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Hemlock Hardwood Pine Forest

Acres in NH: 2,039,406
Percent of NH Area: 34
Acres Protected: 387,487
Percent Protected: 19

Habitat Distribution Map

Habitat Description

The hemlock-hardwood-pine forest is a transitional forest region in New Hampshire (Sperduto 2011). This forest occurs between the northern hardwood - conifer forest to the north and at higher elevations (mostly above 1,400 ft.) and the Appalachian oak - pine forests to the south and at lower elevations (mostly below 900 ft.). This transitional forest lacks most boreal species and central hardwood species that characterize these other forests, but has many Alleghanian species such as white pine (Pinus strobus) and hemlock (Tsuga canadensis). Many of the other species of this system are common throughout the eastern United States. Hemlock - hardwood - pine forests are found throughout the state from the White Mountains south below about 1,500 ft. Dry-mesic to mesic glacial till soils are most abundant, but this system also occupies river terraces, sand plains, and stabilized talus areas covered by a forest canopy. It includes dry, sandy soils with red oak and white pine that have not been burned enough to support pitch pine sand plains system. These areas are likely to succeed to hemlock and/or beech over the long term without the return of fire. The main matrix forest community that defines this system is hemlock - beech - oak - pine forest. Hemlock and American beech (Fagus grandifolia) are the primary late-successional trees in this community, with maximum ages of about 600 and 300 years, respectively. Red oak (Quercus rubra) and white pine are also typically abundant, in contrast to their absence or low abundance in northern hardwood - conifer forests. Most of the old-field white pine stands in central New Hampshire are successional examples of this system. Sugar maple (Acer saccharum) and yellow birch (Betula alleghaniensis) are occasional but of less importance than in northern hardwood - conifer forests. They are most frequent in mesic areas such as concavities and along drainages where white ash...
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(Fraxinus americana) is frequent, or locally abundant in patches of semi-rich mesic sugar maple forest. Red spruce (Picea rubens) and balsam fir (Abies balsamea) are generally sparse or absent, but are occasional on the lower slopes of some mountains south of the White Mountains (i.e., Ossipee Mountains, Mt. Monadnock). Central hardwood/Appalachian species are essentially absent, including hickories (Carya spp.), and oaks (Quercus spp.) other than red oak, (see Appalachian oak - pine forest description).

Variation in soils or landscape position within this system explains much of the variation in community composition. Hemlock forests often occur in ravines or extremely rocky sites; beech forests occur on coarse washed till soils; semi-rich mesic sugar maple forests occur in colluvial landscape positions or are associated with bedrock or till with greater base-cation contributions to the soil; hemlock - oak - northern hardwood forest occurs in more mesic settings or at higher elevations near the transition to northern hardwood - conifer forests; dry red oak - white pine forests occur on sandy or rocky soils that may perpetuate oak and pine dominance locally with repeated disturbance.

Justification (Reason for Concern in NH)

Hemlock - hardwood - pine forest is the most widely distributed forest type in New Hampshire, covering approximately 34% of the state’s land area. Available data indicate that roughly 19% of the state’s potential hemlock - hardwood - pine forest is on permanently protected lands. This forest type supports 140 vertebrate species in the state, including 15 amphibians, 13 reptiles, 73 birds, and 39 mammals. Threatened and endangered wildlife species occurring in this forest type include osprey, timber rattlesnake, and eastern hognose snake.

Protection and Regulatory Status

Approximately 19% of New Hampshire’s hemlock-hardwood-pine forest occurs on conservation lands.

Forestry on state lands is covered by RSAs 216, 217, and 218. RSA 227 stipulates requirements for residual basal area in riparian areas. The manuals “Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire” (NHDFL 2004) and “Good Forestry in the Granite State” (Bennett 2010) provide recommended management practices for sustainable forestry in New Hampshire.

Distribution and Research

Hemlock - hardwood - pine forest is widely distributed in New Hampshire with every county except Coos supporting between 5% and 20% of the total area of this forest type.

Additional fieldwork is needed to evaluate correlations between soil series and forest type as outlined in Homer (2005). County soil surveys outline soils suitable for forestry from an economic perspective. However, little has been done to evaluate soils from an ecological perspective (e.g., if left unmanaged, an area with a particular soil would eventually succeed to hemlock - hardwood - pine forest).

Fieldwork is also needed to ground truth the hemlock - hardwood - pine map.

