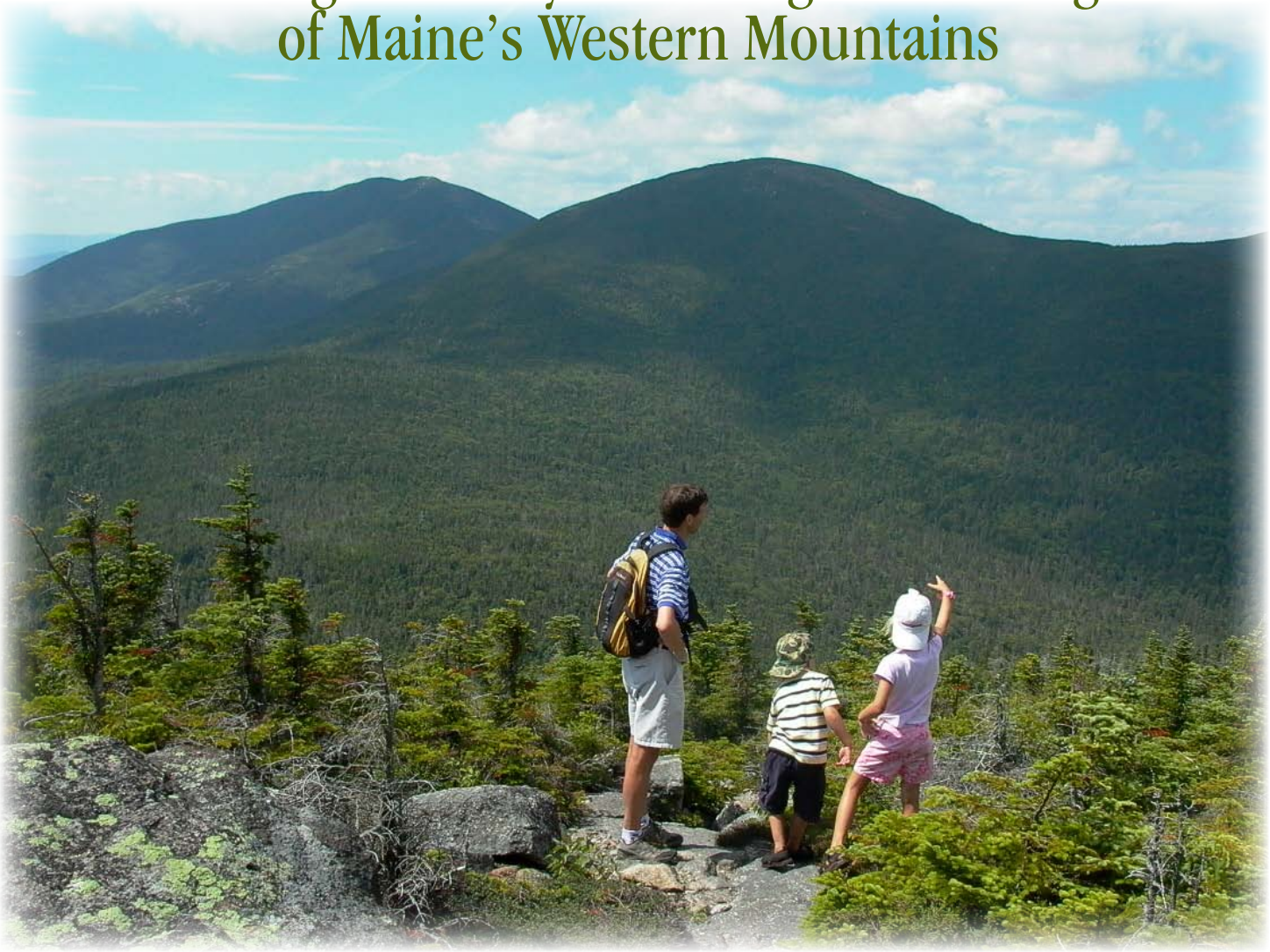
An Ecological Study of the High Peaks Region of Maine's Western Mountains



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Mapping and GIS Analysis by
Center for Community GIS

MAINE Appalachian Trail LAND TRUST

A Project of the Maine Appalachian Trail Land Trust

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High Peaks Initiative

The Maine Appalachian Trail Land Trust (MATLT) was formed in June 2002 by a group of Mainers dedicated to the preservation of the natural qualities of the lands surrounding the Appalachian Trail in Maine. Following our campaign to acquire Mount Abraham and a portion of Saddleback Mountain, MATLT is embarking on a new initiative to conserve the unique ecological qualities and sense of remoteness of the larger Western Maine High Peaks Region. This special and important area, with opportunities for recreation and natural resource based tourism, needs much more protection than it currently enjoys.

MATLT's conservation focus is the 203,400 acres roughly bounded by the communities of Rangeley, Phillips, Kingfield and Stratton. In this region, there are about 21,000 acres above 2700 feet. It is one of only three areas in Maine where the mountains rise above 4000 feet. The other two are the Mahoosuc Range and Baxter Park. Eight (8) of the fourteen (14) highest mountains in Maine are in this region (Sugarloaf, Crocker, South Crocker, Saddleback, Abraham, The Horn, Spaulding and Redington Peak.) These are all above 4000 feet. If one adds the Bigelow Range, across Route 27/16 from Sugarloaf, the region hosts ten (10) of the highest mountains (Avery Peak and West Peak added). This area is comparable in size to Baxter Park but has 40% more area above 2700 feet.

This ecological research project began in the spring of 2006, when the board of directors of the MATLT determined that we needed a detailed ecological report to guide our own efforts. But, perhaps more important, we wanted to share our information with the communities within the region and our conservation partners to help guide their own conservation, recreation, and community planning.

Carole Haas, Executive Director
Maine Appalachian Trail Land Trust

Peter McKinley, Ph.D.

Dr. Peter S. McKinley has 24 years of experience in academic, private nonprofit, and commercial landscape planning and conservation research in the forests of Indiana, Maine, and New Brunswick, Canada. Peter currently lives in Scarborough Maine and directs an estuarine research project for New Hampshire Audubon in the Hampton Estuary while maintaining a consulting practice in Maine.

The Center for Community GIS is a program of the non-profit Quebec-Labrador Foundation dedicated to promoting the broad use and participatory application of Geographic Information Systems. From its base in western Maine, the Center provides technical assistance, training, and educational outreach to public interest organizations engaged in community-based planning and decision-making. For more information, see www.community-gis.org.

The author wishes to thank reviewers from the Maine Appalachian Trail Land Trust board of directors and professional peers who have either read and commented on various written iterations of the report or offered commentary and advice in personal conversation. The author also thanks the Center for Community GIS of the Quebec-Labrador Foundation for their collaboration on landscape analysis and map production, and the Maine Chapter of the Nature Conservancy for access to landscape coverage data. Conclusions, recommendations, omissions, or errors are the sole responsibility of the author.

Ebens Pond

Mt. Abraham

This report defines a landscape unit possessing a rare combination of physical and biological conditions that have produced an equally rare ecological assemblage.

Part 1: Introduction and Study Area

This report defines a landscape unit possessing a rare combination of physical and biological conditions that have produced an equally rare ecological assemblage. The ecological diversity in the form of species, populations, communities, ecosystems, and relevant processes is rare at multiple scales ranging across local, state, regional, continental and even hemispheric perspectives. This report is also intended to serve as a guide to the conservation of the defined Study Area and surrounding landscapes. Four related elements combine to document the ecological qualities and offer a decision-making framework for landscape-based conservation efforts. These four elements are presented as Parts 1 through 4 of the report.

This part (Part 1) introduces the almost 600,000 acre Study Area (see Figures 1 and 2). The study area's landscape position and size are presented as important results of the report in their own right. The project as originally commissioned by the Maine Appalachian Trail Land Trust was limited, both in size and habitat diversity, to the upper elevations of the high peaks region and the associated plant and animal communities of this zone. This zone includes the route of the Appalachian Trail over the summits and ridges of Saddleback Mountain, the Horn, and Saddleback Junior, and such neighboring peaks as Mount Abraham, Black Nubble, and the Redington Range.

The ecological diversity in the form of species, populations, communities, ecosystems, and relevant processes is rare at multiple scales ranging across local, state, regional, continental and even hemispheric perspectives.

Study Area in Regional Context

Figure 1. Study Area within Regional Geographic Context.

High Peaks Study Area

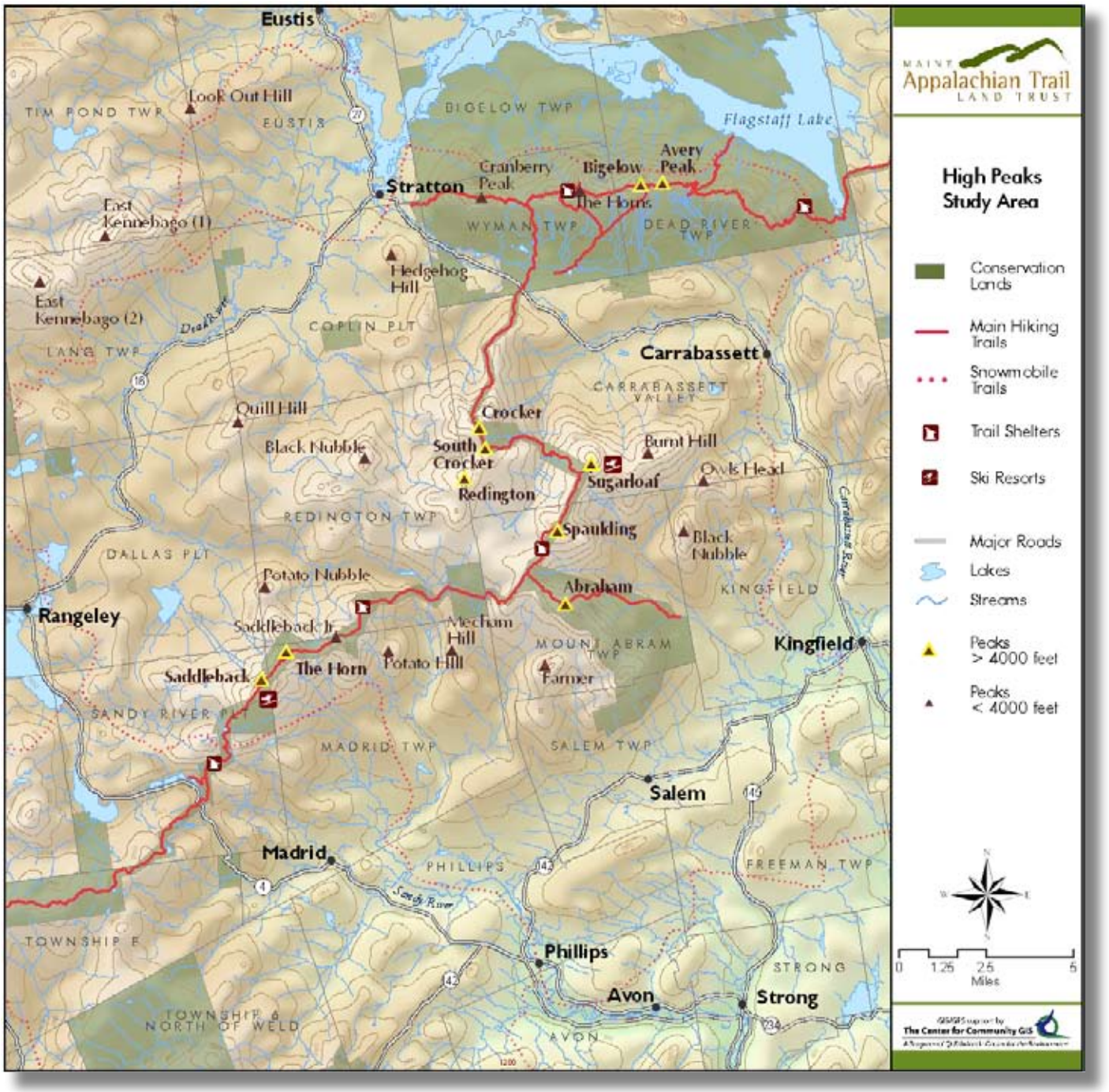


Figure 2. The Study Area with major political, recreational, conservation, and geographic features.

The higher mountain zones and associated ecological communities are indeed regionally rare ecological features of the Study Area and worthy of special and immediate attention and protection. Furthermore, the ecological communities in these zones are also immediately adjacent and relevant to the experience of the Appalachian Trail, an obvious focal point of the Maine Appalachian Trail Land Trust. However, conservation of the western high peaks ecological assemblage, and therefore the entire trail experience, is dependent upon larger scale (minimally the size of the Study Area) and higher level (the landscape position in the ecological hierarchy relevant to this discussion) conservation efforts.

A conservation opportunity exists here that goes far beyond the realm of local trails and peaks to include the realm that we identify as Maine and in turn goes far beyond the state borders to include an opportunity at a continental scale. The convergent effects of latitudinal position, mountain topography, and forest contiguity (the latter interestingly a relic of large scale timber ownership and management) offer a conservation opportunity that is notable at a continental scale. From Pacific to Atlantic shores, from Mexico to Canada, there is one Appalachian transition zone to boreal forest and this Study Area spans approximately one half of the narrowest part of this landscape type. It is, therefore, not only highly significant to the biological diversity of Maine, but to a portion of the continent that includes New York, Vermont, New Hampshire, Maine, Quebec, and the Maritime provinces of Canada due to the landscape contiguity that it provides for the ecosystems present across this northern hardwood, mixed-wood, sub-boreal and boreal transitional landscape.


Abraham Ridge

A conservation opportunity exists here that goes far beyond the realm of local trails and peaks to include the realm that we identify as Maine and in turn goes far beyond the state borders to include an opportunity at a continental scale.

As millions of landbirds, most notably numerous warbler species, migrate from Central and South America to this North American transitional forest (including the Study Area) to breed and return south each year, there is a compelling biological argument that the area in question is a Study Area of hemispheric significance. Such a perspective is not new as demonstrated by the very important and successful Western Hemisphere Shorebird Reserve Network that essentially treats the Arctic breeding sites, North American migratory stop-over sites, and Central and South American Wintering sites of numerous shorebird species as one contiguous (albeit large) landscape mosaic. Various key patches are designated and protected for their hemispheric significance to shorebird population viability.

Sunset over Saddleback

In summary of the evolution of this report's mission, there is a lot more to consider here than the Appalachian Trail, but let's use the trail as a rallying point and very real physical access point to demonstrate and teach about this conservation opportunity waiting to be taken.

Part 2 is an introduction to landscape-based conservation science including principles of conservation design and measures of current and future conditions relevant to the Study Area. Principles of design include qualitative and quantitative aspects of land conservation. The former is exemplified by the habitat requirements of various plant and animal species. The latter involves minimum habitat area requirements, habitat arrangement, and habitat connectivity required for maximum native animal and plant population diversity and viability. Measures of current conditions and planning for future conditions depend upon the use of various indicators. Indicators include plant and animal communities and species that have close associations with particular physical and biological conditions and processes.

The Study Area is located in a potential landscape bottleneck… where the landscape type and contiguity is at a minimum in its span from New York State through New England and into Quebec and the eastern provinces of Canada.

Part 3 deals with the regional context of the Study Area, namely its location within a zone of transition from northern hardwood forests to mixed-wood, softwood, sub-boreal, and boreal forest conditions. This transition occurs across the northeastern states and eastern Canadian provinces. It is a transition that occurs on the same spatial scale and hierarchical ecological level as, for example, the transition from sub-tropical Floridian forest to southeastern pinelands in the United States. Applying landscape principles from Part 2, it is noted that the Study Area is located in a potential landscape bottleneck (further justifying conservation of the Study Area)—where this landscape type and contiguity is at a minimum in its span from New York State through New England and into Quebec and the eastern provinces of Canada.

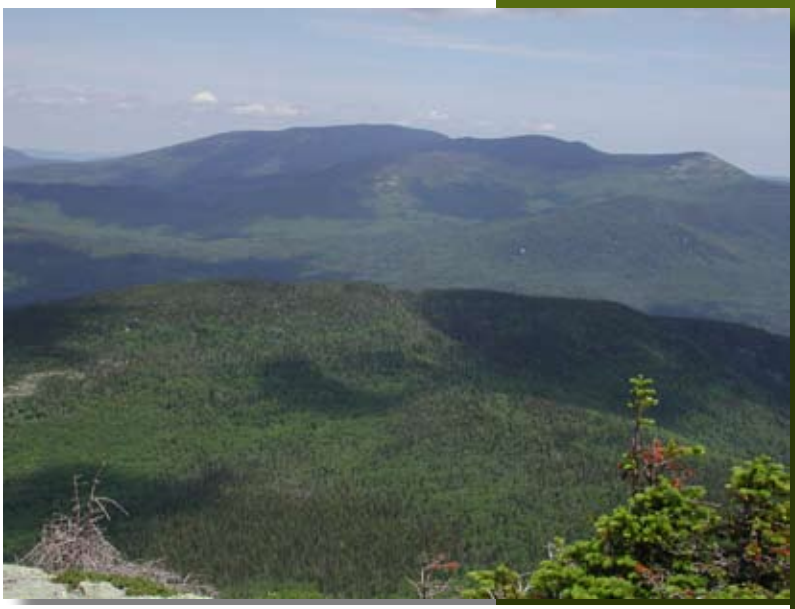
Part 4 shifts to a scale of reference within the Study Area itself to describe and discuss the vegetation communities of the area and the various indicator plant and animal species whose ranges include the Study Area or are projected to exist within the Study Area. The zone-based maps of this part of the report were produced for this study using existing land cover databases organized and ecologically classified by the author for the purpose of presenting a model of the Area's landscape assemblages including the plant and animal indicators of each zone or community type. Extensive ground-truthing in the field was used to delineate the zones on these maps.

Part 5 highlights the regionally rare or under-represented (considering population viability) indicator species, communities, and landscape conditions. These indicators include Diapensia, a true arctic-alpine plant, sub-arctic alpine plant species that may occur above treeline or at lower elevations in acidic wooded bogs such as Leatherleaf, communities of the Bicknell's Thrush, Blackpoll warbler, black-back Woodpecker, Gray Jay, and Boreal Chickadee, species with wide home ranges such as Canada Lynx and Pine Marten, and the contiguous lower elevation hardwood forest communities comprising the valleys.

