

Ecosystem Description

Northern Hardwood Forests are found on high mountain slopes with a cool climate and high levels of rainfall. They are dominated by combinations of moist-site hardwoods such as yellow birch, beech, yellow buckeye, and sugar maple. The herb layer is often lush, and may range from low to fairly high diversity. These forests are subject to periodic widespread disturbances, such as ice storms or severe winds, which provide canopy openings, but probably seldom or never remove the whole canopy at once. The name refers to the resemblance of these forests to those in the northeastern United States, which have similar canopies, but the presence of Southern Appalachian endemics makes the community types in North Carolina different from those of the north. Three recognized variants of this community type are determined primarily by topography and soil chemistry: boulderfield forest, beech-gap, and typic subtypes.

In the boulderfield forest, Ice Age freeze-thaw processes have left the ground completely covered with large boulders with very little soil. These areas are dominated by yellow birch with a distinctive undergrowth of gooseberries and moss on the rocks.

The beech gap subtype occurs in high elevation gaps and peaks, where beech trees stunted by the wind predominate. In the most extreme cases, the tree canopy may be reduced to shrub size. The trees may be quite old, although small, as growth and reproduction are relatively slow.

The typic subtype varies in composition and diversity. Some have a lawn-like ground cover of just a few species of sedges and grasses, while others have a lush and diverse herb layer.

The 2005 Wildlife Action Plan described Southern Blue Ridge Mountain Northern Hardwoods as a priority habitat (see Chapter 5A) (NCWRC 2005). While the northern hardwood habitat can be defined in general terms, ecologically, it should be considered in association with spruce-fir forest for the purposes of maintaining ecological relationships and sustainability. Often components of spruce-fir habitats are present in sub-dominant numbers within northern hardwood communities, and increase in dominance along the elevation gradient to a point where spruce-fir becomes the dominant community (NCWRC 2005).

Northern hardwood forests in western North Carolina are concentrated in many of the same high elevation areas as spruce-fir forests, however they are more widespread throughout the region owing to their respectively lower elevation range. Significant amounts of northern hardwood forest occur in the Great Smoky Mountains, Great Balsams, Plott Balsams, Black/Craggy Mountains, Unicoi Mountains, and in the vicinities of Roan Mountain and Grandfather Mountain. While most of the available northern hardwood forest is associated with these high elevation mountain ranges, significant amounts are present in other areas of

suitable elevation throughout the region, such as in the Amphibolite mountains in Ashe and Watauga counties and in the Nantahala mountains in Macon county (NCWRC 2005).

Table 1 at the end of this report provides a 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.

Northern hardwood forests provide habitat for numerous wildlife species that also rely heavily on spruce-fir forests. Because of the spatial relationship between them, and the fact that they share many ecological components and plant species, northern hardwood forests are critical to maintaining many species of birds and mammals dependent upon spruce-fir habitats. In addition, northern hardwood plant species may be critical components of spruce-fir habitats even in their sub-dominant role. Consider, for example, the fact that many spruce-fir dependent wildlife species are cavity nesters. Yellow birch, beech, sugar maple, and buckeye often provide more natural cavities and decaying wood than spruce or fir for species such as northern flying squirrels, yellow-bellied sapsuckers, black-capped chickadees, northern saw-whet owls, and other wildlife (NCWRC 2005).

There is a major concern about salamanders, as this is a key ecosystem group for rare and southern Appalachian endemic species. On the other hand, the bird species are all more common and widespread farther northward, though a few species may become rare in the state. The aging of many northern hardwood stands has resulted in closed canopy conditions and decreasing habitat for bird species that rely on diverse understory development, such as Canada warbler.

At least six taxa are endemic to Northern Hardwood Forests in the Southern Appalachians; three others may also fall in this category, but have not yet been formally described as separate subspecies. Additionally, one moth appears to be a major disjunct from the Northern Appalachians and several others are likely to have a similar distribution but are presently too poorly known. All species listed for this ecosystem group are likely to be strongly affected by climate change, including the effects of increased fragmentation.

