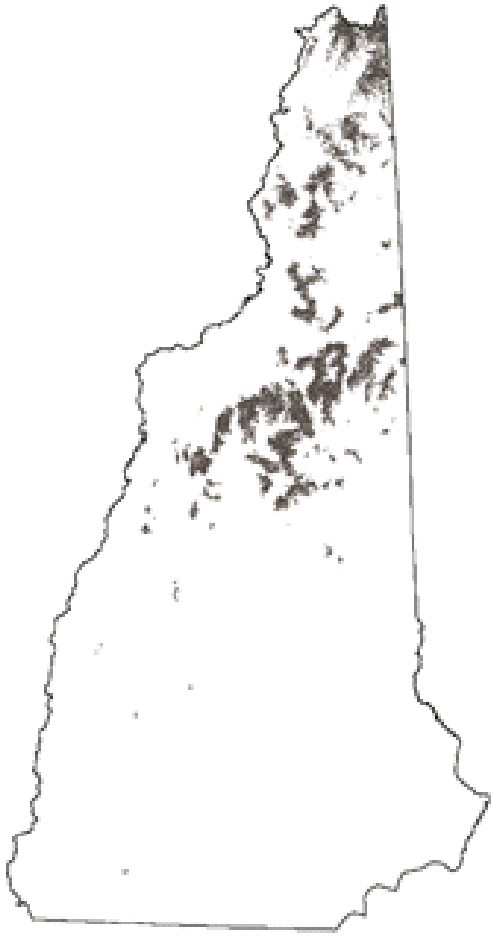
High Elevation Spruce-Fir Forest

Photo by Ben Kimball



Habitat Distribution Map

Acres in NH:	351,537
Percent of NH Area:	6
Acres Protected:	312,868
Percent Protected:	89

Habitat Description

Harsh climatic extremes and highly erosive soils play a significant role in determining the structure and species composition of high elevation spruce - fir forests found in New Hampshire. Increased rainfall (more than 6 inches per 1,000 ft. in elevation), snow cover (increase in weeks of snow cover per year), relative humidity (resulting in prolonged cloud cover) and wind movement (up to 25% more at 3,800 ft.), coupled with decreased mean air temperature (decrease in number of frost free days) and shallow, nutrient poor soils result in stands predominated by coniferous tree species. The coniferous stands found at high elevations experience drastically slowed and limited growth due to the truncated growing season and harsh climatic extremes (Vogelmann et al. 1969). As defined by NHNHB (Sperduto 2011), the high-elevation spruce - fir forest system includes two dominant natural communities—high-elevation spruce - fir and high-elevation balsam fir forests—and one peripheral community—northern hardwood - spruce - fir forest.

At the upper end of the elevation range for this habitat (between 3,500 and 4,500 ft.) is the high-elevation balsam fir forest (Sperduto & Nichols 2011). In this community, balsam fir (*Abies balsamea*) and heart-leaved paper birch (Betula cordifolia) are the dominant tree species. Above 4,500 ft., the forest transitions to subalpine krummholz vegetation, where black spruce (*Picea mariana*) becomes an important component of the community. A distinctive form of natural disturbance within the balsam fir forest is a pattern of wind-induced mortality known as “fir-waves.” Fir waves are linear patches of blown-down or standing dead trees oriented perpendicular to the prevailing wind, and

arranged in a progression of waves of different ages of resulting regeneration adjacent to one another.
Decreasing in elevation, high-elevation spruce - fir forests are generally found between 2,500 and 3,500 ft. on upper mountain slopes and ridge tops, but may be higher or lower depending on local site conditions. The characteristic tree species in this community are red spruce (*Picea rubens*) and balsam fir, along with heart-leaved paper birch, paper birch (*Betula papyrifera*), and yellow birch (*B.alleghaniensis*).

At elevations between 2,100 and 2,800 ft. is the northern hardwood - spruce - fir forest, a transitional community between the high-elevation spruce - fir forest above and the sugar maple - beech - yellow birch forest below. This forest type is characterized by a variable mixture of red spruce, balsam fir, yellow birch, American beech (*Fagus grandifolia*), and sugar maple (*Acer saccharum*). While the boundary between high elevation spruce – fir forest and northern hardwood – conifer forest habitats can be ambiguous, examples of this community that are likely to maintain a mixed composition over the long term are probably most closely aligned with the hardwood forests below, because the northern hardwoods have not been excluded by the climatic and poorer soil conditions closely associated with their disappearance at higher elevations in the high-elevation spruce - fir forest.

