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DRAFT - Montane Cool Water Stream Communities

Ecosystem Description

This Ecosystem Group includes cool water stream systems in the Blue Ridge Mountain physiographic province. Typically, these are the larger rivers in the region and many have impoundments and reservoirs. Many of these rivers originate in high elevation areas in the upper portion of watersheds and are therefore cold water, but transition to cool water with a decrease in elevation and addition of tributaries. Examples of this habitat type include: Valley River, Hiwassee River (below Mission Lake dam), Little Tennessee River, Pigeon River (below the confluence of the East and West Forks Pigeon River), French Broad River (Below Nicholson Creek and Davidson River), Nolichucky River, New River, and Johns River.

The cool water designation is based upon two general principles: fish community structure and temperature regime. Cool water streams generally have a fish species composition that includes: smallmouth bass, rock bass, walleye, muskellunge, creek chub, river chub, bluehead chub, whitetail shiner, white sucker, Tennessee shiner, mirror shiner, warpaint shiner, northern hog sucker, fantail darter, greenside darter, and greenfin darter. This list is not inclusive and provides general guidance on aquatic community structure.

Temperature regime can also be used to help classify cool water streams where summer temperatures typically do not exceed 25 degrees Celsius (76 degrees Fahrenheit). This is a suggested temperature that will typically support the fish community structure (U.S. Army Corps of Engineers 2003).

Riverine aquatic communities, which are identified in the 2005 Wildlife Action Plan (WAP) as a priority aquatic habitat, is a component of this habitat (see Chapter 5A) (NCWRC 2005). Bogs and associated wetlands and floodplain forests are two WAP priority habitats that also may be associated with montane cool water stream communities; they provide habitat for wildlife that use adjacent terrestrial habitats.

Table 1 at the end of this report provides of summary of expected climate change impacts to these natural communities.

Predicted Effects to Wildlife Species

Tables 2 through 5 at the end of this report identify the species of conservation concern and priority species that use habitats in this ecosystem.

Aquatic species could experience shifts in their range or distribution and sensitive species may experience decline or extirpation due to changes in water quality and habitat. Aquatic species are particularly sensitive to temperature cues and warming waters could cause species in these cool water habitats to attempt moving upstream into cooler waters if there is suitable habitat. Some mussel species, for example, are limited in distribution because of cold water influences. Alternatively, species could become extirpated. These systems may experience a change in species composition.

Exotic species invasion is a concern, yet effects on this Ecosystem Group are largely unknown. Asian clam (*Corbicula fluminea*) and rusty (*Orconectes rusticus*) and virile (*Orconectes virilis*) crayfish are known from the mountains ecoregion and have been collected in cool water streams and rivers. Asian clam have increased significantly in recent years and are extremely abundant in certain large rivers of this Ecosystem Group, such as the Little Tennessee River.

There are also issues with species that are native to the state, yet non-native to particular river basins. Yellowfin shiner (*Notropis lutipinnis*), for example, is native to the Savannah River Basin, yet has been introduced to the Little Tennessee River Basin. Changes in stream conditions could increase competition with fish species, in particular the federally threatened spotfin chub (*Erimonax monachus*).

Because of the link between freshwater mussels and fish, phenological disruptions are a possibility, but exact mechanisms or effects are unknown at this time. Freshwater mussel larvae, called glochidia, are dependent on a host fish for transformation into juveniles. Host fish species are known for some mussels species, yet unknown for others. Temperature cues play a large role in the release of glochidia from female mussels and also in the movement and migrations of fish. Therefore, predicted changing temperatures could cause phenological disruptions affecting the reproductive capacity of freshwater mussels.

Cool water riverine habitats are important for a number of reptiles and amphibians including certain turtles, frogs, and salamanders that utilize aquatic habitats during part or all of their life cycle. These habitats are also important for a variety of mammals that are semi-aquatic and/or that have an aquatic food base (e.g., water shrews, muskrats, beavers, river otters, and certain bats). Selected bird species also rely upon aquatic habitats including rivers and streams to provide habitat or a food base, such as various waterfowl, wading birds, and certain songbirds like the Louisiana waterthrush (NCWRC 2005).

