00	5	5	3
T2	Quercus rubra	3.00	3	3	3

T3	Picea rubens	15.29	1	75	84
T3	Betula alleghaniensis var. alleghaniensis	12.84	0.5	40	76
T3	Acer rubrum	5.82	0.5	20	38
T3	Tsuga canadensis	6.13	1	15	22
T3	Acer pensylvanicum	1.70	0.5	5	14
T3	Sorbus americana	6.88	0.5	15	11
T3	Ilex montana	1.50	0.5	3	8
T3	Amelanchier	6.50	5	8	5
T3	Magnolia fraseri	5.01	0.01	10	5
T3	Amelanchier laevis	2.00	2	2	5
T3	Fagus grandifolia	5.00	5	5	3
T3	Acer spicatum	1.00	1	1	3
T3	Amelanchier arborea var. arborea	1.00	1	1	3
T3	Quercus rubra	0.00	0	0	3
S1	Picea rubens	13.61	0.5	55	84
S1	Ilex montana	3.81	0.01	20	49
S1	Kalmia latifolia	12.32	0.01	40	38
S1	Rhododendron maximum	11.05	0.5	24	27
S1	Betula alleghaniensis var. alleghaniensis	1.75	0.5	5	27
S1	Tsuga canadensis	2.92	0.5	5	16
S1	Acer pensylvanicum	1.50	0.01	5	14
S1	Fagus grandifolia	2.17	0.5	5	8
S1	Acer rubrum	1.00	1	1	5
S1	Nemopanthus mucronatus	10.00	10	10	3
S1	Amelanchier laevis	5.00	5	5	3
S1	Hamamelis virginiana	1.00	1	1	3
S1	Sorbus americana	1.00	1	1	3
S1	Menziesia pilosa	0.01	0.01	0.01	3
S2	Picea rubens	6.05	0.5	30	86
S2	Ilex montana	0.53	0.01	2	51
S2	Betula alleghaniensis var. alleghaniensis	0.46	0.01	1	32
S2	Vaccinium erythrocarpum	0.38	0.01	1	32
S2	Kalmia latifolia	5.05	0.5	20	30
S2	Sorbus americana	0.34	0.01	1	24
S2	Rhododendron maximum	1.21	0.5	3	19
S2	Fagus grandifolia	0.50	0.01	1	16
S2	Acer rubrum	0.42	0.01	1	16
S2	Tsuga canadensis	1.10	0.01	3	14
S2	Rubus	0.26	0.01	0.5	11
S2	Menziesia pilosa	0.34	0.01	0.5	8
S2	Vaccinium myrtilloides	1.51	0.01	3	5
S2	Vaccinium angustifolium	0.75	0.5	1	5
S2	Acer pensylvanicum	0.01	0.01	0.01	5
S2	Gaylussacia baccata	1.00	1	1	3
S2	Amelanchier arborea var. arborea	0.50	0.5	0.5	3
S2	Amelanchier laevis	0.50	0.5	0.5	3
S2	Pinus strobus	0.50	0.5	0.5	3
S2	Smilax rotundifolia	0.50	0.5	0.5	3
S2	Viburnum lantanoides	0.50	0.5	0.5	3
S2	Acer spicatum	0.01	0.01	0.01	3

S2	Quercus rubra	0.01	0.01	0.01	3
S2	Rhododendron	0.01	0.01	0.01	3
H	Dryopteris intermedia	3.20	0.01	19	76
H	Picea rubens	0.33	0.01	1	76
H	Acer rubrum	0.14	0.01	0.5	51
H	Betula alleghaniensis var. alleghaniensis	0.12	0.01	1	49
H	Oxalis montana	0.87	0.01	5	41
H	Dennstaedtia punctilobula	4.42	0.01	25	32
H	Trillium undulatum	0.01	0.01	0.01	27
H	Maianthemum canadense	0.78	0.01	3	24
H	Dryopteris campyloptera	2.79	0.5	10	19
H	Rhododendron maximum	0.79	0.01	3	19
H	Ilex montana	0.29	0.01	0.5	19
H	Sorbus americana	0.17	0.01	0.5	16
H	Kalmia latifolia	0.21	0.01	0.5	14
H	Lycopodium obscurum	0.11	0.01	0.5	14
H	Monotropa uniflora	0.01	0.01	0.01	11
H	Oxalis	1.50	0.5	3	8
H	Carex debilis var. rudgei	0.17	0.01	0.5	8
H	Mitchella repens	0.17	0.01	0.5	8
H	Oclemena acuminata	0.01	0.01	0.01	8
H	Lycopodium clavatum	0.75	0.5	1	5
H	Lycopodium dendroideum	0.51	0.01	1	5
H	Rubus	0.50	0.5	0.5	5
H	Amelanchier laevis	0.26	0.01	0.5	5
H	Carex brunnescens	0.26	0.01	0.5	5
H	Clintonia	0.26	0.01	0.5	5
H	Osmunda cinnamomea	0.26	0.01	0.5	5
H	Amelanchier	0.01	0.01	0.01	5
H	Carex	0.01	0.01	0.01	5
H	Medeola virginiana	0.01	0.01	0.01	5
H	Polypodium appalachianum	5.00	5	5	3
H	Arisaema triphyllum ssp. triphyllum	0.50	0.5	0.5	3
H	Polypodium virginianum	0.50	0.5	0.5	3
H	Tsuga canadensis	0.50	0.5	0.5	3
H	Acer pensylvanicum	0.01	0.01	0.01	3
H	Danthonia compressa	0.01	0.01	0.01	3
H	Gaultheria procumbens	0.01	0.01	0.01	3
H	Lycopodium annotinum	0.01	0.01	0.01	3
H	Osmunda	0.01	0.01	0.01	3
H	Rhododendron	0.01	0.01	0.01	3
H	Smilax rotundifolia	0.01	0.01	0.01	3
H	Trientalis borealis ssp. borealis	0.01	0.01	0.01	3
H	Vaccinium myrtilloides	0.01	0.01	0.01	3
H	Thuidium delicatulum	0.00	0	0	3
N	Bazzania trilobata	40.59	0.5	95	95
N	Hypnum imponens	8.79	0.01	40	92
N	Dicranum scoparium	2.69	0.01	20	57
N	Polytrichum pallidisetum	3.00	0.01	20	35
N	Brotherella recurvans	1.54	0.01	5	35

N	Leucobryum glaucum	1.21	0.01	5	32
N	Polytrichum	1.45	0.01	5	27
N	Dicranodontium denudatum	1.05	0.5	3	27
N	Cladonia	0.19	0.01	0.5	22
N	Cladonia squamosa	0.71	0.5	1	19
N	Dicranum	4.75	0.5	20	16
N	Hylocomium splendens	0.83	0.5	1	16
N	Leucobryum	0.34	0.01	1	16
N	Thuidium delicatulum	0.60	0.5	1	14
N	Amanita flavaconia	0.11	0.01	0.5	14
N	Lactarius lignyotellus	0.11	0.01	0.5	14
N	Clavalina cristata	0.13	0.01	0.5	11
N	Amanita	0.01	0.01	0.01	11
N	Sphagnum	0.01	0.01	0.01	11
N	Tylopilus fellus	0.34	0.01	0.5	8
N	Cladonia furcata	1.50	1	2	5
N	Dicranum fuscescens	1.50	0	3	5
N	Flavoparmelia caperata	0.75	0.5	1	5
N	Pseudevernia consocians	0.50	0.5	0.5	5
N	Cladonia coniocraea	0.26	0.01	0.5	5
N	Cladonia ochrochlora	0.26	0.01	0.5	5
N	Lactarius deceptivus	0.01	0.01	0.01	5
N	Lactarius oculatus	0.01	0.01	0.01	5
N	Umbilicaria mammulata	5.00	5	5	3
N	Cladonia rangiferina	2.00	2	2	3
N	Andreaea rupestris	1.00	1	1	3
N	Bazzania	1.00	1	1	3
N	Dicranella heteromalla	1.00	1	1	3
N	Nowellia curvifolia	1.00	1	1	3
N	Ptilium crista-castrensis	1.00	1	1	3
N	Pylaisiadelpha tenuirostris	1.00	1	1	3
N	Cladonia gracilis	0.50	0.5	0.5	3
N	Cladonia grayi	0.50	0.5	0.5	3
N	Leucobryum albidum	0.50	0.5	0.5	3
N	Paraleucobryum longifolium	0.50	0.5	0.5	3
N	Rhytidiadelphus subpinnatus	0.50	0.5	0.5	3
N	Sphagnum quinquefarium	0.50	0.5	0.5	3
N	Amanita ceceliae	0.01	0.01	0.01	3
N	Clitocybe	0.01	0.01	0.01	3
N	Fomes fomentarius	0.01	0.01	0.01	3
N	Ganoderma applanatum	0.01	0.01	0.01	3
N	Gymnopus dryophilus	0.01	0.01	0.01	3
N	Inocybe	0.01	0.01	0.01	3
N	Laccaria laccata	0.01	0.01	0.01	3
N	Leotia viscosa	0.01	0.01	0.01	3
N	Russula	0.01	0.01	0.01	3
N	Russula compacta	0.01	0.01	0.01	3
N	Russula modesta	0.01	0.01	0.01	3
N	Scleroderma citrinum	0.01	0.01	0.01	3
N	Sphagnum rubellum	0.01	0.01	0.01	3

N	Trametes versicolor	0.01	0.01	0.01	3
N	Tricholomopsis decora	0.01	0.01	0.01	3
N	Xanthoconium affine var. affine	0.01	0.01	0.01	3

Picea rubens / Rhododendron maximum Forest (CEGL006152)

Stratum	Scientific Name	Average	Min	Max	Constancy
T2	Picea rubens	44.53	18.7	80	100
T2	Tsuga canadensis	14.49	0.01	34.8	47
T2	Acer rubrum	4.48	0.9	10	40
T2	Betula alleghaniensis var. alleghaniensis	10.70	3	20	33
T2	Betula lenta	5.35	0.7	10	13
T2	Amelanchier arborea var. arborea	3.50	3.5	3.5	7
T3	Betula alleghaniensis var. alleghaniensis	18.71	5	40	93
T3	Picea rubens	8.99	0.5	25	93
T3	Tsuga canadensis	11.29	1	30	47
T3	Acer rubrum	5.45	0.5	10	40
T3	Ilex montana	4.65	2.5	6.8	13
T3	Sorbus americana	0.75	0.5	1	13
T3	Amelanchier arborea var. arborea	4.80	4.8	4.8	7
T3	Betula lenta	4.20	4.2	4.2	7
T3	Magnolia fraseri	0.50	0.5	0.5	7
S1	Rhododendron maximum	57.40	29	90	100
S1	Ilex montana	3.68	0.5	10	67
S1	Picea rubens	2.01	0.5	5	67
S1	Betula alleghaniensis var. alleghaniensis	1.43	0.01	5	53
S1	Tsuga canadensis	0.93	0.7	1	27
S1	Rhododendron catawbiense	10.00	10	10	7
S1	Kalmia latifolia	6.30	6.3	6.3	7
S1	Amelanchier arborea var. arborea	0.80	0.8	0.8	7
S1	Betula lenta	0.30	0.3	0.3	7
S1	Sorbus americana	0.30	0.3	0.3	7
S1	Prunus serotina var. serotina	0.10	0.1	0.1	7
S2	Rhododendron maximum	14.33	0.5	59	80
S2	Picea rubens	0.72	0.01	3	60
S2	Betula alleghaniensis var. alleghaniensis	0.50	0.01	1	33
S2	Ilex montana	0.30	0.01	0.5	33
S2	Vaccinium erythrocarpum	0.21	0.01	0.5	33
S2	Tsuga canadensis	0.75	0.5	1	13
S2	Vaccinium angustifolium	0.50	0.5	0.5	13
S2	Acer rubrum	0.26	0.01	0.5	13
S2	Sorbus americana	0.26	0.01	0.5	13
S2	Menziesia pilosa	0.01	0.01	0.01	13
S2	Kalmia latifolia	1.00	1	1	7
S2	Rhododendron catawbiense	0.50	0.5	0.5	7
S2	Rubus	0.50	0.5	0.5	7
S2	Fagus grandifolia	0.01	0.01	0.01	7
H	Picea rubens	1.08	0.01	6	47

H	Rhododendron maximum	0.42	0.01	1	40
H	Acer rubrum	0.34	0.01	1.5	40
H	Betula alleghaniensis var. alleghaniensis	0.30	0.01	0.5	27
H	Dryopteris intermedia	0.34	0.01	0.5	20
H	Dryopteris campyloptera	1.00	1	1	13
H	Sorbus americana	0.01	0.01	0.01	13
H	Polypodium appalachianum	1.00	1	1	7
H	Oclemena acuminata	0.50	0.5	0.5	7
H	Oxalis montana	0.50	0.5	0.5	7
H	Tsuga canadensis	0.20	0.2	0.2	7
H	Dennstaedtia punctilobula	0.01	0.01	0.01	7
H	Fagus grandifolia	0.01	0.01	0.01	7
H	Monotropa uniflora	0.01	0.01	0.01	7
N	Bazzania trilobata	26.45	0.5	80	93
N	Hypnum imponens	1.86	0.01	5	73
N	Leucobryum glaucum	1.34	0.01	5	40
N	Polytrichum	0.50	0.5	0.5	20
N	Brotherella recurvans	5.25	0.5	10	13
N	Dicranum scoparium	3.00	1	5	13
N	Dicranum	0.51	0.01	1	13
N	Dicranum montanum	0.50	0.5	0.5	13
N	Hylocomium splendens	0.50	0.5	0.5	13
N	Dicranodontium denudatum	5.00	5	5	7
N	Cladonia digitata	0.50	0.5	0.5	7
N	Lepidozia reptans	0.50	0.5	0.5	7
N	Polytrichum pallidisetum	0.50	0.5	0.5	7
N	Tetraphis pellucida	0.50	0.5	0.5	7
N	Umbilicaria mammulata	0.50	0.5	0.5	7
N	Amanita ceceliae	0.01	0.01	0.01	7
N	Amanita flavaconia	0.01	0.01	0.01	7
N	Cladonia squamosa	0.01	0.01	0.01	7
N	Fomitopsis cajanderi	0.01	0.01	0.01	7
N	Leucobryum	0.01	0.01	0.01	7
N	Marasmiellus opacus	0.01	0.01	0.01	7
N	Pleurozium schreberi	0.01	0.01	0.01	7
N	Russula peckii	0.01	0.01	0.01	7
N	Sphagnum	0.01	0.01	0.01	7

Picea rubens – Tsuga canadensis – Fagus grandifolia / Dryopteris intermedia Forest (CEGL006029)

Stratum	Scientific Name	Average	Min	Max	Constancy
T2	Picea rubens	28.09	10	60	100
T2	Betula alleghaniensis var. alleghaniensis	11.56	0.01	25	78
T2	Tsuga canadensis	17.86	3	50	61
T2	Acer rubrum	12.37	3	30	61
T2	Prunus serotina var. serotina	5.83	3	15	30
T2	Betula lenta	7.40	3	10	22

