Bicknell's Thrush: An Endangered Migrant in a Recovering Landscape

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EXECUTIVE SUMMARY

The Bicknell's thrush (*Catharus* bicknelli) is a migratory, Neo-tropical, habitat specialist that is widely regarded as the most vulnerable North American songbird due to the widespread deforestation of overwintering habitat in the Caribbean, recession of spruce-fir forests in North American breeding sites, increased rates of predation as well as migration hazards and pollution deposition at high-elevation. The bird, which is no larger than ones hand, inhabits a several thousand-mile range, spanning from its overwintering sites on the islands of Hispaniola, Cuba and Jamaica to its breeding grounds in southern Canada, Maine and northern New York. Avid birders and recreationists in the Adirondack State Park have long enjoyed the often heard, bur rarely seen, presence of the Bicknell's thrush. Previously considered a subspecies of the Gray-cheeked thrush (*Catharus minimus*), the bird was only recently classified as an individual species in 1995; since then, Bicknell's thrush populations have been monitored for fear that declining montane spruce-fir forest habitat in the Northeast and cloud forest in the Caribbean, combined with various other environmental stressors, will drive populations down.

Bicknell's thrush breeding habitat is categorized as montane spruce-fir forests at, or above, 915m of elevation; nearly a quarter of which is encompassed by the Adirondack State Park, almost exclusively within these forest preserve areas. This effectively protects these areas from any large-scale anthropogenic disturbances (e.g. deforestation, human development). The presence of Bicknell's thrush in the Adirondacks is unique when considering the long history of aggressive and destructive land use in this area. The Adirondack State Park in northern New York State covers 5.9 million acres, with over 60% (or close to 3 million acres) categorized as Forest Preserve, effectively protecting it from development or harvest. Long used for trapping, mining, logging and leather tanning, Adirondack ecology was all but diminished when the Park

was created in 1894 to protect the water supply for downstate New York. The Adirondack Park is a prime example of a recovered landscape and, as such, is running on an inverse trajectory of the thrush's Caribbean overwintering grounds.

The destruction of the Bicknell's thrush's various overwintering habitats is by in far the most pressing issues when considering the purported population declines of this species. The widespread deforestation in the Greater Antilles region of the Caribbean is the result of the presence of subsistence farmers clearing forested regions to allow for small-scale agriculture. While this problem is significantly more noticeable in Haiti (<2% of original forest still in tact), there seems to be a similar, albeit less aggressive, trend of forest clearing in The Dominican Republic.

Bicknell's thrush habitat in the Adirondack State park all falls within various forest preserve areas, thus preventing any forestry operations from disrupting spruce-fir habitat. However, various other environmental stressors, primarily acid deposition, invasive species introduction and climate change, are all causing drastic shifts in the composition and abundance of montane spruce-fir forests. Increasing global temperatures are pushing spruce-fir bands further up elevation gradients to the edge of their feasible habitat range.

Mercury deposition from the combustion of coal in mid-western power plants is responsible for organismal level contamination in the Adirondacks. Typically, this is in regard to apex predators and aquatic species. However, the detritus heavy and herbaceous diet of the Bicknell's thrush causes these birds to accumulate notable quantities of mercury within their bodies.

Acid deposition, in the form of precipitates, in these areas cause various degrees of direct, and indirect, damage to the high elevation spruce-fir forests. The acid rain itself s unable to kill

these trees, however the consistent presence of "acid fog" causes long term damage to needle cuticles, inhibiting photosynthesis and expediting evapotranspiration. Alternatively, acid deposition and accumulation in soils leach vital minerals such as magnesium and calcium while mobilizing previously unavailable and toxic compounds such as aluminum, stunting tree growth and regeneration.

The steady degradation of spruce-fir defenses via acid deposition makes these tree species notably more susceptible to damage from invasive species In the Adirondack Park, the two most pervasive and damaging invasive and pest species are the Balsam wooly adelgid (*Adelgis piceae* and the Eastern Spruce budworm (*Chroristoneura fumiferana*). The Balsam wooly adelgid feeds on, and eventually kills, Balsam firs within the Adirondack State Park. The Balsam wooly adelgid's population is currently kept in check by seasonal cold snaps; cold snaps that are becoming less common due to climbing global temperature. The Eastern spruce budworm is the larval form of an endemic moth. Much like the Balsam wooly adelgid, the populations of eastern spruce budworm are kept down through harsh winter temperatures, as well as insectivorous birds and entomophagous parasites. With these limiting factors disappearing, the eastern spruce budworm and Baslam wooly adelgid populations are beginning to have ramifications for the composition of would be spruce-fir forests.

Lastly, the failure to have continuous policy through the Bicknell's thrush's migratory range stands to negate any major conservation steps taken in the Northeast. Without strong policy, paired with an equally extensive conservation initiative, any

changes made to the ecosystem in the breeding grounds would simply be crowded out by the overwhelming, negative momentum, elsewhere.

Currently, the most feasible means of reducing the rate of population decline for the Bicknell's thrush is to educate stakeholders, provide alternate economic avenues for subsistence farmers in overwintering grounds, prevent further deforestation in The Dominican Republic, restore the degraded forest habitat in these areas, continue to build international support and collaboration, establish Best Management Practices, prevent the further spread of invasive and pest species and minimize atmospheric pollution deposition.

This case study was produced through a comprehensive literature review supplemented with interviews conducted with regional experts on the Bicknell's thrush. A survey was conducted in several locations (Canton, NY, Tupper Lake, NY and Lake Placid, NY) to gauge the extent of public knowledge and opinion regarding the Bicknell's thrush. Lastly, GIS analysis of Bicknell's thrush habitat requirements and land classifications of the Adirondacks allowed for inferences to be made regarding the risk of forestry disturbance to Bicknell's thrush within the Adirondack State Park.

PROBLEM DEFINITION

The goal of our research was to investigate the threats to Bicknell's thrush (*Catharus bicknelli*) in New York State's Adirondack State Park. We necessarily consider threats across the full breadth of habitat occupied by Bicknell's thrush throughout its migratory range. Numerous threats to the maintenance of large and healthy populations are present at all stages the species life cycle, however no data are available to support claims of reliable range-wide declines in Bicknell's thrush populations. Although bird enthusiasts and conservationists in the Adirondack region and in the remainder of the bird's northeast North American nesting grounds have taken the lead on monitoring and conservation efforts for Bicknell's thrush, the most imminent threat to survivorship seems to be centered in the species' Caribbean overwintering sites. Concerns surrounding the population status of Bicknell's thrush are complicated by the species' poorly understood life history, a lack of sufficient historical and current distribution data, and the inter-governmental cooperation required for monitoring a migratory species.

Bicknells thrush life history

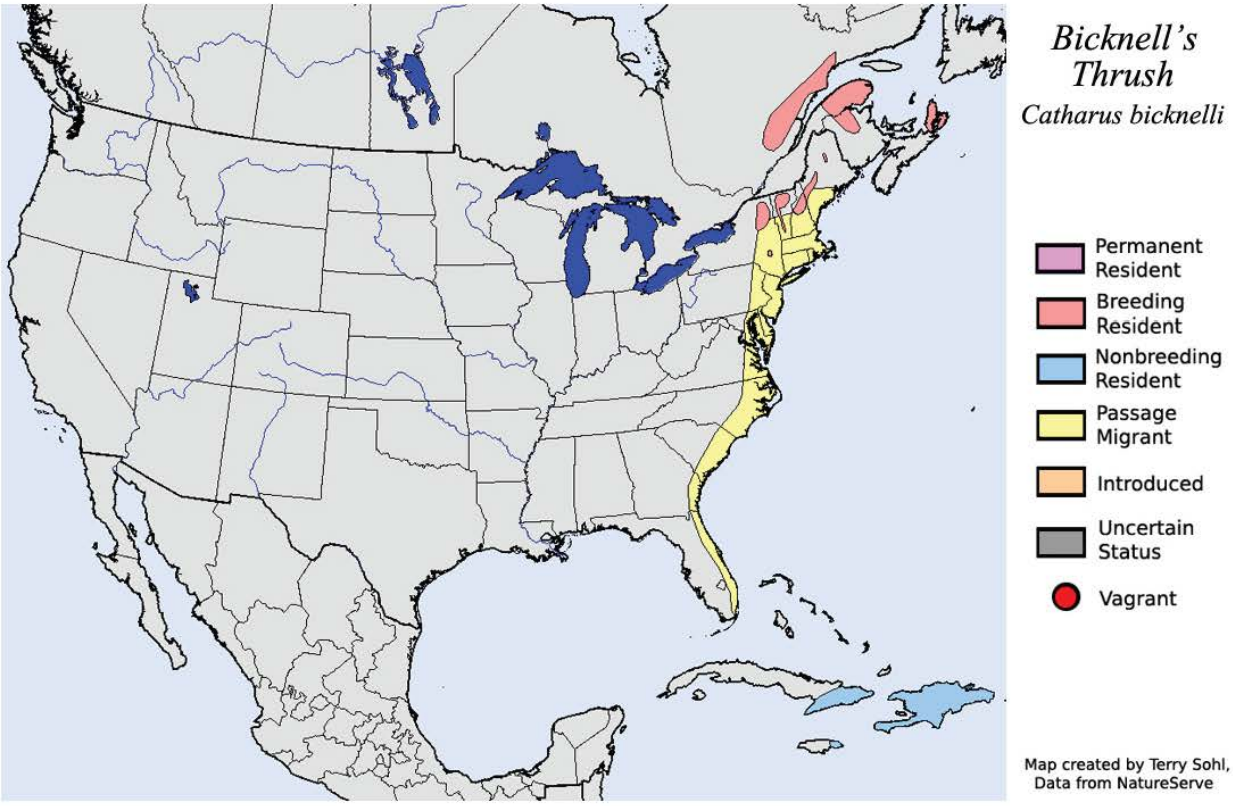
The Bicknell's thrush (Figure 1) is a migratory passerine bird that overwinters in the Greater Antilles region of the Caribbean Sea in the nations of The Dominican Republic, Haiti, Cuba, and Jamaica and breeds in the montane regions of New York, Vermont, New Hampshire, Maine, Quebec, and Nova Scotia (Rimmer *et al.* 2001a) (Figure 2). Great regional and international concern is building regarding the long-term survival of Bicknell's thrush due to the species small population, minimal and threatened breeding and wintering ranges, and specific habitat preferences (Brown 2012, Hart *et al*. 2010, Mikle 2014, Rimmer and McFarland 2001). With a body length of 6.75 inches, it is slightly smaller than the nearly identical Gray-cheeked

thrush which breeds farther to the north and winters farther south (Sibley 2003). The Bicknell's thrush is most reliably identified from the other thrush species in its range by its call (Rimmer et al. 2001a). Slight differences in plumage, such as a more rufous flank, can be hard to confirm in its dark forest habitat (Sibley 2003). The species has an offset sex ratio with approximately 2 males for every 1 female (Hart *et al.* 2010). This imbalance may be influenced by male-dominance in selection of wintering habitat in which females are left with less preferential habitat (Rimmer, personal communication[1]).

http://www.audubon.org/sites/default/files/Bicknell%2527s_Thrush_m50-3-013_l.jpg

Figure 1. Bicknell's thrush perching.

[1] Phone interview 23 April, 2015



http://sdakotabirds.com/species/maps/bicknells_thrush_map_big.jpg

Figure 2. Bicknell's thrush range during winter, migratory, and summer breeding seasons in North America.

