

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

DRAFT

Montane Oak Forests

Ecosystem Group Description:

Montane oak forests occupy much of the landscape in the Mountain region, covering the dry to intermediate slopes and ridgetops over a broad elevational range. All of these communities once included a large component of American chestnut, before the blight in the early part of the century eliminated it as a canopy species. Today, chestnut persists only as short-lived sprouts from old root systems.

Most of the four natural community types recognized within this Ecosystem Group are broad types with many variants that could be recognized. Chestnut Oak Forests occur in the driest sites in low to intermediate elevation steep slopes and sharp ridges. Chestnut oak or scarlet oak are the dominant trees, and an understory of acid-loving plants are usually present. Montane Oak-Hickory Forests are dominated by a mixture of oaks, of which white oak is a prominent part. Hickories are usually a minority component, but are sometimes absent. The understory is generally more diverse than in the other oak forests. High Elevation Red Oak Forests occur at medium to high elevations. In the southern part of the state, where spruce-fir forests are absent and northern hardwoods rare, they may dominate the highest ridges and summits. Farther north they occur below these communities, often in broad zones along mountain slopes. The canopy is usually nearly pure red oak. The lower layers of vegetation vary greatly, but share many species with northern hardwood forests. Montane White Oak Forests occur at fairly high elevations. They are dominated by white oak with few other trees.

Ecosystem Level Effects:

Predicted Impacts of Climate Change:

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Wind Damage	High	Neg	Med	
Fire	High	Mix	Med	Increased low intensity fire would be beneficial, but intense wild fire would be destructive.
Drought	High	Neg	Low	

We expect the future climate to include warmer temperatures, longer growing seasons, likely more hot spells and drought, and more severe storms. The cncm-cm3 model predicts 4.5 degrees warmer annual average temperature by 2050. The mid value of the 16 models in Climate Wizard is about 4 degrees (Maurer et al., 2007). Average annual rainfall is expected to increase, but only slightly. However, the uncertainty is high. Rainfall predictions among the models range from a loss of 12 inches to an increase of 15 inches. Orographic cloud cover, storms, and fog are less crucial in these communities than in those of the higher elevations, but are probably still significant. Since the readily available climate models don't

account for these effects, the future climate experienced by these communities remains very uncertain.

The oaks and other species that dominate these communities are more tolerant of drought than most in the region. However, prolonged or severe drought stress has been associated with oak decline and with canopy mortality. These periods of drought may increase in the future.

All of the Montane Oak Forests burned under natural conditions, and it appears that fire is important in the long run for retaining oak dominance. Many oak forests have seen a lack of oak regeneration that is likely related to lack of fire. If a warmer climate brought an increase in fire, it might offset some of the alterations caused by suppression of fire. However, severe fires during droughts would be destructive to oak forests, especially if occurring with the increased fuel loads resulting from recent fire suppression.

Predicted Ecosystem Responses:

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Exotic species invasion	Med	Neg	Med	Princess tree and tree of heaven are threats. Gypsy moth and exotic tree diseases are potential future threats.
Compositional Change	Med	Mix	Low	Some more southern or low elevation species may migrate into these communities.
Structural Change	Med	Mix	Low	Increased wind damage, fire damage, and drought mortality will result in more canopy gaps and a younger average tree age, but may benefit some herbaceous species.
Elevation change	High	Pos	Med	These communities should be able to move to higher elevations, while they are unlikely to lose much acreage at lower elevations.
Acreage Change	High	Pos	Low	The overall extent of oak forests may increase moderately, as they move to higher elevations and into drier sites

Oak forests occupy much of the mountain landscape, including all but the driest sites. While a warmer climate with more drought may allow pine forests to expand at the expense of oak forests, it will also allow oak forests to expand to higher elevations and into more mesic sites now occupied by cove forests. They are expected to continue to occupy most of the sites they currently occur in and to remain the most abundant communities.

