

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

DRAFT

Grass and Heath Balds

Ecosystem Group Description:

Balds are treeless shrub or herb-dominated communities of the high mountains. Grassy Balds are open meadows typically dominated by mountain oatgrass and sedges, with a fairly diverse mixture of other species. They usually occur on broad ridgetops. Heath Balds are dense thickets of tall shrubs. Catawba rhododendron and mountain laurel are the most common dominants. An unusual variant at Roan Mountain is dominated by green alder, not found elsewhere in North Carolina. Most Heath Balds are on sharp spur ridges, but some occur on rounded peaks or ridgetops.

The ecological factors creating balds are not well understood. The treeless areas do not represent a climatic timberline, and often occur near higher peaks that are forested. Harsh climate and shallow soil seem to be a factor in some, particularly Heath Balds, but many examples of both community types are being invaded by trees and, in the case of Grassy Balds, shrubs. Fire may have been a factor, but many bald sites do not appear prone to fire, and are surrounded by vegetation that apparently did not burn. Some places that superficially resemble balds have been found to have been cleared of forest in historical times, but other balds apparently were open throughout history. The presence of disjunct species which require open habitat suggests that some balds have been open since the Ice Age.

Ecosystem Level Effects:

Predicted Impacts of Climate Change:

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Mild Winters	High	Neg	Med	
Increased Temperature	High	Neg	Med	
Fire	High	Mix	Med	
Drought	High	Mix	Med	

We expect the future climate to include warmer temperatures, longer growing season, 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. 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 (Maurer et al., 2007). But the future climate of the high mountain sites is particularly uncertain. These model results are for the general area and do not account for variation in elevation. Much of the current climate in the high mountains is orographically driven, and is quite different from the general regional climate. The rainfall on many mountain peaks is as much as double that in the lower basins. In Spruce-Fir Forests, a similar amount

of water may be input through fog drip. Fog moisture input to balds has not been measured, but experience suggests it is significant. Much of the distinctive environment here depends on fog and orographic cloud cover. If these phenomena persist, they will ameliorate the effects of warming, drought, and fire. If they are disrupted, climate change effects will be much more drastic.

Increased drought or increased thunderstorm activity may lead to an increased potential for wild fire in the high mountains. Surrounding forest areas are not very flammable in the current climate, and Grassy Balds don't appear to burn naturally. However, farmers who grazed livestock on them in the past have burned them. Some Heath Balds occur on sharp ridges that are prone to lightning and probably do naturally burn. It is possible that increased fire potential in heath balds would allow them to expand.

Predicted Ecosystem Responses:

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Structural Change	Med	Mix	Med	
Exotic species invasion	Med	Neg	Low	
Compositional Change	High	Mix	Med	
Acreage Change	Med	Pos	Med	Fire might expand balds.

Warmer temperatures may change the composition of these communities in uncertain ways. Some of the species of Grassy Balds are northern species that presumably would suffer. However, the dominant species occur at lower elevations, and are unlikely to be eliminated by temperature increases. Changing competitive relationships may change composition in uncertain ways.

The mechanisms that keep most balds open in the current climate are poorly known. They appear to include processes that no longer operate, as many balds are being invaded by trees or shrubs. It is unclear if climate change will be harmful or beneficial to this. Because the cold, wind-swept environment may be partly responsible for keeping trees out, warmer climate and longer growing season may exacerbate this problem, causing some balds to disappear. However, drought may make tree and shrub invasion more difficult.

If wild fires increase, it could offset the problem of tree and shrub invasion and could allow balds to expand. This is, however, uncertain. High elevation forests that have burned in historic times have sometimes grown back into forest quickly and sometimes have remained as shrubby or grassy successional vegetation. However, they do not appear to develop into true Grass or Heath Bald communities. In existing balds, the dominant species, both herbs and shrubs, sprout readily, and would quickly recover from a single fire. The effect of more frequent fire is uncertain; it could shift competitive relationships among species.

Problems with exotic species invasion in Grassy Balds may increase with warmer temperatures and increased fire, but this is not certain. The most abundant exotic species at present are grazing-tolerant grasses such as *Phleum pratense*. They entered some Grassy Balds during past grazing, and they are not known to be expanding where grazing is not occurring. All are abundant in lower elevation pastures. While it is possible that warmer temperatures would make them more competitive with the native species, there is no reason to predict this. Other exotic species that respond to disturbance could increase if fire or drought stressed native plants. Coltsfoot (*Tussilago farfara*) invades disturbed areas at high elevation presently, and could increase in balds. If temperatures become warm enough, invasive plants from low elevations, such as *Microstegium vimineum*, could conceivably spread into these communities. If fires occur, mullein (*Verbascum thapsus*) could become a serious invader. However, the invasion of native shrubs and

trees is a greater concern than exotic species in Grassy Balds.

Heath Balds do not suffer from exotic species invasion at present. No invasive species are known that are likely to become a serious threat to them.

Habitat Level Effects:

Natural Communities:

Third Approximation Name:	Comments:
Heath Bald	Heath Balds are probably less likely to be strongly affected by climate change than Grassy Balds. An increase in fire might allow them to expand at the expense of forests. However, fire at much higher frequency could change their structure.
Grassy Bald	Climate change effects on Grassy Balds are particularly uncertain. The greatest problem of Grassy Balds, invasion by native trees and shrubs, could be helped or hindered by the future climate.