Bicknell's thrush has a high habitat specificity and year-to-year fidelity to breeding and wintering grounds (Rimmer and McFarland 2001). In the Greater Antilles it primarily utilizes old growth (undeveloped or uncut) forests (Rimmer *et al.* 2001a). In its breeding range Bicknell's thrush relies on dense montane (typically above 915 m) red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) forest, especially disturbed forest sites such as those damaged recurrently by high winds (fir waves) with young growth of balsam fir and balsam snags (Atwood *et al*. 1996, IUCN Red List 2012). While many animal and plant species historically occupied continuous tracts of land which have since been heavily fragmented through anthropogenic (human related) road development, resource extraction, and agriculture, Bicknell's thrush has a naturally fragmented breeding range. Natural fragmentation means that

the particular habitat, montane spruce-fir forest, preferred by Bicknell's thrush does not itself exist in a large, continuous area. Montane spruce-fir forest is distributed across the northeastern United States and southeastern Canada is small, disparate patches of land at high elevations. Given the natural fragmentation of montane spruce-fir forest and the density of these forests, it is very difficult to achieve species population assessments for Bicknell's thrush using normal survey techniques (Rimmer *et al.* 2001a). Therefore, information regarding population size, distribution, and growth or decline is rare and difficult to use in making concrete statements regarding the effects of threats to the species. Despite great concern about numerous threats to Bicknell's thrush populations across wintering, breeding, and migratory habitats, minimal historical data and too little current data exist to draw the concrete conclusion that Bicknell's thrush is globally declining as a species (Rimmer, personal communication[2]). Beyond this, the interactions of the Bicknell's thrush with its surrounding habitat, and the implications of these interactions on population health, are not well understood. Recently, an inverse relationship between abundance of pinecones and Bicknell's thrush hatchling survivorship was identified (Rimmer and McFarland 2013). The higher abundance of pinecones leads to greater populations of red squirrel (*Tamiasciurus hudsonicus*), which predate on nestling thrushes (Rimmer, personal communication[3]). The cyclical, "boom-bust", nature of red squirrel population fluctuations is hard to predict even with accurate information about yearly pinecone abundance; however, increasing global temperatures, and subsequent increase in pinecone production, have caused "booms" to become more common, posing a serious threat to Bicknell's thrush populations in their North American breeding grounds (Rimmer, personal communication[4]). The potential for

[2] Phone interview 23 April 2015
[3] Phone interview 23 April 2015
[4] Phone interview 23 April 2015

regional or global declines to be occurring currently is serious and concern for the future of this migrant species and its habitat is warranted.

Global breeding populations are estimated to be between 95,000-126,000 individuals (IUCN Red List 2012; Hart et al. 2010). The International Union for the Conservation of Nature's (IUCN) Red List of Endangered Species designates Bicknell's thrush as Vulnerable due to documented population declines over short periods of time and imminent threats to its habitat (IUCN Red List 2012). Bicknell's thrush is listed by the New York State Department of Environmental Conservation (NYS DEC) as a species of Special Concern, meaning that it is documented to be at risk of endangerment within its range in New York State (NYS DECc 2015).

Bicknell's thrush in the Adirondack State Park

While our study necessarily gives great consideration to the global threats and conservation measures for Bicknell's thrush due to its migratory life history strategy, our primary region of focus is the summer breeding ground that fall inside New York State's Adirondack State Park. The montane spruce-fir forest within the Adirondack Park forms nearly a quarter of all breeding areas for Bicknell's thrush, making the region particularly important for preservation of the species (Figure 3) (Rimmer *et al.* 2001b). Within New York State, which is the southernmost breeding area for the species, the Bicknell's thrush nests only in montane spruce-fir forests in the Catskill and Adirondack mountains (NYS DEC 2015). Montane spruce-fir forests across northeastern North America are currently in decline (Lovett *et al.* 2009). The reduction in the already small range of this species compounds the importance of the remaining Adirondack breeding sites for Bicknell's thrush. To better understand the nature of habitat and species conservation in the Adirondack Park, it is necessary to know the region's history.

Adirondack historical context

Northern New York's Adirondack State Park, what is today a 5.9 million acre conglomeration of state-owned and privately-owned land, was established in New York State in 1894 (Jenkins and Keal 2004). The Park's boundary was first delineated on maps with a line drawn in blue ink. The name Blue Line is still used today to refer to the boundary of the Adirondack State Park. Although the Blue Line was established on maps more than 120 years ago, the lands within have continued to transform. Trapping, logging, tanning, and mining drew developers to the region throughout the nineteenth century, creating an economy that boomed through profits from natural resource extraction (Jenkins and Keal 2004). The land was used for the retreats and hunting grounds of the affluent and the sources of lumber, pulpwood, and hemlock tannins for paper companies and tanneries (Jenkins and Keal 2004). By 1900, carriage roads, railways, and steamboats were stretching their way across the Adirondack region and into its interior. Wealthy elites purchased large parcels of land and solidified the region's future as a mixture of public and private land.

The Adirondack State Park is unique among protected areas across the world due to its size, management strategy, permanence, and history of extensive and degrading land use. Created to stem the onslaught of destruction to the area's natural resources and to protect watersheds from pollution, the Park is larger than any other designated protected area in the United States' lower 48 states. All Adirondack Park land, both private- and state-owned, is governed by the Adirondack Park Agency (APA), formed in 1971. Once purchased and entered into the Forest Preserve, Adirondack Park land is protected in perpetuity under the New York State constitution through the historic 'Forever Wild' clause (Jenkins and Keal 2004). State land, is a mixture of eight separate land use designations, each with varying degrees of protection,

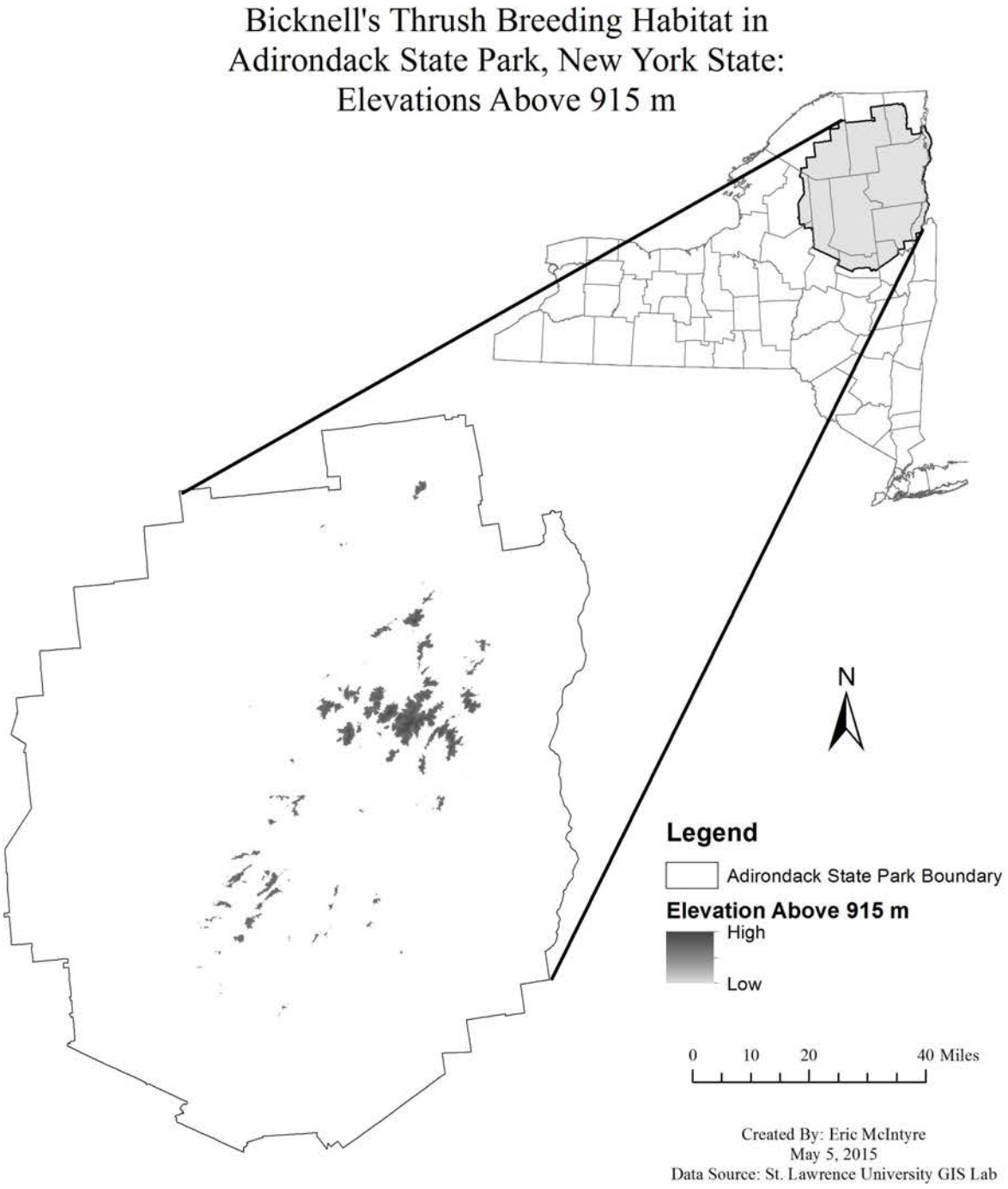


Figure 3. Location and elevation gradient of all land within Adirondack State Park higher than 915m in elevation. Inset shows the location of Adirondack State Park within New York State.

intended uses, and access restrictions: wilderness, primitive, wild forest, intensive use, administrative, historic, water, and unclassified (Jenkins and Keal 2004). More than 100,000 people live permanently within the Blue Line and the population more than doubles in the summers when seasonal residents open their camps in May. When the interface between degraded and recovered land is overlain with the history of settlement and the tensions of ownership and resource rights, one can begin to grasp the difficult and unique experience of creating and maintaining the Adirondack State Park.

Although millions of acres were cut or burned during the 1800's and 1900's, and the incredible diversity that once existed may never return, what is most remarkable above all else may be the rejuvenation of these forests. The region boasts ecological complexity and a diversity of wildlife that must be considered any time humans in the Adirondack region interact with or make decisions that could influence the quality of habitats. Each parcel of land has been and is currently used differently by humans and is thus differentially degraded or recovered. Agricultural lands and plant communities more typical of forests in mid-Atlantic states surround the Park in the St. Lawrence Valley to the west and the Champlain Valley to the east (Jenkins and Keal 2004). Northern hardwood forest of American beech, sugar maple, and yellow birch dominate the lowland foothills and low elevation mountain slopes. The Adirondack High Peaks Region, itself a wilderness area within the State Forest Preserve, along with the surrounding hills, boast the Park's tallest mountains. On their summits exist the remnants of boreal spruce-fir forest and small patches of alpine tundra still persisting above tree line after the last glacial period ended 10,000 years ago. It is here, between the gnarled tree branches that grow at a snail's pace on the crest of sky-scraping mountains, that we encounter the subject of our study, the Bicknell's thrush.

Habitat degradation

Deforestation in Overwintering Grounds

When considering anthropogenic threats to Bicknell's thrush habitat, the montane spruce-fir forest, we often look to seemingly intangible issues like global climate change and acid deposition. However, the issue that is considered the greatest threat to the Bicknell's thrush is deforestation in the Greater Antilles (Chrisholm & Leonard 2008). Bicknell's thrush prefers mesic, dense broadleaf forests that span a wide range of elevations for its overwintering grounds (Hart *et al.* 2010). Currently, forested habitat covers around 27.5% of The Domical Republic and less than 2% of Haiti; of this remaining forest, only 1100km^2 of cloud forest and 3150km^2 of wet broadleaf forest is Hispaniola is able to support thrush (Hart *et al.* 2010). The wide scale destruction of forested areas in the Greater Antilles is a result of increasing demand for agriculture in the Caribbean nation; at the height of the deforestation in the mid 1940s, Hispaniola had lost over 75% of the forest cover that had been present at the beginning of the century (Dominican Republic Encyclopedic Dictionary of the Environment 2015). Subsistence farming practices, as well as logging, has caused drastic habitat destruction on the island of Hispaniola (Hart *et al.* 2010). For the Bicknell's thrush, a habitat specialist with an exceptionally specific habitable zone, this poses a serious risk to population health (Lovett 2009). In regards to habitat specialists' ability to adequately adjust to novel environments, Chrisholm and Leonard made the observation that "the alteration may be greatest for habitat specialists that cannot readily switch environments when their preferred habitat is modified" (2008).