Research conducted by Eaton and Sheller (1996) and Mohseni *et al.* (2003) assessed the effects of climate warming on 57 species of fishes in streams across the U.S. Depending on minimum temperature tolerance assumptions, species requiring cool water habitats could experience a 12 to 15% decrease in available habitat (DeWan *et al.* 2010). When the connectivity between streams and rivers within drainage basins provide adequate dispersal corridors, species at the southern extent of their geographical distribution may shift their distributions northward into cooler habitats (Allan et al. 2005). Where adequate dispersal corridors are limited or restricted, access to or availability of cooler water habitats may limit the range of those species subject to narrow temperature tolerance (DeWan *et al.* 2010).

Severe and prolonged droughts will contribute to decreased streamflows and flushing may occur less frequently. This can allow an accumulation of sediment and chemical inputs from stormwater runoff and effluent discharge. Recent studies have shown that endocrine disrupting chemicals (EDC) in treated wastewater can inhibit reproduction and cause feminization of mussels, fish, and some amphibians (Hayes *et al*. 2006, Elrod *et al.* 2003, Elrod and Huang 2003, Huang *et al.* 2003). Although little is known about the effects of EDCs, additional studies are being conducted to document the levels of EDC's in discharges, and measures are being identified to reduce or eliminate EDC's from wastewater prior to discharge, should those discharge studies show increases in EDC levels (Conn *et al*., 2006; Kim *et al*., 2007; Kasprzyk-Hordern *et al*., 2008; Joss *et al*., 2006; Kolpin *et al*., 2002; Nowotny *et al*., 2007).

Climate Change Compared to Other Threats

Aquatic systems have been under threat from a variety of perturbations in the past and many of those continue today. Conversion of land, both from forest to agriculture or silviculture, as well as from development projects, continues to threaten stream integrity resulting in increased sediment, bank erosion, and stormwater runoff containing sediment and other potentially toxic materials. Climate change is likely to have a synergistic effect with other, more impending threats to these systems.

Table 8 summarizes the comparison of climate change with other existing threats.

Table 8. Comparison Of Climate Change With Other Threats

Threat	Rank Order	Comments
Development	1	Residential development, particularly in steep slope areas, is of particular concern because of increased erosion. Most montane cool water streams are larger streams and rivers and many have wider valleys where land use is more susceptible to being developed than on steeper sloped headwater streams. Row crops, agricultural grazing, and urban/suburban development are common. Increased impervious surfaces due to roads, parking lots, homes, and businesses increases the amount and speed of runoff being delivered into aquatic systems.
Sediment and Erosion	1	Stormwater runoff will amplify the loading of nutrients, sediment, and contaminants into streams, rivers, and reservoirs, which may alter overall channel design, have a negative effect on biota due to habitat changes, increased turbidity, and chemical exposure, and affect drinking water quality (Band and Salvensen 2009).
Pollution	1	Runoff from urban areas often contain higher concentrations of nutrients, such as nitrogen and phosphorus, sediment, metals, hydrocarbons, and microbes. An increase in frequency and intensity of storms due to climate change will have a similar impact on stream systems by increasing pollutant loading. Point and nonpoint sources - runoff, endocrine disrupting chemicals – are threats.

Table 8. Comparison Of Climate Change With Other Threats		
Threat	Rank Order	Comments
Cattle in Streams	1	Livestock access to streams contributes heavily to bank erosion, sedimentation, and nutrient input.
Lack of riparian vegetation	1	Riparian vegetation serves as nutrient input to the stream community and helps regulate stream temperature by providing shade. Lack of riparian vegetation or inadequate width of forested buffer can cause streambank erosion and sedimentation.
Conversion to agriculture/silviculture	2	Loss of forest cover can cause increased erosion and sedimentation and negatively impact aquatic systems. Poorly constructed and maintained timber roads is another source of erosion.
Water Withdrawals	2	Irrigation and water supply withdrawals pose a threat to flow regime. Water withdrawals can be problematic, particularly in streams with already low 7Q10 flows, because they may reduce available habitat for aquatic species. Decreased groundwater recharge between storms due to impervious surfaces leads to a decrease in stream baseflow.
Flood Regime Alteration	2	Many rivers that were once free-flowing are now flooded by reservoirs, severely fragmenting habitat and often isolating populations of species above and below the impoundment. Floodplains and wetlands are natural features designed for flood control through attenuation and dissipation of flood waters. Development and other impacts can reduce this service.
Climate Change	3	Climate change is predicted to decrease rainfall and therefore limit water supply. Effects will likely compound with other threats to increase the severity of several threats to aquatic systems.
Invasive Species	4	Invasive plants in the riparian area can have negative impacts on stream systems by creating a monoculture (such as Japanese knotweed) with poor nutrient inputs, reducing bank stability, and allowing too much sunlight and therefore warmer stream temperatures. Invasive aquatic species, like Asian clam or rusty crayfish, may have negative effects on native species, such as competition for space and resources.