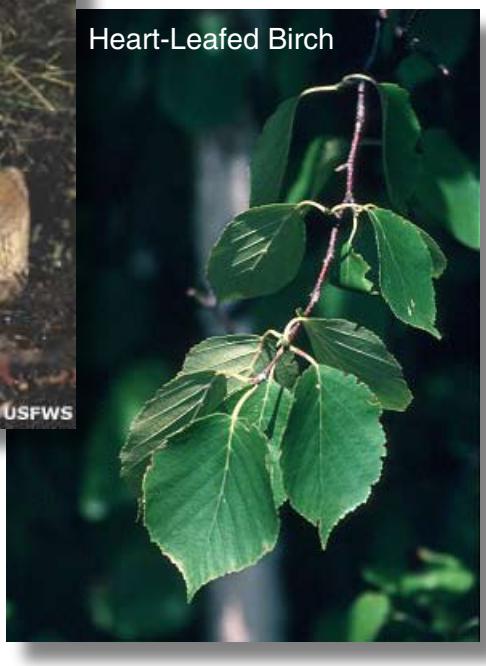
This report takes the stance that Drs. Borns and Davis took in their presentations at the Maine Mountain Conference of 1972. They argued that the mountain is as much the valley as it is the summits and ridges. It perhaps adds a measure of interest that this report's theme was developed independently of their important message of 1972. If the term had been in use during that first conference, they might have used the word landscape in their messages that a mountain or mountains include the mosaic of alpine and valley conditions and communities, and the range of conditions and communities in between these two extremes.

The Study Area includes several towns dependent upon a mixture of light industry, wood harvest, paper and lumber production, and service industries. New home construction is increasingly associated with recreation based on two major ski resorts, extensive hunting and fishing opportunities, nature observation, approximately 93 miles of the Appalachian Trail, and 146 miles of snowmobile trails centered around the Longfellow Mountain Range. The trail and its ecology cannot be examined without minimal attention paid to the ecological relationships and conservation of the defined Study Area under increasing pressure from human development and use.

"...mountains include the mosaic of alpine and valley conditions and communities, and the range of conditions and communities in between these two extremes.



Redington and the Crockers



Observations include Blackpoll Warbler, Bicknell's Thrush, Canada (gray) Jay, Black-backed Woodpecker, Diapensia, Canada Lynx, and Bobcat, in most cases at multiple locations throughout the study area.

Part 2: Indicators and Landscape Concepts in Relation to the Study Area

The indicator concept was instrumental in the production of this report and will continue to be so in future conservation efforts. The science of ecology and the science of conservation can be approached from either top-down or bottom-up perspectives. The two approaches offer their own insights about how nature works and how to conserve it, and may be alternately employed for that reason or reasons of necessity. If one wanted to know something about the presence and distribution of an animal or a plant in an area, one could physically survey the area for that animal or plant species. The survey could be a direct count of all individuals (usually not possible), or a statistically derived estimate based on a count of some subset of the population. Either case would be an example of a top-down approach.

More often, the information available (or not available) drives the selection of a bottom-up approach : estimating the presence or abundance of an animal, plant, or ecological community in a particular area based on the composition of the landscape. Surveys are expensive and time

consuming. It is easier to gather data on categories of vegetative and non-vegetative landcover than to produce a survey of each and every animal and plant population size and distribution in a particular area. The types, areal extent, and connectivity of the landcover types (habitats) can then be used to predict which animals or plants should be present in a given area or study site and, moreover, predict their densities based on established knowledge regarding the ecological requirements or parameters of a species or community type. The method used to determine the animal species present within the Study Area was largely a bottom-up habitat modeling approach, supplemented by new field surveys, examination of existing surveys of plant and animal species and communities, and hunting, trapping, and fishing data.

It is highly probable that every plant and animal species cited in this report resides in the Study Area whether as a summer breeder, permanent resident, or migratory visitor passing through. In all likelihood these animals and plants have been heard, seen, tracked, trapped, caught, or hunted in this Study Area at one time or another within the last year. Indeed, many of the animals and plants associated with the boreal and sub-boreal alpine conditions and of particular conservation interest were physically documented by the author in the field in the course of this study. These observations (either direct or through evidence) include Blackpoll Warbler, Bicknell's Thrush, Canada (gray) Jay, Black-backed Woodpecker, Diapensia, Canada Lynx, and Bobcat, in most cases at multiple locations throughout the study area.

While reporting the various species of animals and plants likely to occur in this particular Study Area is certainly no trivial matter (the diversity is surprisingly high due to the topographic and latitudinal ecotones), the goal of this report is to consider these various animals and plants in relation to long-term population viability and the opportunity that this Study Area presents in its entirety. This region of Maine represents an important conservation opportunity due to its local topography and community diversity, its position at the center of a latitudinal ecotone, its role as a landscape link between upper New York State, New England, and eastern Canadian provinces, and its local, within-landscape contiguity offering high potential for long term viability of transitional forest dependent species and communities.

Indicator Species

The concept of top-down versus bottom-up measures and effects resurfaces here in a consideration of species-based indicators [Figure 3] versus structure-based indicators [Figure 4]. The former is a top-down indicator, while the latter is a bottom-up indicator. Indicator species and communities are selected to inform us about larger-scale and multiple=level ecological patterns or processes. Initially, indicators may be used to identify the type of habitat, ecosystem, community, or landscape under consideration. This leads the way for making state-wide and region-wide assessments regarding the rarity of a particular part of the landscape, and the need for conservation protection. An indicator may be an animal dependant upon a particular ecological community or the ecological community itself—suggesting the existence of known associated species. An indicator might be more directly associated with conservation as it can be defined according to its risk of extinction, either directly based on information about population status, or indirectly based on the status of its ecological requirements across the landscape.

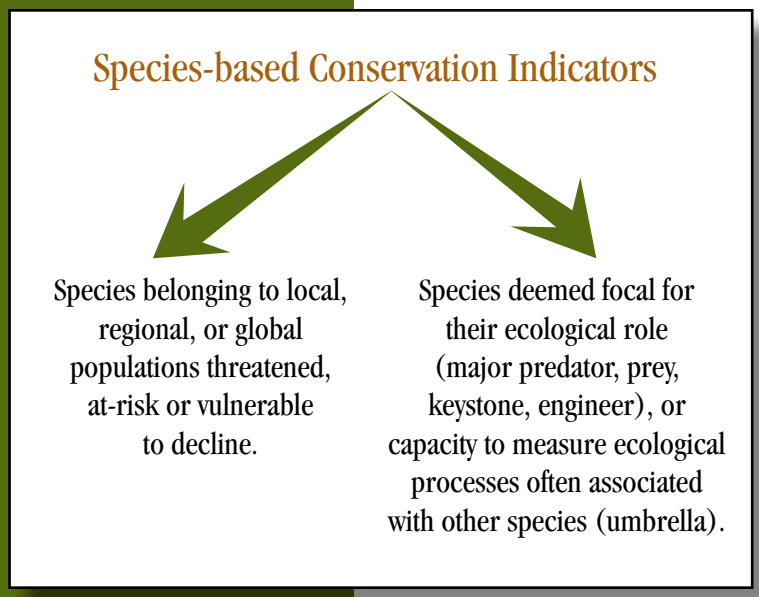


Figure 3. Species-based scheme of measures used to evaluate landscape and habitat for conservation potential.

Species-based indicators are assigned one of two categories; At Risk or Focal [Figure 3]. The At-Risk category includes those species that are threatened, endangered, or otherwise at-risk of local, regional, or global extinction. State and federal programs maintain lists of At-Risk plants and animals based on region-wide population assessments. A more conservative approach (in favor of minimizing local or regional extinctions) often warrants the assignment of some species not on state and federal lists to the At-Risk category because of local extinction risks. Bicknell's Thrush, Canada lynx, and rock (yellow-nosed) voles qualify as At-Risk Indicators based on the limited availability of their habitat type across the landscape and their low population densities either within Maine or the region.

A Focal Indicator can be a species whose sustained presence on a site implies a suite of ecological processes and conditions that, in turn, might predict the presence of other plant and animal species with similar requirements provided their other potentially divergent life history requirements are also satisfied. This type of Focal Indicator is more specifically defined as an Umbrella Species [Figure 3]. Current definitions of umbrella species stress identification of particular processes first, rather than directly indicating another species or suite of species. To the degree that another species or suite of species might have overlapping requirements, it can then be said that an Umbrella Focal Indicator might suggest

other species indirectly. For example, Diapensia on a site is an indicator of arctic-alpine conditions. We might visit a summit ridge or patch above treeline containing Diapensia in the summer and never know the average temperature and moisture conditions over the year, but its presence implies a specific set of conditions that spur us onward to look for other arctic-alpine indicators. Bicknell's Thrush is a good indicator for high mountain and boreal forest conditions. Bobcats, River Otters, and Barred Owls (see tables included in Part 4 for habitat and landscape requirements) are good indicators of landscape contiguity.

A Focal Indicator may also be a species with a functional role in a community or ecosystem, and includes ecosystem engineers, community keystones, and certain predators, prey, decomposers, and primary producers. The beaver is an example of an ecosystem engineer as its construction of dams leading to wetlands alters the landscape and creates numerous niches that would not have otherwise existed on a particular site. Woodpeckers would be an example of a community keystone species. Their foraging and production of nesting cavities in trees incidentally make these snags available to other birds and mammals to use as refuge or nesting sites. Predator, prey, decomposer, and primary producer species are deemed Focal Indicator species if they offer community or ecosystem feedback or energy cycling that would not easily be accomplished in their absence.

While two Focal Indicators might at first appear redundant, closer examination might reveal that each one carries novel information about local pattern and process. While the presence of Bicknell's Thrush implies a set of physical and biological conditions we associate with boreal forest, it does not necessarily mean that gray jays (another boreal forest indicator) will be there. Gray jays require larger territories, so it is conceivable that in spite of the qualitatively appropriate boreal conditions, the presence of Bicknell's Thrush would not automatically imply the presence of gray jays if the patch of boreal or high mountain forest were too small. This is a good example of why it is more appropriate to consider a Focal or Umbrella Species as a representative of processes or conditions rather than as an umbrella for other species with similar (but not entirely coincident) requirements. This is also why it is important to consider multiple indicator species that might at first seem redundant, but in reality capture and represent different information. Of course, there is a balance to be struck as over-zealous inclusion of too many species will defeat the purpose (simplifying the system to the point of practicality) of using indicators to begin with.

A Focal Indicator can be a species whose sustained presence on a site implies a suite of ecological processes and conditions that, in turn, might predict the presence of other plant and animal species with similar requirements.

Indicator Structure

Figure 4 depicts another class of indicators considered Bottom-up Indicators. These indicators dictate and predict the plant and animal species and communities that will occur across the landscape. Types of vegetative cover, amounts of the cover, connectivity of the cover, and isolation of the cover all converge to determine the density, distribution, and long term population viability of plants and animals across the landscape. Tables 2a, 2b, and 3, along with the ecological zonation maps of Part 4, identify the types and amounts of landscape cover or structure available for the various indicator plants and animals described in the indicator tables of Part 4.

Numerous studies of songbirds, mammals, amphibians, reptiles, and even insects have demonstrated the negative effects of high edge-to-area ratios, isolation, and small patch size in landscapes such as those idealized in Landscape A of Figure 5. The five landscapes represent a theoretical, and empirically demonstrated, continuum ranging from bad to best when considering the population viability of many plant and animal species and the sustained existence of ecological communities. Though there are situations where Landscape A can provide benefits, such as risk spreading among sub-populations, it is less of a concern here as loss of fragmented conditions is generally not a concern in any Maine landscape. Probabilities of individual, population, and community dysfunction generally decrease from Landscape A through Landscape E of Figure 5 due to increasing connectivity and interior habitat and decreasing edge-to-area ratios, increasing probabilities of full micro-habitat availability, increasing size of resource and mate supplies, and decreasing isolation for juvenile dispersal from appropriate habitats. These concepts apply at multiple scales such that there are patches and fragments within the Study Area, while at the same time the Study Area itself, when we think of its regional position in the transitional forest landscape across the northeastern U.S. and eastern Canada, can be considered one of the connecting pieces depicted in Landscape B of Figure 5.

Generally speaking then, it is the large, contiguous (like continuous but implies blocks rather than something narrow and linear) connected types of habitat across a landscape that we strive to maintain.


Northern Bog Lemming

Generally speaking then, it is the large, contiguous (like continuous but implies blocks rather than something narrow and linear) connected types of habitat across a landscape that we strive to maintain. High degrees of fragmentation have been repeatedly linked to population dysfunction and local extinctions for a variety of reasons. In fragmented landscapes potential mates have trouble finding one another, dispersing juveniles end up in inappropriate habitats, and small fragments are statistically less likely to have the full array of habitat menu options needed by an animal.

Table 1 demonstrates the landscape requirements of the spectrum of animals in the form of the sizes of contiguous forest they require for the maintenance of viable populations. The land extents cited are not for one animal or a pair, rather they are estimates for the maintenance of locally viable populations. This figure is

especially useful with the information provided in the tables and figures of Part 4. Tables 2a, 2b, and 3 include the acreage available for various habitat types depicted in the landscape figures of Part 4, while the multiple tables of indicator species in Part 4 provide the habitat requirements and minimum landscape sizes needed for the various species of amphibian, reptile, bird, mammal, and fish.

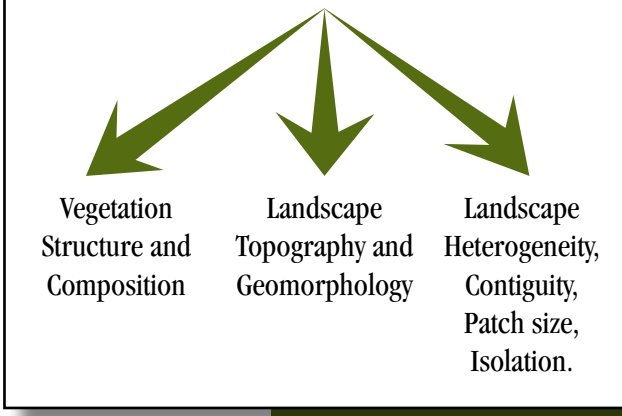


Figure 4. Structure-based scheme of measures used to evaluate landscape and habitat for conservation potential.

An example of the type of planning that this report enables is as follows: From Table 1, a population of bobcats requires approximately 140,000 acres. Based on habitat requirements from the indicator tables we know that the bobcat requires mixed-wood (coniferous and deciduous) and deciduous forest. Perhaps half of the approximately 600,000 acre study landscape is, or with forest maturation (see table 2b for extent of harvested and regenerating forest), could eventually be appropriate for bobcats. The Study Area could then maintain two populations of bobcat. Keep in mind that long term viability of a population of anything depends on close proximity and interaction with multiple sub-populations. It becomes apparent that as large as a 600,000 acre landscape sounds, for some animals at least, it probably needs to be nested within a larger landscape of similar composition. This does not preclude sustainable human uses of such a landscape; such use and conservation are fortunately compatible. What it does preclude is fragmentation and conversion of large landscape blocks.

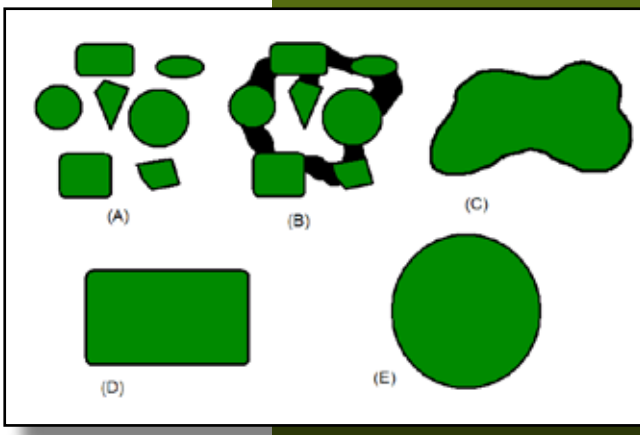


Figure 5. Landscape shapes and conservation. Each schematic landscape has the same area. Landscape A has the highest edge to area ratio and lowest contiguity, while landscape E has the lowest edge to area ratio and highest contiguity. Landscape B demonstrates connectivity through corridors and/or matrix.

A similar analysis can be extended to any of the indicator animals from Part 4. The list of indicator animals from Part 4 was selected to represent the range of ecological processes and conditions native to the Study Area and provision for the needs of these indicators representing the full-range of potential plants and animals native to the area cited in the appendices. Such an analysis as performed above is possible using Table 1 even though it only references the area requirements for population viability of select species. These species were selected to represent the requirements of related species from the various taxonomic groups they represent. Compare other small birds with the data cited for warblers and sparrows. Compare mid-sized mammals with mid-sized mammals and large mammals with large mammals. There are contradictions and counter-intuitive relationships. Table 1 shows larger area requirements for lynx and fisher than for moose, but a general guideline is possible as a first step in trying to figure out, for example, a general conservation strategy for the region.

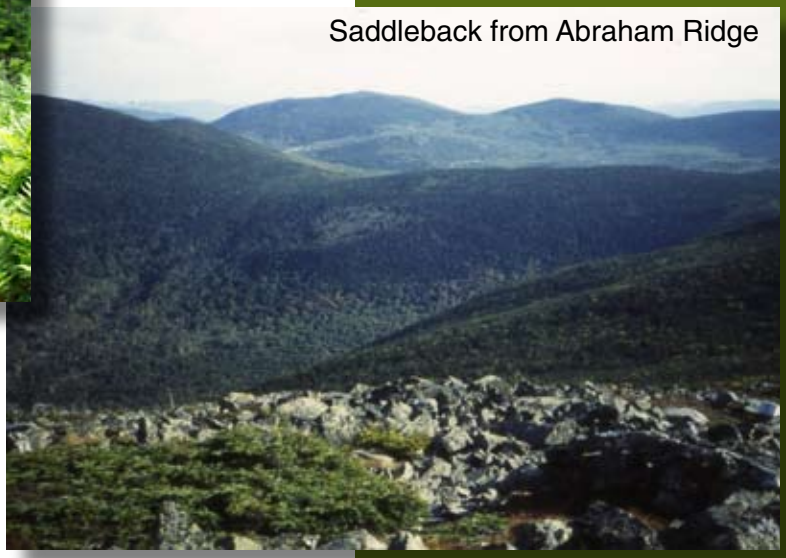

High elevation Spruce-Fir die-back

By looking up the conservation status, local habitat requirements, and landscape requirements in the indicator tables of Part 4, and relating this information to the availability of this habitat type from Tables 2, 2b, or 3, you will have an estimate of what is available. You can judge its contiguity based on the graphic portrayal of each type in the figures of Part 4 and relate this to the importance of contiguity to this animal. Finally, using Table 1 as suggested, the availability of the appropriate habitat type and its contiguity can be compared to the minimum amount of that landscape needed for long term population viability.