T2	Fagus grandifolia	6.00	3	10	13
T2	Acer saccharum var. saccharum	17.50	5	30	9
T2	Magnolia fraseri	3.05	1.1	5	9
T2	Acer pensylvanicum	2.10	2.1	2.1	4
T2	Magnolia acuminata	1.30	1.3	1.3	4
T2	Liriodendron tulipifera	0.50	0.5	0.5	4
T3	Picea rubens	7.21	1	22	83
T3	Betula alleghaniensis var. alleghaniensis	7.92	0.5	20	78
T3	Tsuga canadensis	14.62	1	35	57
T3	Acer pensylvanicum	15.82	0	40	48
T3	Acer rubrum	6.00	1	15	43
T3	Fagus grandifolia	5.20	1	15	43
T3	Acer saccharum var. saccharum	10.23	0.4	35	26
T3	Magnolia acuminata	0.93	0	2	13
T3	Betula lenta	7.50	5	10	9
T3	Crataegus	6.00	2	10	9
T3	Prunus serotina var. serotina	5.70	1.4	10	9
T3	Magnolia fraseri	2.85	0.5	5.2	9
T3	Amelanchier laevis	10.00	10	10	4
T3	Fraxinus americana	5.00	5	5	4
T3	Amelanchier	2.00	2	2	4
T3	Ilex montana	0.50	0.5	0.5	4
T3	Tilia americana	0.20	0.2	0.2	4
S1	Picea rubens	8.17	0.5	55	87
S1	Fagus grandifolia	2.25	0.5	9.8	57
S1	Tsuga canadensis	4.17	0.5	10	39
S1	Acer pensylvanicum	3.86	0.5	8	30
S1	Ilex montana	1.60	0.5	3	22
S1	Betula alleghaniensis var. alleghaniensis	2.43	1	5.7	17
S1	Rhododendron maximum	11.83	0.5	20	13
S1	Acer saccharum var. saccharum	1.03	0.5	1.6	13
S1	Kalmia latifolia	3.00	1	5	9
S1	Acer rubrum	1.25	1	1.5	9
S1	Magnolia acuminata	0.50	0.5	0.5	9
S1	Rubus	30.00	30	30	4
S1	Viburnum lantanoides	12.70	12.7	12.7	4
S1	Betula lenta	5.00	5	5	4
S1	Amelanchier laevis	3.00	3	3	4
S1	Magnolia fraseri	2.30	2.3	2.3	4
S1	Prunus serotina var. serotina	1.40	1.4	1.4	4
S1	Acer spicatum	1.00	1	1	4
S1	Crataegus	1.00	1	1	4
S1	Sambucus nigra ssp. canadensis	0.10	0.1	0.1	4
S2	Picea rubens	3.95	0.01	20	91
S2	Fagus grandifolia	0.81	0.01	3	43
S2	Tsuga canadensis	0.80	0.01	2	43
S2	Acer pensylvanicum	0.82	0.01	3	35
S2	Betula alleghaniensis var. alleghaniensis	0.42	0.01	0.5	26
S2	Magnolia fraseri	0.21	0.01	0.5	22
S2	Vaccinium erythrocarpum	0.11	0.01	0.5	22

S2	Ilex montana	0.50	0.01	1	17
S2	Acer rubrum	0.50	0.5	0.5	13
S2	Smilax rotundifolia	0.34	0.01	0.5	13
S2	Betula lenta	0.01	0.01	0.01	13
S2	Kalmia latifolia	0.75	0.5	1	9
S2	Magnolia acuminata	0.50	0.5	0.5	9
S2	Sorbus americana	0.01	0.01	0.01	9
S2	Menziesia pilosa	3.00	3	3	4
S2	Viburnum lantanoides	2.00	2	2	4
S2	Vaccinium angustifolium	1.00	1	1	4
S2	Amelanchier laevis	0.50	0.5	0.5	4
S2	Crataegus	0.50	0.5	0.5	4
S2	Prunus serotina var. serotina	0.50	0.5	0.5	4
S2	Rhododendron maximum	0.50	0.5	0.5	4
S2	Quercus rubra	0.01	0.01	0.01	4
S2	Rubus	0.01	0.01	0.01	4
H	Dryopteris intermedia	12.95	0.01	40	87
H	Picea rubens	0.12	0.01	1	87
H	Maianthemum canadense	1.03	0.01	5	65
H	Acer rubrum	0.20	0.01	0.5	61
H	Oxalis montana	3.48	0.5	25.8	57
H	Betula alleghaniensis var. alleghaniensis	0.14	0.01	0.5	57
H	Prunus serotina var. serotina	0.19	0.01	0.5	39
H	Mitchella repens	0.17	0.01	1	39
H	Acer pensylvanicum	0.13	0.01	0.6	39
H	Dennstaedtia punctilobula	3.86	0.01	10	30
H	Rubus	0.58	0.01	3	30
H	Trillium undulatum	0.15	0	0.5	30
H	Fagus grandifolia	0.04	0.01	0.2	26
H	Oclemena acuminata	0.90	0.01	3	22
H	Medeola virginiana	0.01	0.01	0.01	22
H	Tsuga canadensis	0.01	0.01	0.01	22
H	Dryopteris campyloptera	10.25	1	30	17
H	Smilax rotundifolia	0.38	0.01	0.5	17
H	Magnolia fraseri	0.15	0.01	0.5	17
H	Anemone quinquefolia	2.34	0.01	5	13
H	Lycopodium dendroideum	0.67	0.5	1	13
H	Acer saccharum var. saccharum	0.57	0.2	1	13
H	Ilex montana	0.17	0.01	0.5	13
H	Betula lenta	0.01	0.01	0.01	13
H	Sorbus americana	0.01	0.01	0.01	13
H	Vaccinium erythrocarpum	0.01	0.01	0.01	13
H	Lycopodium clavatum	5.01	0.01	10	9
H	Polypodium appalachianum	0.51	0.01	1	9
H	Lycopodium obscurum	0.50	0.5	0.5	9
H	Quercus rubra	0.26	0.01	0.5	9
H	Arisaema triphyllum	0.01	0.01	0.01	9
H	Carex debilis var. rudgei	0.01	0.01	0.01	9
H	Clintonia	0.01	0.01	0.01	9
H	Danthonia compressa	0.01	0.01	0.01	9

H	Galium triflorum	0.01	0.01	0.01	9
H	Platanthera orbiculata	0.01	0.01	0.01	9
H	Tiarella cordifolia	0.01	0.01	0.01	9
H	Huperzia lucidula	0.01	0	0.01	9
H	Thelypteris noveboracensis	60.00	60	60	4
H	Carex amphibola	5.00	5	5	4
H	Claytonia caroliniana	5.00	5	5	4
H	Prenanthes	2.00	2	2	4
H	Viola cucullata	2.00	2	2	4
H	Brachyelytrum septentrionale	1.00	1	1	4
H	Carex digitalis var. digitalis	1.00	1	1	4
H	Carex intumescens	1.00	1	1	4
H	Dryopteris carthusiana	1.00	1	1	4
H	Laportea canadensis	1.00	1	1	4
H	Oxalis violacea	1.00	1	1	4
H	Arisaema triphyllum ssp. triphyllum	0.50	0.5	0.5	4
H	Betula	0.50	0.5	0.5	4
H	Cardamine diphylla	0.50	0.5	0.5	4
H	Carex	0.50	0.5	0.5	4
H	Carex debilis	0.50	0.5	0.5	4
H	Carex leptonervia	0.50	0.5	0.5	4
H	Clintonia umbellulata	0.50	0.5	0.5	4
H	Crataegus	0.50	0.5	0.5	4
H	Cypripedium acaule	0.50	0.5	0.5	4
H	Dichanthelium	0.50	0.5	0.5	4
H	Veratrum viride	0.50	0.5	0.5	4
H	Magnolia acuminata	0.02	0.02	0.02	4
H	Ageratina altissima	0.01	0.01	0.01	4
H	Agrostis perennans	0.01	0.01	0.01	4
H	Amelanchier	0.01	0.01	0.01	4
H	Amelanchier arborea var. arborea	0.01	0.01	0.01	4
H	Athyrium filix-femina	0.01	0.01	0.01	4
H	Brachythecium	0.01	0.01	0.01	4
H	Carex aestivalis	0.01	0.01	0.01	4
H	Cymophyllus fraserianus	0.01	0.01	0.01	4
H	Deparia acrostichoides	0.01	0.01	0.01	4
H	Festuca subverticillata	0.01	0.01	0.01	4
H	Fraxinus americana	0.01	0.01	0.01	4
H	Geranium maculatum	0.01	0.01	0.01	4
H	Hamamelis virginiana	0.01	0.01	0.01	4
H	Hydrophyllum virginianum	0.01	0.01	0.01	4
H	Lycopodium digitatum	0.01	0.01	0.01	4
H	Menziesia pilosa	0.01	0.01	0.01	4
H	Monarda didyma	0.01	0.01	0.01	4
H	Monotropa uniflora	0.01	0.01	0.01	4
H	Onoclea sensibilis	0.01	0.01	0.01	4
H	Polygonatum pubescens	0.01	0.01	0.01	4
H	Ranunculus abortivus	0.01	0.01	0.01	4
H	Rhododendron maximum	0.01	0.01	0.01	4
H	Sassafras albidum	0.01	0.01	0.01	4

H	Saxifraga micranthidifolia	0.01	0.01	0.01	4
H	Smilax ecirrata	0.01	0.01	0.01	4
H	Streptopus lanceolatus var. roseus	0.01	0.01	0.01	4
H	Symphyotrichum prenanthoides	0.01	0.01	0.01	4
H	Thalictrum pubescens	0.01	0.01	0.01	4
H	Trillium erectum	0.01	0.01	0.01	4
H	Viola	0.01	0.01	0.01	4
N	Hypnum imponens	6.92	0.5	30	83
N	Bazzania trilobata	11.28	0.5	34	74
N	Dicranum scoparium	1.89	0.5	5	39
N	Thuidium delicatulum	2.72	0.01	5	30
N	Dicranum	0.92	0.01	3	26
N	Brotherella recurvans	13.50	0.5	40	22
N	Dicranodontium denudatum	3.20	0.5	5	22
N	Cladonia	0.70	0.01	2	22
N	Polytrichum	0.40	0.01	1	22
N	Leucobryum glaucum	0.50	0.01	1	17
N	Ceratiomyxa fruticulosa	0.01	0	0.01	17
N	Megacollybia platyphylla	0.01	0	0.01	17
N	Cladonia squamosa	0.17	0.01	0.5	13
N	Chlorociboria aeruginascens	0.01	0	0.01	13
N	Leucobryum	1.75	0.5	3	9
N	Polytrichum pallidisetum	0.75	0.5	1	9
N	Plagiomnium ciliare	0.51	0.01	1	9
N	Cladonia furcata	0.50	0.5	0.5	9
N	Dicranella	0.26	0.01	0.5	9
N	Hylocomium splendens	0.26	0.01	0.5	9
N	Lactarius oculatus	0.01	0.01	0.01	9
N	Lycogala epidendrum	0.01	0.01	0.01	9
N	Mycena sanguinolenta	0.01	0.01	0.01	9
N	Scleroderma citrinum	0.01	0.01	0.01	9
N	Fomes fomentarius	0.01	0	0.01	9
N	Marasmiellus opacus	0.01	0	0.01	9
N	Trichaptum biforme	0.01	0	0.01	9
N	Huperzia lucidula	0.50	0.5	0.5	4
N	Polytrichum commune	0.50	0.5	0.5	4
N	Tetraphis pellucida	0.50	0.5	0.5	4
N	Ptilium crista-castrensis	0.10	0.1	0.1	4
N	Allocetraria oaksiana	0.01	0.01	0.01	4
N	Amanita fulva	0.01	0.01	0.01	4
N	Cladonia coniocraea	0.01	0.01	0.01	4
N	Clavalina cristata	0.01	0.01	0.01	4
N	Cortinarius	0.01	0.01	0.01	4
N	Crepidotus variabilis	0.01	0.01	0.01	4
N	Cystoderma amianthinum	0.01	0.01	0.01	4
N	Galerina	0.01	0.01	0.01	4
N	Ganoderma lucidum	0.01	0.01	0.01	4
N	Gymnopus acervatus	0.01	0.01	0.01	4
N	Gyrodon merulioides	0.01	0.01	0.01	4
N	Lachnum virgineum	0.01	0.01	0.01	4

N	Lycoperdon perlatum	0.01	0.01	0.01	4
N	Marasmius androsaceus	0.01	0.01	0.01	4
N	Marasmius rotula	0.01	0.01	0.01	4
N	Nowellia curvifolia	0.01	0.01	0.01	4
N	Pleurotus ostreatus	0.01	0.01	0.01	4
N	Stemonitis	0.01	0.01	0.01	4
N	Tapesia fusca	0.01	0.01	0.01	4
N	Trametes versicolor	0.01	0.01	0.01	4
N	Trichaptum abietinum	0.01	0.01	0.01	4
N	Ustulina deusta	0.01	0.01	0.01	4
N	Amanita ceceliae	0.01	0.01	0.01	4
N	Apiosporina morbosa	0.01	0.01	0.01	4
N	Boletus badius	0.01	0.01	0.01	4
N	Crepidotus applanatus var. appalanatus	0.01	0.01	0.01	4
N	Cyptotrama chrysopeplum	0.01	0.01	0.01	4
N	Gymnopilus	0.01	0.01	0.01	4
N	Gymnopus alkalivirens	0.01	0.01	0.01	4
N	Gymnopus dichrous	0.01	0.01	0.01	4
N	Gymnopus dryophilus	0.01	0.01	0.01	4
N	Lactarius gerardii var. gerardii	0.01	0.01	0.01	4
N	Phaeocalicium polyporaeum	0.01	0.01	0.01	4
N	Pluteus atricapillus	0.01	0.01	0.01	4
N	Rickenella fibula	0.01	0.01	0.01	4
N	Russula dissimulans	0.01	0.01	0.01	4
N	Sarcoscypha occidentalis	0.01	0.01	0.01	4
N	Xylaria hypoxylon	0.01	0.01	0.01	4

Appendix E *in* Byers, E. A., J. P. Vanderhorst, and B. P. Streets. 2010. **Classification and Conservation Assessment of Upland Red Spruce Communities in West Virginia**. West Virginia Natural Heritage Program, WVDNR. Elkins, WV.

Appendix F. Animal Species Records and Conservation Ranks

Animal records were drawn from published literature, unpublished reports, and databases available at the WVDNR (see Sources at the end of this appendix). Since many animal species use both forested and open habitats during various parts of their life cycles, the criteria for including species in this section is broader than for the floristic descriptions. Faunal records are included from red spruce forests, mixed red spruce-northern hardwood forests, and high elevation wetlands embedded within the red spruce ecosystem. This listing is also broad in the sense that a collection or observation does not imply dependence on or even affinity for red spruce communities. The small number of species that could be identified as having a possible affinity for red spruce communities are described in the "Results" section of the main report.

