DRAFT - High Elevation Rock Outcrops

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Ecosystem Description

High elevation rock outcrop communities occur on ridgetops, peaks, and upper slopes where soils are thin and discontinuous and rock dominates the surface. Even in the most rugged high mountains they represent only a small minority of the landscape. The vegetation is very patchy, reflecting the variability of the soil. Two community types are part of this ecosystem: high elevation granitic domes and high elevation rocky summits.

High elevation granitic domes occur on the exfoliated outcrops that form when massive granitic rock breaks off in sheets parallel to the surface. Exfoliation produces smooth dome-shaped outcrops that lack crevices. Lichens and mosses occur on the bare rock. Soil and vegetation develop together on the rock surface as moss mats gradually deepen and are invaded by a succession of herbs. Soil mats are not anchored to the rock below and eventually fall off or are pulled up by falling trees, leaving the rock bare again. The shallow soils are generally dry, but some zones of seepage are usually present on the edge of the soil of adjacent forests. A number of wetland plants can occur in these saturated areas.

High elevation rocky summit communities occur on fractured rock. The bare rock is similarly vegetated by patches of lichen and moss, and shallow soil mats may develop locally. The presence of fractures, however, offers patches of deeper, more permanent soil that can support deeper rooted plants, and can provide an opportunity to anchor soil mats. The vegetation pattern is less likely to shift over time.

High elevation rock outcrops obviously occur only in the highest mountain ranges of western North Carolina, notably in the Great Smokies, Plott Balsams, Great Balsams, Black/Craggy Mountains, Grandfather Mountain, Roan Mountain, and in the Amphibolite mountains of Ashe County. However, depending upon elevation, they can be found scattered just about anywhere that elevations allow. The 2005 Wildlife Action Plan describes High Elevation Rock Outcrops in the Southern Blue Ridge Mountains as a priority habitat (see Chapter 5A) (NCWRC 2005).

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.

While high elevation rock outcrop habitat and low elevation cliffs/rock outcrops support many of the same animals and plants, there are species of both plants and animals that are found exclusively at high elevation rock communities (e.g. ,rock vole, long-tailed shrew, Allegheny

woodrat, and several rare plant species), and others found only in low elevation cliffs/rock outcrop habitat (*e.g*., southern Appalachian woodrat, spotted skunk, crevice and Southern zigzag salamanders). The elevation limit for each of these species varies, but clearly there is a distinction between the animal assemblage at rock habitats that is dependent upon elevation. (NCWRC 2005).

For many species associated with high elevation rock outcrops we may not currently know the entire spectrum of threats that are affecting populations due to inadequate levels of study or knowledge. For example, green salamander populations in North Carolina may have experienced dramatic declines during the late 1970's and early 1980's (Wilson 2001). Various theories were promulgated to explain the apparent decline including impacts of air pollution, deforestation, development, disease, successive years of extremely cold winters and/or extreme droughts in summer, and over-collection (see Wilson 2001 for discussion). However, there is no definitive cause for the apparent decline and we do not know if an overall population decline occurred or whether isolated impacts upon particular sites caused local declines (NCWRC 2005).

Individual wildlife and plant species may face threats specific to either their particular location or the species itself. For example, timber rattlesnakes face threats in addition to habitat loss including being subject to collection, disturbance of hibernacula/gestation sites, and persecution. There has been considerable effort undertaken in the northeastern United States to determine the impact upon Allegheny woodrat populations from a roundworm parasite that may have impacted populations in that region (McGowan 1993, Stone *et al.* 1993), though no studies have been conducted within North Carolina to assess the level of threat posed to North Carolina woodrat populations.

The decline of peregrine falcons during the last half of the 20th century has been widely attributed to the use of DDT and its concomitant effect on bird reproduction. The use of DDT was banned and peregrine restoration efforts occurred in the late 1980's and 1990's, however peregrine falcons still face threats due to habitat loss to development and recreation impacts at individual cliff sites. Furthermore, the North Carolina population remains at fairly low density, thereby increasing the threat of stochastic events having significant population impacts. (NCWRC 2005).