Table 1. Minimum landscape area (of species-appropriate habitat types) in acres needed to maintain viable populations of the selected indicator animal species in the study area.

Species	Minimum area (acres) of Species-Appropriate Landscape Needed for Population Viability	General Habit Requirements
Spruce Grouse	6,000	mature softwood
Small passerines including Warblers and Sparrows	11,000	depending upon species, full range of mature to early successional forest and regeneration of all types (hardwood, softwood, mixed-wood)
Barred Owl	14,000	mature hardwood or mixed-wood with amply snags for cavity nesting
Pine Marten	28,000	mature softwood and mixed-wood can include proportions of regenerating stands in landscape matrix
Moose	60,000	matrix of mature softwood, mixed-wood, and regenerating forest with ponds or lakes
Lynx and Fisher	90,000	mix of mature softwood, mixed-wood, and regenerating forest matrix
Bobcat	140,000	mix of mature softwood, mixed-wood, and regenerating forest matrix

On the Appalachian Trail



Saddleback from Abraham Ridge

Part 3: The Study Area in Relation to the Regional Landscape

One of the significant factors driving the ecology of this Study Area is related to the latitude it occupies and the influence of the Appalachian Mountains, along with the moisture regime of the eastern United States versus the western United States. This latter point is relevant when tracing the boreal transition zone west and finding that it shifts well into Canada, no longer dipping into the United States. The dark green color code (#1) in Figure 6 demonstrates the southern extension of boreal or boreal-transition forest through western Maine into the high peaks of New Hampshire, Vermont, and the Adirondacks of New York. This is also the southern-most extension of this forest type anywhere in the United States.

The species and community data of Part 4 include numerous plants and animals that occur either strictly to the north or strictly to the south, whereas they mix only in the narrow zone of boreal biome in western Maine occupied by the Study Area depicted in Figure 6. Whether it is a bottom-up cover-type indicator such as Figure 6, more localized bottom-up cover type indicators such as those presented in the zone maps of Part 4, or top-down indicators such as the co-occurrence of transitional indicator species detailed in the tables of Part 4, two contentions of this report should be clear: First, this zone is novel at the continental scale, when considering the suite of southern species mixing in the Appalachian portion of the boreal transition are almost a wholly different set of species as those mixing with boreal forest to the west. Regardless of country then, this transition is novel on a continental scale. Secondly, this transition occurs in a narrow band of appropriate ecosystem—the Study Area spans close to half the entire width of this band within the United States as depicted in

...this zone is novel at the continental scale, when considering the suite of southern species mixing in the Appalachian portion of the boreal transition are almost a wholly different set of species as those mixing with the boreal forest to the west.

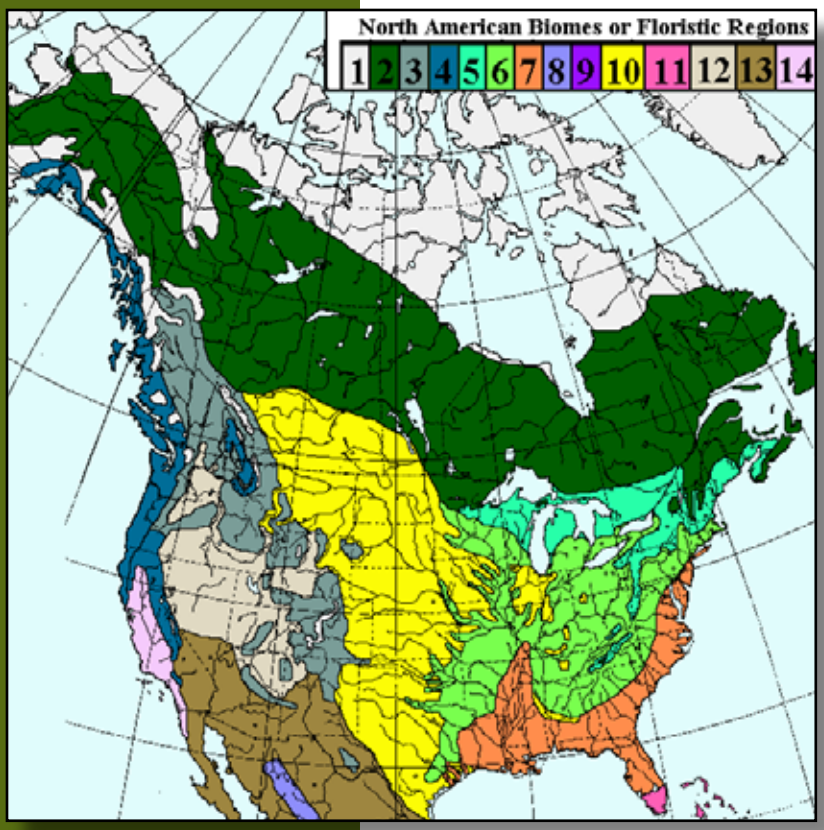


Figure 6. Major forest types, dark green (#2 from key) is boreal, blue-green (#5 from key) is northern transitional hardwood (has softwood component)

Figure 6 does not show that the eastern townships of Quebec actually revert to a lower elevation hardwood-dominated forest so that the landscape linkage spoken of is not only a narrow landscape linkage from a United States territorial point of view, but is narrow on a much greater scale. The scale of resolution of Figure 6 does not allow for this level of detail. A very real pinch in landscape contiguity, that is connectivity of animal and plant populations occurring in boreal and sub-boreal transitional forests across New York State, New England, and into New Brunswick, is at risk of separation without an ecologically intact Study Area. As previously discussed, such fragmentation has potentially negative consequences for long-term population viability on local and regional scales.

The climatic conditions at the latitude of the Study Area allow for this southern extension of a more northerly occurring forest type into the United States from Quebec. This extension is typical of an ecotone, a zone of transition, with plant and animal species from the northern hardwood transitional forest occurring with species characteristic of the northern sub-boreal and boreal forests. Zones of transition are not neat lines as demonstrated in Figures 7 and 8 at a finer scale of resolution.

A very real pinch in the landscape contiguity, this is connectivity of animal and plant populations occurring at high elevations across New York State, New England, and into New Brunswick, is at risk of separation without an ecologically intact Study Area.


Mountain Birch

Figure 7 depicts the transition across the northeastern U.S., offering a context that spans the Adirondacks and New England states. The close-up of Figure 8 offers more detail on the transition as it occurs within the Study Area itself. At this scale it is possible to see the influence of the mountain topography combined with the latitudinal effect. Referring to various topographic figures and vegetation coverage throughout this report we know that the eastern and southern boundaries of the defined Study Area box are in the valleys below the high peaks that are at the center of the Study Area. The yellow pixels, representing softwood boreal indicators, of Figures 7 and 8 would grade back into the greenish-blue pixels, hardwood, just over the border into the portion of Quebec bordering this section of Maine, thus rendering a narrow corridor and potential bottleneck in regional landscape contiguity.

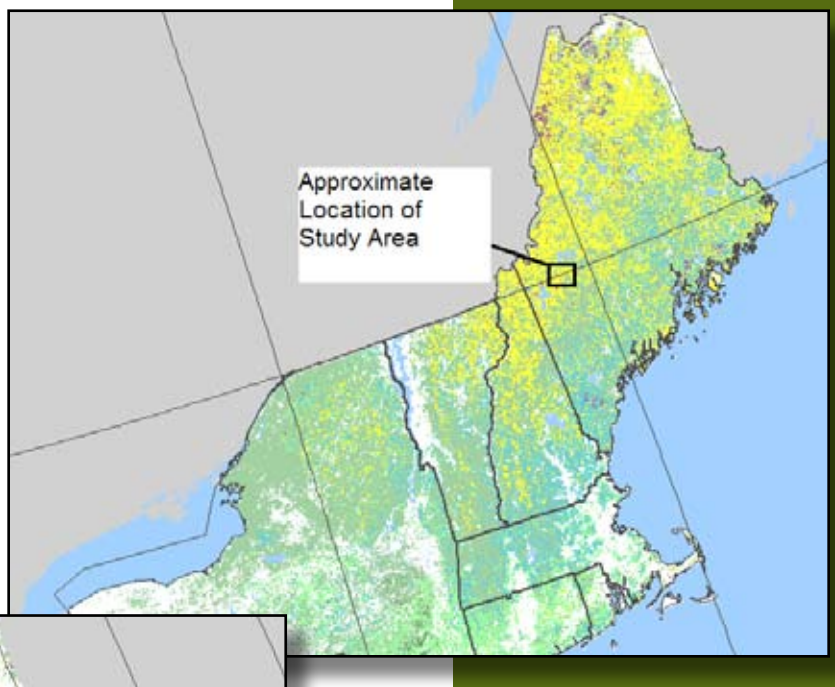


Figure 7. Finer scale representation of the transition from northern hardwood (green-blue) to softwood and boreal forest (yellow) in a regional context.

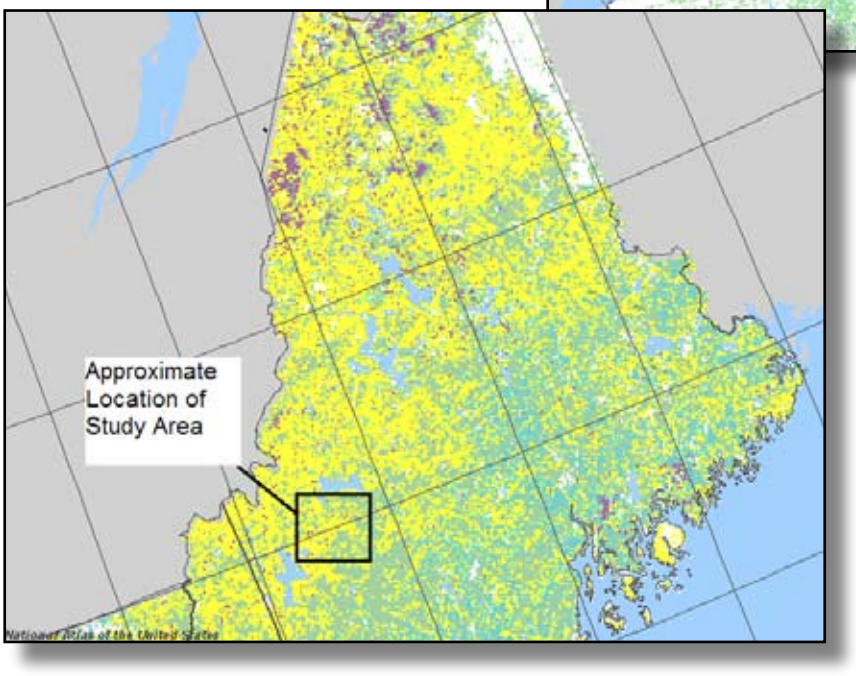


Figure 8. A close-up, fine scale view of the transition from northern hardwood (green-blue) to softwood and boreal forest (yellow) in relation to the study area.

Softwood boreal indicators would grade back into the hardwood just over the border into the portion of Quebec bordering this section of Maine, thus rendering a narrow corridor and potential bottleneck in regional landscape contiguity.

View from Abraham Ridge

Bicknell's Thrush

Photo by Dan Busby

These forests exist in the zone where rare, uncommon, or threatened birds such as the Bicknell's Thrush, Blackpoll Warbler,Spruce Grouse, Canada (gray) Jay, Black-backed and Three-toed Woodpeckers, and Boreal Chickadees take up residence at their upper limit continuing down into subalpine and high elevation forest types.

Part 4: Ecological Zonation, Communities, and Indicator Species Within the Study Area

Topography, Latitude, and Ecological Zonation

The general land cover of the landscape is depicted in Figure 10 and itemized in Tables 2a, 2b and 3. Table 3 includes total length or areal extent of natural features such as permanent streams, intermittent streams, ponds, and lakes, as well as cultural features such as hiking and snowmobile trails, and land in agriculture, light industry, or protected with some type of conservation status. The vegetation types are driven by changes in elevation in addition to local variations in soil types, moisture regimes, slope, and aspect. Generally, as average soil and air temperatures decrease by 3ºF for every thousand feet in elevation, and soil and moisture regimes shift to drier, nutrient limited conditions, the northern hardwood forest type of lower elevations and latitudes shifts to mixed-wood and coniferous forest communities more tolerant of nutrient poor, drier, and colder upper elevations and more northerly latitudes.

The physical zonation of the mountains is not one neat transect from a single valley to a single mountain ridge or peak, rather it can be repeated multiple times as a hiker is well aware following a traverse of the Appalachian Trail across the study area

The physical zonation of the mountains is not one neat transect from a single valley to a single mountain ridge or peak, rather it can be repeated multiple times as a hiker is well aware following a traverse of the Appalachian Trail across the study area. Figure 9 depicts a bent transect from Rangeley Lake to the summit of Saddleback Mountain and back down to the town of Philips. The repetition of the transition from valley to high mountain and high mountain to valley through cycles of ascent and descent as depicted in the profile of Figure 9

Profile Transects

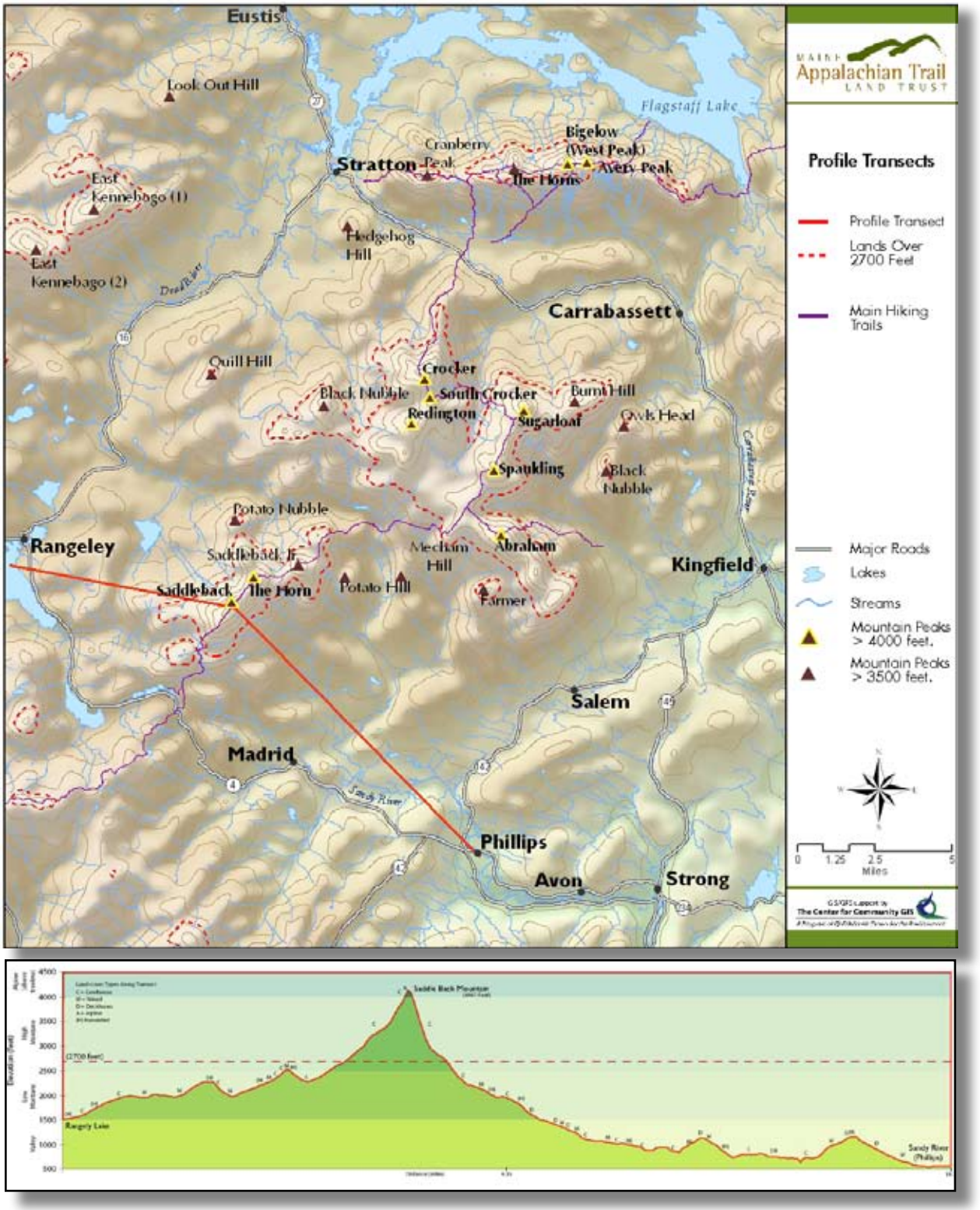


Figure 9. The topography behind the ecological zones replicated across the Study Area on the Appalachian Trail.

