Chapter 6. Virginia's Blue Ridge Mountains

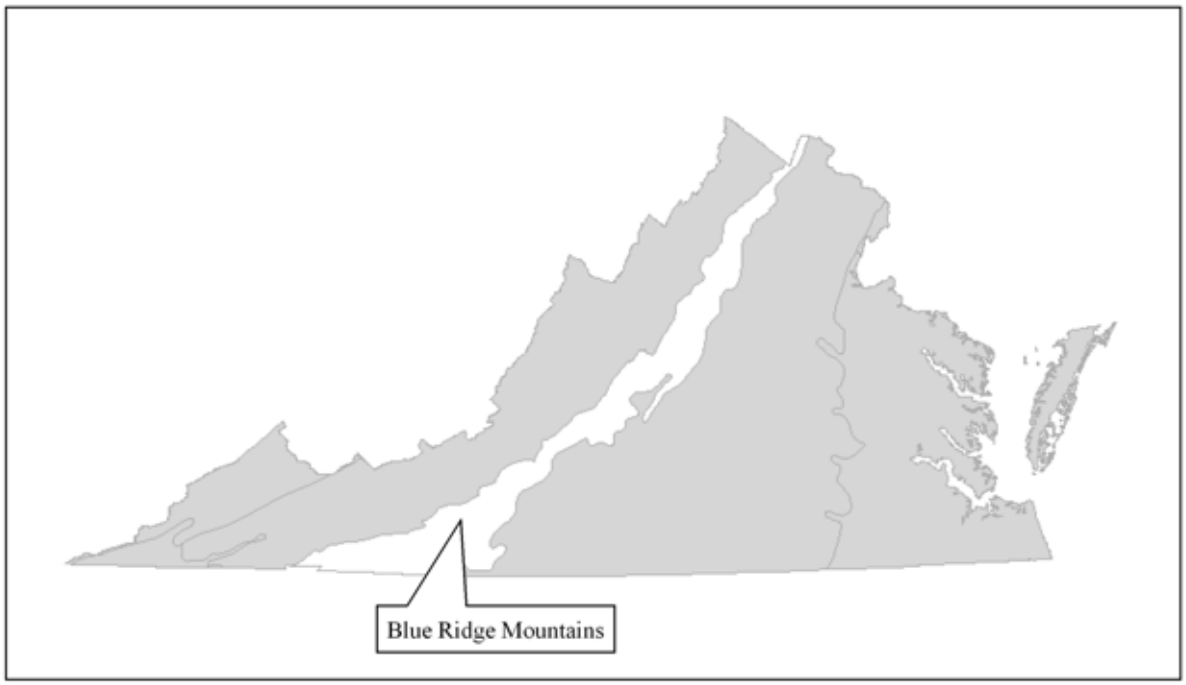

Figure 6.1. The Blue Ridge Mountains ecoregion.

6.1. Introduction

6.1.1. Description

The Blue Ridge Mountains (Blue Ridge, Figure 6.1) runs from northeast to southwest, separating the Piedmont from the Ridge and Valley. The Blue Ridge makes up a large portion of Virginia's Appalachians (Table 6.1). It contains Shenandoah National Park in its central portion and the highest points in Virginia, Mount Rogers (1,746m) and White Top Mountain (1,682m), just before it crosses into North Carolina at its southern end. At its northern end, the Blue Ridge is quite narrow (< 8km), but widens to more than 80km wide south of the Roanoke River as it rises from approximately 600m in the north to an average of approximately 1,000m at to Virginia-North Carolina border (Woodward and Hoffman 1991). Soils of the Blue Ridge are mainly Ochrepts and Udults (McNab and Avers 1995). Precipitation averages 100-130cm annually, though totals may be significantly lower in valleys (McNab and Avers 1995). The Blue Ridge average temperature ranges from 10-16°C, with a growing season that ranges from 150-200 days, depending on elevation and local topographic features (McNab and Avers 1995). Forest cover is largely oak (historically oak-chestnut) and some mixed oak-pine, with a few areas of relict boreal (spruce-fir) forest at the highest points (Woodward and Hoffman 1991). Streams are generally high-gradient perennials in the north, with stream gradients decreasing south of the Roanoke Gap (Woodward and Hoffman 1991). Tourism and retirement homes are increasing in the Blue Ridge, leading to some concerns about water and air quality in the region (McNab and Avers 1995).

Despite breeding and wintering habitat frequently being the subject of focus in conservation of migratory birds, stopover habitat is just as essential (Moore et al. 1995). Some concern exists that migratory habitat may be a limiting factor in some populations, rather than breeding or wintering habitat (Sherry and Holmes 1993). Habitat usage during migration is complicated by the inability of birds to search for the best site, due to time or energy restraints (Moore and Simons 1989). As a result, migration stopover habitat is likely

Table 6.1. Names for the Blue Ridge Mountains as used in other ecoregional schemes and planning efforts. The following at least roughly correspond to the same area as Blue Ridge Mountains as used in this document.

Planning Effort/Regional Scheme	Name of Ecoregion	Reference
NABCI	BCR 28, Appalachian Mountains [1]	NABCI 2000
PIF	Physiographic Areas 12, Mid-Atlantic Ridge and Valley, and 23, Southern Blue Ridge [2]	Hunter et al. 1999; Rosenberg 2003
United States Shorebird Conservation	BCR 28, Appalachian Mountains [3]	Brown et al. 2001
Waterbird Conservation for the Americas	Southeast U.S. [4]	Kushlan et al. 2002
Freshwater Ecoregions	Ecoregion 41, Chesapeake Bay; 40, South Atlantic; 34, Teays-Old Ohio [5]	Abell et al. 2000
TNC, Ecoregional Planning Units	Ecoregions 59, Central Appalachian Forest, and 51, Southern Blue Ridge [6]	Groves et al. 2000
Omernik's Ecoregions	Ecoregion 66, Blue Ridge [7]	Omernik 1987
Bailey's Ecoregions	Section M221D, Blue Ridge Mountains	Bailey 1995

[1] BCR 28 includes all of the Appalachian Mountains, and includes what are identified in the CWCS as the Blue Ridge Mountains, Northern Ridge and Valley, and the Northern and Southern Cumberland Mountains.
[2] Physiographic Area 12 includes most of the Blue Ridge, as well as most of the Southern Cumberlands and all of the Northern Ridge and Valley.
[3] No regional shorebird plan exists for this BCR.
[4] Southeast U.S. is a large region including all of Virginia. The regional scheme used by Kushlan et al. (2002) is based on composites of the Bird Conservation Regions used by NABCI.
[5] The majority of the Blue Ridge occurs within Ecoregions 34 and 41, with a small area in Ecoregion 40 (Roanoke River).
[6] Ecoregion 59 includes a large portion of the Northern Ridge and Valley as used in the CWCS.
[7] Ecoregion 66 also includes parts of the Northern Ridge and Valley as used in the CWCS.

based more on food availability to replenish fat stores than on specific plant community composition (Moore and Simons 1989). For instance, one study found a much higher than expected proportion of migrant birds in scrub-shrub habitat on a barrier island in the Gulf of Mexico (Moore et al. 1990). The crucial conservation issue here is simply that migration stopover habitat is critical, and areas identified as migration pathways must conserve these habitats. All three major bird conservation plans recognize the importance of stopover habitat, and also recognize that in many cases habitat use during migration is poorly understood (Brown et al. 2001; Kushlan et al 2002; Rich et al. 2004).

Due to its position in the center of the Appalachians, Virginia's mountains are critical to hundreds of species of migrant birds, especially diurnal raptors (Hill 1984). The mountains provide updrafts that make migration energetically efficient for raptors (Johnsgard 1990). This makes the mountains of VIrginia an important flyway for raptor migration. For example, in 1997, 35% of the raptors observed during the fall migration hawk watch were in the mountains (with the remaining 65% occurring coastally, Holt 1998). Although many raptors migrate through the mountains and along the coast, it is rare for birds to switch routes: birds banded in the mountains are generally only recovered in the mountains, and vice versa (Hill 1984). Raptor migrants in the mountainous ecoregions include many species that breed in Virginia, such as the Tier I peregrine falcon *Falco peregrinus*, as well as many that do not, such as the northern goshawk *Accipiter gentilis* and golden eagle *Aquila chrysaetos.*

Several species of bats that occur in Virginia are also migratory. These include the Tier I Indiana myotis *Myotis sodalis* and the Tier II gray myotis *M. grisescens*, among many other more common species.

Migratory bats are more difficult to study than migratory birds, both because they migrate nocturnally and because they are more cryptic than birds. As a result, very little is known about migration in bats. However, it appears that bats orient by following ridgelines and other land features during migration (Tuttle 2004). Since individuals of both of the aforementioned *Myotis* species migrate from other states to hibernate in only a few caves in the Appalachians (Pierson 1998), Virginia's mountain ecoregions may be important not only as a winter destination for bats, but also as a migration route. Therefore, even caves that do not serve as hibernacula are probably important as stopover habitat for many species (Whitaker and Hamilton 1998), especially in light of the fact that bats do not travel very far in one night. For instance, gray bats may hibernate up to about 210km from their maternity caves, but only fly 18-52km per night (Whitaker and Hamilton 1998). These bats must be able to find suitable stopover caves for at least three nights during migration, and perhaps many more. Other bats may travel much further (little brown bats *M. lucifugus* may travel as far as 450km, Linzey 1998), and so may require even more stopover sites.

6.1.2. Land Cover Areas

Approximately 88% of the Blue Ridge is montane, 11% submontane, and the remainder, high elevation. The vast majority of the Blue Ridge is forested (Figure 6.2). Agriculture/open areas are the second most abundant land cover type, covering 19% of the area. Just under 2% of the area is developed. Water, wetland, and barren areas (in order of abundance) each account for less than 0.5% of the land area. Over 28% of the area within the Blue Ridge is within a Conservation Land (DCR 2003). This relatively high level of land protection is due to the presence of Shenandoah National Park and the George Washington and Jefferson National Forests. Because of these federal lands, 97% of the protected areas are forested. Agriculture/open areas are vastly underrepresented in Conservation Lands, making up only 3%. Water, developed lands, wetlands, and barren each make up 0.1% or less of land cover on Conservation Lands (DCR 2003).

6.1.3. Human Population in the Blue Ridge

The Blue Ridge, with just over 11% of the land area in Virginia, is home to slightly more than 360,000 people, or 5% of Virginia's population (USCB 2003). The average population density is 31.6 people/km^2. However, most of the area in the Blue Ridge is within the lower population density range (Figure 6.3). The City of Roanoke is the largest high population density area (Figure 6.3). Population in this area is expected to grow by just under 5% from 2000 to 2009 (GeoLytics 2005b).

Only 6.7% of the Blue Ridge is within a High Impact Growth Area (Figure 6.4). Some of these include western Loudoun County, central Greene County, the Interstate 64 corridor between the Cities of Charlottesville and Waynesboro (western Albemarle County), east of the City of Roanoke, and southeast of the City of Galax.

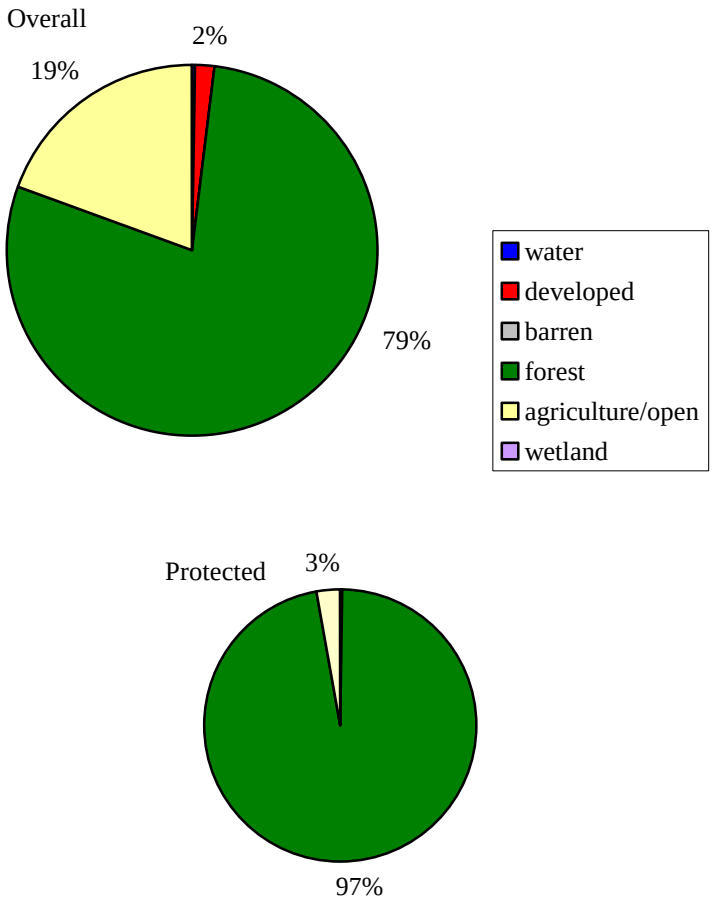

Figure 6.2. Proportional composition of land cover types within the overall Blue Ridge ecoregion compared to proportion of land cover types within protected areas in the Blue Ridge.

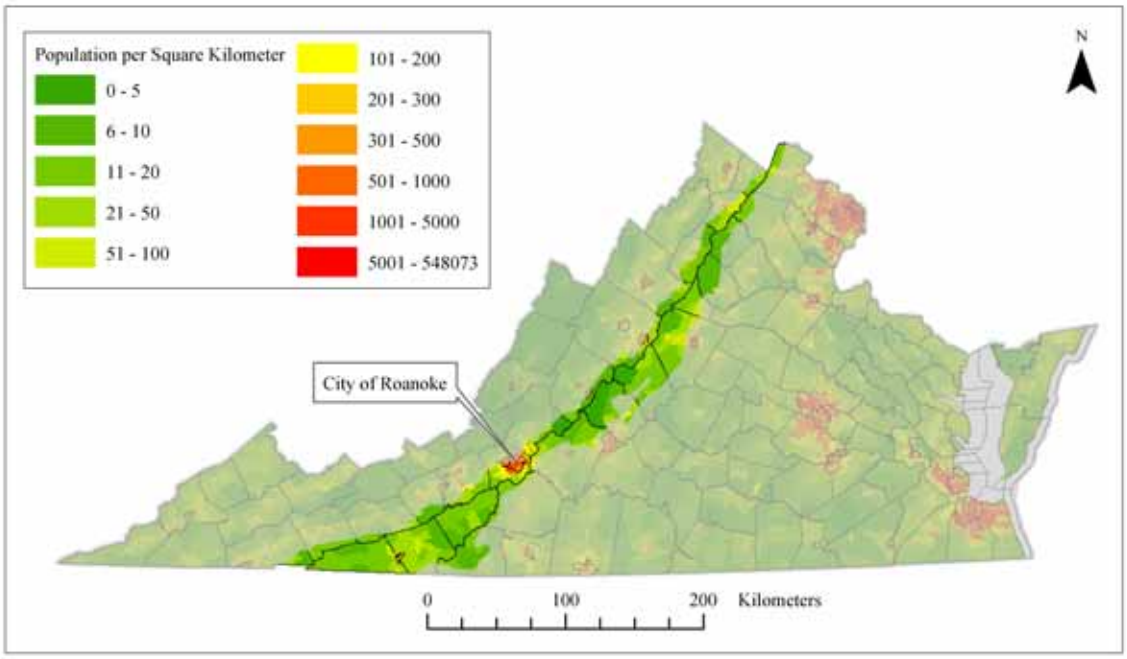

Figure 6.3. Population density from the 2000 census, highlighted for the Blue Ridge ecoregion (USCB 2003).

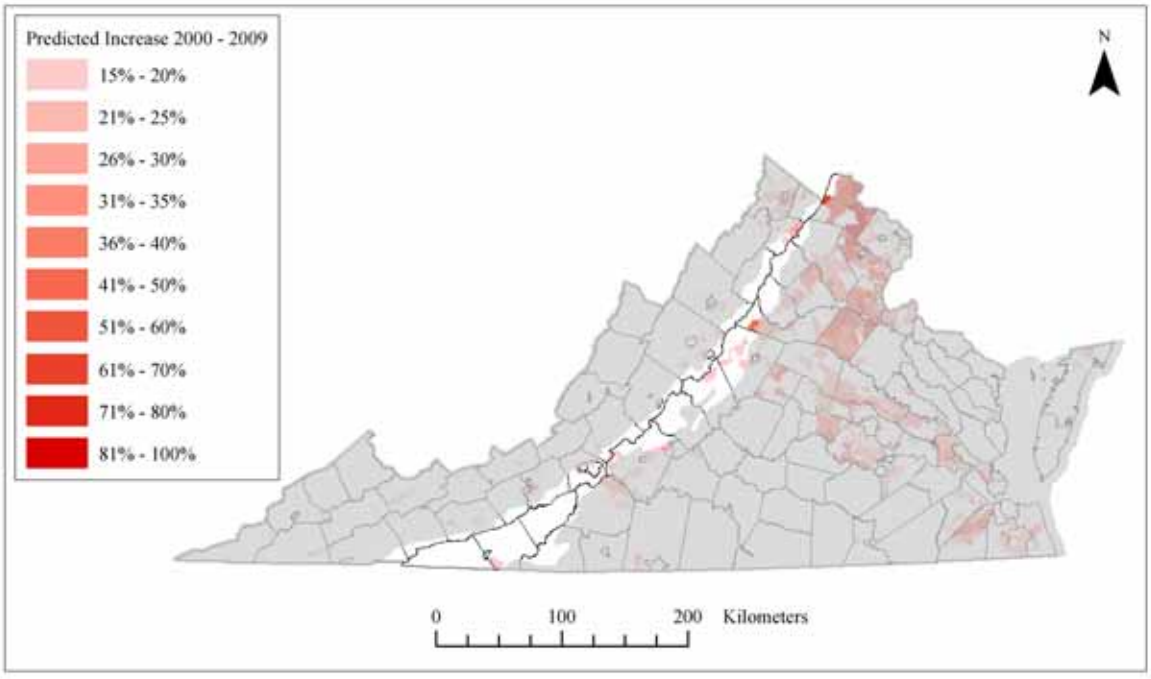

Figure 6.4. High impact growth areas in the Blue Ridge. This figure contains demographic data from GeoLytics, East Brunswick, New Jersey (GeoLytics 2005b).

6.2. The Species of Greatest Conservation Need: Blue Ridge

Of the 174 species of greatest conservation need that occur in the Blue Ridge, 19 (11%) are in Tier I, 34 (19%) are in Tier II, 40 (24%) are in Tier III, and 80 (47%) are in Tier IV (Table 6.2).

Table 6.2. The species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name
Tier I	
Fishes	
Roanoke logperch	*Percina rex*
Tennessee dace	*Phoxinus tennesseensis*
Amphibians	
Shenandoah salamander	*Plethodon shenandoah*
Reptiles	
Wood turtle	*Glyptemys insculpta*
Bog turtle	*Glyptemys muhlenbergii*
Northern pinesnake	*Pituophis melanoleucus melanoleucus*
Birds	
Peregrine falcon	*Falco peregrinus*
Loggerhead shrike	*Lanius ludovicianus*
Red crossbill (type I)	*Loxia curvirostra*
Appalachian yellow-bellied sapsucker	*Sphyrapicus varius appalachiensis*
Golden-winged warbler	*Vermivora chrysoptera*
Mammals	
Carolina northern flying squirrel	*Glaucomys sabrinus coloratus*
Terrestrial Insects	
Mitchell's satyr	*Neonympha mitchellii*
Buffalo Mountain mealybug	*Puto kosztarabi*
Other Terrestrial Invertebrates	
Laurel Creek xystodesmid millipede	*Sigmoria whiteheadi*
Aquatic Mollusks	
James spinymussel	*Pleurobema collina*
Crustaceans	
None	
Aquatic Insects	
Cryptic willowfly	*Taeniopteryx nelsoni*
Other Aquatic Invertebrates	
None	
Tier II	
Fishes	
Roanoke bass	*Ambloplites cavifrons*
Greenfin darter	*Etheostoma chlorobranchium*
Orangefin madtom	*Noturus gilberti*

Common Name	Scientific Name
Spotted margined madtom	*Noturus insignis ssp. 1*
Amphibians	
Tiger salamander	*Ambystoma tigrinum*
Eastern hellbender	*Cryptobranchus alleganiensis*
Peaks of Otter salamander	*Plethodon hubrichti*
Weller's salamander	*Plethodon welleri*
Mountain chorus frog	*Pseudacris brachyphona*
Reptiles	
None	
Birds	
Northern saw-whet owl	*Aegolius acadicus*
Cerulean warbler	*Dendroica cerulea*
Bald eagle	*Haliaeetus leucocephalus*
Yellow-crowned night-heron	*Nyctanassa violacea*
King rail	*Rallus elegans*
Appalachian winter wren	*Troglodytes troglodytes pullus*
Mammals	
None	
Terrestrial Insects	
Tawny crescent	*Phyciodes batesii*
Hubbard's cave beetle	*Pseudanophthalmus hubbardi*
A cave springtail	*Pseudosinella bona*
Other Terrestrial Invertebrates	
A millipede	*Cleidogona lachesis*
Brooks millipede	*Dixioria brooksi*
Montane centipede	*Escaryus cryptorobius*
Black mantleslug	*Pallifera hemphilli*
Highland slitmouth	*Stenotrema altispira*
Aquatic Mollusks	
Green floater	*Lasmigona subviridis*
Crustaceans	
Madison Cave isopod	*Antrolana lira*
Aquatic Insects	
Spatulate snowfly	*Allocapnia simmonsi*
Benfield's bearded small minnow mayfly	*Barbaetis benfieldi*
Green-faced clubtail	*Gomphus viridifrons*
Appalachian stonefly	*Hansonoperla appalachia*
Montane needlefly	*Leuctra monticola*

Common Name	Scientific Name
Mountain river cruiser	*Macromia margarita*
Smokies needlefly	*Megaleuctra williamsae*
Appalachian snaketail	*Ophiogomphus incurvatus*
Gammon's riffle beetle	*Stenelmis gammoni*
Other Aquatic Invertebrates	
None	
Tier III	
Fishes	
Steelcolor shiner	*Cyprinella whipplei*
Kanawha darter	*Etheostoma kanawhae*
Wounded darter	*Etheostoma vulneratum*
Mountain brook lamprey	*Ichthyomyzon greeleyi*
Fatlips minnow	*Phenacobius crassilabrum*
Kanawha minnow	*Phenacobius teretulus*
Bigeye jumprock	*Moxostoma arioummum*
Rustyside sucker	*Thoburnia hamiltoni*
Amphibians	
Shovel-nosed salamander	*Desmognathus marmoratus*
Pygmy salamander	*Desmognathus wrighti*
Blue Ridge two-lined salamander	*Eurycea wilderae*
Reptiles	
Spotted turtle	*Clemmys guttata*
Smooth greensnake	*Opheodrys vernalis*
Eastern box turtle	*Terrapene carolina*
Birds	
Northern harrier	*Circus cyaneus*
Least bittern	*Ixobrychus exilis exilis*
Barn owl	*Tyto alba pratincola*
Mammals	
Southeastern fox squirrel	*Sciurus niger niger*
Terrestrial Insects	
Appalachian grasshopper	*Appalachia hebardi*
Jefferson's short-nosed scorpionfly	*Brachypanorpa jeffersoni*
Barrens tiger beetle	*Cicindela patruela*
A cave beetle	*Pseudanophthalmus pusio*
Other Terrestrial Invertebrates	
Mountain disc	*Anguispira jessica*
A millipede	*Semionellus placidus*
Cupped vertigo	*Vertigo clappi*

Common Name	Scientific Name
Five-tooth vertigo	*Vertigo ventricosa*
Aquatic Mollusks	
Yellow lance	*Elliptio lanceolata*
Notched rainbow	*Villosa constricta*
Crustaceans	
Blue Ridge spring amphipod	*Stygobromus spinosus*
Aquatic Insects	
Smokies snowfly	*Allocapnia fumosa*
Blue Ridge snowfly	*Allocapnia stannardi*
Tennessee sallfly	*Alloperla neglecta*
Mitchell needlefly	*Leuctra mitchellensis*
Shenandoah needlefly	*Megaleuctra flinti*
Widecollar stonefly	*Paragnetina ichusa*
A mayfly	*Paraleptophlebia jeanae*
Blue Ridge stonefly	*Perlesta frisoni*
Blue Ridge springfly	*Remenus kirchneri*
Newfound willowfly	*Strophopteryx limata*
Virginia sallfly	*Sweltsa voshelli*
Other Aquatic Invertebrates	
None	
Tier IV	
Fishes	
American eel	*Anguilla rostrata*
Black sculpin	*Cottus baileyi*
Slimy sculpin	*Cottus cognatus*
Riverweed darter	*Etheostoma podostemone*
Swannanoa darter	*Etheostoma swannanoa*
Banded darter	*Etheostoma zonale*
Lined topminnow	*Fundulus lineolatus*
Roanoke hog sucker	*Hypentelium roanokense*
American brook lamprey	*Lampetra appendix*
Pearl dace	*Margariscus margarita*
Whitemouth shiner	*Notropis alborus*
Redlip shiner	*Notropis chiliticus*
New River shiner	*Notropis scabriceps*
Mirror shiner	*Notropis spectrunculus*
Logperch	*Percina caprodes*
Piedmont darter	*Percina crassa*
Gilt darter	*Percina evides*
Appalachia darter	*Percina gymnocephala*
Blackside darter	*Percina maculata*
Sharpnose darter	*Percina oxyrhynchus*

Common Name	Scientific Name
Amphibians	
Jefferson salamander	*Ambystoma jeffersonianum*
Blue Ridge dusky salamander	*Desmognathus orestes*
Yonahlossee salamander	*Plethodon yonahlossee*
Eastern mud salamander	*Pseudotriton montanus*
Eastern spadefoot	*Scaphiopus holbrookii*
Reptiles	
Timber rattlesnake	*Crotalus horridus*
Eastern hog-nosed snake	*Heterodon platirhinos*
Queen snake	*Regina septemvittata*
Common ribbonsnake	*Thamnophis sauritus*
Birds	
Grasshopper sparrow	*Ammodramus savannarum*
Green heron	*Butorides striatus*
Chuck-will's-widow	*Caprimulgus carolinensis*
Whip-poor-will	*Caprimulgus vociferus*
Brown creeper	*Certhia americana*
Chimney swift	*Chaetura pelagica*
Yellow-billed cuckoo	*Coccyzus americanus*
Northern bobwhite	*Colinus virginianus*
Eastern wood-pewee	*Contopus virens*
Prairie warbler	*Dendroica discolor*
Kirtland's warbler (migrant)	*Dendroica kirtlandii*
Yellow warbler	*Dendroica petechia*
Gray catbird	*Dumetella carolinensis*
Willow flycatcher	*Empidonax traillii*
Rusty blackbird (winter)	*Euphagus carolinus*
Worm-eating warbler	*Helmitheros vermivorus*
Wood thrush	*Hylocichla mustelina*
Yellow-breasted chat	*Icteria virens*
Black-and-white warbler	*Mniotilta varia*
Kentucky warbler	*Oporornis formosus*
Northern parula	*Parula americana*
Rose-breasted grosbeak	*Pheuctitus ludovicianus*
Eastern towhee	*Pipilo erythrophthalmus*
Scarlet tanager	*Piranga olivacea*
Prothonotary warbler	*Protonotaria citrea*
American woodcock	*Scolopax minor*
Ovenbird	*Seiurus aurocapillus*
Louisiana waterthrush	*Seiurus motacilla*
Field sparrow	*Spizella pusilla*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Eastern meadowlark	*Sturnella magna*
Brown thrasher	*Toxostoma rufum*

Common Name	Scientific Name
Eastern kingbird	*Tyrannus tyrannus*
Yellow-throated vireo	*Vireo flavifrons*
Canada warbler	*Wilsonia canadensis*
Mammals	
Allegheny woodrat	*Neotoma magister*
Long-tailed shrew	*Sorex dispar dispar*
Appalachian cottontail	*Sylvilagus obscurus*
Terrestrial Insects	
Diana fritillary	*Speyeria diana*
Other Terrestrial Invertebrates	
A millipede	*Boraria infesta*
Suborb glyph	*Glyphyalinia sculptilis*
Aquatic Mollusks	
Triangle floater	*Alasmidonta undulata*
Seep mudalia	*Leptoxis delatata*
Creeper	*Strophitus undulatus*
Pistolgrip	*Tritogonia verrucosa*
Crustaceans	
New River riffle crayfish	*Cambarus chasmodactylus*
Scioto crayfish	*Cambarus sciotensis*
A crayfish	*Cambarus veteranus*
Aquatic Insects	
A mayfly	*Isonychia serrata*
Johnson's pronggill mayfly	*Leptophlebia johnsoni*
White sand-river mayfly	*Pseudiron centralis*
Other Aquatic Invertebrates	
None	

6.3. Terrestrial and Wetland Species in the Blue Ridge

6.3.1. Tier I Species in the Blue Ridge

6.3.1.1. Shenandoah salamander, *Plethodon shenandoah*

Life History Summary

The Shenandoah salamander is endemic to three slopes within Shenandoah National Park, where it occurs in shallow soil along the edge of talus, at elevations between 914 and 1143m (Petranka 1998). The species is also known to occur in deeper patches of soil within talus (Wynn 1991). It is completely terrestrial, with no aquatic phase, and eats mainly insect larvae and mites (Wynn 1991). The Shenandoah salamander is

legally protected with the status of Federal and State endangered even though locally abundant, due to its extremely limited range and susceptibility to drought and other natural environmental perturbations. According to VA-GAP (DGIF 2004a), 39% of its statewide predicted potential habitat is protected.

