HIGH-ELEVATION SPRUCE-FIR FOREST IN THE NORTHERN FOREST: AN ASSESSMENT OF ECOLOGICAL VALUE AND CONSERVATION PRIORITIES

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ABSTRACT

High-elevation habitats are a limited yet critical component of the northeastern landscape. They provide the primary habitat for Bicknell’s thrush, the northeast’s rarest migratory songbird and a species of highest conservation concern, as well as other species of conservation concern. They are likely to provide refugia for spruce-fir-dependent species in a future warmer climate. While the overall level of conservation of these areas is high relative to other parts of the landscape, significant areas remain unconserved. Evaluation, prioritization and conservation of the most important areas is an objective of many state and regional wildlife conservation plans.

This project seeks to assess the relative ecological value, conservation status and current condition of high-elevation areas across the region to guide future conservation efforts. The project will: 1) delineate all discrete blocks of land above 2700 feet in New England and New York; 2) assess the conservation status of each area; 3) assess the ecological significance and current condition of each area based on available GIS data and aerial photography; 4) identify potential undocumented occurrences of rare subalpine (balsam fir-heartleaved paper birch) forest natural; 5) rank areas to identify the most ecologically significant unconserved areas; 6) evaluate the threat to these areas from commercial wind power development; and 7) identify potential conservation strategies for these areas.

Keywords: mountains, high elevation, subalpine forest, Bicknell’s thrush, wind power.

1. Introduction

High-elevation habitats are a very limited yet critical component of the northeastern landscape, specifically identified in numerous state and regional wildlife conservation plans. They are the most natural and least impacted parts of a region with a long history of human use. They provide the primary habitat for Bicknell’s thrush, the northeast’s rarest migratory songbird and a species of highest conservation concern, as well as numerous other species of conservation concern. They are also likely to provide refugia for spruce-fir-dependent species in a future warmer climate as this habitat is projected to significantly decline at lower elevations. While the overall level of conservation of these areas is high relative to other parts of the landscape, significant areas (especially in northern New Hampshire and western Maine) remain unconserved. These areas have been a target for wind power development, with multiple projects constructed, permitted or planned. Inappropriately sited wind power projects threaten to degrade this critical habitat (a threat recognized in all the wildlife conservation plans).

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The goal of this project is to assess the ecological condition and conservation value of the numerous distinct islands of high-elevation spruce-fir forest across New England and New York (both as current habitat and as potential climate change refugia) in order to prioritize conservation of remaining unprotected areas and reduce conflict over development of these areas (specifically for wind power). The supporting objectives are to:

- assess the size, conservation status, land-use history, current condition, significant identified ecological resources and relationship to identified regional conservation priorities for each distinct area above 2700 feet elevation;
- identify potential undocumented areas of rare balsam fir-heartleaved birch subalpine forest not currently documented in state Natural Heritage databases;
- assess the value of these areas as refugia for spruce-fir forest in a future changed climate;
- assess the relative importance of these areas to an overall regional conservation strategy and their value as potential mitigation sites for development in other high-elevation areas;
- provide information in support of goals and objectives of state wildlife action plans.
- propose proactive strategies to policy makers on how to address the conflicts between development and conservation of these areas.

1.1 Habitat Value of High-Elevation Areas

High-elevation coniferous forest is recognized as a distinct habitat in a wide range of state wildlife action plans and regional bird conservation plans, including:

- Atlantic Coast Joint Venture, Atlantic Northern Forest region (Dettmers 2003) – *Mountaintop Forest/Woodland*.

New York’s Comprehensive Wildlife Conservation Strategy does not provide a similar categorization of habitat, but recognizes “high altitude conifer forest birds” as a distinct guild. The extent of high-elevation habitat in Massachusetts is too small to be specifically characterized.

