

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

*DRAFT*

## Piedmont and Mountain Dry Coniferous Woodlands

### **Ecosystem Group Description:**

The vast majority of land in the Piedmont and Mountain regions is dominated by hardwood forests. Less common are dry coniferous forests, which occur at mid to lower elevations in several kinds of specialized sites that are drier than most environments. They occur primarily in the mountains and are found in a few mountain-like sites in the Piedmont. Piedmont Longleaf Pine Forests, although dominated by coniferous trees and sometimes dry, are included with the more closely related Dry Longleaf Pine Forests Ecosystem Group rather than here.

The Pine-Oak/Heath community occurs on sharp ridgetops and spur ridges, where shallow soils and exposure to drying winds and lightning prevent development of a closed hardwood forest. Extremely acidic soils, created by leaching and by the acidity of plant leaf litter, may also be a factor. The canopy is generally open with a dense, tall shrub layer dominated by mountain laurel or rhododendron occurs beneath the canopy. Herbs are few and sparse, but characteristic acid-loving species often occur in openings among the shrubs. Carolina Hemlock Bluffs occur in settings similar to Pine-Oak/Heath, but usually more on steep bluff-like side slopes. Carolina hemlock dominates the canopy with a shrub and herb layer similar to Pine-Oak/Heath but may be more open. White Pine Forests are poorly understood communities. While white pine is a common successional tree in mountain hardwood forests, natural forests of it most typically occur on the walls of steep gorges. Montane Red Cedar-Hardwood Woodland occurs on shallow soils on gentle slopes. Smooth rock outcrops are usually found in association with it. These woodlands have an open canopy with a understory grassy with patchy shrubs. A number of the species suggest that the soils are less acidic than typical mountain soils.

### **Ecosystem Level Effects:**

#### **Predicted Impacts of Climate Change:**

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Wind Damage	High	Mix	Med	
Fire	Med	Mix	Med	
Drought	High	Mix	Med	

These communities occur through the lower to middle elevations in the mountains and in the foothills. They are particularly abundant in the escarpment. They occur throughout a wide range of present climate, from the highest rainfall in the eastern United States to the driest places in North Carolina, and show little variation in vegetation across this range. In the northern escarpment, the Climate Wizard mid value for average annual temperature increase by 2050 is 4.2 degrees (Maurer et al., 2007). The range of models is

2.6 to 6.2 degrees. In the southern escarpment, the average annual temperature increase is 3.8 degrees, with a model range of 2.6 to 6.0 degrees. The range in the models for rainfall is also wide: -14 inches to +16 inches in the northern mountains and -15 inches to +15 inches in the southern mountains. The general expectations of increased rain event intensity and increased drought presumably apply to all of this range. However, their effect in the Mountain Region is particularly unsure. Rainfall in the mountains is extremely variable, ranging from about 40 inches per year to more than 80 inches. The variation is produced by the interaction of topography with regional weather patterns, and it is unclear how climate change will affect it.

The occurrences of most dry coniferous woodlands depends on a combination of fire behavior and dry soils, both driven by topography. With the suppression of fire, many examples have disappeared or have become degraded by a lack of pine regeneration and invasion by hardwoods and shrubs. Because the characteristic plants are drought-tolerant as well as fire tolerant, an increase in drought may help them retain or regain dominance. In addition, if drought contributes to an increase in wild fire, this may benefit these communities. However, an increase in extreme fires may be detrimental. A major factor in loss of pine dominance is southern pine beetle outbreaks, which are often triggered by droughts. In addition, in the absence of fire, increased wind damage may increase loss of mature pines and contribute to ongoing encroachment of hardwoods.