Location

The map of habitat for the Shenandoah salamander (Figure 6.5) includes confirmed locations (DGIF 2004b) and potential habitat. Potential habitat was determined based on land cover (USGS 2001), elevation (USGS 2003) and aspect, which were derived from NED (USGS 2003). For more details, see Appendix D.

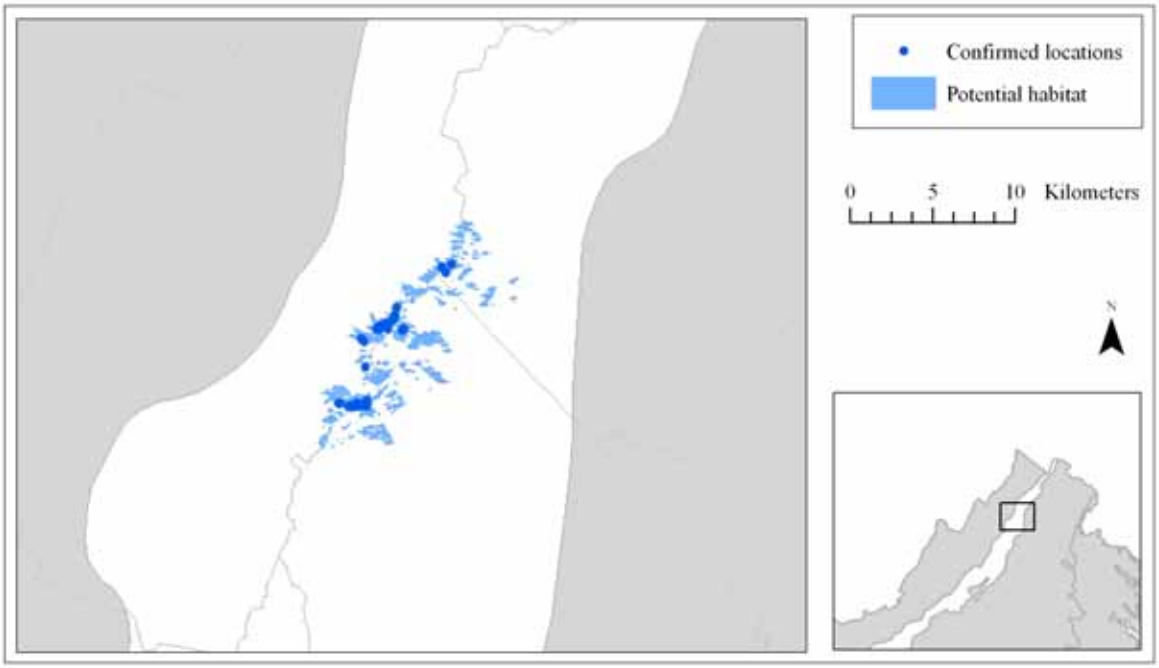

Figure 6.5. Distribution of Shenandoah salamander in the Blue Ridge.

Description of Habitat Requirements

This species inhabits pockets of soil within the talus on the north and northwestern faces of three mountain slopes in Shenandoah National Park that consist of mixed-conifer forest (Wynn 1991; Wilson 1995).

Relative Condition of Habitat

This species is found only on a few ridges in the central portion of Shenandoah National Park. However, there are 56 Collection records (DGIF 2004b), over 1400ha of potential habitat, and four Conservation Sites (DCR-NH 2005) within this small area. Within the Conservation Sites are five Element Occurrences. Four EOs were rated as "excellent" with the other rated as "good" for viability (DCR-NH 2005). All known habitat and observations are protected within the national park.

Since this species' entire known range is within Shenandoah National Park, it is protected from development. However, the talus habitat it inhabits is being degraded by natural advance of the surrounding forest up the talus slopes.

Specific Threats and Trends

Wilson (1995) indicates that competition with the red-backed salamander *Plethodon cinereus* is likely a limiting factor for the Shenandoah salamander. Wynn (1991) explains that the problem is forest encroachment on the talus habitat of the Shenandoah—as the forest advances up the talus slopes, red-backed salamanders seem to competitively exclude Shenandoahs. Petranka (1998) discusses this phenomenon at some length, and while the entire interaction is not clear, only large adult Shenandoah salamanders occur outside the talus in the forest, suggesting that juveniles are competitively excluded from the forested areas. Fundamentally, then, the primary threat to the Shenandoah salamander is loss of its talus habitat to forest encroachment. The Shenandoah salamander appears to be competitively superior to the red-backed salamander in the talus due to the Shenandoah's superior resistance to desiccation (Wynn 1991). However, at one location the two species coexist in the talus, so the details of their interactions are not clear (Wynn 1991; Petranka 1998).

Other threats to this species may include drought and soil acidification (Wynn 1991). Herpetofauna TAC (2004) did not identify any species-specific threats to the Shenandoah salamander, but did list several threats to its mountain forest habitat (Appendix H).

Conservation Actions and Strategies

The process reducing habitat for this salamander is essentially a natural one, so conservation actions are difficult. Artificially slowing forest advance may be possible but seems infeasible.

Herpetofauna TAC (2004) did not identify any species-specific conservation actions for the Shenandoah salamander, but did list some for its mountain forest habitat (Appendix I).

Research and Monitoring Needs

Wynn (1991) suggests mapping all talus habitat and gathering current abundance data as a baseline against which future monitoring data can be compared. In addition, detailed studies of the interaction between this species and the red-backed salamander need to be more fully understood to determine likelihood of extinction as the talus disappears beneath the forest canopy.

Herpetofauna TAC (2004) did not identify any species-specific research or monitoring needs for the Shenandoah salamander, but did list some for its mountain forest habitat (Appendix J).

6.3.1.2. Wood turtle, *Glyptemys insculpta*

Life History Summary

The wood turtle is known from the Potomac drainage across northern Virginia, including the Coastal Plain, Piedmont, Blue Ridge, and Ridge and Valley ecoregions (Mitchell 1994). It requires clear streams and an adjacent terrestrial habitat (often fields, sometimes forests), because the turtle spends part of each year in each habitat (Mitchell 1994). The wood turtle is omnivorous, consuming a variety of vegetation and invertebrate prey, and occasionally vertebrates as well (Mitchell 1994). The wood turtle is legally protected, with the status of State threatened. While its correct accepted generic name is *Glyptemys*, this species is still listed as *Clemmys insculpta* in the Virginia Administrative Code (4 VAC 15-20-130). According to VA-GAP (DGIF 2004a), 7% of its statewide predicted potential habitat is protected.

Location

The map of wood turtle habitat (Figure 6.6) includes confirmed locations from Collections (DGIF 2004b) and potential reaches. Reaches were selected based on DGIF's aquatic habitat classification, where attributes were link magnitude, reach elevation, and gradient. Percentage of undeveloped landcover (USGS 1992) was used in reach selection. For more details, see Appendix D.

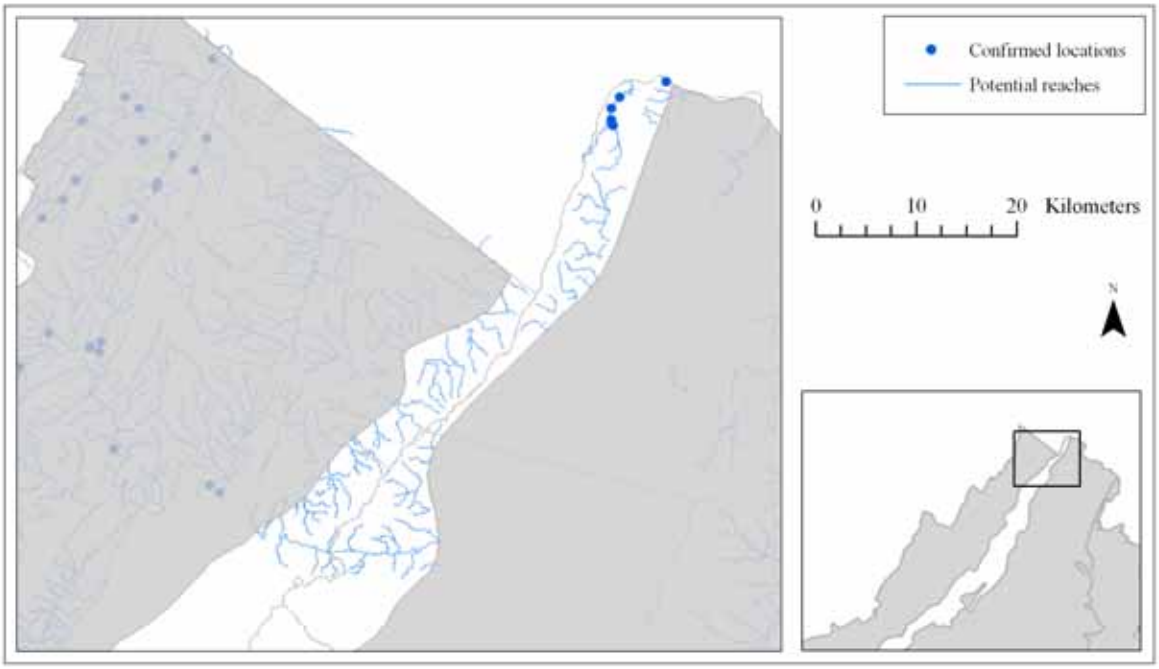

Figure 6.6. Distribution of the wood turtle in the Blue Ridge.

Description of Habitat Requirements

The wood turtle uses riparian areas and streams in Frederick, Shenandoah, Loudoun, Fairfax and northern Rockingham counties (M. J. Pinder, DGIF, pers. comm.). It is found primarily in and near clear brooks and streams in deciduous woodlands in Virginia, but has been found in woodland bogs and marshy fields at more northern sites. It uses variable habitats, as long as some critical aquatic and terrestrial components are present. In all cases, it has been found utilizing wet and/or marshy meadows associated with floodplains. Although highly terrestrial, wood turtles must remain in moist habitats (Mitchell 1994).

The wood turtle was associated with two reaches in the Blue Ridge ecoregion. These reaches represented two different stream types according to the DGIF aquatic classification (Table 6.3).

Table 6.3. DGIF aquatic habitat types used by wood turtle in the Blue Ridge-Potomac EDU.

Aquatic Habitat Type	Number of Reaches
Low gradient small stream connected to another small stream	1
Low gradient headwater stream connected to another headwater stream	1

Relative Condition of Habitat

One of the two confirmed reaches in which the wood turtle occurs in the Blue Ridge has been listed as impaired by fecal coliform from an unknown source (DEQ and DCR 2004).

There are five known wood turtle locations from Collections in the Blue Ridge (113 statewide, DGIF 2004b). Only one is within a Conservation Land, on NPS property (DCR 2003). Just over 10% of the potential reaches are within a Conservation Land. There are two DCR-NH Conservation Sites with known wood turtle populations, one protected within the same NPS property as the Collections site (DCR-NH 2005). Of these Conservation Sites, one is rated as "good" and one as "fair" for viability.

Specific Threats and Trends

The main threats to the wood turtle in Virginia are the illegal pet trade and habitat destruction, particularly as related to riparian zones and effects of siltation from construction (Mitchell 1994), forestry (Herpetofauna TAC 2004), and bank stabilization (NESWDTC 2004) (Table 6.4).

The wood turtle is declining across much of its range (Ernst et al. 1994), though specific trend information is not available and would be difficult to acquire.

Table 6.4. Species-specific stresses on the wood turtle (Herpetofauna TAC 2004). For additional stresses on the wood turtle, please see Appendix H.

Stress	Source of Stress	Scope	Severity	Comments
Intentional take	Economic use of species	3	4	Pet trade
Shoreline alteration	Forestry	2	3	Forestry practices

Conservation Actions and Strategies

Species-specific actions that are necessary for wood turtle conservation include better enforcement and prosecution of capture laws (wood turtle is protected from all unpermitted take by virtue of its State threatened status) (Herpetofauna TAC 2004). In addition, NPS should restrict recreational activities in these areas (Herpetofauna TAC 2004).

Research and Monitoring Needs

Like many reptiles, the basic life history and distribution of the wood turtle are poorly known. As such, research and monitoring needs include surveys to determine overall wood turtle distribution in Virginia; studies on wood turtle life history; and demographic studies, including population connectivity and gene flow (Herpetofauna TAC 2004; NESWDTC 2004).

6.3.1.3. Bog turtle, *Glyptemys muhlenbergii*

Life History Summary

The bog turtle is a small turtle (< 12cm maximum carapace length) that inhabits spring-fed wetlands with slow streams (Mitchell 1994). It occurs from upstate New York to eastern Georgia/western South Carolina in two disjunct populations. Virginia's bog turtle population is part of the southern population, which includes Virginia, Tennessee, North Carolina, South Carolina, and Georgia (Ernst et al. 1994). In Virginia, it is known only in the Blue Ridge (though there may be a few in the southwestern Piedmont). It is an omnivore, eating invertebrates, plant matter, and occasionally frogs and carrion (Ernst et al. 1994). Known predators include most common mesocarnivores, such as the raccoon *Procyon lotor*, striped skunk *Mephitis mephitis*, and spotted skunk *Spilogale putorius*. The two major threats faced by this species include wetland drainage and illegal collection for the pet trade. The bog turtle in Virginia is legally protected with the status of Federal threatened (southern population, by similarity of appearance) as well as State endangered. While its correct accepted generic name is *Glyptemys*, this species is still listed as *Clemmys muhlenbergii* in the Code of Federal Regulations (50 CFR 17.11). According to VA-GAP (DGIF 2004b), only 3% of its statewide predicted potential habitat is protected.

Location

The map of habitat for the bog turtle (Figure 6.7) includes confirmed habitat based on Collections that have been buffered to protect the species' locations (DGIF 2004b). The potential habitat was selected based on landcover (USGS 1992), NED (USGS 2003) and moisture values derived from elevation. For more details, see Appendix D.

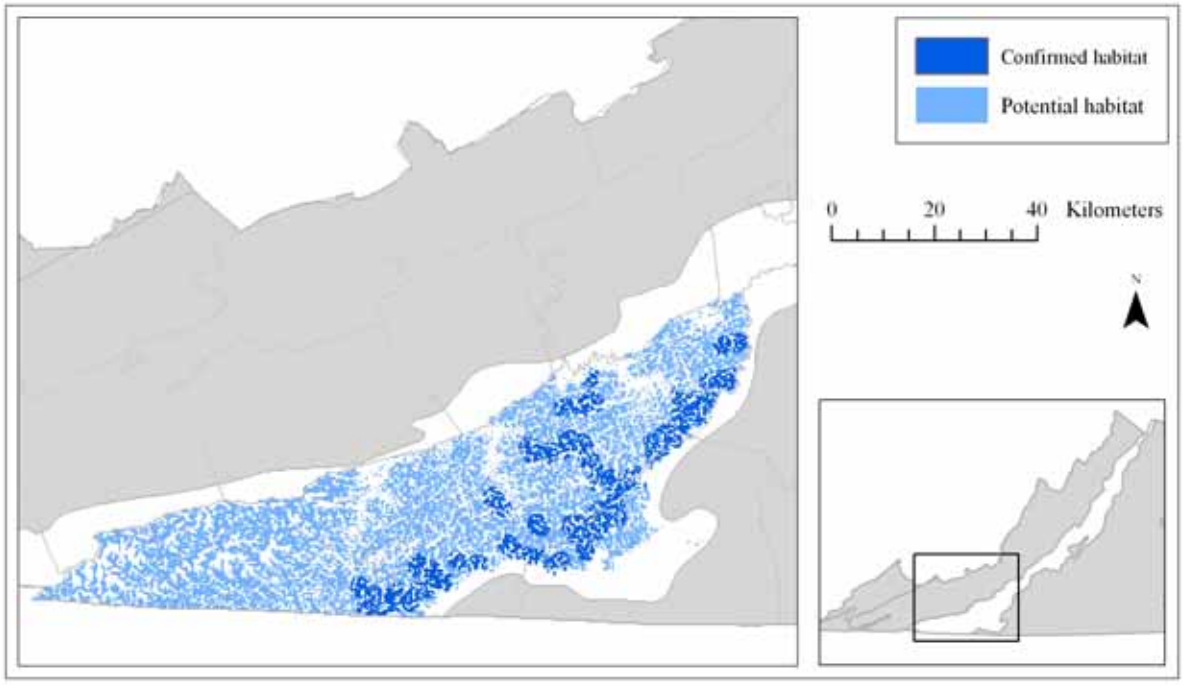

Figure 6.7. Distribution of the bog turtle in the Blue Ridge.

Description of Habitat Requirements

Bog turtles inhabit spring-fed wetlands with saturated soils and modest amounts of running water, which are only infrequently flooded. These sedge or bog meadows are dominated by sedges and have little or no canopy (Somes et al. 2000).

Relative Condition of Habitat

There are 154 bog turtle locations from Collections in the Blue Ridge (157 statewide, DGIF 2004b). Forty-four of these locations are protected in a Conservation Land, many along the NPS Blue Ridge Parkway (DCR 2003). There are over 200,000ha of potential habitat, approximately 7% of which is within a Conservation Land. DCR-NH reports 46 Conservation Sites containing bog turtle populations, 18 of which are at least partially protected by a Conservation Land (DCR-NH 2005). Of these populations, 9% are rated as "excellent" for viability, 26% as "good", 16% as "fair", and 21% as "poor." The remainder has not been rated (DCR-NH 2005).

Specific Threats and Trends

Mitchell (1994) identifies collection for the pet trade and wetland loss as primary threats to the bog turtle. In addition, Herpetofauna TAC (2004) identified several specific stresses on the bog turtle (Table 6.5).

Table 6.5. Species-specific stresses on the bog turtle (Herpetofauna TAC 2004).

Stress	Source of Stress	Scope	Severity	Comments
Habitat destruction	Agriculture	4	3	Wetland drainage
Hydrologic regime alteration	Agriculture	4	3	Wetland drainage and stream channelization
Intentional take	Economic use of species	3	4	Pet trade
Unintentional kills	Agriculture	3	2	Trampling by livestock [1]

[1] This stress is unconfirmed, with estimated scope and severity.

Conservation Actions and Strategies

Herpetofauna TAC (1994) recommends the following conservation actions for the bog turtle: educate landowners on the importance of wetland protection; enforce the prohibition on collection, and prosecute collectors; and implement agricultural BMPs and/or PARC habitat management guidelines.

The recovery plan for this species (USFWS 2001a) only includes the northern population, so it is not directly relevant to the bog turtle in Virginia. Mitchell (1994) and Mitchell et al. (1991) identified a three-pronged approach to the conservation of this species: 1) determine current range and population parameters of the Virginia population; 2) educate landowners on the species' biology and requirements, and law enforcement on identification of the species; and 3) identify and acquire or otherwise protect the best remaining wetland sites as reserves for this species. Mitchell (1994) further recommends the development of a comprehensive regional plan. This would include its ecology, with cultural and economic concerns.

Research and Monitoring Needs

As mentioned above, Mitchell (1994) and Mitchell et al. (1991) recommend complete surveys for this species in the southern Blue Ridge to determine the locations of all extant populations. Herpetofauna TAC (2004) did not mention any specific research or monitoring needs for this species.

6.3.1.4. Northern pinesnake, *Pituophis melanoleucus*

Life History Summary

Little is known about this snake, despite its large size, and both Mitchell (1991) and Tobey (1979) list it as "status undetermined" in Virginia. It occurs in both the Ridge and Valley and the Blue Ridge, where it consumes birds, eggs, and small mammals (Mitchell 1994). It seems to prefer dry, open habitats, often on ridgetops or slopes, where it constructs burrows and is very rarely seen (Mitchell 1994). However, precise habitat requirements or preferences are unknown. Known predators include common mammalian mesocarnivores, such as the raccoon *Procyon lotor* and striped skunk *Mephitis mephitis*, and the short-tailed shrew *Blarina brevicauda*. According to VA-GAP (DGIF 2004a), 54% of its limited statewide predicted potential habitat is protected.

Location

The precise habitat characteristics important to the northern pinesnake are unknown and cannot be mapped, so the habitat map (Figure 6.8) includes only confirmed locations from Collections (DGIF 2004b).

Description of Habitat Requirements

There is limited knowledge of habitat use in mountain populations. Likely essential habitat includes talus slopes, in which they can dig nest sites and burrows (J. C. Mitchell, UR, pers. comm.).

Relative Condition of Habitat

Due to lack of knowledge about the habitat requirements of this species, it is difficult to assess the relative condition of its habitat. There are two known observations from Collections within the Blue Ridge Mountains, six statewide (DGIF 2004b). Both of the Blue Ridge locations are protected by a Conservation Land (DCR 2003). One is within the George Washington National Forest, and the other is on NPS property.

Specific Threats and Trends

The status of this species is completely unknown in Virginia, so specific threats are unknown. Since a viable population has not been discovered in Virginia, no trends are available for the northern pinesnake. Herpetofauna TAC has identified threats for the Mountain Forest habitat group by the (Appendix H).

Figure 6.8. Distribution of the northern pinesnake in the Blue Ridge.

Conservation Actions and Strategies

The status of this species is completely unknown in Virginia. It may be extremely rare, or simply rarely encountered. Therefore, apart from the research and monitoring needs listed below, no specific conservation actions are known at this time. However, conservation actions have been identified for the Mountain Forest habitat group by the Herpetofauna TAC (Appendix I).

Research and Monitoring Needs

A radio-telemetry study should be instituted using the next available live individual, as that may be the only way to get any information on this species (J. C. Mitchell, UR, pers. comm.). Overall, location of a viable population to study is necessary before additional needs can be determined (Mitchell 1994).

6.3.1.5. Peregrine falcon, *Falco peregrinus*

Life History Summary

The peregrine falcon occurs most frequently in the Coastal Plain, but it is regularly observed statewide. In the Blue Ridge, its main nesting habitat is (or will be) cliff faces. They occur year-round in Virginia (Watts 1999). This falcon eats mainly birds, ranging in size from hummingbirds to sandhill cranes (White et al. 2002), but focusing on prey 100-500g (Johnsgard 1990). Young falcons are removed from nests in the Coastal Plain and "hacked," or transplanted, to areas in the mountains, with the hope that these birds will return to their historic mountain range. The PIF southern Blue Ridge conservation plan (physiographic area 23, Hunter et al. 1999) lists the peregrine as a species of moderate conservation concern. The peregrine falcon is legally protected, both under MBTA and with the status of State threatened. According to VA-GAP (DGIF 2004a), 20% of its statewide predicted potential habitat is protected.

Location

The map of peregrine falcon habitat (Figure 6.9) includes cliffs mapped during DGIF aerial surveys (Reynolds 2003).

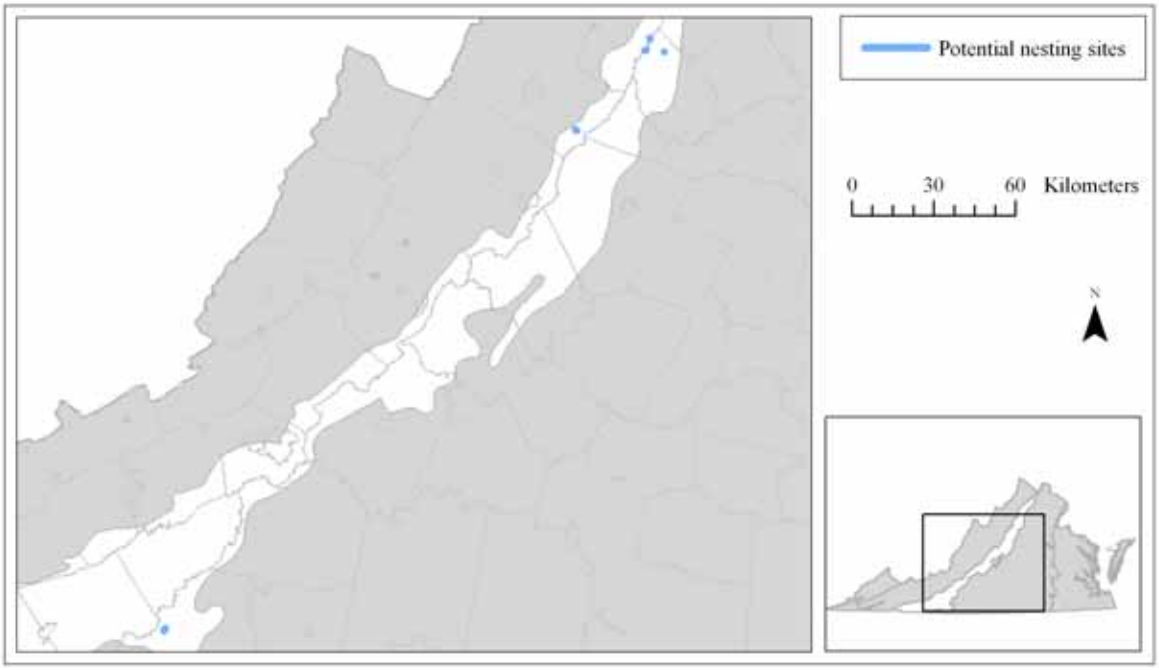

Figure 6.9. Potential peregrine falcon distribution in the Blue Ridge.