Some of these plans (New Hampshire and Vermont) designate the broader extent of high-elevation spruce-fir forest, while others (Maine, PIF, ACJV) focus on the higher-elevation subset of spruce-fir forest commonly called “subalpine forest” (National Vegetation Classification Standard Abies balsamea - Betula papyrifera var. cordifolia [balsam fir – heartleaved paper birch] Forest). This natural community is classified as rare (S3) by Natural Heritage Programs in the four Northern Forest states.
The primary wildlife species of concern associated with high-elevation coniferous forest is Bicknell’s thrush. This species is endemic to this habitat from the Catskill Mountains to northern Maine (and at lower elevations in maritime Canada). It has one of the most restricted breeding ranges of any North American bird, has been called “perhaps the highest priority for conservation planning” by Partners in Flight (Rosenberg and Hodgman 2000), and is being considered for federal Threatened or Endangered listing by the U.S. Fish and Wildlife Service. However, there are other species of concern associated with this habitat in one or more of the wildlife conservation plans, including blackpoll warbler, spruce grouse, boreal chickadee, white-winged crossbill, three-toed woodpecker, purple finch, olive-sided flycatcher, bay-breasted warbler, northern bog lemming, American marten and Canada lynx.

Many of these plans recommend prioritization and conservation of the most significant areas of high-elevation forest, with a particular focus on Bicknell’s thrush. For example:

- Maine Comprehensive Wildlife Conservation Strategy: “Identify and characterize (habitat size, quality, and ownership) all potential habitat patches and prioritize these”; “Initiate efforts to officially recognize Bicknell’s Thrush and mountaintop habitat as a high conservation priority in public agency and private land-use planning efforts”.
- New Hampshire Wildlife Action Plan: “The ecological response objective is no net loss or impact on high elevation spruce-fir”.
- Partners in Flight Area 28 Landbird Conservation Plan: “Ensure the protection of 100% of sites that support populations of Bicknell's Thrush large enough to be considered source populations for other sites, and as many additional high-elevation habitat patches with smaller populations as possible.”
- Atlantic Coast Joint Venture Region 14 Bird Conservation Plan: “Secure protection for core population areas in Maritimes and Maine “.

1.2 Climate Adaptation Value of High-Elevation Areas

The extent of suitable conditions to support spruce-fir forest in the northeast is expected to decline significantly over the next century (Frumhoff et al. 2007, Tang and Beckage 2010). Tang and Beckage (2010) state:

“Under all scenarios, boreal conifer forest is projected to contract to mountain ranges and to the region centered on the corner of northern New Hampshire and northwestern Maine by 2085… Our simulations indicate that the boreal conifer forest may still persist in New England in the late 21st century under some scenarios but its distribution will contract to the ranges of mountains.”

It is important to note that these sources model the climatic conditions suitable to support this type, and not the actual future vegetation distribution, as there is a lag between climate change and the spatial response of vegetation. There are also numerous additional factors that govern the adjustment of vegetation to a changing climate that are not accounted for in these models.

While popular wisdom holds that vegetation will respond to future changes in climate parameters (particularly temperature) in similar fashion both latitudinally and elevationally (with species
ranges rising in elevation and high-elevation communities disappearing), both paleoecological evidence and recent research indicate that high-elevation vegetation may be more resistant to a changing climate than lower-elevation vegetation. In a study of post-glacial vegetation changes in the White Mountains, Spear (1989) found that during the major post-glacial Hypsithermal warming period (5,000 to 9,000 YBP) high elevation forests showed little change during a time when low-elevation spruce-fir forest was greatly reduced, and stated:

“The ecotones between the subalpine spruce-fir and fir forest, and the fir forest and alpine meadow, have not changed altitude much over the last 10,000 years and do not appear to be sensitive to climate change…In contrast to the continual changes in the vast lowland forests surrounding the White Mountain peaks, the high elevations have been remarkably stable. Changes in the lowland forest have had virtually no impact on the subalpine fir forest and alpine meadow.”

Recent research on the historic climate of the Presidential Range of New Hampshire indicates that while significant changes in both certain climatic parameters (Seidel et al. 2010) and the timing of alpine plant flowering (Kimball et al. in prep.) consistent with a warming climate have occurred at high elevations, these changes are much smaller than those observed at lower elevations. These studies reinforce the belief that high-elevation vegetation is to some degree uncoupled from and more resistant to the changes in temperature that are expected to occur over the next century than are lower elevations. The distribution of high-elevation communities in the northeast appears to be governed less by temperature than by other factors such as a high level of immersion in clouds and fog and disturbance caused by wind and icing (Seidel et al. 2010).

The likelihood that spruce-fir forest will be a greatly diminished part of the future northeastern landscape, and its ability to persist at higher elevations in the face of climate change, emphasizes the need to maintain the integrity of high-elevation forests as potential refugia for spruce-fir dependent species.