**Predicted Ecosystem Responses:**

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Structural Change	Med	Neg	Low	Change is likely to be small compared to the ongoing changes caused by fire suppression and pine beetles.
Elevation Change	High	Pos	Low	Warmer temperatures should allow spreading to higher elevation, but the acreage gain is likely to be limited. It may not occur if fires are suppressed.
Compositional Change	Med	Mix	Low	
Acreage Change	Med	Pos	Low	Increased drought and fire may allow expansion

Dry coniferous woodlands, at least the most common Pine-Oak/Heath communities, may be the communities with the most potential to gain from expected climate changes, partly because climate change will act somewhat counter to existing threats rather than exacerbating them. However, these benefits are far from certain. These communities occur in the driest mountain and foothill sites, and increasingly dry climate may allow them to expand into a broader range of topography and to higher elevations. Because of their dependence on fires which have largely been suppressed, they have shrunk in recent decades. Increased drought may favor pines over hardwoods and allow them to regain some of their lost area even without fire. At the same time, increased drought may increase southern pine beetle outbreaks, a major threat to the pine canopy. Without fire to promote pine regeneration, increased pine beetle mortality could hasten the shift from pines to hardwoods.

An increase in mild to moderate intensity fire would benefit coniferous forests. It is unclear whether such an increase in fire is likely, since these fires are likely to be suppressed. The coniferous forests should be able to withstand an increase in severe fires better than most communities, but severe fire may still be detrimental to them, killing canopy trees at too great a frequency.

Climate change may affect vegetation structure and composition, with increased wind damage to canopy trees and decreased age of trees. These communities have undergone drastic changes in vegetation structure in recent decades, changing from open pine-dominated woodlands with grassy or grass-shrub undergrowth, to open or closed hardwood or pine-hardwood forests with dense shrub layers. The structural

effects caused by fire suppression and southern pine beetles much exceed any effect likely from climate change.

## Habitat Level Effects:

### Natural Communities:

Third Approximation Name:	Comments:
Montane Red Cedar--Hardwood Woodland	These communities occur on shallow soils associated with rock outcrops. Fire's role in them is probably limited, because of discontinuous fuels. Drought stress in the shallow soils is likely important in keeping these communities open. Increased drought may allow these communities to expand into more marginal areas on their edges, but may also lead more open rock outcrop communities to expand at their expense. Severe drought may be detrimental to these communities or some of their component species.
Pine--Oak/Heath	These are the most abundant dry coniferous woodlands, and most of the general information about the Ecosystem Group applies to them.
White Pine Forest	The ecology of natural White Pine Forests is not well known. Most examples occur in gorges, where they probably depend on infrequent but possibly severe fire. It is unclear how much they have been altered or have declined because of fire suppression. The fires that maintain them likely occurred in droughts and are difficult to control under the present climate, but likely have become less frequent because of fire suppression. It is unclear if increased drought and potential for wild fire will be beneficial or harmful.
Carolina Hemlock Bluff	Effects of climate change will be different from those on Pine--Oak/Heath. Carolina Hemlock Bluffs are more mesic, and are unlikely to benefit from fire. They occur in sites naturally sheltered from fire, but fires may be able to penetrate them in severe droughts. However, Hemlock Woolly Adelgid is a severe threat, and far exceeds the threat from climate change.

### LHI Guilds:

Guilds with Significant Concentration in Ecosystem Group:	Comments:
Dry-Xeric Mixed Forests, Woodlands, and Barrens	
(Piedmont Dry-Xeric Hardwood/Mixed Forests and Woodlands)	Provisional guild, not yet split off from Dry-Xeric Mixed Forests, Woodlands, and Barrens
(Montane Dry-Xeric Hardwood/Mixed Forests and Woodlands)	Provisional guild, not yet split off from Dry-Xeric Mixed Forests, Woodlands, and Barrens
(Montane Dry Heathlands)	Provisional guild, not yet split off from Dry-Xeric Mixed Forests, Woodlands, and Barrens

No guilds are currently defined that are strictly associated with woodlands whose tree species are predominately pines and other dry conifers. Most animals that are associated with pines and other dry conifers occur in mixed stands of hardwoods and conifers as well as stands composed primarily of conifers. The guilds linked to this Ecosystem Group, consequently, are those associated with dry woodlands and/or heathlands more generally.