Vertebrates

Mammals

Scientific Name	Common Name	State Rank	Global Rank	Source	Habitat and Distribution
Blarina brevicauda	Northern Short-Tailed Shrew	S5	G5	Marshall U. 1994, TNC 2001, Francl et al. 2003, CVNWR 2007, WVDNR 2010	Moist habitats with well-developed layer of leaf litter or humus; statewide
Canis latrans	Coyote	S4	G5	Marshall U. 1994, TNC 2001	Diverse habitats; statewide
Castor canadensis	Beaver	S5	G5	Marshall U. 1994, TNC 2001	Waterways bordered by stands of trees; statewide
Condylura cristata	Star-Nosed Mole	S2	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Wet and mucky habitats; eastern part of state, mostly in the mountains
Corynorhinus townsendii virginianus	Virginia Big-Eared Bat	S2	G4T2	Marshall U. 1994, Whitaker and Hamilton 1998, WVDNR 2010	Caves at an elevation over 760 m (2500 ft); known from Fayette, Grant, Hardy, Nicholas, Pendleton, Pocahontas, Randolph, and

					Tucker counties
Didelphis virginiana	Virginia Opossum	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Habitat generalist; statewide
Eptisicus fuscus	Big Brown Bat	S5	G5	WVDNR 2010	Uses a variety of habitats, overwintering in caves, buildings, and mines and summer roosting in hollow trees, buildings, and crevices; statewide
Glaucomys sabrinus fuscus	WV Northern Flying Squirrel	S2, SGNC	G5T2	WVDNR 2006, WVDNR 2010	Endemic to mature red spruce and northern hardwood forests of West Virginia and Virginia; typically at elevations over 3000 feet, although it has been recorded as low as 2320 feet; most known occurrences are in moist forests with some mature trees, standing snags and downed logs; lichens and mosses often abundant
Glaucomys volans volans	Southern Flying Squirrel	S5	G5	Marshall U. 1994, WVDNR 2010	Deciduous forest; statewide
Lasionycteris noctivagans	Silver-haired Bat	S2	G5	WVDNR 2010	Coniferous and mixed forest; statewide
Lasiurus borealis	Eastern Red Bat	S4	G5	Marshall U. 1994, WVDNR 2010	Forest edges, roosts in trees; statewide
Lasiurus cinereus	Hoary Bat	S3	G5	WVDNR 2010	Forest edges, roosts in trees; statewide
Lepus americanus virginianus	Snowshoe Hare	S4	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Red spruce forest, northern hardwood forest and spruce swamps with brushy understory, esp. of Rhododendron and Mountain Laurel; known from Randolph, Pocahontas, and Tucker counties
Lutra canadensis	River Otter	S1	G5	TNC 2001, Rogers 2009, Sturm 2010	Water with aquatic vegetation; statewide except for 14 counties in the west and panhandles
Lynx rufus	Bobcat	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Swamps, woods, and mountains; statewide
Marmota monax	Groundhog	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Open fields, fencerows, forest edges, and mature forest; statewide
Martes pennanti	Fisher	S3	G5	TNC 2001; Cimarolli 2010,	Red spruce and mixed hardwood forest; known from

				WVDNR 2010	28 counties with about half the records from higher elevations in the Alleghenies
Mephitis mephitis	Striped Skunk	S5	G5	TNC 2001	Diverse habitats; statewide
Microtus chrotorrhinus carolinensis	Southern Rock Vole	S2, SGNC	G4T3	WVDNR 2006, WVDNR 2010	Moist talus or among mossy rocks and logs in spruce and northern hardwood forests; usually near a stream or other surface water; collections from high elevation sites in Greenbrier, Pendleton, Pocahontas, Randolph, Tucker counties
Microtus pennsylvanicus	Meadow Vole	S5	G5	Marshall U. 1994, TNC 2001, Francl et al. 2003, Wykle 2005, WVDNR 2010	Moist meadows and graminoid wetlands; statewide
Microtus pinetorum	Woodland Vole	S4	G5	Marshall U. 1994, WVDNR 2010	Generally forested habitat with moist, friable soil; statewide
Mustela frenata	Long-Tailed Weasel	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Mature forests, woodlands, swamps, marshes, farmlands; statewide
Mustela vison	Mink	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Diverse wetland habitats; statewide
Myodes gapperi (Cleithrionomys gapperi)	Southern Red-Backed Vole	S4	G5	Marshall U. 1994, TNC 2001, Francl et al. 2003, WVDNR 2010	Moist, cool forest with abundant mosses and ferns, also mountaintops; eastern part of state, especially the mountains
Myotis leibii	Eastern Small-footed Bat	S1	G3	Marshall U. 1994, WVDNR 2010	Hibernates in caves and mines, roosts in talus and buildings; known from 14 counties in the eastern, central, and southern parts of the state
Myotis lucifugus	Little Brown Bat	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Diverse habitats; statewide
Myotis septentrionalis	Northern Long-eared Bat	S3S4	G4	WVDNR 2010	Wooded areas; hibernates in caves or mines, roosts in tree cavities, under bark, and in buildings; statewide
Napaeozapus insignis	Woodland Jumping Mouse	S4	G5	Marshall U. 1994, TNC 2001, Francl et al. 2003, CVNWR 2007, WVDNR 2010	Cool moist mixed forests and swamps in the mountains; statewide, but with about half of the collections from high elevations in the Allegheny Mountain counties
Neotoma magister	Allegheny Woodrat	S3, SGNC	G3G4	Marshall U. 1994, WVDNR 2006	Rocky areas, caves, deep crevices, large boulder fields in or around hardwood

					forests with an abundance mast-bearing trees; also known to occur in northern hardwood (beech, birch, maple), oak-pine forests and red spruce/northern hardwood forests; statewide
Odocoileus virginianus	Whitetail Deer	S5	G5	TNC 2001	Diverse habitats; statewide
Ondatra zibethicus	Muskrat	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Marshes, ponds, lakes, wooded swamps, and slow-flowing creeks; statewide
Parascalops breweri	Hairy-tailed Mole	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Diverse habitats with sandy loam soils; statewide
Perimyotis subflavus (Pipistrellus subflavus)	Eastern Pipistrelle	S5	G5	Marshall U. 1994, WVDNR 2010	Hibernates in caves, roosts in trees, cliffs, caves, and buildings; statewide
Peromyscus leucopus noveboracensis	Northern White-footed Mouse	S5	G5	Marshall U. 1994, TNC 2001, Wykle 2005, WVDNR 2010	Broad spectrum of habitats; statewide
Peromyscus maniculatus	Deer Mouse	S5	G5	Marshall U. 1994, TNC 2001, Francl et al. 2003, Wykle 2005, WVDNR 2010	Conifer forest, mixed woods and diverse habitats; statewide except the westernmost counties, with most records from high elevation sites in the Allegheny mountain counties
Procyon lotor	Raccoon	S5	G5	TNC 2001, WVDNR 2010	Woods and wetland combinations in a variety of habitats, including forests, farmland, and urban settings; statewide
Sciurus carolinensis	Eastern Gray Squirrel	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Hardwood and mixed forests; statewide
Sciurus niger	Fox Squirrel	S5	G5	TNC 2001, WVDNR 2010	Open woods or forest edges; statewide
Sorex cinereus	Masked Shrew	S5	G5	Marshall U. 1994, TNC 2001, Francl et al. 2003, CVNWR 2007, WVDNR 2010	Wetlands and moist woodlands; statewide
Sorex dispar	Long-tailed Shrew	S2S3, SGNC	G4	WVDNR 2006, WVDNR 2010	Cool, moist rocky areas in deciduous and mixed forest, wooded talus slopes and colluvial boulder-fields, medium to high elevation; known from 8 counties, with one-third of the records from high elevations in the Alleghenies

Sorex fumeus	Smoky Shrew	S5	G5	Marshall U. 1994, TNC 2001, Wykle 2005, CVNWR 2007, WVDNR 2010	Moist, cool conifer or hardwood forests and swamps; statewide, with one-third of the records from high elevations in the Alleghenies
Sorex hoyi winnemana	Southern Pygmy Shrew	S2S3, SGNC	G5T4	WVDNR 2006, WVDNR 2010	Moist to xeric woodlands with abundant leaf litter and decaying wood; statewide
Sorex palustris punctulatus	Southern Water Shrew	S1, SGNC	G5T3	WVDNR 2006, WVDNR 2010	Rocky mountain streams and wetlands within red spruce and northern hardwood forests; known from high elevation sites in Pendleton, Pocahontas, Preston, Randolph, and Tucker counties
Sylvilagus floridanus	Eastern Cottontail	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Diverse habitats with abundant herbaceous vegetation; statewide
Sylvilagus obscurus	Appalachian Cottontail	S3, SGNC	G4	WVDNR 2006, WVDNR 2010	Dense cover (woods, shrubby/brushy areas) at higher elevations; often associated with red spruce and heaths; known from 9 counties, with most records from high elevations in the Alleghenies
Synaptomys cooperi	Southern Bog Lemming	S2	G5	Marshall U. 1994, Francl et al. 2003, Wykle 2005, WVDNR 2010	Wetlands, especially those with abundant graminoids, also old fields and forest openings; known from 28 counties, with half of the records from high elevations in the Alleghenies
Tamias striatus	Eastern Chipmunk	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Open deciduous woodlands and other habitats; statewide
Tamiasciurus hudsonicus	Red Squirrel	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Mature, closed-canopy conifer forests and mixed or deciduous forests; statewide
Urocyon cinereoargenteus	Gray Fox	S5	G5	Marshall U. 1994, TNC 2001	Deciduous forest; statewide
Ursus americanus	American Black Bear	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Forests, brush, and a variety of habitats; statewide
Vulpes vulpes	Red Fox	S5	G5	Marshall U. 1994, TNC 2001, WVDNR 2010	Brushy successional habitats; statewide

Zapus hudsonius americanus	Meadow Jumping Mouse	S3	G5	Marshall U. 1994, TNC 2001, Francl et al. 2003, Wykle 2005, CVNWR 2007, WVDNR 2010	Wetlands and early successional habitats, especially with abundant herbaceous vegetation; statewide

Breeding Birds

Scientific Name	Common Name	State Rank	Global Rank	Source	Habitat and Distribution
Accipiter gentilis	Northern Goshawk	S1B, S1N, SGNC	G5	Buckelew and Hall 1994, WVDNR 2006, WVPIF 2006	Northern hardwood and mixed hardwood-spruce forests at higher elevations in the Alleghenies
Accipiter striatus	Sharp-shinned Hawk	S3B, S4N	G5	Buckelew and Hall 1994, TNC 2001	Most common in northern hardwoods forest at higher elevations; may be declining
Aegolius acadicus	Northern Saw-whet Owl	S2B, S3N, SGNC	G5	Buckelew and Hall 1994, WVDNR 2006, WVPIF 2006	Red spruce and spruce-hardwood forests, particularly in association with wetland areas; most records are from high elevations in the spruce zone
Agelaius phoeniceus	Red-winged Blackbird	S4N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Pastures, meadows, and wetlands; statewide
Aix sponsa	Wood Duck	S3N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Wooded bottomlands; statewide
Ammodramus savannarum	Grasshopper Sparrow	S3B	G5	Buckelew and Hall 1994, WVPIF 2006	Grass meadows and reclaimed strip mines; most records from the Ridge & Valley, the two panhandles, and the Western Hills
Archilochus colubris	Ruby-throated Hummingbird	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Wooded areas with openings, suburbs; uncommon in the Allegheny Mountains
Ardea herodias	Great Blue Heron	S3B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Ohio Valley wetlands; scarce n the Allegheny Mountains
Asio otus	Long-eared owl	S1B, S1N	G5	Buckelew and Hall 1994, WVPIF 2006, NatureServe 2010	Conifer woodlands; few records
Bombycilla cedorum	Cedar Waxwing	S4N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Wooded habitats; statewide
Bonasa umbellus	Ruffed Grouse	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Thick woods with dense cover and successional forest; broad distribution

Branta candensis	Canada Goose	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Parks, golf courses, ponds; statewide
Bubo virginianus	Great Horned Owl	S4B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Extensive woodlands; broad distribution
Buteo jamaicensis	Red-tailed Hawk	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Woodland edges; broad distribution
Buteo lineatus	Red-shouldered hawk	S4B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Large tracts of forest interspersed with wetlands; broad distribution
Buteo platypterus	Broad-winged Hawk	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Large tracts of upland deciduous forest; broad distribution
Butorides virescens	Green-backed Heron	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Creeks and rivers, mostly at lower elevations
Cardinalis cardinalis	Northern Cardinal	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Forest edges, woodlots, gardens up to 1000 m elevation; statewide
Carduelis pinus	Pine Siskin	S2B, S4N, SGNC	G5	Buckelew and Hall 1994, WVDNR 2006, WVPIF 2006	Red spruce forests, pine plantations, ornamental conifers; these occurrences are far south of the usual breeding range of this boreal forest species
Carduelis tristis	American Goldfinch	S5B, S5N	G5	Buckelew and Hall 1994, TNC 2001, WVPIF 2006	Brushy open habitats with small trees; statewide
Carpodacus purpureus	Purple Finch	S4B, S4N	G5	Buckelew and Hall 1994, TNC 2001	Spruce forest edges and successional spruce habitats; mainly on the higher ridges of the Allegheny Mountains, with scattered lowland outliers
Cathartes aura	Turkey Vulture	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Broad distribution
Catharus fuscescens	Veery	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Mixed spruce-northern hardwood, hemlock-hardwood, and northern hardwood forests; typical of high elevation transition zone between hardwood and spruce
Catharus guttatus	Hermit Thrush	S3B, S4N	G5	Buckelew and Hall 1994, TNC 2001, Francl 2003, WVPIF 2006	Northern hardwood and red spruce forests; most numerous above 1200 m along the higher ridges of the Alleghenies
Catharus ustulatus	Swainson's Thrush	S3B, SGNC	G5	Buckelew and Hall 1994, WVDNR 2006	Red spruce forest and northern hardwood-spruce forest; known from high

					elevation sites in the Allegheny Mountains
Certhia americana	Brown Creeper	S3B, S4N, SGNC	G5	Buckelew and Hall 1994, WVPIF 2006, WVDNR 2006	Red spruce forests and other forests with overhanging slabs of bark on dead or dying trees; most records from Allegheny Mountains
Ceryle alcyon	Belted Kingfisher	S4B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Unpolluted streams; less common in the Allegheny Mountains
Chaetura pelagica	Chimney Swift	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Settled areas, mostly at lower elevations
Charadrius vociferous	Killdeer	S5B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Open habitats; broad distribution
Circus cyaneus	Northern Harrier	S1B, S3N	G5	Buckelew and Hall 1994, TNC 2001	Wet meadows, mountain bogs, fields, reclaimed strip mines
Cistothorus plantensis	Sedge Wren	S1B	G5	Buckelew and Hall 1994	Sedge fens and wet graminoid meadows; few records
Coccyzus americanus	Yellow-billed Cuckoo	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Broad distribution, less common in the mountains
Coccyzus erythropthalmus	Black-billed Cuckoo	S3B	G5	Buckelew and Hall 1994, TNC 2001	Broad distribution in forested habitats, mostly at lower elevations
Colaptes auratus	Northern Flicker	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Open habitats; broad distribution
Contopus cooperi	Olive-sided Flycatcher	S1B, SGNC	G4	Buckelew and Hall 1994, WVPIF 2006	Bogs, beaver meadows, and other openings in red spruce forests, especially where standing snags are present; declining neotropical migrant; known only from Randolph and Pocahontas counties
Contopus virens	Eastern Wood Pewee	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Deciduous and mixed forest, parks; statewide but few records at higher elevations
Corvus brachyrhynchos	American Crow	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Open habitats, farms, forests; statewide
Corvus corax	Common Raven	S4B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Cliffs, tall conifers, riparian, and forest habitats; most records from the Allegheny Mountain counties
Cyanocitta cristata	Blue Jay	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Thickets; statewide
Dendroica caerulescens	Black-throated Blue Warbler	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Red spruce, northern hardwoods-spruce, and hemlock stands, typically