Deforestation in Breeding Grounds

Large-scale forestry is not permitted within the Adirondack State Park Forest Preserves (NYS DEC 2015d). These preserves make up nearly three million acres, or 61%, or the total land area within the Adirondack State Park (NYS DEC 2015d). Spruce fir forests above 915m primarily characterize the Bicknell's thrush breeding habitat within the park (NYS DEC 2015c). With a few small exceptions, this habitat is well within the bounds of forest preserve areas (Figure 4). Because of this, deforestation within the Adirondack Park is not a major concern for Bicknell's thrush populations.

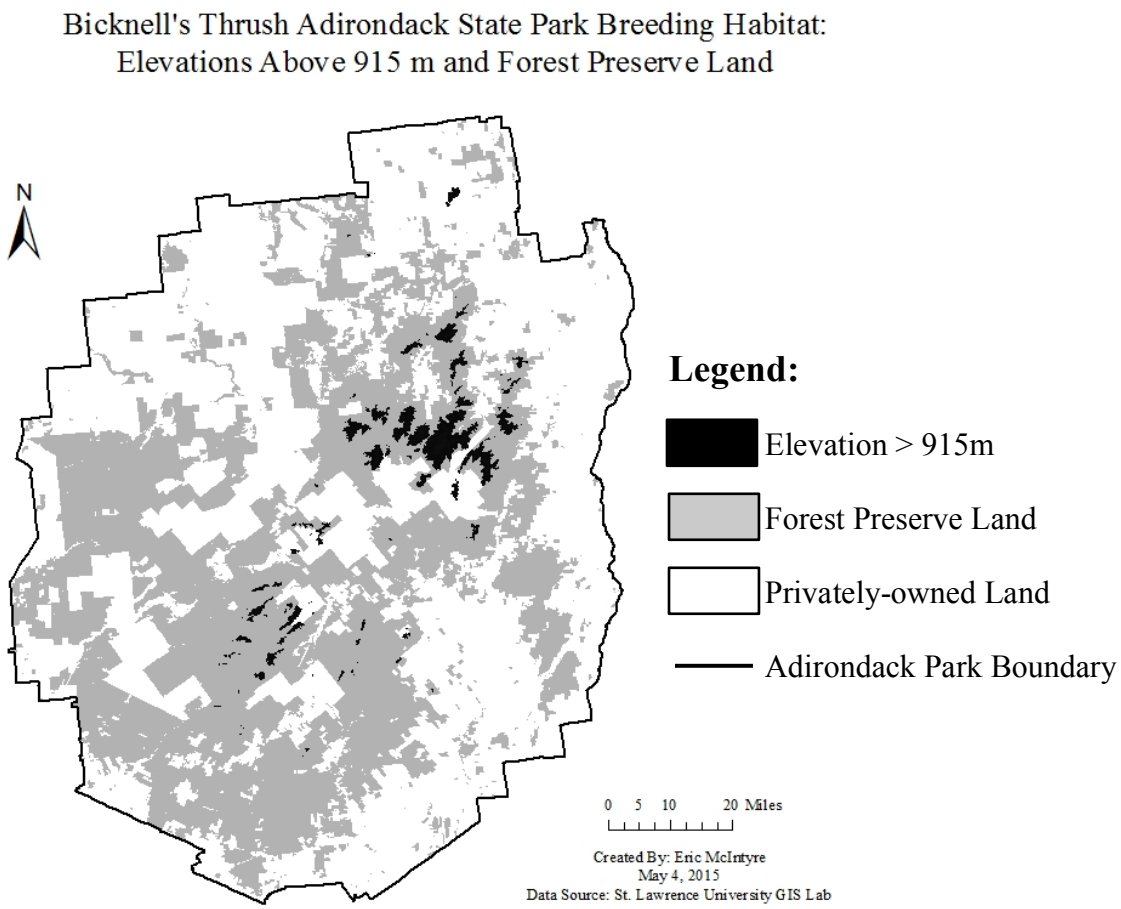


Figure 4. All land within the New York State Forest Preserve (gray) contained within the Adirondack State Park, NY, overlain with all Adirondack State Park land areas higher than 915 m in elevation (black).

Development in Breeding Grounds

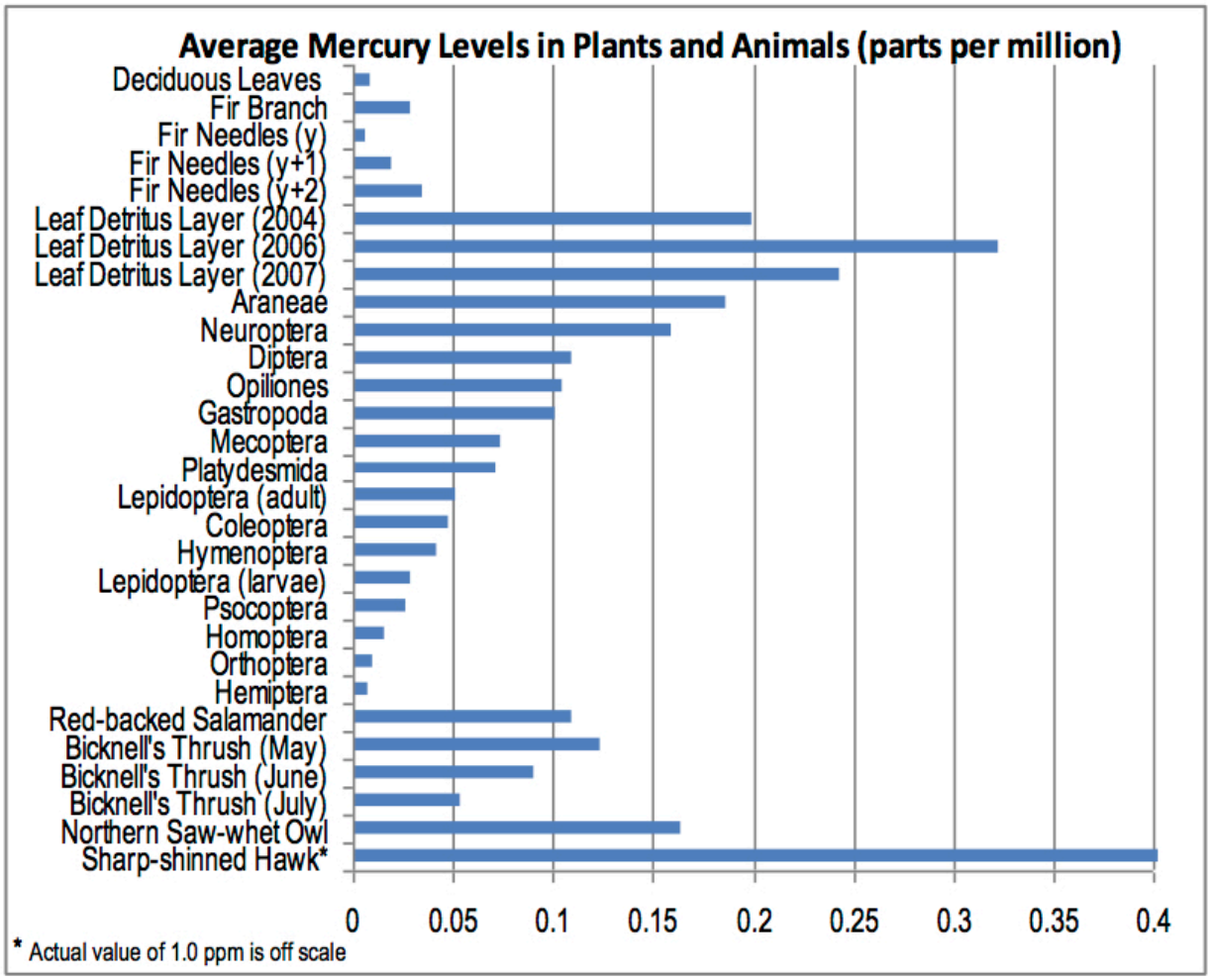
Infrastructure development and human disturbance are the greatest threats to the Bicknell's thrush in its breeding grounds (Watershed Post 2012). The development of recreational ski infrastructure, particularly on Whiteface Mountain, as well as telecommunications equipment throughout the High Peaks region, has made protecting the financial interests of various stakeholders, as well as the interests of the Bicknell's thrush, tremendously challenging (Glennon, personal communication[5]). More recently, the construction and subsequent expansion of the Granite Renewable Wind Energy project in northern New Hampshire has served as example of the potential social and ecological implications of intrusive construction projects on Bicknell's thrush population health (New Hampshire Site Evaluation Committee 2015). Acknowledging the potential risk to the Bicknell's thrush, concerned citizens have directly opposed the implementation of wind power projects all over the northeast if there is a risk of harm to the Bicknell's thrush (Fly Rod and Reel's Blog 2015). This is primarily because there is strong evidence that the establishment of wind turbine farms leads to higher mortality rates in birds, particularly migratory species (New York Times 2007). Several cases have been taken to court advocating for the energy producers' wind projects and more often than not, the courts rule in their favor (Bangor Daily News 2015).

Pollution-Induced Organismal Level Contamination in Breeding Grounds

The introduction of high concentrations of mercury (Hg) into an ecosystem poses a tremendous threat to fish species, terrestrial animals (including ground dwelling bird species) and amphibians (Lambert 2009). Chronic exposure to Hg, as a result of deposition in high

[5] Phone interview 24 February 2015

elevations, has adverse population level for the threatened Bicknell's thrush (Rimmer *et al.* 2005). Bioaccumulation of Hg in Bicknell's thrush is seasonal in nature as the birds diet shifts from heavily Hg laden detritus diet in early summer, to a less Hg laden foliage based diet in late summer (Rimmer *et al.* 2010). The source of the Bicknell's thrush diet is of importance because of the accumulation Hg within abiotic and biotic systems (Figure 5). The accumulation of Hg within the organism is capable of directly affecting the reproductive success of the Bicknell's thrush, but not to the same degree as changes to Bicknell's thrush breeding dependent habitat as a result of Hg deposition and soil acidification (Lambert 2009).



http://vtecostudies.org/wp-content/uploads/2014/10/Hgfoodwebchart.jpg

Figure 5. Average observed levels of Mercury (parts per million) in selected plants and animals of the northeastern United States