## Species Level Effects:

### Plants

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC	Comments:
Hudsonia montana	G1/S1	Yes		Yes	T/E	Shallow soils that form over rock ledges. Usually in the sparsely vegetated ecotone between bare rock and heath bald.
Buckleya distichophylla	G2/S2				FSC/E	A parasitic shrub, often on-but not restricted to-Tsuga.
Weissia sharpii	G3/S1?				/SR-O	Widespread in eastern US, but known from only 3 locations NC. This species occurs on rocks in woodlands with semi-open canopy.
Monotropsis odorata	G3/S3				FSC/SR-T	
Fothergilla major	G3/S3				/SR-T	Also occurs in Montane Oak Forests. Where it is in this theme, this species occurs in more mesic sites that are most likely to be lost in drought or fire.
Macrocoma sullivantii	G3G5/S2				/SR-D	Epiphytic on red cedars in Montane Red Cedar--Hardwood Woodlands. Severe drought that killed red cedars may be particularly detrimental to this species.
Orthotrichum strangulatum	G4/SH				/SR-P	
Metzgeria temperata	G4/S1S2				/SR-D	
Sceptridium lunarioides	G4?/SH				/SR-P	
Primula meadia	G5/S2S3				/SR-P	In Montane Red Cedar--Hardwood Woodlands. Drought stress may be detrimental.

The rare plants associated with this theme are not expected to be particularly threatened by climate change.

Hudsonia montana is an extremely rare, endemic plant that occurs on rock ledges in only one county in NC. This species might benefit from changes that would reduce competition from pine trees and other vegetation, but its degree of drought tolerance is unknown.

Buckleya distichophylla is expected to decline with or without climate change, due to the effects of hemlock woolly adelgid on the hemlock trees that host this parasitic plant. However, if Buckleya is able to colonize other pine species, it may benefit from a somewhat more open canopy that would result from the predicted increase in fires. Monotropsis odorata, another parasitic species associated with pine roots, may benefit from increased fires and the resulting pine regeneration. Little is known about this species, but it is thought to be somewhat ephemeral.

### Terrestrial Animals

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC/WAP	Comments:
Heliomata infulata	G2G4/S2S3				/SR/	
Phyciodes incognitus	G2G4Q/S3?				/W3/	
Ptichodis bistrigata	G3/S2S3				/SR/	

<i>Erynnis martialis</i>	G3G4/S3			/SR/	
<i>Faronta rubripennis</i>	G3G4/S2S3			/W3/	
<i>Acronicta albarufa</i>	G3G4/S1S2	Yes		/SR/	Currently known in North Carolina only from a couple of records from the Sandhills. However, it is likely to occur in the Piedmont, if not the Mountains
<i>Catocala herodias gerhardi</i>	G3T3/SU	Yes	Yes	/SR/	Bear Oak feeder, known in North Carolina only from Hanging Rock
<i>Erastria coloraria</i>	G4/SU	Yes		/W3/	Known in NC only from Sandhills records but likely to occur in the Piedmont.
<i>Euclyptocnemis dapsilis</i>	G4/S2S3			/W3/	
<i>Feltia manifesta</i>	G4/S2S3			/SR/	
<i>Idea eremiata</i>	G4/S3S4			/W3/	
<i>Satyrium edwardsii</i>	G4/S2?			/SR/	
<i>Phyciodes batesii maconensis</i>	G4T2T3/S2	Yes	Yes	FSC/SR/	Recorded at only a few sites in the Southern Mountains
<i>Pituophis melanoleucus melanoleucus</i>	G4T4/S3			FSC/SC/P	
<i>Tantilla coronata</i>	G5/S3S4			//P	
<i>Megathymus yuccae</i>	G5/S3S4			/W2/	
<i>Chlosyne gorgone</i>	G5/S1	Yes		/SR/	Recorded in North Carolina only from Buck Creek and the vicinity of Jones Knob
<i>Cemophora coccinea</i>	G5/S3			/W1,W5/P	
<i>Caprimulgus carolinensis</i>	G5/S5B			//P	
<i>Lobocleta peralbata</i>	GNR/SU			/W3/	
<i>Hemeroplanis n. sp.</i>	GNR/S2S3			/SR/	
<i>Stenoporpia polygrammaria</i>	GU/S1	Yes	Yes	/W2/	Bear oak feeder known in NC only from Hanging Rock