The insect fauna of high elevation rock outcrops has not yet been well-studied and a number of additional species may yet be added. The landscape requirements of these guilds also need more study. Two endemic arachnid species (*Hypochilus*) would be particularly vulnerable to extinction if they are intolerant to increases in temperature and drought, which seems likely. Their current restriction to extremely small ranges suggests that they have only a low level of vagility and may be unable to shift their ranges fast enough to keep up with environmental change. Competition with the more widespread *H. pockocki* may further limit their ability to shift their ranges.

Climate Change Compared to Other Threats

We expect the future climate to include warmer temperatures, longer growing season, more hot spells and drought, and more severe storms.

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

Table . Comparison Of Climate Change With Other Threats

Threat	Rank Order	Comments
Climate Change	1	The most likely effects from changes in temperature and mild winters. Given the high number of endemics and disjuncts, climate-related changes greatly threaten biodiversity. Reduced winter snow and lack of seasonal snow packs will have negative effects on soil moisture.
Development	1	Logging and development are possible on private tracts. Development may not directly impact outcrops, but may increase access and therefore trampling.
Trampling	2	Trampling from recreational users (hikers and rock climbers) is probably the most immediate threat.
Woody Succession	3	Trees and shrubs may invade if enough water is available during the growing season. Intrusion by alder, rhododendron and other woody plants can cause rock outcrops to become overgrown.
Invasive Species	4	As temperatures increase, native and exotic species from lower elevations may be able to invade these areas more easily. Coltsfoot (*Tussilago farfara)* is the most common exotic species in High Elevation Rock Outcrops.
Pollution	5	There has been suggestion that air pollution could be having an impact upon the high elevation rock communities of western North Carolina (TNC and SAFC 2000); however, there has not been definitive evidence of air pollution impacts upon wildlife species associated with high elevation rock outcrops. (NCWRC 2005).

Summary and Recommendations

This ecosystem is among the most vulnerable to the effects of climate change of any in the state. Given the high number of endemics and disjuncts, climate-related changes greatly threaten biodiversity here. Several of the species face outright extinction and others, if lost, are unlikely to ever recover within the region.

Priority should be given to several measures that may secure them enough time and space to survive both short term environmental disturbances as well as adapt to longer term changes in the climate. Since virtually all examples of this theme are located on public lands and already

managed to preserve their natural features, implementation of recommended interventions should be feasible.

Recommended Actions

Surveys	• Survey for new peregrine falcon nests. • Obtain baseline data on reptile communities and habitat use (*e.g.*, identify timber rattlesnake den sites). • Obtain baseline data on small mammal communities and habitat use. •
Monitoring	• Endemic species should be monitored closely for declines in the near future, and transplantation may be required to prevent extinction. • Continue monitoring the peregrine falcon population. • Monitor priority reptile population trends and habitat use. • Monitor priority small mammal population trends and habitat use.
Research	• Reintroduction of rare species to patches or mountain ranges where they have been lost, as well as to restored areas, would improve their prospects for survival in the future climate. • Study timber rattlesnake movements, use of hibernacula, and reproductive success at gestation sites.
Management Practices	• Work cooperatively with regional partners to develop a high elevation communities management plan. • Maintenance of biologically significant areas, including peregrine falcon nesting areas, reptile den sites and significant salamander occurrences (NCWRC 2005). • Management of outcrops to reduce intrusion by alder, rhododendron, and other species, which contributes to the disappearance of some vertebrates. • Control invasive species and protect or restore areas already affected by invasive species to protect against changing climate conditions.
Land Protection	• Protection from trampling would allow the species pool to expand through suitable habitat, producing larger, more robust, populations that would be better able to survive climate-related changes. • High elevation rock outcrops are extremely rare, have a very restricted range, and are subject to extreme environmental conditions. All existing habitats of this type should be high priorities for conservation action (NCWRC 2005).

- Closure of sensitive areas at certain times (*e.g.,* during timber rattlesnake emergence or peregrine falcons nesting) or permanently to stop direct trampling, loss of habitat to recreation developments, trails, vistas, etc. and indirect human impacts (disturbance) (NCWRC 2005).
- Easements and land acquisition to protect from long term impacts such as housing development (NCWRC 2005).