2. Methods

This project utilizes the following methodology to identify and assess the status and conservation value of high-elevation areas:

Delineation of study units: Areas above 2700 feet in elevation across Maine, New Hampshire, Vermont, Massachusetts and New York were identified from USGS 30-meter Digital Elevation Model data. Contiguous areas were converted to ArcView shapefile polygons, with boundaries smoothed to avoid the jagged boundaries associated with raster pixels.

Assessment of conservation status: Publicly-available data on conservation lands for each state was used to determine the proportion of each area conserved through public ownership, non-profit ownership and conservation easement.

Current condition: The current condition of each area was assessed in two areas:
- Development. Existing development in each area was delineated on 2009 National Agricultural Imagery Program (NAIP) digital imagery. A variety of sources were used to identify the nature of the development.

- Timber harvesting. Areas showing evidence of timber harvesting since 1975 were identified from a range of sources, including 2009 NAIP imagery, historical Google Earth Imagery, and the ESRI ChangeMatters web site. Areas showing evidence of harvesting prior to 1975 was also delineated, though because of vegetative regrowth this delineation significantly underestimates the extent of earlier harvesting, and pre-1975 harvest data was not used in the subsequent evaluation.

**Delineation of subalpine forest occurrences**: Documented occurrences of this community on public lands in Maine were obtained from the Maine Natural Areas Program. Potential occurrences in other states, and on non-public lands in Maine, were delineated from 2009 NAIP digital imagery.

**Other ecological values**: The overlap of high-elevation areas with other ecological values was assessed using data obtained from various sources including:

- Elevation range. Derived from USGS Digital Elevation Model data.
- Rare plant and natural community element occurrences (EOs). Data on EOs was obtained from state Natural Heritage databases. Because of data restrictions of these programs, data represents the number of plant and community EOs occurring within each high-elevation polygon.
- Potential Bicknell’s thrush habitat. Developed by Vermont Center for Ecostudies (Lambert et al. 2005).
- Documented occurrences of Bicknell’s thrush. Obtained from Vermont Center for Ecostudies Mountain Bird Watch database.
- Contiguous blocks of spruce-fir forest. Derived from National Land Cover Database (NLCD).
- Large roadless areas. Roadless areas greater than 5,000 acres were delineated following the procedures and criteria set forth in (Publicover and Poppenwimer 2002). Current NAIP imagery was used to update previously delineated areas and areas beyond the extent of the previous study.
- Priority summit ecosystems. Obtained from The Nature Conservancy’s Northern Appalachian/Boreal Ecoregional Assessment (Anderson et al. 2006).
- High value habitats. Habitat focus areas from the Maine Comprehensive Wildlife Conservation Strategy and highest value habitat from the New Hampshire Wildlife Action Plan; equivalent delineations for the other states are not available.

One of the limitations of this assessment is that some of these data sources are not comprehensive across all areas. In particular, data on Natural Heritage Inventory element occurrences and documented Bicknell’s thrush occurrences is limited by the fact that surveys have not been undertaken in all areas.
Climate change adaptation value: The adaptation value of each high-elevation area will be assessed by reference to data developed by The Nature Conservancy’s Resilient Sites for Terrestrial Conservation in the Northeast and Mid-Atlantic Region analysis (Anderson et al. 2012). Use of the TNC data allows areas to be evaluated not as isolated units but as a component of the broader surrounding landscape.

Combined ranking and assessment of high-elevation areas: Data on the condition and ecological values of each area will be combined into a single evaluation rating system that allows the relative significance of the areas to be determined. While this type of ranking system involves some degree of subjectivity (both in the choice of data to include and the manner in which they are quantified), it has previously used in a variety of resource evaluations, including the Maine Wildland Lakes Assessment (LURC 1987), the Maine Rivers Study (MDOC 1982), and previous AMC research on high-elevation ridgelines (Publicover et al. 2011). The results will be used to identify the most ecologically significant unconserved areas, and their value relative to other areas that are already conserved.

In addition, the data will be made available in an on-line Google Earth application intended to serve as an initial site screening tool for wind power development, following guidelines developed by the U.S. Fish and Wildlife Service.

3. Results

Data compilation and analysis for this project is on-going; what follows is a summary of results to date.