					with rhododendron; most records from above 600 m in the Allegheny Mountains, with an additional population in the higher elevation northern hardwood forest of the southern Western Hills
Dendroica coronata	Yellow-rumped Warbler	S3B, S3N, SGNC	G5	Buckelew and Hall 1994, WVDNR 2006, WVPIF 2006	Red spruce woodland/forest and mixed spruce-hardwood forest; known from spruce stands in Pendleton, Pocahontas, Randolph, and Tucker counties
Dendroica discolor	Prairie Warbler	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Young pine forests and brushy scrub; occurs in the Western Hills and Ridge & Valley; scarce in the higher Allegheny Mountains
Dendroica dominica	Yellow-throated Warbler	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Mature bottomland hardwoods and some scrub pine on low ridges; mostly in the western part of the state with one unusual record from the high Allegheny Mountains
Dendroica fusca	Blackburnian Warbler	S3B, SGNC	G5	Buckelew and Hall 1994, WVDNR 2006, WVPIF 2006	Red spruce and northern hardwood forests; most records above 900 m in the Allegheny Mountains with some as low at 600 m in oak-hickory-pine forest in the eastern panhandle
Dendroica magnolia	Magnolia Warbler	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Red spruce and spruce-hardwood forests, with lesser numbers in northern hardwoods; limited to the Allegheny Mountains above 900 m elevation
Dendroica pensylvanica	Chestnut-sided Warbler	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Brushy habitats above 500 m; most records in the Allegheny Mountains
Dendroica petechia	Yellow Warbler	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Second-growth woodlands, wetland edges, farms, gardens; statewide
Dendroica virens	Black-throated Green Warbler	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Mature coniferous or mixed hardwoods-coniferous forest; most records in the Allegheny Mountains and along the southwestern border of the state
Dolichonyx oryzivorus	Bobolink	S3B	G5	Buckelew and Hall 1994, WVPIF 2006	Grasslands at high elevations; mostly in the Allegheny Mountains with a few outlying records

Dryocopus pileatus	Pileated Woodpecker	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Mixed hardwood forest; statewide with few records in the Allegheny Mountains
Dumetella carolinensis	Gray Catbird	S1N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Brushy habitats; statewide
Empidonax alnorum	Alder Flycatcher	S3B, S4N	G5	Buckelew and Hall 1994, TNC 2001, WVPIF 2006	Alder swamps; most records from high elevations in Allegheny Mountain wetlands
Empidonax flaviventris	Yellow-bellied Flycatcher	S1B	G5	Buckelew and Hall 1994, WVPIF 2006	Red spruce forest with moss carpet; known only from Pocahontas County
Empidonax minimus	Least Flycatcher	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Woodland edges, successional forest, and parks; most records from middle elevations
Empidonax traillii	Willow Flycatcher	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Alder or willow swamps and brushy fields; broad distribution
Empidonax virescens	Acadian Flycatcher	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Mixed deciduous forest; less frequent at higher elevations in the Alleghenies
Eremophila alpestris	Horned lark	S2B, S3N	G5	Buckelew and Hall 1994, WVPIF 2006	Grassland; scattered in the northern panhandle, Ohio River valley, Alleghenies, and Ridge & Valley regions
Gallinago delicata	Wilson's Snipe	S3B, S3N	G5	Buckelew and Hall 1994, NatureServe 2010	Tussocky vegetation in marshes, wet meadows, or bogs; records from Altona Marsh and high elevations in Grant and Tucker counties, where it reaches its southernmost breeding station in the US
Geothlypis trichas	Common Yellowthroat	S2N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Wetlands and brushy areas; statewide
Hirundo rustica	Barn Swallow	S5B	G5	Buckelew and Hall 1994	Open rural area; statewide
Hylocichla mustelina	Wood Thrush	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Deciduous forest; statewide at elevations below 1000 m
Junco hyemalis	Dark-eyed Junco	S5B, S5N	G5	Buckelew and Hall 1994, TNC 2001, Francl 2003, WVPIF 2006	Open brushy areas, forest edges, and clearings above 700 m elevation; mostly in the Allegheny Mountains with some records from the Ridge & Valley and southernmost counties
Loxia curvirostra	Red crossbill	S2N	G5	Buckelew and Hall 1994, WVPIF 2006	Summer records only, breeding unconfirmed

Melanerpes carolinus	Red-bellied Woodpecker	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Dense forests; scarce in the Allegheny Mountain counties
Meleagris gallopavo	Wild Turkey	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Mature mast-bearing deciduous forest; broad distribution
Melospiza georgiana	Swamp Sparrow	S3B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Alder swamps and other wetlands with low bushes or trees; primarily in the high elevations of the Allegheny Mountains, with a few outlying records in other state wetlands
Melospiza melodia	Song Sparrow	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Forest edges, brushy areas, gardens; statewide
Mniotilta varia	Black and White Warbler	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Deciduous and mixed deciduous-conifer forest; statewide except the eastern panhandle
Molothrus ater	Brown-headed Cowbird	S4N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Farms and lightly wooded habitat; statewide but rare at high elevations
Myiarchus crinitus	Great Crested Flycatcher	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Mature oak and deciduous forest; scarce at high elevations
Oporormis philadelphia	Mourning Warbler	S3B	G5	Buckelew and Hall 1994, TNC 2001, WVPIF 2006	Brushy successional deciduous forest at elevations above 900 m; restricted to the Allegheny Mountains
Oporornis formosus	Kentucky Warbler	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Deciduous, oak-pine, and northern hardwood forest up to 1000 m; mostly west of the Allegheny Mountains
Parula americana	Northern Parula	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Mature forest; most records from hemlock-hardwoods and sycamore bottomlands; statewide except northern panhandle
Parus bicolor	Tufted Titmouse	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Woodlands and residential areas; statewide with fewer records at high elevations
Passerculus sandwichensis	Savannah Sparrow	S3B, S3N	G5	Buckelew and Hall 1994, WVPIF 2006	Open habitats; Allegheny Mountains and northern panhandle
Passerina cyanea	Indigo Bunting	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Clearings, second-growth forest, and forest edges; statewide
Pheucticus ludovicianus	Rose-breasted Grosbeak	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Northern hardwood forests, also spruce-hardwood and oak forest; mostly in the Allegheny Mountains and higher ridges of the Ridge & Valley

Picoides pubescens	Downy Woodpecker	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Wooded areas; uncommon at high elevations
Picoides villosus	Hairy Woodpecker	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Mature forest; common in the Allegheny Mountains and southwestern counties
Pipilo erythrophthalmus	Rufous-sided Towhee	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Open woodland, forest edge, brushy areas; statewide
Piranga olivacea	Scarlet Tanager	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Mostly in oak-hickory forest, but also in northern hardwoods and mixed hardwoods-spruce forest (area-sensitive); statewide
Poecile atricapilllus	Black-capped Chickadee	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006, TNC 2001	Mixed deciduous-conifer forest, northern hardwood forest, residential areas, and woodlots with snags, natural cavities or bird boxes; most records from higher elevations in the Allegheny Mountains and Ridge & Valley
Polioptila caerulea	Blue-gray Gnatcatcher	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Mature deciduous forests; mostly at elevations below 1000 m
Pooecetes gramineus	Vesper Sparrow	S3B, S2N	G5	Buckelew and Hall 1994, WVPIF 2006	Grassland or savannas; mostly from the Ridge & Valley
Quiscalus quiscula	Common Grackle	S3N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Forest clearings, edges, and suburbs; statewide
Regulus satrapa	Golden-crowned Kinglet	S4B, S4N	G5	Buckelew and Hall 1994, TNC 2001, WVPIF 2006	Mature red spruce forests; known from spruce forests in Preston, Tucker, Pendleton, Randolph and Pocahontas counties
Sayornis phoebe	Eastern Phoebe	S3N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Open woodlands and buildings; broad distribution
Scolopax minor	American Woodcock	S3N, S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Alder thickets, brushy fields, fencerows, second-growth forest; distributed in the Allegheny Mountains, lower Ohio River valley and northern panhandle
Seiurus aurocapillus	Ovenbird	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Mature deciduous forest interior; statewide
Seiurus motacilla	Louisiana Waterthrush	S5B	G5	Buckelew and Hall 1994, WVPIF 2006, TNC 2001	Streamsides in deciduous forest up to 1000 m; statewide

Seiurus noveboracensis	Northern Waterthrush	S2B, SGNC	G5	Buckelew and Hall 1994, WVPIF 2006, WVDNR 2006	Cool wooded swamps, bog thickets, and shrub swamps above 1000 meters elevation in the Allegheny Mountains; may be declining, WV is southernmost breeding population
Sialia sialis	Eastern Bluebird	S4B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Open country with occasional trees or nest boxes; statewide
Sitta canadensis	Red-breasted Nuthatch	S4B, S4N	G5	Buckelew and Hall 1994, TNC 2001, WVPIF 2006	Red spruce and spruce-hardwood; known from higher elevations of eight Allegheny Mountain counties
Sitta carolinensis	White-breasted Nuthatch	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Deciduous forest; statewide
Sphyrapicus varius	Yellow-bellied Sapsucker	S1B, S3N, SGNC	G5	Buckelew and Hall 1994, WVDNR 2006	Remote, mixed hardwood - red spruce forests in the Allegheny Mountains
Spizella passerina	Chipping Sparrow	S3N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Open woodland, forest edge, gardens; statewide
Spizella pusilla	Field Sparrow	S4B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Open habitats; statewide
Strix varia	Barred Owl	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Mature deciduous forests statewide and rare in spruce forest
Sturnella magna	Eastern Meadowlark	S4N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Grasslands; statewide except in the southwest
Sturnus vulgaris	European Starling	SNA	G5	Buckelew and Hall 1994, WVPIF 2006	Diverse habitats but scarce at high elevations and in heavily forested areas; statewide
Tachycineta bicolor	Tree Swallow	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Open habitats near water; most records from the Allegheny Mountains and Ridge & Valley
Thryothorus ludovicianus	Carolina Wren	S5B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Open deciduous woodlands and residential areas; rare at high elevations
Toxoxtoma rufum	Brown Thrasher	S3N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Brushy habitats; statewide
Troglodytes aedon	House Wren	S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Open or semi-open habitats, buildings; statewide
Troglodytes troglodytes	Winter Wren	S4B, S4N	G5	Buckelew and Hall 1994, WVPIF 2006	Red spruce, spruce-hardwood, and hemlock-hardwood forests; most records from high elevations in eight Allegheny Mountain counties

Turdus migratorius	American Robin	S4N, S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Diverse habitats; statewide
Vermivora chrysoptera	Golden-winged Warbler	S2B	G4	Buckelew and Hall 1994, WVPIF 2006	Low second-growth, open woodlands, power line rights-of-way; mostly at mid-high elevations west of the Allegheny Mountains
Vermivora pinus	Blue-winged Warbler	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Second-growth woodlands and brushy areas; principally in the western part of the state and at low elevations
Vermivora ruficapilla	Nashville Warbler	S1B	G5	Buckelew and Hall 1994, TNC 2001, WVPIF 2006	Second-growth woodland and forest edge of bogs; records from high elevation bogs near the Allegheny Front in Tucker and Grant counties
Vireo flavifrons	Yellow-throated Vireo	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Mature deciduous forest at lower elevations
Vireo griseus	White-eyed Vireo	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Brushy second-growth woodlands; statewide but missing at high elevations
Vireo olivaceus	Red-eyed Vireo	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Mature forest and wooded habitats; statewide with the exception of pure spruce forest
Vireo solitarius	Blue-headed Vireo	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Coniferous and mixed coniferous-hardwood forest; main distribution in spruce and spruce-hardwood forests above 300 m in the Allegheny Mountains, with additional populations in hemlock-hardwood and hardwood forests of the Ridge & Valley and southwest
Wilsonia canadensis	Canada Warbler	S4B	G5	Buckelew and Hall 1994, WVPIF 2006	Undergrowth of spruce-hardwood forest, open woodland and wetland margins, usually above 650 m elevation; restricted to the Allegheny Mountains
Wilsonia citrina	Hooded Warbler	S5B	G5	Buckelew and Hall 1994, WVPIF 2006	Undergrowth of mature deciduous forest; mostly in the Western Hills, sparingly in Allegheny Mountains and uncommon in Ridge & Valley
Zenaidura macroura	Mourning Dove	S5B, S5N	G5	Buckelew and Hall 1994, WVPIF 2006	Open habitats with scattered trees; broad distribution

Zonotrichia albicollis	White-throated Sparrow	S1B, S4N	G5	Buckelew and Hall 1994	Mountain bogs or thickets on the edge of spruce or spruce-hardwood forests; known only from high elevation bogs in Pocahontas County

Reptiles and Amphibians

Scientific Name	**Common Name**	**State Rank**	**Global Rank**	**Source**	**Habitat and Distribution**
Agkistrodon contortrix mokasen	Northern Copperhead	S5	G5T5	Green et al. 2006	Rocky wooded areas; statewide
Ambystoma jeffersonianum	Jefferson's Salamander	S3	G4	Pauley 2006, Marshall U. 2006, WVDNR 2006	Underground or in stacks of wet leaves in forests and wetlands; statewide
Ambystoma maculatum	Spotted Salamander	S5	G5	Green and Pauley 1987, Pauley 2006	Deciduous and mixed forests; statewide
Bufo americanus americanus	Eastern American Toad	S5	G5	Green and Pauley 1987, Pauley 2006, TNC 2001, CVNWR 2007	Woodlands and open areas; statewide
Chelydra serpentina serpentina	Eastern Snapping Turtle	S5	G5	Pauley 2006	Variety of aquatic habitats; statewide
Crotalus horridus	Timber Rattlesnake	S3	G4	Green and Pauley 1987, Marshall U. 2006	Rough, rocky mountainous habitats; known from 27 counties in the east, south, and Allegheny Mountains
Coluber constrictor	Black Racer	S5	G5	TNC 2001, Green et al. 2006	Moist woodlands and fields; statewide
Desmognathus fuscus	Northern Dusky Salamander	S5	G5	TNC 2001, Pauley 2004, CVNWR 2007	Seeps, springs, and small streams; statewide
Desmognathus ochrophaeus	Allegheny Mountain Salamander	S4	G5	Green and Pauley 1987, TNC 2001, Pauley 2004, CVNWR 2007	Red spruce and hardwood forests, springs, seeps, and streams; mainly in the mountains from Preston to McDowell counties
Diadophis punctatus edwardsii	Northern Ringneck Snake	S5	G5T5	TNC 2001, Green et al. 2006	Moist woodlands with rotting logs, piles of dead leaves, or under rocks; statewide
Elaphe alleghaniensis (E. obsoleta , Pantherophis obsoletus)	Black Ratsnake	S5	G5	Green and Pauley 1987, TNC 2001	Forests and a variety of habitats; statewide
Eurycea longicauda	Long-tailed Salamander	S5	G5	TNC 2001, Pauley 2004	Streams, springs, seeps, and caves; statewide