Summary and Recommendations

Expand research, survey, and monitoring efforts beyond collecting presence-absence data, to look at long-term trends across species groups, habitats, and the effects of management actions. Work with adjacent states on joint survey and monitoring efforts for priority species of regional concern to detect and evaluate population growth or decline trends due to climate change.

Recommended Actions

Surveys	• Conduct stream surveys adjacent to areas poised for development (edge of urban expansion) to establish baseline populations and identify problems before development expands. • Work cooperatively with partners to collect occurrence and abundance data on macrobenthic species. • Surveys to detect presence and collect life history and abundance data are especially needed for freshwater snail and crayfish as there is limited information available on these species.
Monitoring	• Monitor aquatic non-native invasive species, analyze population trends, and assesses their effect on native priority species populations. • Monitor the effect of base flow impacts on priority species and correlate results with climate conditions.
Research	• Investigate relationship between macrobenthic and aquatic priority species assemblages. • Conduct studies to improve our understanding of habitat trends and key habitat associations for priority species. • Establish a captive breeding program for bog turtles and work with land conservation partners to identify sites for population augmentation. • Statewide, assess stream habitats and the effect of perched and undersized pipes and culverts that are a barrier to fish passage. • Use propagation techniques to grow new populations of priority and declining aquatic populations. • Examine stream temperature and associated microclimatic responses to a range of shading variables from riparian vegetation.
Management Practices	• Expand the Center for Aquatic Conservation (CAC) at Marion Fish Hatcher to create more production capacity for propagation of priority and nongame species. • Work with partners and support development of regulations for control of aquatic nuisance species. • Implement and support use of agriculture and forestry best management practices (BMPs) to control stormwater runoff. Structures such as bioretention cells (i.e., rain gardens), cisterns, permeable pavement, runnels, vegetated swales, and filter strips can be used in various ways as stormwater best management practices (BMPs). • Support fencing livestock out of streams as a measure to reduce nutrient inputs to the aquatic system. • Impose impervious surface limits as a measure of controlling runoff and

erosion. Research has shown that at levels of 8-12% imperviousness, major negative changes in stream condition occur (Wang *et al.*, 2001).

- Initiate a drought management program that modifies discharge permits when base flow conditions decrease and the 7Q10 is lowered.
- Management of riverine habitats should promote the natural evolution and movement of woody and rocky structures and natural processes like bank dynamics, channel meanders, and flood regimes. (NCWRC 2005).

Land Protection

- Support fencing livestock out of streams as a measure to reduce nutrient inputs to the aquatic system.
- Impose impervious surface limits as a measure of controlling runoff and erosion. Research has shown that at levels of 8-12% imperviousness, major negative changes in stream condition occur (Wang *et al.*, 2001).
- Initiate a drought management program that modifies discharge permits when base flow conditions decrease and the 7Q10 is lowered.
- Management of riverine habitats should promote the natural evolution and movement of woody and rocky structures and natural processes like bank dynamics, channel meanders, and flood regimes. (NCWRC 2005).
- Protect floodplains and riparian wetlands from development or land uses that interfere with flood control or flood water attenuation.
- Preserve forests and open space, farm land, rural landscapes, and park lands manage open lands, and plant trees and vegetation in urban areas to aid in carbon sequestration.
- Plant riparian areas with vegetation with a broad elevational range within a particular watershed and with broad hydrologic tolerance to promote resiliency from climate change.

