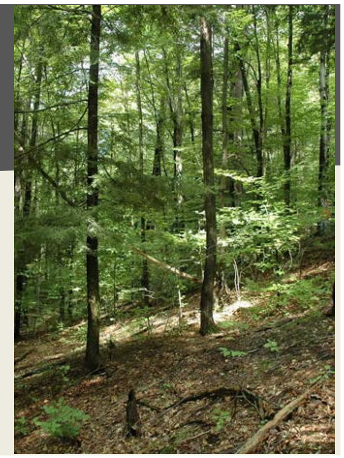
HEMLOCK–HARDWOOD–PINE FOREST
CLIMATE ASSESSMENT



Hemlock–hardwood–pine forest covers about half the forested area of New Hampshire, much of that south of the White Mountains. The tree species composition of this forest type can vary significantly from site to site, but red oak and white pine are usually present in early to mid-successional forests, while hemlock and beech are more frequent in older stands.

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, hemlock–hardwood pine species are more likely to shift north or up slope, and replace those more typical of northern hardwood–conifer forests. The timing of such shift will vary considerably among species, and any migration is also likely to take place over timeframes longer than the present assessment considers. At the same time, Appalachian oak–pine forests may replace hemlock–hardwood–pine in some areas in southern New Hampshire.
- 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 (beech and hemlock). Higher rates of disturbance would also alter the relative proportions of different seral stages of forest.
- Some forest pests are likely to increase with warmer and/or drier conditions (e.g., hemlock wooly adelgid). The adelgid in particular has the potential to remove significant amounts of hemlock and dramatically alter forest composition.
- 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.

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 hemlock-hardwood-pine habitats will shift north or upslope, replacing northern hardwood-conifer species and being replaced in turn by Appalachian oak-pine. 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 (e.g., loss of American chestnut).

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 hemlock may be disproportionally negatively affected by more frequent disturbance events.

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 all forests could be removed 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. An increase in deer with changing habitat will also expose moose to increased incidences of brain worm. 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 (Rodenhouse 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 phenological 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. Increase monitoring and management for hemlock wooly adelgid, especially in deer wintering areas. Incorporate into adaptive management.
2. Research and develop effective biocontrol for hemlock wooly adelgid.

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)