Shifts in alpine tree species composition

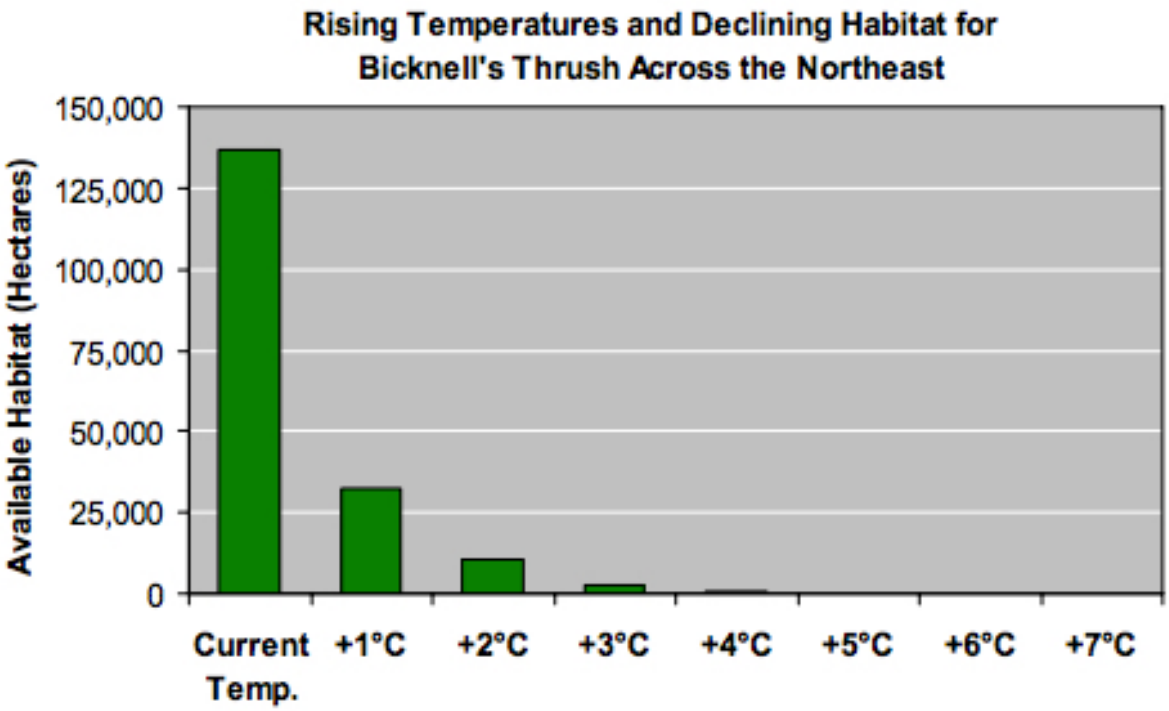
Climate change

Montane spruce-fir forest (MSFF) covers a small percentage of the landscape in the northeast (approximately 275,000 acres), yet 23% of all available habitat is present within the Adirondack State Park (Rimmer *et al.* 2001b). When addressing the decline of Bicknell's thrush populations in the northeast, we are not solely discussing the loss of a species but more so the decimation of the MSFF, the Bicknell's thrush's primary breeding habitat (Hart 2010). In the northeast, MSFF covers less than 1% of the landscape and is predominantly confined to alpine areas (Rodenhouse 2007). Pollen and microfossil records suggest that climatic changes have influenced forest composition (Rustad 20150). There has been a steady shift from softwoods (primarily white pine, oak, hickory and birch) to the current forests (boreal firs and spruce as well as beech and maple) over the past 1,500 years (Rustad 2015). Since the early 1960s, there has been widespread decline of MSFF in the northeast; however, the rates of change seen in the northeast are notably faster than what has historically been observed (Rustad 2015). This change is largely attributed to rapidly rising global temperatures, a trend that can be easily seen through the changes in the spruce-fir location across elevation gradients (Rustad 2015). Others attribute these changes to other environmental factors such as acid rain and subsequent calcium and aluminum leaching as well as changes in land use (Rustad 2015).

The rapid loss of MSFF is of considerable ecological significance to the Bicknell's thrush. This habitat specialist, with an incredibly narrow habitable zone, has to deal with diminishing levels of distribution and availability of spruce-fir breeding habitat (Atwood 1996). These changes have been observed all over the northeast from the White Mountains, to Baxter State Park in Maine, but the cumulative losses of MSFF in most other locations are dwarfed by those

within the Adirondacks (Atwood 1996). Careful monitoring has been done in these areas, and changes in Bicknell's thrush habitat have already been observed in much of the northeast (Hale 2006). This metric has been used as a proxy for abundance of the Bicknell's thrush because of their habitat specificity (Lambert 2008).

In an attempt to better understand the role that climate change has in the loss of Bicknell's thrush habitat, extensive modeling has been done to predict the changes in forest composition given various emission scenarios (Lambert 2005). Migratory birds are expected to be affected by climatic change during all phases of their phenological cycle with close to half of all neotropical and temperate migrant's populations decreasing as a result of climatic change (Rodenhouse 2007). This is primarily due to the compositional change of forest species and the subsequent loss of breeding habitat (Figure 6).



http://vtecostudies.org/wp-content/uploads/2014/11/BITH-habitat-and-climate-change.jpg

Figure 6. Declines in the extent of montane spruce-fir forest habitat for Bicknell's thrush under multiple climate warming scenarios.

Deposition

The massive decline in spruce-fir forests in the northeastern United States is attributed to the prevalence of acid precipitates in the form of rain or fog as these acidification events remove soil nutrients at higher elevations, cause damage to spruce needles and weaken the natural defenses these trees have against pest and invasive species (EPA Index 2015). The mobility of nitrogen oxide (NO) and sulfur dioxide (SO2) is also of serious concern when considering its potential impacts on forest composition within the Park (Lovett 2009). These compounds leach into topsoil, where they cause issues associated with root damage, leaching of vital nutrients like calcium and magnesium while mobilizing other, previously unavailable, toxins such as aluminum, which severely inhibits plant metabolism (Lovett 2009). Beyond the indirect damages associated with acid rain, substantial direct cuticle damage can be caused by the deposition of acidic precipitates on the needles of spruce-fir forests, decreasing the ability of trees to photosynthesize (Lovett 2009).

The montane spruce-fir forests of the Adirondack State Park are tremendously sensitive to environmental stressors. This is evident in the rapid forest compositional change that has been observed since peak atmospheric nitrogen oxide (NO) and sulfur dioxide (SO2) concentrations in 1973 (Shea 2008). The introduction of these compounds into the environment through atmospheric deposition have played a role in modifying the Adirondack alpine ecosystem through three different avenues: 1) by directly discouraging spruce-fir growth via soil acidification and calcium leaching 2) by making vegetation more susceptible to exotic pests and 3) by making some habitats more suitable for weedy invasive plants as well as some parasitic animal species (Lovett 2009).

Invasive and Pest Species

The Bicknell's thrush stands to directly benefit from the removal of parasitic invasive species within their breeding grounds in the Adirondack Park (Matteson 2010). Of the introduced species present in the Park, the two that are of the most concern to the Bicknell's thrush conservation initiatives are the balsam woolly adelgid *(Adelgis piceae)* and the eastern spruce budworm *(Choristoneura fumiferana)*.

The balsam wooly adelgid is an invasive insect species that feeds on, and eventually kil, balsam firs within the Adirondack State Park (Lambert 2005). The presence of these parasitic organisms is punctuated by the decimation of large stands of spruce-fir forest, a trend that has already been observed within the Appalachian mountains (Iverson 1999). While the parasite is well documented within the Park, there is a considerable lag time between the start of parasitism and the eventual death of a tree simply because of the slow consumption rates and because of cold snaps (Adirondack Park Invasive Plant Program 2015). Currently, cold temperatures are the limiting factor that keeps adelgid populations in check within the Adirondacks (Hart *et al.* 2010). As climate change increases global temperature, this line of defense may be lost, resulting in widespread loss of balsam fir in Bicknell's thrush breeding grounds (Rodenhouse 2007). There is also evidence, which suggest that higher levels of NO within an alpine ecosystem encourages the presence of a similar species of adelgid, the hemlock woolly adelgid *(Adelgis sugae)* (McClure 1991). While this does not serve as proof that higher levels of nitrogen would lead to increased indices of balsam woolly adelgid, it is safe to assume that there could be a similar effect.

The eastern spruce bud worm (*Choristoneura fumiferana)* is a larval form of a species of moth that has been present within the Park for close to three quarters of a century (Kucera and

Orr 1981). In 1945, there was a large outbreak that had run its course by 1948 without causing any serious tree damage (Dowden 1950). It was shown that low overwintering survivorship (~18%), insectivorous birds and entomophagous parasites were directly responsible for the rapid decline of budworm population (Dowden 1950). Given that close to 80% of total mortality in this particular outbreak was attributed to overwintering loss, there are growing concerns that rising global temperatures will increase the likelihood of outbreak, while also increasing the possibility of long term organismal establishment within the ecosystem (Weed 2013).

Beyond the already established invasive and pest species populations, there is a risk that human activity will introduce additional invasive to the MSFF. The expansion of alpine wind turbine projects in the northeast (along with their corresponding construction related infrastructure and activities) stands to potentially introduce invasive species into fragile ecosystems (New Hampshire Site Evaluation Committee 2015). Although the Park is protected from wide scale forestry and wind development, established invasive communities in proximity to the Park could potentially carry over into the habitat of the Bicknell's thrush populations in unprotected areas (Berlin Daily Sun 2015).

International and Domestic Policy

The current lack of international management policy for Bicknell's thrush represents one impediment to the establishment of range-wide best management practices and monitoring programs. See Governmental Issues Chapter for further details pertaining to issue of inter-governmental cooperation.

Public Knowledge Base

Based on surveying done in Canton, NY (3/25/15), Tupper Lake (4/25/15) and Lake Placid (4/25/15) the base of public knowledge and opinion regarding the Bicknell's thrush, as well as other conservation based issues, was gauged. Our primary goal of this survey was to better understand the variations in public awareness about these issues in towns both inside and outside of the Adirondack Park. Furthermore, the survey illustrates the role that distance from Bicknell's thrush habitat (e.g. Mt. Marcy) plays in level of awareness. The most common response for each question, in each respective town, is shown below in Table 1.

Table 1. Summary of survey data collected from Lake Placid, NY, Tupper Lake, NY and Canton, NY highlighting metrics of importance to Bicknell's thrush conservation efforts.

Question	Lake Placid	Tupper Lake	Canton
Sample Size	15	3	10
"Were you aware of the Bicknell's thrush prior to this survey?"	No	Yes	No
"How much would you be willing to pay annually to ensure the presence of Bicknell's thrush in the Adirondack State park?"	$87.50	$73.33	$37.50
"I am willing to adjust my own daily practices to accommodate Bicknell's thrush conservation."	Somewhat Agree	Neutral	Neutral
"I want to have a say in how land is managed for Bicknell's thrush."	Neutral	Somewhat Agree	Somewhat Disagree

METHODS

Our research was conducted through surveys of stakeholders, interviews with individuals and organizations influential in land management and conservation in northern New York, Geographic Information Systems (GIS) habitat modelling, and a review of published primary, secondary, and gray literature pertinent to Bicknell's thrush and alpine habitat conservation.

Survey procedures

We conducted surveys of stakeholders (both resident and non-resident citizens) in three towns in northern New York: Canton, Tupper Lake, and Lake Placid (Table 1). Canton is the only town situated outside of the Adirondack Park and is located 65 miles from the center of Bicknell's thrush breeding habitat in the Adirondack Mountains (considered here to be Mount Marcy, New York's tallest summit). Tupper Lake and Lake Placid are all situated within the Adirondack Park and are 27 and 12 miles from the main area of subalpine breeding habitat, respectively. We selected towns to include areas with variable proximity to the center of New York State Bicknell's thrush breeding habitat and conservation initiatives because we were interested in understanding whether proximity to the species' breeding range influences the level of awareness or opinions of stakeholders surround the issue. We constructed survey questions with the input of Dr. Michale Glennon, Science Coordinator for the Wildlife Conservation Society's Adirondack branch located in Saranac Lake, NY (Glennon, personal communication[6]). Surveys were carried out in person through random encounter procedures in which we walked the streets in each town, asking individuals if they would be willing to take

[6] Phone interview 24 February 2015

part in our survey. In each encounter with potential participants, we pitched our survey with a similar introduction to increase consistency in our survey methods:

> "Hello, do you have a moment? Our names are Eric McIntyre and Jack Riordan. We are conducting a case study as part of our senior year research at St. Lawrence University regarding the conservation of a migratory bird species that breeds in the Adirondack Mountains, the Bicknell's thrush. We are conducting a survey to learn more about the opinions of stakeholders concerning the conservation efforts being made for this species and the value of wilderness areas and alpine environments. Your participation in this survey would greatly help our research because we believe it is important to the success of our work to know your opinion on these issues. Would you be willing to take a few minutes to fill out our survey?"