Landcover Categories

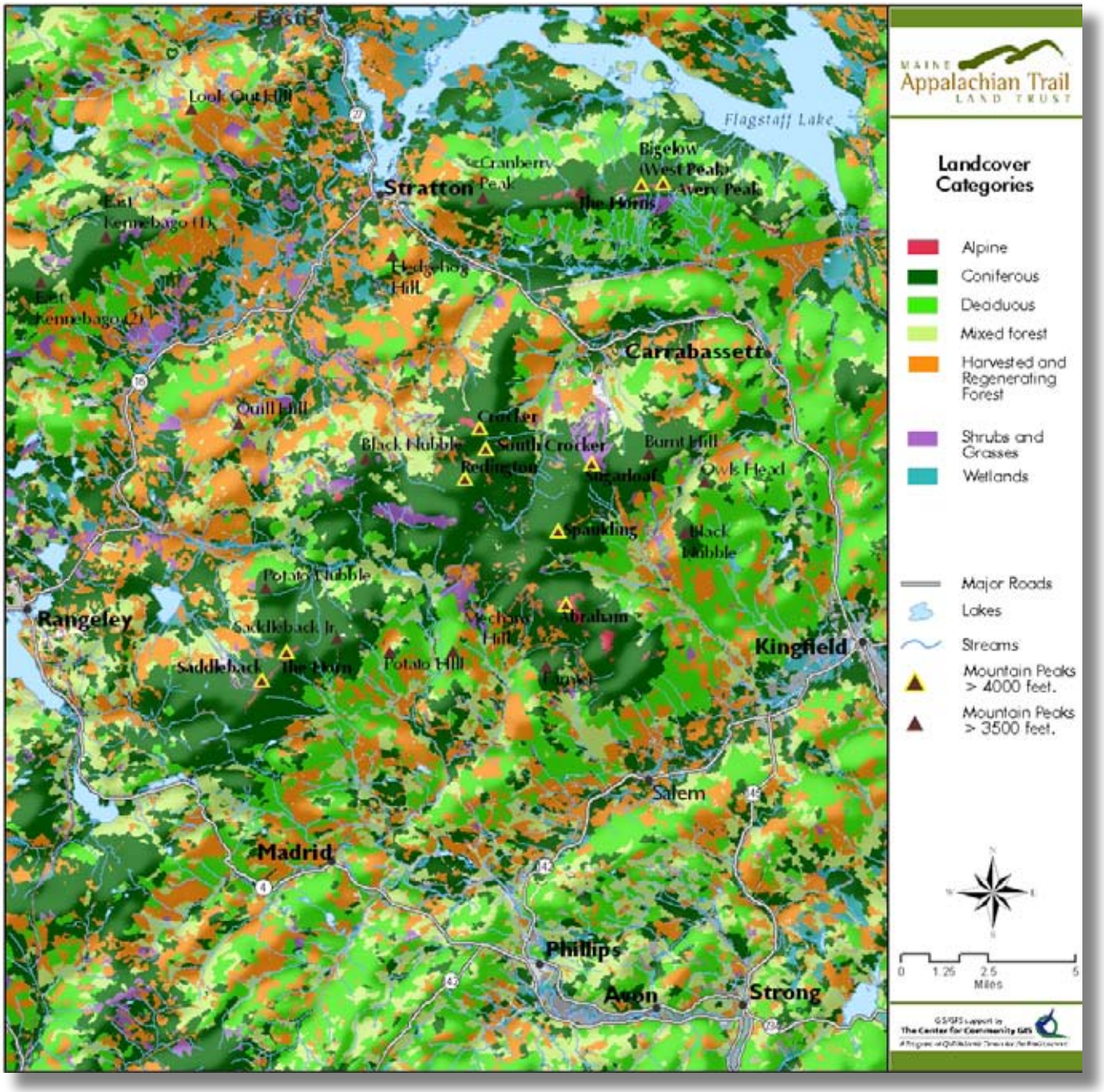


Figure 10. General cover across elevational zones as represented in Table 1 and Table 2

Elevation Changes on Mt. Abraham

Elevation 3,870 feet: alpine zone

Elevation 3,800 feet: high elevation patch of krummholz

Elevation 3,200 feet: transition from subalpine to alpine zone

Elevation 2,700 feet: primarily; spruce-fir subject to wind throw

2,450 feet: spruce-fir zone established, hardwood component falling out

Elevation 2100 feet: primarily hardwood

A central argument of this report is that the 600,000 acres under consideration does not simply include mountains, but is 600,000 acres of physical and biological interactions defined by a mountain landscape from the shores of Rangeley and Flagstaff Lakes to the summits of Saddleback and Bigelow Mountains.

This elevational gradient is responsible for some of the rarest community types classified by the state of Maine [Table 5] and documented within the Study Area.

lends support to the contention that the mountain landscape is characterized as much by the summits as it is the valleys. A central argument of this report is that the 600,000 acres under consideration does not simply include mountains, but is 600,000 acres of physical and biological interactions defined by a mountain landscape from the shores of Rangeley and Flagstaff Lakes to the summits of Saddleback and Bigelow Mountains.

This elevational gradient is responsible for some of the rarest community types classified by the state of Maine [Table 4] and documented within the Study Area. These communities are not limited to the Dwarf Heath–Graminoid Alpine Ridge or Diapensia Alpine Ridge, the latter documented at less than five places in the entire state and the former found at less than 20 locations [Table 4]. Two other communities from Table 4, Spruce-Fir-Birch krummholz (less than 100 occurrences statewide) and Fir-Heart-leaved Birch Subalpine Forest (also less than 100 occurrences statewide) are located a little further down the slopes and in greater abundance. These forests exist in the zone where rare, uncommon, or threatened birds such as the Bicknell's Thrush, Blackpoll Warbler, Spruce Grouse, Canada (gray) Jay, Boreal Chickadees, and Black-backed and Three-toed Woodpeckers take up residence at their upper limit continuing down into subalpine and high elevation forest types. Table 4 includes two remaining Maine Natural Areas Program communities of concern that are wetland based and also present in the Study Area. Heath-Lichen Subalpine Slope is found in fewer than five locations statewide, and Cotton-grass – Heath Alpine Bog is found in fewer than twenty locations statewide.

Table 2a. General Ecological Cover Type by Mountain Zone Part 1

	Arctic-Alpine Indicator Plants and/or Communities	Arctic-Alpine Tundra, Sub-arctic-Alpine, and Krumm-holz Matrix	Coniferous Cover (acres)	Deciduous Cover (acres)	Mixed Coniferous and Deciduous Cover (acres)
Valley (up to 1500')	0	0	59,433	63,238	39,193
Low Montane (1500' to 2500')	0	0	65,801	69,512	59,044
High Montane (above 2500' and below treeline)	0	0	46,128	1,125	7,681
Above Treeline	267	615	0	0	0
Total	**0**	**615**	**171,364**	**133,875**	**105,920**

Table 2b. General Ecological Cover Type by Mountain Zone Part 2

	Regenerated Forest (acres)	Recently Harvested Forest (acres)	Shrub Wetland (acres)	Forested Wetland (acres)	Nonforested Wetland (acres)
Valley (up to 1500')	5,142	51,936	4,522	11,470	6,055
Low Montane (1500' to 2500')	21,433	43,130	8,547	4,829	1,448
High Montane (above 2500' and below treeline)	489	2,341	1,966	4	25
Above Treeline	0	0	0	0	0
Total	**27,065**	**97,437**	**15,038**	**16,304**	**7,530**

Table 3. Surface Water (other than wetlands, see tables 2 and 3) and Cultural Features Across Elevation Zones within Study Area

Feature	Surface Area in Acres (ac) and Linear Extent in miles (mi)
Open water (portions of major lakes, small lakes, ponds etc.)	27,819 ac
Low intensity development (residential)	1,472 ac
Agriculture	8,608 ac
Perennial stream	1,029 mi
Intermittent stream	456 mi
Snowmobile trails	146 mi
Appalachian trail	93 mi
Conservation lands (state ownership, land trust ownership, development easement, etc.)	88,892 ac

Table 4. Rare to Vulnerable (S-1 to S-3) Maine Natural Areas Program communities occurring in the study area

Community	Important Characteristics	State Status*
Dwarf Heath – Graminoid Alpine Ridge	Most common community type above treeline, includes true, arctic alpine indicator plant species. Mixture of dwarf evergreen shrubs and herbs, scattered boulders interspersed among vegetation cover.	S-2
Diapensia Alpine Ridge	Diapensia cushions are the dominant and defining characteristic. Matted evergreen shrubs and low herb cover among bedrock and boulder matrix.	S-1
Fir – Heart-leaved Birch Subalpine Forest	Dense canopy of stunted balsam fir and heart-leaved birch. Recent openings may include hobblebush and mountain ash. Herb species in dense patches. Typically above 2700' on ridgetops or slopes.	S-3
Spruce-Fir-Birch krummholz	Dense mats of prostrate black spruce, balsam fir and heart-leaved paper birch and shrubs under 2 meters high. Total shrub cover up to 100 %. Small patches of herbs such as bluebead lily and Canada Mayflower among shrubs.	S-3
Heath – Lichen Subalpine Slope Bog	A tilted ericaceous bog shrubs growing on Sphagnum moss carpet on rocky slopes. Sparse trees may include heart-leaved paper birch, northern white cedar, paper birch, and black spruce.	S-1
Cotton-grass – Heath Alpine Bog	Graminoids such as deer-hair sedge and tufted cotton grass in patches covering 25-40 percent of the sphagnum/peat layer. Ericaceous shrubs include bilberries, crowberry, Labrador tea, leatherleaf, rhodora, and sheep laurel. Some stunted black spruce and balsam fir scattered. Alpine or subalpine at or near treeline.	S-2

S-1 = Vulnerable to extirpation in state of Maine due to rarity, fewer than 5 occurrences in state. S-2 = Limited distribution, 6-20 occurrences statewide and at risk for further loss. S-3 = Rare in Maine, 20-100 occurrences.

As discussed in Part 2, conservation concerns and population viability should not be limited to the species or communities on state or federal lists. States and federal agencies can fall short of what is actually needed to ensure local long-term ecological viability. This happens because state and federal mandates often consider only those species of plant or animal in some form of peril across an entire range. The science of conservation biology tells us that long-term viability of species and regional populations usually rely on the maintenance of numerous sub-populations across the entire range. With that in mind, it is inappropriate to wait for the last sub-population to dwindle before triggering protective measures. This is not to imply that our ecological communities are currently in danger of wholesale collapse in the immediate future, but should serve as a warning especially in cases where disjunctive populations are likely.


Diapensia

Arctic-Alpine Tundra

Central to any discussion of these mountains is the issue of defining true arctic alpine communities versus subarctic alpine communities and the benchmark for subalpine forest and high mountain forest conditions. Numerous reports and original work conducted for this study confirm that the physical conditions and biological transition to boreal forest takes place in the western mountains of Maine in the vicinity of 2,500 feet in elevation. With less than 1% of the state of Maine above this elevation, the high montane forest and associated plant and animal communities are rare enough prior to any discussion of the rarity of true arctic-alpine communities.

...the physical conditions and biological transition to boreal forest takes place in the western mountains of Maine in the vicinity of 2,500 feet in elevation. With less than 1% of the state of Maine above this elevation...

Multiple sources and original field surveys conducted for this report confirm that true arctic alpine tundra indicator plant species and communities exist within the Study Area on Saddleback Mountain, Bigelow Mountain, and Mount Abraham. While plant ecologists may debate the definitions of true arctic-alpine tundra communities versus alpine communities with arctic indicator plants versus alpine communities with no arctic indicator plant species, the more important point from a landscape perspective is that we have a rare mosaic of biological conditions associated with the physical conditions found in this Study Area.

While these islands of red in Figure 11 are indeed looking like isolated fragments of habitat, various plant species associated with them extend into lower zones that includes the low stunted krummholz and subalpine forests of slightly lower elevations, as depicted in Figure 19. Field work conducted for this study on the major mountains of the Study Area demonstrated the patchy and convoluted boundary between the zones depicted in Figures 11 and 19. The field work demonstrated patches of true arctic alpine and sub-arctic alpine occurring

Arctic Alpine Tundra

Figure 11. Arctic-alpine and subarctic-alpine zone of study area. See Tables 1 and 2 for relevant for acreage

throughout the coverage depicted in Figure 19, that is the patches of red from Figure 11 occur, in reality, in patches throughout the cover depicted in Figure 19. The cover data that was used for this study was the most comprehensive and up-to-date data available. Unfortunately, short of an expensive site-intensive study design, the boundaries are obscured by a scale of resolution that under-represents true arctic alpine and obscures krummholz and subalpine boundaries as confirmed by field work for this study. Some alpine indicators are true arctic alpine plants found only at high elevation or in the Arctic. Unlike other alpine indicators, the arctic indicators are designated as a Species of Special Concern.

Figure 12. Saddleback Mountain ridge alpine mosaic

Table 5 summarizes the plant species composition for the alpine communities represented in Figure 16 and depicted in the representative photographs of Figures 12 through 14. As previously discussed, some of these species, especially the herbaceous species, are classified as rare in Maine by the Maine Natural Areas Program. Other species in this community are indicators of sub-arctic alpine communities and boreal bog communities and uncommon if not officially designated as rare.

Figure 13. Elevation 3,870 ft., Diapensia community on Mt. Abraham

Selected plant species from Table 5 are treated in greater detail below in Table 6 with respect to their population status as determined by the Maine Natural Areas Program and their specific habitats. While interpreting these tables please keep in mind that the plant species and communities considered rare and very rare with respect to Maine (and beyond in the northeast) are limited to the alpine zone that comprises less than 1 % of the state of Maine. This is one half of the already limited area (less than 2% of the state of Maine is available for use by the Bicknell's Thrush and other high montane bird species from Table 8).

Figure 14. Diapensia cushion with old flower stalks on Mt. Abraham

Table 5. Study Area alpine (arctic and sub-arctic) indicator plant species

Trees	**Herbaceous * = varying degrees of category "rare" in Maine (Maine Natural Areas Program)**
Balsam Fir (stunted and prostrate) *Abies balsamifera*	Alpine Sweet-grass*
Black Spruce (stunted and prostrate) *Picea mariana*	Bigelow's Sedge* *Carex bigelowii*
Mountain Birch *Betula minor*	Boott's Rattlesnakeroot* *Prenanthes boottii*
Shrubs	Boreal Bentgrass* *Agrostis mertensii*
Lapland Rosebay* *Rhododendron lapponicum*	Cutler's Goldenrod* *Solidago cutleri*
Alpine Bilberry *Arctostaphylos alpina*	Diapensia* *Diapensia lapponica*
Black Huckleberry *Gaylussacia baccata*	Mountain Firmoss* *Huperzia appalachiana*
Labrador Tea *Ledum groenlandicum*	Mountain Sandwort* *Aranaria groenlandica*
Rhodora *Rhododendron canadense*	Highland Rush *Juncus trifudus*
Alpine Blueberry* *Vaccinium boreal*	Three-toothed Cinquefoil *Potentilla tridentata*
Pale (Bog) Laurel *Kalmia polifolia*	Mountain Avens *Geum peckii*
Alpine Azalea *Losieleuria procumbens*	Bearberry Willow *Salix uva-ursi*
Snowberry *Gaultheria hispidula*	
Bog Bilberry *Vaccinium uliginosum*	
Alpine Bearberry* *Arctostaphylos alpina*	
Mountain Cranberry Mountain cranberry	
Small Cranberry *Vaccinium oxycocos*	
Dwarf Bilberry *Vaccinium cespitosum*	
Black Crowberry *Empetrum nigrum*	
Alpine Willow *Salix uva-arsi*	
Alpine Birch *Betula glandulosa*	
Alpine Bearberry *Arctostaphylos alpina*	
Alpine Alder *Alnus crispa*	

Table 6. Occasional though rare (Maine Natural Areas Program Designation) arctic-alpine and subarctic-alpine indicator plants occurring in the study area

Species	Environmental Characteristics	Population Status*
Bearberry Willow *Salix uva-ursi*	Arctic-alpine	Very rare, S-1 status by Maine Natural Areas Program
Lappland Rosebay *Rhdodendron lapponicum*	Arctic-alpine	Very rare, S-1 status by Maine Natural Areas Program
Alpine Bearberry *Arctostaphylos alpina*	Arctic-alpine	Very rare, S-1 status by Maine Natural Areas Program
Diapensia *Diapensia lapponica*	Arctic-alpine	Rare, S-1 status b Maine Natural Areas Program
Alpine Sweet Grass *Hierchloe alpine*	Arctic-alpine	Very rare, S-1 status by Maine Natural Areas Program
Bigelow Sedge *Carex bigelowii*	Arctic-alpine	Rare, S-2 status by Maine Natural Areas Program
Bog Bilberry *Vaccinium uliginosum*	Exposed rocky slopes	Uncommon
Dwarf bilberry *Vaccinium cespitosum*	Rocky shores, openings, and alpine areas	Uncommon
Black Crowberry *Empetrum nigrum*	Exposed peat and rock	Occasional
Mountain Sandwort *Minuartia groenlandica*	Exposed gravel	Rare, S-3 status by Maine Natural Areas Program
Deer-hair Sedge *Scirpus cespitosus*	Ledge, gravel, rocky shores	Uncommon

* Occasional = throughout much of state, but limited to certain ecosystems. Uncommon = Infrequently found in state, occurrences usually more than 30, often limited to certain ecosystems. Rare = Usually fewer than 30 occurrences throughout state. Very Rare = Either one geographic occurrence or fewer than 5 occurrences throughout state. S-1 = Vulnerable to extirpation in state of Maine due to rarity or aspect of its life history, fewer than 5 occurrences in state. S-2 = Limited distribution, 6-20 occurrences statewide and at risk for further decline. S-3 = Rare in Maine, 20-100 occurrences.

High Montane Including Subalpine Forest, Krummholz, and Patches of Alpine (Arctic and Sub-Arctic)

Rare communities and rare plant and animal species as designated by the Maine Natural Areas Program occur in the high montane zone depicted in Figure 19 with the transition occurring in patches as high as the areas depicted in Figure 16. The krummholz and subalpine zones occur in a patchy distribution rather than as distinct or even loosely defined lines. Figure 17 is a photo of a patch on Mt. Abraham where Bicknell's Thrush were singing on breeding territories in mid-June of 2006. Similar patches of habitat with territorial Bicknell's Thrush and Blackpoll Warblers were documented at 3,982 ft. on Mt. Abraham within the zone depicted in Figure 16. Ecological classification and categorization is a challenge in the absence of detailed on-site mapping. Field checks repeatedly demonstrated the need to view these transitions in terms of inter-grading of patches rather than a smooth gradient. This is reflected in the use of categories such as alpine, subalpine-krummholz, and high montane that have distinct meanings regarding some species and community characteristics but share considerable attributes as well. The high montane category is most meaningful when considering locally contiguous populations of the bird species classified by the same name and discussed in Table 8.