Gyrinophilus porphyriticus porphyriticus	Northern Spring Salamander	S5	G5T5	Green and Pauley 1987, TNC 2001, Francl 2003, Pauley 2006	Cool springs, small streams, fens, and caves; statewide except the southwest
Hemidactylium scutatum	Four-toed Salamander	S5	G5	Green and Pauley 1987, TNC 2001, Pauley 2006, CVNWR 2007	Sphagnum peatlands and hardwood forests; statewide with most records in the mountain and eastern counties
Hyla chrysoscelis	Cope's Gray Treefrog	S4	G5	Green and Pauley 1987, Pauley 2006	Open woodlands; statewide except southeast
Hyla versicolor	Gray Treefrog	S5	G5	Green and Pauley 1987, Pauley 2006	Open woodlands; southeastern counties
Lampropeltis triangulum	Eastern Milksnake	S5	G5	TNC 2001, Green et al. 2006	Variety of habitats; statewide
Liochlorophis vernalis (Opheodrys vernalis)	Smooth Green Snake	S5	G5	Green and Pauley 1987, TNC 2001, Green et al. 2006	Open habitats; known from 19 counties but most common in the mountains
Nerodia sipedon sipedon	Common Watersnake	S5	G5	Pauley 2006, Green et al. 2006, TNC 2001	Small streams, ponds, and rivers; statewide
Notophthalmus viridescens viridescens	Red-spotted Newt, Red Eft	S5	G5	Green and Pauley 1987, Pauley 2006, TNC 2001, CVNWR 2007	Aquatic habitats and forests; statewide
Plethodon cinereus	Red-backed Salamander	S5	G5	Green and Pauley 1987, TNC 2001, Pauley 2004	Cool, moist coniferous, mixed, or deciduous forest; statewide except the Ohio Valley
Plethodon glutinosus	Slimy Salamander	S5	G5	Green and Pauley 1987, TNC 2001	Variety of woodland habitats; statewide
Plethodon nettingi	Cheat Mountain Salamander	S2, SGNC	G2 / LT	Green and Pauley 1987, Marshall U., 2006, WVDNR 2006	Cool, moist red spruce – yellow birch forest with a ground cover including the liverwort *Bazzania* and an abundance of leaf litter, fallen logs and sticks; endemic to West Virginia, where it is known from Grant, Pendleton, Pocahontas, Randolph, and Tucker counties
Plethodon wehrlei	Wehrle's Salamander	S4	G4	Green and Pauley 1987, Pauley 2004	Red spruce – yellow birch forest at high elevations and mixed deciduous woodlands at lower elevations; statewide except the southwest and eastern panhandle

Pseudacris crucifer crucifer (Hyla crucifer crucifer)	Northern Spring Peeper	S5	G5	Green and Pauley 1987, Pauley 2006, TNC 2001, CVNWR 2007	Woods, thickets, and pools; statewide
Pseudotriton ruber ruber	Northern Red Salamander	S3	G5	Green and Pauley 1987, TNC 2001, Pauley 2004, Pauley 2006	Springs, small streams, fens, and caves; statewide
Rana clamitans melanota	Northern Green Frog	S5	G5T5	Green and Pauley 1987, Pauley 2006, TNC 2001, CVNWR 2007	Open and wooded aquatic habitats; statewide
Rana pipiens	Northern Leopard Frog	S2	G5	Green and Pauley 1987, Francl 2003	Aquatic habitats; probably statewide but rare
Rana palustris	Pickerel Frog	S5	G5	Green and Pauley 1987, Pauley 2006, TNC 2001, CVNWR 2007, Francl 2003	Cool, shady ravines along clear streams and springs; statewide
Rana sylvatica	Wood Frog	S5	G5	Green and Pauley 1987, Pauley 2006, TNC 2001, CVNWR 2007	Moist woodlands with well-developed leaf litter; statewide
Regina septemvittata	Queen Snake	S4	G5	Francl 2003, Green et al. 2006	Small, rocky creeks and rivers; statewide
Storeria dekayi dekayi	Brownsnake	S4	G5	Green and Pauley 1987, TNC 2001, Green et al. 2006	Moist woodlands and urban areas, secretive; known from seven counties
Storeria occipitomaculata occipitomaculata	Red-bellied Snake	S5	G5	Green and Pauley 1987, TNC 2001, Green et al. 2006	Wooded areas; statewide with a preference for mountainous terrain
Thamnophis sirtalis sirtalis	Garter Snake	S5	G5	TNC 2001, Green et al. 2006, CVNWR 2007	Meadows, marshes, hillsides, urban areas; statewide
Virginia valeriae puchra	Mountain Earthsnake	S2, SGNC	G5T3T4	Green and Pauley 1987, Marshall U. 2006, WVDNR 2006, PA Herp Atlas 2009	Moist rocky northern hardwood and red spruce forests, often on slopes with flat sandstone rocks and open vegetation; known from high elevation sites in Pendleton, Pocahontas, Preston, and Randolph counties

Invertebrates

Snails

Scientific Name	Common Name	State Rank	Global Rank	Source	Comment
Anguispira alternata	Flamed Disc	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Deciduous and mixed forest; statewide
Appalachina sayana	Spike-lip Crater	SNR	G5	Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Moist leaf litter or near logs on wooded hillsides, often on rich sites; statewide except west-central
Arion subfuscus	Dusky Arion	SNA	G5	Dourson 2010	Exotic (native to western Europe)
Carychium clappi	Appalachian Thorn	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Wooded hillsides and talus slopes with leaf litter; central and southern portions of the state
Carychium exiguum	Obese Thorn	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Leaf litter on richer sites; eastern, northern, and southern portions of the state
Carychium exile	Ice Thorn	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Leaf litter; statewide
Carychium nannodes	File Thorn	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Leaf litter on richer sites; eastern and southern portions of the state
Catinella vermeta	Suboval Ambersnail	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Floodplains, ponds, swamps, hillside springs; statewide
Cochlicopa lubrica	Glossy Pillar	SNR	G5	Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008	Meadows, roadsides, disturbed areas; statewide
Cochlicopa morseana	Appalachian Pillar	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Mature forests; statewide
Columella simplex	High-spire Column	SNR	G5Q	Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008	Leaf litter in moist woods, talus slopes, and ravines; statewide
Discus catskillensis	Angular Disc	S1	G5	Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008	High elevation woods, in leaf litter and about logs; only two known collections of this northern species, at high elevation sites in Pocahontas and Tucker counties
Euchemotrema fraternum	Upland Pillsnail	SNR	G5	FMNH 2006, Hotopp and	Upland woods; statewide

				Pearce 2008	
Euconulus fulvus	Brown Hive	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Damp leaf litter; statewide
Glyphyalinia picea	Rust Glyph	SNR	G3	Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008	Moist leaf litter on wooded hillsides; known from high elevation sites in Pendleton, Pocahontas, Preston, and Randolph counties
Glyphyalinia wheatleyi	Bright Glyph	SNR	G5	Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008	Moist leaf litter on wooded hillsides or ravines; statewide
Haplotrema concavum	Gray-foot Lancetooth	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Leaf litter in upland woods; statewide
Helicodiscus notius	Tight Coil	SNR	G5Q	FMNH 2006, Hotopp and Pearce 2008	Leaf litter; southern and central portions of the state
Helicodiscus shimeki	Temperate Coil	SNR	G4G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Leaf litter in upland woods, including red spruce forest, often on very acid soil; most collections at higher elevations in the mountain counties
Mesodon andrewsae	Balsam Globe	SNR	G3	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Found crawling on the ground; high elevation species of the southern Appalachians; known from high elevation sites including red spruce forest in Pocahontas and Randolph counties
Mesodon zaletus	Toothed Globe	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Mature forests; statewide
Mesomphix cupreus	Copper Button	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Leaf litter; statewide
Mesomphix inornatus	Plain Button	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Leaf litter; statewide
Mesomphix perlaevis	Smooth Button	SNR	G4G5	FMNH 2006, Hotopp and Pearce 2008	Leaf litter on wooded hillsides; northern counties and one record from Spruce Knob.
Neohelix albolabris	Whitelip	SNR	G5	WVDNR 2010	Common statewide

Neohelix dentifera	Big-tooth Whitelip	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Rocky streamsides, ravines, and mesic forest slopes; statewide
Novisuccinea chittenangoensis	Chittenango Ambersnail	SNR	G1	FMNH 2006, Hotopp and Pearce 2008	Two 1982 records, possibly mis-identified, from talus under red spruce forest in Pendleton County
Novisuccinea ovalis	Oval Ambersnail	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Stream valleys, floodplains, and uplands; statewide
Pallifera secreta	Severed Mantleslug	SNR	G4	Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008	Deep pockets of wet leaves from moderate up to high elevations; known from Pendleton, Pocahontas, Randolph, Logan, Mingo, Raleigh, and Kanawha counties
Paravitrea multidentata	Dentate Supercoil	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Leaf litter; statewide
Philomycus flexuolaris	Winding Mantleslug	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Wooded hillsides; Appalachian species known from 10 counties in WV
Philomycus venustus	Brown-spotted Mantleslug	SNR	G4	FMNH 2006, Hotopp and Pearce 2008	Upland forest; southern Appalachian species known from high elevation sites in Pendleton, Pocahontas, and Randolph counties
Punctum minutissimum	Small Spot	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Leaf litter; statewide
Stenotrema hirsutum	Hairy Slitmouth	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Forests; statewide
Stenotrema simile	Bear Creek Slitmouth	SNR	G2	FMNH 2006, Hotopp and Pearce 2008	Logs and leaf litter on rocky wooded hillsides; known from higher elevations in Nicholas, Pocahontas, Randolph, and Webster counties
Striatura exigua	Ribbed Striate	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Leaf litter; known from eight higher-elevation mountain counties including within red spruce forest
Striatura ferrea	Black Striate	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Leaf litter; known from 17 counties with most specimens from higher elevations including within

					red spruce forest
Striatura meridionalis	Median Striate	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Leaf litter; known from 15 counties with most specimens from higher elevations
Triodopsis fraudulenta	Baffled Threetooth	SNR	G4	FMNH 2006, Hotopp and Pearce 2008	Central Appalachian endemic known from 24 counties with a number of specimens from higher elevations
Triodopsis juxtidens	Atlantic Threetooth	S1S2	G5	Hubricht 1985, FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Leaf litter, logs, and rocks on wooded hillsides, ravines, and disturbed areas; statewide
Triodopsis picea	Spruce Knob Threetooth	S2	G3	TNC 2001, FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Cool ravines, stream valleys, and high elevation red spruce and spruce-northern hardwoods; records from high elevation sites in Greenbrier, Nicholas, Pendleton, Pocahontas, Randolph, and Webster counties
Triodopsis tridentata	Northern Threetooth	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Upland woods, leaf litter, logs, rocks, disturbed areas; statewide
Triodopsis vulgata	Dished Threetooth	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Leaf litter and logs in ravines and on wooded hillsides; known from 9 counties
Ventridens arcellus	Golden Dome	SNR	G4	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Cool coves and hardwood or mixed forests; known from 10 counties with most specimens from higher elevations including within red spruce forests
Ventridens demissus	Perforate Dome	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Leaf litter on wooded hillsides, ravines, floodplains, and urban areas; statewide
Ventridens ligera	Globose Dome	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Wet, weedy, open ground and low woods; statewide
Vertigo milium	Blade Vertigo	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Wet leaves and woods; distribution unknown

Vertigo ventricosa	Five-tooth Vertigo	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Marshes, low wet woods, leaf litter in upland woods; known from Pocahontas, Nicholas, Raleigh, and Munroe counties
Webbhelix multilineata	Striped Whitelip	S1	G5	TNC 2001, Hotopp and Pearce 2008	Wetlands and riparian zones; Midwestern species known only from Cranesville Swamp and the Ohio River Islands in WV
Xolotrema denotata	Velvet Wedge	SNR	G5	FMNH 2006, Hotopp and Pearce 2008	Rotten logs in forests; statewide
Zonitoides arboreus	Quick Gloss	SNR	G5	FMNH 2006, Hotopp and Pearce 2008, Dourson 2010	Leaf litter and woody debris in forests; statewide

Crayfish

Scientific Name	**Common Name**	**State Rank**	**Global Rank**	**Source**	**Comment**
Cambarus bartonii bartonii	Appalachian Brook Crayfish	S4	G5T5	Jezerinac et al. 1995, TNC 2001, WVDNR 2010	Cranesville Swamp; small (2 m) to moderately wide (10 m) streams with high gradient having cobble and boulder substrates. In West Virginia, this subspecies is only found in the mountainous streams of the Potomac River drainage in the eastern panhandle.
Cambarus carinirostris	Rock Crayfish	S4	G5	Jezerinac et al. 1995, Loughman 2009, WVDNR 2010	Type locality is Gandy Creek at Osceola; occupies Allegheny Mtn province & northern panhandle; inhabits small streams to 10 m wide with cobble and boulder substrates; also in intermittent streams and seeps.
Cambarus chasmodactylus	New River Crayfish	S3	G4	WVDNR 2010	East Fork Greenbrier, West Fork Greenbrier
Cambarus elkensis	Elk River Crayfish	S1	G2	Loughman 2009, Loughman and Welsh 2010	Loose cobble and rock slabs in relatively undisturbed tributaries and mainstem sections of the upper Elk R.
Cambarus monongalensis	Monongahela Crayfish	S3, SGNC	G5	Jezerinac et al. 1995, Loughman 2009, WVDNR 2006	Allegheny Mtn region and northern panhandle; primary burrower - constructs burrows in seeps, springs, and roadside ditches; deciduous woods

Cambarus robustus	Big Water Crayfish	S4	G5	WVDNR 2010, Loughman and Welsh 2010	East Fork Greenbrier, West Fork Greenbrier; Kanawha and southwestern Ohio River basins and central portions of Ohio River direct drains
Cambarus sciotensis	Teays River Crayfish	S3	G5	WVDNR 2010, Loughman and Welsh 2010	Little Clear Creek, Cranberry River, Williams River; southwestern Ohio and Kanawha River basins
Orconectes obscurus	Allegheny Crayfish	S4	G5	Jezerinac et al. 1995, Loughman 2009, WVDNR 2010	headwater streams (up to 10 m wide) with cobble and boulder substrates, that are not affected by acid mine drainage or clear-cutting in northern portion of state
Orconectes sanbornii	Sanborn Crayfish	S4	G5	WVDNR 2010, Loughman and Welsh 2010	Little Clear Creek; small and large streams in the Kanawha and southwestern Ohio River Basins