Description of Habitat Requirements

Nest sites for this species are typically located on ledges or shelves on cliff faces (J. L. Cooper, DGIF, pers. comm.). Analysis of 15 historic Virginia eyries revealed that all nests were located on sedimentary rock facing southwest or northeast, 402m from flowing water (Gabler 1983).

Relative Condition of Habitat

There are five potential nest cliffs within the Blue Ridge (17 statewide), two of which are historic next sites (DGIF 2004b). Four of these potential nest sites are within a Conservation Land, all within Shenandoah National Park. Three of these within Shenandoah are also DCR-NH Conservation Sites, two of which have viability rankings of "poor" (DCR-NH 2005). The other Conservation Site was unranked.

Specific Threats and Trends

The peregrine falcon is recovering range-wide since the pesticide DDT was banned in the U.S. (Johnsgard 1990; Rich et al. 2004). Within Virginia, the breeding population is very small but undergoing active management. Bird TAC (2004) reports a statewide population of < 20 individuals.

Conservation Actions and Strategies

Bird TAC (2004) reported a goal of population maintenance in the Coastal Plain while increasing the population in the mountains (including the Blue Ridge) of Virginia. Reduction of organochlorine pesticide contamination is important in continuing the peregrine's recovery (White et al. 2002). Protection of nesting areas from disturbance and destruction is important (White et al. 2002). A thorough treatment of needed conservation actions is given in USFWS (1987).

Research and Monitoring Needs

Little is known of nesting populations and success in the mountain population (R. J. Reynolds, DGIF, pers. comm.). An aerial mountain survey of 23 potential nesting sites found no nesting pairs, but identified key

sites that are in need of additional surveying and could be potential hack sites (Reynolds 2003). Specific sublethal effects of toxins on peregrines are poorly known (Bird TAC 2004). Monitoring of the recovery of all populations and the dynamics of these recovering populations should be continued (White et al. 2002).

6.3.1.6. Loggerhead shrike, *Lanius ludovicianus*

Life History Summary

The loggerhead shrike occurs most frequently in Virginia in the Blue Ridge Mountains and Ridge and Valley (Fraser 1991). It occurs year-round in Virginia (Yosef 1996). It prefers open habitats with occasional shrubs, such as large grazed pastures (Fraser 1991). The loggerhead is a predator, taking mostly invertebrates but also some vertebrate prey, such as lizards, birds or rodents (Yosef 1996). It is well known for its habit of impaling its prey on spines of vegetation or barbed wire. Important threats include conversion from pasture to other uses and excessive use of pesticides (Fraser 1991; Yosef 1996). The loggerhead shrike is legally protected, both under MBTA and with the status of State threatened. According to VA-GAP (DGIF 2004a), 14% of its statewide predicted potential habitat is protected.

Location

Loggerhead shrike habitat in this part of the state is ephemeral and cannot be accurately mapped, so the map (Figure 6.10) includes confirmed locations from the breeding season (DGIF 2004b).

Description of Habitat Requirements

Essential habitat for the loggerhead shrike includes open fields with scattered shrubs, small trees and/or hedges (DeGraff and Rappole 1995). In Virginia, the highest-quality breeding habitat consists of short grass, particularly active pastures with many perches (Luukkonen 1987).

Relative Condition of Habitat

Due to the ephemeral nature of habitat for this shrike, it is difficult to determine the total area and the status of available habitat. There are nine known Collections locations in the Blue Ridge (145 statewide, DGIF 2004b). Three of these locations, occurring within 0.5km of each other, are protected in a Conservation Land (DCR 2003).

Specific Threats and Trends

The loggerhead shrike has declined > 50% over the last 30 years range-wide (Rich et al. 2004). The same trend appears to hold for the PIF Mid-Atlantic Ridge and Valley (Rosenberg 2003), and Rosenberg (2004) and Bird TAC (2004) report a similar trend in Virginia. A decline of 87% in the northeast (which includes Virginia) is reported by NESWDTC (2004). Rosenberg (2004) estimates the statewide population of this species to be 1,400 individuals. However, Bird TAC (2004) reports that the population levels of this species are unknown in Virginia, but could be as low as < 100 individuals.
The reasons for the decline of the loggerhead shrike range-wide are unclear (Bird TAC 2004; Yosef 1996). However, threats to its preferred habitat are great and are enumerated in Appendix H. Yosef (1996) reports that the decline of this species corresponded with the increase in organochlorine pesticide use, and these substances are found in the birds in high concentrations. However, the decline also seems to correspond with the decline of pasturelands across its range, though birds do not seem to be habitat-limited in Virginia (that is, habitat exists that is not utilized by shrikes, Bird TAC 2004).

Conservation Actions and Strategies

The primary, species-specific action necessary for loggerhead shrike conservation in Virginia is a concerted, targeted survey effort to determine distribution of the species within the state (Bird TAC 2004) and throughout its breeding range in the northeast U.S. (NESWDTC 2004). This could include following the success of every individual nest (NESWDTC 2004). Other conservation actions are habitat-related.

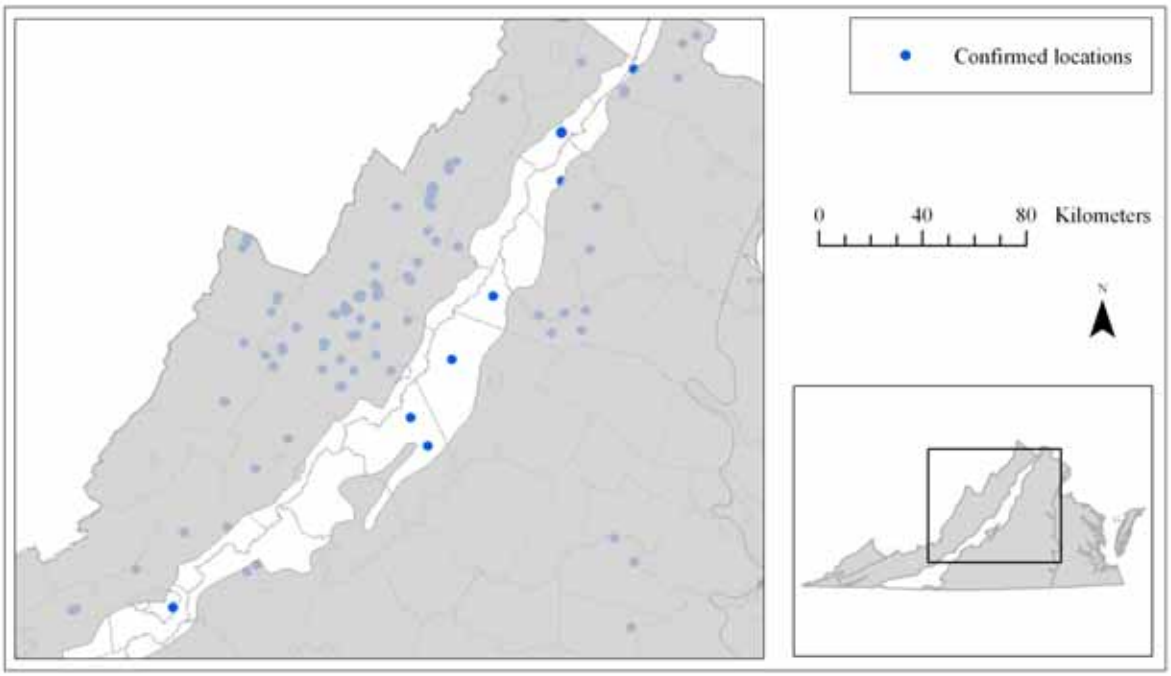

Figure 6.10. Distribution of the loggerhead shrike in the Blue Ridge.

These can be found in Appendix I and generally involve grassland management. Yosef (1996) points out that mid-successional grasslands are often overlooked in habitat restoration in favor of grasslands without the shrubby vegetation that shrikes require for nesting and perching. Bird TAC (2004) indicates a goal or increasing the population of this species while performing additional inverntory. Rosenberg (2004) suggests a goal of doubling the statewide population; using his estimate, this is a goal of 2,800 individuals.

Research and Monitoring Needs

Little is known about historical distribution of the loggerhead shrike in Virginia, and such information would be useful if compiled (Bird TAC 2004). In addition, due to its spotty distribution across the state, targeted surveys should be considered to determine its true distribution and habitat usage across Virginia (Bird TAC 2004). The causes for the species' decline, both in Virginia and throughout its range, are unclear and need further research (Yosef 1996; Bird TAC 2004). Certainly, the role of pesticides in the decline of this species needs to be better understood.

6.3.1.7. Red crossbill, *Loxia curvirostra* (Type 1)

Life History Summary

The red crossbill is among the most interesting birds in North America, for several reasons. As its name implies, the mandibles of its bill cross (that is, the tips of the mandibles are offset), though not consistently in one direction across the species (or even a population). Eight types have been distinguished, based on their flight calls (Adkisson 1996). These "types," while currently holding no taxonomic status, appear to select mates based on this call and to be reproductively isolated from other types, even where they occur together (Groth 1993). In Virginia, birds of Type 1 and 2 occur together (Groth 1993). However, type 1 birds are spruce-fir specialists, occurring only at high elevations, and are much more rare (M. D. Wilson, CCB, pers. comm.). Interestingly, type 1 birds are known from the southern Appalachians, Maine, and the Pacific Northwest, with no known populations between (Adkisson 1996). This may be explained by this species' nomadic lifestyle, caused by its reliance on conifer seed crops for food. In Virginia, this species eats seeds of spruce, fir, and eastern white pine *Pinus strobus* (where available). Important threats include loss of old growth conifer forests, which produce the highest density seed crops (Adkisson 1996). This

habitat is under siege by forestry practices, but more importantly by invasive adelgid insect pests (such as balsam woolly adelgid *Adelges piceae*, Wallace and Hain 2002). The red crossbill (all types) is protected under MBTA and has been designated as a State special concern species within Virginia. According to VA-GAP (DGIF 2004), 27% of its statewide predicted potential habitat is protected.

Location

The map of habitat for this species (Figure 6.11) includes confirmed locations (DGIF 2004a) and potential areas selected using NED (USGS 2003) and spruce-fir data (SAMAB 1995). For details, see Appendix D.

Description of Habitat Requirements

This species requires high altitude spruce-fir or hemlock (Adkisson 1996). In Virginia, it typically inhabits spruce forests above 4000 feet (1219m, M. D. Wilson, CCB, pers. comm.), but will use eastern white pine where available (Adkisson 1996).

Relative Condition of Habitat

There is only one known Collection of the red crossbill in the Blue Ridge (6 statewide, DGIF 2004b). However, all 780ha of the potential habitat area is within the Blue Ridge ecoregion. The Collections location and potential habitat fall within high-elevation spruce-fir forests in the Jefferson National Forest (DGIF 2004b).

Specific Threats and Trends

While there exist no known, species-specific stresses for the red crossbill in Virginia, it shares stresses with other members of the "Bird: High-elevation coniferous" habitat group (Bird TAC 2004; Appendix H). These include habitat loss due largely to exotic pest infestations. In addition, global climate change may raise the average air temperature in the region, which could affect the distribution of this habitat, which is a northern relict. Due to its habit of moving along ridgelines during food-induced nomadic activity, wind turbine development in these areas could be a risk (Adkisson 1996).

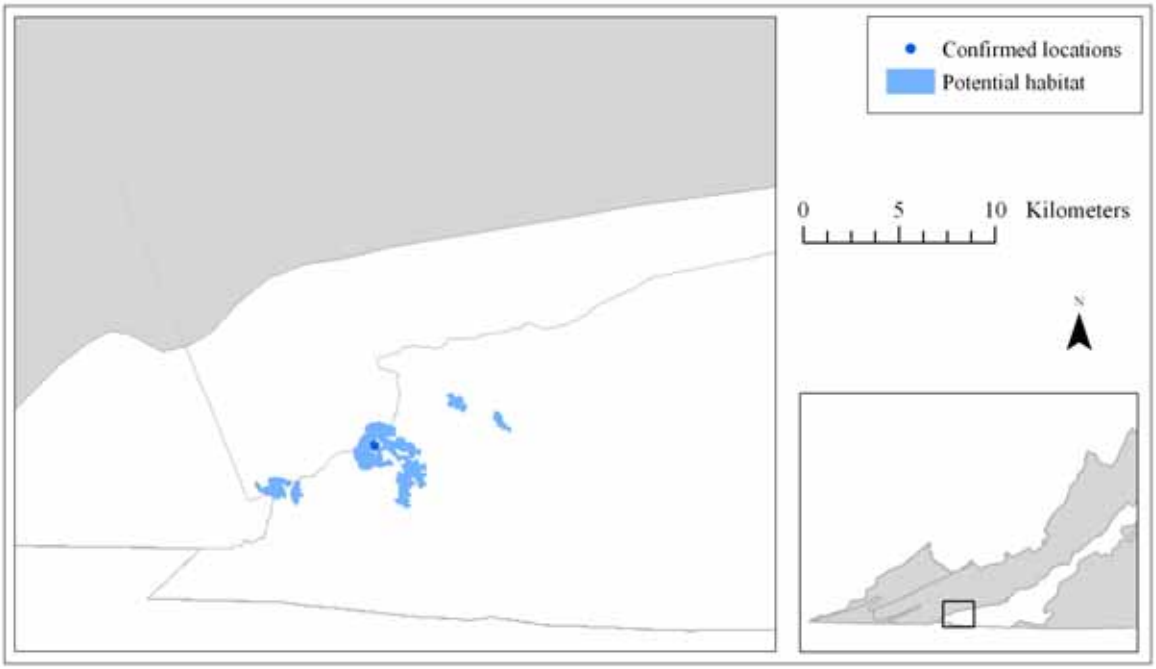

Figure 6.11. Distribution of the red crossbill (type I) in the Blue Ridge.

Conservation Actions and Strategies

While there exist no known, species-specific conservation actions for the red crossbill in Virginia, it shares conservation actions that are related to habitat with other members of the "Bird: High-elevation coniferous" habitat group (Bird TAC 2004; Appendix I). Protection and connection of existing habitat patches is important (Adkisson 1996; Bird TAC 2004). Bird TAC (2004) indicates that the population of this taxon in Virginia is possibly < 500 individuals, and that a primary goal is to increase the population.

Research and Monitoring Needs

The taxonomic question of whether these types are actually biological species is important, as is the extent of the crossbills' dependence on old-growth conifer forest (Adkisson 1996). The effects of acid precipitation and global climate change need to be investigated (Bird TAC 2004). In addition, assessment of these habitats, targeted surveys for this species, and development of survey protocols for all species of this habitat type is important, due to difficulty accessing these areas (Bird TAC 2004).

6.3.1.8. Appalachian yellow-bellied sapsucker, *Sphyrapicus varius appalachiensis*

Life History Summary

The yellow-bellied sapsucker is a common winter bird in Virginia but rare in summer, breeding only in high-elevation, early- to mid-successional deciduous and mixed forests. Its food consists largely of tree sap, but it also consumes arthropods and fruits (Walters et al. 2002). Potential threats to this species are mostly habitat-based, and include acid precipitation, overbrowsing by deer, and global climate change. Appalachian yellow-bellied sapsucker is legally protected under MBTA. According to VA-GAP (DGIF 2004a), 12% of its statewide predicted potential habitat is protected.

Location

The map of habitat for this species (Figure 6.12) includes confirmed locations from the breeding season (DGIF 2004b) and potential habitat based on landcover data (USGS 1992) and NED (USGS 2003). For more details on potential habitat mapping, see Appendix D.

Description of Habitat Requirements

This species requires very high altitude mixed forest with standing dead or live decaying trees (DeGraaf and Rappole 1995). More specific habitat parameters include forests above 3000ft (914m) in elevation and below 37.5° latitude (M. D. Wilson, CCB, pers. comm.).

Relative Condition of Habitat

There are four known Collections locations for this subspecies in the Blue Ridge Ecoregion (DGIF 2004b). No other Collections records exist in Virginia for the Appalachian subspecies. There are slightly less than 70,000ha of potential habitat, over 30,000 of which are protected by a Conservation Land (DCR 2003). Most of the protected habitat occurs in National Forest land.

Specific Threats and Trends

Trends and population size are unknown for this subspecies, but there are possibly < 100 individuals in the state (Bird TAC 2004). While there exist no known, species-specific stresses for Appalachian yellow-bellied sapsucker in Virginia, it shares stresses with other members of the "Bird: High-elevation Deciduous" habitat group (Appendix H). This species seems to be somewhat susceptible to collisions with stationary objects (such as buildings or communications towers) during migration (Walters et al. 2002).

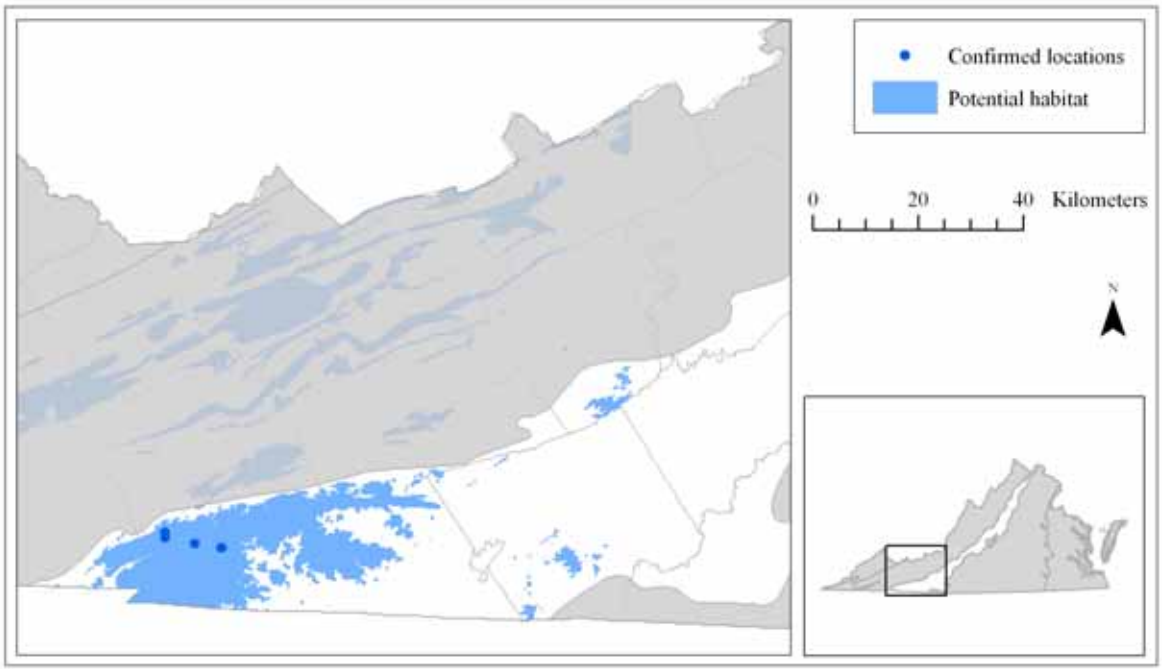

Figure 6.12. Distribution of Appalachian yellow-bellied sapsucker in the Blue Ridge.

Conservation Actions and Strategies

While there exist no subspecies-specific conservation actions for Appalachian yellow-bellied sapsucker in Virginia, it shares those of the rest of the "Bird: High-elevation Deciduous" habitat group (Appendix I).

Research and Monitoring Needs

Dispersal of young and migratory routes are not well-known (Walters et al. 2002). The role of sapsuckers in forest ecology should be studied (Walters et al. 2002). Bird TAC (2004) reports that more inventory is needed for this species.

6.3.1.9. Golden-winged warbler, *Vermivora chrysoptera*

Life History Summary

The golden-winged warbler occurs in the mountains of Virginia, where its preferred habitat is shrubby areas with scattered trees, generally near forest edge (Confer 1992; Confer and Larkin 1998; Confer et al. 2003). It eats mostly moths and caterpillars, along with other insects and spiders (Confer 1992). Important threats to the golden-winged warbler include natural succession and hybridization with and competitive exclusion by the blue-winged warbler *Vermivora pinus* (Confer 1992). Interaction and hybridization with the blue-winged warbler has been studied extensively. The golden-winged warbler tends to disappear from an area within about 50yr of initial invasion of *V. pinus* (Gill et al. 2001), although there is some evidence that the blue-winged does not competitively exclude the golden-winged (Confer and Larkin 1998). The dynamics of this interaction are not entirely clear, though the genetic pattern of hybridization that accompanies this phenomenon is beginning to be understood (Gill 2004; Shapiro et al. 2004). The golden-winged warbler is protected under MBTA and has been designated a State special concern species. According to VA-GAP (DGIF 2004a), 19% of its statewide predicted potential habitat is protected.

Location

Because this species has very specific needs, requiring early successional habitat, the map (Figure 6.13) only includes confirmed locations from the breeding season (DGIF 2004b).

Description of Habitat Requirements

This species may breed in a variety of early-successional or disturbed habitats, including shrubby fields, abandoned farmland, shrubby swamps, successional forest, utility right-of-ways, clearings within forests, brushy clearcuts or shelterwood cuts, in deciduous woods. The common features of these habitats are patches of dense herbaceous growth, shrubby cover, scattered young trees and, often, a forested perimeter. It is very specific in its habitat requirements, and once a disturbed area becomes too old, this species disappears (Curson et al. 1994).

Relative Condition of Habitat

There are two locations of golden-winged warblers within Collections in the Blue Ridge (25 statewide, DGIF 2004b). One of these locations is protected within Shenandoah National Park.

Specific Threats and Trends

The only species-specific stress reported by Bird TAC (2004) is hybridization with the blue-winged warbler. This species also appears to displace golden-winged warblers, although the dynamics of this process is not clear (e.g., is it direct competition, or is it more closely related to habitat structure?). In addition, the golden-winged warbler shares stresses with other members of the "Bird: Early Successional" habitat group (Bird TAC 2004; Appendix H). However, due to it only occurring at high elevations, some of these threats may not be as severe to this species as those that occur at lower elevations. It seems likely that loss of habitat due to natural succession and human development, as well as competition with blue-winged warblers, have contributed significantly to the decline of this species. In addition, nest parasitism by brown-headed cowbird *Molothrus ater* affects this species in many parts of its range, though its impact in Virginia is not clear and seems likely to be minor (Confer et al. 2003).

Figure 6.13. Distribution of the golden-winged warbler in the Blue Ridge.

Rosenberg (2003) reports a decline of 8.6% annually over the last 30 years for the golden-winged warbler in PIF's physiographic area 12 (Mid-Atlantic Ridge and Valley). Rosenberg (2004) reports an estimated population of 770 golden-winged warblers in Virginia, while Bird TAC (2004) reports a population of possibly < 500 pairs. The goal proposed by Bird TAC (2004) is to increase the population while continuing targeted monitoring. Rosenberg's (2004) goal is to double the population which, based on his current estimate of the population size, gives an effective goal of 1,500 birds.

Conservation Actions and Strategies

Active management is essential to maintain quality early successional habitat on the landscape in the Southern Appalachians (Bulluck et al. 2005). In this region, regenerating clearcuts are occupied by golden-winged warblers from approximately 4-13 years post-harvest (Klaus and Buehler 2001). In West Virginia, golden-winged warblers remained in cut-over areas for only 3-8 years following a harvest, and colonized burned areas 2-6 years after a burn (Canterbury 2005). Prescribed fire is an effective management tool for maintaining early successional habitat suitable for the species. The burning cycle should be planned so as to ensure that suitable habitat is available between burns. Because this approach manages directly for this species (and possibly a few others, such as the Appalachian Bewick's wren) at the expense of birds of mature forests, management planning should take place within the context of the larger surrounding landscape. The use of prescribed burning may, in this way, mimic natural historical disturbance regimes, such as lightning-caused fires. Grazing at low cattle densities also appears to be an effective management tool in the Southern Appalachian region (Bulluck et al. 2005). In addition, the golden-winged warbler shares conservation actions with other members of the "Bird: Early Successional" habitat group (Bird TAC 2004; Appendix I). Rosenberg (2003) proposes a goal of > 6,000 pairs of golden-winged warblers in the entire PIF Mid-Atlantic Ridge and Valley (physiographic area 12) by maintaining known breeding sites and creating new sites with similar conditions where possible.

Research and Monitoring Needs

Bird TAC (2004) recommends targeted surveys for this species, plus accumulation of historical distribution and abundance data. As mentioned throughout, study of interactions of golden-winged with blue-winged warblers, including dominance and patterns of hybridization at first contact, are warranted specifically for Virginia birds, since these interactions seem to differ greatly depending on location (Shapiro et al. 2004).

6.3.1.9. Carolina northern flying squirrel, *Glaucomys sabrinus coloratus*

Life History Summary

The Carolina northern flying squirrel is one of two subspecies of this northern relict species in Virginia, and one of two species of flying squirrel (the other being the southern flying squirrel *Glaucomys volans*, which is common statewide, Linzey 1998). The Carolina northern flying squirrel requires high-altitude, old growth forest with a significant spruce-fir component (Linzey 1998). This subspecies occurs only in Grayson, Smyth, and Washington Counties in Virginia (Linzey 1998). Food habits of this species are not well understood, but appear to revolve around lichens and fungi, supplemented with nuts, seeds, and arthropod and vertebrate flesh (Whitaker and Hamilton 1998). It is entirely nocturnal, being active just after dusk, then again in the hours before dawn (Wells-Gosling and Heaney 1984). This species is often displaced from nest cavities in areas with a large hardwood component by the smaller but more aggressive southern flying squirrel (Wells-Gosling and Heaney 1984). Important threats to this species include competition from southern flying squirrel and habitat loss. This subspecies is protected with the status of Federal and State endangered. VA-GAP was performed using both subspecies of *G. sabrinus*, so no "percentage of habitat protected" is available.

Location

The map of habitat for the Carolina northern flying squirrel (Figure 6.14) includes confirmed locations (DGIF 2004a) and potential habitat selected from spruce-fir data (SAMAB 1995). For more details, see Appendix D.