One of these high montane bird species is particularly deserving of more in depth discussion. The Bicknell's Thrush (Catharus bicknelli) worldwide population is at considerable risk of decline and conceivable extinction in the absence of aggressive conservation efforts in the near future. Due to this species' sensitivity to breeding habitat disturbance, conservation efforts will best be achieved through outright land acquisition. Ownership by groups such as the Maine Appalachian Trail Land Trust enables complete control of land use in this species' limited montane breeding environment and the surrounding landscape under increasing threat of direct degradation and disturbance from resort, vacation home, and wind power development activities. The species' breeding habitat consists of young to medium-aged fir dominated montane forests in the northeastern United States and eastern Canada above 2,700 meters in elevation. Such habitat is limited in overall areal extent and is distributed in patches across the local and regional landscapes.

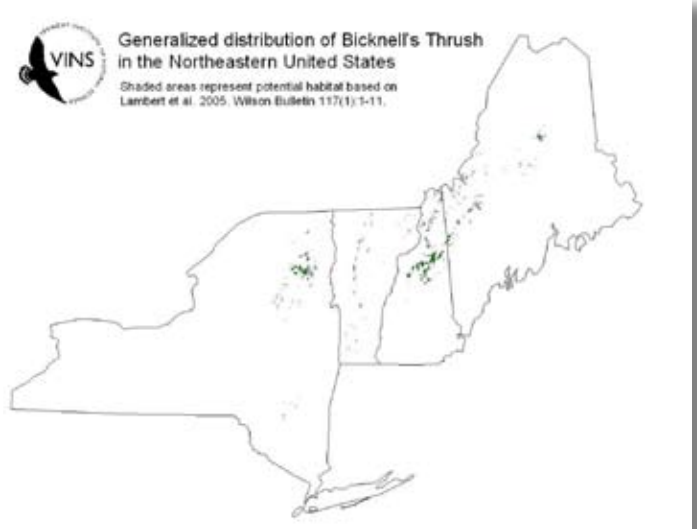


Figure 15. Bicknell's Thrush locations across high peaks of New York, Vermont, New Hampshire, and Maine. This map also represents the approximate distribution of other boreal forest plant and animal indicators. Note that the high peaks region of Maine represents a relatively narrow broad linkage across the region.

Alpine and Krummholz

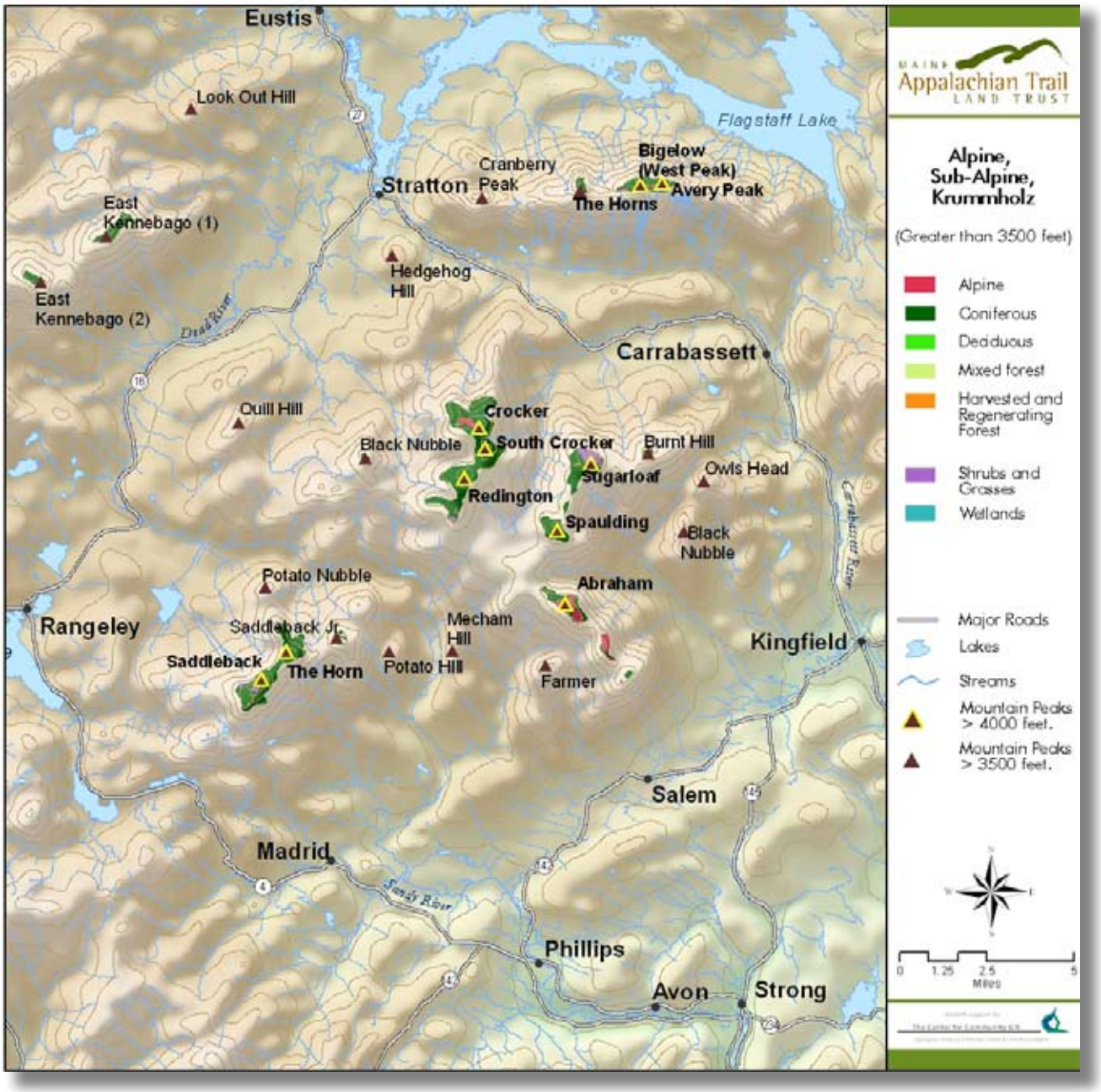


Figure 16. Primarily sub-alpine and krummholz of study area. See Tables 1 and 2 for relevant for acreage.

Figure 17. Elevation 3,200 feet, transition from subalpine to alpine zone on Mt. Abraham; Bicknell's Thrush documented here.

Approximately 90% of the world's population of Bicknell's Thrush is located within the northeastern United States in New York, Vermont, New Hampshire, and Maine. Within the states of New York, Vermont, and Maine its status is designated as a Species of Special Concern. Within New Hampshire it is considered a "species of special concern". The Committee on the Staus of Endangered Wildlife in Canada also lists Bicknell's Thrush as a species of special concern. The Partners in Flight Program considers the Bicknell's conservation a top priority among Neotropical migratory birds in the northeast.

The total population is likely less than 100,000 individuals throughout its range in the United States and Canada. This already limited population is fragmented and therefore subject to a myriad of stochastic population dysfunctions associated with isolation and habitat fragmentation in addition to direct deterministic effects associated with habitat loss. Other threats such as acid rain and projected climate change will likely result in further degradation and elimination of the already patchy and limited fir dominated montane habitat.

Elevation-based models suggest that Maine has 23% of the appropriate breeding habitat for the Bicknell's Thrush in the United States. The Mt. Abraham land unit including Black Nubble, Redington, and Sugarloaf is the single largest unit of Bicknell's Thrush breeding habitat in Maine, approximately 17% in one block with a high degree of contiguity. Saddleback Mountain and its environs contain the fourth greatest unit of Bicknell's Thrush breeding habitat, representing approximately 6% of the total breeding habitat available in Maine.

Figure 18. Elevation 2,700 feet, spruce fir subject to windthrow in patches; black-backed woodpecker, gray jay, boreal chickadee, Swainson's Thrush, and Blackpoll Warbler documented here.

Note: Figures 17 and 19 on following pages

In light of the sensitivity of this species to environmental degradation, its already low population numbers, and its world breeding population being limited to relatively rare habitat conditions within its breeding range, it is particularly important to note that in Maine only 41% of its habitat is protected. Compared to 83-94% of habitat protection in other states, two of which have either the same or less total appropriate habitat acreage Greater protection efforts must be achieved in the state of Maine.

High Montane Forest

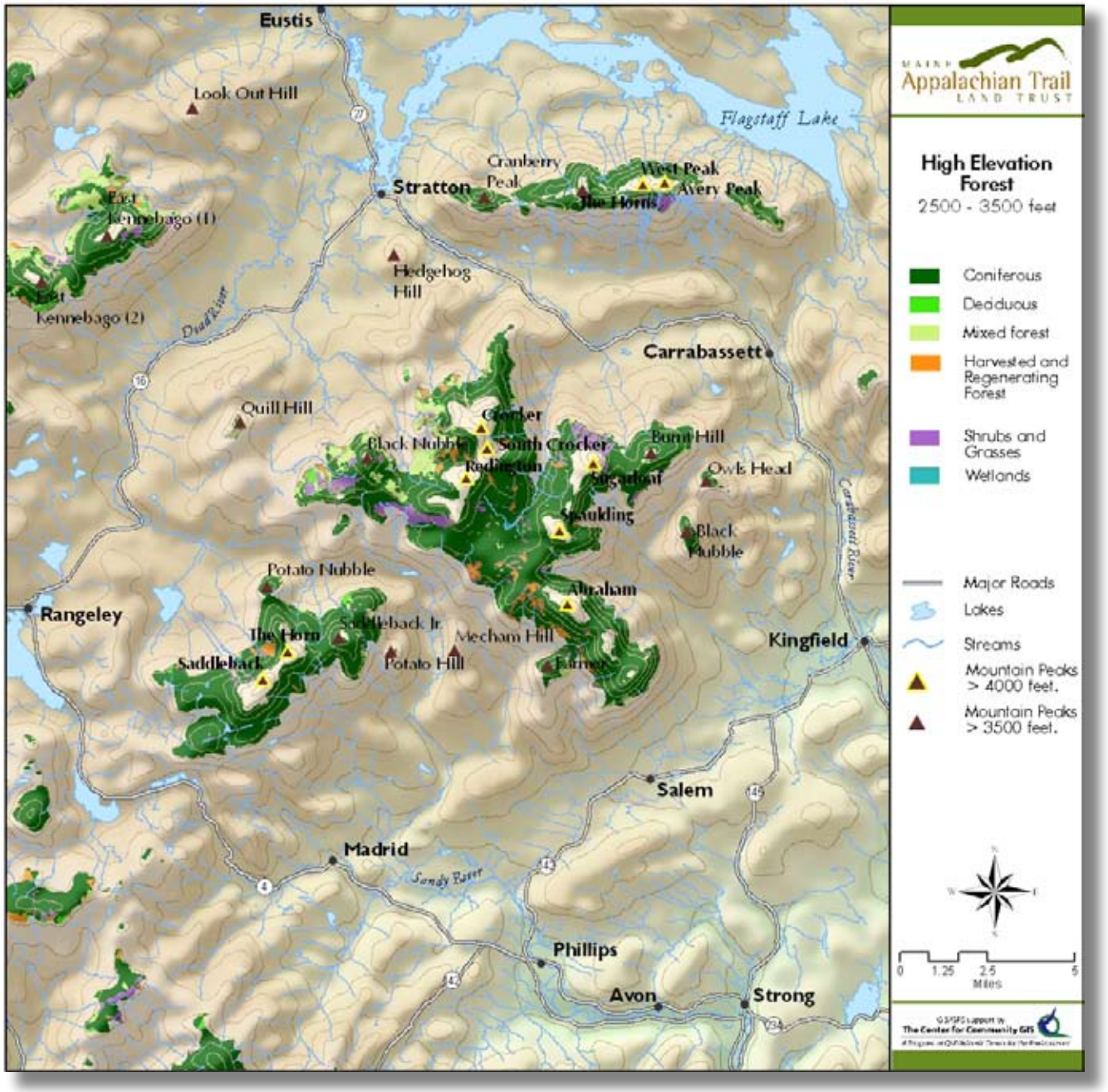


Figure 19. Primarily high montane and subalpine forest. See Tables 2a and 2b for relevant for acreage.

Table 7. Study Area high montane forest indicator plant species

Trees	Shrubs	Herbaceous
White Spruce *Picea glauca*	Mountain Maple Acer spicatum	Red Baneberry Actaia rubra
Black Spruce *Picea mariana*	Mountain Ash Sorbus decora	Red Trillium Trilium erectum
Red Spruce *Picea rubens*	Mountain Holly Nemopanthus mucronatus	Bunchberry Cornus canadensis
Balsam Fir *Abies balsamifera*	Mountain Alder Alnus veridis	Canada Mayflower Maianthemum canadense
Balsam Poplar *Populus balsamifera*	Sheep Laurel Kalmia angustifolia	Teaberry Gaultheria procumbens
Paper Birch *Betula papyrifera*	Lowbush Blueberry Vaccinium angustifolium	Goldthread Coptis trifolia
Bigtooth Aspen *Populus grandidentata*	Elderberry Sambucus canadensis	Mountain Sorrel Oxyria digyna
Quaking Aspen *Populus tremuloides*	Alpine Bearberry Arctostaphylos alpina	Clintonia Clintonia borealis
Tamarack *Larix laricina*	Bush Honeysuckle Diervilla lonicera	Twinflower Linnaia borealis
Mountain Birch *Betula minor*	Mountain Honeysuckle Lonicera villosa	Starflower trientalis borealis
Alpine Birch *Betula glandulosa*	Bearberry Willow *Salix uva-ursi*	One-sided Pyrola Pyrola secunda
Heart-leaved Paper Birch *Betula papyrifera* var. *cordifolia*		Shinleaf Pyrola elliptica

Table 8. Study Area high montane forest bird indicator species

Species	Important Habitat or Landscape Features	Population Status and Conservation
Spruce grouse *Falcipennis canadensis*	Contiguous boreal/boreal transition forest, large stands of dense fir and spruce.	Vermont endangered, heritage list in New Hampshire, uncommon in Maine and rangewide in U.S. due to limited transitional boreal forest.
Black-backed Woodpecker *Picoides arcticus*	Dead and declining mature spruce and fir in boreal/boreal transition forest. Contigous landscape matrix of mature, disturbed, and regenerating patches	Vermont special concern, heritage list in New Hampshire, uncommon in Maine and rangewide in U.S. due to limited transitional boreal forest.
Three-toed Woodpecker *Picoides tridactylus*	Dead and declining mature spruce and fir in boreal/boreal transition forest. Contigous landscape matrix of mature, disturbed, and regenerating patches	Maine and Vermont special concern, heritage list in New Hampshire, uncommon in Maine and rangewide in U.S. due to limited transitional boreal forest.
Gray Jay *Perisoreus canadensis*	Contiguous, boreal/boreal transition forest, dense medium aged to mature coniferous forest structure.	Vermont special concern, heritage list in New Hampshire, uncommon in Maine and rangewide in U.S. due to limited transitional boreal forest.
Boreal Chickadee *Poecile hudsonicus*	Contiguous mature coniferous forest with dead and declining trees for cavity nesting in boreal/boreal transition forest.	Uncommon in Maine and rangewide in U.S. due to limited transitional boreal forest.
Bicknell's Thrush *Catharus bicknelli*	Low, dense, contiguous spruce-fir forest at high elevation in U.S. portion of range in boreal/boreal transtion forest.	Maine and Vermont state special concern. Uncommon rangewide in U.S. due to limited transitional boreal forest.
Blackpoll Warbler *Dendroica striata*	Low, dense, contiguous spruce/spruce-fir stands in boreal/boreal transition forest.	Uncommon in Maine and rangewide in U.S. due to limited transitional boreal forest.
Boreal Owl *Aegolius funereus*	Dense, contiguous, coniferous or mixed wood stands, occurs in Study Areaduring winter only.	Uncommon in Maine and rangewide in U.S. due to limited transitional boreal forest.

Low Montane and Valley Forest

These categories represent landscape connections between the upper zones, contribute to the landscape contiguity that spans the region, and together with the upper zones determine the high native ecological diversity of the Study Area itself. The close proximity of low montane and valley forests to the high montane through alpine communities is a measure of ecosystem, community, and species diversity that stands on its own as a significant unit of conservation. More than just an incidental region of mixing among northern hardwood, mixed-wood, sub-boreal and boreal types, it is its own one-of-a-kind ecological landscape with unique communities comprised of animals and plants otherwise separated by hundreds of miles into proximity.

Figure 20. 2,450 feet: spruce/fir zone established, hardwood component falling out, represented here by birch

Low montane forest on the southern side of the mountain chain is represented by a shallow band as depicted in Figure 22. Higher elevations to the north and west demonstrate the occurrence of low montane communities surrounding the town of Rangeley, while the towns of Philips and Kingfield are well within the valley forest of Figure 23. A conservation opportunity exists here, as this frontier of contiguous mixed-wood and hardwood forest, increasingly fragmented to the south in the state of Maine, is poised for potential rapid development.

Examination of the associated indicator species tables suggests the species of animal first on the list for range contraction and localized extinctions. A conservation strategy not only looks at the needs of the various indicator species as outlined previously, but considers potential threats in the form of land use conversion and fragmentation. Loss of the valley forest would not only effect the dynamics of low montane forest but would also represent a loss of contiguous forest type undergoing rapid conversion as close as the Route 2 corridor in the next several decades.likely to undergo rapid conversion in the absence of conservation planning now.