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Table 1. Predicted Impacts of Climate Change	
Climate Change Factor	**Comments**
Wind Damage	These areas already experience more high wind than other areas, and it is unclear if an increase in storms will mean more wind damage than already occurs.
Mild Winters	Winter cold is the most likely reason many species are currently excluded from these communities. Competition may increase if species currently limited by cold to lower elevations are able to invade high elevation rock outcrops. Wind damage from increased storms may mitigate this effect for woody species.
Temperature Increase/Hot Spells	Heat stress may possibly lead to mortality in some species, including dominant plants. May depend on the behavior of cloud cover. Warmer temperatures and drought may accelerate organic matter decomposition, reducing soil organic layer and slowing the rate of succession. Loss of soil organic matter is a particular concern in these systems because the soil sometimes consists largely of organic matter.
Drought	Potential for drought effects is uncertain, and depends on the effect of the climate on orogenic rainfall. Plants occurring at rock outcrops can be dramatically affected by droughts because of the limited water available around the crevices of rocks.
Fire	Fire rarely occurs naturally under current conditions. Bare rocks and sparse vegetation do not carry fire well, and the natural vegetation virtually never burns under the current climate, so the biota are not thought to be adapted to fire. Increased drought or lightening from increased thunderstorms may cause an increase in wildfire, which could actually promote the expansion of rock outcrop community structure around the existing outcrops.
Elevation Change	Coltsfoot may increase with surrounding canopy disruption and warming
Structural Change	In surviving patches, structural change may result from increased wind or drought damage.
Increased Fragmentation	High Elevation Rock Outcrops are naturally fragmentary, but upward migration may create additional gaps between patches.
Compositional Change	Species adapted to lower elevations may invade high elevation sites if climate becomes more moderate. This may convert the Theme to Low Elevation Rock Outcrop communities, so it is uncertain how much change will occur in the higher elevation patches that survive.

Table 1. Predicted Impacts of Climate Change	
Climate Change Factor	**Comments**
Acreage Change	Sites at low elevations may convert to Low Elevation Rock Outcrop communities. The area of this ecosystem group may actually increase if drought and wind damage reduce tree and shrub cover around margins and in crevices. Because the current area is limited and many patches have been reduced further in size, some species are likely already close to minimum viable population size.
Elevation Change	There is no potential for latitudinal migration of these systems. No high elevation areas exist for a considerable distance north of their current range. All patches are isolated by low elevation areas that are already unsuitable in today's climate.

Table 2. Bird Species Utilizing High Elevation Rock Outcrops							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
BIRDS							
Corvus corax	Common raven	G5/S3				/W2/	
Falco peregrinus	Peregrine falcon	G4/ S1B,S2N				/E/P	

Table 3. Mammal Species Utilizing High Elevation Rock Outcrops							
Species	**Common Name**	**Element Rank:**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
MAMMALS							
Microtus chrotorrhinus	Rock Vole					/SC/P	
Neotoma floridana haematoreia	Eastern woodrat	G5T4Q/ S3				FSC/ W2/P	Southern Appalachian population
Neotoma magister	Appalachian woodrat	G3G4/S2				FSC/ SC/P	
Sorex dispar	Rock Shrew					/SC/P	

Table 4. Reptile Species Utilizing High Elevation Rock Outcrops							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
REPTILES							
Crotalus horridus	Timber Rattlesnake	G4/S3				/SC/P	
Eumeces anthracinus	Coal Skink	G5/S2S3				/SR/P	

Table 5. Amphibian Species Utilizing High Elevation Rock Outcrops							
Species	**Common Name**	**Element Rank:**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
AMPHIBIANS							
Aneides aeneus	Green Salamander	G3G4/S2				FSC/ E/P	
Desmognathus imitator pop. 1	Imitator Salamander						Waterrock Knob population known from high elevation rock outcrops and road cut rock faces at Blue Ridge Parkway

Table 6. Invertebrate Species Utilizing							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
INVERTEBRATES							
Hypochilus sheari	A lampshade spider	G2G3/ S2S3	YES		YES	/SR/	Restricted to rock outcrop habitats in the southern mountains of NC.
Hypochilus coylei	A lampshade spider	G3?/S3?	YES		YES	/SR/	Restricted to rock outcrop habitats in the southern mountains of NC.
Trimerotropis saxatilis	Rock-loving grasshopper	G3?/S1S2		YES	YES	/SR/	Known in NC from just a few sites, primarily in the southern mountains. The main part of the range for this species is located west of the mountains, including areas in the Ozarks.

*** 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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