Procedures for surveying stakeholders and the survey instrument were approved by the St. Lawrence University Institutional Review Board for Human Participants Research, Project Number 2015-09 (Appendix A). As an incentive to participate, survey participants had the option to be entered into a raffle for a $50.00 VISA gift card. Surveys were separated by town to enable spatial analysis of the responses.

Survey data was organized and summarized using Microsoft Excel 2010.

Interviews

We held phone interviews with important leaders in the Adirondack region who, either personally or through the organizations that they work with, have an influence on land management or conservation of Bicknell's thrush (Table 2). We were interested in gaining first-hand knowledge from these leaders to learn what they and their organizations are doing to accommodate or enhance Bicknell's thrush-related research, education, and preservation. Dr. Michale Glennon provide the perspective of a conservation researcher and shared about the work the conservation organization Wildlife Conservation Society (WCS) is doing to study and protect

breeding habitat for Bicknell's thrush and other sub-alpine-zone breeding birds. We conducted interviews with Chris Rimmer of the Vermont Center for Ecostudies (VCE), a prominent researcher on Bicknell's thrush and Chair of the International Bicknell's Thrush Conservation Group (IBTCG) who provided information regarding both the strategies for northeastern U.S. conservation efforts and details about the efforts being made on an international scale. John O'Connor of the NYS DEC shared about the work that New York State land managers are doing to accommodate Bicknell's thrush habitat conservation. Julia Goren Coordinator of the Adirondack Mountain Club's (ADK) Summit Steward Program told us about the work she is doing with her team of educators to spread awareness of the rarity, fragility, and importance of alpine habitats and unique species living in mountain top environments.

Table 2. Names, professional titles, organizations, and dates of interviews for key leaders interviewed by phone. See Appendix B for contact information for each individual interviewed.

Name	Professional Title	Organization	Date of Interview
Michale Glennon	Science Coordinator	Wildlife Conservation Soceity	24 February, 2015
Julia Gorren	Coordinator	Adirondack Mountain Club Summit Steward Program	21 April, 2015
John O'Connor	Wildlife Biologist	New York State Department of Environmental Conservation	24 April, 2015
Chris Rimmer	Executive Director	Vermont Center for Ecostudies	23 April, 2015

Geographic information systems (GIS) modeling

Based on Bicknell's thrush minimum habitat elevation requirements of 915 meters, we used GIS software (ArcMap 10.2.2) to create maps of the available habitat within northern New York State. We also overlaid the area of potential Bicknell's thrush breeding grounds in the

Adirondack Park with areas of state-owned land in the Park to visually depict how much of the breeding ground exists within already protected land parcels.

Literature review

We conducted an internet-based review of relevant primary literature using library databases (JSTOR, Environment Complete, Birds of North America) and Google Scholar, to locate research on Bicknell's thrush and the threats to its environment in the northeastern U.S. including development, pollution, climate change, and invasive species. Secondary literature sources and summaries of Bicknell's thrush research and species management strategies were particularly beneficial, as the conservation of a migrant species is a varied and complex issue. Particularly helpful was the collected list of resources under the Bibliography section of the IBTCG website. Finally, we reviewed newspaper articles and press releases to understand the types of issues that media sources portray as relevant to the protection of Bicknell's thrush.

IDENTIFICATION OF STAKEHOLDERS

A stakeholder is any group, person, or identifiable entity which stands to gain or lose from decisions made surrounding a particular topic. In the case of decisions that could be made regarding conservation efforts for Bicknell's thrush, we consider stakeholders to include the Bicknell's thrush as a species, its breeding habitat and the species that habitat contains, residents of northern New York, recreationalists and visitors, recreation outfitters and guide services, forestry groups and developers, governing bodies, non-governmental organizations (NGO), and international stakeholder groups.

Bicknell's Thrush and its Forest Habitat

The Bicknell's thrush and its summer and winter habitat represent the most significant stakeholders in decisions made by humans regarding the management of the species. Human actions appear to be causing the declines in Bicknell's thrush populations and are dramatically decreasing its overwintering habitat in the Caribbean (Rimmer and McFarland 2001; Chisholm 2008). Just as human action is currently determining the success of the species, decisions about how humans will interact in the future with land areas critical to the birds' persistence will influence how well or how poorly Bicknell's thrush is able to maintain and recover its populations across the Caribbean and the northeastern U.S. Similarly, the forested land being cut for lumber and development harbors many species. While Bicknell's thrush may be a charismatic representative of species that are being hurt by forest cutting and thus receives much of the international conservation attention, the other plant and animal species in these forests are equally valuable. Furthermore, these species are likely experiencing varied levels of disturbance and some might be faring worse than Bicknell's thrush without our knowing it. For example,

just as the reductions in spruce-fir forest due to climate change and the increasing presence of the invasive species spruce budworm and balsam wooly adelgid are negatively impacting Bicknell's thrush populations, we must also recognize the impact that management decisions will have on red spruce and balsam fir populations in the region.

Residents of Northern New York

Residents of northern New York, both year-round and seasonal, are stakeholders as well. The decisions made concerning land management and the work completed through New York State-funded conservation efforts, environmental assessments, and education work is and would be conducted by the NYS DEC, which is funded by citizen's taxes (NYS DEC 2015a). Additionally, citizens may be influenced by the decisions made regarding habitat management. For example, if it is determined that a certain area of land is too sensitive to disturbance because the Bicknell's thrush breeds there, access or development of the area may become restricted. Finally, citizens may appreciate the intrinsic value of the Bicknell's thrush in the forests around them and wish to know how the avian species is faring and to have an a say in how the species is cared for, regardless of whether they directly interact with Bicknell's thrush or its montane breeding habitat on a regular basis.

Recreationalists and Visitors

Recreationalists share a similar role as stakeholders to that of residents, and the two are not mutually exclusive, but are distinguished separately due to the activities that they partake in. The Adirondack mountains, particularly those of the Eastern and Western High Peaks, are a haven for outdoor enthusiasts. Recreational opportunities in the Adirondack region include

hiking, skiing, canoeing, swimming, rock climbing, bicycling, fishing, photography, and others. While recreationalists may also be resident citizens, people travel from around the earth each year to explore the Park's wild lands, historic sites, and towns. These stakeholders may come in frequent contact with the breeding grounds of Bicknell's thrush, particularly if they are hiking, skiing, or mountaineering. With more than 250 people visiting the summit of Mount Marcy, New York's highest peak, on a busy summer day, human interaction with the sub-alpine spruce-fir forest is higher than many would expect. The actions of visitors to these areas may influence the survivorship of Bicknell's thrush or the species they rely on for nesting. Also, recreationalists and visitors to the Adirondack State Park may find their opportunities limited if restrictions were put in place regarding the activities that could be done at higher elevations. Tourism and recreation are encouraged and advertised through resources such as those found on the Visit Adirondacks website (http://visitadirondacks.com/).

Recreation Outfitters and Guide Services

In the Adirondack region, many businesses are supported through the sale of goods and services related to outdoor recreation. These include the sale of equipment for outdoor activities and offering the experience of trained, professional guides who take recreationalists on organized trips to the mountains, rivers, and cliffs in the Adirondack Park. Conservation action taken on behalf of the Bicknell's thrush may limit the products that would be useful to recreationalists or decrease the services that could be offered if certain types of terrain were made off-limits to recreational activity. Alternately, protection of Bicknell's thrush and successful increases in populations could lead to opportunities for new types of equipment sales (clothing, binoculars, etc. related to bird watching) or guided trips (bird watching). Finally, deciding whether to

support and promote Bicknell's thrush conservation may either improve the public image of individual companies, depending on the values of its customers.

Forestry groups and developers

Within the Adirondack State Park, state-owned Forest Preserve land is not logged but privately-owned resource management land can be logged and developed to varying degrees, depending on the area's use designation assigned to it by the APA land use master plan (Jenkins and Keal 2004). In regions where forest management and logging overlap with Bicknell's thrush breeding grounds, private companies are important stakeholders in decisions regarding what to log, when it will be logged, and which resource management techniques will be utilized in an area. While logging practices such as pre-commercial thinning and clear cutting significantly decrease Bicknell's thrush populations (Chrisholm and Leonard 2008), most of the Bicknell's thrush breeding ground in northern New York is on mountainous wilderness land, owned by the Forest Preserve, where logging activity does not take place (Figure 3). In certain cases, such as during planning to rebuild mountain-top fire towers, contracted builders must be included in decisions of when and how to carry out work in montane forests to reduce the negative results of human intrusion (Glennon, personal communication[7]).

Forestry groups, while not a major stakeholder in Bicknell's thrush conservation decisions in the Adirondack region, are a larger stakeholder in parts of the northeast outside of New York where logging activity and Bicknell's thrush breeding do coincide. For example, in southern Quebec, logging activities can occasionally overlap with nesting sites and seem to cause Bicknell's thrush population declines (Chrisholm and Leonard 2008, Lambert *et al*. 2008). In

[7] Phone interview 24 February 2015

these areas, we suggest that resource extraction industries should be considered as major stakeholders in conservation efforts. Additionally, foresters, land developers, and agriculturalists in the bird's wintering grounds will be very important to consider in any management decisions that could have international influence (Lambert *et al.* 2008, Harris 2012, Rimmer and McFarland 2001). These decisions could come from governing bodies within the respective countries or through international collaboration.

Governing bodies

Two government groups must be considered as stakeholders in management for New York's breeding population of Bicknell's thrush. First, the NYS DEC, whose mission it is "To conserve, improve and protect New York's natural resources…" must contribute and guide management decisions for both the Bicknell's thrush and every other species under its jurisdiction (NYS DEC 2015a). Citizens of New York State rely on the DEC to construct and carry out effective species and resource management for all natural resources within the state, according to the law (NYS DEC 2015a). If regulations were changed for land and species conservation to benefit Bicknell's thrush, NYS DEC might be required to increase enforcement of regulations, outreach to New York State residents and visitors, or species management efforts.

Currently, the NYS DEC works to promote the preservation of Bicknell's thrush and other Adirondack montane species through the implementation of the Adirondack Sub-Alpine Forest Bird Conservation Area (ASAF BCA) that protects all mountain tops in the Adirondack region above 2,800 ft. (853 m) with the goal to "continue to maintain the wilderness quality of the area, while facilitating recreational opportunities in a manner consistent with conservation of the unique bird species present" (NYS DEC 2015b). The ASAF BCA is just 1 of 59 Bird

Conservation Areas established by the NYS DEC throughout the state (NYS DEC 2015b). One of the primary ways the ASAF BCA benefits the Bicknell's thrush is through raising awareness of the species' presence among and providing education for recreational visitors to subalpine forests (O'Connor, personal communication[8]). The NYS DEC also works to restrict construction on structures such as communication towers to times of the year that will have less effect on the breeding success of Bicknell's thrush (O'Connor, personal communication[9]). Furthermore, the NYS DEC helps monitor birds by contributing the Mountain Bird Watch, a sub-alpine bird monitoring program coordinated by the VCE (O'Connor, personal communication[10]). When asked about public perceptions of Bicknell's thrush, John O'Connor indicated that he did not think Bicknell's thrush was a particularly strong ambassador for Adirondack and montane conservation efforts due to the low level of awareness of the species (Personal communication[11]). The bird's rarity makes it unknown. He added, however, that among avid bird watchers, the species is well known and may represent a rallying point for conservation efforts for montane spruce-fir forest decline and the effects of climate change on sub-alpine habitat.

