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DRAFT - Montane Cold Water Stream Communities

Ecosystem Group Description

This Ecosystem Group includes cold water stream systems in the Blue Ridge physiographic province. Often these cold water streams are headwater systems, but the upper portions of some large rivers may be considered cold water, particularly if they are influenced by hydroelectric projects. The cold water designation is based upon two general principles: fish community structure and temperature regime.

Whether natural or induced, seasonal and daily variations of water temperatures will influence the distribution of aquatic species in aquatic systems (Caissie 2006). Cold water streams generally have a fish species composition that includes: brook, brown, and rainbow trout, mottled sculpin, longnose dace, blacknose dace, and central stoneroller. This list is not inclusive and provides general guidance on community structure.

Temperature regime can also be used to help classify cold water streams, where summer water temperatures typically do not exceed 20 degrees Celsius (°C) [68 degrees Fahrenheit (°F)]. This is a suggested temperature that will typically support the fish community structure (US Army Corps of Engineers 2003). For migrating salmonids in the Pacific northwest, the EPA recommends a 7-day average daily maximum water temperature of 20°C (EPA 2012). McCullough *et al.* (2009) suggests 22 – 23°C as a threshold for juvenile salmonid species. A review of research literature seems to indicate the need for availability of a temperature gradient appropriate to support differing size, age, and possibly sex of the species.

Cold water riverine aquatic communities can be found in the upper Yadkin, Hiwassee, Little Tennessee, Savannah, French Broad, Watauga, New, Catawba, and Broad River basins (NCWRC 2005). Examples include Peachtree Creek, Fires Creek, Tellico Creek, Nantahala River, Davidson River, Spring Creek, Big Crabtree Creek, Helton Creek, and Wilson Creek. The 2005 Wildlife Action Plan includes Southern Blue Ridge Mountain Riverine Aquatic Communities, which are a component of this community, as a priority habitat (see Chapter 5A) (NCWRC 2005).

Table 1 at the end of this report provides a summary of expected climate change impacts to Montane Cold Water Stream Communities.

Predicted Effects to Wildlife Species

Tables 2 through 6 at the end of this report identify the species of conservation concern and priority species that use habitats in this ecosystem.

Cold water stream communities contain several rare species that are vulnerable to extinction. Their rarity makes them vulnerable to changes in habitat.

Trout populations in NC are already at the southern end of their range and the native brook trout should be a species considered vulnerable to extinction in this Ecosystem Group. They typically occupy the upper reaches of mountain headwater streams and few populations have the ability to migrate to cooler waters. Typically trout are unable to survive in waters where summer temperatures rise above 20 – 24 °C. Because of the already limited range of trout in North Carolina it is unlikely these fish will be able to seek refuge from warming water temperatures. It should be noted that Weaver (2010) examined the effects of trout stocking on native nongame fishes and found no significant differences in fish density, species richness, species diversity, or fish microhabitat use associated with short-term effects of trout stocking.

Freshwater mussels rarely overlap habitat with trout; however, with changes to the temperature regimes in these systems, trout may be extirpated and freshwater mussels could expand or shift habitats. As water temperatures increase, freshwater mussels inhabiting montane cool water systems could move into cold water systems as their host fish move upstream.

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 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).

Climate Change Compared to Other Threats

Comparing climate change to other ecosystem threats can help define short-term and long-term conservation actions and recommendations. While climate change is not the most severe threat to these systems, it, in conjunction with development and lack of riparian corridors, could stress these systems to the point where several species are unable to persist.

Table 7 compares climate change with other existing threats.

Table 7. Comparison Of Climate Change With Other Threats

Threat	Rank Order	Comments
Development	1	Direct, secondary, and cumulative effects from development. Residential development, particularly in steep slope areas, is of particular concern because of increased erosion.