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Table 1. Predicted Impacts of Climate Change	
Climate Change Factor	**Comments**
Increased Temperature/ Hot Spells	Chronically warmer temperatures and lower dissolved oxygen levels may increase stress on organisms. May shift and compress cool water communities to higher elevation stream reaches that are currently cold water systems. Because rivers in this group are relatively shallow, thermal stratification will likely not be an issue; however, the reservoirs could experience stratification, algal blooms, and potential fish kills. Hot spells can have the same effect as overall increased air temperatures but on a much more acute scale. (DeWan *et al.,* 2010; Karl *et al*., 2009; Band and Salvensen 2009; U.S. EPA, 2010).
Drought	Will result in decrease streamflow, decrease groundwater recharge, and increase evaporation. Lower water levels during dry times will increase stress to the system. Connectivity to contributing waters within the system will be restricted or eliminated by low and no-flow conditions.
Flooding	Increased severity and frequency of storm events, similar to hurricanes, will have impacts. Keim (1997) documents an increase in heavy rainfall events in the western mountains of the state, which will likely affect soil erosion, sedimentation, and stream dynamics (DeWan *et al*. 2010).
Phenological Disruption	Disruptions in organismal interactions (mussel-fish host relationship; pollinator-bloom time synchronization).
Sediment Transport	Changes in streamflow could change overall sediment transport dynamics, leading to altered habitat composition.
Flow Regime	Flashiness of the system may increase with more storm events, thus changing overall habitat composition.
Exotic species invasion	Warming temperatures may allow Asian clam, rusty crayfish (*Orconectes rusticus*), and virile crayfish (*O. virilis*) to move into these habitats.
Channel Hydrodynamics	Changes in flow regime will likely result in changes in the overall stream morphology and transport of sediment.
Storm Frequency and Intensity	Increased storm intensity can lead to flooding and therefore increased stormwater runoff and increased erosion. An increase in the number of tropical events can lead to flash flooding, which causes many of the abovementioned responses. With a change in intensity and variability of rainfall, there are potential changes to streamflow patterns, channel hydrodynamics, and the volume of groundwater (Band and Salvensen 2009; U.S. EPA, 2010; Bakke 2009).

Table 2. Fish Species Utilizing Montane Cool Water Streams							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
FISH							
Aplodinotus grunniens	Freshwater drum	G5/S1				/SC/	
Carpiodes carpio	River carpsucker	G5/S1				/SC/P	
Carpiodes cyprinus	Quillback	G5/S1				/SR/P	
Clinostomus funduloides	Rosyside dace	G5/S5				/ /	
Clinostomus sp. 1	Smoky dace	G5T3Q/ S3				FSC/SC/P	
Cottus carolinae	Banded sculpin	G5/S1				/T/	
Cyprinella zanema	Santee chub	G4/S3				/SR/P	
Erimonax monachus	Spotfin chub	G2/S1				T/T/P	
Erimystax insignis	Southern blotched chub	G4/S2				/ /P	
Etheostoma acuticeps	Sharphead darter	G3/S1				FSC/T/P	
Etheostoma kanawhae	Kanawha darter	G4/S3				/SR/P	
Etheostoma vulneratum	Wounded darter	G3/S1				FSC/SC/P	
Exoglossum laurae	Tonguetied minnow	G4/S2				/SR/P	
Exoglossum maxillingua	Cutlip minnow	G5/S1				/SC/P	
Hiodon tergisus	Mooneye	G5/S1				/SC/	
Ichthyomyzon bdellium	Ohio lamprey	G3G4/ S1				/SR/	
Ichthyomyzon greeleyi	Mountain brook lamprey	G3G4/ S3				/ /P	
Ictiobus bubalus	Smallmouth buffalo	G5/S1				/SR/P	
Ictiobus niger	Black buffalo	G5/S1				/SR/	
Lampetra appendix	American brook lamprey	G4/S1				/T/P	

Table 2. Fish Species Utilizing Montane Cool Water Streams							
Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/ Extirpation Prone	US/ NC/ WAP*	Comments
FISH							
Luxilus chrysocephalus	Striped shiner	G5/S2				/SC/P	
Moxostoma breviceps	Smallmouth redhorse	G5/S2				/SR/	
Moxostoma collapsum	Notchlip redhorse	G5/S5				/ /P	
Moxostoma pappillosum	V-lip redhorse	G4/S4				/ /P	
Moxostoma sp. 2	Sicklefin redhorse	G2Q/S1	YES		YES	C/T/P	
Notropis lutipinnis	Yellowfin shiner	G4Q/ S1				/SC/P	
Notropis micropteryx	Highland shiner	G5/S2				/SR/	
Notropis photogenis	Silver shiner	G5/S3				/W5/P	
Notropis sp. 1	Kanawha rosyface shiner	GNR/ S2				/SR/P	
Notropis volucellus	Mimic shiner	G5/S2				/SR/P	
Noturus eleutherus	Mountain madtom	G4/S1				/SC/P	
Noturus flavus	Stonecat	G5/S1				/E/P	
Percina aurantiaca	Tangerine darter	G4/S3				/W2/P	
Percina burtoni	Blotchside logperch	G2G3/ S1				FSC/E/P	
Percina caprodes	Logperch	G5/S1				/T/P	
Percina oxyrhynchus	Sharpnose darter	G4/S1				/SC/P	
Percina squamata	Olive darter	G3/S2				FSC/SC/P	
Phenacobius teretulus	Kanawha minnow	G3G4/ S2				FSC/SC/P	
Pimephales notatus	Bluntnose minnow	G5/S3				/ /P	
Sander canadensis	Sauger	G5/S2				/SR/	

