October 12, 2010

Marcia Spencer Famous
Senior Planner
Land Use Regulation Commission
Department of Conservation
22 State House Station
Augusta, ME 04333-0022

RE: Amended DP 4860 Amended Kibby Expansion Project

Dear Marcia:

We are writing as the Consolidated Parties (Maine Audubon, the Appalachian Mountain Club, and the Natural Resources Council of Maine) to provide comments in opposition to the Amended Kibby Expansion Project. If TransCanada's application is approved, the project would cause undue adverse impacts to multiple high-priority resource values including a documented and ecologically significant occurrence of a rare community type and breeding Bicknell's thrush (Catharus bicknelli), a species endemic to the northeast and one of the highest conservation priorities for the region. The project would also cause an unreasonable adverse impact to the character of outstanding scenic resources of both state and national significance. **It therefore fails to meet the criteria for approval set forth in 12 M.R.S.A. §685-B.4.C, 35-A MRSA §3452, and LURC Land Use Districts and Standards Chapter 10.24.**

While it is true that the number of turbines has been reduced from the original project, the number of turbines is not as important as the level of adverse impact to the resources. Although the revised application reduces some impacts to natural resources, the remaining impacts are still undue adverse impacts. We stand behind our original

testimony that the northern eight turbines would not cause an undue or unreasonable adverse impact, and that development of turbines in the area to the south would cause undue or unreasonable adverse impacts.

Smaller Project of the Eight Northern Turbines Meets the Legal Criteria

As we have consistently stated, we support a smaller project consisting of the eight northern turbines. The project area consists of two ecologically distinct parts – the northern area (containing Turbines 1 through 8) and the revised southern area (containing turbines 9 through 11). Consistent with our support of other wind power development in Maine, we support the construction of the eight turbines and their associated roads in the northern portion of this project area.

Turbines 1 through 7 and the associated access roads lie entirely outside of the mapped extent of the rare Fir-Heartleaved Birch Subalpine Forest Natural community.[1] Turbine 8 and its associated road lie within the community, but impact only a small area at the northern tip of it. The impact of Turbine 8 on the community can legitimately be described as "minimal" and is therefore not undue.

This northern part of the project area is located outside of high-quality Bicknell's thrush habitat, is not now in use by Bicknell's nor is it likely potential habitat in the future.[2] Therefore, concern over both habitat loss and risk of collisions with turbines is minimal.

Scenic impacts from the northern eight turbines meet the standards[3] and would be notably reduced in comparison to the project as proposed. The removal of turbines 9 – 11 would not eliminate the adverse impacts of the project on the Chain of Ponds, including the Public Lands Unit and the Arnold Trail, but it would reduce them below the level of undue adverse impacts.

[1] Testimony of W. Donald Hudson, April 21, 2010, Exhibit B; See also Testimony of David Publicover, April 21, 2010.
[2] See Testimony of Susan M. Gallo, April 21, 2010.
[3] See Testimony of Catherine B. Johnson, April 21, 2010.

Amended Project Would Cause Undue Adverse Impact on a Rare Natural Community With Very Limited Extent Within the State

We do not repeat herein the full original testimony of Dr. David Publicover[4] on behalf of the Consolidated Parties regarding the value of this rare natural community and of this particular occurrence, but summarize the testimony's important points that remain relevant to the amended project:

- The Fir-Heart-leaved Birch Subalpine Forest natural community is ranked S3 (Rare) by the Maine Natural Areas Program, with only 19 documented occurrences in the state encompassing 40,000 acres in total, or just 0.2% of the state's land area. Eighty-six percent of this total is found in just five areas (Mount Katahdin, the Mahoosuc Range, Bigelow Mountain, Redington/Crocker and Baker/Lily Bay). The Maine Natural Area Program (NAP) states that this community "should not be considered common anywhere in Maine."[5]
- The occurrence of the Fir-Heart-leaved Birch Subalpine Forest natural community on Sisk Mountain encompasses 358 acres, making it the eleventh largest of the nineteen documented occurrences in the state. The Sisk occurrence is more than twice as large as seven of the nineteen documented occurrences.
- The occurrence on Sisk Mountain was assigned an Element Occurrence Rank of "B", or "Good", by MNAP. Of the three elements that go into this ranking (condition, size and landscape context), the occurrence on Sisk was given the highest ranking for condition, with MNAP noting its undisturbed and natural condition.[6]
- The size and natural condition of the occurrence of this rare natural community on Sisk Mountain are such that it should be considered an ecologically significant occurrence.