Second, the Adirondack Park Agency (APA), which forms the Park's land use master plans for both private- and state-owned land and reviews all development proposals, should be and is, by law, consulted any time development is planned which could influence Bicknell's thrush. For example, in 2013 the APA reviewed and approved a proposal to replace a ski patrol building on Whiteface Mountain, Wilmington, NY (Knight 2013). This building proposal included specific considerations to ensure minimal impacts on any Bicknell's thrush nesting near the construction site.

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[8] Phone interview 24 April 2015
[9] Phone interview 24 April 2015
[10] Phone interview 24 April 2015
[11] Phone interview 24 April 2015

Non-governmental organizations

Conservation action frequently is driven by small groups of citizens unified by a common goal of preservation and integrity for natural ecosystems. These groups of people often form organizations and function as a single body. Non-governmental organizations include those working to understand Bicknell's thrush as a species and the threats to the species' populations within the Adirondack region, nationally, and globally. The organizations we consider here include the Wildlife Conservation Society, Adirondack Mountain Club Summit Steward Program, Vermont Center for Ecostudies, Center for Biological Diversity, and International Bicknell's Thrush Conservation Group.

One of the primary organizations working in the Adirondack Region which addresses the impacts of climate change on alpine habitats and populations of species in alpine habitats is the Saranac Lake-based Adirondack branch of the WCS (Wildlife Conservation Society 2015). Through an interview with WCS science coordinator Dr. Michale Glennon, we learned about the efforts WCS makes to better understand climate change in the Adirondacks. WCS conducts research on the effects of development in Bicknell's thrush and other montane habitat in the Adirondack region, including that related to ski area development (Glennon, personal communication[12]). Based on this research, WCS is able to contribute suggestions for better management of habitat. For example, WCS was able to advise the Olympic Regional Development Authority (ORDA), which manages, among other facilities, the Whiteface Mountain Ski Area in Wilmington, NY, on the placement of a new ski trail to decrease the loss

[12] Phone interview 24 February 2015

and degradation of montane forest for Bicknell's thrush (Glennon, personal communication[13]; Olympic Regional Development Authority 2015). The WCS suggests that the greatest threat to Bicknell's thrush in its Adirondack nesting sites is from climate-change-related upslope shifts in tree species (Glennon, personal communication[14]). According to Dr. Glennon, there is general awareness of the Bicknell's thrush among bird enthusiasts and visitors to montane habitats (such as those that may have encountered educational information at Whiteface Mountain Ski Area) but there is likely limited knowledge in the general public (Glennon, personal communication[15]). More work is needed to understand the effectiveness of current outreach and educational efforts related to Bicknell's thrush and the willingness of individuals, private interest groups, and developers to adjust their day-to-day activities in montane locations to accommodate thrush conservation (Glennon, personal communication[16]).

An additional organization is the Adirondack Mountain Club (ADK), which supports the Summit Steward Program (ADK 2015). Summit Steward Coordinator, Julia Goren, told us about the work that the ADK carries out to increase awareness of alpine habitats and threatened alpine species among recreational visitors to the Adirondack summits. The alpine zone, often considered to be any area above the tree line, is higher in elevation and even rarer is extent than montane spruce-fir forest. In particular, the Summit Steward Program educates hikers about alpine plant species and the effects of foot traffic on the alpine summits of Adirondack mountains through a technique called 'Site-based Non-formal Interpretation' (Goren, personal communication[17]). In effect, Summit Stewards, individuals who have been trained to educate

[13] Phone interview 24 February 2015
[14] Phone interview 24 February 2015
[15] Phone interview 24 February 2015
[16] Phone interview 24 February 2015
[17] Phone interview 21 April 2015

about the Adirondack summits and who are hired or volunteer their time, go to specified summits with the goal of holding a conversation with every hiker that visits the mountain (Goren, personal communication[18]). Somewhere during this conversation, the Summit Stewards try to interject a message that conveys to hikers, "Plants in the alpine zone are fragile. Protect the plants by staying on exposed bedrock" (Goren, personal communication[19]). Although Summit Stewards are not specifically working on Bicknell's thrush conservation or even within Bicknell's thrush nesting areas, we consider ADK a stakeholder because every hiker Summit Stewards encounter has already and will again pass through montane spruce fir forest during their outing. The conversations Summit Stewards hold with hikers and the knowledge imparted through those conversations directly affect the attitudes and actions of recreationalists spending time in Adirondack mountain-top environments. Alpine habitat is very rare in the northeastern United States. Hikers care about its presence and are willing to contribute to conservation both through their actions (not stepping on alpine vegetation) and through monetary donations (Goren, personal communication[20]). Summit Stewards do discuss montane-breeding bird species and the effects of climate change with hikers when the conversation leads to those topics, but do not regularly strive to broach these topics (Goren, personal communication[21]). Julia Goren estimated that fewer than 10% of encounters with recreationalists involved discussions of birds. Climate change is discussed less frequently because it is much more difficult to give hikers a concrete action step to take related to climate change than an action step related to alpine plant preservation in response to the conversation (Goren, personal communication[22]). While it was

[18] Phone interview 21 April 2015
[19] Phone interview 21 April 2015
[20] Phone interview 21 April 2015
[21] Phone interview 21 April 2015
[22] Phone interview 21 April 2015

once thought that alpine habitat was gravely threatened by climate change, it is now predicted that climate change will not entirely remove alpine plants from Adirondack summits (Goren, personal communication[23]). Soil is thin and accumulates slowly in alpine zones and climate change will likely make wind and ice damage more severe, preventing the encroachment of larger, taller plant species (Goren, personal communication[24]). The most likely observable change to alpine habitat is changes in the relative abundance of each species (Goren, personal communication[25]). While this prediction may be good news for alpine habitat, it means that, while broadleaf forest continues to move upslope and encroach on montane spruce-fir forests, red spruce and balsam fir will not be able to move upslope nearly as quickly, if at all, contributing to the regional decline of these species and Bicknell's thrush habitat. Julia Goren said that the best way to garner support for Bicknell's thrush and montane species conservation would be to allow those who feel passionately connected to these beautiful environments share their voices on the matter and take ownership of solutions to the problem. Furthermore, support could be increased by improving recreationalists' sense of pride and belonging toward and capacity to connect with montane habitat (Goren, personal communication[26]).

Outside of the Adirondack State Park, the most prominent organization working on Bicknell's thrush is the Vermont Center for Ecostudies (VCE), which is a project partner of the International Bicknell's Thrush Conservation Group (IBTCG) that published *A Conservation Action Plan for Bicknell's Thrush: Catharus bicknelli* (Hart *et al.* 2010; Vermont Center for Ecostudies 2015). Their work is foundational to understanding species-specific habitat needs, habitat conversion in both summer and winter grounds, and the international efforts for

[23] Phone interview 21 April 2015
[24] Phone interview 21 April 2015
[25] Phone interview 21 April 2015
[26] Phone interview 21 April 2015

collaborative conservation work on Bicknell's thrush. The VCE (and as a partner, the IBTCG from 2007 onward) began working in Hispaniola in 1994 and in those twenty years have laid the foundation for budding Bicknell's thrush management in this area (Rimmer, personal communication[27]). Initially, the group started conducting field-based research into habitat use, by the bird and the residents, as well as the natural history of the bird, in The Dominican Republic (Rimmer, personal communication[28]). However, the VCE/ IBTCG have now taken on the responsibility of encouraging community-based conservation approaches, training partner groups in the area and protecting habitat through education and economic alternatives for subsistence farmers with destructive farming practices (Rimmer, personal communication[29]). Currently, VCE and IBTCG have a full time conservation biologist, who is an ornithologist by training, conducting this groundwork in The Dominican Republic (Rimmer, personal communication[30]).

The VCE and IBTCG play an important role in understanding the interactions small-scale agrarian communities have with their surrounding environment. The current lack of adequate protection for Bicknell's thrush habitat is not a result of public opposition but instead of scarcity of resources and lack of incentives (Rimmer, personal communication[31]). It has been observed that the individuals in The Dominican Republic degrading the environment are "apologetic" towards nature that is damaged as a result of their actions (Rimmer, personal communication[32]). The major challenge is identifying and implementing alternative economic routes that are less detrimental to surrounding ecosystems (Rimmer, personal communications). This could be through various avenues, such as payment for ecocentric farming approaches or reimbursement

[27] Phone interview 23 April 2015
[28] Phone interview 23 April 2015
[29] Phone interview 23 April 2015
[30] Phone interview 23 April 2015
[31] Phone interview 23 April 2015
[32] Phone interview 23 April 2015

for losses accrued during less ecologically harmful economic endeavors (Rimmer, personal communications[33]).

These two conservation groups are considered stakeholders because of their understanding of the intrinsic value of the Bicknell's thrush as well as the ecological value of their habitat. Through their education programs, economic motivation and monitoring of current populations, the VEC and IBTCG are creating a better informed populous who may be more inclined to alter their habits to protect the Bicknell's thrush.

The Center for Biological Diversity, a national organization advocating for the conservation of threatened species and lands, is working to see Bicknell's thrush protected under the Endangered Species Act of 1973 (CBD 2015; Dillon 2010). See Government Issues Chapter for further information.

International stakeholder groups

We recognize the legitimate concerns and valid input that should and does come from international stakeholders, including residents, agriculturalists, and governments. They do not exist in our primary study region and thus are given less consideration here, but we do recognize their role and their capacity to gain or lose as a result of Bicknell's thrush conservation similarly to Adirondack-based stakeholders.

Government bodies will be responsible for implementing monitoring programs and regulatory practices in accordance with further research. The governments of nations in the Greater Antilles will also be tasked with ensuring the equitable treatment of both human citizens and the environment as conservation initiatives progress. Residents, especially agriculturalists

[33] Phone interview 23 April 2015

seeking new land, will have to adjust their day-to-day interactions with the land if regulations are established placing limits on forest cutting. Incentives associated with these regulations may enable them to benefit in others ways. Residents may also have particular personal experiences that give value to the presence of Bicknell's thrush and other species in their forests or to the progress and state of development in their countries.

GOVERNMENTAL ISSUES

The largest obstacle the conservation efforts of the Bicknell's thrush face is the current lack of coordinated domestic and international policy. Being a habitat specialist, the Bicknell's thrush has a tremendously narrow niche and, as a result, is exceptionally sensitive to rapid changes in habitat availability (Matteson, 2010). The drivers behind the major population declines observed in the Adirondack population of Bicknell's thrush are not a result of localized human activity within the Adirondack State Park, but instead the result of environmental degradation of areas far from the threatened habitat (Matteson 2010). The Bicknell's thrush migratory range spans from parts of southern Maine and Canada all the way to its overwintering sites in the Caribbean including Hispaniola, Cuba, Puerto Rico and Jamaica (Figure 2) (Hart *et al.* 2010). In the Caribbean overwintering sites, the practice of clearing potential Bicknell's thrush habitat, below 1,000m elevation, for farming purposes is proving to be severely detrimental to Bicknell's thrush populations (Matteson 2010). Despite these countries, separated by thousands of miles, sharing a common threatened species, there is still very little collaboration and policy formation between the United States, Canada and the Caribbean (Matteson 2010). Without policy consensus, it will be challenging to make any meaningful changes to the overall health of the Bicknell's thrush populations based solely on actions in the northeast.