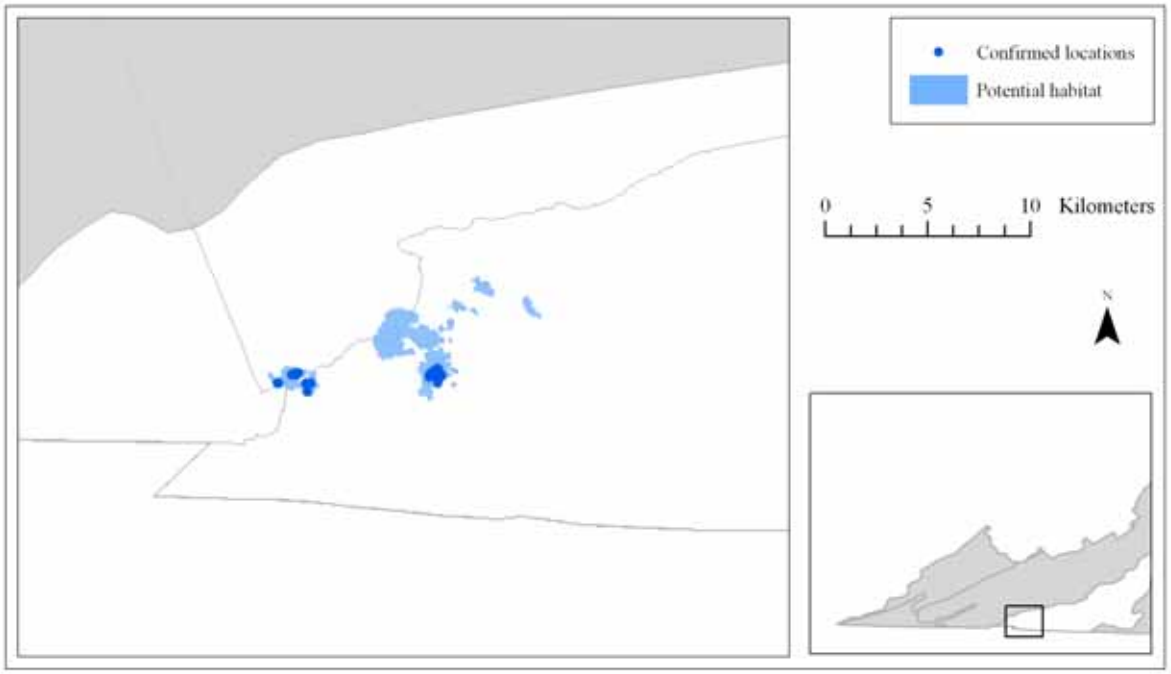

Figure 6.14. Distribution of the Carolina northern flying squirrel in the Blue Ridge.

Description of Habitat Requirements

This species requires high-altitude old growth forest with a significant component of spruce-fir (Wells-Gosling and Heaney 1984; Whitaker and Hamilton 1998).

Relative Condition of Habitat

There are 42 known Collections locations of Carolina northern flying squirrel, concentrated in two small areas in the southern portion of the Blue Ridge (DGIF 2004b). Surrounding these locations is almost 900ha of potential spruce fir habitat. All known locations and potential habitat are within the Jefferson National Forest. Three separate but adjacent DCR Conservation Sites also encompass Carolina northern flying squirrel habitat in this area (DCR 2003). These three sites are rated as "excellent," "excellent/good," and "poor" for viability. The "poor" Conservation Site contained none of the known Collections locations and relatively small amount of potential habitat. The "excellent" and "excellent/good" sites contain the vast majority of potential habitat and all of the known locations (DCR-NH 2005).

This habitat is threatened by one major issue: balsam woolly adelgid *Adelges piceae*. Global climate change and acid precipitation are also possibly problematic for spruce-fir in Virginia (Bird TAC 2004).

Specific Threats and Trends

Mammal TAC (2004) identified mostly habitat stresses for this species (Table 6.6). In addition, USFWS (1990a) discusses other stresses, including: heavy metals, which concentrate at higher elevations and could be bioaccumulated by squirrels through lichens and fungi; acid precipitation, which damages mature conifers and kills mycorrhizal fungi, an important food source; discontinuous distribution due to natural causes and historical deforestation; and possibly parasites contracted from southern flying squirrels.

Conservation Actions and Strategies

Conservation actions for the Carolina northern flying squirrel identified by Mammal TAC (2004) include maintenance or increase of population levels, a return of spruce forest area to historic levels, improvement

Table 6.6. Species-specific stresses on the Carolina northern flying squirrel (Mammal TAC 2004).

Stress	Source of Stress	Scope	Severity	Comments
Habitat degradation	Atmospheric deposition	3	3	Heavy metals, acidification
Habitat degradation	Exotic/invasive species	3	3	Spruce and balsam adelgids
Habitat degradation	Climate alteration	2	2	Global climate change
Competition	Native species	2	2	Southern flying squirrel

of air quality, and connection of existing habitat patches. The recovery plan for this species (USFWS 1990a) is 15 years old and needs to be updated to integrate accomplishments that have occurred during the time it has been in place. It focuses on research questions (discussed in the following section), developing and implementing management guidelines, habitat acquisition and protection, and "vigorous enforcement" of legal protections (USFWS 1990a). Menzel (2003) provides a thorough summary of the management implications of her work with the Virginia subspecies in West Virginia that may be applicable to habitat restoration and management efforts for the Carolina subspecies as well.

Research and Monitoring Needs

Mammal TAC (2004) did not identify any research needs for this subspecies. Research needs mentioned by the recovery plan (USFWS 1990a) include determination of current range and survey of that range to identify all populations; in-depth life history and ecological studies to identify critical factors in population regulation; squirrel densities related to habitat quality; and toxic accumulation in its food supply. For a complete list of research needs, see USFWS (1990a).

6.3.1.11. Mitchell's satyr, *Neonympha mitchellii*

Life History Summary

This species has a complicated taxonomic history, having been separated from *Neonympha areolata* in the last 20 years (Scott 1986). The subspecies have also proved to be problematic, as the population at Fort Bragg, North Carolina is *N. m. franciscii*, but the Virginia population seems to be the nominate subspecies, more closely related to the form in the upper midwestern U.S. (S. Roble, DNH, pers. comm.).

This is a species of wet sedge meadows and fens. Its larval food plants seem to be sedges, since captive larvae eat multiple species of *Carex* and females have been observed ovipositing on them. Its main threats are habitat loss and poor habitat management, such as poorly-timed prescribed burns, or fire regimes that burn too extensively at any one time. It is legally protected, with the status of Federal and State endangered.

Location

Because of its sensitivity to collection, the map of habitat for the Mitchell's satyr (Figure 6.15) includes areas delineated by DCR-NH (2005), which are larger areas encompassing conservation sites.
Description of Essential Habitat

This species uses wet meadows, fens, and bogs with a component of sedge in the Blue Ridge.

Relative Condition of Habitat

There is one DCR-NH Element Occurrence of Mitchell's satyr within the Blue Ridge (DCR-NH 2005). This occurrence is not protected by any Conservation Lands. The occurrence has a viability rating of "excellent" (DCR-NH 2005).

Specific Threats and Trends

Loss of wetland habitat (sedge fens or meadows) is the major threat to this species. In addition, it has been decimated in some parts of its range by overcollection (Dunkle 2000; NatureServe 2004).

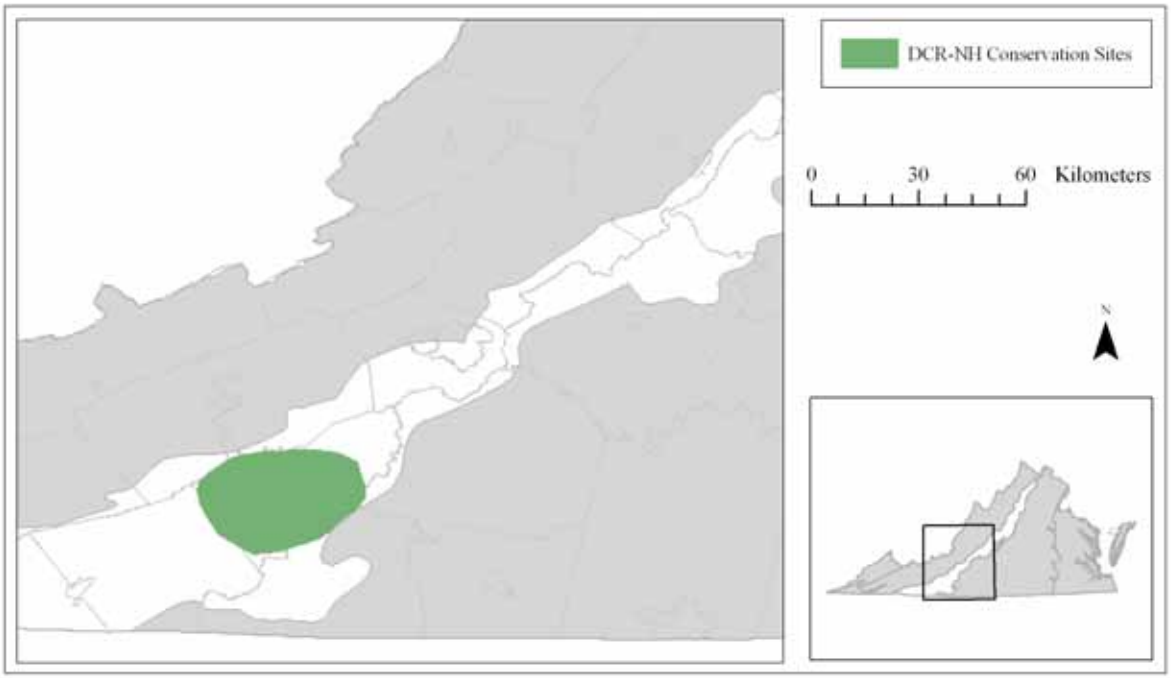

Figure 6.15. Distribution of Mitchell's satyr in the Blue Ridge.

Conservation Actions and Strategies

Invertebrate TAC did not identify any conservation actions for this species.

Research and Monitoring Needs

Invertebrate TAC did not identify any research or monitoring needs for this species. Clearly, the taxonomy of this species needs to be clarified, as does the distribution of this species in Virginia.

6.3.1.12. Buffalo Mountain mealybug, *Puto kosztarabi*

Life History Summary

Very little is known about this species. It is endemic to Buffalo Mountain in Floyd County, Virginia. It has been found only on poverty oatgrass *Danthonia spicata* in open glades Buffalo Mountain's south slope. Males fly briefly in early August (R. L. Hoffman, VMNH, pers. comm.). This species is listed as State endangered and has been designated a species of concern by the Virginia Field Office of USFWS.

Location

The map of habitat for the Buffalo Mountain mealybug (Figure 6.16) includes a Conservation Site (DCR 2003). The specific habitat requirements for this species are at a finer scale than we are able to identify and map with existing data.

Description of Habitat Requirements

This species has been found only on one species of grass, *Danthonia spicata*, growing in open meadows on glades on the south slope of Buffalo Mountain near its westernmost end, elevation approximately 800-3900 feet (244-1190m). The substrate rock has very high magnesium content. However, searches in similar habitats in nearby counties have proven negative (R. L. Hoffman, pers. comm.).

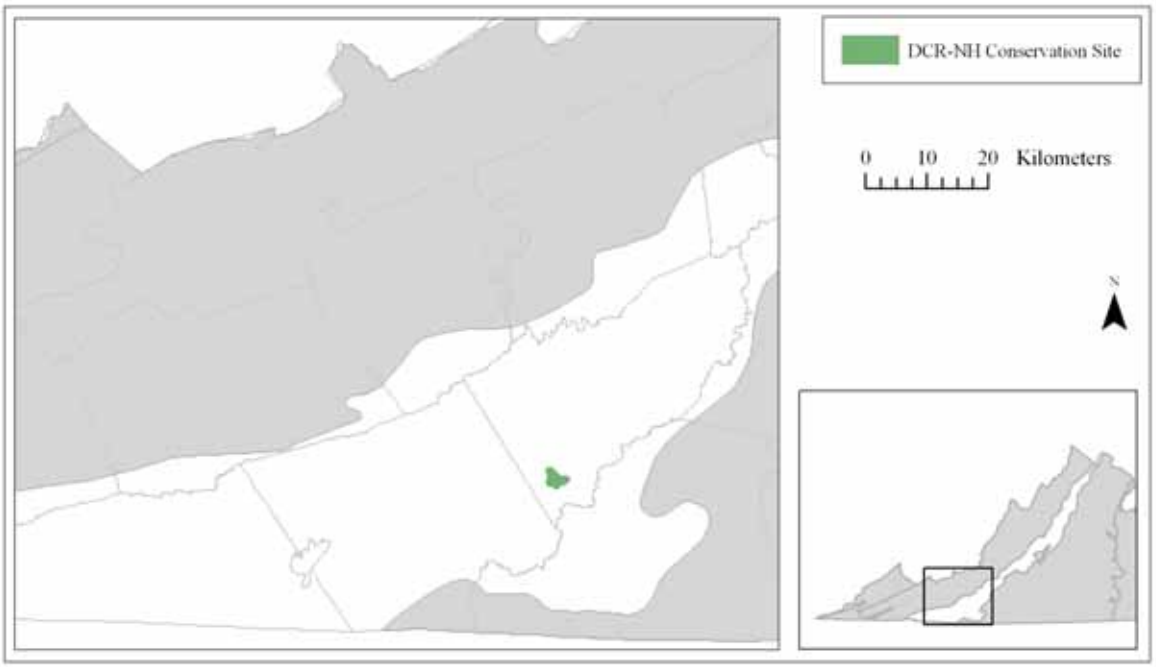

Figure 6.16. The distribution of the Buffalo Mountain mealybug in the Blue Ridge.

Relative Condition of Habitat

There is one DCR Conservation Site for the Buffalo Mountain mealybug (DCR 2003). This site is rated as "excellent" for viability. Most of this Conservation Site is protected by the Buffalo Mountain Natural Area Preserve, which is owned by DCR.

Specific Threats and Trends

No specific threats were identified by Invertebrate TAC. No trend is known for this species.

Conservation Actions and Strategies

No specific conservation actions were identified by Invertebrate TAC. The only known location for the Buffalo Mountain mealybug is already under state ownership.

Research and Monitoring Needs

Basic life history and population studies are necessary. Continued surveys in similar habitats should be conducted to identify additional populations.

6.3.1.13. Laurel Creek xystodesmid millipede, *Sigmoria whiteheadi*

Life History Summary

This species has been observed at only one location, near the headwaters of Laurel Creek in Floyd County, Virginia (Hoffman 1991). It occurs in the leaf litter beneath *Rhododendron maximum* with a hardwood canopy, 3-5m from the creek, over sandy loam (R. L. Hoffman, VMNH, pers. comm.). R. L. Hoffman (pers. comm.) reports that this site may be marginal habitat. However, extensive surveying has occurred at Buffalo Mountain in rich deciduous woods lacking *Rhododendron*, and these surveys have been negative for *S. whiteheadi*, despite seeming to be likely habitat (R. L. Hoffman, VMNH, pers. comm.). This species is listed as State threatened, and has been designated a species of concern by the Virginia Field Office of USFWS.

Location

The map of habitat for the Laurel Creek xystodesmid millipede (Figure 6.17) includes a location from Collections (DGIF 2004a). The specific habitat requirements for this species are at a finer scale than we are able to identify and map with existing data.

Description of Habitat Requirements

This species is known from only one locality, where it occurs under leaf litter of rhododendrons and hardwoods, 3-5m from the stream, at the headwaters of Laurel Creek (Hoffman 1991). The substrate is a deep layer of sandy loam and likely has a low pH (R. L. Hoffman, pers.comm.).

Relative Condition of Habitat

The location from which this species is known occurs within the Blue Ridge Parkway and is owned by NPS, so is relatively free of human disturbance.

Specific Threats and Trends

Hoffman (1991) reports that this species may be declining. No current threats are known, since the locality is owned by NPS. He suggests that this decline may be a natural extinction event of a relict species. Invertebrate TAC reported no known threats to this species.

Conservation Actions and Strategies

Hoffman (1991) recommends only that the type locality continue to be protected. Invertebrate TAC did not identify conservation actions for this species.

Research and Monitoring Needs

Hoffman (1991) reports that the population at the type locality should be carefully monitored and that additional surveys of likely habitat for as-yet-unknown populations should be conducted. He also states

Figure 6.17. Distribution of the Laurel Creek xystodesmid millipede in the Blue Ridge.

(pers. comm.) "it would seem to be a good candidate for some simple survey work along the Blue Ridge north and south of Meadows of Dan."

6.3.2. Forest Species of Greatest Conservation Need in the Blue Ridge

6.3.2.1. Species of Greatest Conservation Need by Forest Type

Of the 71 tiered species that occur in Blue Ridge forest, 24 are generalists that occur in all forest types (Table 6.7). Of the remaining 32 species, 22 occur in deciduous forest (Table 6.8), 10 occur in coniferous forest (Table 6.9) and 21 occur in mixed forest (Table 6.10).

Table 6.7. Forest generalist species of greatest conservation need in the Blue Ridge. "Open woods," throughout Tables 6.7-6.10, unless otherwise indicated, indicates mature, closed canopy, open understory forest, and not open canopy, shrubby understory forests, such as shelterwood cuts.

Common Name	Scientific Name	Tier	Special Habitat Needs
Peregrine falcon	*Falco peregrinus*	I	Cliffs for nesting, often near water
Bald eagle	*Haliaeetus leucocephalus*	II	Large trees near a river or lake
Southeastern fox squirrel	*Sciurus niger niger*	III	Open forest with an oak component
Eastern box turtle	*Terrapene carolina*	III	Forest generalist
Green heron	*Butorides striatus*	IV	Near streams or wetlands
Chuck-will's-widow	*Caprimulgus carolinensis*	IV	Open woods
Northern bobwhite	*Colinus virginianus*	IV	Open woods
Eastern wood-pewee	*Contopus virens*	IV	Open second-growth to mature woods
Prairie warbler	*Dendroica discolor*	IV	Open woods
Blue Ridge dusky salamander	*Desmognathus orestes*	IV	In and around high-elevation streams and seeps
Worm-eating warbler	*Helmitheros vermivorus*	IV	Thick understory near water
Eastern hog-nosed snake	*Heterodon platirhinos*	IV	Forest ecotones with sandy soils
Yellow-breasted chat	*Icteria virens*	IV	Open shrubby woods
Black-and-white warbler	*Mniotilta varia*	IV	Forest generalist
Allegheny woodrat	*Neotoma magister*	IV	Wooded bottomlands, banks, cliffs
Kentucky warbler	*Oporornis formosus*	IV	Thick understory, closed canopy near water
Northern Parula	*Parula americana*	IV	Damp or wet woods near water
Eastern towhee	*Pipilo erythrophthalmus*	IV	Shrubby openings and edges
Eastern spadefoot	*Scaphiopus holbrookii*	IV	Forest with sandy or otherwise loose soil
Ovenbird	*Seiurus aurocapillus*	IV	Open mature woods
Long-tailed shrew	*Sorex dispar*	IV	Talus slopes and moist rocky areas at high altitudes
Appalachian cottontail	*Sylvilagus obscurus*	IV	Thickets within mixed forest
Brown thrasher	*Toxostoma rufum*	IV	Shrubby clearcuts
Canada warbler	*Wilsonia canadensis*	IV	Thick understory near water

Table 6.8. Deciduous forest species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Wood turtle	*Glyptemys insculpta*	I	Clear streams
Shenandoah salamander	*Plethodon shenandoah*	I	Talus slopes; three locations

Common Name	Scientific Name	Tier	Special Habitat Needs
Laurel Creek xystodesmid millipede	*Sigmoria whiteheadi*	I	Single location; moist leaf litter
Golden-winged warbler	*Vermivora chrysoptera*	I	Regenerating clearcuts with scattered saplings
Cerulean warbler	*Dendroica cerulea*	II	Mature forest with complex canopy structure
Peaks of Otter salamander	*Plethodon hubrichti*	II	Mesic forest floor > 845m elevation
Mountain chorus frog	*Pseudacris brachyphona*	II	Wooded hillsides near wet areas
Jefferson salamander	*Ambystoma jeffersonianum*	IV	Shallow ponds within woodlands
Whip-poor-will	*Caprimulgus vociferus*	IV	Open woods near large fields
Chimney swift	*Chaetura pelagica*	IV	Large snags or houses with chimneys
Yellow-billed cuckoo	*Coccyzus americanus*	IV	Tall forest with partially open canopy
Timber rattlesnake	*Crotalus horridus*	IV	South-facing ledges and talus slopes
Gray catbird	*Dumetella carolinensis*	IV	Dense thickets in forest openings or edges
Willow flycatcher	*Empidonax traillii*	IV	Willow thickets near wetlands
Wood thrush	*Hylocichla mustelina*	IV	Mature upland forest with undergrowth
Rose-breasted grosbeak	*Pheuctitus ludovicianus*	IV	Second-growth mesic forest
Scarlet tanager	*Piranga olivacea*	IV	Mature forest, min. size 10-12ha
Yonahlossee salamander	*Plethodon yonahlossee*	IV	Mountain slopes with deep leaf litter
Prothonotary warbler	*Protonotaria citrea*	IV	Near water
American woodcock	*Scolopax minor*	IV	Moist or wet woods near wetlands
Louisiana waterthrush	*Seiurus motacilla*	IV	Near water
Yellow-throated vireo	*Vireo flavifrons*	IV	Tall forest with partially open canopy

Table 6.9. Coniferous forest species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Carolina northern flying squirrel	*Glaucomys sabrinus coloratus*	I	High-elevation spruce-fir
Red crossbill (type I)	*Loxia curvirostra*	I	High-elevation spruce-fir
Northern pinesnake	*Pituophis melanoleucus*	I	Dry upland forest on ridges
Northern saw-whet owl	*Aegolius acadicus*	II	High-elevation spruce-fir
Tiger salamander	*Ambystoma tigrinum*	II	Fish-free ponds in wooded areas
Weller's salamander	*Plethodon welleri*	II	High-elevation spruce-fir
Appalachian winter wren	*Troglodytes troglodytes pullus*	II	Cool moist forest with thickets
Pygmy salamander	*Desmognathus wrighti*	III	High-elevation spruce-fir or mature cove forest
Brown creeper	*Certhia americana*	IV	Mature montane spruce-fir (breeding)
Yellow-throated vireo	*Vireo flavifrons*	IV	Tall forest with partially open canopy

Table 6.10. Mixed forest species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Carolina northern flying squirrel	*Glaucomys sabrinus coloratus*	I	High-elevation spruce-fir component
Red crossbill (Type 1)	*Loxia curvirostra*	I	High-elevation spruce-fir component
Shenandoah salamander	*Plethodon shenandoah*	I	Talus slopes; three locations

Common Name	Scientific Name	Tier	Special Habitat Needs
Appalachian yellow-bellied sapsucker	*Sphyrapicus varius appalachiensis*	I	High-elevation forest with large deciduous portion
Golden-winged warbler	*Vermivora chrysoptera*	I	Regenerating clearcuts with scattered saplings
Northern saw-whet owl	*Aegolius acadicus*	II	High-elevation spruce-fir component
Tiger salamander	*Ambystoma tigrinum*	II	Fish-free ponds in wooded areas
Mountain chorus frog	*Pseudacris brachyphona*	II	Wooded hills with wet areas or pools
Appalachian winter wren	*Troglodytes troglodytes pullus*	II	Cool moist forest with thickets
Jefferson salamander	*Ambystoma jeffersonianum*	IV	Shallow ponds within woodlands
Whip-poor-will	*Caprimulgus vociferus*	IV	Open woods near fields
Chimney swift	*Chaetura pelagica*	IV	Large snags or houses with chimneys
Yellow-billed cuckoo	*Coccyzus americanus*	IV	Open woods with dense understory
Timber rattlesnake	*Crotalus horridus*	IV	South-facing ledges and talus slopes
Gray catbird	*Dumetella carolinensis*	IV	Dense thickets in forest openings or edges
Wood thrush	*Hylocichla mustelina*	IV	Mature upland forest with undergrowth
Rose-breasted grosbeak	*Pheuctitus ludovicianus*	IV	Second-growth mesic forest
Scarlet tanager	*Piranga olivacea*	IV	Mature forest, min size 10-12ha
Prothonotary warbler	*Protonotaria citrea*	IV	Near water
American woodcock	*Scolopax minor*	IV	Moist or wet woods near wetlands
Louisiana waterthrush	*Seiurus motacilla*	IV	Near water

6.3.2.2. Status of Forested Habitats

The 2001 Forest Inventory Analysis (FIA) reported 197,000 acres (80,000ha) of coniferous forest, 1.4 million acres (0.57 million ha) of deciduous forest, 148,000 acres (60,000ha) of mixed forest, and 0.84 million acres (0.34 million ha) of non-forested land in the Blue Ridge.

6.3.2.3. Trends in Forested Habitats

According to the 1997 NRI (USDA 2000), forestland in the Blue Ridge increased slightly (> 10,000ha increase). This does not include > 0.5 million acres of Federal land in the ecoregion, much of which is forested. Forest trends by type are not available at the ecoregional level. Please see Section 3.2.3.1 for statewide status and trends in forested habitats.

6.3.3. Open Vegetated Habitat Species of Greatest Conservation Need in the Blue Ridge

6.3.3.1. Species of Greatest Conservation Need by Open Vegetated Habitat Type

Of the 32 tiered species that occur in open habitats in the Blue Ridge, 14 are generalists that occur in all open vegetated habitat types (Table 6.11). Of the remaining 17 species, 10 occur in herbaceous open habitats (Table 6.12) and seven occur in scrub-shrub (Table 6.13).