3.1 Extent of areas

There are an estimated 766,974 acres (1,198 square miles) of land above 2700 feet elevation across the five states, comprising about 1.2% of the land area of these states (Figure 1, Table 1). Extensions of areas in New Hampshire and Maine across the Canadian border encompass an additional 10,839 acres. New York has the greatest extent of high-elevation land (nearly 300,000 acres), while New Hampshire has the greatest proportion of high elevation land (4%).

<table>
<thead>
<tr>
<th>State</th>
<th>Acres</th>
<th>% of state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>139,222</td>
<td>0.7%</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>228,787</td>
<td>4.0%</td>
</tr>
<tr>
<td>Vermont</td>
<td>98,418</td>
<td>1.7%</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>1,866</td>
<td>0.0%</td>
</tr>
<tr>
<td>New York</td>
<td>298,679</td>
<td>1.0%</td>
</tr>
<tr>
<td>Total (U.S. only)</td>
<td>766,974</td>
<td>1.2%</td>
</tr>
<tr>
<td>Canada*</td>
<td>10,839</td>
<td></td>
</tr>
</tbody>
</table>

*Extension of areas across Maine and New Hampshire borders
There are numerous small areas (which in most cases will be relatively indistinguishable in an ecological sense from the upper slope forest below 2700 feet) and a much smaller number of large areas, which possess the defining characteristics of high-elevation ecosystems. Of the over 1000 distinct areas delineated in this study, nearly two-thirds are less than 10 acres in size, which collectively encompass only about 0.2% of the total high-elevation area (Table 2). At the other end of the scale, the 39 areas greater than 5,000 acres in size encompass over 60% of the high elevation land. These areas are well-distributed across the region, with twelve in the Adirondacks, ten in New Hampshire (nine of which are in the White Mountain National Forest), eight in Maine, five in the Catskills and four in Vermont. The fourteen areas greater than 10,000 acres in size encompass many of the iconic mountainous regions in the northeast (Table 3).

Table 2. Distribution of high-elevation areas by size class (including Canada).

<table>
<thead>
<tr>
<th>Size class (ac.)</th>
<th>Number of areas</th>
<th>Total area (ac.)</th>
<th>% of area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 10</td>
<td>272</td>
<td>1,242</td>
<td>0.2%</td>
</tr>
<tr>
<td>11 - 100</td>
<td>372</td>
<td>13,858</td>
<td>1.8%</td>
</tr>
<tr>
<td>101 - 500</td>
<td>202</td>
<td>50,820</td>
<td>6.5%</td>
</tr>
<tr>
<td>501 - 1000</td>
<td>50</td>
<td>34,872</td>
<td>4.5%</td>
</tr>
<tr>
<td>1001 - 2500</td>
<td>55</td>
<td>85,155</td>
<td>10.9%</td>
</tr>
<tr>
<td>2501 - 5000</td>
<td>34</td>
<td>108,714</td>
<td>14.0%</td>
</tr>
<tr>
<td>5001 - 10000</td>
<td>25</td>
<td>165,208</td>
<td>21.2%</td>
</tr>
<tr>
<td>&gt;100000</td>
<td>14</td>
<td>317,944</td>
<td>40.9%</td>
</tr>
<tr>
<td>Total</td>
<td>1,024</td>
<td>777,813</td>
<td></td>
</tr>
</tbody>
</table>

3.2 Conservation Status

Across the region 83% of land above 2700 feet has some form of conservation protection, with over three-quarters in public ownership and smaller amounts conserved through non-profit ownership or conservation easement (Table 4). Over 95% of the high-elevation land in New Hampshire, Massachusetts and the Adirondacks, and over 80% in Vermont and the Catskills is conserved. Maine is the outlier in terms of high-elevation land conservation, with only 47% of the area conserved and less than one-third in public ownership. The greatest expanse of unconserved high-elevation land is across the Western Mountains region of Maine and adjacent northern New Hampshire (Figure 2).

Of the fourteen areas over 10,000 acres, eleven are at least 95% conserved (Table 3), with two others at least 80% conserved. The exception is the Sugarloaf/Abraham/Crocker region in Maine; this is the largest expanse of high elevation land in the state but only 22% of the area is currently conserved. (Another 9% is owned by the U.S. Navy as a wilderness survival training base.)
### Table 3. High-elevation areas over 10,000 acres in size.

