North Carolina Ecosystem Response to Climate Change: DENR Assessment of Effects and Adaptation Measures

DRAFT

Northern Hardwood Forests

Ecosystem Group 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.

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. Three recognized variants of this community type are determined primarily by topography and soil chemistry. 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.

Ecosystem Level Effects:

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Wind Damage	High	Neg	Med	
Phenological Disruption	High	Neg	Med	
Hot Spells	High	Neg	High	
Fire	High	Neg	Med	
Drought	High	Neg	High	
Increased Temperature	High	Neg	Med	Minimum winter temperatures are expected to increase, as well as number of days with freezing temperatures.

Predicted Impacts of Climate Change:

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. Climatic effects will still be more

drastic if fog and orographic clouds become less frequent, while these might mitigate the effect of temperature changes if they persist.

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.

Predicted Ecosystem Reponses:

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Increased Fragmentation	Med	Neg	Med	
Elevation change	Med	Neg	Med	
Acreage Change	High	Neg	Med	

Heat or drought stress could lead to mortality of species, including canopy trees. Deeper soils and greater tolerance of plants makes this less likely than in spruce-fir forests, but it is still a threat in these mesophytic communities.

Invasion by species from lower elevations could lead to competitive exclusion of northern hardwood species. However, the canopy species are highly competitive and could hold their own for many years. Under current fire-free conditions, shade-tolerant northern hardwood forest species invade drier oak forests, suggesting they can tolerate drier conditions than currently prevail in these communities. Changes might be slow, resulting from changed reproductive rates, or could be fast if wind or fire destroyed existing canopy. Typic northern hardwood forests may be able to migrate to higher elevation without much change in community composition. Boulder fields can't migrate, and beech gaps may or may not be able to.

Increased wind storm damage might favor some trees species over others, but this is likely to be minor. All characteristic trees have the ability to sprout and all are shade-tolerant enough to exist as advance regeneration.

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.

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. Patches in different mountain ranges are already naturally isolated by the warmer climate at lower elevations. These communities were presumably shifted upward in elevation during the Hypsithermal period, and those on lower ranges may have been eliminated then. There is likely to be little additional wholesale loss of communities or species until the climate becomes warmer than the Hypsithermal. The Hypsithermal was drier as well as warmer, and if our future climate is not drier, the change may be less. However, having more severe drought and increased fire frequency may be sufficient to cause substantial changes even if the average rainfall does not change.

Effects of reduced area and fragmentation may be significant, reducing some species populations enough to cause demographic problems. Because the current area is limited, some species populations are likely already small enough to be close to demographic problems.

Habitat Level Effects:

Natural Communities:

Third Approximation Name:	Comments:			
Boulderfield Forest	Tied to distinctive sites, these communities will generally not be able to migrate at all. A few new examples may develop, where bouldery sites are currently covered with spruce-fir, as at Grandfather Mountain. The distinctive boulderfield environment is occupied by the Boulderfield Subtype of Rich Cove Forest at lower elevations, and this community will spread into some of the lower elevation Boulderfield Forests. Some Boulderfield Forests have substantial seepage. Droughts may be a threat to seepage and disrupt the water-dependent component of the community.			
Northern Hardwood Forest (Beech Gap Subtype)	Tied to distinctive microsites either high elevation gaps or high elevation peaks that might otherwise have spruce-fir. Both may be particularly vulnerable to warming climate. The most likely community to develop in their place would be typic Northern Hardwood Forest.			
Northern Hardwood Forest (Typic Subtype)	Usually occurs in large patches. Patches will likely migrate uphill and shrink but most are unlikely to be eliminated.			

LHI Guilds:

Guilds with Significant Concentration in Ecosystem Group: Comments:

High Elevation Montane Mesic Hardwood and Mixed Forests

The High Elevation Montane Mesic Hardwood and Mixed Forests guild has most of its habitat contained within this Ecosystem Group, although the Spruce-Fir Forests group also contributes a small amount. The Spruce-Fir Forests guild, conversely, has some of it habitat contained within this Ecosystem Group, but is otherwise primarily concentrated within Spruce-Fir Forests.

