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## Ecosystem Description

This ecosystem group includes intermittent and first and second order streams of the Piedmont. Headwater streams are very important elements in the stream and river networks in terms of influencing water quality and quantity. In fact, the majority of land area (approximately 80 to 85%) drains to headwater streams (Gregory 2009) and they constitute at least 80% of the nation's stream network (Meyer *et al*. 2003).

Many headwater systems are associated with small wetland systems and some originate at natural spring heads. Species diversity tends to be a bit lower in these systems, with benthic macroinvertebrates being a very important component of the community. Fish assemblage is typically lower than in small river systems and mussels are often absent from these headwater streams.

Examples include Morgan Creek, Parkers Creek, Little Creek, and White Oak Creek, although many streams in this community are unnamed tributaries. The 2005 Wildlife Action Plan described Piedmont Small Wetland Communities and Riverine Aquatic Communities, which would include headwater streams, as priority habitats (see Chapter 5A).

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 7 at the end of this report identify the species of conservation concern and priority species that use habitats in this ecosystem.

Climate change effects, especially drought and higher temperatures, will likely have a significant impact on headwater stream communities, possibly creating a shift where several perennial streams will become intermittent or ephemeral systems. This potential shift will result in the loss of aquatic species diversity. 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. Headwater streams could dry up, potentially leading to aquatic species extirpation (DeWan *et al*., 2010; Karl *et al*., 2009; Band and Salvensen, 2009; U.S. EPA, 2010).

Potential increased air temperatures and therefore increased water temperatures can lead to algal blooms in aquatic systems, which diminishes stream oxygen availability. The increased water temperature alone can cause a decline in dissolved oxygen (DO) and any decline in DO can lead to fish kills, whether as a direct result of increased water temperature or as a secondary effect of algal blooms.

Maintaining water quality is important for the species that rely upon headwater streams for habitat as well as for those species which rely indirectly on the system as provision of habitat for their prey (NCWRC 2005). Wetlands associated with headwater streams are important as breeding sites for amphibian species and can also be important breeding habitat for crayfishes. Concentrated stormwater flows can strip salamander eggs from river banks and vegetation, reducing reproductive success.

Riparian areas serve as thermal refugia because they provide stream shading but also because they have higher water content than upland areas. Animals with thermoregulatory limitations have refugia which will become increasingly important with anticipated increases in air temperatures. Drought and loss of vegetated cover will reduce available refugia for these species.

Riparian areas associated with headwater streams provide habitat for terrestrial wildlife species and are a linkage between aquatic and terrestrial systems which serve as corridors for movement of terrestrial wildlife species (Seavy *et al*. 2009; NCWRC 2002; Wenger 1999). Some birds may use headwater stream communities and associated small wetlands for nesting and feeding areas.

## Climate Change Compared to Other Threats

These stream systems are vitally important to the overall health of the downstream watershed, yet are likely to experience potentially severe physical, chemical, and biological changes with temperature and dissolved oxygen alteration (DeWan *et al*., 2010; Karl *et al*., 2009; Band and Salvensen, 2009).

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 | An increase in impervious surfaces due to roads, parking lots, homes, and businesses increases the amount and speed of runoff being delivered into aquatic systems and decreased groundwater recharge between storms leads to a decrease in stream baseflow. Runoff from urban areas often contain higher concentrations of nutrients, such as nitrogen and phosphorus, sediment, metals, hydrocarbons, and microbes. |
| Erosion and Sedimentation | 1 | Streams in the Triassic Basin are particularly susceptible to erosion and are likely at greatest risk for erosion given proximity to many urban and suburban development centers. Erosion and the resultant sedimentation are the largest sources of nonpoint source pollution in most all aquatic systems. |

