

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

*DRAFT*

## Piedmont and Coastal Plain Oak Forests

### **Ecosystem Group Description:**

Oak forests were once the most common natural community type in the Piedmont, occurring over most of the uplands. In the Coastal Plain they were much more limited, occurring primarily in dissected areas near streams. Although traditionally called oak-hickory forests, oaks are by far the predominant genus.

Dry-Mesic Oak-Hickory Forest and Dry Oak-Hickory Forest are the most typical of the five community types, occurring on upland slopes and ridgetops on acidic soils. White oak is usually the most abundant tree in both. Post oak and southern red oak are the primary associates in Dry Oak-Hickory Forests and red oak and black oak in Dry-Mesic Oak-Hickory Forests. Piedmont Monadnock Forests, typically dominated by chestnut oak and scarlet oak, occur on scattered hills, which are resistant to the erosion affecting the surrounding land. Basic Oak-Hickory Forests occur on upland flats and slopes in sites similar to Dry and Dry-Mesic Oak-Hickory Forests, but with soils that are not acidic. Most of the soils are apparently near neutral pH rather than truly basic and usually occur over mafic rocks such as gabbro and diabase. They are dominated by white oak in combination with post, red, or black oak and a number of understory, shrub, and herb species that are scarce or absent on acidic soils are present.

Xeric Hardpan Forests are the most distinctive of the Piedmont and Coastal Plain oak forests. They occur on flat to gently sloping uplands with clay hardpans that restrict water and root penetration. This situation is most common on mafic rocks, but it also occurs on acidic shales. These sites may have shallow standing water in wet seasons, but are extremely dry in dry seasons. The canopy is dominated by some of the most drought tolerant species in the state, post oak and blackjack oak, and is often somewhat open. While dense brush often occurs beneath the open canopy, these communities were likely once open and grassy beneath. A number of plants that need full sunlight are present in openings and along adjacent roadsides. The interaction of the unusual soils with fire was almost certainly what produced the open aspect.

### **Ecosystem Level Effects:**

#### Predicted Impacts of Climate Change:

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Wind Damage	High	Neg	High	
Mild Winters	High	Mix	Low	
Hot Spells	High	Mix	Low	
Fire	Med	Mix	High	Low intensity fires would be beneficial, but intense wild fires would be destructive.

Drought	High	Neg	Med
Increased Temperature	High	Mix	Med

The Climate Wizard mid model temperature increase is about 4 degrees by 2050, in the Asheboro area (Maurer et al., 2007). The cmd model predicts an increase of 4.5 degrees. The mid value rainfall forecast is for a slight increase, but there is substantial variation among the models: anywhere from a decrease of 13 inches to an increase of 18 inches per year. Some models predict that rainfall will be concentrated during the fall, and there will be increased droughts in the spring and summer. This may reflect an expectation of increased hurricane activity rather than well-distributed rainfall.

There may be an increase in natural fires (due to increased drought and higher average temperatures), but landscape fragmentation and fire suppression practices likely will continue to prevent most fires from spreading very far in the Piedmont and in the dissected lands where oak forests occur in the Coastal Plain. Most oak forests are expected to benefit from increased fire frequency, as long as the fire intensity is not too high.

An increase in hurricanes or other severe storms may increase wind damage in forests.

**Predicted Ecosystem Responses:**

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Structural Change	Med	Neg	Med	
Exotic species invasion	Med	Neg	Med	
Compositional Change	Low	Neg	Med	
Acreage Change	Med	Pos	Low	

Direct effects of the warmer climate on these communities are likely to be limited. Similar oak forests range well to the south of North Carolina. The most severe droughts and hot spells of recent record have had only limited effects on them. They occupy the driest places on the Piedmont landscape.

Oak forests likely will spread downslope into more mesic sites if the landscape becomes warmer and more dry. The overall effect on extent is uncertain but probably not drastic. Changes will likely occur gradually, through death of trees in drought or storms, along with greater survival and gap capture by drier-site species. Most species have broad ecological tolerances and likely could survive in their current locations through their life span. Increased fire would accelerate change.