Table 7. Comparison Of Climate Change With Other Threats		
Threat	**Rank Order**	**Comments**
Lack of riparian vegetation	1	Lack of riparian vegetation or inadequate width of forested buffer can cause streambank erosion and sedimentation. Vegetation also provides shading that reduces water temperature and is a source of detritus that is a food resource for macrobenthic species.
Pollution	2	Point and Nonpoint sources - runoff, endocrine disrupting chemicals - are threats. Recent studies have shown that endocrine disrupting chemicals (EDC) in treated wastewater can inhibit reproduction and cause feminization of mussels and fish. Christmas tree farms uses high amounts of herbicides and pesticides which may persist in soil for long periods of time or run off into streams.
Cattle in Streams	2	Livestock access to streams contributes heavily to bank erosion, sedimentation, and nutrient input.
Climate Change	3	Cold water systems may shrink in habitat and extent, making small streams more vulnerable to water temperature increases because of their low thermal capacity (Caissie 2006)..
Water Withdrawals	4	Water withdrawals can be problematic, particularly in streams with already low 7Q10 flows, because they may reduce available habitat for aquatic species. Irrigation withdrawals pose a threat to flow regime.
Conversion to agriculture/silviculture	4	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. Timber harvests with improper erosion controls and poorly constructed and maintained timber roads can cause erosion.
Impoundment/Dams	4	Effects are both direct and indirect, including loss of habitat, shifts in food web, and change in species composition. Numerous watershed in the mountains no longer contain trout assemblages likely due to a proliferation of ponds that not only block fish movements, but also cause decreased stream flows and increased temperatures.
Invasive Species	5	Invasive plants in the riparian area can have negative impacts on stream systems by creating a monoculture (*e.g.* Japanese knotweed) with poor nutrient inputs, reducing bank stability, and allowing too much sunlight and therefore warmer stream temperatures. Asian clam or rusty crayfish may compete for space and resources, although specific interactions are largely unknown.

Summary and Recommendations

It will be important to preserve habitat connectivity because of their elevation and location within the watershed (usually as headwater streams), many species will not be able to migrate

to cooler temperature streams. This makes it important to preserve these habitats and their connectivity throughout the watershed.

Recommended Actions

Surveys

- Several of the priority species associated with riverine habitat in western North Carolina are known from only a few localities, and/or are considered rare or declining. Priority needs to be placed upon the conduct of baseline surveys to determine their current range and distribution (*e.g.,* water shrew, hellbender, Junaluska and longtail salamander, mudpuppy, eastern spiny softshell, and loggerhead musk turtle) (NCWRC 2005).
- Gather better information about the status and distribution of more common species associated with riverine habitats (*e.g.,* shovel-nosed and three-lined salamanders) (NCWRC 2005).
- Investigate population status of native brook trout.

Monitoring

- Monitor aquatic taxa to assess species and ecosystem health and in gauging resiliency of organisms to a changing climate.
- Development of long-term monitoring strategies to document population trends, from which conservation strategies can be specifically designed to target those species which are experiencing declines (NCWRC 2005).

Research

- Expand efforts of Conservation Aquatics Center at NCWRC Marion Hatchery to support mussel and fish propagation programs and release juveniles as part of a reintroduction and augmentation program.
- Priority research topics related to these species and riverine habitats include investigations into the relationships between water quality and hydrologic regimes and population change of selected species (NCWRC 2005).
- Potential studies also include efforts to determine specific flow regimes necessary to support microhabitat for particular species (*e.g.,* Junaluska salamander) and investigations to determine the effect that beaver ponds have on downstream movement of toxins and sediment (NCWRC 2005).
- Investigate the specific microhabitat requirements for priority species in order to develop long-term conservation strategies (NCWRC 2005).
- To accurately predict the influence of climate change in coldwater systems, better information is needed regarding the inputs and influence of groundwater sources.
- Genetic research is needed to resolve taxonomic issues for aquatic species.
- Use propagation techniques to grow new populations of priority and declining aquatic populations.
- Augment and restore populations of priority and declining aquatic populations using propagated populations.

- Study the combined effect of land use changes and climatic effects on long-term stream temperature trends as they relate to native brook trout protection, restoration, and management.
- Investigate thermal tolerance for brook trout and other native species.
- Examine stream temperature and associated microclimatic responses to a range of shading variables from riparian vegetation.

Management Practices

- Increase the effective connectivity (*i.e*., gene flow) between headwater brook trout populations through removal of artificial barriers and promote habitat connectivity.
- 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

- In general the most critical conservation actions necessary to sustain populations of riverine habitat species involve protection of water quality and aquatic habitats. Immediate and continuing efforts need to be undertaken to limit water quality deterioration from point sources of pollution as well as non-point sources (NCWRC 2005).
- Encourage use of pervious paving materials where feasible.
- Preservation or restoration of riparian vegetation to maintain stable streambanks.
- Design bridges and culverts to allow for stream movement and aquatic organism passage. Design standards may need alteration to accommodate environmental changes due to climate change.
- 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 Climate Change Impacts	
Climate Change Factor	**Comments**
Drought	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.
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. Low dissolved oxygen associated with hot spells may increase fish kills.
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.
Compositional Change	Piedmont shiner (Notropis sp cf chlorocephalus), native to the Broad River, and yellowfin shiner (N. lutipinnis), native to the Savannah River Basin, have been introduced to the Little Tennessee River Basin. Their range could expand into other cold water systems with warming water temperatures.
Channel Hydrodynamics	Changes in flow regime will likely result in changes in the overall stream morphology and transport of sediment.
Distribution Limits	Several priority species have very limited distributions or widely dispersed but small populations (*e.g.*, eastern spiny softshell turtle, loggerhead musk turtle, Junaluska and longtail salamanders). Isolation or habitat fragmentation could affect life cycle or prey components for a variety of species.