<table>
<thead>
<tr>
<th>Name of area</th>
<th>State</th>
<th>Size (ac.)</th>
<th>% conserved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adirondack High Peaks</td>
<td>NY – Adirondack SP</td>
<td>50,419</td>
<td>100%</td>
</tr>
<tr>
<td>Presidential Range</td>
<td>NH – WMNF</td>
<td>43,320</td>
<td>100%</td>
</tr>
<tr>
<td>Franconia Range/Pemigewasset No.</td>
<td>NH - WMNF</td>
<td>32,353</td>
<td>100%</td>
</tr>
<tr>
<td>Pemigewasset So./Sandwich Range</td>
<td>NH - WMNF</td>
<td>25,607</td>
<td>100%</td>
</tr>
<tr>
<td>Graham/Doubletop mountains</td>
<td>NY – Catskill SP</td>
<td>23,504</td>
<td>81%</td>
</tr>
<tr>
<td>Sugarloaf/Abraham/Crocker</td>
<td>ME</td>
<td>20,802</td>
<td>22%</td>
</tr>
<tr>
<td>Carter Range</td>
<td>NH - WMNF</td>
<td>17,384</td>
<td>100%</td>
</tr>
<tr>
<td>Mount Katahdin</td>
<td>ME – Baxter SP</td>
<td>17,304</td>
<td>100%</td>
</tr>
<tr>
<td>Kilkenny Range</td>
<td>NH - WMNF</td>
<td>16,144</td>
<td>98%</td>
</tr>
<tr>
<td>White Cap/Kennebago Divide*</td>
<td>ME</td>
<td>15,904</td>
<td>84%</td>
</tr>
<tr>
<td>Slide Mountain</td>
<td>NY – Catskill SP</td>
<td>15,470</td>
<td>99%</td>
</tr>
<tr>
<td>Dix Mountain</td>
<td>NY – Adirondack SP</td>
<td>13,789</td>
<td>96%</td>
</tr>
<tr>
<td>Pemigewasset East</td>
<td>NH - WMNF</td>
<td>13,428</td>
<td>99%</td>
</tr>
<tr>
<td>Glastenbury Mountain</td>
<td>VT - GMNF</td>
<td>12,517</td>
<td>99%</td>
</tr>
</tbody>
</table>

*8,479 acres in the United States; proportion conserved is for U.S. area only.

### Table 4. Proportion of high-elevation land conserved by category.

<table>
<thead>
<tr>
<th></th>
<th>Public</th>
<th>Non-profit</th>
<th>Easement</th>
<th>Total conserved</th>
<th>Other private</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>32%</td>
<td>0%</td>
<td>15%</td>
<td>47%</td>
<td>53%</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>87%</td>
<td>4%</td>
<td>4%</td>
<td>95%</td>
<td>5%</td>
</tr>
<tr>
<td>Vermont</td>
<td>77%</td>
<td>1%</td>
<td>5%</td>
<td>83%</td>
<td>17%</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>98%</td>
<td>0%</td>
<td>0%</td>
<td>98%</td>
<td>2%</td>
</tr>
<tr>
<td>New York</td>
<td>87%</td>
<td>1%</td>
<td>3%</td>
<td>91%</td>
<td>9%</td>
</tr>
<tr>
<td>Adirondacks</td>
<td>91%</td>
<td>1%</td>
<td>4%</td>
<td>97%</td>
<td>3%</td>
</tr>
<tr>
<td>Catskills</td>
<td>79%</td>
<td>0%</td>
<td>1%</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Total</td>
<td>76%</td>
<td>2%</td>
<td>6%</td>
<td>83%</td>
<td>17%</td>
</tr>
</tbody>
</table>

3.3 Development

Notwithstanding that high-elevation areas are generally the most “pristine” parts of the northeastern landscape, some areas have seen a relatively high level of human impact, including some of the region’s highest and most significant mountains (such as Mount Washington, Mount Mansfield and Whiteface Mountain. Some of this development dates back to the nineteenth century (e.g. Mount Washington) or the Civilian Conservation Corps era of the 1930s. In the decades following World War II the development of downhill ski areas was the most significant impact to high-elevation areas, while in recent years commercial wind power development has had the greatest impact.
Of the 765 areas at least ten acres in size, 68 have some type of development that could be discerned on the NAIP imagery. (Some areas have more than one type of development.) This includes:

- Ten areas with significant roads (not including logging roads), including one public highway (the Kancamagus Highway) and five public summit access roads (Mount Washington, Mount Mansfield, Equinox Mountain, Whiteface Mountain and Mount Utsayantha).
- Thirty-four areas with downhill ski areas. Together these areas encompass over 9,000 acres of high-elevation land (more than 1% of the total).
- Eight areas with commercial wind power development encompassing three active facilities (Kibby, Granite Reliable and Searsburg) and one abandoned project (Little Equinox Mountain).
- Seven areas with mixed uses (generally recreation and communications), including the summit complexes on Mount Washington, Whiteface Mountain and Mount Greylock.
- Eight areas with recreational facilities (such as AMC’s huts in the White Mountains).
- Six areas with lookout towers.
- Nine areas with utility corridors.
- Seven areas with residential development (all but one of which are in the Catskills).
- Four areas with communications facilities.
- Six areas with miscellaneous other development (including the Mount Washington Cog Railway, a garnet mine in the Adirondacks and a Buddhist monastery in the Catskills).

3.4 Timber harvesting

In most areas timber harvesting at high elevations is severely limited by difficult topography, low timber value and the high level of conservation ownership. Across the region over 29,000 acres of high-elevation land (3.8% of the total) showed evidence of harvesting since 1975 (Table 5). Over three-quarters of this acreage was located on private land in western Maine and northern New Hampshire (including land covered by conservation easement), which is primarily the domain of large commercial timber companies. About 14.9% of private land across the region (and over 20% in Maine) showed evidence of harvesting. In contrast, only 0.6% of public and non-profit land showed evidence of harvesting, some of which occurred prior to public or non-profit acquisition.

The concentration of high-elevation harvesting on large commercial ownerships is illustrated by the fact that three-quarters of all the harvested acreage across the region occurred on just eleven large (>1,000 acres) high-elevation areas under these ownerships. These include Saddleback/Sugarloaf/Crocker (which alone accounted for 20% of the high-elevation harvest acreage across the entire region), White Cap/Kennebago Divide, Bemis/Elephant/Old Blue, West Kennebago Mountain, East Kennebago Mountain, Cow Ridge and Heather Mountain in Maine; Bunnell Mountain, Crystal Mountain and Stub Hill in New Hampshire; and Seneca Mountain in Vermont.
Table 5. Extent of high-elevation land harvested since 1975.

<table>
<thead>
<tr>
<th></th>
<th>Public and non-profit ownership</th>
<th>Private land (incl. easements)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acres</td>
<td>%</td>
<td>Acres</td>
</tr>
<tr>
<td>Maine</td>
<td>652</td>
<td>1.4%</td>
<td>18,716</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>2,404</td>
<td>1.2%</td>
<td>3,823</td>
</tr>
<tr>
<td>Vermont</td>
<td>426</td>
<td>0.6%</td>
<td>2,642</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
</tr>
<tr>
<td>New York</td>
<td>332</td>
<td>0.1%</td>
<td>233</td>
</tr>
<tr>
<td>Total</td>
<td>3,815</td>
<td>0.6%</td>
<td>25,413</td>
</tr>
</tbody>
</table>

3.5 Assessment of Conservation Priorities

The comprehensive assessment across the entire region is underway; what follows is a general preliminary assessment for Maine.

There are 36 areas in Maine at least 500 acres in size. Nearly all of these areas contain documented or potential occurrences of subalpine forest, though the size of these occurrences varies widely. However, other values show wide variation across these areas.

At one end of the scale are those areas that comprise the state’s most recognized high value mountain regions. Four areas in the Mahoosuc (Mahoosuc, Old Speck, Baldpate and Sunday River Whitecap), two in the Western High Mountains (Saddleback and Bigelow) and two in Baxter State Park (Katahdin and Traveler) share most if not all of the following characteristics: mostly or entirely within large roadless areas, little to no harvesting since 1975 (though Saddleback does have ski area development), large occurrences of subalpine forest, documented presence of Bicknell’s thrush, the presence of TNC priority summit ecosystems, and inclusion in Maine Comprehensive Wildlife Conservation Strategy focus areas. Not surprisingly, all of these areas have a high level of conservation protection, though only five of the eight are completely conserved. The only other area that shares these characteristics is Tumbledown Mountain (T6 North of Weld).