| Table 8. Comparison Of Climate Change With Other Threats | | |
|---|---|---|
| **Threat** | **Rank Order** | **Comments** |
| Climate Change | 2 | Piedmont headwater streams may shrink in habitat or extent. |
| Lack of riparian vegetation | 2 | Lack of riparian vegetation or inadequate width of forested buffer can cause streambank erosion and sedimentation. In addition to stabilizing stream banks, riparian vegetation serves as a food/nutrient input to the stream community and helps regulate stream temperature by providing shade. |
| Logging/Exploitation | 2 | While bank vegetation is usually undisturbed, logging is a major threat to streams if proper erosion controls are not used and maintained. Poorly constructed and maintained timber roads contribute to erosion. |
| Flood Regime Alteration | 3 | High and low flow extremes pose a threat. |
| Invasive Species | 4 | Invasive plants in the riparian area can have negative impacts on stream systems by often times creating a monoculture with poor nutrient inputs, reducing bank stability, and allowing too much sunlight and therefore warmer stream temperatures. Invasive aquatic species, like Asian clam, may have negative effects on native species, such as competition for space and resources. |
| Cattle in Streams | 4 | Livestock access to streams contributes heavily to bank erosion, sedimentation, and nutrient input.. |
| Pollution | 5 | The majority of these headwater streams are in private ownership and therefore are threatened by land use practices that may increase stormwater runoff of nutrients, sediment, and contaminants. Endocrine disrupting chemicals (EDC) in treated wastewater can inhibit reproduction and cause feminization of mussels and fish (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). Runoff from impervious surfaces carry lawn pesticides, road oil, and other pollutants from developed areas into surface waters. |

## Summary and Recommendations

Land conservation or preservation can serve numerous purposes in the face of anticipated climate change but overall it promotes ecosystem resilience, such as: protecting watersheds for clean water, flood attenuation, and decreased erosion and sedimentation; providing ecological corridors for species movement throughout the landscape in response to changing habitats; preserving existing habitats to help prevent forced migration (Band and Salvensen, 2009).

**Recommended Actions**

Surveys

- Identify the location of key small wetland communities in the Piedmont.
- Initiate distribution surveys for all amphibian species associated with small wetland communities, but especially the mole salamander, eastern tiger salamander, dwarf salamander, and four-toed salamander.
- Gather better information about the status and distribution of more common species associated with Piedmont wetland habitats (*e.g.*, three-lined salamander, common ribbonsnake).

Monitoring

- Changes in flood patterns (frequency and duration) and flooded lands may periodically require updating flood maps to ensure protection of life and property (Band and Salvensen, 2009).
- Determine population trends and persistence of small wetland breeding amphibian populations, particularly mole salamander, eastern tiger salamander, dwarf salamander, and four-toed salamander.
- Development of long-term monitoring strategies to document population trends, from which conservation strategies can be specifically designed to target those species.

Research

- Study the efficacy and practicality of "toad tunnels" and other wildlife crossings that allow passage under roadways and help maintain connectivity between wetland metapopulations.
- Determine minimum upland buffers required to sustain at-risk amphibian populations.

Management Practices

- The preservation or restoration of riparian vegetation is crucial to the maintenance of stable streambanks, in addition to the role that riparian vegetation serves to dissipate water runoff energy and allow for sediment deposition.
- Fence livestock to prevent direct access to streams as a means to prevent erosion, protect riparian vegetation, and reduce nutrient inputs to the aquatic system.
- Protect floodplains and wetlands from development to preserve a natural and economical means for flood water attenuation.
- Stormwater management techniques should strive to restore or maintain the pre-development hydrograph.
- Promote infiltration and natural recharge of groundwater and surface waters through bioretention cells (i.e., rain gardens), cisterns, permeable pavement, runnels, vegetated swales, and filter strips used in various ways as stormwater best management practices (BMPs) (Shuford *et al.*, 2010).

| | |
|---|---|
| Land Protection | • Use easements, use-value taxation and fee simple purchase for land conservation or preservation.<br>• Protect potential migration corridors and preserve connectivity that allows for species and ecosystem migration. |

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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. Higher air and water temperatures can lead to increased evaporation, which results in less flowing water available for aquatic species use. Hot spells can have the same effect as overall increased air temperatures but on a much more acute scale. Low dissolved oxygen associated with hot spells may increase fish kills. |
| Flooding | Increased storm intensity can lead to flooding and therefore increased stormwater runoff and increased erosion. Increased severity and frequency of storm events, similar to hurricanes, will have impacts. With a change in intensity and variability of rainfall, there are potential changes to streamflow patterns and channel hydrodynamics (Band and Salvensen, 2009; U.S. EPA, 2010; Bakke 2009). An increase in the number of tropical events can lead to flash flooding. Effects are likely increased sediments and contaminants into aquatic systems, in addition to major disruption to channel design and hydrodynamics, potentially upset the physical, chemical, and biological structure of streams (Band and Salvensen, 2009). |
| Drought | Potential changes in precipitation have numerous and varied effects. Severe and prolonged droughts may decrease streamflow, decrease groundwater recharge, contribute to warmer water temperatures, and increase evaporation. Lower water levels during dry times will increase stress to the system. |
| Groundwater Drawdown | During droughts, recharge of groundwater will decline as the temperature and spacing between rainfall events increase. Groundwater pumping in response to increased drinking water or agriculture irrigation demands will further stress or deplete aquifers and place increasing strain on surface water resources. |
| Compositional Change | Aquatic species could become extirpated or may move further downstream into higher order streams. Therefore, these systems may experience a change in species composition. |
| Channel Hydrodynamics | Changes in channel morphology and streamflow could change overall habitat composition. |
| Flow Regime | Flashiness of the system may increase with more storm events, thus changing overall habitat composition. |
| Sediment Transport | Changes in streamflow could change overall sediment transport dynamics, leading to altered habitat composition. |