Table 2. Fish Species Utilizing Montane Cold Water Stream Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
FISH							
Clinostomus sp 1	Smoky dace	G5T3Q/S3				FSC/SC/P	
Cottus carolinae	Banded sculpin	G5/S1				/T/	
Erimystax insignis	Botched chub	G4/S2				//P	
Etheostoma inscriptum	Turquoise darter	G4/S1				/T/P	
Etheostoma kanawhae	Kanawha darter	G4/S3				/SR/P	
Exoglossum laurae	Tonguetied minnow	G4/S2				/SR/P	
Hybopsis rubrifrons	Rosyface chub	G4/S1				/T/P	
Ichthyomyzon greeleyi	Mountain brook lamprey	G3G4/S3				//P	
Lampetra appendix	American brook lamprey	G4/S1				/T/P	
Luxilus chrysocephalus	Striped shiner	G5/S2				/SC/P	
Moxostoma breviceps	Smallmouth redhorse	G5/S2				/SR/	
Moxostoma collapsum	V-lip redhorse	G5/S5				//P	
Notropis lutipinnis	Yellowfin shiner	G4Q/S1				/SC/P	
Notropis sp. 1	Kanawha rosyface shiner	GNR/S2				/SR/P	
Percina nigrofasciata	Blackbanded darter	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	
Salvelinus fontinalis	Brook trout		YES				

Table 3. Mammal Species Utilizing Montane Cold Water Stream Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
MAMMALS							
Sorex palustris	Water Shrew					/SC/P	

Table 4. Reptile Species Utilizing Montane Cold Water Stream Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
REPTILES							
Apalone spinifera spinifera	Eastern Spiny Softshell					/SC/P	
Sternotherus minor	Loggerhead musk turtle	G5/S1				/SC/P	
Thamnophis sauritus sauritus	Common Ribbonsnake					/ /P	

Table 5. Amphibian Species Utilizing Montane Cold Water Stream Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
AMPHIBIANS							
Cryptobranchus alleganiensis	Hellbender	G3G4/S3				FSC/SC/P	
Desmognathus folkertsi	Dwarf Blackbelly Salamander						
Desmognathus marmoratus	Shovel-nosed Salamander					/ /P	
Eurycea guttolineata	Three-lined Salamander					/ /P	
Eurycea junaluska	Junaluska Salamander					/T/P	
Eurycea longicauda	Longtail Salamander					/SC/P	
Necturus maculosus	Common mudpuppy	G5/S1				/SC/P	

Table 6. Invertebrate Species Utilizing Montane Cold Water Stream Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
INVERTEBRATES							
Attaneuria ruralis	Giant stone (stonefly)	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 chaugaensis	Chauga cryfish	G2/S2				/SC/P	
Cambarus georgiae	Little Tennessee crayfish	G2/S2S3				/SC/P	
Cambarus hiwasseensis	Hiwassee crayfish	G3G4/S3S4				/W2/P	
Cambarus nodosus	Knotty burrowing crayfish	G4/S2				/SR/P	
Cambarus parrishi	Hiwassee headwaters crayfish	G2/S1				FSC/SC/P	
Cambarus reburrus	French Broad River crayfish	G3/S3				FSC/SR/P	
Cambarus tuckasegee	Tuckasegee stream cryfish	G1G2/S1S2			YES	/SR/P	
Drunella lata	A mayfly	G5/S3				/SR/	
Elimia christyi	Christy's elimia (snail)	G2/S1				FSC/E/	
Ephemerella berneri	A mayfly	G4/S3				/SR/	
Isoperla frisoni	Wisconsin stripetail (stonefly)	G5/S3				/SR/	
Leptoxis dilatata	Seep mudalia (snail)	G3/S1				/T/P	
Macromia margarita	Mountain river cruiser (dragonfly)	G3/S2S3				FSC/SR/	
Matrioptila jeanae	A caddisfly	G4/S3				/SR/	

Table 6. Invertebrate Species Utilizing Montane Cold Water Stream Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
INVERTEBRATES							
Megaleuctra williamsae	Williams' rare winter stonefly	G2/S1				/SR/	
Palaeagapetus celsus	A caddisfly	G5/S2				/SR/	
Rhyacophila amicis	A caddisfly	G2/S2				/SR/	
Skistodiaptomus carolinensis	Carolina skistodiaptomus (copepod)	GNR/S1?				/SC/	
Stygobromus carolinensis	Yancey sideswimmer (amphipod)	G1G2/S1			YES	FSC/SR/	
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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