Figure 21. Mature hardwood forest
Note: Figure 22 on following page

Low Montane Forest

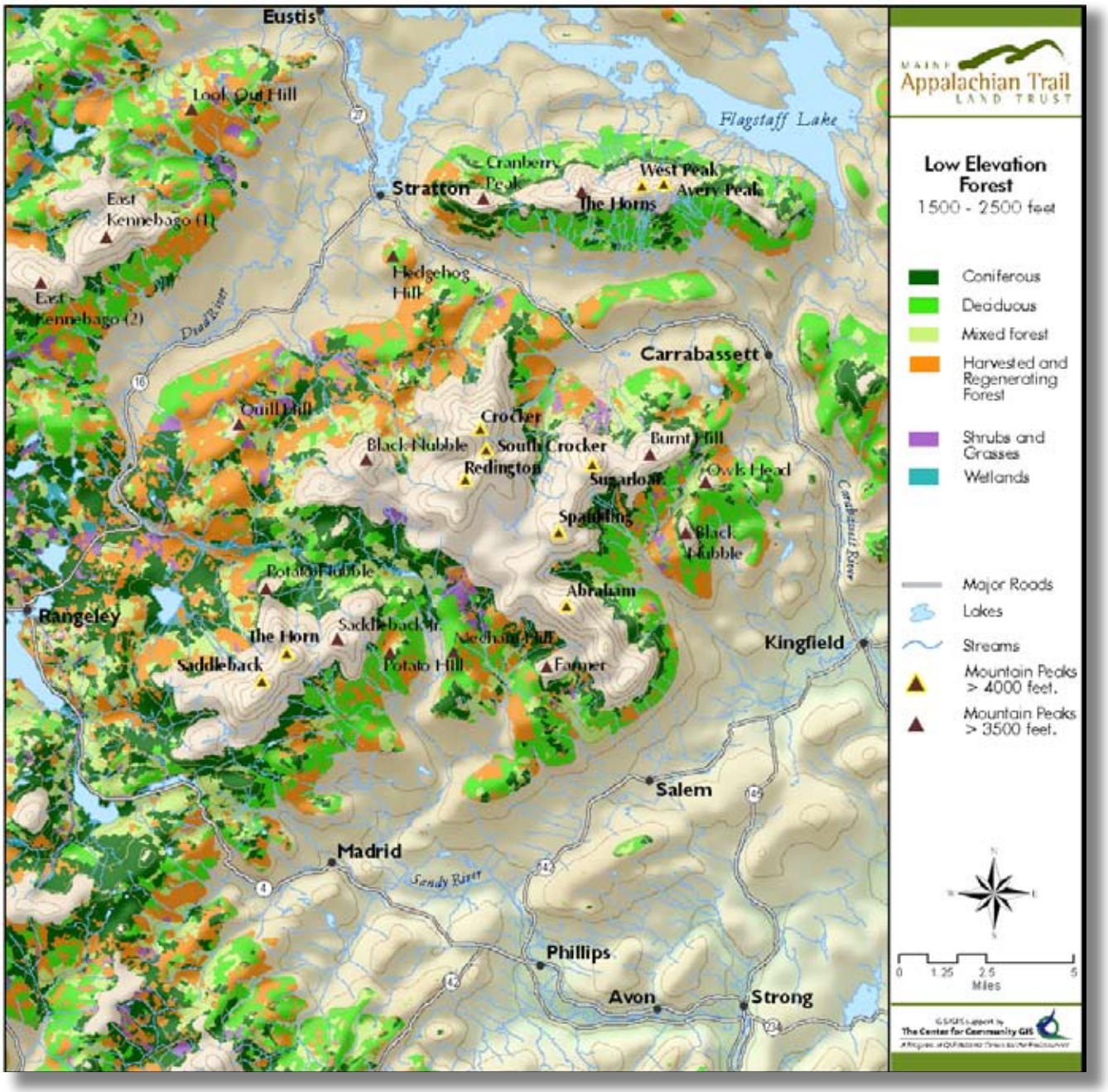


Figure 22. Low montane forest of the study area. See Tables 1 and 2 for relevant for acreage.

Valley Forest

Figure 23. Valley forest of the study area. See Tables 1 and 2 for relevant for acreage.

Table 9. Study Area low montane forest bird indicator species

Species	Important Habitat or Landscape Features	Population Status and Conservation
Tennessee Warbler *Vermivora peregrina*	Contiguous northern coniferous and mixed-wood boreal/boreal transition forest	New Hampshire and Vermont heritage lists, could face declines with fragmentation and conversion of already limited appropriate contiguous forest
Black-throated Green Warbler *Dendroica virens*	Contiguous mature, closed canopy mixed-wood stands	Populations viable, could face declines with fragmentation and conversion of already limited coniferous and mixed-wood contiguous forest
Blackburnian Warbler *Dendroica fusca*	Contiguous mature coniferous forests or hardwood with softwood component. Mature forest with Usnea lichens,	Populations viable, could face declines with fragmentation and conversion of already limited contiguous softwood and mixed-wood forest
Magnolia Warbler *Dendroica magnolia*	Coniferous and mixed-wood forests, low dense regenerating spruce and fir stands.	Populations viable, could face delines with continued loss of already limited boreal transitional forest
Cape May Warbler *Dendroica tigrina*	Contiguous northern coniferous and mixed-wood boreal/boreal transition forest. Dense stands of low growing conifers.	New Hampshire and Vermont heritage lists, could face delines with continued loss of already limited boreal transitional forest.
Bay-breasted Warbler *Dendroica castanea*	Contiguous boreal/boreal transition forests, northern coniferous mixed-wood	Vermont heritage list, could face delines with continued loss of already limited boreal transitional forest.
Palm Warbler *Dendroica palmarum*	Open bogs within contiguous boreal/boreal transition forest	New Hampshire heritage list, could face delines with continued loss of already limited boreal transitional forest.
Northern Parula *Parula americanus*	Northern coniferous and mixed-wood boreal/boreal transition forests. Uses mature, contiguous, closed canopy stands with Usnea lichen for nest building. Often nests in forest on margins of ponds and lakes.	Populations viable, could face delines with continued loss of already limited mature boreal transitional forest with ample well developed Usnea, used in nest building.
Olive-sided Flycatcher *Contopus cooperi*	High elevation coniferous forests near open areas including burns, wooded streams, and bogs	Maine state special concern. Uncommon in Maine and rangewide in U.S. due to limited transitional boreal forest. mosaic includnig bogs and wooded streams.
White-winged Crossbill	Dense, contiguous stands of spruce including groves of mature cone bearing trees	New Hampshire heritage list, could face delines with continued loss of already limited boreal transitional forest.
Red Crossbill *Loxia curvitostra*	Dense, contiguous stands of spruce including groves of mature cone bearing trees	Limited to the transitional boreal forest in western Maine mountains and northern Maine.
Swainson's Thrush *Catharus ustulatus*	Dense, contiguous stands of coniferous forest, minor hardwood component possible. Landscape can include small pathes of advanced regeneration. Damp areas near mountain streams.	Populations viable, could face declines with fragmentation and conversion of already limited coniferous and mixed-wood contiguous forest.

Table continued on next page

Winter Wren *Troglodyte troglodytes*	Dense understory of contiguous coniferous or mixed-wood stands near bogs and small streams and woodland seeps. Oten uses root-ball of large overturned trees for next placement.	Populations viable, could face declines with fragmentation and conversion of already limited coniferous and mixed-wood contiguous forest.
White-throated Sparrow *Zonotrichia albicollis*	Decidous, mixed-wood, or coniferous stands regenerating or stunted at highre elevations.	Limited to the transitional boreal forest in western Maine mountains and northern Maine.
Golden-crowned Kinglet *Regulus satrapa*	Dense, contiguous, spruce-fir forest, or other mixed conifers.	Populations viable, could face declines with fragmentation and conversion of already limited coniferous and mixed-wood contiguous forest.
Ruby-crowned Kinglet *Regulus calendula*	Dense, contiguous, spruce-fir forest, or other mixed conifers.	Populations viable, could face declines with fragmentation and conversion of already limited coniferous and mixed-wood contiguous forest.
Saw-whet Owl *Aegolius acadicus*	Mature, contiguous, dense forested wetlands of white cedar, spruce, fir, and tamarack.	Populations viable, could face declines with fragmentation and conversion of already limited coniferous and mixed-wood contiguous forest.
Red-breasted Merganser *Mergus serrator*	Wooded margins of ponds, lakes, streams and rivers.	Concerns about long-term population viability include development of shorelines, watershed fragmentation, water quality, and water level fluctuation.
Common Merganser *Mergus mergus*	Oligotrophic lakes, rivers with forested shores. Requires large cavity trees for nesting.	Concerns about long-term population viability include development of shorelines, watershed fragmentation, water quality, and water level fluctuation.
Common Loon *Gavia immer*	Large and small oligotrophic lakes with fish prey base.	Concerns about long-term population viability include development of shorelines, watershed fragmentation, water quality, and water level fluctuation.

Table 10. Study Area low montane mixed-wood and high montane soft wood forest mammal indicator species

Species	Important Habitat or Landscape Features	Population Status and Conservation
Rock (or Yellow-nosed) Vole *Microttus chrotorrhinus*	Coniferous and mixed-wood forests at higher elevations. Talus slopes near streams. Moss covered rocks.	Maine and Vermont state special concern. Uncommon in Maine and range-wide in U.S. due to limited transitional boreal forest. Naturally patchy and localized populations vulnerable to habitat loss or alteration.
Southern Red-backed Vole *Clethrionomys gapperi*	Mesic, cool coniferous, mixed-wood, and deciduous forest. Bogs, streams, downed woody material, stumps, rocks	Populations viable, required downed woody material dependent upon mature forest conditions.
Red-backed Vole *Synaptomus borealis*	Cool, moist, deciduous, mixed-wood, and coniferous forests. Moss covered rocks, woody debris, roots. Springs, bogs, streams.	Populations viable, required downed woody material dependent upon mature forest conditions.
Pygmy Shrew *Microsorex hoyi*	Deciduous and coniferous moist forest. Leaf mold near water.	Vermont heritage list. Naturally patchy and localized populations vulnerable to habitat loss or alteration.
Long-tailed Shrew *Sorex dispar*	Cold, damp coniferous forests at higher elevations. Downed woody debris.	Maine and Vermont state special concern.
Northern Bog Lemming *Synaptomys borealis*	Moist soils in spruce-fir forest, mosses.	Maine state threatened, New Hampshire heritage list. Naturally patchy and localized populations vulnerable to habitat loss or alteration.
Southern Bog Lemming *Synamptomys cooperi*	Higher herbaceous cover under shrublands and forest. Sphagnum bogs, moist soils, leaf mold.	Vermont heritage list. Naturally patchy and localized populations vulnerable to habitat loss or alteration.
Short-tailed Weasel *Mustela erminea*	Alpine meadows, forest edge, riparian woodlands, various seral stages of deciduous, mixed-wood, and coniferous forests.	Populations viable
Northern Flying Squirrel *Glaucomys sabrinus*	Dense, mature mixed-wood, coniferous, or deciduous forest. Hollow trees and tree cavities. Feeds on arboreal lichens in winter.	Populations viable, but limited especially in winter by need for den trees and lichens for food, both derived from mature forest structure and conditions. Much of Maine's commercial forest is in uniform early successional stage.
Showshoe Hare *Lepus americanus*	Deciduous, mixed-wood, and coniferous forest with dense shrub understory. Mosaic of regenerating vegetation for cover and browse within forested landscape.	Populations viable.
Canada Lynx *Lynx canadensis*	Extensive boreal/boreal transitional forest that includes variety of successional stages. Large quantities of snowshoe hare in early successional habitat. Home ranges in the thousands to 10's of thousands of acres.	Federally threatened, Maine state special concern, New Hampshire and Vermont state endangered. At southern extent of its range, it is most competitive with the bobcat under heavy snows. Though variety of seral stages used, contiguity still important and needs boreal/boreal transition forest type.

Table continued on next page

Bobcat *Lynx rufus*	Extensive mixed-wood and hardwood forests with high densities of hardwood and softwood understory. Rocks and ledge for denning. Home ranges in the thousands to 10's of thousands of acres.	Habitat conversion and fragmentation at fringes of Study Area could threaten viability or contraction of localized populations.
Fisher *Martes pennanti*	Closed canopy contiguous coniferous or mixed-wood forests interspersed with wetlands across the landscape mosaic. Home ranges in the thousands of acres.	Requires large blocks of contiguous forest. Habitat conversion and fragmentation at fringes of Study Areacould threaten viability or contraction of localized populations.
Pine Marten *Martes americanus*	Spruce-fir forest, cedar swamps and thick mixed-wood forest. Den sites in large cavity trees, downed woody material on forest floor. Home ranges of several thousand acres. Contigous landscape matrix of mature forest can include disturbed, and regenerating patches. Home ranges in the thousands of acres.	Requires large blocks of contiguous softwood and mixed-wood forest that includes mature forest patches. Habitat conversion and fragmentation at fringes of Study Areacould threaten viability or contraction of localized populations.
Moose *Alces alces*	Landscape mosaic of boreal/boreal transition forest in various stages of succession. Regenerating forest stage critical for food. Swamps and lakes for aquatic vegetation foraging. Home ranges up to 15,000 acres.	Populations viable. Though it uses a matrix of varied forest types and conditions, landscape contiguity still important for long term population viability

Table 11. Study Area low montane mixed-wood and valley forest hard wood indicator plant species

Trees	Shrubs	Herbaceous
Yellow Birch Betula allegheniensis	Striped Maple Acer pennsylvanicum	Painted Trillium Trillium undulatum
Sugar Maple Acer saccarum	Hobblebush Viburnum alterniflora	Goldthread Coptis trifolia
American Beech Fagus grandifolia	Nannyberry Viburnum lentago	Common Wood-Sorrel Oxalis montana
Balsam Fir Abies balsamifera	Mountain Laurel	Pink Lady's Slipper Cypripedium acaule
Red Spruce Picea rubens	Canada Honeysuckle Lonicera canadensis	Wood Lily Lilium philadelphicum
Eastern Hamlock Thuja occidentalis	Red-berried Elder Sambucus pubens	Wild Sarsaparilla Aralia nudicaulis
White Pine Pinus strobus	High Bush Cranberry Viburnum trilobum	Spotted Wintergreen Chimaphila maculata
Paper Birch Betula papyrifera	Witherrod Viburnum cassiniodes	Kidney-leaved Violet Viola renifolia
Balsam Poplar Populus balsamifera	Squashberry Viburnum edule	
Mountain Ash Sorbus decora	Sweetgale Myrica gale	
Mountain Maple Acer spicatum		

Table 12. Study Area valley hard wood forest bird indicator species

Species	Important Habitat or Landscape Features	Population Status and Conservation
Ovenbird *Seirius aurocapillus*	Mature contiguous hardwood forest or mixe-wood with minor softwood compoent. Relatively open open understory, but with some shrub layer. Layer of dead leaves and downed woody debris.	Populations viable, could face local declines with fragmentation and conversion of already limited mature, contiguous hardwood forest.
Black-throated Blue Warbler *Dendroica caerulescens*	Mature contiguous hardwood forests with softwood understory, usually contiguous but with small canopy gaps where it often nests.	Populations viable, could face local declines with fragmentation and conversion of already limited mature, contiguous hardwood and mixed-wood forest.
Wilson's Warbler *Wilsonia pusilla*	Shrub swamps and bogs. Early regneration. Alder, tamarack. Beaver ponds, riparian shrub forest.	New Hampshire heritage list, Vermont state special concern. Further loss of softwood wetlands poses threat to long term population viability.
Wood Thrush *Hylocichla mustelina*	Mature contiguous hardwood and mixed-wood forests. Especially sensitive to landscape fragmentation.	Distribution is patchy and localized. Particularly sensitive to fragmentation and loss of closed canopy hardwood forest. Widespread under-aged forest throughout Maine and habitat conversion threaten long term population viability.
Veery *Catharus fuscescens*	Bottom-land contiguous forests with moist intermittent cover of deciduous or deciduous-light coniferous mix, wooded swamps.	Distribution is patchy and localized. Particularly sensitive to fragmentation and loss of closed canopy hardwood forest associated with seeps and wooded swamps. Loss of mature forest with wooded swamps threatens long term population viability.
Hermit Thrush *Catharus guttatus*	Dense coniferous and mixed-wood forest, sometimes nesting near edges of gaps and openings.	Populations viable. Though more tolerant of forest fragmentation and younger seral stages than other thrush, landscape contiguity still important as is the softwood component. Fragmentation and loss of softwood could pose threats to local populations.
Scarlet Tanager *Piranga olivacea*	Mature deciduous or mixed-wood forests.	Populations viable. Though this species does use patches of small forest, mature forest conditions offer the optimal breeding habitat. Localized loss of mature forest conditions will lead to localized loss of this species.
Red-eyed Vireo *Vireo olivaceous*	Mature, closed canopy hardwood forests.	Populations viable, could face local declines with fragmentation and conversion of already limited mature, contiguous hardwood and mixed-wood forest.
Blue-headed Vireo *Vireo solitarius*	Contiguous mature coniferous or mixed-wood forests.	Populations viable, could face local declines with fragmentation and conversion of already limited mature, contiguous hardwood and mixed-wood forest.

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Pileated Woodpecker *Dryocopus pileatus*	Mature forest structure including declining and dead trees. Large areas preferably contiguous of this habitat type. Deciduous or mixed wood stands. An important keystone species for numerous birds and mammals using tree cavities for nest, dens, or foraging sites.	Needs mature forest structure and dead and declining trees in multiple size classes. These elements are poorly represented in much of Maine's commericially managed forests and thus poses a threat to long term population viability.
Northern Goshawk *Accipiter gentilis*	Interior of contiguous, mature, coniferous and mixed-wood forests.	Maine state special concern, New Hampshire heritage list.
Barred Owl *Strix varia*	Large blocks of contiguous mature mixed wood forest often bordering lakes, streams, or beaver flowages. Stand structure must include selection of large declining or dead trees for cavity nesting. Home range of approximately 600 acres.	Populations viable, could face local declines with fragmentation and conversion of already limited mature, contiguous hardwood forest. Particularly dependent upon ample declining and dead trees for nesting. These features are derived from mature forest and natural tree decline and death and are notable deficient throughout much of Maine's commerically managed forests.
Common Goldeneye *Bucephala clangula*	Open mature forest with cavity trees surrounding lakes, ponds, shallow rivers, and and forested wetlands	New Hampshire heritage list.
American Bittern *Botaurus lentiginosus*	Extensive, contigous freshwater marshes and wooded swamps. Dense emergent wetland vegetation.	Declining due to loss of wetland habitat within U.S. range.