[4] Testimony of David Publicover, April 21, 2010.
[5] Letter from Sarah Demers, Maine Natural Areas Program, to Marcia Spencer Famous dated February 24, 2010; Testimony, Publicover, Attachment A.
[6] Demers Letter, p. 1.

- Peer-reviewed climate/vegetation modeling indicates that areas capable of supporting spruce-fir forests will likely contract again to just the mountainous regions of northwestern Maine and northern New Hampshire as the climate warms over the coming century, even under relatively conservative assumptions about the projected increase in atmospheric CO_2.[7] Subalpine forests in northwestern Maine will have an important adaptive role in a future warmer climate. Areas such as Sisk Mountain are likely to maintain spruce-fir habitat on the landscape at a time when this habitat has been greatly reduced or eliminated at lower elevations, and will serve as refugia for species dependent on this habitat.

While we agree that the amended proposal has lessened the impact to this community, we believe that the impacts that remain still constitute *an undue adverse impact* on this rare and pristine community occurrence.

Project Will Cause Fragmentation, Direct Habitat Loss and Edge Effects

The impacts of the project as originally proposed were created by two clusters of southern turbines within this ecologically important community – the southernmost four turbines (T12 through T15, plus roads south of T11) and the middle southern four (T8 through T11, plus connecting roads). While the elimination of the southernmost cluster (T12 - T15) significantly reduces the fragmenting impact ("Habitat area fragmented by project footprint" in Amendment Exhibit 4), it does not adequately reduce the direct impact ("Habitat area coincidental with project footprint") and edge effect ("Habitat area adjacent to project footprint").

As set forth in our original pre-filed testimony, the use of a 50-foot buffer to estimate indirect ("edge") effect greatly underestimates the extent of this impact and is not supported by the scientific literature.[8] While there is no single accepted standard for estimating edge effects on forest communities, commonly accepted practice indicates that use of a wider buffer is warranted. For example, the Maine Department of Inland

[7] Testimony, Publicover, pp. 6-8; references submitted as Rebuttal Testimony, Publicover Attachments B, C and D.
[8] Testimony, Publicover, p. 9.

Fisheries and Wildlife's Beginning With Habitat Program applies a minimum 250-foot buffer around larger roads and developed areas when mapping Undeveloped Habitat Blocks.[9] This buffer has been applied to roads through undeveloped forested areas that are significantly narrower than the summit roads in this project (for example, the KI Road in the eastern part of Greenville). Applying a 250-foot buffer increases the impact to this important ecological community by more than 10 acres – an increase of over 20% compared to the Applicant's estimate.[10] (This is based on an estimated 2200 feet of edge along the southern and eastern sides of the project area along turbines T8 through T11 and associated roads where this additional impact would occur). This brings the total amount of this community occurrence that would be destroyed or indirectly impacted in a significant way to at least 55 acres.

Most Ecologically Significant Area Impacted

In addition, the great majority of this impact would occur above 3200 feet in elevation – the most ecologically significant part of this community, as indicated by the fact that this is where the core Bicknell's thrush habitat is located. Turbines 9 and 10 are located along the highest portion of the ridge above an elevation of 3350 feet (Figure 1). Land above 3350 feet, in addition to being a very tiny fraction of the state, represents just 8% of the land *within this particular community occurrence*.