The impacts to other wildlife from stand level disturbance will need to be examined. For example, soricids such as masked and smoky shrews can respond favorably to forest disturbance in northern hardwoods (Ford *et al.* 2002), but this may not be true for other small mammals or salamanders. Many of the former fir forests and logged or grazed areas are regenerating into northern hardwood stands without a conifer component (spruce or fir). (Korstian 1937, NCWRC 2005).

Development pressure includes threats from a large increase in second homes and recreation facilities. Many non-native pathogens are a potential problem for several tree species in this ecosystem including hemlock woolly adelgid, balsam woolly adelgid, gypsy moth, emerald ash borer, and beech scale. The isolated nature of several populations of wildlife, such as northern flying squirrel, northern saw-whet owl, black-capped chickadee and Weller’s salamander, is likely detrimental to the genetic flow and overall long-range health of the species. (NCWRC 2005).

Climate Change Compared to Other Threats

The majority of Northern Hardwood Forests are on public lands and many are in protected status. Development on private lands, and logging on private and some public lands remain threats, and are likely the most immediate and greatest threat to a significant number of good examples. Climate change, particularly associated drought and wild fire, is the greatest threat to protected examples. However, the threat of climate change is less severe than in Spruce-Fir Forests and the threat of logging and development are relatively greater.

Table 6 compares climate change with other existing threats.

Threat	Rank Order	Comments
Climate Change	1	Expected climate changes include warmer average temperatures, longer growing season, probably more hot spells, more drought, and more intense storms. We don’t know the effect on rainfall and fog. Much of the climate in this zone is orographically determined, and may not follow the same patterns as the general regional climate, but this is less so than in the spruce-fir zone.
Development	2	Fragmentation and increased edge areas can increase predation on forest interior species, increase competition from more common species. Warmer winters and more hot spells may fuel increasing desire for housing development at the higher elevations where these communities occur.
Logging/Exploitation	2	
Invasive Species/Pathogens	3	Invasion by species from lower elevations could lead to competitive exclusion of northern hardwood species. May contribute to changes in community composition

Summary and Recommendations

Although occupying a larger area and probably somewhat more resilient than Spruce-Fir Forests, this group contains a similar high proportion of endemics and major disjuncts, the loss of which cannot be replaced. Along with the Spruce-Fir Forests, Northern Hardwood Forests

should be considered as one of the most threatened by climate change and should receive a high priority for intervention. Like the Spruce-Fir Forests, a substantial amount of the acreage of this group is located on public lands or on other conservation lands. Consequently, intervention should be easier to implement for Northern Hardwood Forests than for many others.

Recommended Actions

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| Surveys | <ul style="list-style-type: none">● Fill in distribution gaps for Carolina northern flying squirrel.● Obtain baseline data on high elevation bird species of Northern hardwood forests.● Obtain baseline data on high elevation amphibian communities of Northern hardwood forests. |
| Monitoring | <ul style="list-style-type: none">● Develop and implement monitoring systems and protocols for population trends for all high elevation species, including those associated with northern hardwood forest, with top priority towards rare species and secondary priority towards all species occurring in this relatively rare community of the North Carolina landscape (NCWRC 2005). |
| Research | <ul style="list-style-type: none">● Conduct genetic studies across taxonomic groups to assess degree of population isolation/gene flow, and determine taxonomic status (primarily bird taxa thought to be southern Appalachian endemics) (NCWRC 2005).● Initiate habitat use studies for many species to assess use of microhabitats, forest age classes and habitat spatial relationships.● Conduct research on habitat management techniques to successfully establish mixed spruce-northern hardwood stands in non-forested areas or appropriate pure/young northern hardwood stands.● Research phenological relationships of priority species to better understand how changing climate conditions will affect seasonal availability of food resources. |
| Management Practices | <ul style="list-style-type: none">● Consider and implement silvicultural management at appropriate locations to enhance understory development, provide regeneration and habitat for disturbance dependent species or early successional species, and enhance mature forest conditions in young to middle-aged pure stands (NCWRC 2005).● Management of existing northern hardwood forests and adjacent habitats (particularly spruce-fir forests) needs to be expanded to ensure the complete mix of age class, composition, and conditions necessary to sustain populations of a wide range of species that utilize this community (NCWRC 2005) |