Table 3. Bird Species Utilizing Montane Cool Water Streams							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
BIRDS							
Coccyzus americanus	Yellow-billed Cuckoo						
Empidonax alnorum	Alder Flycatcher					/SR/	
Empidonax traillii	Willow Flycatcher						
Limnothlypis swainsonii	Swainson's Warbler						
Oporornis formosus	Kentucky Warbler						
Vermivora chrysoptera	Golden-winged Warbler					/SR/	
Wilsonia citrina	Hooded Warbler						

Table 4. Mammal Species Utilizing Montane Cool Water Streams							
Species	**Common Name**	**Element Rank:**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
MAMMALS							
Microtus pennsylvanicus	Meadow Vole						
Myotis sodalis	Indiana Bat					E/E/	
Sorex fumeus	Smoky Shrew						
Sorex palustris	Water Shrew					/SC/	
Zapus hudsonius	Meadow Jumping Mouse						

Table 5. Reptile Species Utilizing Montane Cool Water Streams							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
REPTILES							
Apalone spinifera spinifera	Eastern Spiny Softshell						
Clemmys muhlenbergii	Bog Turtle					T(SA)/T/	
Crotalus horridus	Timber Rattlesnake					/SC/	
Heterodon platirhinos	Eastern Hog-nosed Snake						
Lampropeltis getula getula	Eastern Kingsnake						
Sternotherus minor peltifer	Stripe-necked musk turtle	G5/S1				/SC/P	
Terrapene carolina	Eastern Box Turtle						
Thamnophis sauritus sauritus	Common Ribbonsnake						

Table 6. Amphibian Species Utilizing Montane Cool Water Streams							
Species	**Common Name**	**Element Rank:**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
AMPHIBIANS							
Ambystoma maculatum	Spotted Salamander	G5/S5				/ /P	
Ambystoma opacum	Marbled Salamander	G5/S5				/ /P	
Ambystoma talpoideum	Mole Salamander	G5/S2				/SC/P	
Cryptobranchus alleganiensis	Eastern Hellbender	G3G4/ S3				FSC/SC /P	
Desmognathus aeneus	Seepage Salamander	G3G4/S3				FSC/SR /P	
Desmognathus folkertsi	Dwarf Blackbelly Salamander						Its range only includes the headwaters of one Clay County watershed
Desmognathus marmoratus	Shovel-nosed Salamander	G4/S4				/ /P	
Eurycea guttolineata	Three-lined Salamander	G5/G5				/ /P	
Eurycea junaluska	Junaluska Salamander	G3/S2				FSC/T/ P	
Eurycea longicauda	Longtail Salamander	G5/S1S2				/SC/P	
Hemidactylium scutatum	Four-toed Salamander	G5/S3				/SC/P	
Necturus maculosus	Common Mudpuppy	G5/S1				/SC/P	
Pseudacris brachyphona	Mountain Chorus Frog	G5/S2				/SC/P	