Habitats that may be embedded in high elevation spruce - fir forests include alpine communities, rocky ridges, cliffs, talus slopes and landslides, and high elevation wetlands. See associated profiles.

Justification (Reason for Concern in NH)

High elevation spruce - fir forest has a very limited distribution in New Hampshire, covering between 4 and 6% of the state's land area (Publicover et al. 2015). This forest type supports 66 vertebrate species in the state, including 2 amphibians, 2 reptiles, 38 birds, and 24 mammals. Threatened and endangered wildlife using this forest type include Canada lynx and American marten. Blackpoll warblers and Bicknell's thrush breed exclusively in high elevation spruce - fir habitats. Other species that use high elevation habitat and may be less common at lower elevations include spruce grouse, boreal chickadee, white-winged crossbill, and American three-toed woodpecker. Common species that use the spruce - fir cover at high elevations include moose, deer, bear, fisher, and common raven. Moose tend to winter at higher elevations where they browse on fir, mountain ash, and yellow birch. Black bears will use these stands for escape, denning, or even resting cover. High elevation ridgelines also serve as important migratory routes for songbirds, raptors, and bats.
High elevation spruce - fir provides some of the last areas relatively free of human disturbance. Furthermore, due to conservation efforts and poor accessibility, the high elevation areas represent some of the last large, remote, contiguous blocks of spruce - fir habitat. Silviculture practices resulting from budworm harvests and the historic high value of spruce - fir and/or mill demands that have been placed on spruce - fir have dramatically affected spruce - fir distribution at lower elevations, thus making high elevation habitat that much more important (Staats 1996).
Lastly, soil cover at these higher elevations is much more fragile (i.e., soil compaction can dramatically reduce the ability of the soil absorb extra moisture) than that found at lower elevations. Soils above 2,700 ft. are usually very acidic, resulting in reduced nutrient availability to plants. Increased rainfall, snowfall, and moisture absorption capabilities of high elevation soils (due to the higher organic components) also make them a prime area for water filtration and water supply.

Protection and Regulatory Status

Approximately 89% of New Hampshire's high elevation spruce - fir forest occurs on conservation

lands. Current protection for high elevation spruce - fir includes a no-cut zone above 2,700 ft on state lands and Forest Service property and private conservation lands (Bunnell Tract and The Nature Conservancy), zoning ordinances (PD6 zones) in unincorporated towns, the cooperative High Elevation MOU for large landowners developed by NHFG and DRED, a conservation easement (held by DRED), and finally an MOU between the WMNF and NHFG pertaining to the management of wildlife habitats.

Distribution and Research

High elevation spruce - fir habitat occurs in the White Mountain, Mahoosuc-Rangeley, and Connecticut Lake ecological subsections. High elevation spruce - fir can also occur locally at higher elevations of the Vermont Uplands subsection in central/south-central New Hampshire. The majority of this forest type is found within the White Mountain subsection.
Distribution research should concentrate on the area of high elevation spruce - fir forest that has experienced harvesting within the past 20 years, the long-term impacts of harvesting on forest structure and species composition, the overall effectiveness of the High Elevation MOU, and the effects of acid deposition and global warming on the distribution and abundance of high elevation spruce - fir.

Relative Health of Populations

Historically, extensive alteration and harvesting occurred throughout the distribution of high elevation spruce - fir. Current habitat under federal or state ownership is protected from further harvesting, while parcels that remain under private ownership exhibit extensive impacts from recent harvesting.

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

Habitat Management Status:

Habitat management and restoration policy in the WMNF and virtually all state and conservation land is to allow natural succession to regenerate as much of the historical spruce - fir area as possible. Timber harvesting is still proposed under private land ownerships, with little to no effort to maximize spruce - fir regeneration after harvesting.

Threats to this Habitat in NH

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.