Land
Protection

- Effort should particularly be made to protect examples at the higher elevations, where the community is likely to persist and where the seed source for migration to higher elevations will primarily come from.
- The current habitat and connectivity of isolated patches needs to be protected through conservation ownership acquisition or easement (NCWRC 2005).
- Increased connectivity among habitat patches, both through acquisition or management of adjacent stands. Preservation of large tracts of minimally disturbed older forests may be key to maintaining forest litter amphibian populations (NCWRC 2005).

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Table 1. Predicted Impacts of Climate Change

Climate Change Factor	Comments
Wind Damage	These are wind-disturbed forests. Increased wind storm damage might favor some trees species over others, but this is likely to be minor.
Drought	Drought may lead to increased potential for wild fire. Northern hardwood forests are not very flammable under the current climate, but could become so in more severe droughts. Drought may eliminate seepage, which is important in some boulder fields.
Fire	Fire would likely be harmful to northern hardwood forests, but may not be catastrophic. Hardwood litter and forb-dominated herb layers carry fire poorly. All major plant species can sprout if burned. However, severe fire could kill old trees. Frequent fire would promote the transition to oak forest. If fire became more common, the current topographic relationship of high elevation red oak forest on dry slope aspects and northern hardwood forest on moist might be altered. This could potentially reduce northern hardwood forests more than elevational shifts alone would predict. Frequent fire may result in drier soils and encroachment by oak, plus loss of large den trees (snags).
Increased Temperature/ Hot Spells	Minimum winter temperatures are expected to increase, as well as number of days with freezing temperatures.
Increased Fragmentation	Patches in different mountain ranges are already naturally isolated by the warmer climate at lower elevations. Effects of reduced area and fragmentation may be significant, reducing some species populations enough to cause demographic problems.
Elevation Change	Northern hardwood forests in lower mountain ranges could be eliminated if their zone shifts upward too far. Those in higher ranges are unlikely to be eliminated, but their extent will become more limited. Loss of lower elevation portions of patches will increase fragmentation to some degree. Some patches that now are connected may become isolated if the lower elevation limit rises.
Invasive Species	Many non-native pathogens are a potential problem for several tree species in this ecosystem including hemlock woolly adelgid, balsam woolly adelgid, gypsy moth, emerald ash borer, and beech scale. May contribute to changes in community composition.
Acreage Change	Patches will likely migrate uphill and shrink but most are not likely to be eliminated.
Phenological Disruption	Warmer weather and drier conditions will likely affect growing seasons and the timing of food resource availability. Changes in seasonality could disrupt predator-prey and other wildlife-food usage associations such as bloom time and pollinator occurrence (Bater <i>et al.</i> 2011).