Relative Health of Populations

An approximately 3% decrease in forest area occurred between 1992 and 1993 and 2001 in the 9-county area where nearly 100% of New Hampshire’s potential hemlock - hardwood - pine forest is found.
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Habitat Condition

**Biological Condition:**
Species richness of rare animals within their dispersal distances from the polygon
Species richness of rare plants in polygon
Richness of rare and exemplary natural communities in polygon
Vertebrate species richness (VT/NH GAP Analysis)

**Landscape Condition:**
Landscape Complexity
Local Connectedness
Similarity of habitat within 5km
Size of unfragmented block within which matrix forest is located

**Human Condition:**
Index of Ecological Integrity

<table>
<thead>
<tr>
<th>Threats to this Habitat in NH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a “medium” or “high” score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.</td>
</tr>
<tr>
<td>Habitat degradation and mortality from insect pests (hemlock wooly adelgid and others) (Threat Rank: High)</td>
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</tbody>
</table>

The hemlock wooly adelgid (*Adelges tsugae*), a small, sap-sucking insect native to Japan and China, became established in the Pacific Northwest in 1924 (na.fs.fed.us/fhp/hwa,). This insect became established in Virginia in the early 1950s and has since been spreading in the northeastern United States. As of 2015, infestations have been identified in 82 towns in eight counties in the state (NHDFL 2015). This species can be spread through the transportation of infected nursery stock as well as by wind, birds, and mammals. Eastern hemlock (*Tsuga canadensis*) has demonstrated little or no resistance to adelgid damage and mortality (McClure et al. 2001).

Based on FIA plot data, hemlock is the second most abundant tree species in New Hampshire (Morin & Pugh 2014), with the greatest concentration in the hemlock - hardwood - pine forest habitat. The hemlock wooly adelgid sucks sap from young hemlock twigs, resulting in needle drop, twig die-back, growth reduction, and tree mortality over the course of several years (Havill et al. 2014). It is difficult to overestimate both the ecological and economic impacts if hemlock wooly adelgid causes high mortality throughout New Hampshire.

<table>
<thead>
<tr>
<th>Habitat degradation and impacts (fragmentation) from increased demand for wind power and associated transmission lines (Threat Rank: Medium)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In response to the threats associated with climate change, there is a strong incentive to develop renewable wind energy facilities. These &quot;wind farms&quot; are typically located on long ridgetops to maximize exposure to sustained winds. The habitats that occupy the footprints of wind turbines and transmission corridors are lost, and the remaining adjacent habitat is fragmented. There is an increased risk of migratory bird and bat mortality in areas with towers and turbines.</td>
</tr>
</tbody>
</table>
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Kerlinger (2000) prepared an extensive literature review for the USFWS Office of Migratory Bird Management on avian mortality at towers and turbines. Birds that migrate along ridgelines at night are at greatest risk for tower collision by becoming disorientated when encountering lighted towers (Partners in Flight, unpublished data). Current estimates of the numbers of birds killed annually by communication towers range between 4 and 10 million (www.towerkill.com). A study at a West Virginia wind energy facility identified significant mortality of bats from collisions with wind turbines (Hein et al. 2013).

Habitat impacts from an increase in invasive plants moving north (Threat Rank: Medium)

Many invasive plants are currently limited by temperature, and are likely to expand northward into New Hampshire as a result of climate change. These species can displace or outcompete native plants and alter the composition and structure of habitats.

Invasive species can have a variety of negative impacts on natural communities and habitats (Stein and Flack 1996). In some cases, they can alter the chemistry of forest soils, leading to permanent changes in species composition (Ehrenfeld et al. 2001). A warming climate can enhance the spread of invasive plants through multiple pathways (Hellman et al. 2008).

Habitat degradation from warming conditions that allow cold-limited forest pests to move north (Threat Rank: Medium)

New Hampshire forests are currently at risk from a variety of insect pests (emerald ash borer, balsam wooly adelgid, gypsy moth, etc.). The current ranges of some of these pests, such as hemlock wooly adelgid, are believed to be limited by cold winter temperatures (NHDFL 2015). Under a warming climate scenario, the ranges of some of these species could expand, and new insect species could move into the state.

Hemlock woolly adelgid has significantly impacted stands of hemlock in the southern and central Appalachians, but has only spread slowly in northern New England due to its inability to tolerate cold winter temperatures (Paradis et al. 2007). However, under warming climatic conditions, it could expand its range northward, with the potential for widespread mortality of hemlock in New Hampshire.

Habitat degradation from succession to mature age structure (Threat Rank: Medium)

Early successional areas and young forest are critical habitats for a variety of wildlife species (DeGraaf et al. 2006). As forests mature, they lose many of the attributes that support these early-successional species, with potentially significant impacts on wildlife populations.