Species Level Effects:

<u>Plants</u>	Element		Maior	Extinction/	Status:	
Species:	Rank:	Endemic	Disjunct	Extirpation Prone	US/NC	Comments:
Stachys clingmanii	G2Q/SH				/SR-T	
Scutellaria saxatilis	G3/S1				/SR-T	
Aconitum reclinatum	G3/S3				/SR-T	This species is at the southern limit of its range in NC and TN.
Brachyelytrum aristosum	G4G5/S3				/SR-P	
Robinia hispida var. fertilis	G4T1Q/S1				/SR-O	

Trientalis borealis	G5/S1	Yes	/SR-P	This species is a long-distance northern disjuct existing in scattered small populations. It is particularly at risk of warmer temperatures.
Streptopus amplexifolius	G5/S1		/SR-P	
Meehania cordata	G5/S2		/SR-P	This species is at the southern limit of its range in NC and TN.
Scutellaria ovata ssp. rugosa var. 1	G5T1?Q/S1		/SR-T	The taxonomy of the Scutellaria ovata group is poorly understood.

Warmer temperatures in the winter may allow new species to invade areas where cold winter temperatures would otherwise be a limiting factor. Where invaders compete with rare species, there could be detrimental effects to populations.

Terrestrial Animals	Element		Major	Extinction/	Status:	
Species:	Rank:	Endemic	Disjunct	Extirpation Prone	US/NC/ WAP	Comments:
Plethodon welleri	G3/S2	Yes			/SC/P	
Desmognathus imitator	G3G4/S3	Yes			/W2/	
Desmognathus wrighti	G3G4/S3	Yes			FSC/SR/P	
Desmognathus santeetlah	G3G4Q/S2S	3 Yes			/SR/	
Desmognathus imitator pop. 1	G3G4T1Q/S	1 Yes		Yes	/SR/	Taxonomic status needs to be resolved
Itame subcessaria	G4/S1S3				/SR/	
Polygonia progne	G5/S1				/SR/	
Lithophane georgii	G5/S1?		Yes		/SR/	Disjunct from New England and Canada.
Certhia americana	G5/S3B,S5N				/SC/P	
Troglodytes troglodytes	G5/S3B,S5N				/W2,W5/	
Glaucomys sabrinus coloratus	G5T1/S2	Yes			LE/E/P	Likely to face increased competition from southern flying squirrels
Poecile atricapillus practica	G5TNR/S3	Yes			FSC/SC/P	Likely to face increased competition from Carolina chckadees
Aegolius acadicus pop. 1	G5TNR/S2B,	.S Yes			FSC/T/P	Endemic subspecies?; major disjunct as a species
Eulithis propulsata	GNR/SU				/W3/	
Korscheltellus gracilis	GNR/S2S3				/W5/	Southern Appalachian endemic but recorded as far north as West Virginia
Erora laeta	GU/S2S3				/SR/	

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.

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.

Combined Threats and Synergistic Impacts:

Threat:	Rank Order:	Comments:
Climate Change	1	
Development	2	
Logging/Exploitation	2	

Importance of Climate Change Factors Compared to Other Ecosystem 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.

Recommendations for Action:

Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Restore/Maintain Landscape Connections	Mediu	Medium	
Protect/Expand Remaining Examples	High	High	
Protect from Wildfire	High	High	

For unprotected examples, protection from development and logging is the most important action needed. While many areas are protected, many good examples are unprotected, and some portions of the mountains have little protected area. Warmer winters and more hot spells may fuel increasing desire for housing development at the higher elevations where these communities occur. 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. Because the overall extent of the community and of individual patches will decrease, loss of these areas will become more important than at present. There are some opportunities to restore and expand these communities into areas where they have been lost, but the overall loss and potential for restoration has been less significant than in Spruce-Fir Forests.

Protecting examples from wild fire, especially severe fires under drought conditions, would help prevent catastrophic loss of these communities or would allow them to persist longer and migrate more slowly. However, in lower elevation areas where a transition to oak forest is inevitable, prescribed burning in the near future, before severe conditions develop, would promote a more gradual and less disruptive transition. It would allow more fire-tolerant and drought-tolerant species to become established.

Some areas that appear to be young Northern Hardwood Forests at present are actually successional communities. Some developed after the destruction of Spruce-Fir Forest. Others developed where exclusion of fire shifted canopy dominance away from oak species. In both cases, where this can be documented,

restoration to the original communities rather than attempting to retain them as Northern Hardwood Forests, is desirable.

Ecosystem Group Summary:

Communities and species associated with Northern Hardwood Forests are all highly likely to be affected by changes in temperature and moisture associated with climate change. 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.

References:

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