Table 6.11. Open vegetated habitat generalist species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Loggerhead shrike	*Lanius ludovicianus*	I	Scattered perches over short vegetation
Buffalo Mountain mealybug	*Puto koszterabi*	I	Poverty oatgrass glades

Common Name	Scientific Name	Tier	Special Habitat Needs
Golden-winged warbler	*Vermivora chrysoptera*	I	Old fields with scattered saplings
Northern harrier	*Circus cyaneus*	III	Damp to wet fields with few trees/shrubs
Eastern box turtle	*Terrapene carolina*	III	Dense groundcover, some shrubs
Whip-poor-will	*Caprimulgus vociferus*	IV	Forages over open fields
Northern bobwhite	*Colinus virginianus*	IV	Grassy fields with shrubby cover, also agricultural fields (active and fallow)
Prairie warbler	*Dendroica discolor*	IV	Open habitat with some trees or shrubs
Eastern hog-nosed snake	*Heterodon platirhinos*	IV	Ecotonal areas with sandy soils
Yellow-breasted chat	*Icteria virens*	IV	Dense tall vegetation
Eastern towhee	*Pipilo erythrophthalmus*	IV	Dense tall vegetation
American woodcock	*Scolopax minor*	IV	Fields for foraging and in winter
Field sparrow	*Spizella pusilla*	IV	Weedy fields with scattered shrubs
Brown thrasher	*Toxostoma rufum*	IV	Dense tall vegetation
Eastern kingbird	*Tyrannus tyrannus*	IV	Scattered perches (shrubs, trees, fences)

Table 6.12. Herbaceous habitat species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Wood turtle	*Glyptemys insculpta*	I	Clear streams
Mountain chorus frog	*Pseudacris brachyphona*	II	Breeds in wet fields near woodlands
Smooth greensnake	*Opheodrys vernalis*	III	High-elevation grassy areas
Barn owl	*Tyto alba*	III	Dense grass near human structures
Grasshopper sparrow	*Ammodramus savannarum*	IV	Grassy fields with few to no shrubs
Chuck-will's-widow	*Caprimulgus carolinensis*	IV	Near pine forest (forages over fields)
Rusty blackbird (winter)	*Euphagus carolinus*	IV	Croplands in winter
Queen snake	*Regina septemvittata*	IV	Open riparian areas
Northern rough-winged swallow	*Stelgidopteryx serripennis*	IV	Stream banks in open areas
Eastern meadowlark	*Sturnella magna*	IV	Grassy fields (pastures, etc.)

Table 6.13. Scrub-shrub habitat species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Northern pinesnake	*Pituophis melanoleucus*	I	Open hilly areas with sandy soils
Yellow-billed cuckoo	*Coccyzus americanus*	IV	Dense shrubby thickets
Willow flycatcher	*Empidonax traillii*	IV	Willow thickets near water
Gray catbird	*Dumetella carolinensis*	IV	Ecotonal thickets and shrubby clearings
Wood thrush	*Hylocichla mustelina*	IV	Shrubby clearings within deciduous forest
Black-and-white warbler	*Mniotilta varia*	IV	Sapling stage of forest clearings
Kirtland's warbler	*Dendroica kirtlandii*	IV	Pine scrub (migration only)

6.3.3.2. Status of Open Habitats

The 1997 NRI reports 18,700 acres (7,600ha) of cultivated cropland and 0.5 million acres (0.2 million ha) of noncultivated cropland, CRP, and pasture in the Blue Ridge (USDA 2000). This does not include > 0.5 million acres of Federal land in the ecoregion (USDA 2000).

6.3.3.3. Trends in Open Habitats

According to USDA (2000), during the period from 1982 through 1997, cultivated cropland decreased by > 30,000 acres (> 12,000ha) and pastureland, CRP, and non-cultivated cropland decreased by > 70,000 acres (> 28,000ha) in the Blue Ridge. These totals do not include > 0.5 million acres of federal land in the ecoregion. Please see Section 3.2.3.2 for statewide status and trends in open habitats for Virginia.

6.3.4. Barren Habitat Species of Greatest Conservation Need in the Blue Ridge

6.3.4.1. Species of Greatest Conservation Need by Barren Habitat Type

Of the 13 tiered species that occur in barren or developed habitats in the Blue Ridge, eight occur primarily in developed residential areas (Table 6.14), five occur in other barren areas (Table 6.15), and one occurs on balds (Table 6.16).

Table 6.14. Developed habitat generalist species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Eastern box turtle	*Terrapene carolina*	III	Residential areas
Yellow-billed cuckoo	*Coccyzus americanus*	IV	Residential areas
Chuck-will's-widow	*Caprimulgus carolinensis*	IV	Residential areas
Chimney swift	*Chaetura pelagica*	IV	Residential areas (chimneys)
Eastern wood-pewee	*Contopus virens*	IV	Residential areas
Northern rough-winged swallow	*Stelgidopteryx serripennis*	IV	Bridges
Gray catbird	*Dumetella carolinensis*	IV	Residential areas
Brown thrasher	*Toxostoma rufum*	IV	Residential areas

Table 6.15. Other barren habitat species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Northern pinesnake	*Pituophis melanoleucus*	I	Open rocky areas
Peregrine falcon	*Falco peregrinus*	I	Cliffs
Timber rattlesnake	*Crotalus horridus*	IV	Ledges and talus slopes
Northern rough-winged swallow	*Stelgidopteryx serripennis*	IV	Sand pits
Allegheny woodrat	*Neotoma magister*	IV	Cliffs, ledges, rockslides

Table 6.16. Balds species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Smooth greensnake	*Opheodrys vernalis*	III	Balds and rock piles

Beach species of greatest conservation need in the Blue Ridge

Appropriate beaches do not occur in the Blue Ridge of Virginia.

6.3.4.2. Status of Barren Areas

The 1997 NRI reports 180,000 acres (73,000ha) of urban and built-up land in the Blue Ridge (USDA 2000). This does not include > 0.5 million acres of Federal land in the ecoregion (USDA 2000).

6.3.4.3. Trends in Barren Areas

Trends for most barren areas are not available at any scale. However, the NRI (USDA 2000) does track developed areas. Developed areas in the Blue Ridge and Valley increased by > 40,000 acres (> 15,000ha) during the period 1982-1997. Please see Section 3.2.3.3 for statewide status and trends of barren and developed areas in Virginia.

6.3.5. Wetland Species of Greatest Conservation Need in the Blue Ridge

6.3.5.1. Species of Greatest Conservation Need by Wetland Type

Of the 39 tiered species that occur in Blue Ridge wetlands, eight are generalists that may occur in either wetland type (Table 6.17). Of the remaining 30 species, four occur only in emergent wetlands (Table 6.18), while 26 occur in wooded wetlands (Table 6.19).

Table 6.17. Wetland generalist species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Wood turtle	*Glyptemys insculpta*	I	Adjacent to clear streams
Bald eagle	*Haliaeetus leucocephalus*	II	Large trees for nesting
Mountain chorus frog	*Pseudacris brachyphona*	II	Seepage areas in wooded hills
Spotted turtle	*Clemmys guttata*	III	Shallow wetlands
Green heron	*Butorides striatus*	IV	Nests in wooded wetlands, forages in any but avoids open water
Willow flycatcher	*Empidonax traillii*	IV	Willow thickets near water
Eastern spadefoot	*Scaphiopus holbrookii*	IV	Vernal/temporary pools with sandy soil
Common ribbonsnake	*Thamnophis sauritus*	IV	Access to permanent or semi-permanent water bodies

Table 6.18. Emergent wetland species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Bog turtle	*Glyptemys muhlenbergii*	I	Bogs and wet meadows near small slow streams
Northern harrier	*Circus cyaneus*	III	Fresh marshes
Least bittern	*Ixobrychus exilis*	III	Dense emergent vegetation (*Typha/Carex/Scirpa*)
Yellow warbler	*Dendroica petechia*	IV	Willow thickets near water

Table 6.19. Wooded wetland species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Tiger salamander	*Ambystoma tigrinum*	II	Fish-free ponds in wooded areas
Yellow-crowned night-heron	*Nyctanassa violacea*	II	Wooded wetland with open understory
Appalachian winter wren	*Troglodytes troglodytes pullus*	II	Cool moist forests with thickets
Blue Ridge two-lined salamander	*Eurycea wilderae*	III	Rocky streams or seeps
Eastern box turtle	*Terrapene carolina*	III	Forest generalist
Jefferson salamander	*Ambystoma jeffersonianum*	IV	Shallow ponds in deciduous/mixed forest
Brown creeper	*Certhia americana*	IV	Mature montane spruce-fir (breeding)
Yellow-billed cuckoo	*Coccyzus americanus*	IV	Dense thickets in deciduous bottomland

Common Name	Scientific Name	Tier	Special Habitat Needs
Eastern wood-pewee	*Contopus virens*	IV	Seasonally-flooded bottomland forest
Blue Ridge dusky salamander	*Desmognathus orestes*	IV	Wet areas in and around seeps and small streams
Gray catbird	*Dumetella carolinensis*	IV	Dense shrubs near water
Rusty blackbird (winter)	*Euphagus carolinus*	IV	Trees near marshes or wooded swamps
Worm-eating warbler	*Helmitheros vermivorus*	IV	Thick understory near water
Wood thrush	*Hylocichla mustelina*	IV	Mature forest
Black-and-white warbler	*Mniotilta varia*	IV	Hardwood swamps and bottomlands
Kentucky warbler	*Oporornis formosus*	IV	Dark, wooded swamps
Northern Parula	*Parula americana*	IV	Wooded swamps with tree moss present
Rose-breasted grosbeak	*Pheuctitus ludovicianus*	IV	Deciduous wooded swamps
Scarlet tanager	*Piranga olivacea*	IV	Mature bottomland forest
Prothonotary warbler	*Protonotaria citrea*	IV	Open wooded swamps with snags
Eastern mud salamander	*Pseudotriton montanus*	IV	Muddy areas along streams or wetlands, usually < 700m elevation
Queen snake	*Regina septemvittata*	IV	Water with overhanging branches
American woodcock	*Scolopax minor*	IV	Moist or wet woods near wetlands
Louisiana waterthrush	*Seiurus motacilla*	IV	Wooded streams or wooded swamps
Diana fritillary	*Speyeria Diana*	IV	Streamside forests with *Viola* spp.
Yellow-throated vireo	*Vireo flavifrons*	IV	Wooded swamps

6.3.5.2. Status and Trends of Wetlands

According to the 1992 NLCD (USGS 1992), the Blue Ridge contains 942ha of wooded or shrubby wetlands and 424ha of emergent wetlands.

Trends in wetlands are not currently available at an ecoregional level for Virginia. Please see Section 3.2.3.4 for statewide status and trends of wetlands in Virginia.

6.4. Aquatic Species in the Blue Ridge

6.4.1. Blue Ridge -Holston EDU

The Blue Ridge-Holston River EDU is part of the Tennessee-Cumberland freshwater ecoregion, which is considered "globally outstanding" in terms of biological distinctiveness (Abell et al. 2000) (Figure 6.18). Abell et al. (2000) also considered this freshwater ecoregion to be "Endangered." The Tennessee drainage contains the most diverse fish assemblage in North America (Jenkins and Burkhead 1994). There is a high level of endemism in this freshwater ecoregion, with 29% of the fish, 16% of the mussels, and 62% of the crayfish considered to be endemic (Abell et al. 2000).

The Holston River has three primary branches in Virginia: the South, Middle, and North Forks. The Holston River itself does not flow in Virginia. The South Fork and Middle Fork join and then merge with the North Fork just a few kilometers south of the border with Tennessee. Most of the Holston in Virginia drains the Northern Ridge and Valley ecoregion, with a few tributaries draining the Blue Ridge and Southern Cumberland Mountains ecoregions.

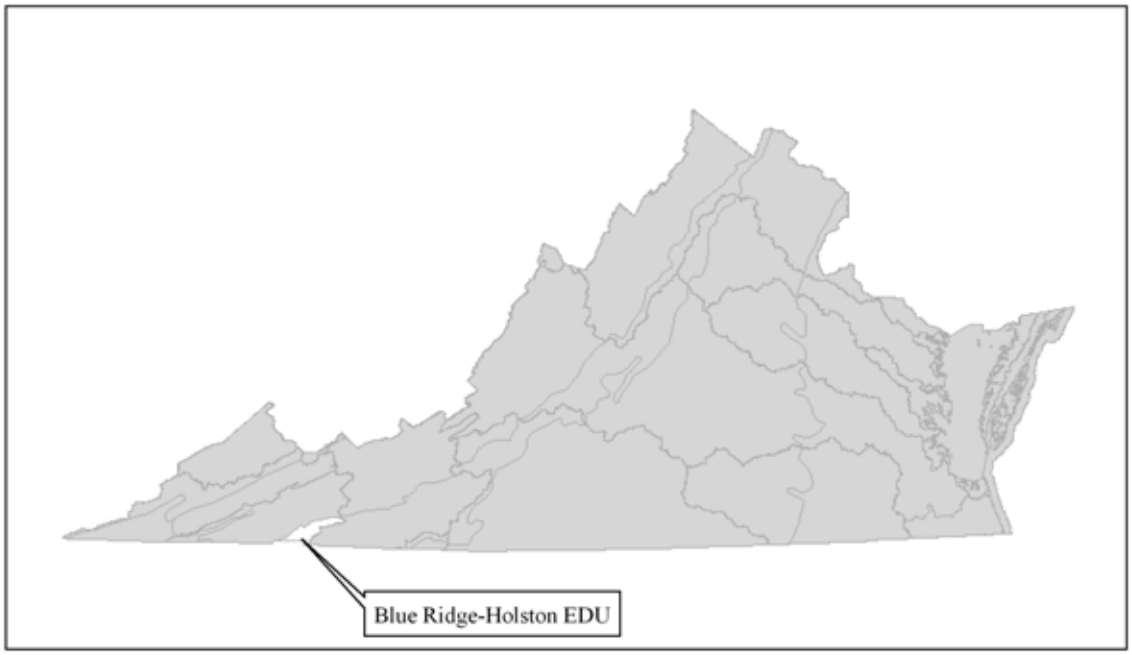

Figure 6.18. Location of the Blue Ridge-Holston EDU.

6.4.1.1. Tier I Species in the Blue Ridge-Holston EDU

6.4.1.1.1. Tennessee dace, *Phoxinus tennesseensis*

Life History Summary

The Tennessee dace has been shown to eat mostly living and decaying plant material (Starnes and Jenkins 1988). Maturity is not reached until after the first year, and its life span is likely three years (Burkhead and Jenkins 1991). The largest known specimen in Virginia was 58mm. This species breeds in May (Jenkins and Burkhead 1994). The Tennessee dace is legally protected, with the status of State endangered. It has also been designated a species of concern by the Virginia Field Office of USFWS.

Location

Most records of the Tennessee dace are in the Ridge and Valley-Holston drainage (see Chapter 7). However, since it is a headwater species, some streams draining the Blue Ridge are known or potential habitat. The map of Tennessee dace habitat (Figure 6.19) includes confirmed reaches based on Collections (DGIF 2004) and potential reaches selected from DGIF's aquatic habitat classification based on link magnitude. For more details, see Appendix D.

Description of Essential Habitat

The Tennessee dace occurs in clear, small, cool to cold creeks with rock, gravel, or silt substrates (Jenkins and Burkhead 1994). It typically prefers wooded reaches, though a large population was found in a reach surrounded by pasture. Studies of habitat use in Lick Creek and Lynn Camp Creek only found the Tennessee dace in pools (Underwood and Dolloff 1999). It was not found in any of the sampled riffles. It is also found in standing pools in otherwise dry streams (M.J. Pinder, DGIF, pers.comm.).

An evaluation of this species' habitat use was completed using the DGIF aquatic habitat classification. In the entire Holston watershed, this species was found in six habitat types; in the Blue Ridge-Holston EDU it was found in only one habitat type (Table 6.20).

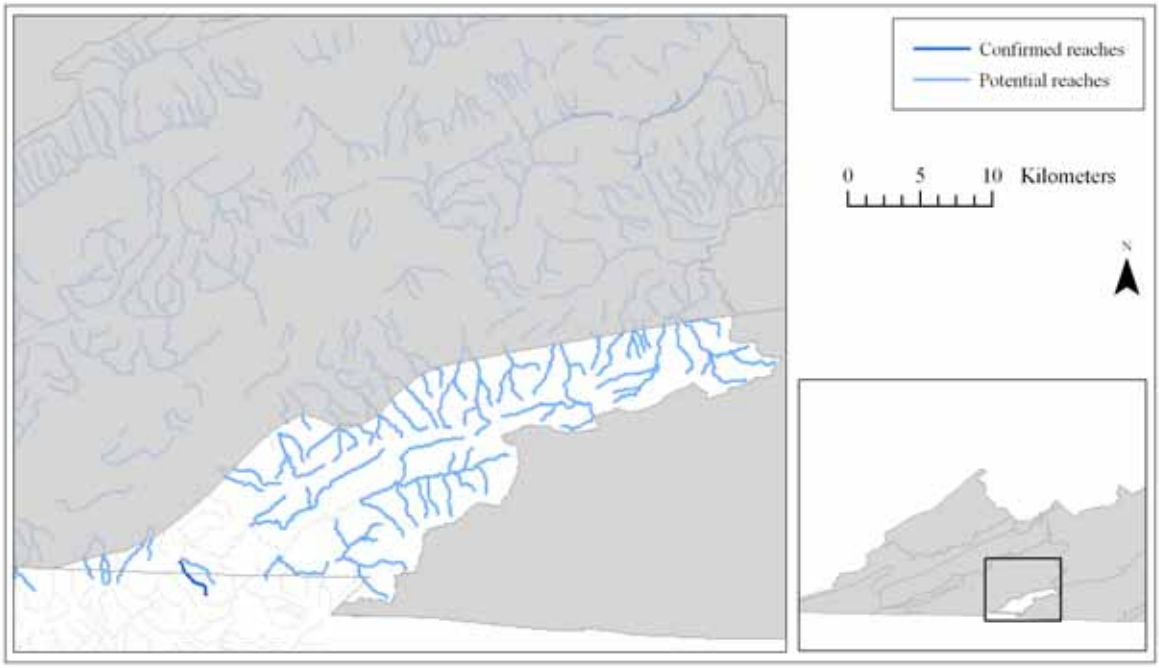

Figure 6.19. Location of confirmed and potential Tennessee dace habitat in the Blue Ridge-Holston EDU.

Table 6.20. DGIF aquatic habitat types used by Tennessee dace in the Blue Ridge-Holston EDU.

Aquatic Habitat Type	Number of Reaches
High gradient headwater stream connected to a large stream	1

Relative Condition of Habitat

None of the known habitat for the Tennessee dace is within impaired waters (DEQ and DCR 2004). However, it is believed that much of the potential or historic habitat for this species has been destroyed or degraded (DGIF 2001).

Specific Threats and Trends

Populations of Tennessee dace have been reduced due to habitat destruction and degradation (DGIF 2001). Current threats include channelization, impoundment, excessive siltation through removal of riparian vegetation or construction, flow impermanence, overcollection via bait seining, and introduction of the mountain redbelly dace *Phoxinus oreas* (Burkhead and Jenkins 1991; DGIF 2001).

Fish TAC (2004) did not identify any specific threats to the Tennessee dace. However, they identified several threats to the Holston River drainage (Appendix H).

Conservation Actions and Strategies

The DGIF recovery plan for the Tennessee dace recommends protection, maintenance, and enhancement of existing populations and habitats as its top priority conservation actions (DGIF 2001). It further lists eliminating or minimizing threats and soliciting widespread support for the recovery plan as important conservation actions. More detailed conservation actions include protecting current habitats from channelization and impoundment, prohibiting activities that jeopardize the stability of the riparian corridor, and prohibiting bait seining and bait fishing in streams containing Tennessee dace (Burkhead and Jenkins 1991; DGIF 2001).

Fish TAC (2004) identified a suite of conservation actions for the Holston River drainages (Appendix I), but nothing specific to this species.

Research and Monitoring Needs

Several research and monitoring needs have been identified for Tennessee dace. These include monitoring existing populations and habitats; identifying current and foreseeable threats; investigating the effects of trout stocking; and examining the feasibility of reintroducing the Tennessee dace into watersheds within its historic range (Burkhead and Jenkins 1991; DGIF 2001). Fish TAC (2004) identified several research or monitoring needs for the Holston River drainage (Appendix J), but nothing specific to the Tennessee dace.

6.4.1.1.2. Cryptic willowfly, *Taeniopteryx nelsoni*

Life History Summary

The cryptic willowfly is very rare, known only from the streams of Mount Rogers, Virginia (Kondratieff and Kirchner 1991). Little is known of the life history of this species; however, it is assumed similar to other stoneflies in this genus. Adults emerge in early February (Kondratieff and Kirchner 1991). This species has been designated a species of concern by the Virginia Field Office of USFWS.

Location

The map of habitat for the cryptic willowfly (Figure 6.20) includes only Grindstone Branch, digitized from topographic maps (1:24,000, USGS 1995). This is one of two reaches with confirmed records for this species (Kondratieff and Kirchner 1991).

Description of Essential Habitat

Essential habitat for this species is uncertain. It has been found in clear, cold, headwater mountain streams with rocky substrates and alternating riffle and pool structure (Kondratieff and Kirchner 1991). Elevation of these sites is approximately 1300m. They are typically associated with detritus in deeper riffles and pools.

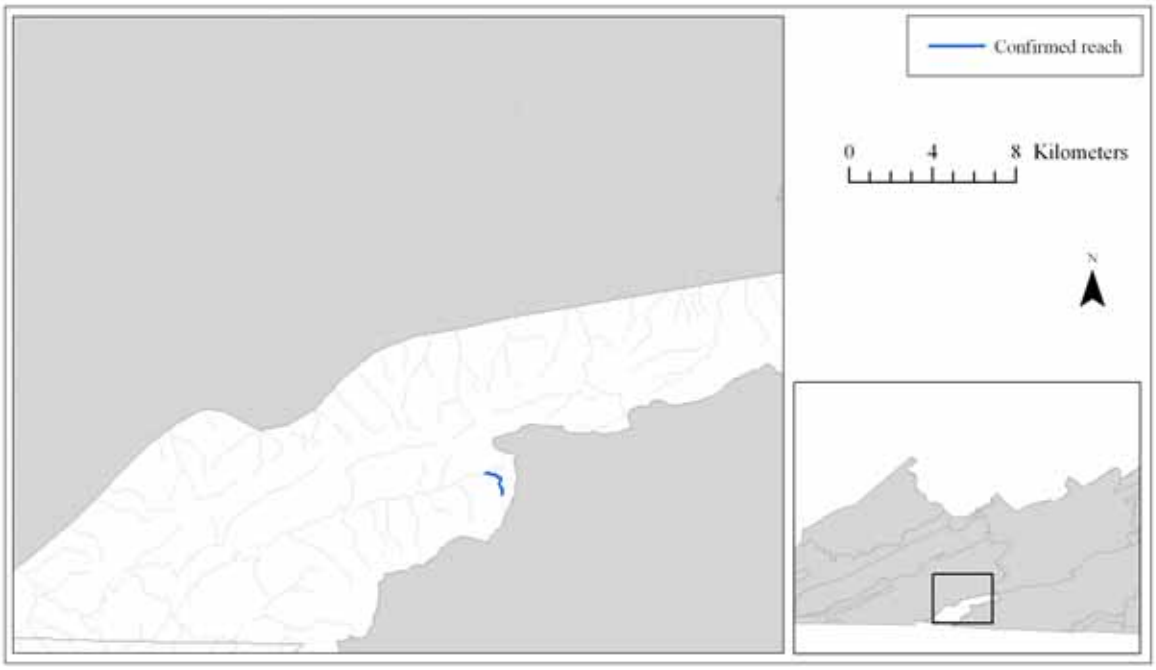

Figure 6.20. Location of confirmed cryptic willowfly habitat in the Blue Ridge-Holston EDU.

Relative Condition of Habitat

Kondratieff and Kirchner (1991) report that there were currently no problems with the habitat at this location. However, any development at Mount Rogers National Recreation Area since that time may have impacted this location. The known habitat for the cryptic willowfly has not been identified as impaired (DEQ and DCR 2004).

Specific Threats and Trends

Kondratieff and Kirchner (1991) indicate that habitat destruction from expansion of the recreational facilities at Mount Rogers National Recreation Area is a potential threat to this species. Cattle grazing along Lewis Fork are also indicated as a threat.

Conservation Actions and Strategies

Kondratieff and Kirchner (1991) recommend avoiding further development of the watersheds within the distribution of this species.

Research and Monitoring Needs

Water quality and habitat monitoring should be established to pinpoint any deterioration of habitat quality (Kondratieff and Kirchner 1991). Life history data are needed for this species.

6.4.1.2. Aquatic SGCN by Habitat Group: Blue Ridge-Holston EDU

Two habitat groups were identified for tiered species in the Blue Ridge-Holston EDU (Tables 6.21 and 6.22). There were 11 species for which a habitat group could not be identified (Table 6.23). There are a total of 12 fish, one amphibian, one aquatic insect, and one mussel located in this EDU.

Table 6.21. Aquatic species of greatest conservation need in small to large streams with low to moderate gradient connected to similarly sized streams (DGIF classification types 222, 223, 232, and 332).

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
Greenfin darter	*Etheostoma chlorobranchium*	II	100	4
Swannanoa darter	*Etheostoma swannanoa*	IV	100	4

Table 6.22. Aquatic species of greatest conservation need in headwater and small streams with low to high gradient (DGIF classification types 114, 123, 124, 134, 222, 223, and 232).

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
Tennessee dace	*Phoxinus tennesseensis*	I	100	1 (1 occurrence)
Black sculpin	*Cottus baileyi*	IV	85	7

Table 6.23. Aquatic species of greatest conservation need: generalists and those with unknown habitat requirements.

Common Name	Scientific Name	Tier	Number of Types Used (DGIF Aquatic Classification)
Cryptic willowfly	*Taeniopteryx nelsoni*	I	NA
Eastern hellbender	*Cryptobranchus alleganiensis*	II	NA
Wounded darter	*Etheostoma vulneratum*	III	1 (1 occurrence)
Mountain brook lamprey	*Icthyomyzon greeleyi*	III	1 (1 occurrence)
Fatlips minnow	*Phenacobius crassilabrum*	III	1 (1 occurrence)
Banded darter	*Etheostoma zonale*	IV	1 (1 occurrence)
American brook lamprey	*Lampetra appendix*	IV	1 (1 occurrence)
Mirror shiner	*Notropis spectrunculus*	IV	1 (1 occurrence)
Logperch	*Percina caprodes*	IV	1 (1 occurrence)
Gilt darter	*Percina evides*	IV	1 (1 occurrence)
Creeper mussel	*Strophitus undulates*	IV	NA

Relative Condition of Habitat

Within the Blue Ridge-Holston EDU, nearly 8% of the riverine habitat is impaired (DEQ and DCR 2004). The impairments are fecal coliform from unknown sources. Within this EDU, 4.6% of the land cover is agricultural and 0.8% is developed (USGS 1992). Within the state, agricultural land cover ranges from 2 to 41%, and developed land use ranges from 0.4 to 15%.

Threats, conservation actions, and research and monitoring needs for the Tier II through Tier IV species are available in Appendices H, I, and J. Mussel TAC (2004) and Fish TAC (2004) provided this information within habitat groups selected at the workshops. The level of detail within these groups does not correspond to that used in the DGIF aquatic habitat classification.

6.4.2. Blue Ridge-New EDU

The Ridge and Valley-New EDU is part of the Teays-Old Ohio freshwater ecoregion (Abell et al. 2000) (Figure 6.21). The Teays-Old Ohio is considered "globally outstanding" because of the large number of species found here, second only to the Tennessee-Cumberland freshwater ecoregion. The level of endemism is considered moderately high, with 12% of fish, 14% of mussels, and 47% of crayfish found nowhere else. Abell et al. (2000) consider this region to be "Vulnerable."