Thus, not only are these turbines located within a rare community, they are located within the rarest part of this rare community. While at first glance it may seem as though the impacts of the revised project are limited to the edge of this community occurrence, they in fact would destroy or degrade a significant part of its highest-elevation core.

Undue Adverse Impacts

The occurrence of this community on Sisk Mountain is one of only 13 in the state ranked as a "Good" or better quality occurrence by the Maine Natural Areas Program[11]. The loss of over 50 acres of a pristine example of this rare community (especially within the high

[9] See http://www.beginningwithhabitat.org/the_maps/map3-undev_habitat.html
[10] Testimony, Publicover, p. 9.
[11] Testimony, Publicover, Attachment A.

elevation core of the area) goes beyond the level of impact that should be considered acceptable. For context, the loss of 55 acres of this habitat as proposed by this Application is equivalent to eliminating the 16th largest documented occurrence of this community in Maine. Clearly the modified Application still constitutes *an undue adverse impact* on this rare and very important ecological community.

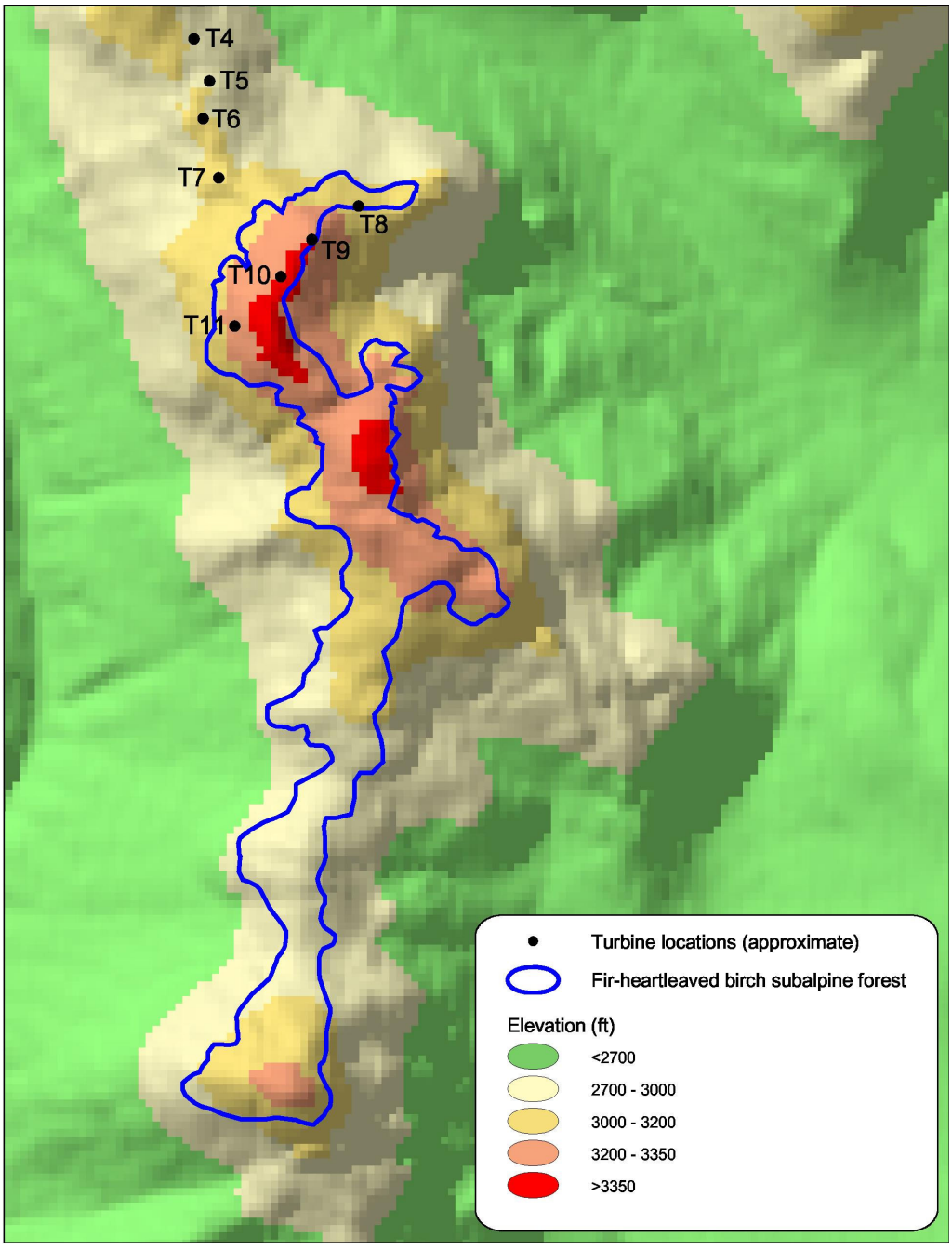

Figure 1. Position of Turbines 9 and 10 illustrating their location at or above 3300 feet elevation, likely the more ecologically important and sensitive part of this ridgeline.

Project Would Cause Undue Adverse Impact to Bicknell's Thrush

Even with the elimination of the four southernmost turbines from the original project, the remaining three southern turbines in the revised project area would still have an undue adverse impact on breeding Bicknell's thrush. The revised project would still cause direct habitat loss, degrade additional habitat, and pose direct mortality risks. We will not repeat the extensive testimony of Susan Gallo from Maine Audubon in these comments,[12] but reiterate several pertinent points:

- Bicknell's thrush is one of the highest conservation priorities in our region,[13] and is listed by multiple conservation organizations and government agencies as a species of highest conservation concern. This is due in part to its restricted range (the northeastern U.S. and southeastern Canada) and also to its narrow habitat niche (high-elevation, stunted spruce-fir forest).[14]