Cairn on Abraham

Table 13. Study Area valley forest hard wood mammal indicator species

Species	Important Habitat or Landscape Features	Population Status and Conservation
Black bear *Ursus americanus*	Extensive deciduous, mixed-wood, and coniferous forest landscape mosaic that includes openings of wetlands and regneration. Home range size in the thousands up to approximately 15,000 acres.	Though it uses a matrix of varied forest types and conditions, landscape contiguity still important for long term population viability.
Beaver *Castor canadensis*	Slowly flowing brooks, streams, rivers, or lakes bordered by woodlands. Young hardwoods within 100 feet of water for dam construction.	Local populations threatened when beaver dams disrupt roads. Though regionally the population is viable, localized beaver removal leads to the loss of valuable and sometimes scarce wetland habitat and jeopardizes numerous threatened species of multiple taxa that use wetland landscapes.
Red Bat *Lasiurus borealis*	Hardwood, mixed-wood and softwood forests. Dense foliage cover for roosting.	Rare and uncommon, its localized populations are vulnerable to local extinctions from even normal population fluctuation.
Short-tailed Shrew *Blarina brevicauda*	Forested and open deciduous and mixed-wood forests. Streamside vegetation.	Populations viable.
River Otter *Lontra canadensis*	Lake, pond, stream, river with dense vegetation structure and downed woody material. Den sites along stream banks. Fish prey populations. Home range size approximately 15,000 acres.	Populations localized and linked to important landscape mosaic of required terrestrial and aquatic habitat, and healthy fish populations. Need for variety of aquatic habitats places long term viability of populations at risk from habitat conversion and fragmentation near lakeshores and rivers.
Mink *Mustela vision*	Wetlands, rivers, streams, downed woody debris, dens sites in hollow logs or banking.	Populations localized and linked to important landscape mosaic of required terrestrial and aquatic habitat, and healthy fish populations. Large home range sizes and need for variety of aquatic habitat places long term viability of populations at risk from habitat conversion and fragmentation near lakeshores and rivers.
Water Shrew *Sorex palustris*	Cold ponds, streams, and lakes bordered by marsh and shrubs in coniferous forest.	New Hampshire heritage list. Naturally patchy population distribution places populations at localized risk for extinction due to natural population fluctuations.

Wetlands, Streams, Ponds, and Lakes

Some landscape features, because of their importance and rarity if not their abundance, contribute to native ecological diversity out of proportion to their areal extent and abundance. Wetlands, streams, ponds, and lakes are just such a feature. As previously discussed in reference to Maine Natural Areas Program data presented in Table 4, two of these communities are high elevation water-based ecological units. Elevation determines diversity in aquatic as well as strictly terrestrial communities. Many animals use these features exclusively or at some point during seasonal cycles or daily routines. Assemblages of plants and animals found in this range of aquatic habitat add to the ecological diversity of the region at multiple scales whether they offer migratory stop-over sites for various species of ducks, permanent residence for fish, breeding sites for amphibians, or crucial parts of the landscape menu required by moose, otter, or mink. The importance goes across broad taxonomic boundaries. As with previous sections, the various indicators can be related to species and population requirements and availability of this feature across the landscape.

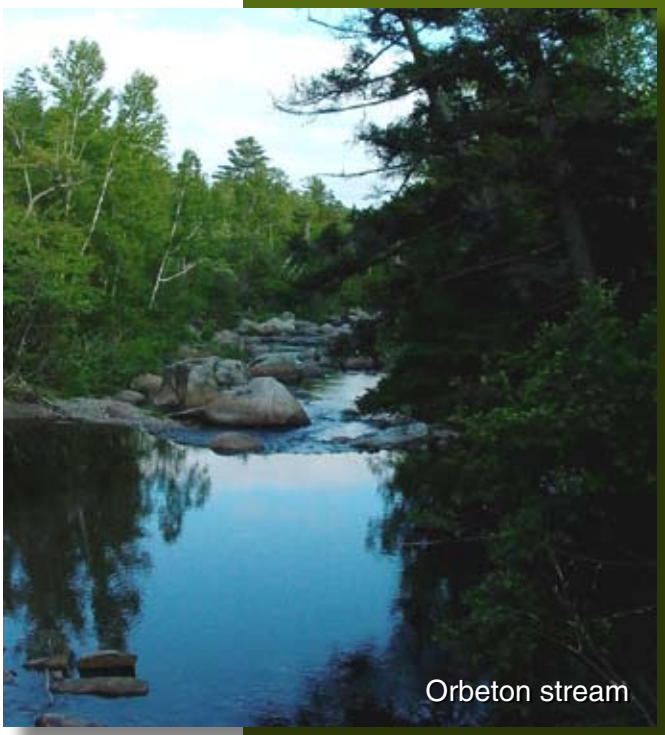
Orbeton stream

Table 14. Study Area boreal bog indicator plant species

Trees	Shrubs	Herbaceous
Black Spruce *Picea mariana*	Labrador Tea *Ledum groenlandicum*	Sphagnum Moss *Sphagnum sp.*
Tamarack *Larix laricina*	Leather Leaf *Chamaedaphne calyculata*	Pitcher Plant *Sarracenia purpurea*
Northern White Cedar *Thuja occidentalis*	Bog Rosemary *Vaccinium uliginosum*	Sundews
Balsam Fir *Abies balsamifera*	Rhodora *Rhododendron canadense*	Cotton-grass
Paper Birch *Betula papyrifera*	Pale Laurel *Kalmia polifolia*	Cranberries
Balsam Poplar *Populus balsamifera*	Winterberry *Ilex verticillata*	Creeping Snowberry *Gaultheria hispidula*
Black Ash *Fraxinum nigra*		Orchids
		Sedges
		Three-leaved False Solomon's Seal *Smilacina racemosa*

Wetlands, Streams, Ponds, and Lakes

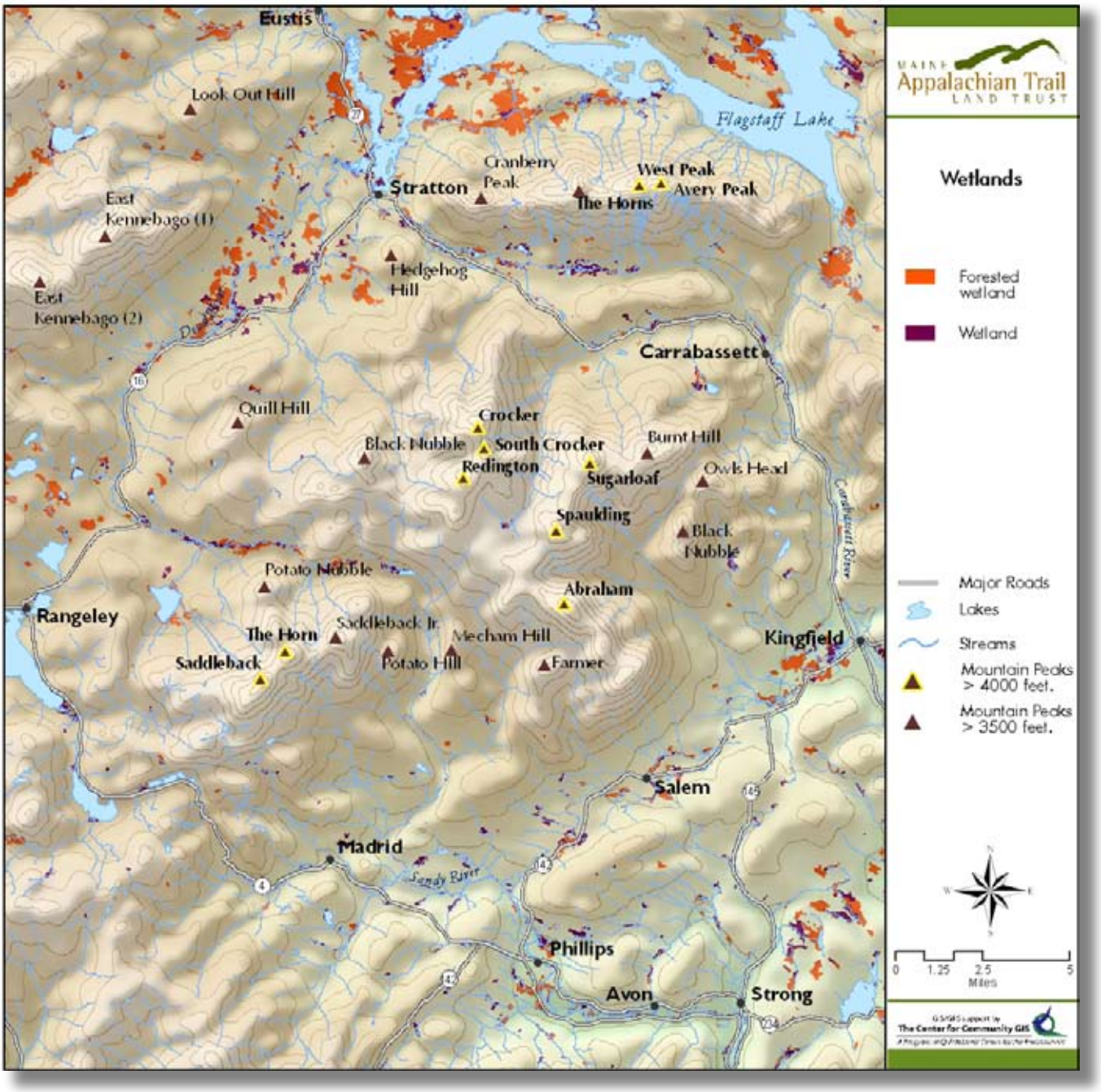

Figure 24. Wetlands, lakes, ponds, rivers, and streams of the study area. 1029 miles of perennial stream, 456 miles of intermittent stream and see Table 2 for wetland data.

Watershed Boundaries

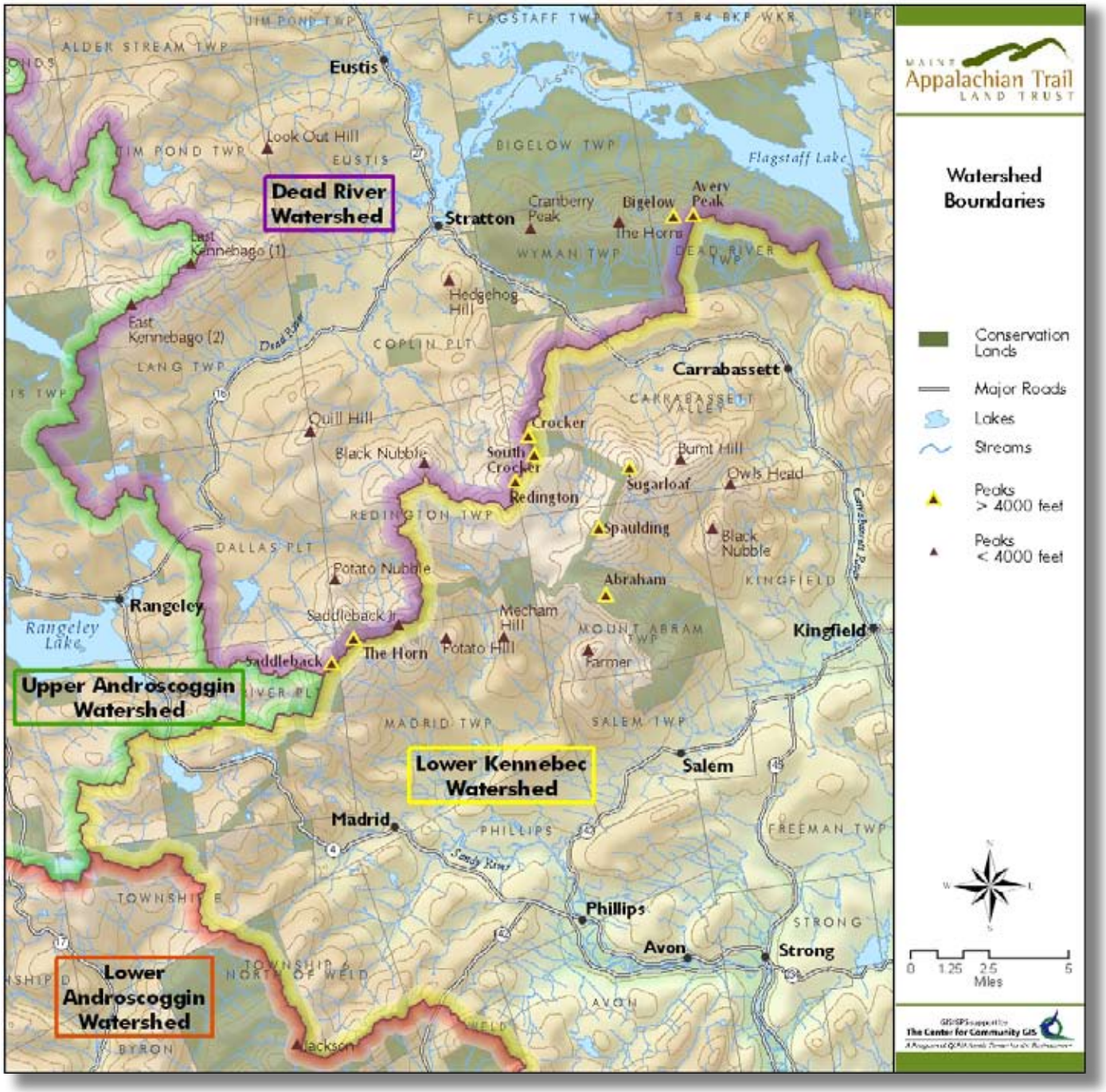

Figure 25. Watershed Boundaries

Here lie the headwaters of several important rivers-the Kennebec, the South Branches of the Dead and Carrabasset, the Sandy, and the Adroscoggin.

Table 15. Study Area amphibian, reptile, and fish indicator species.

Species	Important Habitat Features	Population Status and Conservation
Amphibians and Reptiles		
Wood Frog *Rana sylvatica*	Moist hardwood and mixed-wood forest mosaics including seeps, vernal pools, and upland habitat with dense canopy coverage.	Populations viable in Study Area, but dependent upon maintenance of landscape mosaics of mature forest cover and vernal pool breeding habitat. The latter can be a limiting factor to populations and is an important element in conservation planning in areas of forest management and development
Mink Frog *Rana septentrionalis*	Oligotrophic lakes, ponds, springs and stream inlets. Abundant lily pads and pickerel weed.	Natural scarcity of cold, oxygen rich water bodies has led to patchy landscape distribution. Such a distribution is particularly vulnerble to localized extinctions from habitat loss and conversion. Potential for conflict is high due to fragility of aquatic systems and human development potential near lakes, ponds, and streams.
Spotted Salamander *Ambyostoma maculatum*	Wet woodlands, streambanks. Require vernal pools for breeding. Coarse woody material on forest floor such as downed logs and rocks.	Populations viable in Study Area, but dependent upon maintenance of landscape mosaics of mature forest cover and vernal pool breeding habitat. The latter can be a limiting factor to populations and is an important element in conservation planning in areas of forest management and development
Blue-spotted Salamander *Ambystoma laterale* and hybrid forms including *A. tremblayi*	Deciduous forests, wooded swamps. Vernal pools for breeding.	Vermont state special concern. Populations viable in Study Area, but dependent upon maintenance of landscape mosaics of mature forest cover and vernal pool breeding habitat. The latter can be a limiting factor to populations and is an important element in conservation planning in areas of forest management and development.
Northern Two-lined Salamander *Eurycea bislineata*	Mixed wood at higher elevations near streams or bogs. Breeds in streams with rocky bottoms or cobble.	Populations viable, though dependent upon aquatic resources which are often vulnerable to effects of forest management and development.
Wood Turtle *Clemmys insculpta*	Slow moving streams with overhanging vegetation. Spends summer in moist woodlands.	Population declining due to habitat loss. Vulnerability of aquaic habitat to forest management and develoment coupled with poor dispersal and recolonization potential places long term viability of wood turtle populations at considerable risk.
Northern Redback Salamander *Plethodon cinereus*	Mixed-wood and coniferous forest. Uses interior of decaying logs and stumps.	Populations viable.

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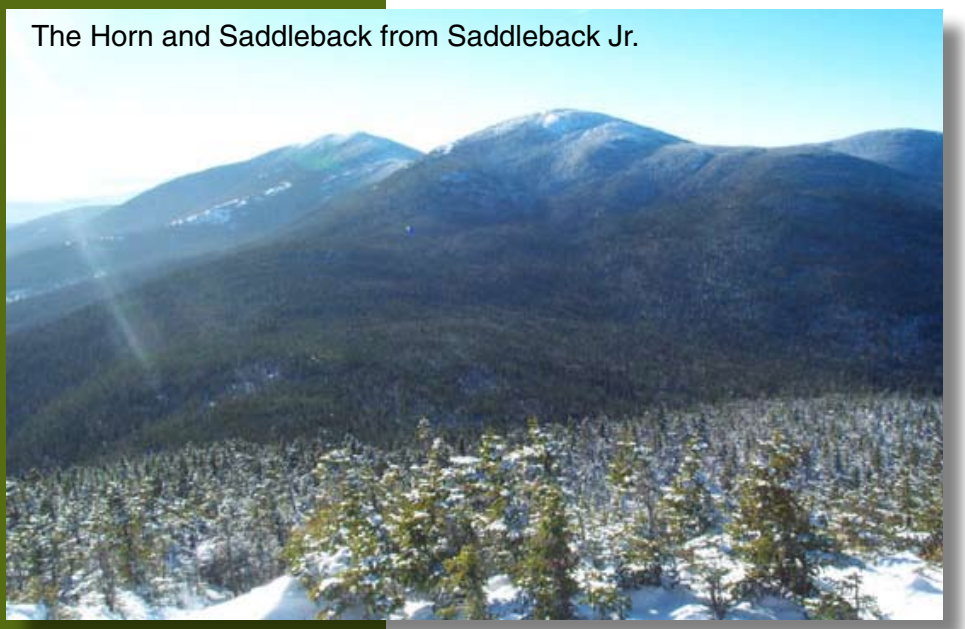
Fish		
Brook Trout *Salvelinus fontinalis*	Cold water streams, rivers, and lakes. May use full range of water courses and water bodies in course of life and reproduction. Well oxygenated high quality water for spawning. Spawning waters highly susceptible to road building, timber harvests in watersheds, and inadequate riparian buffers	Populaitons viable but continue to depend upon maintenance of primary habitat and the watersheds that influence water quality and temperatures especially in shallow water spawning areas.
Lake Trout *Salvelinus naymaycush*	Deep, large, cold-water lakes with irregular bottom topography including rocks. High water quality important at all depths including shallow spawning waters.	Populations viable but continue to depend upon water quality of limited appropriate northern deep water lakes. In turn water quality, especially shallow water spawning dependent upon lakeshore and watershed conservation.
Landlocked Salmon *Salmon salar*	Deep, large, cold-water lakes with irregular bottom topography including rocks. High water quality important at all depths including shallow spawning waters.	Populations viable but continue to depend upon water quality of limited appropriate northern deep water lakes.