The headwaters of the New River are in North Carolina. The river then cuts north across Virginia and enters West Virginia (Jenkins and Burkhead 1994). Approximately 245km flow through Virginia. Most of the drainage is located in the Ridge and Valley and Blue Ridge ecoregions.

6.4.2.1. Tier I Species in the Blue Ridge-New EDU

6.4.2.1.1. Cryptic willowfly, *Taeniopteryx nelsoni*

Life History Summary

The cryptic willowfly is very rare, known only from the streams of Mount Rogers, Virginia (Kondratieff and Kirchner 1991). Little is known of the life history of this species; however, it is assumed to be similar to other stoneflies in this genus. Adults emerge in early February (Kondratieff and Kirchner 1991). This species has been designated a species of concern by the Virginia Field Office of USFWS.

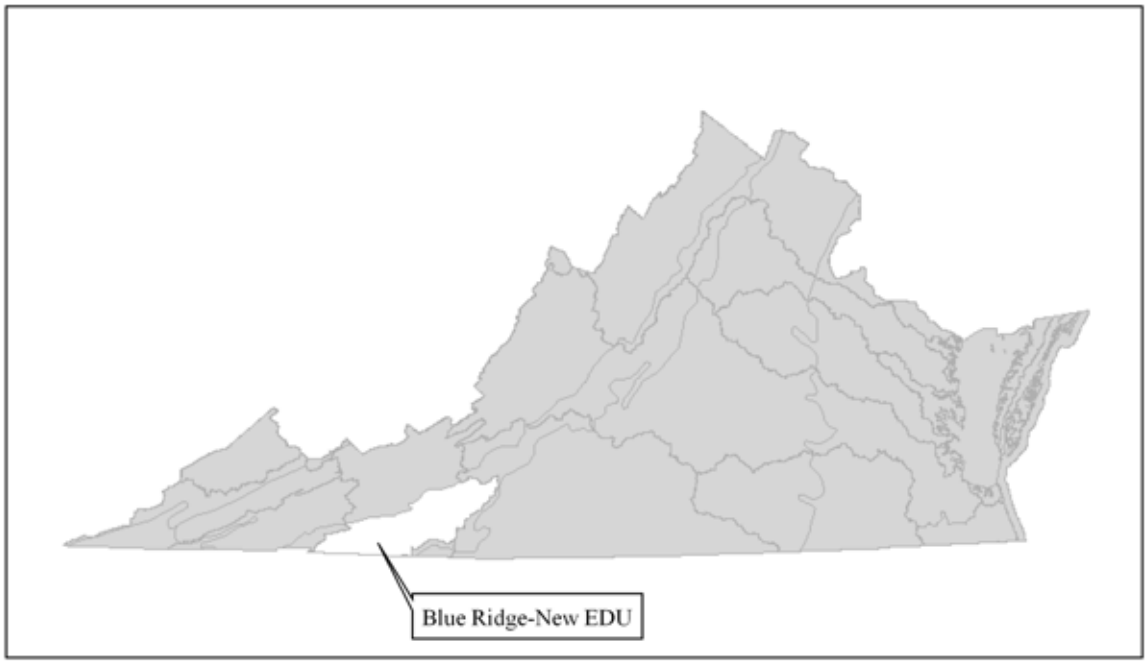

Figure 6.21. Location of the Blue Ridge-New EDU.

Location

The map of habitat for the cryptic willowfly (Figure 6.22) includes Lewis Fork from DGIF's aquatic habitat classification. This is one of two reaches with confirmed records for this species (Kondratieff and Kirchner 1991).

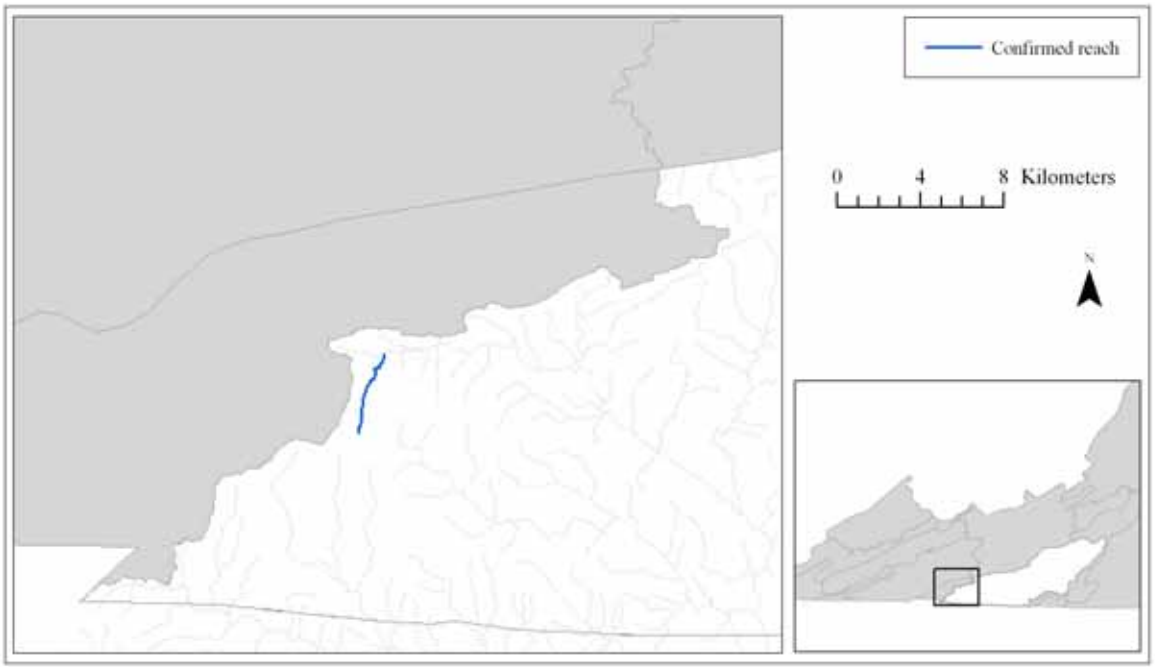

Figure 6.22. Location of confirmed cryptic willowfly habitat in the Blue Ridge-New EDU.

Description of Essential Habitat

Essential habitat for this species is uncertain. It has been found in clear, cold, headwater mountain streams with rocky substrates and alternating riffle and pool habitat structure (Kondratieff and Kirchner 1991). The elevation of these sites is approximately 1300m. They are typically associated with detritus in deeper riffles and pools. The DGIF habitat classification for the reach in which this species has been found supports these habitat descriptions (Table 6.24).

Table 6.24. DGIF aquatic habitat types used by cryptic willowfly in the Blue Ridge-New EDU.

Aquatic Habitat Type	Number of Reaches
High gradient headwater connected to another headwater	1

Relative Condition of Habitat

Kondratieff and Kirchner (1991) report that there were currently no problems with the habitat at this location. However, any development at Mount Rogers National Recreation Area since that time may have impacted this location. The known habitat for the cryptic willowfly has not been identified as impaired (DEQ and DCR 2004).

Specific Threats and Trends

Kondratieff and Kirchner (1991) indicated that habitat destruction from expansion of recreational facilities at Mount Rogers National Recreation area is a potential threat to this species. Cattle grazing along Lewis Fork is also indicated as a threat.

Conservation Actions and Strategies

Kondratieff and Kirchner (1991) recommend avoiding further development of the watersheds within the distribution of this species.

Research and Monitoring Needs

Water quality and habitat monitoring should be established to pinpoint any deterioration (Kondratieff and Kirchner 1991). Life history data are needed for this species.

6.4.2.2. Aquatic SGCN by Habitat Group: Blue Ridge-New EDU

There are 16 tiered species in the Blue Ridge-New EDU. These species are distributed among two habitat groups and one unknown or generalist group (Tables 6.25-6.27). The SGCN are represented by six fish, one amphibian, two mussels, one snail, three aquatic insects, and two crayfish.

Table 6.25. Aquatic species of greatest conservation need in small streams, large streams, and small rivers with very low to moderate gradient connected to similarly sized streams (DGIF classification types 221, 221w, 222, 222w, 223, 223w, 331, 331w, 441, and 442).

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
Kanawha darter	*Etheostoma kanawhae*	III	93	12
Kanawha minnow	*Phenacobius teretulus*	III	93	14
New River shiner	*Notropis scabriceps*	IV	96	11
Appalachia darter	*Percina*	IV	98	6

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
Sharpnose darter	*gymnocephala Percina oxyrhynchus*	IV	97	7

Table 6.26. Aquatic species of greatest conservation need in small to large streams with very low to moderate gradient connected to similarly sized streams (DGIF classification types 221, 222, 223, 231, and 331).

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
New River riffle crayfish	*Cambarus chasmodactylus*	IV	73	9
Scioto crayfish	*Cambarus sciotensis*	IV	80	7

Table 6.27. Aquatic species of greatest conservation need: generalists and those with unknown habitat requirements.

Common Name	Scientific Name	Tier	Number of Types Used (DGIF Aquatic Classification)
Cryptic willowfly	*Taeniopteryx nelsoni*	I	NA
Benfield's bearded small minnow mayfly	*Barbaetis benfieldi*	II	NA
Eastern hellbender	*Cryptobranchus alleganiensis*	II	2 (2 occurrences)
Green floater	*Lasmigona subviridis*	II	2 (2 occurrences)
Mountain river cruiser	*Macromia margarita*	II	NA
Seep mudalia	*Leptoxis dilatata*	IV	NA
Logperch	*Percina caprodes*	IV	4 (7 occurrences)
Pistolgrip mussel	*Tritogonia verrucosa*	IV	1 (1 occurrence)

Relative Condition of Habitat

Within the Blue Ridge-New EDU, approximately 9% of the riverine habitat is impaired (DEQ and DCR 2004). The impairments include fecal coliform, *Escherichia coli*, temperature, fish tissue contamination (mercury), and general standard benthics. The sources of these impairments are unknown, non-point sources (agriculture, wildlife, and residential), livestock grazing and feeding operations, and resource extraction. Over 31% of the land cover in this EDU is agricultural, and less than 1% is developed. Within the state, agricultural land cover ranges from 2 to 41%, and developed land use ranges from 0.4 to 15%.

Threats, conservation actions, and research and monitoring needs for the Tier II through Tier IV species are identified in Appendices H, I, and J. Mussel TAC (2004) and Fish TAC (2004) provided this information within habitat groups selected at the workshops. The level of detail within these groups does not correspond to that used in the DGIF aquatic habitat classification.

6.4.3. Blue Ridge-Roanoke EDU

The headwaters of the Roanoke River drain the Northern Ridge and Valley and Blue Ridge Mountains of Virginia (Figure 6.23). The Roanoke drains the Piedmont, then crosses into North Carolina before entering

the Mid-Atlantic Coastal Plain. Several rivers within the drainage are significant on their own and include the Dan, Smith, Mayo, and Banister rivers.

The Roanoke joins the Pee Dee and Chowan drainages to form the South Atlantic freshwater ecoregion, which is considered "globally outstanding" in terms of biological distinctiveness (Abell et al. 2000). The South Atlantic freshwater ecoregion is home to 48 endemic aquatic species (fish, mussels, and amphibians).

6.4.3.1. Tier I Species in the Blue Ridge-Roanoke EDU

6.4.3.1.1. Roanoke logperch, *Percina rex*

Life History Summary

The Roanoke logperch is found only in the Roanoke and Nottoway River systems of Virginia. It is usually rare or uncommon. The populations are disjunct, separated by large stretches of unsuitable river habitat or impoundments (Burkhead and Jenkins 1991). It feeds on immature benthic invertebrates and exhibits the feeding behavior of flipping rocks to expose prey items (Jenkins and Burkhead 1994). The Roanoke logperch spawns in spring and early summer. Recent work (Rosenberger and Angermeier 2003) reveals that throughout its life, the Roanoke logperch inhabits a changing and varied array of habitats. A preference for relatively silt-free substrates and its restricted distribution have made it vulnerable to extinction. The Roanoke logperch is legally protected, with the status of Federal and State endangered.

Location

The map of habitat for the Roanoke logperch (Figure 6.24) contains confirmed reaches based on Collections (DGIF 2004b) and potential reaches. Potential reaches were determined in DGIF's aquatic habitat classification using reach size, connectivity, gradient and elevation. See Appendix D for details.

Description of Essential Habitat

The most "essential" aspect of Roanoke logperch habitat is silt-free, unembedded substrate including clean sand, as well as larger particles (P. L. Angermeier, VCFWRU, pers. comm.). In the Roanoke River, this species occupies warm, moderate to large streams and small rivers. Rosenberger and Angermeier (2003).found that there were shifts in habitat use across life stages and between drainages. Adult and subadult logperch were found in runs, riffles, and pools, in order of preference, while YOY were found exclusively in backwaters and secondary channels. Adults were observed in the deepest water (mean of 52.5cm) of significantly higher velocity than subadults or YOY.

Roanoke logperch is intolerant of moderately to heavily silted areas except in winter periods of inactivity (Jenkins and Burkhead 1994). In the warmer months, the adults are usually found on gravel and rubble in runs and riffles, occasionally pools. When the water temperature drops below 8°C, this species becomes quiescent under rocks in pools. Prior to spawning, the adults segregate, with the males going to the riffles and the females to deeper runs.

The DGIF aquatic habitat classification was also used to identify the diversity of habitat types used by Roanoke logperch and to assess patterns of distribution (Table 6.28). Neither headwaters nor large rivers were used by Roanoke logperch. Most of the specimens were collected from reaches characterized as large streams to small rivers with very low gradient across the length of the reach.

Relative Condition of Habitat

All but three known reaches for the Roanoke logperch in the Blue Ridge-Roanoke EDU are impaired (DEQ and DCR 2004). The impairments include bacteria, temperature, fish tissue contamination (PCBs), and general standard benthics. The sources of impairment include non-point source urban (primarily), agriculture, wildlife, and residential, but the source of many of the impairments is unknown.

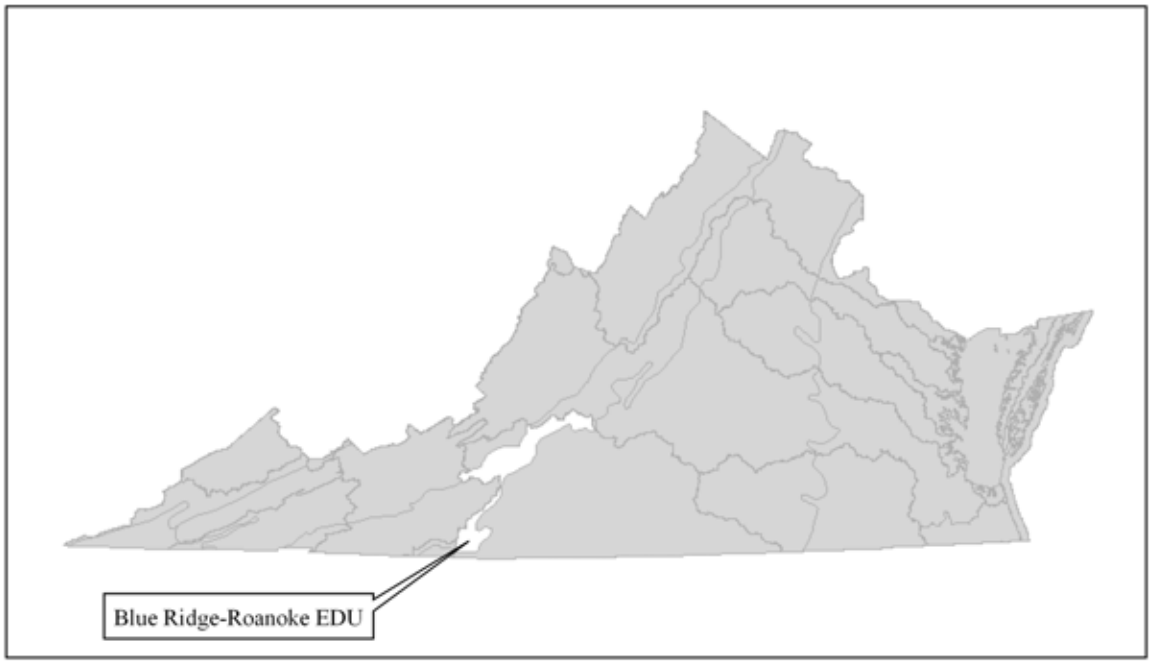

Figure 6.23. Location of the Blue Ridge-Roanoke EDU.

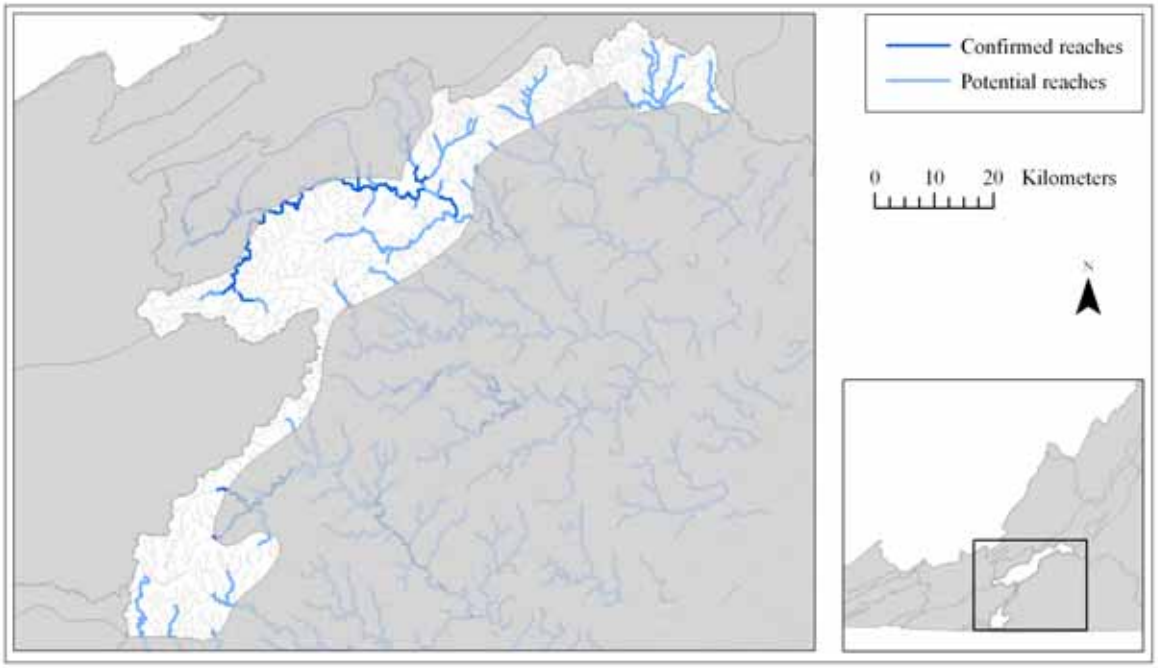

Figure 6.24. Confirmed and potential Roanoke logperch habitat in the Blue Ridge-Roanoke EDU.

Table 6.28. DGIF aquatic habitat types used by Roanoke logperch in the Blue Ridge-Roanoke EDU.

Aquatic Habitat Type	Number of Reaches
Very low gradient large streams connected to other large streams	17
Very low gradient small rivers connected to other small rivers	5
Low gradient small streams connected to large streams	3
Low gradient small streams connected to other small streams	3

Aquatic Habitat Type	Number of Reaches
Low gradient large streams connected to other large streams	2
Very low gradient small streams connected to large streams	1
Low gradient small river connected to other small rivers	1
Low gradient small river connected to other small rivers (impoundment or wetland)	1

Specific Threats and Trends

Burkhead and Jenkins (1991) list channelization, siltation, chronic pollution of various types, catastrophic chemical spills, impoundment and dewatering as major stresses to this species. In addition, a report by Wheeler et al. (2003) describes many potential direct and indirect effects, including those mentioned above, from the proposed construction of I-73 on the Roanoke logperch and other aquatic biota. No species-specific threats were listed by the Fish TAC (2004) for the Roanoke logperch. A summary of the stresses and sources of stress identified for the Roanoke River drainage is available in Appendix H.

Conservation Actions and Strategies

Burkhead and Jenkins (1991) list several specific conservation actions, and generally recommend long-term bank stabilization and better monitoring and enforcement of regulations regarding silt control in construction projects to reduce sedimentation. They also recommend the review of discharge permits to evaluate cumulative concentration of effluents in the Roanoke drainage. The USFWS identified four actions needed to meet the recovery objectives listed in this species' recovery plan (USFWS 1992). They include using existing legislation to protect it; developing educational programs and other resources to inform the public about the species and its status; determining feasibility of re-establishing or reintroducing populations where appropriate; and implementing measures to reduce sedimentation and other identified threats. More conservation actions related to threats to the Roanoke drainage were identified by Fish TAC (2004) (Appendix I).

Research and Monitoring Needs

Three research or monitoring activities are identified by USFWS to meet the recovery objectives listed in this species' recovery plan (USFWS 1992). These include surveys for additional populations and habitats for possible reintroduction; characterization of the species habitat requirements and population viability, including monitoring of threats; and surveys to monitor population levels and habitat conditions.

6.4.3.2. Aquatic SGCN by Habitat Group: Blue Ridge-Roanoke EDU

There are 14 tiered species in the Blue Ridge-Roanoke EDU. Eleven are fish and three are mussels. They were split among four habitat groups and one unknown or generalist group (Tables 6.29-6.33).

Table 6.29. Aquatic species of greatest conservation need with migratory habits. These species use a range of habitats from large tidal rivers to small streams.

Common Name	Scientific Name	Tier
American eel	*Anguilla rostrata*	IV

Table 6.30. Aquatic species of greatest conservation need in small to large streams with low to moderate gradient connected to similarly sized streams (DGIF classification types 221, 222, 223, 231, 232, 331, 332, and 341).

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
Orangefin madtom	*Noturus gilberti*	II	83	10
Bigeye jumprock	*Moxostoma ariommum*	III	74	11
Roanoke hog sucker	*Hypentelium roanokense*	IV	86	13

Table 6.31. Aquatic species of greatest conservation need in small streams, large streams, and small rivers with very low gradient connected to similarly sized streams (DGIF classification types 222, 231, 232, 331, 332, 441, 442, and 442w).

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
Roanoke logperch	*Percina rex*	I	100	8
Roanoke bass	*Ambloplites cavifrons*	II	91	5
Riverweed darter	*Etheostoma podostemone*	IV	92	17

Table 6.32. Aquatic species of greatest conservation need in headwaters and small streams (DGIF classification types 113, 114, 123, and 222).

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
Rustyside sucker	*Thoburnia hamiltoni*	III	100	4
Redlip shiner	*Notropis chiliticus*	IV	100	1 (type 222)

Table 6.33. Aquatic species of greatest conservation need: generalists and those with unknown habitat requirements.

Common Name	Scientific Name	Tier	Number of Types Used (DGIF Aquatic Classification)
Spotted margined madtom	*Noturus insignis ssp. 1*	II	NA
Notched rainbow	*Villosa constricta*	III	NA
Triangle floater	*Alasmidonta undulata*	IV	NA
Whitemouth shiner	*Notropis alborus*	IV	1 (1 occurrence)
Creeper mussel	*Strophitus undulatus*	IV	NA

Relative Condition of Habitat

Just over 11% of the riverine habitat in the Blue Ridge-Roanoke EDU is impaired (DEQ and DCR 2004). The impairments include bacteria, temperature, fish tissue contamination (PCBs), and general standard benthics. Sources of impairment include non-point source agriculture (to include pasture and grazing), urban, and wildlife. Within this EDU, 4.8% of the land cover is developed and 15% is agricultural (USGS 1992). Within the state, agricultural land cover ranges from 2 to 41%, and developed land use ranges from 0.4 to 15%.

Threats, conservation actions, and research and monitoring needs for the Tier II through Tier IV species are available in Appendices H, I, and J. Mussel TAC (2004) and Fish TAC (2004) provided this information within habitat groups selected at the workshops. The level of detail within these groups does not correspond to that used in the DGIF aquatic habitat classification.

6.4.4. Blue Ridge-Pee Dee EDU

A very small portion of the Pee Dee drainage is located in Virginia (Figure 6.25). The remainder flows through North Carolina and South Carolina. The drainage crosses the Blue Ridge and upper Piedmont. The streams in Virginia are actually part of the Ararat River, which flows into the Yadkin. There are four species and two subspecies of fish that are found only in the Pee Dee drainage in Virginia (Jenkins and Burkhead 1994). Three of them have been identified as SGCN: highback chub *Hybopsis hypsinotus*, thicklip chub *Cyprinella labrosa*, and the Piedmont darter *Percina crassa*.

The Pee Dee joins the Roanoke and Chowan drainages to form the South Atlantic freshwater ecoregion, which is considered "globally outstanding" in terms of biological distinctiveness (Abell et al. 2000). The South Atlantic freshwater ecoregion is home to 48 endemic aquatic species, including fish, mussels, and amphibians.

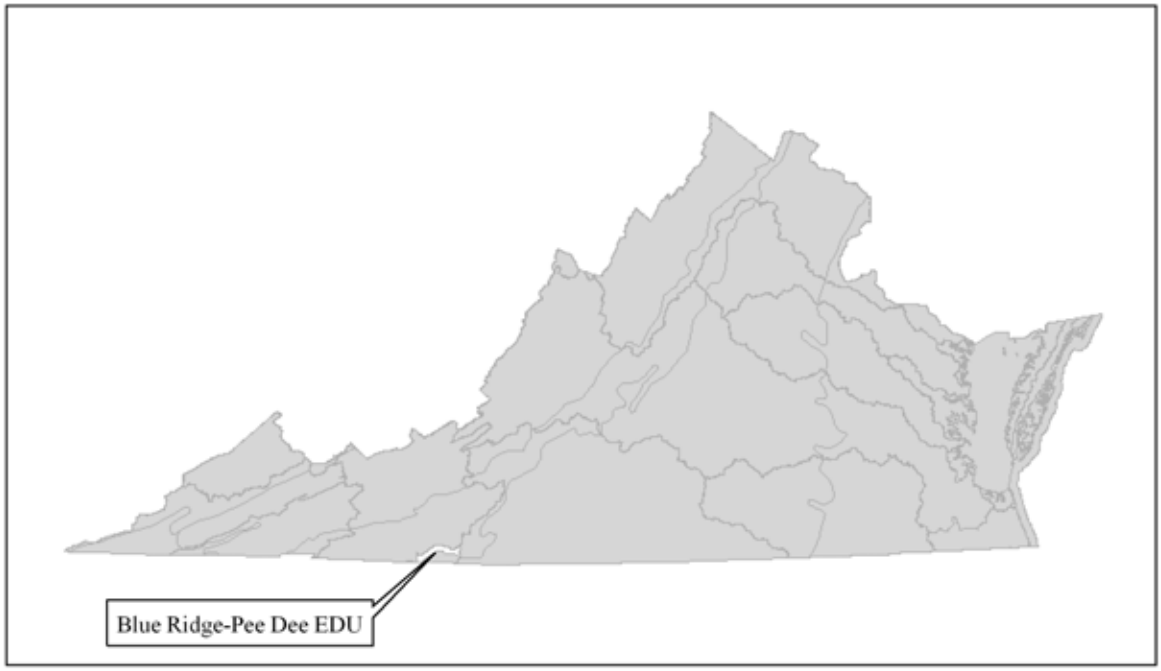

Figure 6.25. Location of the Blue Ridge-Pee Dee EDU.