An important question is how readily communities will be able to migrate. The Piedmont landscape is highly fragmented. However, most component species are abundant and widespread. Most natural sites remaining are on dissected landscapes with multiple community types.

Community structure and dynamics may change to a moderate degree. If there is increased burning, it will produce a more open canopy, reduced understory, increased herb cover with more grasses, and longer lasting canopy gaps. These are believed to have been natural characteristics of these communities in earlier times. Warmer summers and more frequent droughts might produce a similar effect without fire, but this is uncertain.

There is much uncertainty whether the current trend of oaks being supplanted by red maple will continue. Increased fire frequency would favor oaks over maples. Drought would likely favor oaks over maples.

However, increased wind throw would probably favor existing understory maples over the long-lived oaks. Older trees will withstand fire better than younger, but will be more susceptible to wind. Increased wind throw would reduce the average longevity of trees. These effects are likely small in comparison to the effects of logging.

Some more southerly species may migrate into these communities. However, these communities are very similar southward to Georgia, so such changes are likely to be limited. Invasive plants are currently increasing and are likely to continue to spread. Princess tree (*Paulownia tomentosa*) and tree of heaven (*Ailanthus altissima*) are able to invade disturbed areas and capture canopy gaps in some places. They will likely continue to expand, but it is unclear if a warmer climate will accelerate this. However, increased canopy disturbance by wind, drought mortality, or severe fire will hasten invasion.

## Habitat Level Effects:

### Natural Communities:

Third Approximation Name:	Comments:
Xeric Hardpan Forest	These communities naturally existed as open woodlands or prairie savannas. They have become denser in recent years because of fire suppression. Drought will likely shift them to more open structure, more resembling their natural condition, perhaps even without increased fire.
Basic Oak--Hickory Forest	These communities are tied to characteristic soils and can't migrate very far. There will be a general shift to more of the drier subtype. General community changes will parallel those in the acidic community types. A larger fraction may be lost to the expansion of Xeric Hardpan Forests and glades (since these are more often on basic soils), but both subtypes should remain fairly abundant.
Dry-Mesic Oak--Hickory Forest	These communities will move downslope into more mesic areas, as Dry Oak--Hickory Forest will expand at their expense. It is unclear whether there will be a net gain or loss of area, but they should remain abundant.
Dry Oak--Hickory Forest	These communities will likely expand in extent, as they move into more moist areas.
Piedmont Monadnock Forest	These communities are restricted to characteristic sites and are unlikely to migrate. Their extent probably will stay the same but some aspects of the communities may change. Monadnock sites tend to be dry. Increased dryness might stress chestnut oaks, but it is unclear how serious this is; they do not appear to be limited by moisture at present. The shortleaf pine component may increase, particularly if there is more fire. Most species will probably persist.

### LHI Guilds:

Guilds with Significant Concentration in Ecosystem Group:	Comments:
Piedmont Dry-Wet Hardwood and Mixed Forests	
Piedmont Dry-Wet Basic Hardwood Forests	
Dry-Xeric Mixed Forests, Woodlands, and Barrens	

Habitat for the Dry-Xeric Mixed Forests, Woodlands, and Barrens may increase with increasing frequency of drought and fires. Habitat trends for the Piedmont Dry-Wet Hardwood and Mixed Forests and Piedmont Dry-Wet Basic Hardwoods Forests Guilds are more difficult to predict but given the wide range of moisture conditions occupied by these guilds, they are likely to remain fairly common.

## Species Level Effects:

### Plants

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC	Comments:
<i>Helianthus schweinitzii</i>	G3/S3	Yes			E/E	This species is endemic to NC and SC (most populations occur in NC).
<i>Berberis canadensis</i>	G3/S2				/SR-T	
<i>Anemone berlandieri</i>	G4?/S2				/SR-P	
<i>Liatris squarrulosa</i>	G4G5/S2				/SR-P	
<i>Quercus ilicifolia</i>	G5/S2				/T	
<i>Hexalectris spicata</i>	G5/S2				/SR-P	
<i>Fleischmannia incarnata</i>	G5/S2				/SR-P	
<i>Cirsium carolinianum</i>	G5/S2				/SR-P	
<i>Agastache nepetoides</i>	G5/S1				/SR-P	This species prefers relatively mesic conditions and may suffer from drought.
<i>Boechera missouriensis</i>	G5?Q/S1				/SR-P	
<i>Baptisia australis</i> var. <i>aberrans</i>	G5T2/S2				/T	
<i>Symphotrichum laeve</i> var. <i>laeve</i>	G5T5/SH				/SR-P	