The Sugarloaf/Abraham/Crocker region also contains these high value resources (as well as six of the state’s fourteen peaks over 4000 feet in elevation), but has a much higher level of human impact (extensive harvesting as noted previously as well as ski area development) and a lower level of conservation. Despite the high level of human impact, nearly half of the area remains within large roadless areas.

Of the remaining areas, there are only five that lie mostly within large roadless areas and show little or no evidence of harvesting since 1975: Bear Mountain in the Mahoosucs, Whitecap and Baker/Lily Bay mountains in the 100-Mile Wilderness, and Snow and Boundary Bald Mountains in the Boundary Mountains. Whitecap and Snow have documented Bicknell’s thrush activity, and Boundary Bald contains a TNC priority summit ecosystem. Bear, Whitecap and Baker/Lily Bay are all more than 50% conserved.
The remaining areas lie primarily in the Boundary Mountains. The southern Boundary Mountains (between the New Hampshire border and the Chain of Ponds area, including most notably Kennebago Divide, East and West Kennebago mountains, Cow Ridge and Snow Mountain) have a higher level of conservation protection (through the Pingree and Boundary Headwaters easements) but are characterized by fairly high levels of timber harvesting (see previous discussion). The northern Boundary Mountains (between the Chain of Ponds and the Moose River, including most notably the Caribou, Kibby and Tumbledown mountain areas) has very little conservation protection but a much higher level of ecological integrity, with more extensive potential occurrences of subalpine forest and very little impact from timber harvesting\(^2\). (The exception is the presence of the Kibby wind power project and the permitted expansion on to Sisk Mountain, which lie on the southern edge of this region.)

Within the Boundary Mountains, the Vermont Center for Ecostudies Mountain Bird Watch database documents the presence of Bicknell’s thrush only on Snow and West Kennebago mountains, though this may reflect lack of survey in other areas rather than the absence of the species. Bicknell’s thrush were documented on both Kibby and Sisk mountains in consultant surveys for the wind power developments on these mountains, though these observations are not included in the VCE database. However, in a preliminary assessment of the potential of the Boundary Mountains region to support Bicknell’s thrush, VCE found that the northern Boundary Mountains region had a much higher “probability of occurrence” of this species than the areas to the south (McFarland and Rimmer undated, slide 31). The Atlantic Coast Joint Venture regional bird conservation plan (Dettmers 2006) identifies Snow and Kibby mountains (along with the Saddleback-Sugarloaf region) as landbird habitat focus areas due to the presence of Bicknell’s thrush. (Mont Gosford, within the Canadian portion of the Kennebago Divide area, is also a focus area.)

4. Discussion

4.1 The History and Pattern of Mountain Land Conservation

The northeast’s mountains have been a focus of regional conservation efforts since the late 19th century, primarily due to their scenic and recreational values and their relatively low value for settlement and agriculture. Significant portions of the White Mountain and Green Mountain national forests and Adirondack, Catskill and Baxter state parks (as well as other significant peaks such as Mount Mansfield and Camel’s Hump in Vermont, Mount Monadnock in New Hampshire and Mount Greylock in Massachusetts) were conserved prior to World War II.

Conservation of significant mountain regions has continued to this day, with greater attention to the ecological values of high elevation areas in recent years. Among the notable additions to high-elevation land conservation in recent decades are the Jay State Forest in Vermont; the Nash Stream State Forest and Bunnell Preserve in New Hampshire; the Mahoosuc, Bigelow,

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\(^2\) In an earlier assessment of high-elevation ridgelines in Maine (Publicover et al. 2011), a number of ridgelines in the northern Boundary Mountains were characterized as lying within large roadless areas. This was based on delineations of these areas in 2000. Subsequent harvesting at lower elevations has reduced the extent of these areas to the point where they no longer meet the 5,000 acre threshold, though the high-elevation areas have remained unaffected.
Tumbledown Mountain and Big Spencer tracts in Maine; and lands along the Long Trail in Vermont and the Appalachian Trail in New Hampshire and Maine. The large conservation easements of the late 1990s and early 2000s (including the Champion lands easement in Vermont, the Connecticut Headwaters easement in New Hampshire and the Pingree easement in Maine) protected additional high-elevation areas from development, though harvesting is still allowed.