6.4.4.1. Tier I Species in the Blue Ridge-Pee Dee EDU

There are currently no documented occurrences of Tier I species in the Blue Ridge-Pee Dee EDU.

6.4.4.2. Aquatic Species of Greatest Conservation Need by Habitat Group: Blue Ridge-Pee Dee EDU

Due to a lack of data, no habitat groups were identified in the Blue Ridge-Pee Dee EDU except for the migratory American eel (Tables 6.34 and 6.35).

Table 6.34. Aquatic species of greatest conservation need with migratory habits. These species use a range of habitats from large tidal rivers to small streams.

Common Name	Scientific Name	Tier
American eel	*Anguilla rostrata*	IV

Table 6.35. Aquatic species of greatest conservation need: generalists and those with unknown habitat requirements.

Common Name	Scientific Name	Tier	Number of Types Used (DGIF Aquatic Classification)
Redlip shiner	*Notropis chiliticus*	IV	NA
Piedmont darter	*Percina crassa*	IV	NA

Relative Condition of Habitat

None of the riverine habitat in this EDU is considered impaired (DEQ and DCR 2004). Nineteen percent of the land cover is agricultural and 0.7% is developed (USGS 1992). Within the state, agricultural land cover ranges from 2 to 41%, and developed land use ranges from 0.4 to 15%.

Threats, conservation actions, and research and monitoring needs for the Tier II through Tier IV species are available in Appendices H, I, and J. Mussel TAC (2004) and Fish TAC (2004) provided this information within habitat groups selected at the workshops. The level of detail within these groups does not correspond to that used in the DGIF aquatic habitat classification.

6.4.5. Blue Ridge-James EDU

The James River drainage occurs almost wholly within Virginia and covers over 25% of the land area of the state (Jenkins and Burkhead 1994). It crosses the Ridge and Valley, Blue Ridge, Piedmont, and Coastal Plain. The Ridge and Valley-James EDU (Figure 6.26) is found within the Chesapeake Bay freshwater ecoregion (Abell et al. 2000). As its name implies, this ecoregion encompasses all of the drainages of the Chesapeake Bay. This freshwater ecoregion supports four endemic mussel species and seven endemic fish species, including the roughhead shiner *Notropis semperasper*, found only in the headwaters of the James River. It is also home to several migratory fish including American shad *Alosa sapidissima*, alewife *A. pseudoharengus*, and American eel *Anguilla rostrata*. Abell et al. (2000) list the Chesapeake Bay freshwater ecoregion as "continentally outstanding" in terms of biological distinctiveness.

6.4.5.1. Tier I Species in the Blue Ridge-James EDU

6.4.5.1.1. James spinymussel, *Pleurobema collina*

Life History Summary

Most of the work regarding the Federal and State endangered James spinymussel has involved the James River drainage population. It is a short-term brooder. Hove (1990) identified several fish hosts for this species from work in Craig Creek including rosyside dace *Clinostomus funduloides*, bluehead chub *Nocomis leptocephalus*, mountain redbelly dace *Phoxinus oreas*, blacknose dace *Rhinichthys atratulus*, central stoneroller *Campostoma anomalum*, rosefin shiner *Lythrurus ardens*, satinfin shiner *Cyprinella analostana*, and swallowtail shiner *Notropis procne*. In the James River drainage, this species occupies a wide range of habitats, which suggests that it used to be much more widespread and that its current rarity is due to decline from habitat loss or other external threats, rather than an innate characteristic of the species. This species is legally protected with the status of Federal and State endangered.

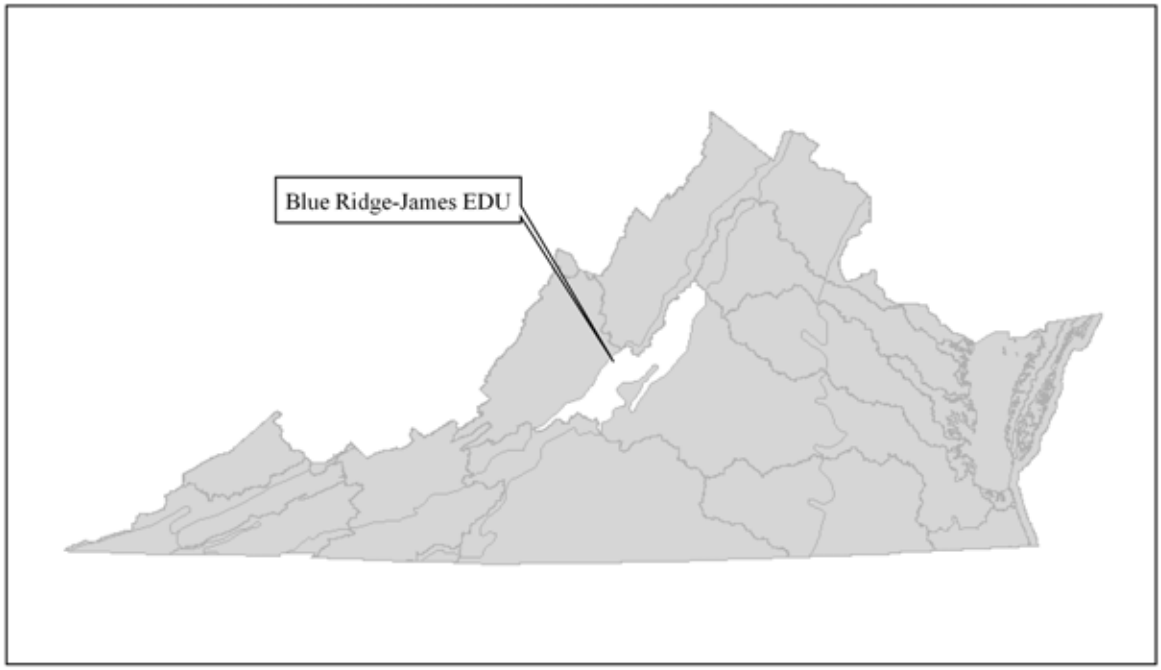

Figure 6.26. Location of the Blue Ridge-James EDU.

Recently (2000-2002), R. J. Neves discovered a population in the Dan River (R. J. Neves, VCFWRU, unpublished data). Little is known about the life history, distribution, or even precise taxonomy of this population. Currently it is considered *Pleurobema collina*; however, research is underway to validate its taxonomy. For management purposes, the populations are currently considered different management units of the same species (B. T. Watson, DGIF, pers. comm.).

Location

The map of habitat for the James spinymussel (Figure 6.27) contains confirmed reaches based on Collections (DGIF 2004b) and potential reaches. Potential reaches were determined in DGIF's aquatic habitat classification using reach size, connectivity and gradient attributes. See Appendix D for details.

Description of Essential Habitat

This species is found in second and third order streams that are unpolluted, well-oxygenated, and of moderate hardness ($CaCO_3$ > 50mg/l). It is found in runs with moderate current and with a sand, gravel, and cobble substrate (Clarke and Neves 1984). Streams containing James spinymussel range from 0.3 - 2m deep and 1 - 20m wide (Hove 1990). They prefer bottom sediments of sand and cobble, with or without boulders, pebbles or silt, and are usually buried in the substrate near stagnant riffle-run flows (Hove 1990).

Extirpated populations may have occurred in larger rivers with sandy bottoms. This species was once more widely distributed throughout the James River drainage and has been significantly reduced to about 5-10% of its historic distribution (B. T. Watson, DGIF, pers. comm.). The DGIF aquatic habitat classification was used to identify the habitat types used by this species and to assess patterns of distribution (Table 6.36). It has been found in six habitat types. All are small to large-sized streams with very low to low gradient.

Relative Condition of Habitat

Approximately 40% of the known habitat for the James spinymussel in the Blue Ridge-James EDU is within or downstream of impaired waters (DEQ and DCR 2004). The impairments are fecal coliform from unknown sources and general standard benthics from unknown sources.

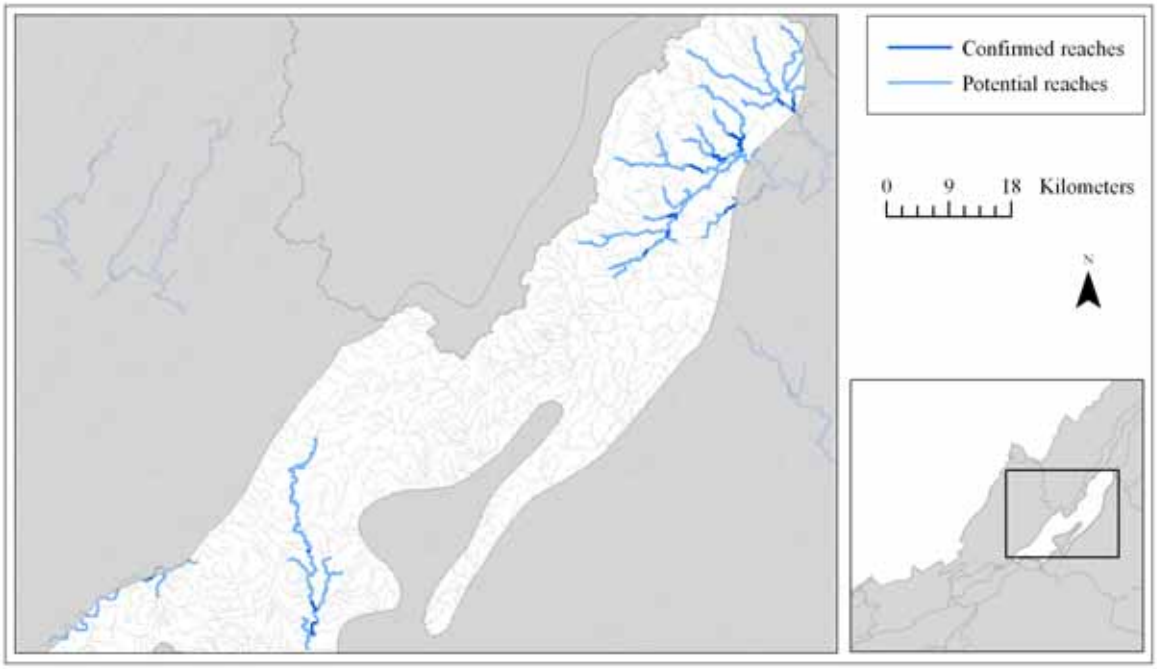

Figure 6.27. Location of confirmed and potential James spinymussel habitat in the Blue Ridge-James EDU.

Table 6.36. DGIF aquatic habitat types used by James spinymussel in the Blue Ridge-James EDU.

Aquatic Habitat Type	Number of Reaches
Very low gradient small streams connected to other small streams	5
Very low gradient small streams connected to large streams	4
Low gradient small streams connected to other small streams	3
Low gradient large streams connected to other large streams	2
Very low gradient large streams connected to other large streams	1
Low gradient small streams connected to large streams	1

Specific Threats and Trends

Neves (1991) suggests that habitat degradation and reproductive isolation have caused the decline of the James spinymussel. Clarke (1986) also lists competition from the Asian clam *Corbicula fluminea* as a possible threat. Table 6.37 summarizes the data on stresses received from Mussel TAC (2004). These cover the threats to both the James River and the Dan River populations, but some of the stresses pertaining to municipal development are not as widespread or severe in the Dan River system.

Table 6.37. Stresses on the James spinymussel (Mussel TAC 2004).

Stress	Source of Stress	Scope	Severity	Comments
Hydrologic regime alteration	a) dam b) water withdrawal c) municipal development d) beaver activity	a) 2 b) 2 c) 2 d) 1	a) 4 b) 2 c) 3 d) 1	Dam building also floods habitat, causing habitat destruction
Sediment load alteration	Municipal development	4	3	
Insecticides	Municipal development	2	1	Molluscicides possible on lawns
Nutrient regime alteration	Agriculture	3	2	Livestock

Stress	Source of Stress	Scope	Severity	Comments
Complications due to small populations		4	4	
Toxins	Industrial, other	1	4	Spills (trucks/ industrial accidents

Conservation Actions and Strategies

The recovery plan for the James spinymussel identifies two initial conservation actions: investigation of specific threats such as siltation, pesticides, municipal and industrial effluents, and Asian clam interactions; and assessment of projects that pose potentially negative effects on the species or its habitat (USFWS 1990b). Following the implementation and assessment of these actions and monitoring actions listed below, other secondary actions should be undertaken: implement control of Asian clams; implement appropriate protection strategies as identified; and re-establish populations as appropriate.

Mussel TAC (2004) identified conservation actions specific to the threats outlined above (in no particular order):

- Dam removal and/or installation of fish passage for necessary fish host migration and habitat restoration
- Stormwater management
- More efficient use of water
- Education of regional and county planning administrators
- Education of homeowners regarding the use of fertilizers and pesticides (especially molluscicides)
- Work with VDOT to develop possible solutions to salt application and subsequent runoff
- Implementation of appropriate best management practices for agriculture and stormwater management
- Augment population where possible
- Increase response to hazardous materials spills
- Improve enforcement of existing water quality and permitting regulations

Research and Monitoring Needs

The recovery plan for the James spinymussel identifies the following research or monitoring needs: determination of essential habitat; threats monitoring; life history and ecology studies to establish the feasibility and methods to re-introduce this species to its historic range; and monitoring of existing and introduced populations (USFWS 1990b). Mussel TAC (2004) listed other research needs tied to stress reduction. These include researching and subsequently implementing minimum flow requirements; investigating the amount of sediment reduction needed to see a positive effect on mussel community; researching the impacts of biocide runoff from residents; and researching the impacts of creosote from wooden bridges and road salts on mussel populations.

6.4.5.2. Aquatic SGCN by Habitat Group: Blue Ridge-James EDU

There are eight species of greatest conservation need in the Blue Ridge-James EDU. Two are fish and six are mussels. They were distributed among two habitat groups and one unknown group (Tables 6.38-6.40).

Table 6.38. Aquatic species of greatest conservation need with migratory habits. These species use a range of habitats from large tidal rivers to small streams.

Common Name	Scientific Name	Tier
American eel	*Anguilla rostrata*	IV

Table 6.39. Aquatic species of greatest conservation need in small to large streams with very low or low gradient connected to similarly sized streams (DGIF classification types 221, 222, 231, 232, 331 and 332).

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
James spinymussel	*Pleurobema collina*	I	100	6
Green floater	*Lasmigona subviridis*	II	100	2
Notched rainbow mussel	*Villosa constricta*	III	100	4
Creeper mussel	*Strophitus undulatus*	IV	100	3

Table 6.40. Aquatic species of greatest conservation need: generalists and those with unknown habitat requirements.

Common Name	Scientific Name	Tier	Number of Types Used (DGIF Aquatic Classification)
Atlantic pigtoe	*Fusconaia masoni*	II	NA
Yellow lance	*Elliptio lanceolata*	III	2 (4 occurrences)
Triangle floater	*Alasmidonta undulata*	IV	NA

Relative Condition of Habitat

Within the Blue Ridge-James EDU, 6.2% of riverine habitat is impaired (DEQ and DCR 2004). Listed impairments include fecal coliform, dissolved oxygen, general standard benthics, and bacteria. Sources include non-point sources such as agriculture, urban, and wildlife and unknown sources. Approximately 14% of the land cover in this EDU is agricultural and 0.8% is developed. Within the state, agricultural land cover ranges from 2 to 41%, and developed land use ranges from 0.4 to 15%.

Threats, conservation actions, and research and monitoring needs for the Tier II through Tier IV species are available in Appendices H, I, and J. Mussel TAC (2004) and Fish TAC (2004) provided this information within habitat groups selected at the workshops. The level of detail within these groups does not correspond to that used in the DGIF aquatic habitat classification.

6.4.6. Blue Ridge-Rappahannock EDU

The Rappahannock River drainage occurs entirely within the state of Virginia. The headwaters of the Rappahannock drain the Blue Ridge ecoregion and flow through the Piedmont and Coastal Plain. The Piedmont-Rappahannock EDU (Figure 6.28) is found within the Chesapeake Bay freshwater ecoregion (Abell et al. 2000). As its name implies, this ecoregion encompasses all of the drainages of the Chesapeake Bay. This freshwater ecoregion supports four endemic mussel species and seven endemic fish species, including the roughhead shiner *Notropis semperasper* found only in the headwaters of the James River. It is also home to several migratory fish, including the American shad *Alosa sapidissima*, alewife *A. pseudoharengus*, and American eel *Anguilla rostrata*. Abell et al. (2000) list the Chesapeake Bay freshwater ecoregion as "continentally outstanding" in terms of biological distinctiveness.

6.4.6.1. Tier I Species in the Blue Ridge-Rappahannock EDU

There are currently no documented occurrences of Tier I species in the Blue Ridge-Rappahannock EDU.

6.4.6.2. Aquatic SGCN by Habitat Group: Blue Ridge-Rappahannock EDU

There are two fish and three mussels representing the species of greatest conservation need in the Blue Ridge-Rappahannock EDU. There are two habitat groups and one group of species with unknown habitat requirements (Tables 6.41-6.43).

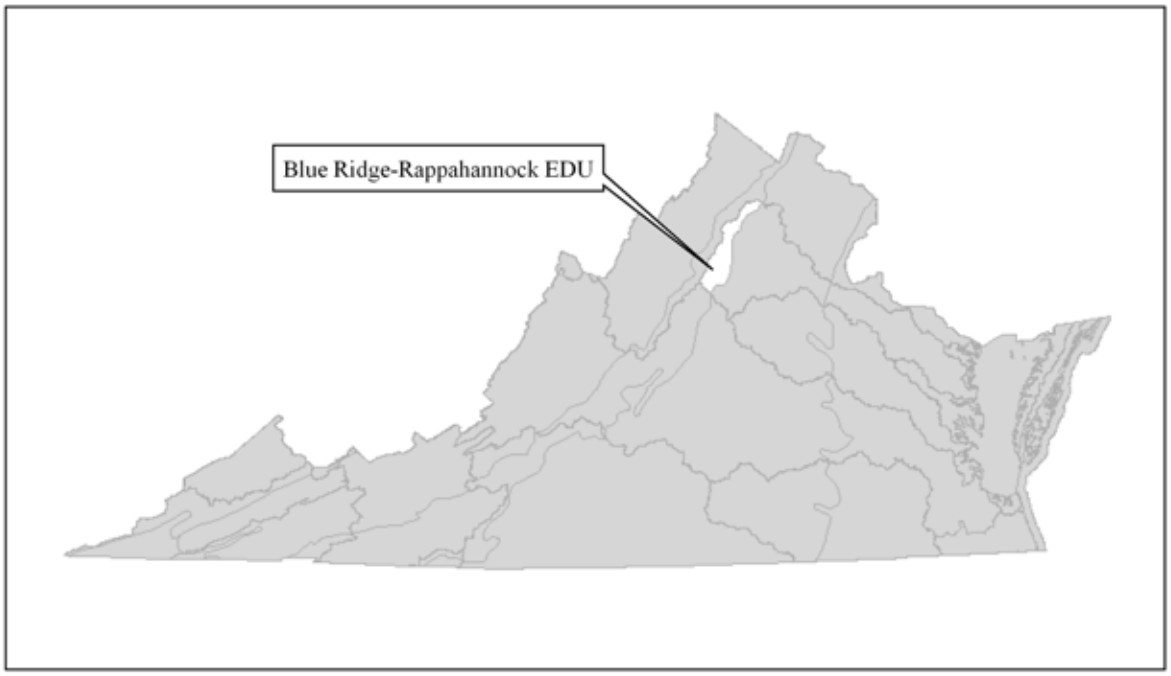

Figure 6.28. Location of the Blue Ridge-Rappahannock EDU.

Table 6.41. Aquatic species of greatest conservation need with migratory habits. These species use a range of habitats from large tidal rivers to small streams.

Common Name	Scientific Name	Tier
American eel	*Anguilla rostrata*	IV

Table 6.42. Aquatic species of greatest conservation need in small streams with low gradient connected to similarly sized streams (DGIF classification type 222).

Common Name	Scientific Name	Tier	Percent Occurrences in This Habitat Group	Number of Types Used (DGIF Aquatic Classification)
American brook lamprey	*Lampetra appendix*	IV	100	1

Table 6.43. Aquatic species of greatest conservation need: generalists and those with unknown habitat requirements.

Common Name	Scientific Name	Tier	Number of Types Used (DGIF Aquatic Classification)
Yellow lance	*Elliptio lanceolata*	III	NA
Triangle floater	*Alasmidonta undulate*	IV	NA
Creeper mussel	*Strophitus undulates*	IV	NA

Relative Condition of Habitat

Approximately 3.2% of the riverine habitat in the Blue Ridge-Rappahannock EDU is impaired (DEQ and DCR 2004). All impaired reaches are impaired by fecal coliform. One is also impaired by temperature. Sources of these impairments are largely unknown. Non-point source pollution is a source for one reach. Within this EDU, 15.5% of the land use is agricultural, and 0.4% is developed (USGS 1992). Within the state, agricultural land cover ranges from 2 to 41%, and developed land use ranges from 0.4 to 15%.

Threats, conservation actions, and research and monitoring needs for the Tier II through Tier IV species are available in Appendices H, I, and J. Mussel TAC (2004) and Fish TAC (2004) provided this information within habitat groups selected at the workshops. The level of detail within these groups does not correspond to that used in the DGIF aquatic habitat classification.

6.4.7. Blue Ridge-Potomac EDU

The Potomac River drainage covers a large area encompassing parts of Pennsylvania, Maryland, Virginia, and West Virginia. Within Virginia, the watershed drains the Ridge and Valley, Blue Ridge, Piedmont, and the Coastal Plain. Several tributaries of the middle Potomac drain the eastern front of the Blue Ridge. The fall line, which occurs at the break between the Piedmont and Coastal Plain, is a natural barrier to most migratory fish. The Blue Ridge-Potomac EDU (Figure 6.29) is found within the Chesapeake Bay freshwater ecoregion (Abell et al. 2000). As its name implies, this ecoregion encompasses all of the drainages of the Chesapeake Bay. This freshwater ecoregion supports four endemic mussel species and seven endemic fish species, including the roughhead shiner *Notropis semperasper*, found only in the headwaters of the James River. It is also home to several migratory fish including American shad *Alosa sapidissima*, alewife *A. pseudoharengus*, and American eel *Anguilla rostrata*. Abell et al. (2000) list the Chesapeake Bay freshwater ecoregion as "continentally outstanding" in terms of biological distinctiveness.

6.4.7.1. Tier I Species in the Blue Ridge-Potomac EDU

There are currently no documented Tier I species in the Blue Ridge-Potomac EDU.

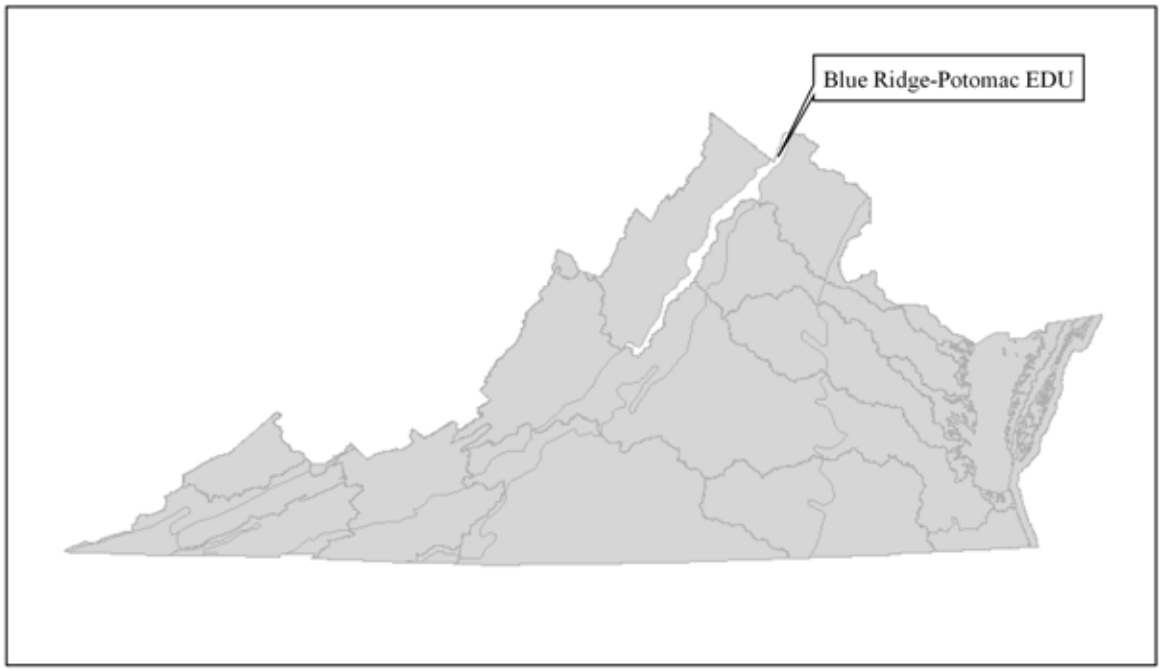

Figure 6.29. Location of the Blue Ridge-Potomac EDU

6.4.7.2. Aquatic Species of Greatest Conservation Need by Habitat Group: Blue Ridge-Potomac EDU

There are seven tiered species in the Blue Ridge-Potomac EDU. Three are fish, three are mussels, and one is an aquatic insect. Except for the migratory American eel, no other habitat groups could be defined (Tables 6.44 and 6.45).

Table 6.44. Aquatic species of greatest conservation need with migratory habits. These species use a range of habitats from large tidal rivers to small streams.

Common Name	Scientific Name	Tier
American eel	*Anguilla rostrata*	IV

Table 6.45. Aquatic species of greatest conservation need: generalists and those with unknown habitat requirements.

Common Name	Scientific Name	Tier	Number of Types Used (DGIF Aquatic Classification)
Yellow lance	*Elliptio lanceolata*	III	NA
Shenandoah needlefly	*Megaleutra flinti*	III	NA
Triangle floater	*Alasmidonta undulata*	IV	NA
Slimy sculpin	*Cottus cognatus*	IV	1 (1 occurrence)
Pearl dace	*Margariscus margarita*	IV	2 (2 occurrences)
Creeper mussel	*Strophitus undulatus*	IV	NA

Relative Condition of Habitat

Large stretches of the South River, South and North Forks of the Shenandoah, and the Shenandoah River itself are impaired by fish tissue contamination by mercury and PCBs (DEQ and DCR 2004). Other impairments in this EDU included general standard benthics, fecal coliform, and pH. The sources of impairment are unknown, non-point agricultural or urban sources, and atmospheric deposition. Just over 12% of the land cover is agricultural and 1.6% is developed (USGS 1992). Within the state, agricultural land cover ranges from 2 to 41%, and developed land use ranges from 0.4 to 15%.