LHI Guilds:

Guilds with Significant Concentration in Ecosystem Group:	Comments:
(Montane Dry Heathlands)	

The guilds for these two types of habitat have not yet been fully developed but are likely to be very different from one another. Species associated with open, herbaceous habitats are likely to show affinities with semi-natural grassland habitats, including high elevation pastures, while those associated with heath thickets are likely to show affinities with dry-xeric, open woodlands and barrens.

Species Level Effects:

<u>Plants</u>	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC	Comments:
Houstonia montana	G2/S2	Yes		Yes	E/E	If conditions become too warm and dry for this species to persist in NC, it may go extinct.
Gentiana austromontana	G3/S2?				/SR-L	This species is poorly understood due to taxonomic questions.
Lilium grayi	G3/S3	Yes			FSC/T-SC	
Rhododendron vaseyi	G3/S3	Yes			/SR-L	
Delphinium exaltatum	G3/S2				FSC/E-SC	
Spiranthes ochroleuca	G4/S1				/SR-P	
Rhododendron cumberlandense	G4?/S1				/SR-P	
Monarda media	G4?/S1?				/SR-P	
Poa palustris	G5/S1				/SR-P	
Dendrolycopodium dendroideum	G5/S2				/SR-P	

<i>Agrostis mertensii</i>	G5/S1	Yes	/E	This species is at the southern limit of its range in NC.
<i>Carex cristatella</i>	G5/SH		/SR-P	
<i>Platanthera grandiflora</i>	G5/S2		/SR-P	Occurs in seeps. Probably particularly prone to drought.
<i>Rhytidium rugosum</i>	G5/S2		/SR-P	
<i>Sceptridium multifidum</i>	G5/S1		/SR-P	
<i>Sphagnum capillifolium</i>	G5/S1		/SR-P	Occurs in wetlands. Probably particularly prone to drought.
<i>Bromus ciliatus</i>	G5/S1		/SR-P	This species is at the southern limit of its range in NC and TN.
<i>Trisetum spicatum</i>	G5/SX		/E	This species is at the southern limit of its range in NC. It was historically known from only one site in NC (a grassy bald). If conditions change at that site, it is likely to go extinct (if it hasn't already gone extinct in NC).
<i>Packera schweinitziana</i>	G5?/S2		/E	
<i>Lilium philadelphicum</i> var. <i>philadelphicum</i>	G5T4T5/S2		/SR-P	
<i>Chamerion platyphyllum</i>	G5T5/S1		/SR-P	
<i>Spiranthes lacera</i> var. <i>lacera</i>	G5T5/SH		/SR-D	This species was historically known from only one site in NC (a grassy bald). If conditions change at that site, it is likely to go extinct (if it hasn't already gone extinct in NC).
<i>Alnus viridis</i> ssp. <i>crispa</i>	G5TNR/S1	Yes	/SR-D	This species is at the southern limit of its range in NC and TN. It might be particularly harmed by fire in its habitat.

The effect of climate change on the species of balds is particularly uncertain. Some species are at their southern range limits and some are northern disjuncts, and these may be directly harmed by warmer temperatures. Some are dependent on seeps or wet areas, and may be harmed by more frequent or more intense drought. However, for most, competitive relations and the status of tree and shrub invasion are probably the most important factor for survival.

Houstonia montana is an extremely rare species, which occurs at high elevation balds and rock outcrops. If conditions become too warm and dry for this species, it is unlikely to migrate north because of the limited habitat available for migration corridors (mountaintops are effectively isolated from one another, making migration difficult or impossible for species with limited dispersal capabilities). *Houstonia montana* should be monitored closely for declines in the near future, and intervention may be required to prevent extinction.

Combined Threats and Synergistic Impacts:

Importance of Climate Change Factors Compared to Other Ecosystem Threats:

Threat:	Rank Order:	Comments:
Woody Succession	1	Trees and shrubs have been invading grassy balds in recent years.

Conversion to agriculture/sylvicu	2	Conversion to pasture land has historically degraded some grassy balds, and continues to be a threat even at otherwise protected sites.
Development	3	Second home development has increased in recent decades.
Climate Change	4	
Fire	5	
Invasive Species	6	Pasture grasses, coltsfoot, and Angelica are the most common exotic species in grassy balds.

Grassy Balds and some of the Heath Balds are already seriously threatened by invasion by native trees and shrubs. The ecological processes that kept them open in the past are not well known, and appear to no longer operate. Some of these balds are maintained by cutting of invading plants, or by grazing. It is unclear how climate change will affect these processes. This process is a more serious threat than anticipated direct effects of climate change.

Recommendations for Action:

Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Restore Extirpated and Degraded Areas	High	High	
Protect/Expand Remaining Examples	High	High	
Protect from Wildfire	Low	High	It is unclear if fire is likely to be harmful or beneficial.
Control Invasive Species	High	High	Feasible but extremely labor intensive.

Most recommended interventions are for the more serious threat of invading woody species, rather than for the effect of climate change per se.

Ecosystem Group Summary:

Communities and species associated with this Ecosystem Group are likely to be affected by changes in temperature and mild winters associated with climate change. Changes in precipitation may not be drastic. However, it is uncertain if fog and cloud cover will change in these high elevation communities, potentially altering moisture from fog deposition. Increased drought or lightening from increased thunderstorms may cause an increase in wildfire, which could actually promote the expansion of grass and heath balds. As temperatures increase, exotic species in lower elevations may be able to invade these areas more easily, however, the current invasion of native trees and shrubs, development, and conversion to agriculture are much more of a concern than impacts from climate change. Thus, controlling invasive species and protecting or restoring areas is critical to protect these habitats against these threats.

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.