Since 1960, the acreage of forest characterized by large-diameter trees has been increasing (Morin & Pugh 2014). Prior to 1983, the acreage of young forests (1-5" diameter) had been declining, and has since been stable. However, this young forest is not evenly distributed among forest types, and the amount of early successional habitat in areas of hemlock – hardwood – pine forest is well until 10% of the total acreage of the type.

Habitat conversion and impacts to wildlife from fragmentation (Threat Rank: Medium)

Within the past 10 years, there have been 3 large scale wind energy facilities constructed in New Hampshire. These "wind farms" are typically located on long ridgetops to maximize exposure to sustained winds, and include turbines that are approximately 400 feet tall, which can pose a significant
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threat to birds and bats. Birds that migrate along ridgelines at night are at greatest risk for tower collision by becoming disoriented when encountering lighted towers (Partners in Flight, unpublished data). The habitats that occupy the footprints of wind turbines and transmission corridors are lost, and the remaining adjacent habitat is fragmented.

There were 78 known towers sited in New Hampshire as of 2010 (www.towerkill.com) and 475 towers currently mapped by NHFG. Kerlinger (2000) prepared an extensive literature review for the USFWS Office of Migratory Bird Management on avian mortality at towers and turbines. Current estimates of the numbers of birds killed annually by communication towers range between 4 and 10 million (www.towerkill.com). Bats are also vulnerable to impacts from wind energy facilities. Based on field data collection in a study of bat mortality at a wind energy facility in West Virginia, Hein et al. (2013) estimated a mortality rate of roughly 100 bats per turbine per year.

Habitat conversion due to development (Threat Rank: Medium)

Development reduces matrix forest habitat by converting natural forest to landscaped lawns and impermeable surfaces (e.g., buildings, roads). Development also contributes to forest fragmentation by directly reducing habitat, increasing traffic on existing roads, and requiring construction of new transportation infrastructure.

A study of 10 New Hampshire communities found that their populations increased by an average of 70.9% (range 9.7 to 189.7%) between 1974 and 1992, while developed land increased by an average of 137.2%. In the community with 9.7% population growth, developed land increased by 15.9% (New Hampshire Office of State Planning (NHOSP) 2000).

Habitat conversion resulting from decisions on land use and management (Threat Rank: Medium)

In New Hampshire, land use decisions are made at the municipal scale by volunteer planning boards with little or no training in natural resource issues. In cities and some of the larger towns, professional planning staff evaluate proposed developments and provide input to the planning board, but this is the exception rather than the rule. Most professional planners lack training in ecology or natural resources. Decisions are typically based on engineering and aesthetic considerations, with no recognition of direct or cumulative impacts on the underlying ecological functions of the affected lands or on impacts to wildlife habitat.

A Growth Management Advisory Committee convened by the New HOSP in 1999 concluded that:
• Impacts of growth and development are cumulative over decades
• Development in New Hampshire has occurred incrementally, resulting in fragmentation and loss of important and environmentally sensitive areas, including forestlands and wildlife habitat
• Communities seldom evaluate the potential impacts of their zoning ordinance or land use regulations (NHOSP 2000)

List of Lower Ranking Threats:

Mortality from pesticides used to control insect outbreaks
Habitat degradation from increased storm intensity and frequency
Mortality and habitat degradation from the creation and presence of roads
Mortality and habitat degradation from road fragmentation
Habitat impacts and conversion from the reduction in forest-based economy and infrastructure

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Disturbance and habitat degradation from hiking and biking trails
Habitat degradation and mortality from legal and illegal OHRV and snowmobile activity
Habitat conversion and degradation of forest to permanent openings and infrastructure, fragmentation, and disturbance to wildlife by visitor activity
Habitat degradation from increased storm intensity and frequency
Mortality from pesticides used to control insect outbreaks
Habitat and species impacts from salvage logging that occurs after storms and pest invasions resulting in species composition changes
Mortality from pesticides used to control insect outbreaks
Habitat degradation from acid deposition
Habitat degradation from mercury deposition
Habitat degradation from increased ice and wind storms that cause damage to trees resulting in acceleration of species composition changes
Species and habitat impacts from species composition changes related to climate change
Habitat degradation from drought that changes soil composition and reduced seedling recruitment
Habitat degradation and impacts from increased and unsustainable harvest due to demand for biomass fuel
Habitat degradation from groundwater and surface withdrawals

Actions to benefit this Habitat in NH

Protect unfragmented blocks and other key wildlife habitats.