Table 7. Invertebrate Species Utilizing Montane Cool Water Streams							
Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/ Extirpation Prone	US/ NC/ WAP*	Comments
INVERTEBRATES							
Alasmidonta raveneliana	Appalachian elktoe	G1/S1	YES		YES	E/E/P	
Alasmidonta varicosa	Brook floater	G3/S1				FSC/E/P	
Alasmidonta viridis	Slippershell mussel	G4G5/ S1				/E/P	
Ameiurus brunneus	Snail bullhead	G4/S4				//P	
Attaneuria ruralis	Giant stone	G4/ S2S3				/SR/	
Barbaetis benfieldi	Benfield's bearded small minnow mayfly	G2G4/ S1				/SR/	
Bolotoperla rossi	Smoky willowfly	G4/S3				/SR/	
Cambarus acanthura	Thornytail crayfish	G4G5/ S1				/SR/P	
Cambarus georgiae	Little Tennessee crayfish	G2/ S2S3				/SC/P	
Cambarus hiwasseensis	Hiwassee crayfish	G3G4/ S3S4				/W2/P	
Cambarus howardi	Chattahoochee crayfish	G3/S3				/SR/	
Cambarus lenati	Broad River stream crayfish	G2/S2				/SR/P	
Cambarus reburrus	French Broad River crayfish	G3/S3				FSC/SR/P	
Cambarus spicatus	Broad River spiny crayfish	G3/S2				/SC/P	
Cambarus tuckasegee	Tuckasegee stream crayfish	G1G2/ S1S2				/SR/P	
Ceraclea mentiea	A caddisfly	G5/S2				/SR/	
Ceraclea slossonae	A caddisfly	G4/S1				/SR/	
Cyclonaias tuberculata	Purple wartyback	G5/S1				/E/P	

Table 7. Invertebrate Species Utilizing Montane Cool Water Streams							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
INVERTEBRATES							
Drunella lata	A mayfly	G5/S3				/SR/	
Elimia christyi	Christy's elimia	G2/S1				FSC/E/	
Elliptio dilatata	Spike	G5/S1				/SC/P	
Ephemerella berneri	A mayfly	G4/S3				/SR/	
Fusconaia barnesiana	Tennessee pigtoe	G2G3/ S1				/E/P	
Fusconaia subrotunda	Long-solid	G3/S1				/SR/P	
Homoeoneuria cahabensis	Cahaba sand-filtering mayfly	G2G3/ S2				/SR/	
Isoperla frisoni	Wisconsin stripetail	G5/S3				/SR/	
Lampsilis fasciola	Wavy-rayed lampmussel	G5/S1				/SC/P	
Lasmigona holstonia	Tennessee heelsplitter	G3/S1				FSC/E/P	
Lasmigona subviridis	Green floater	G3/S1				FSC/E/P	
Leptoxis dilatata	Seep mudalia	G3/S1				/T/P	
Macdunnoa brunnea	A mayfly	G3G4/ S2				/SR/	
Macromia margarita	Mountain River cruiser	G3/ S2S3				FSC/SR/	
Matrioptila jeanae	A caddisfly	G4/S3				/SR/	
Medionidus conradicus	Cumberland moccasinshell	G3G4/ SX				/EX/	
Ophiogomphus aspersus	Brook snaketail	G4/ S1S2				/SR/	
Ophiogomphus howei	Pygmy snaketail	G3/ S1S2				FSC/SR/	
Ophiogomphus rupinsulensis	Rusty snaketail	G5/S1?				/SR/	
Pegias fabula	Littlewing pearlymussel	G1/S1			YES	E/E/P	

Table 7. Invertebrate Species Utilizing Montane Cool Water Streams							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
INVERTEBRATES							
Pleurobema oviforme	Tennessee clubshell	G2G3/ SU				FSC/E/P	
Potamilus alatus	Pink heelsplitter	G5/S1				/SR/	
Stenelmis gammoni	Gammon's stenelmis riffle beetle	G1G3/ SH				FSC/SR/	
Strophitus undulatus	Creeper	G5/S2				/T/P	
Sympetrum obtrusum	White-faced meadowhawk	G5/S1?				/SR/	
Triaenodes marginatus	A triaenode caddisfly	G5/S3				/SR/	
Villosa delumbis	Eastern creekshell	G4/S3				/SR/P	
Villosa iris	Rainbow	G5Q/S1				/SC/P	
Villosa trabalis	Cumberland bean	G1/S1			YES	E/SR/P	
Villosa vanuxemensis	Mountain creekshell	G4/S1				/T/P	
Zapada chila	Smokies forestfly	G2/ S1S2				/SR/	

* US/ NC/ WAP Abbreviations (species are subject to reclassification by USFWS, NHP, or WRC).					
E	Endangered	SC	Special Concern	P	WAP Priority Species
T	Threatened	SR	Significantly Rare		
FSC	Federal Species of Concern	W	Watch Category		
T(S/A)	Threatened due to similarity of appearance				

NatureServe Element Rank: http://www.natureserve.org/explorer/ranking.htm

USFWS Endangered Species Listing Status: http://www.fws.gov/raleigh/es_tes.html

NC Natural Heritage Program Status:
http://www.ncnhp.org/Images/2010%20Rare%20Animal%20List.pdf

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