Table 2. Bird Species Utilizing Northern Hardwood Forests

Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
BIRDS							
<i>Accipiter cooperii</i>	Cooper's Hawk					/SC/P	
<i>Accipiter striatus</i>	Sharp-shinned Hawk					/SR/P	
<i>Aegolius acadicus pop. 1</i>	Southern Appalachian northern saw-whet owl	G5TNR/S2B,S2N	YES			FSC/T/P	Endemic subspecies?; major disjunct as a species
<i>Cardellina canadensis</i>	Canada Warbler					/ /P	
<i>Certhia americana</i>	Brown creeper	G5/S3B,S5N				/SC/P	
<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo					/SR/P	
<i>Pheucticus ludovicianus</i>	Rose-breasted Grosbeak					/ /P	
<i>Picoides villosus</i>	Hairy Woodpecker					/ /P	
<i>Poecile atricapillus practica</i>	Southern Appalachian black-capped chickadee	G5TNR/S3	YES			FSC/ SC /P	Likely to face increased competition from Carolina chickadees
<i>Setophaga pensylvanica</i>	Chestnut-sided Warbler					/ /P	
<i>Sphyrapicus varius</i>	Yellow-bellied Sapsucker					/SC/P	
<i>Troglodytes troglodytes</i>	Winter wren	G5/S3B,S5N				/W2,W5/	
<i>Vermivora chrysoptera</i>	Golden-winged Warbler					/SR/P	

Table 3. Mammal Species Utilizing Northern Hardwood Forests

Species	Common Name	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
MAMMALS							
<i>Glaucomys sabrinus coloratus</i>	Carolina northern flying squirrel	G5T1/S2		YES		E/E/P	Likely to face increased competition from southern flying squirrels
<i>Lasionycteris noctivagans</i>	Silver-haired Bat					/SR/P	
<i>Mustela frenata</i>	Long-tailed Weasel					/ /P	
<i>Napaeozapus insignis</i>	Woodland Jumping Mouse					/ /P	
<i>Parascalops breweri</i>	Hairy-tailed Mole					/ /P	
<i>Scalopus aquaticus</i>	Eastern Mole					/ /P	
<i>Sorex cinereus</i>	Masked Shrew					/ /P	
<i>Sorex dispar</i>	Rock Shrew					/SC/P	
<i>Sorex fumeus</i>	Smoky Shrew					/ /P	
<i>Sorex hoyi winnemana</i>	Southern Pygmy Shrew					/ /P	
<i>Sorex palustris</i>	Water Shrew					/SC/P	
<i>Sylvilagus obscurus</i>	Appalachian Cottontail					/SR/P	

Table 4. Amphibian Species Utilizing Northern Hardwood Forests

Species	Common Name	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
AMPHIBIANS							
<i>Ambystoma maculatum</i>	Spotted Salamander	G5/S5				/ /P	
<i>Desmognathus imitator</i>	Imitator Salamander	G3G4/ S3	YES			/W2/	
<i>Desmognathus imitator pop. 1</i>	Imitator Salamander Waterrock Knob pop.	G3G4T1Q /S1	YES		YES	/SR/	Taxonomic status needs to be resolved
<i>Desmognathus santeetlah</i>	Santeetlah Dusky Salamander	G3G4Q/ S2S3	YES			/SR/	
<i>Desmognathus wrighti</i>	Southern Pigmy Salamander	G3G4/S3	YES			FSC/SR /P	
<i>Plethodon aureolus</i>	Tellico Salamander	G2G3/S2?				/SR/P	
<i>Plethodon glutinosus</i>	Northern Slimy Salamander					/ /P	
<i>Plethodon richmondi</i>	Southern Ravine Salamander					/ /P	
<i>Plethodon welleri</i>	Weller's Salamander	G3/S2	YES			/SC/P	

Table 5. Invertebrate Species Utilizing Northern Hardwood Forests

Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/Extirpation Prone	US/NC/WAP*	Comments
INVERTEBRATES							
<i>Erora laeta</i>	Early hairstreak	GU/S2S3				/SR/	
<i>Eulithis propulsata</i>	A geometrid moth	GNR/SU				/W3/	
<i>Itame subcessaria</i>	Barred itame (moth)	G4/S1S3				/SR/	
<i>Korscheltellus gracilis</i>	Conifer swift moth	GNR/S2S3				/W5/	Southern Appalachian endemic but recorded as far north as West Virginia
<i>Lithophane georgii</i>	A pinion moth	G5/S1?		YES		/SR/	Disjunct from New England and Canada.
<i>Polygonia progne</i>	Gray comma	G5/S1				/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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