Despite this extensive history, significant areas of high elevation land remain unconserved. Documenting the values of these areas in order to guide future conservation priorities is a major goal of this project. There are over two dozen contiguous unconserved blocks of high-elevation land over 1,000 acres in size across the region. Not all of these are appropriate targets for conservation, as some contain extensive development (primarily ski areas but also wind power). However, others have significant ecological value and should be considered for conservation. The current priority for high-elevation conservation is the Saddleback/Abraham/Crocker region in Maine, the largest high-elevation area in the state and the greatest expanse of mostly unconserved high-elevation land in the northeast. Because of its recognized ecological, recreational and scenic importance this area is currently the focus of a high level of conservation attention with multiple projects underway.

Throughout the long history of mountain conservation in the northeast, the Boundary Mountains region, stretching along the western border of Maine and Canada into northern Coos County, NH, has been the one range that has received little conservation attention. There are several reasons for this, including the lack of public road access and the relatively gentler terrain. The region does not possess the spectacular topography or prominent summits of the region’s better-known ranges, with no area rising above 4000 feet and very few maintained recreational trails. Ownership of this region was long dominated by commercial paper companies. Several recent large conservation easements have protected significant high-elevation areas in the region from development, but the northern part of the range, stretching from Snow Mountain to Boundary Bald (and particularly the region around Kibby, Caribou and Tumbledown mountains) remains the most significant concentration of high-elevation land in the northeast with very little conservation protection.

The northern Boundary Mountains region appears to contain extensive areas of undocumented subalpine forest supporting Bicknell’s thrush. The region may also be important for climate change adaptation. The broad areas of high-elevation coniferous forest lie at the core of the area modeled by Tang and Beckage (2010) as likely to maintain suitable conditions for this forest type at the end of the 21st century. This region should receive a higher level of attention for future conservation than it has in the past.

4.2 High-elevation wind power development

The modern era of commercial wind power development in the region began in the early-to mid-2000s. During that time there was a strong interest in development in more mountainous regions because the higher winds at higher elevations were thought to be necessary for an economically viable project. Two of the earliest proposed projects (Kibby Mountain and Redington/Black Nuble in Maine) were located above 2700 feet. However, other early projects (such as Mars
Hill and Stetson Mountain in Maine and Lempster Mountain in New Hampshire) demonstrated the viability of projects at lower elevations. In recent years advances in wind turbine technology (including taller towers and larger rotor diameters) have increased the viability of projects in lower wind regimes and significantly expanded the extent of lower-elevation land capable of supporting economically viable wind power development.

Of the nearly three dozen commercial wind power projects in New England that have submitted permit applications, the majority are located at lower elevations. There are two operating wind power projects above 2700 feet (Kibby Mountain in Maine and Granite Reliable in New Hampshire) and two others that have been permitted and are under construction (an expansion of the Kibby project onto Sisk Mountain and Deerfield in Vermont). Two of these (Granite Reliable and Sisk) are located in areas of high-quality subalpine forest with populations of Bicknell’s thrush). Two other high-elevation projects have been denied permits (Redington/Black Nubble and East Mountain in Vermont). At least two others are in the planning stages – Seneca Mountain in Vermont and an unnamed project north of Dixville Notch in New Hampshire – and other areas may be under consideration.

While projects at lower elevations are not without their own issues, they generally are located in areas of relatively common second-growth forest types with a long history of human use. Higher-elevation projects have a greater likelihood of impacting relatively pristine areas, and because of the strong association of these areas with subalpine forest and Bicknell’s thrush, they have a higher likelihood of impacting regionally rare habitat as well. It is almost unthinkable that a project would be proposed that would destroy lower-elevation old growth forest. However, three high-elevation projects (Redington/Black Nubble and Kibby Expansion in Maine and Granite Reliable in New Hampshire) have been proposed in areas of undisturbed subalpine forest. Because of the recognized nature of these impacts, one of these projects (Granite Reliable) was required to provide significant compensatory conservation of other high-elevation land as mitigation. However, whether development in these areas should take place at all is an important question facing developers, permitting agencies and stakeholders.

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6. References


Figure 1. Areas above 2700 feet elevation in New England and New York.
Figure 2. Conservation status of high-elevation land in New England and New York.