It is widely recognized that deforestation in the lower elevation, broadleaf forests, of Caribbean sites has been a main driver behind the supposed Bicknell's thrush population declines (Hart *et al.* 2010). The forests of Hispaniola are being converted, without serious regulation, to be utilized for agrarian purposes and are no longer suitable for Bicknell's thrush habitation (Rimmer 2001). The Vermont Center for Ecostudies (hereinafter referred to as VCE), of White River Junction, Vermont, currently leads the field in cross border Bicknell's thrush

conservation efforts (Hart *et al.* 2010). Currently, the VCE's International Bicknell's Thrush Conservation Group (IBTCG) is one of the only examples of collaboration between the United States and Caribbean nations on Bicknell's thrush conservation (Hart *et al.* 2010). The IBTCG's commitment towards fostering positive, collaborative, multinational Bicknell's thrush conservation initiatives is realized through education efforts, direct outreach to stakeholders and even a grant that is rewarded to conservation groups in the Dominican Republic every year to propagate sustainable forestry and agricultural practices (Fox News Latino 2015). Beyond monetary support for the Dominican Republic, VCE and IBTCG also organize volunteer groups who travel throughout the northeast to identify nesting sites during the spring migration as part of the Mountain Birdwatch program (Valley News 2013).

While the initial steps are being taken to bridge the conservation gaps between the United States' and Canada's breeding sites and the Caribbean wintering sites, there is clearly still a sizable amount of work to be done. In 2010 the Center for Biological Diversity pushed the U.S. Fish and Wildlife Service to review the Bicknell's thrush for protection under the Endangered Species Act (Dillon 2010). The process of making a decision finally got under way in 2012 (Idlebrook 2012). When the Fish and Wildlife Service took too long to make a decision, the Center for Biological Diversity filed a lawsuit (Matteson 2013). Matteson claims the reason efforts to protect the Bicknell's thrush, along with other alpine species, under the Endangered Species Act are being hindered is because the government is not willing to accept the responsibility of significantly reducing atmospheric pollutants from fossil fuels to reduce the threats of climate change (Matteson in Idlebrook 2012). There will not be an opportunity for the formation of meaningful policy until the Bicknell's thrush is listed as threatened or endangered under the United States' Endangered Species Act (Matteson 2010).

DEVELOPMENT OF SOLUTIONS TO THE PROBLEM

Parameterizing solutions

As described in the Problem Definition Chapter, there are numerous threats to the Bicknell's thrush. It is clear that the species is in danger of decline as forests continue to be cut in the Greater Antilles and climate change takes a stronger hold across the globe. To adequately prevent the extinction of this migrant bird, at least a few threats will need to be addressed for a conservation plan to show any successful results. However, to achieve the full recovery and preservation of the Bicknell's thrush, complicated and multi-faceted approaches will be required to ensure the long-term survival and population expansion desired by many of the people who care deeply about the species. We support the idea that comprehensive inclusion of and support from stakeholder groups will be important to the success of conservation solutions. Management of habitat and populations should adapt according to the findings of new research as it becomes available through making adjustments to policies, protocols, regulations, and monitoring initiatives.

The focus of our study has been on the threats to Bicknell's thrush and relevant stakeholders in the Adirondack State Park, New York State, but has also given serious consideration to international threats. We had initially thought that the loss of montane spruce-fir forest habitat in the Adirondack region would be the greatest threat to Bicknell's thrush, making Bicknell's thrush conservation predominately a northern New York issue. Through conducting research, interviewing and surveying stakeholders, and GIS modeling of Adirondack Park Bicknell's thrush habitat, we have concluded that the threatened state of our focal species is not specifically a New York State issue. Although conservation groups and bird enthusiasts in New York, New England, and southeastern Canada have begun rallying behind the species and

appear to be taking it upon themselves to see the successful recovery of the species, it appears that larger threats may exist in the Greater Antilles. Despite the fact that the Adirondack region is not the area in which Bicknell's thrush is most at risk of decline, we assert that the Adirondack State Park can contribute greatly to range-wide conservation efforts.

Most importantly, the history of the Adirondack State Park as a once degraded and now dramatically recovering landscape, filled both with wilderness and with people, may offer a fresh perspective to those attempting to actualize conservation and restoration on seriously degraded tracts of land. In his essay *Home*, author and climate activist Bill McKibben writes of the Adirondacks:

> "Perhaps no place on the planet has recovered as comprehensively from deforestation as these mountains five hours' drive from New York City...For conservationists imagining not simply the salvation of what remains pristine, but the restoration of what has been degraded, this is just about the most heartening spot on earth. The Adirondacks offer a few scattered reminders of what Eden looked like, and a million vistas from which to imagine redemption" (McKibben 1995).

McKibben's thoughts, along with the thoughts of researchers and leaders interviewed in our study, lead us to believe that there is a strong sense of regional pride among stakeholders that interact with the Adirondack mountains. Simply put, people care deeply about the Adirondack Park and those that know its history are in awe of the region's resilience. We assert that the awareness of the story of redemption for a once deforested landscape in the northeastern United States could be used to build support, pride, and hope for the restoration and redemption of destroyed habitat elsewhere in the world.

A complete, successful set of solutions to the threats facing Bicknell's thrush will address the threats in the bird's summer nesting areas, migratory stopover locations, and overwintering sites. Each of these three target locations experiences differential levels of similar pressures. While an issue, such as deforestation, may take place in each area, the methods for addressing conservation will necessarily be different across regions. Breeding ground forests in New York exist within a different ecological and human landscape than overwintering forests in Hispaniola or Cuba. The varied cultural histories, political institutions, and expectations of stakeholders across the annual range of the Bicknell's thrush dictates equally specialized and adapted solutions to threats. Such adaptations of management and recovery techniques require large amounts of resources. Any solution that is devised must make careful consideration of each stakeholder's needs as projects will surely fail without a majority support for the work being done.

Successful conservation approaches contributing to comprehensive solutions will work in at least one of the three target locations to prevent Bicknell's thrush population decline, prevent further habitat loss, assess poorly understood threats (ex. climate change, pollution, invasive species), increase our understanding of Bicknell's thrush life history (ex. migratory routes), raise awareness among stakeholders, or improve funding for conservation and habitat restoration efforts.

Identification and evaluation of potential solutions

We propose here all potential solutions that could contribute to Bicknell's thrush conservation and fulfill the parameters for solutions as established above. Much work is already

underway through the efforts of the IBTCG, regional and national conservation NGOs, and government bodies.

Prevent additional deforestation

Preventing further deforestation is important because forests are where the Bicknell's thrush lives. Without forests, particularly undisturbed forests in the Greater Antilles and montane spruce-fir forest in the breeding grounds, we will no longer have Bicknell's thrush. This preservation of habitat will require the cooperation of stakeholders, economic incentives provided by conservationists or conservation related government bodies to persons willing to not cut their forested land.

Restore degraded forest habitat

This solution would enable populations of Bicknell's thrush that may have declined to rebuild and inhabit forest patches that it was extirpated (made locally extinct) from. The IBTCG seeks to see an increase in Bicknell's thrush populations globally, and the solution to restore degraded forest habitat represents one way to contribute to that goal (Hart *et al.* 2010). Restoration of forests that have been clear cut is a long and complicated process. Full resilience of the forest patch is not likely to be restored, however, functional groups, some native species assemblages, and well replicated forest physical structure may be achievable if proper techniques for ecosystem rehabilitation and reference ecosystems are utilized in the process of restoration.

Educate stakeholders

Educating stakeholders builds awareness about the species and may help to increase regional pride in an endemic and distributionally restricted bird. Education and outreach to stakeholders will likely improve funding for other conservation efforts and gain supporters among individuals and organizations. To properly carry out this education researchers must first understand Bicknell's thrush better than they currently do. For this reason, the solution Monitor Bicknell's thrush populations is required for to successfully address the solution Educate stakeholders. Education can be participatory in that stakeholders could learn through partaking in citizen science efforts and contributing to the monitoring of populations.

Build international support and collaboration

To actually work toward range-wide conservation of Bicknell's thrush, government, research, and conservation bodies will need to collaborate across national boundaries to enable the sharing of information and resources. This international work is complicated by the need to include stewards from the six different countries that Bicknell's thrush is known to spend time in. Better collaboration may increase the understand of the life history of Bicknell's thrush.

Establish best management practices

Best management practices set ground rules for conduct in a particular environment. Specifically, best management practices could be refined for development in sub-alpine ecosystems and forestry in the woodlands inhabited by Bicknell's thrush. These best management practices will be enhanced through comprehensive international collaboration and sharing of information.

Locate migratory stopover sites

Migratory pathways are specific to each bird species. Understanding these migratory paths is important, as many species pause at certain points along their migration routes to refuel on energy stores before continuing their long flight in the spring or fall. Without the protection of stopover sites, habitat loss in these areas could make it impossible for a species to complete its migration. For Bicknell's thrush, the location of the migratory path is unclear and the location of the stopover sites is unknown. Thus, pin pointing stopover sites is important for knowing the state of habitat and for enabling assessment of the need for habitat protection in these areas. For example, in Sandy Hook, New Jersey, one suspected stopover site for Bicknell's thrush, a proposed building project that required forest removal is under scrutiny due to Bicknell's thrush activists making known the potential importance of the forest habitat for the migrant bird (Mikle 2014).

Monitor Bicknell's thrush populations

Current knowledge of Bicknell's thrush distribution is not sufficient for understanding presence and absence of the species in habitat patches, for determining trends in growth or decline of the species, or for creating legislative action and best management practices. Monitoring should be conducted across the species' range to improve understanding of life history and distribution. This monitoring will help assessment of poorly understood threats, enable prevention of further population declines, and could include raising awareness among stakeholders where citizen scientists were used to monitor the Bicknell's thrush.

Stop climate change

As a solution stopping climate change would help to mitigate many of the threats to Bicknell's thrush including changes in tree distribution, pollution, and the spread of invasive and pest species. Although climate change is caused by humans across the globe and, as such, requires global human behavior change, the benefits of stopping climate change for Bicknell's thrush could be tremendous. Achieving this goal would prevent habitat loss and further population decline.

Prevent the spread of invasive and pest insect species

Invasive and pest insect species are broadening their distribution and having greater impacts on montane spruce-fir forests as a result of warming climates. Stopping their spread would help to reduce the decline of Bicknell's thrush breeding habitat and could involve the help of stakeholder volunteers or citizen scientists in removal of the species, helping to increase overall stakeholder awareness of the threats to the species.

Reduce atmospheric pollutant deposition

Acid deposition in reduces the health of tree species and mercury deposition reduces the health of Bicknell's thrush individuals. Reducing the deposition of these environmental pollutants would help to prevent loss of Bicknell's thrush habitat and reduce the potential for Bicknell's thrush population declines. To do so, production of the pollutants would need to be slowed greatly in parts of the United States outside of the breeding grounds for Bicknell's thrush that serve as the source of these atmospheric pollutants.

Identification of feasible solutions

Some solutions to the threats facing Bicknell's thrush are likely to be achieved feasibly by Bicknell's thrush conservation efforts alone, while others are not and would require larger regional or global initiatives to see them accomplished. We consider the potential solutions Stop climate change, Prevent the spread of invasive and pest insect species, and Reduce atmospheric pollutant deposition to be beyond the scope of Bicknell's thrush conservation efforts. These issues are driven by larger anthropogenic changes to the earth's environment with causes that are inter-state or international in scope. Climate change is caused globally by humans and would require drastic and comprehensive behavior change on the part of a majority of the human population to bring a stop to warming and climatic effects in way to make a meaningful difference for Bicknell's thrush and its habitat. The large scale behavior change campaign that would be required of this solution is not within the scope of the efforts achievable by Bicknell's thrush conservationists alone. Similarly, the spread of invasive and pest insect species in montane spruce-fir forest is both nearly impossible to halt or reverse and linked to increasing annual temperatures at northern latitudes resulting from the anthropogenic climate change that cannot be fixed by efforts for Bicknell's thrush alone. Finally, atmospheric pollutants damaging montane spruce-fir forest and bioaccumulating in forest of the Adirondack Park are not directly from northern New York and are caused by millions of people. Behavior change to reduce the production of atmospheric pollutants by Bicknell's thrush activists and those reached by possible outreach campaigns would not be enough to stop pollution within the Adirondack Park. Pollutant reduction efforts would have to be large-scale and take place to the south west of the Adirondack region where pollutants being transported from on the wind. For each of these three solutions deemed infeasible, we reassert that we do not condemn these solutions as entirely

impossible by global conservation efforts and activism, but simply recognize them as beyond the scope of the work that can be done related to Bicknell's thrush. We encourage Bicknell's thrush conservationists to contribute their voices and knowledge of the plight of the Bicknell's thrush to the great efforts already being made on the issues of climate change, invasive and pest species spread, and atmospheric pollutant deposition. Without earnest and immediate global action on these issues, we do not foresee that the forests inhabited by Bicknell's thrush will continue to thrive. Therefore, we encourage Bicknell's thrush conservationists to partner with other stakeholder organizations and governments working on these issues to do their part in seeing each of these threats sufficiently addressed by the global community.