| Table 2. Fish Species Utilizing Piedmont Headwater Streams | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Species** | **Common Name** | **Element Rank** | **Endemic** | **Major Disjunct** | **Extinction/ Extirpation Prone** | **US/ NC/ WAP*** | **Comments** |
| **FISH** | | | | | | | |
| *Thoburnia hamiltoni* | Rustyside sucker | G3/S1 | | | | FSC/E/P | |
| *Notropis chlorocephalus* | Greenhead shiner | G4/S3 | | | | /W5/ | |
| *Lampetra aepyptera* | Least brook lamprey | G5/S2 | | | | /T/P | |

| Table 3. Bird Species Utilizing Piedmont Headwater Streams | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Species** | **Common Name** | **Element Rank** | **Endemic** | **Major Disjunct** | **Extinction/ Extirpation Prone** | **US/ NC/ WAP*** | **Comments** |
| **BIRDS** | | | | | | | |
| *Melanerpes erythrocephalus* | Red-headed Woodpecker | G5/S4 | | | | / /P | |
| *Nyctanassa violacea* | Yellow-crowned Night-heron | G5/S3B | | | | / /P | |

| Table 5. Reptile Species Utilizing Piedmont Headwater Streams | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Species** | **Common Name** | **Element Rank** | **Endemic** | **Major Disjunct** | **Extinction/ Extirpation Prone** | **US/ NC/ WAP*** | **Comments** |
| **REPTILES** | | | | | | | |
| *Clemmys guttata* | Spotted Turtle | G5/S3 | | | | / /P | |
| *Thamnophis sauritus sauritus* | Common Ribbonsnake | G5/S4 | | | | / /P | |
| *Apalone spinifera aspera* | Gulf Coast Spiny Softshell | G5T5/S3 | | | | / /P | |
| *Farancia abacura abacura* | Eastern Mudsnake | G5/S4 | | | | / /P | |
| *Kinosternon baurii* | Striped Mud Turtle | G5/S3 | | | | / /P | |

| Table 6. Amphibian Species Utilizing Piedmont Headwater 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 | |
| *Ambystoma tigrinum* | Eastern Tiger Salamander | G5/S2 | | | | /T/P | |
| *Eurycea guttolineata* | Three-lined Salamander | G5/S5 | | | | / /P | |
| *Eurycea quadridigitata* | Dwarf Salamander | G5/S2 | | | | /SC/P | |
| *Hemidactylium scutatum* | Four-toed Salamander | G5/S3 | | | | /SC/P | |
| *Hyla gratiosa* | Barking Treefrog | G5/S3S4 | | | | / /P | |
| *Hyla versicolor* | Northern Gray Treefrog | G5/S1? | | | | /SR/P | |
| *Scaphiopus holbrookii* | Eastern Spadefoot | G5/S5 | | | | / /P | |

| Table 7. Invertebrate Species Utilizing Piedmont Headwater Streams | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Species** | **Common Name** | **Element Rank** | **Endemic** | **Major Disjunct** | **Extinction/ Extirpation Prone** | **US/ NC/ WAP*** | **Comments** |
| **INVERTEBRATES** | | | | | | | |
| *Barbaetis benfieldi* | Benfield's bearded small minnow mayfly | G2G4/S1 | | | | /SR/ | |
| *Cambarus lenati* | Broad River stream crayfish | G2/S2 | | | | /SR/P | |
| *Cambarus davidi* | Carolina Ladle crayfish | G3/S2S3 | | | | /SR/P | |
| *Cambarus catagius* | Greensboro burrowing crayfish | G3/S2 | | | | /SC/P | |
| *Macromia margarita* | Mountain river cruiser | G3/S2S3 | | | | /SR/ | |
| *Diplectrona metaqui* | A diplectronan caddisfly | G4G5/S3 | | | | /SR/ | |
| *Triaenodes marginatus* | A triaenode caddisfly | G5/S3 | | | | /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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