Brook trout



The Horn and Saddleback from Saddleback Jr.

Part 5:
Conservation Recommendations

The data presented demonstrates the transition from northern hardwood to sub-boreal and boreal forest occurring within the Study Area. Numerous threatened, endangered, and at-risk species of plant and animal from the respective ecosystems north and south of this transition occur here. Moreover, the mix of ecosystems, communities, and species in this landscape is a form of ecological diversity on its own. The existence of genuine arctic-alpine communities and sub-arctic alpine communities in the Study Area is a significant, but by no means the only, distinctive quality of this Study Area worthy of conservation.

A diversity of topography that includes deep water lakes, extensive un-fragmented lowland, mid-slope, high elevation forest, and alpine communities ranks the study landscape as an important conservation package from multiple standpoints. These various elements are summarized in Figure 26. Physical conditions and as represented by the top cell of the Figure 26 have coincided to produce a rare and biologically diverse landscape in this section of Maine. While the first three middle-level cells of Figure 26 are essentially the biological responses to the top cell, the far right middle cell is the legacy of a history of forest management in the area. Large-scale industrial forest management has up to this point been responsible for maintenance of large intact tracts of land, though this is currently changing and the Study Area is at the boundary of a likely rapid increase in forest fragmentation. Finally, as the bottom cell demonstrates, a rare conservation package is contained within this Study Area that is a relatively small area of Maine especially considering its enormous potential for conservation, sustainable resource extraction, and recreation based industries.

A thriving recreation and tourist based economy possible only through maintenance of the native ecological qualities of the Study Area should be packaged, promoted, and expanded.

Protection from fragmentation and land conversion is perhaps the obvious plan of action for the Study Area.

Protection from fragmentation and land conversion is perhaps the obvious plan of action for the Study Area. This report frames the scale and size of the efforts needed for meaningful conservation. Meaningful conservation is defined here as providing the ecological conditions necessary for long-term population viability of all animal and plant species, and long-term viability of the various ecological processes of the Study Area and greater region. To this end, an attempt to provide a conservation biology-driven framework has been made in the course of describing the Study Area. Conservation short of this spatial scale directed at only the rare and scattered high elevation ecological communities would not only sacrifice the other community types but would likely sacrifice the higher elevation community types as well through increasing isolation and patch size reduction. This, in turn, could lead to reductions in ecological diversity at much larger spatial scales well outside the region due to the landscape contiguity of the transitional to sub-boreal and boreal forest that this particular Study Area provides.

Land protection includes the very same uses that have contributed to maintenance of these contiguous tracts of land for over 200 years. Sustainable forest management, including longer rotation ages than currently practiced, is a legitimate conservation option that contributes to local economies as well. A thriving recreation and tourist-based economy possible only through maintenance of the native ecological qualities of the Study Area should be packaged, promoted, and expanded. Increased capacity to house and host visitors in the region is more than offset by the conservation benefits derived from a paying public using the very qualities that this report highlights and recommends protecting.

Sustainable forest management, including longer rotation ages than currently practiced, is a legitimate conservation option that contributes to local economies as well.

Short of reporting an explicit conservation wish list on a parcel-by-parcel basis at this point, this report suggests conservation of large blocks of forest at low and mid-elevations composed of hardwood and mixed-wood, especially where they offer contiguity with higher slopes and ridges are a priority for protection from further land use conversion and fragmentation. The ecological patterns and processes of high elevation and alpine areas at a lower risk from large scale conversion are nonetheless threatened by a poorly developed policy on alternative land uses at high elevation. Just as biological information informs various wildlife departments on game animal harvest levels, we need similarly informed decisions on high elevation land uses threatening ecological pattern and process present across less than 2% of the state.

Mt. Abraham from the Appalachian trail


Saddleback

Combing indicator species' qualitative (habitat types), quantitative (landscape extent) and qualitative/quantitative (spatial arrangement, contiguity) requirements not only for individuals but for viable populations, provides a window of criteria that can be imposed and shifted over the various community maps. Imagine an ecological diversity conservation counter value rising up and down as this window is shifted across the landscape. Using the tools provided in this report it should be possible to approximate such a counter or overall indicator as plans are developed for land protection and use policy strategies. Such an exercise should strive to provide for ecological dynamics spatially scaled to the range cited across all organisms in Table 1 and should continue to include the distribution of forest types of Tables 2a and 2b.

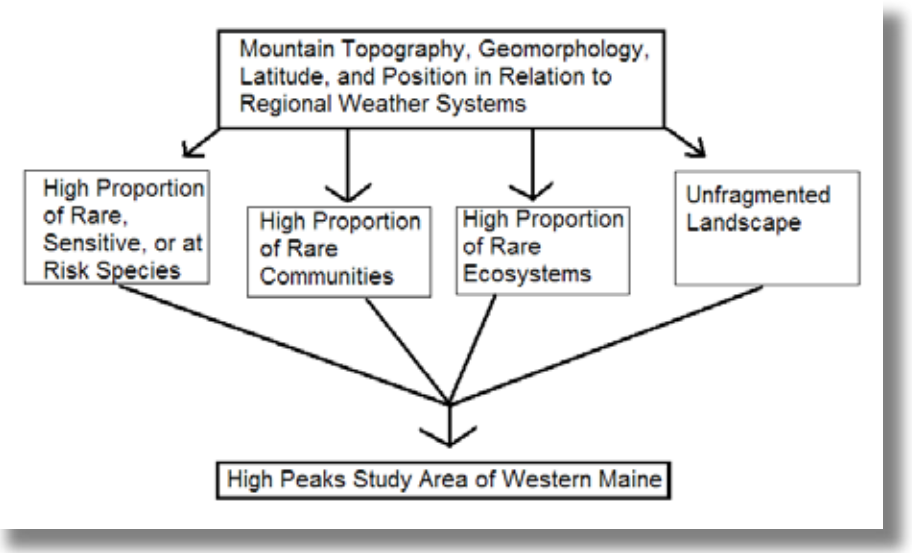


Figure 26. The Convergence of Rare Ecological Patterns and Processes and Conservation Opportunity of the Study Area

Appendices

Appendix 1: Bird Species of Study Area

Species in red with * are minimally under watch for conservation concern in one or more New England states. See tables 8, 9, 12 in body of text for more detail on some of these species and for conservation concerns regarding species not yet on state lists and therefore not highlighted below, yet worthy of conservation planning now.

*Great Blue Heron *Ardea herodias*
Wood Duck *Aix sponsa*
American Black Duck *Anas rubripes*
*Common Goldeneye *Bucephala clangula*
*Hooded Merganser *Lophodytes cucullatus*
Common Merganser *Mergus merganser*
*Bald Eagle *Haliaeetus leucocephalus*
*Sharp-shinned Hawk *Accipiter striatus*
*Cooper's Hawk *Accipiter cooperii*
*Northern Goshawk *Accipiter gentilis*
*Red-shouldered hawk *Buteo lineatus*
Broad-winged Hawk *Buteo platypterus*
Red-tailed Hawk *Buteo jamaicensis*
*Golden Eagle *Aquila chrysaetos*
*American Kestrel *Falco sparverius*
Ruffed Grouse *Bonasa umbellus*
*Spruce grouse *Falcipennis canadensis*
American Woodcock *Scolopax minor*
Mourning Dove *Zenaida macroura*
Black-billed Cuckoo *Cocczus erythropthalmus*
Great Horned Owl *Bubo viginianus*
Barred Owl *Strix varia*
Great Gray Owl *Strix nebulosa*
Long-eared Owl *Asio otus*
Boreal Owl *Aegolius funereus*
*Northern Saw-whet Owl *Aegolius acadicus*
*Common Nighthawk *Chordeiles minor*
*Whip-poor-will *Caprimulgus vociferus*
Ruby-throated Hummingbird *Archilochus colubris*
Yellow-bellied Sapsucker *Sphyrapicus varius*
Downy Woodpecker *Picoides villosus*
*Three-toed Woodpecker *Picoides tridactylus*
*Black-backed Woodpecker *Picoides arcticus*
Northern Flicker *Colaptes auratus*
*Pileated Woodpecker *Dryocopus pileatus*
Blue Jay *Cyanocitta cristata*
American Crow *Corvus corax*
Tree Swallow *Tachycineta bicolor*
Northern Rough-winged Swallow *Stelgidopteryx serripennis*
Bank Swallow *Riparia riparia*
Cliff Swallow *Petrochelidon pyrrhonata*
Barn Swallow *Hirundo rustica*
Black-capped Chickadee *Poecile atricapillus*
Boreal chickadee *Poecile hudsonicus*
Red-breasted Nuthatch *Sitta canadensis*
White-breasted Nuthatch *Sitta carolinenesis*
Brown Creeper *Certhia americana*
House Wren *Troglodytes aedon*
*Winter Wren *Troglodytes troglodytes*
*Golden-crowned Kinglet *Regulus setrapa*
Ruby-crowned Kinglet *Regulus calendula*
Eastern Bluebird *Sialia sialis*
Veery *Catharus fuscescens*
*Bicknell's Thrush *Catharus bicknelli*
Swainson's Thrush *Catharus ustulatus*
Hermit Thrush *Catharus guttatus*
Wood Thrush *Hylocichla mustelina*
American Robin *Turdus migratorius*
Gray Catbird *Dumetella carolinenesis*
Brown Thrasher *Toxostoma rufum*
European Starling *Sturnus vulgaris*
Bohemian Waxwing *Bombycilla garrulus*
Cedar Waxwing *Bombycilla cedrorum*
*Tennessee Warbler *Vermivora peregrina*
Nashville Warbler *Vermivora ruficapilla*
*Northern Parula *Parula americanus*
Yellow Warbler *Dendroica petechia*
Chestnut-sided Warbler *Dendroica pensylvanica*
Magnolia Warbler *Dendroica magnolia*
*Cape May Warbler *Dendroica tigrina*

Eastern Wood-Pewee *Contopus virens*

Yellow-bellied Flycatcher *Empidonax flaviventris*

*Alder flaycatcher *Empidonax alnorum*

Least Flycatcher *Empidonax minimus*

Eastern Phoebe *Sayornix phoebe*

Great Crested Flycatcher *Myiarchus crinitus*

Eastern Kingbird *Tyrannus tyrannus*

Northern Shrike *Lanius excubitor*

Blue-headed Vireo *Vireo solitarius*

Warbling Vireo *Vireo gilvus*

*Philadelphia Vireo *Vireo philadelphicus*

Red-eyed Vireo *Vireo olivaceous*

*Gray Jay *Perisoreus canadensis*

Common Yellowthroat *Geothlypis trichas*

*Wilson's Warbler *Wilsonia pusilla*

Canada Warbler *Wilsonia canadensis*

Scarlet Tanager *Piranga olivacea*

Eastern Towhee *Pipilo erythrophthalmus*

American Tree Sparrow *Spizella Arborea*

Chipping Sparrow *Spizella passerina*

Field Sparrow *Spizella pusilla*

Song Sparrow *Melospiza melodia*

Lincoln's Sparrow *Melospiza lincolnii*

Swamp Sparrow *Melospiza georgiana*

*White-throated Sparrow *Zonotrichia albicollis*

*Dark-eyed Junco *Junco hyemalis*

Northern Cardinal *Cardinalis cardinalis*

Rose-breasted Grosbeak *Pheucticus ludovicianus*

Indigo Bunting *Passerina cyanea*

Red-winged Blackbird *Agelaius phoenicens*

*Rusty Blackbird *Euphagus carolinus*

Common Grackle *Quiscalus quiscula*

Brown-headed Cowbird *Molothurs ater*

Baltimore Oriole *Icterus galbula*

Pine Grosbeak *Pinicola enucleator*

Purple Finch *Carpodacus purpureus*

House Finch *Carpodacus mexicanus*

*Red Crossbill *Loxia curvirostra*

*White-winged Crossbill *Loxia leucoptera*

Common Redpoll *Carduelis flammea*

Hoary Redpoll *Carduelis hornemanni*

Pine Siskin *Carduelis pinus*

*Black-throated Blue Warbler *Dendroica caerulescens*

Yellow-rumped Warbler *Denroica coronata*

Black-throated Green Warbler *Dendroica virens*

*Blackburnian Warbler *Dendroica fusca*

*Pine Warbler *Dendroica pinus*

Palm Warbler *Dendroica palmarum*

*Bay-breasted Warbler *Dendroica castanea*

*Blackpoll Warbler *Dendroica striata*

Black-and-White Warbler *Mniotilta varia*

American Redstart *Setophaga ruticilla*

Ovenbird *Seiurus aurocapillus*

Northern Waterthrush *Seiurus noveboracensis*

*Mourning Warbler *Oporornis philadelphia*

American Goldfinch *Carduelis tristis*

Evening Grosbeak *Coccothraustes vespertinus*

*Common Loon *Gavia immer*

*Pied-billed Grebe *Podilymbus podiceps*

*American Bittern *Botaurus lentiginosus*

Canada Goose *Branta canadensis*

Mallard *Anas platyrhynchos*

*Green-winged Teal *Anas crecca*

*Ring-necked Duck *Aythya collaris*

*Osprey *Pandion haliaetus*

*Northern Harrier *Cirus cyaneus*

Rough-legged Hawk *Buteo lagopus*

*Virginia Rail *Rallus limicola*

*Sora *Porzana carolina*

Killdeer *Charadrius vociferus*

Spotted Sandpiper *Actitis macularia*

Common Snipe *Gallinago gallinago*

Herring Gull *Larus argentatus*

Snowy Owl *Nyctea scandiaca*

Chimney Swift *Chaetura pelagica*

Belted Kingfisher *Ceryle alcyon*

*Horned Lark *Eremophila alpestris*

*Savannah Sparrow *Passerculus sandwichensis*

Lapland Longspur *Calcarius lapponicus*

Bobolink *Dolichonyx oryzivorus*

Eastern Meadowlark *Sturnella magna*

*Olive-sided flycatcher *Contopus cooperi*

Appendix 2: Mammals of Study Area

Species in red with * are minimally under watch for conservation concern in one or more New England states. See tables 10, 13 in body of text for more detail on some of these species and for conservation concerns regarding species not yet on state lists and therefore not highlighted below, yet worthy of conservation planning now.

Masked Shrew *Sorex cinereus*
*Water Shrew *Sorex palustris*
*Smoky Shrew *Sorex fumeus*
*Long-tailed Shrew *Sorex dispar*
*Pygmy Shrew *Sorex hoyi*
Northern Short-tailed Shrew *Blarina brevicauda*
Hairy-tailed Mole *Parascalops breweri*
Star-nosed Mole *Condylura cristata*
*Little Brown Myotis *Myotis lucifugus*
*Northern Long-eared Bat *Myotis septentrionalis*
*Silver-haired Bat *Lasionycteris noctivagans*
*Eastern Pipistrelle *Pipistrellus subflavus*
*Big Brown Bat *Eptesicus fuscus*
*Red Bat *Lasiurus borealix*
*Hoary Bat *Lasiurus cinereus*
Snowshoe Hare *Lupus americanus*
Eastern Chipmunk *Tamias striatus*
Woodchuck *Marmota monax*
Gray Squirrel *Sciurus carolensis*
Red Squirrel *Tamiascurus hudsonicus*
Northern Flying Squirel *Glaucomys volans*
Beaver *Castor canadensis*
Deer Mouse *Peromyscus maniculatus*
White-footed Mouse *Peromyscus leucopus*
Southern Red-backed Vole *Clethriomys gapperi*
Meadow Vole *Microtus pennsylvanicus*
*Rock Vole (Yellow-nosed) *Microtus chrotorrhinus*
Muskrat *Ondatra zibethicus*
*Southern Bog Lemming *Synaptomys cooperi*
*Northern Bog Lemming *Synaptomys borealis*
Norway Rat *Rattus norvegicus*
House Mouse *Mus musculus*
Meadow Jumping Mouse *Sapus hudsonius*
Woodland Jumping Mouse *Napaeozapus insignis*
Porcupine *Erethizon dorsatum*
Coyote *Canis latrans*
Red Fox *Vulpes vulpes*
Gray Fox *Urocyon cinereoargenteus*
Black Bear *Ursus americanus*
Racoon *Procyon lotor*
*American Marten *Martes americana*
*Fisher *Martes pennanti*
Ermine *Mustela erminea*
Long-tailed Weasel *Mustela frenata*
Mink *Mustela vison*
Striped Skunk *Mephitis mephitis*
River Otter *Lontra canadensis*
*Lynx *Lynx canadensis*
*Bobcat *Lynx rufus*
White-tailed Deer *Odocoileus virginianus*
Moose *Alces alces*

Appendix 3: Amphibians of Study Area

Species in red with * are minimally under watch for conservation concern in one or more New England states. See table 15 in body of text for more detail on some of these species and for conservation concerns regarding species not yet on state lists and therefore not highlighted below, yet worthy of conservation planning now.

*Blue-spotted Salamander *Ambystoma laterale*

Spotted Salamander *Ambystoma maculatum*

Red-spotted Newt *notophthalums v. viridescens*

Northern Dusky Salamander *Desmognathus fuscus*

Northern Redback Salamander *Plethodon cinereus*

Northern Spring Salamander *Gyrinophilus p. porphyriticus*

Northern Two-lined Salamander *Eurycea bislineata*

Eastern American Toad *Bufo a. americanus*

Northern Spring Peeper *Pseudacris c. crucifer*

Gray Treefrog *Hyla versicolor*

Mink Frog *Rana septentrionalis*

Wood Frog *Rana sylvatica*

*Northern Leopard Frog *Rana pipiens*

Pickerel Frog *Rana palustris*

Green Frog *Rana clamatans melonata*

Appendix 4: Reptiles of Study Area

Species in red with * are minimally under watch for conservation concern in one or more New England states. See table 15 in body of text for more detail on some of these species and for conservation concerns regarding species not yet on state lists and therefore not highlighted below, yet worthy of conservation planning now.

Common Snapping Turtle *Chelydra s. serpentina*

Northern Redbelly Snake *Storeria o. occipitomaculata*

Common Garter Snake *Thamnophis sirtalis*

Northern Ringneck Snake *Diadophis punctatus edwardsii*

*Wood Turtle *Clemmys insculpta*

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