It is unclear if changes in fire regime will be beneficial or harmful to oak forests. They would benefit from an increase in low to moderate intensity fire, which might reverse the alteration of composition and structure caused by fire suppression. However, severe fire during droughts would cause extensive canopy mortality and exacerbate the effects of increased wind damage and drought, as well as the alterations caused by logging. Any expansion of pine forests in the warmer climate would likely depend on fire. Such shifts should not necessarily be regarded as negative. Pine forests have declined since fire suppression began, and a further expansion of them would be appropriate in a warmer, drier climate.

While the exotic chestnut blight is the most severe alteration ever to have happened in these communities, it has become part of the current equilibrium state of them. Other exotic species are not a major problem at present. However, Princess tree (*Paulownia tomentosa*) and tree of heaven (*Ailanthus altissima*) are invading some places, and may be becoming more frequent with time. It is unclear if the future climate will increase their competitiveness, but increased canopy disturbance is likely to facilitate their invasion. Gypsy moths continue to spread toward western North Carolina, and represent a significant threat to Montane Oak Forests. It is unclear how climate change will affect them.

Habitat Level Effects:

Natural Communities:

Third Approximation Name:	Comments:
Montane Oak--Hickory Forest	
Chestnut Oak Forest	Chestnut Oak Forests has expanded into sites once occupied by Pine--Oak/Heath. The warmer climate and any increase in fire are likely to reverse this expansion. Chestnut Oak Forests may expand at the expense of more mesic oak forests.
Montane White Oak Forest	
High Elevation Red Oak Forest	High Elevation Red Oak Forests presumably will shift to higher elevations. This will cause a significant loss of area, even as lower elevation oak forests may expand.

LHI Guilds:

Guilds with Significant Concentration in Ecosystem Group:	Comments:
Low Elevation Montane Dry-Mesic Hardwood and Mixed Forests	
General Montane Dry-Mesic Hardwood and Mixed Forests	
Dry-Mesic Montane Basic Hardwood Forests	
(Montane Dry-Xeric Hardwood/Mixed Forests and Woodlands)	

Although this Ecosystem Group covers a wide range of the moisture gradient, the only guilds included here are those that occur at least partly in the drier range. Species more restricted to mesic oaks are grouped under other groups.

Species Level Effects:

<u>Plants</u>	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC	Comments:
<i>Isotria medeoloides</i>	G2/S2				T/T	The reason for rarity in this species is not well understood. Much suitable habitat seems to exist.
<i>Pycnanthemum torrei</i>	G2/S1			Yes	FSC/SR-T	This species is apparently declining throughout its range. Historic occurrences out-number extant occurrences in almost all of the states having available information within the range of the species. The species is considered historical in North Carolina.
<i>Silene ovata</i>	G3/S3				FSC/SR-T	
<i>Rhododendron vaseyi</i>	G3/S3				/SR-L	This species also occurs in Heath Balds and is not expected to be impacted by climate change.
<i>Euphorbia purpurea</i>	G3/S2				FSC/SR-T	This species is expected to benefit from openings in the canopy.
<i>Robinia hispida</i> var. <i>kelseyi</i>	G4T1/S1				/SR-O	

Smilax lasioneura	G5/S1			/SR-P	
Frasera caroliniensis	G5/S2S3			/SR-P	
Solidago rigida var. rigida	G5T5/S1			/SR-P	
Zygodon viridissimus var. 1	GU/SH		Yes	/SR-L	This variety is known from only two counties in MS and one historical location in NC; it may already be extirpated.

Most rare species associated with Montane Oak Forests are expected to benefit from light gaps or other canopy openings, which may be caused by fire or wind throw. Increased fire and warmer, drier temperatures are not expected to have major negative impacts to these species, and may even improve or expand suitable habitat.