Butterflies and Moths

Scientific Name	Common Name	State Rank	Global Rank	Source
Abagrotis alternata	Greater Red Dart	SNR	G5	WVDNR 2010
Acasis viridata	Olive-and-black Carpet	SNR	GNR	WVDNR 2010
Achalarus lyciades	Hoary Edge	S4	G5	Allen 1997, WVDNR 2010
Achatia distincta	Distinct Quaker	SNR	G5	WVDNR 2010
Achatodes zeae	A Moth	SNR	G5	WVDNR 2010
Acronicta afflicta	A Moth	SNR	G5	WVDNR 2010
Acronicta americana	A Moth	SNR	G5	WVDNR 2010
Acronicta dactylina	Fingered Dagger Moth	SNR	G5	TNC 2001, WVDNR 2010
Acronicta fragilis	A Moth	SNR	G5	WVDNR 2010
Acronicta grisea	Gray Dagger Moth	SNR	G5	TNC 2001
Acronicta haesitata	A Moth	SNR	G5	WVDNR 2010
Acronicta hasta	A Moth	SNR		WVDNR 2010
Acronicta impressa	A Moth	SNR	G5	WVDNR 2010
Acronicta inclara	A Moth	SNR		WVDNR 2010
Acronicta increta	A Moth	SNR	G5	WVDNR 2010
Acronicta innotata	A Moth	SNR	G5	WVDNR 2010
Acronicta interrupta	A Moth	SNR	G5	WVDNR 2010
Acronicta laetifica	A Moth	SNR	G5	WVDNR 2010
Acronicta lobeliae	A Moth	SNR	G5	WVDNR 2010
Acronicta longa	A Moth	SNR	G5	WVDNR 2010
Acronicta modica	A Moth	SNR	G5	WVDNR 2010
Acronicta ovata	A Moth	SNR	G5	WVDNR 2010
Acronicta retardata	A Moth	SNR	G5	WVDNR 2010
Acronicta spinigera	A Moth	SNR	G4	WVDNR 2010
Acronicta superans	A Moth	SNR	G5	WVDNR 2010
Acronicta vinnula	A Moth	SNR	G5	WVDNR 2010

Actias luna	Luna Moth	SNR	G5	WVDNR 2010
Aethalura intertexta	Four-barred Gray	SNR	GNR	WVDNR 2010
Agrotis gladiaria	A Moth	SNR	G5	WVDNR 2010
Agrotis ipsilon	Dark Sword Grass	SNR	G5	WVDNR 2010
Agrotis venerabilis	A Moth	SNR	G5	WVDNR 2010
Aletia oxygala	A Moth	SNR	GNR	WVDNR 2010
Allagrapha aerea	A Moth	SNR	G5	WVDNR 2010
Alsophila pometaria	Fall Cankerworm Moth	SNR	GNR	WVDNR 2010
Amblyscirtes hegon	Pepper and Salt Skipper	S3	G5	Allen 1997, TNC 2001, WVDNR 2010
Amphipoea americana	A Moth	SNR	G5	WVDNR 2010
Amphipoea velata	A Moth	SNR	G5	WVDNR 2010
Amphipyra pyramidoides	A Moth	SNR	G5	WVDNR 2010
Amphipyra tragopoginis	A Moth	SNR	G5	WVDNR 2010
Amyna octo	A Moth	SNR	G5	WVDNR 2010
Anacamptodes humaria	Small Purplish Gray	SNR	GNR	WVDNR 2010
Anagoga occiduaria	American Barred Umber	SNA	G5	WVDNR 2010
Anagrapha falcifera	Celery Looper Moth	SNR	G5	WVDNR 2010
Anaplectoides brunneomedia	A Noctuid Moth	SU	G4	WVDNR 2010
Anaplectoides prasina	A Noctuid Moth	SNR		WVDNR 2010
Anatrytone logan	Delaware Skipper	SNR		WVDNR 2010
Ancyloxypha numitor	Least Skipper	SNR		TNC 2001
Anicla infecta	Green Cutworm	SNR	G5	WVDNR 2010
Anomogyna atrata	A Noctuid Moth	SNR		WVDNR 2010
Anomogyna badicollis	A Noctuid Moth	SNR		WVDNR 2010
Anorthodes tarda	A Noctuid Moth	SNR	G5	WVDNR 2010
Antheraea polyphemus	Polyphemus Moth	SNR	G5	WVDNR 2010
Anticarsia gemmatalis	Velvetbean Caterpillar Moth	SNR	G5	WVDNR 2010
Anticlea vasiliata	A Geometrid Moth	SNR	G5	WVDNR 2010
Apamea amputatrix	A Noctuid Moth	SNR		WVDNR 2010
Apamea cariosa	A Noctuid Moth	SNR		WVDNR 2010
Apamea cristata	A Noctuid Moth	SNR		WVDNR 2010
Apamea dubitans	A Noctuid Moth	SNR	G5	WVDNR 2010
Apamea finitima	A Noctuid Moth	SNR		WVDNR 2010
Apamea lignicolora	A Noctuid Moth	SNR		WVDNR 2010
Apamea nigrior	A Noctuid Moth	SNR	G5	WVDNR 2010
Apamea verbascoides	A Noctuid Moth	SNR	G5	WVDNR 2010
Apamea vulgaris	A Noctuid Moth	SNR		WVDNR 2010
Apantesis anna	A Moth	SNR		WVDNR 2010
Apantesis figurata	A Moth	SNR		WVDNR 2010
Apantesis virgo	A Moth	SNR		WVDNR 2010
Apatelodes torrefacta	A Moth	SNR	G5	WVDNR 2010
Aplectoides condita	A Noctuid Moth	S1	G4	WVDNR 2010
Apoda biguttata		SNR		WVDNR 2010
Apoda y-inversum		SNR		WVDNR 2010
Artogeia virginiensis		SNR		WVDNR 2010

Atrytonopsis hianna	Dusted Skipper	SNR		TNC 2001
Autographa ampla	A Noctuid Moth	SNR	G5	WVDNR 2010
Autographa biloba	A Noctuid Moth	SNR	G5	WVDNR 2010
Autographa precationis	A Noctuid Moth	SNR	G5	WVDNR 2010
Automeris io		SNR		WVDNR 2010
Bagisara rectifascia		SNR		WVDNR 2010
Baileya doubledayi	A Moth	SNR	G5	WVDNR 2010
Baileya ophthalmica	A Moth	SNR	G5	WVDNR 2010
Balsa labecula	A Noctuid Moth	SNR	G5	WVDNR 2010
Balsa malana	A Noctuid Moth	SNR	G5	WVDNR 2010
Basilarchia archippus		SNR		WVDNR 2010
Battus philenor	Pipevine Swallowtail	S5	G5	Allen 1997, WVDNR 2010
Besma endropiaria	Straw Besma	SNR	GNR	WVDNR 2010
Besma quercivoraria	A Geometrid Moth	SNR	G5	WVDNR 2010
Biston betularia		SNR		WVDNR 2010
Bleptina caradrinalis		SNR		WVDNR 2010
Boloria bellona	Meadow Fritillary	S5	G5	Allen 1997, TNC 2001, WVDNR 2010
Boloria selene myrina	Silver-bordered Fritillary	S3	G5T5	Allen 1997, WVDNR 2010
Bomolocha baltimoralis	Baltimore Bomolocha	SNR	G5	WVDNR 2010
Bomolocha deceptalis	Deceptive Bomolocha	SNR	G5	WVDNR 2010
Bomolocha edictalis	A Moth	SNR	G4	WVDNR 2010
Bomolocha madefactalis	Grey-eyed Bomolocha	SNR	G5	WVDNR 2010
Bomolocha palparia	Mottled Bomolocha	SNR	G5	WVDNR 2010
Cabera erythemaria		SNR		WVDNR 2010
Cabera quadrifasciaria	Four-lined Cream Moth	SNR	G5	WVDNR 2010
Caenurgina crassiuscula	A Noctuid Moth	SNR	G5	WVDNR 2010
Caenurgina erechtea	A Noctuid Moth	SNR	G5	WVDNR 2010
Calledapteryx dryopterata		SNR		WVDNR 2010
Callopistria cordata	Silver-spotted Fern Moth	SNR	G5	WVDNR 2010
Callopistria mollissima	A Moth	SNR	G5	WVDNR 2010
Callosamia angulifera		SNR		WVDNR 2010
Campaea perlata		SNR		WVDNR 2010
Capis curvata	A Noctuid Moth	SNR	G4	WVDNR 2010
Caripeta angustiorata	Brown Pine Looper Moth	SNR	GNR	WVDNR 2010
Caripeta divisata	A Geometrid Moth	SNR	G5	WVDNR 2010
Catocala andromedae	Andromeda Underwing	SNR	G5	WVDNR 2010
Catocala blandula	Charming Underwing	SNR	G5	WVDNR 2010
Catocala cerogama	Yellow Banded Underwing	SNR	G5	WVDNR 2010
Catocala coccinata	Scarlet Underwing	SNR	G5	WVDNR 2010
Catocala concumbens	Sleepy Underwing	SNR	G5	WVDNR 2010
Catocala epione	Epione Underwing	SNR	G5	WVDNR 2010
Catocala grynea	Woody Underwing	SNR	G5	WVDNR 2010
Catocala habilis	Habilis Underwing	SNR	G5	WVDNR 2010
Catocala ilia	Ilia Underwing	SNR	G5	WVDNR 2010
Catocala micronympha	Little Nymph Underwing	SNR	G5	WVDNR 2010

Catocala palaeogama	Oldwife Underwing	SNR	G5	WVDNR 2010
Catocala praeclara	Praeclara Underwing	SNR	G5	WVDNR 2010
Catocala relicta	White Underwing	SNR	G5	WVDNR 2010
Catocala retecta	An Underwing Moth	SNR	G5	WVDNR 2010
Catocala serena	Serene Underwing	SNR	G5	WVDNR 2010
Catocala sordida	Sordid Underwing	SNR	G5	WVDNR 2010
Catocala subnata	Youthful Underwing	SNR	G5	WVDNR 2010
Catocala ultronia	Ultronia Underwing	SNR	G5	WVDNR 2010
Catocala vidua	Widow Underwing	SNR	G5	WVDNR 2010
Celastrina ladon	Spring Azure	S5	G5	Allen 1997, TNC 2001, WVDNR 2010
Celastrina neglecta	Summer Azure	SNR	G5	Allen 1997, WVDNR 2010
Celastrina neglecta major	Appalachian Azure	SNR	G4	Allen 1997
Cepphis armataria		SNR		WVDNR 2010
Cerastris salicarum	Willow Dart	S1	G5	WVDNR 2010
Cerastis tenebrifera		SNR		WVDNR 2010
Ceratomia amyntor	Elm Sphinx	SNR	G4G5	WVDNR 2010
Ceratomia undulosa	Waved Sphinx	SNR	G5	WVDNR 2010
Cercyonis pegala	Common Wood Nymph	S5	G5	Allen 1997, TNC 2001, WVDNR 2010
Cerma cerintha		SNR		WVDNR 2010
Charadra deridens		SNR		WVDNR 2010
Chlorochlamys chloroleucaria		SNR		WVDNR 2010
Chlosyne harrisii liggetti	Harris' Checkerspot	S2	G4	Allen 1997, WVDNR 2010
Chlosyne nycteis	Silvery Checkerspot	S4	G5	Allen 1997, WVDNR 2010
Chrysanympha formosa		SNR		WVDNR 2010
Chytolita morbidalis	Morbid Owlet	SNR	G5	WVDNR 2010
Chytolita petrealis	A Noctuid Moth	SNR	GNR	WVDNR 2010
Chytonix palliatricula		SNR		WVDNR 2010
Cisseps fulvicollis		SNR		WVDNR 2010
Cissusa spadix		SNR		WVDNR 2010
Cladara anguilineata	A Moth	SNR	GNR	WVDNR 2010
Cladara atroliturata	The Scribbler	SNR	GNR	WVDNR 2010
Cladara limitaria	Mottled Gray Carpet	SNR	GNR	WVDNR 2010
Clemensia albata		SNR		WVDNR 2010
Clostera albosigma		SNR		WVDNR 2010
Coenonympha tullia	Common Ringlet	S1	G5	Allen 1997, WVDNR 2010
Coenonympha tullia inornata	Inornate Common Ringlet	SNR	GNR	Allen 1997, WVDNR 2010
Colias eurytheme	Orange Sulphur	S5	G5	Allen 1997, TNC 2001, WVDNR 2010

Colias interior	Pink-edged Sulphur	S1	G5T1T2Q	Allen 1997, TNC 2001, WVDNR 2010
Colias philodice	Clouded Sulphur	S5	G5	Allen 1997, WVDNR 2010
Colocasia propinquilinea		SNR		WVDNR 2010
Copipanolis styracis		SNR		WVDNR 2010
Copivaleria grotei		SNR		WVDNR 2010
Cosmia calami	A Moth	SNR	G5	WVDNR 2010
Crambidia pallida		SNR		WVDNR 2010
Crocigrapha normani		SNR		WVDNR 2010
Crymodes devastator		SNR		WVDNR 2010
Ctenucha virginica	A Noctuid Moth	SNR	G5	WVDNR 2010
Cucullia asteroides	The Asteroid	SNR	G5	WVDNR 2010
Cucullia convexipennis	A Moth	SNR	G5	WVDNR 2010
Cucullia florea	A Moth	SNR	GNR	WVDNR 2010
Cyclophora pendulinaria		SNR		WVDNR 2010
Cycnia tenera		SNR		WVDNR 2010
Danaus plexippus	Monarch	SNA	G5	Allen 1997, TNC 2001, WVDNR 2010
Darapsa pholus	A Sphinx Moth	SNR		WVDNR 2010
Darapsa versicolor	Hydrangea Sphinx	SNR	G4	WVDNR 2010
Dasychira basiflava	A Moth	SNR	G5	WVDNR 2010
Dasychira dorsipennata	Sharp-lined Tussock Moth	SNR	G4G5	TNC 2001, WVDNR 2010
Dasychira manto	Manto Tussock Moth	SNR	G5	WVDNR 2010
Dasychira obliquata	A Moth	SNR	G4	WVDNR 2010
Dasychira plagiata	Northern Pine Tussock Moth	SNR	GNR	TNC 2001, WVDNR 2010
Dasychira vagans	Variable Tussock Moth	SNR	GNR	WVDNR 2010
Dasylophia thyatiroides		SNR		WVDNR 2010
Datana drexelii	Drexel's Datana	SNR	G5	WVDNR 2010
Datana major	A Notodontid Moth	SNR	G4G5	WVDNR 2010
Datana ministra	Yellow-necked Caterpillar Moth	SNR	G5	WVDNR 2010
Diachrysia aeroides	Dark-spotted Looper Moth	SNR	GNR	WVDNR 2010
Diarsia jucunda		SNR		WVDNR 2010
Diarsia rubifera	Rubifera Dart	SNR	G5	WVDNR 2010
Digrammia ocellinata	A Geometrid Moth	SNR	G5	WVDNR 2010
Dolba hyloeus		SNR		WVDNR 2010
Drepana arcuata	A Moth	SNR	G5	WVDNR 2010
Dryocampa rubicunda		SNR		WVDNR 2010
Dysstroma hersiliata		SNR		WVDNR 2010
Dysstroma truncata	Dark Marbled Carpet	SNR	GNR	WVDNR 2010
Ectropis crepuscularia		SNR		WVDNR 2010
Egira alternans		SNR		WVDNR 2010
Eilema bicolor	Bicolor Moth	S1	G5	WVDNR 2010
Elaphria festivoides	A Noctuid Moth	SNR	G5	WVDNR 2010