We consider each of the remaining solutions, Prevent additional deforestation, Restore degraded forest habitat, Educate stakeholders, Build international support and collaboration, Establish best management practices, Locate migratory stopover sites, and Monitor Bicknell's thrush populations, to be feasibly achieved by efforts to protect Bicknell's thrush alone. Each of these requires education of stakeholders, behavior change, and scientific research at a scale that is manageable by the select stakeholders willing to work toward Bicknell's thrush conservation.

Identification of best solutions

Out of each solution proposed that we deem feasible, Prevent additional deforestation and Monitor Bicknell's thrush populations are considered the best solutions. Working to prevent additional deforestation, especially in the Greater Antilles, is imperative to retaining as much remnant old growth forest in Bicknell's thrush overwintering sites as possible. Preventing deforestation should also be a priority in migratory stopover sites and in any unprotected nesting areas. This solution addresses several of the parameters for successful solutions. It prevents

additional habitat loss while providing the opportunity for Bicknell's thrush populations to stabilize. Effectively executed education campaigns required to stop deforestation would include engagements with as many individuals as possible from each stakeholder group, potentially helping to raise awareness among stakeholders and improve funding for future efforts if stakeholders gained an increased sense of appreciation for Bicknell's thrush and the rarity of mountain-top habitat and decided to contribute financially to conservation for the species.

Monitoring of populations is required to assess poorly understood threats, increase understanding of Bicknell's thrush life history, and improve the credibility of efforts to raise funds for conservation among stakeholders and through grant opportunities. Monitoring has been insufficient in the past to provide a proper understanding of Bicknell's thrush currently. Improved monitoring will be necessary to accomplish many of the other feasible solutions, such as the establishment of best management practices and the location and protection of migratory stopover sites.

EASE OF IMPLEMENTATION

Preservation of Bicknell's thrush is a complicated task, but can be accomplish through implementing multiple complementary solutions that can together diminish many of the threats facing the species. Each of the solutions that we propose to be feasible requires the implementation of one of the other feasible solutions. Some are easier to accomplish than others. Monitoring and education of stakeholders are only difficult in that they can be costly and require long-term commitment from researchers and organizations dedicated to educating about biodiversity. Additionally, stakeholder education requires that the stakeholders perceived to be in need of knowledge regard Bicknell's thrush must be willing to receive that knowledge. Even though locating stopover sites and understanding complicated and currently under researched aspects of Bicknell's thrush life history will be accomplished through monitoring programs for the species if the monitoring is designed to be comprehensive and adaptive, additional specialized studies may be required to gather data on specific life history traits. Gaining international support and building collaboration among stakeholders, completing restoration of degraded habitat, and the establishment of best management practices will be complicated by the need for range-wide work on these solutions. Stakeholders, particularly agriculturalists in the Greater Antilles that would be asked to stop cutting forests, will need to be compensated in some way, likely through economic incentives (Rimmer, personal communication[34]). It is unclear how to properly incentivize the act of not cutting forests. Economic alternatives are hard to find due to the fact that the region is going through the processes of globalization and development (Rimmer, personal communication[35]). Proper compensation is difficult because the amount of capital required to make a compensation program equitable is currently unavailable (Rimmer,

[34] Phone interview 23 April 2015
[35] Phone interview 23 April 2015

personal communication[36]). Communication between researchers and conservation advocate across language barriers will slow down progress. Also, restoration work can be very costly and may require greater funding than is readily available from stake holder donations.

Fortunately, extensive work is already underway on many of these solutions through the work of the IBTCG and monitoring efforts by the VCE's Mountain Birdwatch program (Hart *et al.* 2010, Vermont Center for Ecostudies 2015). We suggest that bolstering the already high regional pride for Bicknell's thrush, Adirondack mountain habitat, and the incredible success story of Adirondack ecosystem recovery may enable reliance on funding from stakeholders in New York and New England to support thrush conservation in the Greater Antilles. While not everyone in the Adirondack Park knows about montane habitat or recognizes its intrinsic value, and although few people are aware of the presence of Bicknell's thrush in the northern New York (Table 1), those who do know care deeply and are willing to act (Goren, personal communication[37]). We wonder if a hiker in the Adirondack mountains might be able to look out over the landscape from one of the "million vistas from which to imagine redemption" that Bill McKibben speaks of, and later turn south and look with hope beyond our region to the Greater Antilles and imagine the same redemption for degraded forests there.

[36] Phone interview 23 April 2015
[37] Phone interview 21 April 2015

IMPLEMENTATION PLAN

Conservation of Bicknell's thrush through the solutions proposed above as feasible should build off of conservation actions that are already taking place for the species. Adding additional layers to this conservation plan will require additional funding. It is not likely that either governments or residents of developing countries in the Greater Antilles possess sufficient capital to support habitat preservation and restoration, which we predict to be the most costly restoration work needed for the species. Funding could come from enthusiastic stakeholders in the United States and Canada who feel a strong sense of ownership for the long-term preservation of Bicknell's thrush.

Monitoring of the Bicknell's thrush is a major priority to understand what habitat is actually important to the species, which habitat parcels are threatened, and what types of activities limit the usefulness of habitat fragments for Bicknell's thrush. Monitoring efforts by the Mountain Bird Watch could be increased to better evaluate presence, absence, and declines in populations of Bicknell's thrush in the northeastern United States and Canada. As necessary, stakeholders in the United States and Canada could also fund increases in monitoring needed across the species' range, though much of this work could be done through volunteers and citizen scientists. Monitoring will also help clear up poorly understood threats and life history traits and can be utilized to establish best management practices.

The best way to contribute to preservation of Bicknell's thrush may be through the education of stakeholders to help them understand the value and importance of the species (Rimmer, personal communication[38]). The resulting improved perceptions of the species due to education efforts could help reduce forest cutting, encourage land owners to allow reforestation

[38] Phone interview 23 April 2015

of their land, build local and international support for conservation efforts, and contribute to inter-stakeholder and international collaboration on conservation practices and the health of Bicknell's thrush. Education of and engagement with stakeholders could be improved through the use of multimedia and news outlets. For example, newspapers, magazines, radio shows, and videos keeping stakeholders up-to-date on the status of the Bicknell's thrush and displaying the importance and value of the species could be used for outreach.

CONCLUSIONS

The efforts to protect Bicknell's thrush from decline and extinction is gaining support throughout New York and New England as NGOs, governments, and residents work locally and internationally to protect the species' diminishing habitat and reduce the threats caused by humans. The Bicknell's thrush nesting habitat contained within New York State's Adirondack State Park represents a relatively stable breeding zone for the species. Threats in the Adirondack region are certainly present but may not be as serious as those facing the species in its Greater Antilles overwintering habitat. Locally-caused threats to Bicknell's thrush in the Adirondack State Park are well managed and monitored through the NYS DEC, APA, and NGOs such as WCS. Because the major threats present in the Adirondack montane spruce-fir forest are of global origin, little can be done specifically within the Adirondack mountains to increase protection for Bicknell's thrush or its habitat. However, the great history of restoration in the Adirondack State Park and the region's continuing recovery today may contribute much needed hope for the success of forest restoration in the Greater Antilles.

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APPENDICES

Appendix A. Survey instruments including questions and optional prize card

Bicknell's Thrush Survey

Listed below are several statements regarding the Bicknell's thrush. For the following statements, please circle the degree to which you agree with each statement. CD = Completely Disagree, SD = Somewhat Disagree, N = Neutral, SA = Somewhat Agree, CA = Completely Agree.

Mountain top habitats and the species in them are worth preserving for future human generations to enjoy.

CD SD N SA CA

Mountain top habitats are valuable and should not be destroyed simply because they have the right to continue existing as they are now.

CD SD N SA CA

Climate change is causing shifts in the distribution of species in the Adirondack region.

CD SD N SA CA

There are impacts from pollutants, such as mercury deposition and acid rain, on animals and plants in the Adirondack region.

CD SD N SA CA

I believe scientific data about species should strongly influence land management and development decisions in the Adirondack State Park.

CD SD N SA CA

I am aware of the threats to Bicknell's thrush.

CD SD N SA CA

I have seen articles and/or informational displays in the Adirondack State Park drawing attention to the threats facing Bicknell's thrush.

CD SD N SA CA

The long-term presence of Bicknell's thrush in the Adirondack State Park is important to me.

CD SD N SA CA

The long-term preservation of Bicknell's thrush will increase tourism in the High Peaks region, providing economic benefit to the area.

CD SD N SA CA

It is up to land managers and government officials alone to decide how and whether to protect Bicknell's thrush habitat.

CD SD N SA CA

Deforestation causes reductions in Bicknell's thrush populations.

CD SD N SA CA

If Bicknell's thrush populations are declining, we should allow the species to go extinct.

CD SD N SA CA

I am willing to adjust my own daily practices to accommodate Bicknell's thrush conservation.

CD SD N SA CA

The costs of conservation do not outweigh the potential benefits.

CD SD N SA CA

I want to have a say in how land is managed for Bicknell's thrush.

CD	SD	N	SA	CA

The Bicknell's thrush should be protected under the Endangered Species Act of 1973.

CD	SD	N	SA	CA

Please circle the most appropriate answer for the following questions:

1. What is your age?
    a. 18-24
    b. 25-34
    c. 35-44
    d. 45-54
    e. Over 55

2. What type of resident are you?
    a. Tourist
    b. Seasonal
    c. Permanent

3. What is your highest level of education?
    a. Less than high school
    b. High school or GED
    c. Some college
    d. Undergraduate degree
    e. Masters degree
    f. Doctoral or Professional degree (MD, JD, PhD, etc.)

4. Which answer(s) best describes your recreational interactions with the High Peaks region:
    a. Birding
    b. Hiking/climbing
    c. Winter sports (e.g. skiing, snowshoeing, snowmobiling)
    d. Water sports (e.g. canoeing, kayaking, fishing)
    e. Other
    f. None

5. Were you aware of the Bicknell's thrush prior to this survey?
    a. Yes
    b. No

Please fill in the blank for question 6:

6. How much ($US) would you be willing to pay annually to ensure the presence of Bicknell's thrush in the Adirondack State Park?

    _____

Prize Card Drawing

Name _____

If you are interested in being entered in the drawing for the $50 Visa gift card, please list below the address to which we should send the card in the event that you were to win the drawing.

_____
_____
_____

Appendix B. Contact information for interviewed leaders, researchers, and managers

1) Wildlife Conservation Society :

   Michale Glennon

   Office: 518-891-8872

2) Adirondack Mountain Club Summit Steward Program

   Julia Gorren

   Office: 518-523-3480

3) NYS Department of Environmental Conservation:

   John O'Connor

   Office: 518-402-8920

4) Vermont Center for Ecostudies:

   Chris Rimmer

   Mobile: 802.922.8465

   Office: 802.649.1431 ex. 1