Most or all rare plants in this group are likely to benefit from more canopy openings and more fire. Climate change is not expected to be a significant threat, and may even improve or create more habitat. Most are tolerant of drought. Many are tied to basic soils and are unlikely to migrate far.

### Terrestrial Animals

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC/WAP	Comments:
<i>Heliomata infulata</i>	G2G4/S2S3	Yes	Yes		/SR/	Only known from Hanging Rock State Park in the Piedmont
<i>Callophrys irus</i>	G3/S2		Yes		/SR/	Only a few widely separated populations are known from the Piedmont
<i>Ptichodis bistrigata</i>	G3/S2S3				/SR/	
<i>Erynnis martialis</i>	G3G4/S3				/SR/	
<i>Acronicta albarufa</i>	G3G4/S1S2		Yes		/SR/	Known in the Piedmont only from a single historical record
<i>Catocala herodias gerhardi</i>	G3T3/SU		Yes		/SR/	Restricted to bear-oak stands associated with Piedmont monadnocks.
<i>Eucoptocnemis dapsilis</i>	G4/S2S3				/W3/	
<i>Idea eremiata</i>	G4/S3S4				/W3/	
<i>Nemoria bifilata</i>	G4/S3?				/W3/	
<i>Coccyzus americanus</i>	G5/S5B				//P	
<i>Ambystoma maculatum</i>	G5/S5				//P	
<i>Ambystoma opacum</i>	G5/S5				//P	
<i>Ambystoma talpoideum</i>	G5/S2				/SC/P	

<i>Callophrys augustinus</i>	G5/S4	Yes	//	Only known from a few monadnocks in the Piedmont
<i>Ulolonche modesta</i>	G5/SU		/W3/	
<i>Caprimulgus carolinensis</i>	G5/S5B		//P	
<i>Caprimulgus vociferus</i>	G5/S5B		//P	
<i>Cemophora coccinea</i>	G5/S3		/W1,W5/P	
<i>Tantilla coronata</i>	G5/S3S4		//P	
<i>Picoides villosus</i>	G5/S4		//P	
<i>Wilsonia citrina</i>	G5/S5B		//P	
<i>Hylocichla mustelina</i>	G5/S5B		//P	
<i>Papilio crespontes</i>	G5/S2		/SR/	
<i>Megathymus yuccae</i>	G5/S3S4		/W2/	
<i>Terrapene carolina</i>	G5/S5		//P	
<i>Hemeroplanis n. sp.</i>	GNR/S2S3	Yes	/SR/	Only known from Hanging Rock State Park in the Piedmont
<i>Lobocleta peralbata</i>	GNR/SU		/W3/	
<i>Stenoporpia polygrammaria</i>	GU/S1	Yes	/W2/	Only recorded at Hanging Rock State Park in North Carolina

Rare species of animals associated with this Ecosystem Group occupy habitats at the dry to xeric extreme, with some occurring only on a few isolated monadnocks in the Piedmont. These include *Acronicta albarufa* (associated with post oak), *Catocala herodias* and *Stenoporpia polygrammaria* (associated with bear oak), *Fixsenia ontario* (associated with dry oaks in general), *Heliomata infulata* and *Hemeroplanis n. sp.* (associated with dwarf locusts), *Erynnis martialis* (associated with *Ceanothus*), *Callophrys augustinus* (associated with upland heaths), *Callophrys irus* (associated with *Baptisia* and lupines), and *Ptichodis bistrigata* (a barrens species of unknown host plants). Habitat for these species is likely to expand with increased frequency of drought and fires, both of which favor development of open woodlands and barrens. However, species that are confined to monadnocks or other small patches of habitat may be vulnerable to increased perturbations, such as fire, if their entire block of habitat is affected by any one event.