Elaphria grata	A Noctuid Moth	SNR	G5	WVDNR 2010
Elaphria versicolor	Variegated Midget	SNR	G5	WVDNR 2010
Epargyreus clarus	Silver-spotted Skipper	S5	G5	Allen 1997, TNC 2001
Epiglaea apiata	Pointed Sallow	SNR	G5	WVDNR 2010
Epimecis hortaria		SNR		WVDNR 2010
Epirrhoe alternata		SNR		WVDNR 2010
Erannis tiliaria		SNR		WVDNR 2010
Erora laeta	Early Hairstreak	S2	GU	Allen 1997, Maryland SGCN list, WVDNR 2010, WVDNR 2010
Erynnis baptisiae	Wild Indigo Duskywing	S4	G5	Allen 1997
Erynnis icelus	Dreamy Duskywing	S5	G5	Allen 1997, TNC 2001, WVDNR 2010
Erynnis juvenalis	Juvenal's Duskywing	S5	G5	Allen 1997
Euagrotis illapsa		SNR		WVDNR 2010
Euchaetes egle		SNR		WVDNR 2010
Euchlaena effecta	A Looper Moth	S1	G5	WVDNR 2010
Euchlaena johnsonaria	A Looper Moth	SNR		WVDNR 2010
Euchlaena obtusaria	A Looper Moth	SNR		WVDNR 2010
Euchlaena serrata	A Looper Moth	SNR		WVDNR 2010
Euchlaena tigrinaria	A Looper Moth	SNR		WVDNR 2010
Eucirroedia pampina		SNR		WVDNR 2010
Euclea delphinii		SNR		WVDNR 2010
Eucoptocnemis fimbriaris	A Noctuid Moth	SNR	G4	WVDNR 2010
Eudryas grata		SNR		WVDNR 2010
Eueretagrotis attenta	A Noctuid Moth	SNR		WVDNR 2010
Eueretagrotis perattenta	A Noctuid Moth	SNR	G5	WVDNR 2010
Eufidonia notataria		SNR		WVDNR 2010
Eulithis explanata		SNR		WVDNR 2010
Eumorpha pandorus	Pandorus Sphinx	SNR	G5	WVDNR 2010
Euparthenos nubilis		SNR		WVDNR 2010
Euphydryas phaeton	Baltimore Checkerspot	S3S4	G4	Allen 1997, WVDNR 2010
Euphyes conspicua	Black Dash	S1	G4	WVDNR 2010
Euphyes ruricola		SNR		WVDNR 2010
Euphyes vestris	Dun Skipper	S4	G5	Allen 1997
Euplexia benesimilis		SNR		WVDNR 2010
Eupsilia morrisoni	Morrison's Sallow	SNR	GNR	WVDNR 2010
Eupsilia sidus	Sidus Sallow	SNR	GNR	WVDNR 2010
Euptoieta claudia	Variegated Fritillary	SNA	G5	Allen 1997
Eurema lisa	Little Yellow	SNR		Allen 1997, WVDNR 2010
Eurema nicippe	Sleepy Orange	SNR		Allen 1997, WVDNR 2010
Eurytides marcellus	Zebra Swallowtail	S4	G5	WVDNR 2010

Eusarca confusaria		SNR		WVDNR 2010
Euthyatira pudens		SNR		WVDNR 2010
Eutolype grandis		SNR		WVDNR 2010
Euxoa redimicula	Fillet Dart	SNR	GNR	WVDNR 2010
Euxoa velleripennis	Fleece-winged Dart	SNR	GNR	WVDNR 2010
Everes comyntas	Eastern Tailed Blue	SNR		Allen 1997, TNC 2001
Faronta diffusa		SNR		WVDNR 2010
Feltia geniculata	A Moth	SNR		WVDNR 2010
Feltia herilis	A Moth	SNR	G5	WVDNR 2010
Feltia jaculifera	Dingy Cutworm Moth	SNR	G5	WVDNR 2010
Feltia subgothica	A Moth	SNR	G5	WVDNR 2010
Feniseca tarquinius	Harvester	S4	G4	Allen 1997
Feralia comstocki	A Noctuid Moth	SNR	G4	WVDNR 2010
Feralia jocosa	Jocose Sallow	SNR	GNR	WVDNR 2010
Feralia major	Major Sallow	SNR	G5	WVDNR 2010
Furcula borealis	White Furcula	SNR	G5	WVDNR 2010
Furcula cinerea	Gray Furcula	SNR	G5	WVDNR 2010
Galgula partita		SNR		WVDNR 2010
Glena cribrataria		SNR		WVDNR 2010
Gluphisia septentrionis		SNR		WVDNR 2010
Graphiphora haruspica	Soothsayer Dart	SNR	G5	WVDNR 2010
Habrosyne scripta		SNR		WVDNR 2010
Halysidota tessellaris		SNR		WVDNR 2010
Haploa lecontei		SNR		WVDNR 2010
Harrisimemna trisignata	A Noctuid Moth	SNR	G5	WVDNR 2010
Heliomata cycladata		SNR		WVDNR 2010
Heliothis zea		SNR		WVDNR 2010
Hemaris thysbe	Hummingbird Clearwing	SNR	G5	WVDNR 2010
Heptagrotis phyllophora		SNR		WVDNR 2010
Hesperia leonardus	Leonard's Skipper	S3S4	G4	Allen 1997
Hesperia sassacus	Indian Skipper	S4	G5	Allen 1997, TNC 2001, WVDNR 2010
Heterocampa biundata	Wavy-lined Heterocampa	SNR	G5	WVDNR 2010
Heterocampa guttivitta	Saddled or Maple Prominent	SNR	G5	WVDNR 2010
Heterocampa umbrata	White-bloched Heterocampa	SNR	G5	WVDNR 2010
Heterophleps refusaria		SNR		WVDNR 2010
Holomelina aurantiaca		SNR		WVDNR 2010
Homochlodes disconventa	A Geometrid Moth	SNR	G4	WVDNR 2010
Homophoberia apicosa		SNR		WVDNR 2010
Homorthodes furfurata		SNR		WVDNR 2010
Horisme intestinata		SNR		WVDNR 2010
Hormisa absorptalis	A Noctuid Moth	SNR	GNR	WVDNR 2010
Hyalophora cecropia		SNR		WVDNR 2010
Hydrelia condensata	A Geometroid Moth	SNR	GNR	WVDNR 2010
Hydrelia inornata	Unadorned Carpet	SNR	G5	WVDNR 2010

Hydria prunivorata		SNR		WVDNR 2010
Hydriomena divisaria	Black-dashed Hydriomena	SNR	GNR	WVDNR 2010
Hydriomena pluviata	A Moth	SNR	G4	WVDNR 2010
Hyles lineata		SNR		WVDNR 2010
Hypagyrtis piniata	Pine Measuringworm Moth	SNR	GNR	WVDNR 2010
Hypagyrtis unipunctata	One-spotted Variant	SNR	G5	WVDNR 2010
Hypena humuli		SNR		WVDNR 2010
Hyperaeschra georgica		SNR		WVDNR 2010
Hyperstrotia secta	A Noctuid Moth	SNR	G5	WVDNR 2010
Hyperstrotia villificans	White-lined Graylet	SNR	G5	WVDNR 2010
Hyphantria cunea		SNR		WVDNR 2010
Hypoprepia fucosa		SNR		WVDNR 2010
Hyppa contrasta	A Noctuid Moth	SNR	G3G4	WVDNR 2010
Hyppa xylinoides	Common Hyppa	SNR	G5	WVDNR 2010
Idia aemula	A Moth	SNR	G5	WVDNR 2010
Idia americalis	A Moth	SNR	G5	WVDNR 2010
Idia julia	A Moth	SNR	GNR	WVDNR 2010
Idia rotundalis	Rotund Idia	SNR	GNR	WVDNR 2010
Idia scobialis	Smoky Idia	SNR	GNR	WVDNR 2010
Iodopepla u-album		SNR		WVDNR 2010
Iridopsis larvaria		SNR		WVDNR 2010
Itame evagaria	A Geometrid Moth	SNR		WVDNR 2010
Itame pustularia	Lesser Maple Spanworm Moth	SNR	G5	WVDNR 2010
Lacanobia grandis	A Moth	SNR		WVDNR 2010
Lacanobia legitima	A Moth	SNR		WVDNR 2010
Lacanobia lutra	A Moth	SNR		WVDNR 2010
Lacanobia subjuncta	A Moth	SNR	G5	WVDNR 2010
Lacinipolia lorea	A Noctuid Moth	SNR	G4	WVDNR 2010
Lacinipolia meditata	A Noctuid Moth	SNR	G5	WVDNR 2010
Lacinipolia olivacea	Olive Arches	SNR	G5	WVDNR 2010
Lacinipolia renigera	A Noctuid Moth	SNR	G5	WVDNR 2010
Lagoa crispata		SNR		WVDNR 2010
Lambdina fervidaria	Curve-lined Looper Moth	SNR	G5	WVDNR 2010
Lambdina fiscellaria	A Moth	SNR	G5	WVDNR 2010
Lambdina pellucidaria	A Moth	SNR	G5	WVDNR 2010
Laothoe juglandis		SNR		WVDNR 2010
Leucania commoides		SNR		WVDNR 2010
Leucania linda	A Moth	SNR	G5	WVDNR 2010
Leucania multilinea	A Moth	SNR	G5	WVDNR 2010
Leucania phragmatidicola	Phragmites Wainscot	SNR	G5	WVDNR 2010
Leucania ursula	Ursula Wainscot	SNR	G5	WVDNR 2010
Leuconycta diphteroides		SNR		WVDNR 2010
Libytheana bachmanii		SNR		WVDNR 2010
Limenitis archippus	Viceroy	SNR		TNC 2001
Limenitis arthemis astyanax	Red-spotted Purple	S5	G5	Allen 1997, TNC 2001, WVDNR 2010

Lithacodes fasciola	A Moth	SNR	G5	WVDNR 2010
Lithacodes fiskeanus	A Moth	SNR		WVDNR 2010
Lithacodia albidula	A Noctuid Moth	SNR		WVDNR 2010
Lithacodia bellicula	A Noctuid Moth	SNR	G5	WVDNR 2010
Lithacodia synochitis	A Noctuid Moth	SNR		WVDNR 2010
Lithomoia solidaginis	A Noctuid Moth	SNR	G5	WVDNR 2010
Lithophane antennata	Ashen Pinion	SNR	G5	WVDNR 2010
Lithophane grotei	Grote's Pinion	SNR	GNR	WVDNR 2010
Lithophane innominata	Nameless Pinion	SNR	G5	WVDNR 2010
Lithophane oriunda	A Noctuid Moth	S1	G4	WVDNR 2010
Lithophane tepida	A Noctuid Moth	SNR	GNR	WVDNR 2010
Lochmaeus manteo		SNR		WVDNR 2010
Lomographa glomeraria	Gray Spring Moth	SNR	GNR	WVDNR 2010
Lomographa semiclarata	A Moth	SNR	G5	WVDNR 2010
Lomographa vestaliata	A Moth	SNR	G5	WVDNR 2010
Lophocampa caryae	A Moth	SNR		WVDNR 2010
Lophocampa maculata	Spotted Tussock Moth	S1	G5	WVDNR 2010
Lycaena epixanthe	Bog Copper	S1	G4G5	TNC 2001
Lycaena hyllus	Bronze Copper	S2	G5	Allen 1997, TNC 2001
Lycaena phlaeas	Little Copper	S5	G5	Allen 1997, TNC 2001
Lycomorpha pholus		SNR		WVDNR 2010
Lytrosis unitaria		SNR		WVDNR 2010
Macaria aemulataria	Common Angle	SNR	GNR	WVDNR 2010
Macaria bisignata	A Geometrid Moth	SNR	G5	WVDNR 2010
Macaria distribuaria	A Geometrid Moth	SNR	G4	WVDNR 2010
Macaria pinistrobata	White Pine Angle	SNR	GNR	WVDNR 2010
Macaria ulsterata	A Geometrid Moth	SNR	G4G5	WVDNR 2010
Macrurocampa marthesia		SNR		WVDNR 2010
Magusa orbifera		SNR		WVDNR 2010
Malacosoma americanum	Eastern Tent Caterpillar	SNR	G5	WVDNR 2010
Malacosoma disstria	A Moth	SNR	G5	WVDNR 2010
Manduca quinquemaculata		SNR		WVDNR 2010
Megisto cymela	Little Wood Satyr	S5	G5	Allen 1997
Melanchra adjuncta		SNR		WVDNR 2010
Melanchra assimilis	Similar Black Noctuid	S1	G5	WVDNR 2010
Melanolophia canadaria		SNR		WVDNR 2010
Meropleon diversicolor	A Noctuid Moth	SNR	G4	WVDNR 2010
Metalectra discalis		SNR		WVDNR 2010
Metanema determinata	Dark Metanema	SNR	GNR	WVDNR 2010
Metanema inatomaria	Pale Metanema	SNR	GNR	WVDNR 2010
Metarranthis duaria	Ruddy Metarranthis	SNR	GNR	TNC 2001
Metarranthis hypocharia	A Moth	SNR	G5	WVDNR 2010
Metarranthis obfirmaria	Yellow-washed Metarranthis	SNR	GNR	TNC 2001
Metaxaglaea inulta		SNR		WVDNR 2010
Mocis texana		SNR		WVDNR 2010
Morrisonia confusa	A Noctuid Moth	SNR	G5	WVDNR 2010

Morrisonia evicta	A Noctuid Moth	SNR	G5	WVDNR 2010
Morrisonia mucens	A Noctuid Moth	SNR	G4G5	WVDNR 2010
Nacophora quernaria		SNR		WVDNR 2010
Nadata gibbosa		SNR		WVDNR 2010
Nedra ramosula		SNR		WVDNR 2010
Nemoria mimosaria	White-fringed Emerald	SNR		WVDNR 2010
Nemoria pistaciaria	A Geometrid Moth	SNR	GNR	WVDNR 2010
Nemoria tuscarora	Appalachian Emerald	SNR		TNC 2001
Nephelodes minians		SNR		WVDNR 2010
Nola ovilla		SNR		WVDNR 2010
Nymphalis antiopa	Mourning Cloak	S5	G5	Allen 1997, TNC 2001, WVDNR 2010
Nymphalis vau-album j-album	Compton Tortoiseshell	SU	G5	Allen p. 149
Ochropleura plecta		SNR		WVDNR 2010
Odontosia elegans		SNR		WVDNR 2010
Oecophoridae	Oecophorid Moths	SNR		WVDNR 2010
Ogdoconta cinereola		SNR		WVDNR 2010
Oligia bridghami	A Noctuid Moth	SNR	G4	WVDNR 2010
Oligia crytora	A Noctuid Moth	SNR		WVDNR 2010
Oligia illocata	Wandering Brocade	SNR	GNR	WVDNR 2010
Oligia mactata	A Noctuid Moth	SNR	GNR	WVDNR 2010
Oligocentria semirufescens		SNR		WVDNR 2010
Oreta rosea		SNR		WVDNR 2010
Orgyia leucostigma		SNR		WVDNR 2010
Orthodes crenulata	A Moth	SNR	G5	WVDNR 2010
Orthodes cynica	A Moth	SNR	G5	WVDNR 2010
Orthofidonia exornata	A Geometrid Moth	SNR	GNR	TNC 2001
Orthofidonia flaviventa	A Geometrid Moth	SNR	GNR	WVDNR 2010
Orthonama centrostrigaria		SNR		WVDNR 2010
Orthosia alurina	Gray Quaker	SNR	GNR	WVDNR 2010
Orthosia hibisci	A Moth	SNR	G5	WVDNR 2010
Orthosia revicta	Subdued Quaker	SNR	GNR	WVDNR 2010
Orthosia rubescens	A Moth	SNR	G5	WVDNR 2010
Ostrinia nubilalis		SNR		WVDNR 2010
Pachysphinx modesta		SNR		WVDNR 2010
Packardia albipunctata	A Moth	SNR	GNR	WVDNR 2010
Packardia elegans	A Moth	SNR	GNR	WVDNR 2010
Packardia geminata	A Moth	SNR	G5	WVDNR 2010
Paectes abrostoloides	A Noctuid Moth	SNR	G5	WVDNR 2010
Paectes pygmaea	A Noctuid Moth	SNR	G5	WVDNR 2010
Paleacrita merriccata		SNR		WVDNR 2010
Palthis angulalis	A Moth	SNR	G5	WVDNR 2010
Pangrapta decoralis		SNR		WVDNR 2010
Panopoda rufimargo		SNR		WVDNR 2010
Panthea acronyctoides	A Noctuid Moth	SNR	G5	WVDNR 2010
Panthea furcilla	A Noctuid Moth	SNR	G5	WVDNR 2010
Paonias excaecatus	Blinded Sphinx	SNR	G5	WVDNR 2010

