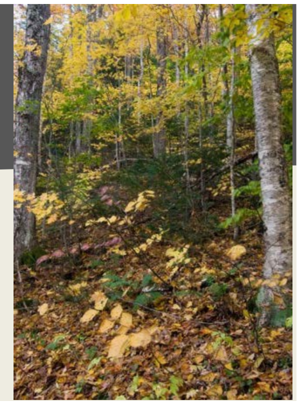
NORTHERN HARDWOOD–CONIFER FOREST
CLIMATE ASSESSMENT



Northern hardwood-conifer forest is found primarily in the northern half of the state and at elevations between 1500 and 2500 feet. It is characterized by sugar maple, American beech and yellow birch, with American hemlock at lower elevations and red spruce at higher elevations.

POTENTIAL CHANGES TO HABITAT

- Because these forest types are so widespread, overall impacts from climate change are likely to be highly variable, and often limited by specific site conditions (soil, existing species composition, etc.). In general, northern hardwood species are more likely to shift north or up slope, and be replaced by hemlock-hardwood-pine species. The timing of such shifts will vary considerably among species, and any migration is also likely to take place over timeframes longer than the present assessment considers.
- More frequent disturbance events (e.g., hurricanes, ice storms, tornadoes) will likely favor shade-intolerant, early successional species (paper birch and aspen) over shade tolerant, late successional species (sugar maple and beech). Higher rates of disturbance would also alter the relative proportions of different seral stages of forest.
- Both disturbance and pest/pathogen related mortality could result in larger areas of salvage logging and resulting habitat changes. This could in turn affect nutrient cycling and local hydrology.
- Pressure to develop alternative energy sources (wind turbines) could have significant effects on some areas of northern hardwood-conifer forest. Associated shifts in government policy may open currently protected areas to such development.

WHAT DOES THIS MEAN?

Predicting the responses of forests to climate change is a complicated endeavor. The response of a particular habitat to climate change is actually comprised of the individual responses of the habitat's component species. As a result, it is unlikely that forest types will simply shift their positions on the landscape. Instead, some species will increase and others decrease depending on specific climate needs and site conditions, resulting in subtly different forest types than those currently described (e.g., Zhu et al.2011). These changes will likely take place over a much longer time frame than the roughly 100 years under consideration for this current assessment, although the rate of change will be heavily influenced by local conditions.

In a very general sense, specific climate tolerances predict that most species typical of northern hardwood-conifer habitats will shift north or upslope (Beckage et al. 2008), replacing spruce-fir species and being replaced in turn by hemlock-hardwood-pine species. However, these same species are often broadly tolerant of variation in temperature and moisture, so any changes will likely be subtle as mentioned above. In cases where a given species disappears because of climate change, site conditions may prevent colonization by new species, resulting in a less dramatic shift of dominance among those species that remain. For example, sugar maple requires richer soils, and will likely be limited in its ability to migrate out of its current range, irrespective of its climate tolerance.

The effects of altered precipitation patterns on hardwood-conifer forests are harder to predict, and are largely tied to the interactions between precipitation and temperature. Increased drought may reduce seed set in some species, and thus limit their ability to migrate or recolonize after disturbance. Drier summers could also increase the chance of fire, although fire is historically rare and unlikely to increase to such an extent that it would dramatically alter existing habitats.

The role of altered disturbance regimes in these habitats will similarly affect species composition rather than outright forest type. Post-disturbance species composition is likely to be more influenced by existing understory composition and nearby seed sources than by climate tolerances. Shade-tolerant species like sugar maple may be disproportionally negatively affected by more frequent disturbance events. In extreme cases, loss of forest cover in combination with poor site conditions (e.g., compacted soils, shallow mountaintop soils, etc.) may result in replacement communities being dominated by shrubs rather than trees.

Increased numbers and diversity of forest pests and pathogens is potentially one of the most important results of climate change in these habitat types. Species currently kept in check by cold winters will increase, and in extreme cases have the potential to dramatically reduce the abundance of their host species. Currently the hemlock wooly adelgid is moving north as temperatures increase, and has already destroyed significant areas of hemlock to the south. Not only does this alter a forest's tree species composition, but there are secondary effects resulting from the loss of the dense shade that hemlock typically provides. Similarly, the almost inevitable colonization of New Hampshire by the emerald ash borer will result in loss of ash, and the potential for future pests is large and immeasurable.

In addition to insect pests, non-native invasive plant species are likely to increase with climate change. Already-established invasives will expand their ranges and increase in abundance, while southern species are more likely to colonize the state. High densities of invasives can potentially alter the type of forest that regenerates after a major disturbance event.

Human response to climate change could affect this habitat type in three broad ways: 1) direct losses to development (including energy infrastructure), 2) conversion through harvest, or 3) facilitation of other stressors. In the former category, hardwoods along ridgelines could be vulnerable to wind power development, and forests could be cleared to make way for the infrastructure related to power transmission. Increased population pressures as people move north (to avoid heat, drought, sea level rise, etc.) will result in expanded areas of housing and transportation infrastructure, although this impact is still largely speculative. Accelerated harvest of hardwoods could result from either salvage logging after major disturbance events or through an increased demand for wood as fuel. Finally, existing or future human infrastructure can serve as a conduit for invasive species whose colonization would otherwise be limited.

How does this affect wildlife?

Moose are already experiencing extreme stress related to increased infestation of winter tick with a warmer climate. Some birds that currently occupy wide elevational ranges (e.g., Black-throated Blue Warbler) experience lower productivity at their lower limits, probably a result of habitat-influenced food supplies (Rodenhous et al. 2008). Extrapolation of these results suggests that a warming climate would reduce the range of elevation where habitat is most suitable, and thus result in potential population declines. Many forest birds are important predators of defoliating insects, and phonological decoupling of bird migration and insect emergence may reduce predation pressure, with negative impacts on both forest trees and the birds that depend on these insects to feed their young.

General Strategies to Address these Vulnerabilities:

See the full Climate Change Adaptation Plan for strategy descriptions

S1: Conserve Areas for Habitat Expansion and/or Connectivity
S2: Habitat Restoration and Management
S5: Invasive Species Plan
S6: Comprehensive Planning
S9: State Energy Policy

Specific Strategies:

1. Map areas where the elevation and topography might allow for cold pockets. Encourage timber management for spruce fir or sugar maple as appropriate for the soil conditions.
2. Identify suite of calcium-dependent indicator plants and their change in dominance at semi-rich to rich mesic sites. Used to assess habitat change due to Ca^{+2} loss.
3. Protect a sufficient acreage and dispersion of high quality northern hardwood-conifer to allow for natural successional processes and the possibility of migration.
4. Develop programs and materials that capitalize on the popularity of fall foliage and maple syrup to educate people on the importance of this type of habitat and its potential response to climate change.

This Climate Assessment is a section of the **Ecosystems and Wildlife Climate Change Adaptation Plan (2013)**, an *Amendment to the NH Wildlife Action Plan*, developed by New Hampshire Fish and Game with the help of many conservation partners. The full plan can be found at http://www.wildlife.state.nh.us/Wildlife/Wildlife_Plan/climate.html. (Photo by Ben Kimball)