## Combined Threats and Synergistic Impacts:

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

Threat:	Rank Order:	Comments:
Development	1	
Logging/Exploitation	2	
Invasive Species	3	Primarily <i>Elaeagnus</i> , <i>Baccharis</i> , <i>Ailanthus</i> , and <i>Paulownia</i> .
Fire	4	Lack of fire is leading to slow changes in composition, including reduced oak regeneration.
Climate Change	5	

While climate change is a significant concern for these communities, several other threats are more severe. Both the extensive examples in the Piedmont and the more limited range in the Coastal Plain continue to be rapidly destroyed by ongoing urban, suburban, rural, residential and commercial development. Continued

population growth makes this the most severe threat, in the current and the future climate. However, the fragmentation and loss of extent caused by it will increase the alteration caused by climate change, as isolated communities are unable to migrate and species are unable to move to more favorable sites.

Logging remains widespread, and continues to destroy examples and to severely alter the structure and composition of others. While many examples logged in the past regenerated as oak forests, many become successional pine forests or become dominated by maple or other hardwoods after logging. The loss of old trees caused by increased disturbance in the future climate exacerbates that caused by logging. Demand for biofuels may increase the risk of damage by logging or biomass harvest.

The threat posed by fire regime alteration is less certain in rank. The growth of dense shade-tolerant understories and the consequent failure of oaks to regenerate is likely a result of long fire suppression. It is an ongoing problem regardless of climate change. Increased drought may possibly favor oaks, but increased wind damage favors the understory species. If drought leads to severe wildfires, it would be harmful to oak forests, but the ease with which fires may usually be controlled in them makes this unlikely.

Invasive species are not a severe threat at present. However, tree of heaven (*Ailanthus altissima*), mimosa (*Albizia julibrissin*), and princess tree (*Paulownia tomentosa*) are likely to continue to expand, regardless of climate, and pose an increasing threat. A number of smaller invasive plants are increasing in disturbed oak forests and pose a risk of increase. Exotic diseases, such as sudden oak death fungus, represent a severe potential threat even under the current climate.

## Recommendations for Action:

### Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Control Invasive Species	High	Medium	
Conduct Prescribed Burns	Medium	High	
Restore/Maintain Landscape Connections	High	Medium	
Protect/Expand Remaining Examples	High	Medium	

The greatest threat to these systems is continued destruction and degradation of remaining examples. Past and ongoing loss also creates fragmentation among the remaining areas. These represent much more severe loss than is expected through climate change itself. Continued protection of the best examples and of areas important to landscape connections is the most important action needed for this theme.

It is becoming increasingly clear that fire is beneficial and likely crucial to Piedmont and Coastal Plain Oak Forests. Burning will restore more natural forest structure, and will favor species that tolerate drought and wild fire. Fire suppression has shifted these communities toward more mesophytic plant composition than would naturally occur, making them more susceptible to climate change. Burning would increase their resilience to warmer climate and drought, as well as make them less prone to destruction by wild fire. Prescribed burning will have to account for younger canopies whose trees may be more susceptible to fire than in the past. At the same time, there is a need to control wild fires in drought conditions, to prevent intense fires and to prevent whole patches of fragmented forest from being burned at the same time.

Control of invasive species in the short run, while populations are relatively limited and small, will prevent

greater damage by them in the future. It will reduce the chance that future disturbances will promote rapid spread.

## **Ecosystem Group Summary:**

Piedmont and Coastal Plain Oak Forests are likely to be relatively resilient to the effects of climate change. These communities are tolerant of severe droughts, hot spells, and fires of low intensity. However, they occur in a fragmented landscape and migration may be problematic. Development, logging, and invasive species are much more of a threat to these communities than climate change. Protection of remaining examples and restoration of degraded sites and landscape-level connections would allow for adaptation in the future, as well as provide protection and promote the ecosystem viability under the current climate.

## **References:**

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