Terrestrial Animals

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC/WAP	Comments:
Papaipema astuta	G2G4/SH		Yes		/SR/	This species was known in North Carolina from a single individual taken in the Black Mountain area early in the last century.
Plethodon wehrlei	G4/S1				/T/P	
Papaipema polymniae	G4/SU				/W3/	
Celastrina neglectamajor	G4/S3S4				/W2/	
Catocala sappho	G4/SU				/W3/	
Wilsonia citrina	G5/S5B				//P	
Terrapene carolina	G5/S5				//P	
Pheucticus ludovicianus	G5/S3B				/W1/P	
Papilio cresphontes	G5/S2				/SR/	
Hylocichla mustelina	G5/S5B				//P	
Coccyzus americanus	G5/S5B				//P	
Caprimulgus vociferus	G5/S5B				//P	
Pyreferra citromba	GNR/S1S2		Yes		/W2/	Main range is from Pennsylvania northward
Eupithecia cimucifugata	GNR/S1S2		Yes		/W2/	Widespread throughout the northern and middle Atlantic states but uncommon; probably extends into the western states"" (McDunnough, 1949).

Only three moths associated with this Ecosystem Group appear to be major disjuncts. No endemic species are associated with Montane Oak Forests.

Combined Threats and Synergistic Impacts:

Importance of Climate Change Factors Compared to Other Ecosystem Threats:

Threat:	Rank Order:	Comments:
Logging/Exploitation	1	
Development	1	
Invasive Species	2	Past effects of chestnut blight, likely future effects of gypsy moth, and potential introduction of sudden oak death make this a severe threat.
Conversion to agriculture/sylvicu	3	
Climate Change	4	

Although Montane Oak Forests remain extensive in western North Carolina, development, logging has historically impacted much of this habitat. Development may now be a bigger threat, one that is likely to increase with the warming climate as well as with continued population growth. However, logging continues to alter the structure and composition of unprotected forests, and increases the potential for exotic plant invasion. In addition, though oak forests regenerated after past logging, many that are logged now appear more severely altered.

Chestnut blight caused dramatic compositional shift by almost extirpating the American chestnut. Planting of blight-resistant chestnut trees may eventually reverse this damage, but for the present this is part of the general condition of Montane Oak Forests. Two invasive tree species (tree of heaven - *Ailanthus altissima* and princess tree - *Paulownia tomentosa*) are now a local threat, but it is unclear how widespread they will become. The greatest threats from exotic species are from gypsy moth (*Lymantria dispar*), which is spreading toward the area, and the potential introduction of sudden oak death or other diseases. Fire ants may be able to invade these communities and cause significant impacts if temperatures become warm enough.

Recommendations for Action:

Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Restore/Maintain Landscape Connections	Mediu	High	There is a need for wildlife passages along highways as well as for protection of forested connections.
Protect/Expand Remaining Examples	High	Medium	Much is protected, but there is a need to identify and protect strategically important areas.
Conduct Prescribed Burns	High	Medium	

Prescribed burning is perhaps the most important action that can make oak forests better able to withstand climate change. Fire suppression has allowed non-fire-tolerant species, including tree species, to increase in Montane Oak Forests. These species are also less tolerant of drought and warm temperatures than oaks. Conducting low intensity prescribed burns would begin restoring these communities to a more natural composition that would also be better suited to the future climate. It would also reduce fuel loads, reducing the chances of catastrophic wild fires in the future.

Because they are the most extensive communities, Montane Oak Forests are crucial to the larger landscape. While more intact landscapes remain in the mountains than in other parts of the state, some crucial landscape connections are threatened. Because species will need to be able to shift their ranges northward in response to climate change, barriers to migration represent a serious concern.

Ecosystem Group Summary:

The oaks that dominate these communities are more tolerant of drought and fire than others in the region. Therefore, if a warmer climate brought an increase in fire it would benefit these communities. However, severe fires during droughts would be destructive to oak forests, especially if occurring with the increased fuel loads resulting from recent fire suppression. While warmer temperatures and more droughts may allow pine forests to encroach into oak forests, it will also allow oak forests to expand to higher elevations and into more mesic sites.

Montane Oak Forests will likely be resilient to the effects of climate change and are expected to continue to occupy most of the sites they currently occur in and to remain the most abundant communities. Development and logging remains to be the most severe threat to these communities as well as other invasive species or blights. Prescribed fire is most important to promote resiliency in these systems in addition to protecting remaining areas and restoring connectivity among areas.

References:

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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.