The two species of moths that feed on bear oak have a highly confined distribution in North Carolina (as does their host plant). While climate change may create conditions -- including increased fire -- that may favor the oak, the moths are likely to be highly vulnerable to extirpation if fires completely consume all available habitat in the few areas where the moth currently exists.

## Combined Threats and Synergistic Impacts:

### Importance of Climate Change Factors Compared to Other Ecosystem Threats:

Threat:	Rank Order:	Comments:
Fire	1	Suppression of fire has caused severe alteration and loss in Pine-Oak/Heath.
Logging/Exploitation	2	
Invasive Species	2	Hemlock Woolly Adelgid is expected to devastate Carolina Hemlock Bluff, if this species is as susceptible as Canada hemlock.
Development	3	
Climate Change	4	

The most significant threats vary among the different community types. Lack of fire is the greatest threat to the majority of remaining Pine--Oak/Heath. Hemlock woolly adelgid is the greatest threat to Carolina Hemlock Bluff. Logging is a threat to unprotected examples, particularly on Pine--Oak/Heath and White Pine Forest.

Fire ants may invade these communities with warmer climate. Disturbance including logging, severe fire, and storm damage may increase invasion.

## Recommendations for Action:

### Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Restore Extirpated Areas	Mediu	High	
Protect/Expand Remaining Examples	Mediu	High	
Control Invasive Species	High	Medium	
Conduct Prescribed Burns	High	High	

For Pine--Oak/Heath, the most extensive community type in this group, by far the most important action that could be taken is bringing fire back to more examples through prescribed burning. A warmer, drier climate may partially compensate for the effects of fire, but only to a limited degree. Most of the potential benefit of climate change to these communities will be realized. At the same time, increasing fire in the short run will make these communities more stable and resilient in the face of the changing climate. Fire would also help them expand back into areas they once occupied. Because these communities are more tolerant of drought than those that have replaced them, this will help make the larger landscape more stable as the climate changes.

Control of the hemlock woolly adelgid is crucial for the Carolina Hemlock Bluff communities. Without control, most or all of these communities may be lost in the near future.

Protection of good examples of all community types remains important. Because of the widespread loss of Pine--Oak/Heath and the likely loss of Carolina Hemlock Bluff, restoration of degraded examples is also important. As in all communities, protection of surrounding communities and protection or restoration of landscape connections will improve the viability of communities and allow native species to migrate to adjust to the changing climate.

## **Ecosystem Group Summary:**

Piedmont and Mountain Dry Coniferous Forests will likely be resilient to the effects of climate change and may actually benefit from increased fire frequency and drought. Fire suppression over the years has degraded or caused the disappearance of many Pine-Oak/Heath communities, the most abundant community type within this Ecosystem Group. Invasive species, such as southern pine beetle and hemlock wooly adelgid in the Carolina Hemlock Bluffs, is also a severe threat. Although drought could lead to more wildfires, it may also cause and increase of invasive species outbreaks. Above all else, conducting prescribed burns and controlling invasive species are the most important conservation actions to take in order to restore degraded sites and allow these communities to be more stable and resilient in the face of climate change.

## **References:**

Maurer, E.P, L.Brekke, T.Pruitt, and P.B. Duffy. 2007. Fine-resolution climate projections enhance regional climate change impact studies. *Eos Trans. AGU*, 88(47), 504.

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