Threats, conservation actions, and research and monitoring needs for the Tier II through Tier IV species are available in Appendix H, I, and J. Mussel TAC (2004) and Fish TAC (2004) provided this information within habitat groups selected at the workshops. The level of detail within these groups does not correspond to that used in the DGIF aquatic habitat classification.

6.5. Subterranean Species in the Blue Ridge

6.5.1. Tier I Subterranean Species in the Blue Ridge

There are no subterranean Tier I species in the Blue Ridge.

6.5.2. Subterranean Species of Greatest Conservation Need in the Blue Ridge

6.5.2.1. Species of Greatest Conservation Need by Subterranean Habitat Type

Of the five subterranean species occurring in the Blue Ridge, four occur in caves (Table 6.46) and two occur in groundwater (Table 6.47).

Table 6.46. Cave species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Madison Cave isopod	*Antrolana lira*	II	Phreatic groundwater
Hubbard's cave beetle	*Pseudanophthalmus hubbardi*	II	Cave riparian areas and mudbanks
A cave springtail	*Pseudosinella bona*	II	Unknown
A cave beetle	*Pseudanophthalmus pusio*	III	Cave riparian areas and mudbanks

Table 6.47. Groundwater species of greatest conservation need in the Blue Ridge.

Common Name	Scientific Name	Tier	Special Habitat Needs
Madison Cave isopod	*Antrolana lira*	II	Phreatic groundwater
Blue Ridge spring amphipod	*Stygobromus spinosus*	III	Springs and seeps along the Blue Ridge

6.5.2.2. Status and Trends of Subterranean Habitats

The status of these habitats is very difficult to ascertain, and so is not available at an ecoregional scale. For statewide status and trends of subterranean habitats, see Section 3.2.5.

6.6 Overview of Tier I Species Habitat in the Blue Ridge

In order to highlight geographic areas that are likely important for one or more Tier I species, the potential and confirmed habitats for Tier I terrestrial (Section 6.3.1) and aquatic (Sections 6.4.1-6.4.7) species were overlaid in one map (Figure 6.30). Please note that potential habitat for many Tier I species could not be mapped, and that areas containing habitat for only one or a few Tier 1 species are important for conservation. However, areas with a higher density of Tier I species habitat may represent extraordinary conservation opportunities.

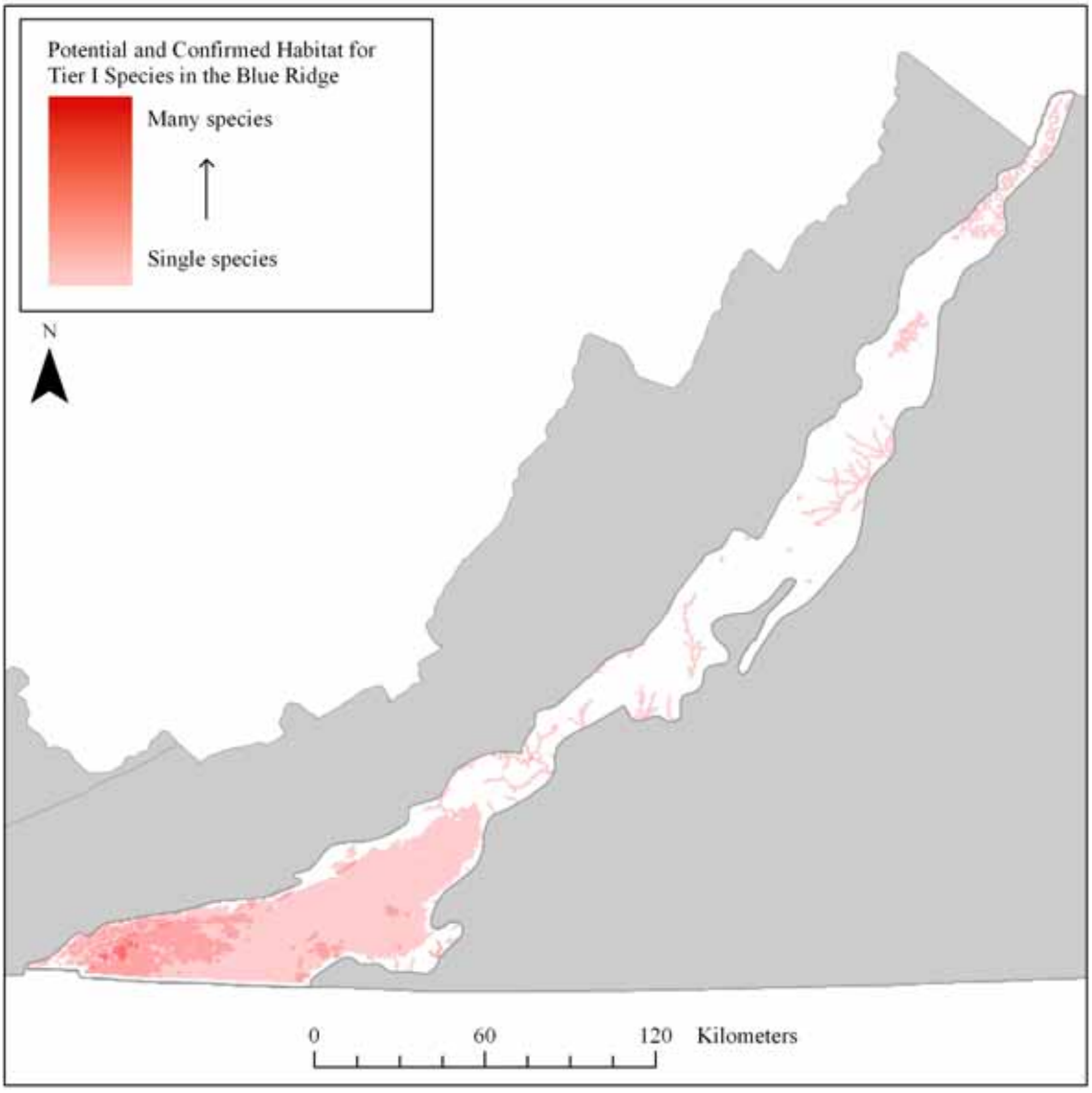

Figure 6.30. Potential and confirmed habitat for Tier I species in the Blue Ridge. Darker shades represent areas with a higher co-occurrence of these habitats.

Literature Cited

Abell, R. A., D. M. Olson, E. Dinerstein, P. T. Hurley, J. T. Diggs, W. Eichbaum, S. Walters, W. Wettengel, T. Allnutt, C. J. Loucks, and P. Hedao. 2000. Freshwater ecoregions of North America: a conservation assessment. Island Press, Washington, D.C.

Adkisson, C. S. 1996. Red crossbill. Number 256 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, DC.

Allen, T. J. 1997. The butterflies of West Virginia and their caterpillars. University of Pittsburgh, Pittsburgh, Pennsylvania.

Bailey, R. G. 1995. Descriptions of the ecoregions of the United States. U.S. Forest Service Miscellaneous Publication 1391, Washington, D.C.

Bird TAC (Taxonomic Advisory Committee). 2004. Unpublished proceedings of a workshop on bird threats, conservation actions, and monitoring, Fredericksburg, Virginia, 30 November 2004. Department of Game and Inland Fisheries, Richmond, Virginia.

Brown, S., C. Hickey, B. Harrington, and R. Gill, editors. 2001. The U.S. shorebird conservation plan, 2nd edition. Manomet Center for Conservation Sciences, Manomet, Massachusetts.

Bulluck, L.P., D.A. Buehler, R. Canterbury and C. Smalling. 2005. Golden-winged Warbler Habitat Associations in the Southern Appalachians. Presented at Golden-winged Warbler Conservation Workshop, August 10-12, 2005, Siren, WI.

Burkhead, N. M. and R. E. Jenkins. 1991. Fishes. Pages 321-409 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

Canterbury, R. 2005. Response by Golden-winged Warblers to Habitat Changes in southern West Virginia. Presented at Golden-winged Warbler Conservation Workshop, August 10-12, 2005, Siren, WI.

Chazal, A. C., S. M. Roble, C. S. Hobson, and K. L. Derge. 2004. Status of the Appalachian grizzled skipper (*Pyrgus centaureae wyandot*) in Virginia. Banisteria 24:15-22.

Clarke, A. H. 1986. Competitive exclusion of *Canthyria* (Unionidea) by *Corbicula fluminea* (Muller). Malacology Data Net 1:3-10.

_____ and R. J. Neves. 1984. Status survey of the James River spiny mussel, *Canthyria collina*, in the James River, Virginia. Unpublished report, U. S. Fish and Wildlife Service, Newton Corner, Massachusetts.

Confer, J. L. 1992. Golden-winged warbler. Number 20 *in* A. Poole, P. Stettenheim, and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, DC.

_____ and J. L. Larkin. 1998. Behavioral interactions between golden-winged and blue-winged warblers. Auk 115:209-214.

_____, _____, and P. E. Allen. 2003. Effects of vegetation, interspecific competition, and brood parasitism on golden-winged warbler (*Vermivora chrysoptera*) nesting success. Auk 120:138-144.

Curson, J., D. Quinn, and D. Beadle. 1994. Warblers of the Americas. Houghton Mifflin, Boston.

DCR (Virginia Department of Conservation and Recreation). 2003. Conservation Lands Database. Richmond, Virginia. http://www.dcr.state.va.us/dnh/ conslandindex.htm.

DCR-NH (Virginia Department of Conservation and Recreation, Division of Natural History). 2005. Virginia Natural Heritage Program's Biotics Data System. Richmond, Virginia. Data provided through cooperative agreement with DCR. For more information about these data, please contact the DCR data manager. http://www.dcr.virginia.gov/dnh.

DeGraaf, R. M and J. H. Rappole. 1995. Neotropical migratory birds: Natural history, distribution, and population change. Comstock, Ithaca.

DEQ (Virginia Department of Environmental Quality) and DCR (Virginia Department of Conservation and Recreation). 2004. Virginia water quality assessment: 305b/303d integrated report to Congress and the EPA Administrator for the period January 1, 1998 to December 31, 2002. Richmond, Virginia.

DGIF (Virginia Department of Game and Inland Fisheries). 2001. Tennessee dace (*Phoxinus tennesseensis*) draft recovery plan. Nongame and Endangered Wildlife Program, Richmond, Virginia.

_____. 2004a. Virginia Fish and Wildlife Information Service (VAFWIS): Biota of Virginia (BOVA) online database. http://vafwis.org/WIS/ASP/ default.asp.

_____. 2004b. Virginia fish and wildlife information service: Collections database. http://www.vafwis.org/WIS/ASP/default.asp.

Douglas, H. H. 1964. Caves of Virginia. Virginia Cave Survey, Falls Church, Virginia.

Ernst, C. H., J. E. Lovich, and R. W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution, Washington.

Fish TAC (Taxonomic Advisory Committee). 2004. Unpublished proceedings of a workshop on fish threats, conservation actions, and monitoring, Charlottesville, Virginia, 03 December 2004. Department of Game and Inland Fisheries, Richmond, Virginia.

Fitzpatrick, J. F. 1983. How to know the freshwater Crustacea. The Pictured Key Nature Series. Wm. C. Brown Company, Dubuque.

Fraser, J. D. 1991. Loggerhead shrike. Pages 520-522 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

Gabler, J. 1983. The peregrine falcon in Virginia: Survey of historic eyries and reintroduction effort. Thesis, College of William and Mary, Williamsburg, Virginia.

GeoLytics. 2005. CensusCD estimates (2004), projections (2009), consumer expenditures and profiles. Digital spatial and tabular data. Acquired March 2005. GeoLytics, Inc. East Brunswick, NJ.

Gill, F. B. 2004. Overview: Blue-winged warblers (*Vermivora pinus*) versus golden-winged warblers (*V. chrysoptera*). Auk 121:1014-1018.

_____, R. A. Canterbury, and J. L. Confer. 2001. Blue-winged warbler. Number 584 *in* A. Poole, P. Stettenheim, and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, DC.

Groth, J. G. 1993. Evolutionary differentiation in morphology, vocalizations, and allozymes among nomadic sibling species in the North American red crossbill (*Loxia curvirostra*) complex. Contribution from the Museum of Vertebrate Zoology of the University of California at Berkeley Number 127, University of California, Berkeley.

Groves, C., L. Valutis, D. Vosick, B. Neely, K. Wheaton, J. Touval, and B. Runnels. 2000. Designing a geography of hope: A practitioner's handbook to ecoregional conservation planning, Volume II. The Nature Conservancy.

Harrington, B. and E. Perry. 1995. Important shorebird staging sites meeting: Western hemisphere shorebird reserve network criteria in the United States. Western hemisphere Shorebird Reserve Network.

Herpetofauna TAC (Taxonomic Advisory Committee). 2004. Unpublished proceedings of a workshop on herpetofaunal threats, conservation actions, and monitoring, Richmond, Virginia, 30 November 2004. Department of Game and Inland Fisheries, Richmond,Virginia.

Hill, J. M. 1984. Autumn migration of selected raptors and passerines on the Delmarva Peninsula. Thesis, George Mason University, Fairfax, Virginia.

Hoffman, R. L. 1991. Laurel Creek xystodesmid millipede. Pages 191-192 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

Holsinger, J. R. 1975. Descriptions of Virginia caves. Bulletin 85, Virginia Division of Mineral Resources, Charlottesville, Virginia.

_____. 1979a. Ephemeral cave amphipod. Page 159 *in* D. W. Linzey, editor. Endangered and threatened plants and animals of Virginia. Center for Environmental Studies, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

_____. 1979b. Madison cave amphipod. Pages 152-153 *in* D. W. Linzey, editor. Endangered and threatened plants and animals of Virginia. Center for Environmental Studies, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

_____. 1979c. Rye Cove isopod. Page 131 *in* D. W. Linzey, editor. Endangered and threatened plants and animals of Virginia. Center for Environmental Studies, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

_____. 1991a. Freshwater amphipods. Pages 180-186 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

_____. 1991b. Freshwater isopods. Pages 186-189 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

_____ and D. C. Culver. 1988. The invertebrate cave fauna of Virginia and a part of eastern Tennessee: zoogeography and ecology. Brimleyana 14:1-162.

Holt, D. 1998. The Virginia hawkwatch: a raptorian report, Fall 1997. Hawk Migration Association of North America.

Hove, M. C. 1990. Distribution and life history of the endangered James spinymussel, *Pleurobema collina* (Bivalvia: Unionidae). Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Hunter, C., R. Katz, D. Pashley, and B. Ford. 1999. Partners in Flight conservation plan for the Southern Blue Ridge (physiographic area 23). Version 1.0. American Bird Conservancy.

Jenkins, R. E. and N. M. Burkhead. 1994. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland.

Johnsgard, P. A. 1990. Hawks, eagles and falcons of North America. Smithsonian Institution, Washington.

Kearney, R. F. 2003. Partners in Flight landbird conservation plan, physiographic area 10: Mid-Atlantic Piedmont. Version 1.0. American Bird Conservancy.

Klaus, N.A. and D.A. Buehler. 2001. Golden-winged warbler breeding habitat characteristics and nest success in clearcuts in the southern Appalachian Mountains. Wilson Bulletin 114:297-301.

Kondratieff, B. C. and R. F. Kirchner. 1991. Nelson's early black stonefly *Taeniopteryx nelsoni*. Pages 216-218 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. wheeler, and K. Wohl. 2002. Waterbird conservation for the Americas: The North American waterbird conservation plan, version 1. Waterbird Conservation for the Americas, Washington, DC.

Linzey, D. W. 1998. The mammals of Virginia. The McDonald & Woodward Publishing, Blacksburg, Virginia.

Luukkonen, D. R. 1987. Status and breeding ecology of the loggerhead shrike in Virginia. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Mammal TAC (Taxonomic Advisory Committee). 2004. Unpublished proceedings of a workshop on mammal threats, conservation actions, and monitoring, Richmond, Virginia, 01 November 2004. Department of Game and Inland Fisheries, Richmond, Virginia.

McNab, W. H. and P. E. Avers. 1994. Ecological subregions of the United States. Technical Report WO-WSA-5, U.S. Forest Service, Washington, DC.

Menzel, J. M. 2003. An examination of the habitat requirements of the endangered Virginia northern flying squirrel (*Glaucomys sabrinus fuscus*) by assessing nesting sites, habitat use and the development of a habitat model. Dissertation, West Virginia University, Morgantown, West Virginia.

Mitchell, J. C. 1991. Amphibians and reptiles. Pages 411-476 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

_____, K. A. Buhlmann, and C. H. Ernst. 1991. Pages 457-459 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

_____. 1994. The reptiles of Virginia. Smithsonian Institution Press, Washington and London.

Moore, F. R. and T. R. Simons. 1989. Habitat suitability and stopover ecology of Neotropical landbird migrants. Pages 345-355 *in* J. M Hagan III and D. W. Johnston, editors. Ecology and conservation of Neotropical migrant landbirds. Smithsonian Institution, Washington.

Moore, F. R., P. Kerlinger, and T. R. Simons. 1990. Stopover on a Gulf coast barrier island by spring trans-Gulf migrants. Wilson Bulletin 102:487-500.

Moore, F. R., Gauthreaux, S. A., Jr., Kerlinger, P., and Simons, T. R. 1995. Habitat requirements during migration: important link in conservation. Pages 121-144 *in* T. E. Martin and D. M. Finch, editors. Ecology and management of newtropical migratory birds: A synthesis and review of critical issues. Oxford University, Oxford.

Mussel TAC (Taxonomic Advisory Committee). 2004. Unpublished proceedings of a workshop on mussel threats, conservation actions, and monitoring, Forest, Virginia, 08 November 2004. Department of Game and Inland Fisheries, Richmond, Virginia.

NABCI (North American Bird Conservation Initiative). 2000. North American Bird Conservation Initiative: Bird conservation region descriptions. U.S. Fish and Wildlife Service, Washington, DC.

NatureServe. 2004. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.0. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.

NESWDTC (Northeast Endangered Species and Wildlife Diversity Technical Committee). 2004. Northeast wildlife species of regional conservation concern: management and research needs. Draft report. Northeast Association of Fish and Wildlife Agencies.

Neves, R. J. 1991. James spinymussel. Pages 281-282 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

Omernik, J. M. 1987. Ecoregions of the conterminous United States. Annals of the Association of American Geographers 77:118-125.

Opler, P. A. and G. O. Krizek. 1984. Butterflies east of the Great Plains: An illustrated natural history. Johns Hopkins University, Baltimore and London.

Petranka, J. W. 1998. Salamanders of the United States and Canada. Smithsonian Institution, Washington.

Pierson, E. D. 1998. Tall trees, deep holes, and scarred landscapes: Conservation biology of North American bats. Pages 309-325*in* T. H. Kunz and P. A. Racey, editors. Bat biology and conservation. Smithsonian Institution, Washington.

Reynolds, R. J. 2003. Virginia aerial mountain survey for nesting peregrine falcons. Nongame and Endangered Wildlife Technical Report TR2004.1. Virginia Department of Game and Inland Fisheries, Wildlife Diversity Division, Nongame and Endangered Wildlife Program, Richmond, Virginia. Unpublished Report submitted to U.S. Fish and Wildlife Service.

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Inigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, and T. C. Will. 2004. Partners in Flight North American landbird conservation plan. Cornell Laboratory of Ornithology, Ithaca, New York.

Rosenberg, K. V. 2003. Partners in Flight landbird conservation plan, physiographic area 12: Mid-Atlantic Ridge and Valley. Version 1.0. American Bird Conservancy.

_____. 2004. Partners in Flight continental priorities and objectives defined at the state and bird conservation region levels: Virginia. Unpublished report, Cornell Laboratory of Ornithology, Ithaca.

Rosenberger, A. and P. L. Angermeier. 2003. Ontogenetic shifts in habitat us by the endangered Roanoke logperch (*Percina rex*). Freshwater Biology. 48:1563-1577.

SAMAB (Southern Appalachian Man and the Biosphere Program). 1996. Southern Appalachian Assessment (SAA): A cooperative multi-agency effort to assess the environmental condition of the Southern Appalachian region. Downloaded from http://samab.org/data/ SAA_data.html, April 2004.

Schweitzer, D. F. 1991a. Appalachian grizzled skipper. Pages 240-241 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

Scott, J. A. 1986. The butterflies of North America: A natural history and field guide. Stanford University, Stanford, California.

Shapiro, L. H., R. A. Canterbury, D. M. Stover, and R. C. Fleischer. 2004. Reciprocal introgression between golden-winged warblers (*Vermivora chrysoptera*) and blue-winged warblers (*V. pinus*) in North America. Auk 121:1019-1030.

Sherry, T. W. and R. T. Holmes. 1993. Are populations of Neotropical migrant birds limited in summer or winter? Implications for management. Pages 47-57 *in* D. M. Finch and P. W. Stangel, editors. Status and management of Neotropical migratory birds. Gen. Tech. Rep. RM-229, U.S. Deaprtment of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Somes, A. B., K. J. Bridle, D.W. Human, and A.B. Nelson. 2000. The restoration and management of small wetlands of the mountains and piedmont in the southeast: a manual emphasizing endangered and threatened species habitat with a focus on bog turtles. University of North Carolina at Greensboro.

Starnes, W. C. and R. E. Jenkins. 1988. A new cyprinid fish of the genus *Phoxinus* (Pisces: Cypriniformes) from the Tennessee River drainage with comments on relationships and biogeography. Proceedings of the Biological Society of Washington 101:517-529.

Tobey, F. J. 1979. Amphibians and reptiles. Pages 375-414 *in* D. W. Linzey, editor. Endangered and threatened plants and animals of Virginia. Center for Environmental Studies, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Tuttle, M. D. 2004. Wind energy & the threat to bats. Bats 22:4-5.

Underwood, M.K. and C.A. Dolloff. 1999. An inventory of stream habitat and Tennessee dace *Phoxinus tennesseensis* in Lynn Camp Creek and Lick Creek, George Washington-Jefferson National Forest, Virginia. Report from the U.S. Department of Agriculture Forest Service, Center for Aquatic Technology Transfer, Blacksburg, Virginia.

USCB (U.S. Census Bureau). 2003. Virginia: 2000 population and housing unit counts. PHC-3-48. United States Department of Commerce. Washington, D.C.

USDA (U.S. Department of Agriculture). 2000. Summary Report: 1997 national resources inventory (revised December 2000). Natural Resources Conservation Service, Washington, DC, and Statistical Laboratory, Iowa State University, Ames, Iowa.

USGS (U.S. Geological Survey). 1992. National Land Cover dataset: Virginia. Land Cover based on classication of Landsat Thematic Mapper (TM) at 30m resolution. Digital data version 5/27/1999, downloaded December 2001 from http://seamless.usgs.gov/.

_____. 1995. Digital raster graphic (DRG) topographical maps. 1:24,000 scale.

_____. 2001. National Land Cover dataset: USGS Mapping Zone 60. Land Cover based on Landsat 5 and Landsat 7 at 30m resolution. Digital data downloaded January 2004 from http:// seamless.usgs.gov/.

_____. 2003. National Elevation Dataset. Elevation measured using the North American Vertical Datum of 1998 at 30m resolution. Digital data version April 2004, downloaded from http://seamless.usgs.gov/, April 2004.

USFS (U.S. Forest Service). 2001a. FIA (Forest Inventory and Analysis). Digital data, downloaded 04 February 2004. http://www.nrcs2.fs.fed.us/4801/FIADB/fiadb_dump/fiadb_dump.html.

_____. 2001b. Bog turtle (*Clemmys muhlenbergii*), northern population, recovery plan. Hadley, Massachusetts.

_____. 2002. Continuous Inventory of Stand Condition (CISC). Digital data downloaded from http://www.fs.fed.us/gwjnf/ftp/gis/, October 2002.

USFWS (U.S. Fish and Wildlife Service). 1987. Revised peregrine falcon, eastern population recovery plan. U.S. Fish and Wildlife Service, Newton Corner, Massachusetts.

_____. 1989. Title 50, Part 17, Subpart B, Section 17.11, Endangered and threatened wildlife and plants; Animal notice of review. Federal Register.

_____. 1990a. Appalachian northern flying squirrels (*Glaucomys sabrinus fuscus, Glaucomys sabrinus coloratus*) recovery plan. Newton Corner, Massachusetts.

_____. 1990b. James spinymussel (*Pleurobema collina*) recovery plan. Newton Corner, Massachusetts.

_____ . 1992. Roanoke logperch (*Percina rex*) recovery plan. Newton Corner, Massachusetts.

Wallace, M. S. and F. P. Hain. 2002. Summary of native and established predators of the hemlock woolly adelgid and the balsam woolly adelgid (Homoptera: Adelgidae) in the southeastern United States. Pages 141-149 i*n* B. Onken, R. Reardon, and J. Lashomb, editors. Proceedings: Hemlock woolly adelgid in the eastern United States symposium. Rutgers University and the U.S. Forest Service.

Walters, E. L., E. H. Miller, and P. E. Lowther. 2002. Yellow-bellied sapsucker. Number 662 *in* A. Poole and F. Gill, editors. The birds of North America. The Birds of North America, Inc., Philadelphia, Pennsylvania.

Watts, B. D. 1999. Partners in Flight: Mid-Atlantic Coastal Plain bird conservation plan. Version 1.0. American Bird Conservancy, The Plains, Virginia.

Wheeler, A.P., A.E.K. Rosenberger, and P.L. Angermeier. 2003. Potential impacts of I-73 on stream habitat and biota, with emphasis on the endangered Roanoke logperch. Final report to Virginians for Appropriate Roads. Rocky Mount, Virginia.

Whitaker, J. O., Jr. and W. J. Hamilton, Jr. 1998. Mammals of the eastern United States. Cornell University, Ithaca.

Wells-Gosling, N. and L. R. Heaney. 1984. *Glaucomys sabrinus*. Number 229 *in* Mammalian species. American Society of Mammalogists.

White, C. M., N. J. Clum, T. J. Cade, and W. G. Hunt. 2002. Peregrine falcon. Number 660 *in* A. Poole and F. Gill, editors. The birds of North America. The Birds of North America, Inc., Philadelphia, Pennsylvania.

Wilson, L. A. 1995. The land manager's guide to amphibians and reptiles of the South. The Nature Conservancy Southeastern Region, Chapel Hill, North Carolina.

Woodward, S. L. and R. L. Hoffman. 1991. The nature of Virginia. Pages 23-48 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

Wynn, A. H. 1991. Shenandoah salamander. Pages 439-442 *in* K. Terwilliger, editor. Virginia's endangered species. McDonald and Woodward Publishing, Blacksburg, Virginia.

Yosef, R. 1996. Loggerhead shrike (*Lanius ludovicianus*). Number 231 *in* A. Poole and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.