Habitat degradation from insect pests (Balsam wooly adelgid, spruce budworm) (Threat Rank: High)

There are a number of native and non-native insect pests that have the potential significantly impact high elevation spruce fir forests including spruce budworm and balsam woolly adelgid. Both forest pests could drastically reduce the amount of fir on the landscape, especially at lower elevations. Spruce budworm is projected to increase over the next ten years and we are already seeing impacts from small infestations of balsam woolly adelgid on the landscape in northern New Hampshire. Some are projecting that the spruce budworm will have a greater impact on higher elevation fir as a result of prolonged warmer temperatures, allowing the insect to complete its lifecycle at higher elevations than the previous outbreak. Similarly, balsam wooly adelgid is often controlled due to prolonged periods of cold temperatures in the winter, which have been reduced as a result of climate change.

The impacts of balsam woolly adelgid and spruce budworm are well documented (Ragenovich and Mitchell 2006; Kucera and Orr 1981).

Habitat impacts and conversion due to unfavorable conditions for spruce-fir to move into the alpine zone which allows replacement by hardwoods (Threat Rank: Medium)

Habitat degradation and impacts (fragmentation) from increased demand for wind power and associated transmission lines (Threat Rank: Medium)

Habitat conversion and degradation of forest to permanent openings and infrastructure, fragmentation, and disturbance to wildlife by visitor activity (Threat Rank: Medium)

Development such as roads, ski slopes, and energy and communication infrastructure reduce the matrix forest habitat by converting forests to permanent openings. Development also contributes to forest fragmentation and shifting wildlife community composition, especially during winter months. Roads and compacted surfaces exposed to wind and weather events allow competing species and predator access to historically isolated habitats resulting in overlap in distribution and home ranges that were historically partitioned.

While development in this habitat is limited, a variety of facilities have been documented, including roads, ski areas, wind power facilities and transmission lines, communication towers, and other recreational facilities (hiking huts) (Publicover and Kimball 2011).

Habitat conversion and impacts to wildlife from fragmentation associated with renewable energy development (Threat Rank: Medium)

High elevation spruce-fir forests are often regenerated through natural processes such as fir waves, wind throw and natural gap dynamics. When development occurs that can exacerbate the effects of the natural system dynamics it can create an imbalance of habitat structure over time. For example, fragmenting a large patch of high elevation spruce - fir with a wide road can impact the natural movement of a fir wave across a slope. This can also cause additional blow down which then creates a

much larger gap within the forest than would typically occur with a natural disturbance.
Within the past 10 years, there have been 3 large scale wind energy facilities constructed in New Hampshire. These facilities include wind turbines that are approximately 400 feet tall, which can pose a significant 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).

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)

Potential impacts of hiking and biking trails include soil compaction and loss, reduced soil moisture, loss of organic litter, loss of ground cover vegetation, loss of native plant species, introduction of weeds and pathogens, and change in vegetation composition (Pickering et al. 2010).

Even low-impact, dispersed recreation has the potential to have serious effects on wildlife (Reed & Merenlender 2008). Mountain biking has become a popular recreation activity in New Hampshire. The New England Mountain Biking Association has over 5,000 members and 5 local chapters in New Hampshire (http://www.nemba.org/about). While anecdotal evidence suggests that the intensity of mountain biking activity has increased in New Hampshire in recent years, there is currently no documentation of impacts to wildlife or habitat.

List of Lower Ranking Threats:

Species and habitat impacts from species composition changes related to climate change

Habiat impacts from increased temperatures that reduce seed production in some species (balsam fir)

Habitat degradation from mercury deposition

Habitat degradation from acid deposition

Habitat degradation from introduced or invasive plants

Habitat degradation and mortality from legal and illegal OHRV and snowmobile activity

Disturbance and habitat degradation from hiking and biking trails

Habitat degradation from forestry practices that cause a loss of natural age structure, soil compaction and erosion

Habitat degradation from temperature stress

Habitat conversion resulting from decisions on land use and management

Actions to benefit this Habitat in NH

Advise Site Evaluation Committee on wind energy facilities

Primary Threat Addressed: Habitat conversion and impacts to wildlife from fragmentation associated with renewable energy development

Specific Threat (IUCN Threat Levels): Energy production & mining

Objective:
No net loss or impact on high elevation spruce-fir.

General Strategy:
Examining potential long and short-term implications of wind farm development and maintenance will aid in making decisions and recommendations dealing with wind farm proposals at local, state, regional and a national level.

Political Location:
Coos County

Watershed Location:
Androscoggin-Saco Watershed

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2005 Authors:
Carol R. Foss, NHA

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