Paonias myops	Small-eyed Sphinx	SNR	G5	WVDNR 2010
Papaipema arctivorens	Northern Burdock Borer Moth	SNR	G5	WVDNR 2010
Papaipema baptisiae	Wild Indigo Borer Moth	SNR	G4	WVDNR 2010
Papaipema impecuniosa	Aster Borer Moth	SNR	G5	WVDNR 2010
Papaipema nelita	A Borer Moth	SNR	G4	WVDNR 2010
Papaipema pterisii	Bracken Borer Moth	SNR	G5	WVDNR 2010
Papaipema rigida	A Borer Moth	SNR	G5	WVDNR 2010
Papaipema rutila	Mayapple Borer Moth	SNR	G4	WVDNR 2010
Papaipema unimoda	Meadowrue Borer Moth	SNR	G5	WVDNR 2010
Papilio canadensis	Canadian Tiger Swallowtail	SNA	G5	Allen 1997, WVDNR 2010
Papilio glaucus	Tiger Swallowtail	S5	G5	Allen 1997, TNC 2001, WVDNR 2010
Papilio polyxenes	Black Swallowtail	S5	G5	Allen 1997, TNC 2001
Papilio troilus	Spicebush Swallowtail	S5	G5	Allen 1997, TNC 2001
Parallelia bistriaris		SNR		WVDNR 2010
Parrhasius m-album	White-m Hairstreak	S2	G5	Allen 1997
Peridea angulosa	Angulose Prominent	SNR	G5	WVDNR 2010
Peridea basitriens	Oval-based Prominent	SNR	G5	WVDNR 2010
Peridea ferruginea	Chocolate Prominent	SNR	G5	WVDNR 2010
Peridroma saucia		SNR		WVDNR 2010
Perigea xanthioides		SNR		WVDNR 2010
Pero honestaria	A Moth	SNR	G4	WVDNR 2010
Pero morrisonaria	A Moth	SNR	G5	WVDNR 2010
Petrophora divisata	Common Petrophora	SNR	G4	WVDNR 2010
Phalaenophana pyramusalis	A Moth	SNR	G5	WVDNR 2010
Phalaenostola eumelusalis	A Moth	SNR		WVDNR 2010
Phalaenostola metonalis	A Moth	SNR		WVDNR 2010
Pheosia rimosa		SNR		WVDNR 2010
Phigalia titea		SNR		WVDNR 2010
Phlogophora iris	Oval Angle Shades	SNR	GNR	WVDNR 2010
Phlogophora periculosa	A Noctuid Moth	SNR	G5	WVDNR 2010
Phoberia atomaris		SNR		WVDNR 2010
Phoebis sennae	Cloudless Sulphur	SNA	G5	Allen 1997
Phosphila miselioides	Spotted Phosphila	SNR	G5	WVDNR 2010
Phosphila turbulenta	A Noctuid Moth	SNR	G5	WVDNR 2010
Phragmatobia assimilans	Tiger Moth	SNR		TNC 2001, WVDNR 2010
Phyciodes tharos	Pearl Crescent	S5	G5	Allen 1997, TNC 2001
Pieris rapae	Cabbage Butterfly	SNA	G5	Allen 1997, TNC 2001
Pieris virginiensis	West Virginia White	S3	G3G4	Allen 1997
Plagodis alcoolaria	A Moth	SNR	G5	WVDNR 2010
Plagodis fervidaria	A Moth	SNR	G5	WVDNR 2010

Plagodis phlogosaria	A Moth	SNR	G5	WVDNR 2010
Plagodis serinaria	Lemon Plagodis	SNR	G5	WVDNR 2010
Plathypena scabra		SNR		WVDNR 2010
Platyperigea multifera	Speckled Rustic	SNR	GNR	WVDNR 2010
Platysenta sutor	The Cobbler	SNR	G5	WVDNR 2010
Platysenta vecors	A Moth	SNR	G5	WVDNR 2010
Pleuroprucha asthenaria	A Geometrid Moth	SNR		WVDNR 2010
Pleuroprucha insulsaria	Common Tan Wave	SNR	G5	WVDNR 2010
Poanes hobomok	Hobomok Skipper	S5	G5	Allen 1997, TNC 2001
Polia detracta	A Moth	SNR		WVDNR 2010
Polia goodelli	A Moth	SNR		WVDNR 2010
Polia imbrifera	Cloudy Arches	SNR	GNR	WVDNR 2010
Polia latex	Fluid Arches	SNR	GNR	WVDNR 2010
Polia nimbosa	Stormy Arches	SNR		TNC 2001, WVDNR 2010
Polia purpurissata	Purple Arches	SNR	GNR	WVDNR 2010
Polites mystic	Long Dash	S4	G5	Allen 1997, TNC 2001, WVDNR 2010
Polites origenes	Crossline Skipper	SNR		WVDNR 2010
Polites peckius	Peck's Skipper	S5	G5	Allen 1997, TNC 2001
Polygonia comma	Eastern Comma	S5	G5	Allen 1997, TNC 2001, WVDNR 2010
Polygonia faunus smythii	Smyth's Green Comma	S1	G5T3	Allen 1997
Polygonia interrogationis	Question Mark	S5	G5	Allen 1997, WVDNR 2010
Polygonia progne	Gray Comma	S3	G4G5	Allen 1997
Polygrammate hebraeicum		SNR		WVDNR 2010
Pompeius verna	Little Glassywing	S4S5	G5	Allen 1997, TNC 2001
Probole alienaria	Dogwood Probole	SNR	G5	WVDNR 2010
Probole amicaria	A Geometrid Moth	SNR	G5	WVDNR 2010
Prochoerodes transversata		SNR		WVDNR 2010
Protagrotis obscura	A Noctuid Moth	SNR	GNR	WVDNR 2010
Protitame virginalis	Virgin Moth	SNR	GNR	WVDNR 2010
Protoboarmia porcelaria		SNR		WVDNR 2010
Protolampra brunneicollis	Scarley-backed Dart	SNR	G5	WVDNR 2010
Protorthodes oviduca		SNR		WVDNR 2010
Proxenus miranda		SNR		WVDNR 2010
Psaphida resumens	Figure-eight Sallow	SNR	GNR	WVDNR 2010
Psaphida thaxteriana	A Noctuid Moth	SNR	G4	WVDNR 2010
Pseudaletia unipuncta		SNR		WVDNR 2010
Pseudeva purpurigera		SNR		WVDNR 2010
Pseudorthodes vecors	A Noctuid Moth	SNR	G5	WVDNR 2010
Pseudothyatira cymatophoroides		SNR		WVDNR 2010

Pyralidae	Pyralid Moths	SNR		WVDNR 2010
Pyreferra citrombra	A Noctuid Moth	SNR	GNR	WVDNR 2010
Pyreferra hesperidago	Mustard Sallow	SNR	G5	WVDNR 2010
Pyrgus communis	Common Checkered Skipper	S4	G5	Allen 1997
Pyrrharctia isabella		SNR		WVDNR 2010
Pyrrhia exprimens		SNR		WVDNR 2010
Raphia frater		SNR		WVDNR 2010
Renia sobrialis	A Moth	SNR	G5	WVDNR 2010
Rheumaptera hastata		SNR		WVDNR 2010
Rhynchagrotis cupida	A Noctuid Moth	SNR	GNR	WVDNR 2010
Rivula propinqualis		SNR		WVDNR 2010
Satyrium calanus	Banded Hairstreak	S5	G5	Allen 1997
Satyrium liparops strigosum	Striped Hairstreak	SNR		WVDNR 2010
Satyrium titus	Coral Hairstreak	S4	G5	Allen 1997
Satyrodes appalachia appalachia	Appalachian Brown	S3	G4	Allen 1997, WVDNR 2010
Schinia florida		SNR		WVDNR 2010
Schizura badia	Chestnut Schizura	SNR	G5	WVDNR 2010
Schizura ipomoeae	Morning Glory Prominent	SNR	G5	WVDNR 2010
Schizura leptinoides	Black-blotched Schizura	SNR	G5	WVDNR 2010
Schizura unicornis	Unicorn Caterpillar Moth	SNR	G5	WVDNR 2010
Scoliopteryx libatrix		SNR		WVDNR 2010
Selenia kentaria		SNR		WVDNR 2010
Setagrotis atrifrons		SNR		WVDNR 2010
Sicya macularia		SNR		WVDNR 2010
Sideridis rosea		SNR		WVDNR 2010
Smerinthus jamaicensis	Twin-spotted Sphinx	SNR	G5	WVDNR 2010
Spaelotis clandestina		SNR		WVDNR 2010
Speyeria aphrodite aphrodite	Aphrodite Fritillary	S5	G5	Allen 1997, TNC 2001, WVDNR 2010
Speyeria atlantis	Atlantis Fritillary	S3	G5	Allen 1997, TNC 2001, WVDNR 2010
Speyeria cybele cybele	Great Spangled Fritillary	S5	G5	Allen 1997, TNC 2001, WVDNR 2010
Speyeria diana	Diana Fritillary	S2S3	G3G4	Allen 1997, WVDNR 2010
Sphecodina abbottii		SNR		WVDNR 2010
Sphinx drupiferarum	Wild Cherry Sphinx	SNR	G4	WVDNR 2010
Sphinx gordius	Gordian Sphinx	SNR	G4	WVDNR 2010
Sphinx kalmiae	Laurel Sphinx	SNR	G5	WVDNR 2010
Spodoptera exigua	Beet Armyworm Moth	SNR	G5	WVDNR 2010
Spodoptera frugiperda	Fall Armyworm Moth	SNR	G5	WVDNR 2010
Spodoptera ornithogalli	A Moth	SNR	G5	WVDNR 2010
Stamnodes gibbicostata		SNR		WVDNR 2010
Strymon melinus	Gray Hairstreak	S4	G5	WVDNR 2010

Sunira bicolorago		SNR		WVDNR 2010
Sutyna privata		SNR		WVDNR 2010
Symmerista albifrons	White-headed Prominent	SNR	G5	WVDNR 2010
Symmerista canicosta	A Notodontid Moth	SNR	G4	WVDNR 2010
Symmerista leucitys	A Notodontid Moth	SNR	G5	WVDNR 2010
Syngrapha rectangula	Salt & Pepper Looper Moth	S1	G5	WVDNR 2010
Tacparia detersata	Pale Alder Moth	SNR	GNR	WVDNR 2010
Tetracis cachexiata		SNR		WVDNR 2010
Thymelicus lineola	European Skipper	SNA	G5	Allen 1997, WVDNR 2010
Tolype notialis	A Moth	SNR	G4G5	WVDNR 2010
Tolype velleda	A Moth	SNR	G5	WVDNR 2010
Tortricidia testacea		SNR		WVDNR 2010
Trichodezia albovittata	A Geometrid Moth	SNR	G5	WVDNR 2010
Tricholita signata		SNR		WVDNR 2010
Trichoplusia ni	Cabbage Looper Moth	SNR	GNR	WVDNR 2010
Trigrammia quadrinotaria	Four-spotted Angle	SNR	G4	WVDNR 2010
Vanessa atalanta	Red Admiral	SNA	G5	Allen 1997, TNC 2001, WVDNR 2010
Vanessa cardui	Painted Lady	SNA	G5	Allen 1997, WVDNR 2010
Vanessa virginiensis	American Painted Lady	SNA	G5	Allen 1997, WVDNR 2010
Venusia cambrica		SNR		WVDNR 2010
Wallengrenia egeremet	Northern Broken-dash	S4	G5	Allen 1997, TNC 2001, WVDNR 2010
Xanthorhoe labradorensis	A Moth	SNR	G4	WVDNR 2010
Xanthorhoe lacustrata	Toothed Brown Carpet	SNR	G5	WVDNR 2010
Xanthotype sospeta		SNR		WVDNR 2010
Xestia atrata	A Noctuid Moth	SNR	G5	WVDNR 2010
Xestia bicarnea	A Noctuid Moth	SNR		WVDNR 2010
Xestia dilucida	A Noctuid Moth	SNR	G5	WVDNR 2010
Xestia dolosa	Greater Black-lettered Dart	SNR	G5	WVDNR 2010
Xestia normaniana	Norman's Dart	SNR	G5	WVDNR 2010
Xestia smithii	Dotted Clay	SNR	G5	WVDNR 2010
Xylena cineritia	Gray Sword Grass Moth	SNR	G4	WVDNR 2010
Xylena curvimacula	Dot-and-dash Sword Grass Moth	SNR	GNR	WVDNR 2010
Zale bethunei	Bethune's Zale	SNR	GNR	TNC 2001
Zale duplicata	Pine False Looper	SNR	GNR	TNC 2001, WVDNR 2010
Zale horrida	Horrid Zale	SNR	GNR	WVDNR 2010
Zale lunata	A Moth	SNR	G5	WVDNR 2010
Zale lunifera	A Moth	SNR	G5	WVDNR 2010
Zale minerea	A Moth	SNR	G5	WVDNR 2010
Zale unilineata	One-lined Zale	SNR	GNR	WVDNR 2010
Zanclognatha cruralis	A Noctuid Moth	SNR	G5	WVDNR 2010

Zanclognatha inconspicualis	A Noctuid Moth	SNR	GNR	WVDNR 2010
Zanclognatha jacchusalis	A Noctuid Moth	SNR	GNR	WVDNR 2010
Zanclognatha laevigata	A Noctuid Moth	SNR	G5	WVDNR 2010
Zanclognatha lituralis	A Noctuid Moth	SNR	G5	WVDNR 2010
Zanclognatha ochreipennis	A Noctuid Moth	SNR	G5	WVDNR 2010
Zanclognatha protumnusalis	A Noctuid Moth	SNR	GNR	WVDNR 2010

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Appendix F *in* Byers, E. A., J. P. Vanderhorst, and B. P. Streets. 2010. **Classification and Conservation Assessment of Upland Red Spruce Communities in West Virginia**. West Virginia Natural Heritage Program, WVDNR. Elkins, WV.