Primary Threat Addressed: Habitat conversion due to development

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
The objective is to protect the largest and highest quality occurrences of hemlock – hardwood - pine forest habitat, with an emphasis on developing and maintaining corridors for wildlife movement and species dispersal.

General Strategy:
NHFG should use maps of prioritized unfragmented blocks and other key habitat information to review and identify land protection projects. These maps should also be distributed to the conservation community. Virtually all wildlife and habitats will directly or indirectly benefit from habitat protection, and the land protection strategy should be viewed as one of the most important ways to ensure long-term wildlife protection.

Political Location: Statewide
Watershed Location: Merrimack Watershed

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Support the Division of Forests and Lands in the implementation of the hemlock woolly adelgid action plan.

Primary Threat Addressed: Habitat degradation and mortality from insect pests (hemlock woolly adelgid and others)

Specific Threat (IUCN Threat Levels): Invasive & other problematic species, genes & diseases

Objective:
The objective is to minimize the impact of hemlock woolly adelgid on NH forests and control its spread in the state.

General Strategy:
The “Action Plan to Restrict the Spread and Manage Hemlock Woolly Adelgid within the State of New Hampshire” is designed to guide the appropriate agencies and personnel in the management of hemlock woolly adelgid. The action plan was developed by the NH Division of Forests and Lands and recommended by the state’s Forest Pest Advisory Group which is comprised of pest specialists representing the NH Division of Forests and Lands, USDA Forest Service, NH Department of Agriculture Markets and Foods, UNH Cooperative Extension, The Society for the Protection of New Hampshire’s Forests, The Nature Conservancy, the Granite State Society of American Foresters, and the USDA Animal and Plant Health Inspection Service. These organizations are brought together by the State Forester to provide oversight in the management of major forest pest outbreaks.

Political Location: Watershed Location:

Continue monitoring program to identify new pests and pathogens that threaten forest health.

Primary Threat Addressed: Habitat degradation from warming conditions that allow cold-limited forest pests to move north

Specific Threat (IUCN Threat Levels): Climate change & severe weather

Objective:
The objective is to protect forest habitats from new forest pests arriving in New Hampshire as a result of movement by people or natural dispersal.

General Strategy:
The Division of Forests and Lands Forest Health Program currently conducts regular monitoring of forest health issues, and undertakes activities specifically designed to document the arrival of new pests and pathogens. One example is the program using swimming pool filters to try and document occurrences of Asian longhorned beetle.

Political Location: Watershed Location:
Statewide

Protect unfragmented blocks and other key wildlife habitats.

Primary Threat Addressed: Habitat conversion due to development

Specific Threat (IUCN Threat Levels): Residential & commercial development
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Objective:
The objective is to protect the largest and highest quality occurrences of hemlock – hardwood - pine forest habitat, with an emphasis on developing and maintaining corridors for wildlife movement and species dispersal.

General Strategy:
NHFG should use maps of prioritized unfragmented blocks and other key habitat information to review and identify land protection projects. These maps should also be distributed to the conservation community. Virtually all wildlife and habitats will directly or indirectly benefit from habitat protection, and the land protection strategy should be viewed as one of the most important ways to ensure long-term wildlife protection.

Political Location: Merrimack County
Watershed Location: Merrimack Watershed

Incorporate habitat conservation into local land use planning.

Primary Threat Addressed: Habitat conversion due to development
Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Enhance protection of hemlock - hardwood - pine forests by incorporating conservation goals into planning documents, such as municipal and regional master plans, zoning ordinances, and subdivision regulations.

General Strategy:
The critical gap that NHFG can address is the scientific basis for implementing land use policies and regulations that protect the ecological function and health of wildlife populations and their habitats. This technical assistance needs to be combined with an integrated approach to land use decisions among local decision-makers. NHFG should work with UNH Cooperative Extension and New Hampshire Office of Energy and Planning, key outreach partners to facilitate training for NHFG biologists on the integration of wildlife habitat information into local land use planning and regulation. Likewise, Cooperative Extension can facilitate training for town planners, planning boards, regional planners, and others involved in writing master plans and local ordinances, on how to integrate wildlife considerations into local planning.

Political Location: Statewide
Watershed Location: Merrimack Watershed

Location Description:
Hemlock - hardwood - pine forests are found throughout southern and central NH.

References and Authors

2015 Authors:
Peter Bowman, NHNHB

2005 Authors:
Carol R. Foss, NHA
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Literature:


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NHDFL. 2015. Action Plan to Restrict the Spread and Manage Hemlock Woolly Adelgid within the State of New Hampshire. NH Division of Forests and Lands, Concord.


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