- Habitat for this species is extremely limited, occurring primarily above 3,000 feet. Despite a few isolated observations of this species in regenerating clearcuts at lower elevations, there is no peer-reviewed scientific evidence (despite extensive research and interest in the species) that Bicknell's thrush breed successfully in Maine in any habitat other than high-elevation spruce-fir forest.
- Their restriction to high-elevation forest makes them a top priority for conservation, especially in light of climate change. High-elevation, resilient "islands" of Bicknell's thrush habitat will likely remain as refugia for species as climate changes, providing critical and extremely limited habitat to this species of special concern.[15]

[12] Testimony of Susan M. Gallo, April 21, 2010.
[13] Susan Gallo testified, "Multiple conservation agencies and organizations from state, national and international groups are in agreement that the Bicknell's thrush is a species of global conservation concern, a very high priority, a species of continental concern facing multiple threats." Transcript of May 12, 2010, p. 183.
[14] Testimony, Gallo, pp. 6-7.
[15] Pre-filed testimony of AMC, David Publicover, pp. 7-8.

- The habitat lost from a wind power development goes well beyond the actual footprint of roads, collector corridors and turbines. Aside from the direct loss of habitat, the creation of multiple and extensive openings in the forest can degrade forest habitat, creating "edge effects" that can degrade habitat beyond the physical boundary of the edge in question.[16]
- The Applicant's "connect-the-dot" approach to identifying core habitat significantly underestimates the amount of direct breeding habitat loss. Search areas for spot-mapping efforts were limited to 10 ha plots around each of six point count locations, so there is no information about Bicknell's thrush use of habitat beyond these plots. The Applicant also made questionable assumptions about Bicknell's thrush observations on the edges of the search area.[17]

Experts Urge Protection of Known and Potential Breeding Habitat

In July of 2010, the International Bicknell's Thrush Conservation Group (IBTCG) released "A Conservation Action Plan for Bicknell's Thrush,"[18] a comprehensive review of population status, population threats, and goals (including research and conservation actions needed to address those threats). Several findings in the Action Plan are relevant to deliberations on the proposed expansion:

- Population Trends: High-elevation songbird monitoring programs generally indicated declining populations of Bicknell's thrush, especially in core and northern parts of the breeding range. The current project area is considered part of their core breeding range (page 7).
- Population Threats: The Action Plan recognizes that industrial development, including the construction and operation of wind power and telecommunications facilities and recreational skiing "threaten to remove, fragment or alter habitat." Twenty of the 27 threats to Bicknell's thrush populations identified by the IBTCG occur on the breeding grounds, and

[16] Testimony, Gallo, p. 9.
[17] Transcript of May 12, 2010, pp. 182-188 and Consolidates Parties Exhibit 1 (Gallo PowerPoint).
[18] Attached as Appendix B, also available at http://www.bicknellsthrush.org/pdf/conservationactionplan.pdf

industrial development was listed as one of 16 "medium" level threats (page 15).

- Climate change is also noted as an important threat to Bicknell's thrush. This is a reminder of the challenging trade-offs posed by wind power; however in the context of this project, the climate benefits of three wind turbines do not make the acute impacts acceptable.
- Conservation Goals: The overall conservation goal in the Action Plan is to increase the global population of Bicknell's thrush by 25% in the next 50 years, and to maintain or increase the species' current extent of breeding occurrence. The plan emphasizes immediate action should be taken to protect or manage known and potential breeding habitat (page 16).

This conservation plan, developed by a team of international Bicknell's thrush experts, reaffirms the threat of wind development to Bicknell's thrush and highlights the need to protect known and potential breeding habitat.

Habitat Loss in the Revised Project Area – Direct Loss and Habitat Degradation

The revised project eliminates and degrades substantial Bicknell's thrush habitat, rising to the level of an *undue adverse impact*. As previously stated, we question the Applicant's delineation of "core" habitat and instead consider all mapped Bicknell's thrush habitat as equally important for this species.[19] The IBTCG points out in its Conservation Action Plan that due to its unusual mating system (males lacking territories and mating with multiple females) the estimation of breeding densities of Bicknell's thrush by traditional methods (like spot mapping) is difficult.[20]

Although the revised layout reduces the three areas of incursion into Bicknell's thrush habitat to just one, that one remaining area is the largest of the three original areas, and also occurs in an area of highest elevation and potentially higher habitat quality. Although the Applicant claims the habitat affected by this project has been reduced from

[19] Pre-filed testimony of MAS, Susan Gallo, pp. 8-9.
[20] Appendix A, IBTCG Conservation Plan, p. 6.

8 to 5 acres, we repeat our earlier assertion that the Applicant grossly underestimated the amount of habitat that would be lost in its original proposal.[21]

This is because the Applicant continues to completely ignore the habitat degradation that would occur due to edge effects in its application. The Applicant's estimate of habitat degradation only includes the direct project footprint[22] and the Applicant has failed to provide an estimate of the total habitat degradation as a result of the revised project.[23]

A more accurate estimate of the total habitat impacts would include edge effects and a broader interpretation of the spot mapping results. Previous testimony referenced edge effects that have been documented up to 492 feet from the edge of forested habitat.[24] If we apply even an extremely conservative estimate of the habitat degraded by edge effects by adding a roughly 100 foot buffer around the area designated by the Applicant as lost habitat (Figure 2), it, at the very least, doubles the Applicant's estimate of habitat impacts to 10 acres. Obviously, a more liberal buffer of 200 or even 250 feet would increase the area impacted several fold. Because the "core" habitat was delineated by "connecting the dots" between individual bird observations, and because spot-mapping efforts were limited to areas surrounding established point counts, the use of areas beyond the searched areas are unknown. The limits to the survey methods do not preclude the potential of Bicknell's thrush to use habitat beyond the mapped "suitable" habitat (which was based primarily on vegetation and aerial survey maps). As illustrated in Figure 3, this additional potential area triples the original estimate of habitat lost to at least 15 acres, possibly more.

The Applicant's failure to acknowledge the concept of edge effect, and to include an appropriate buffer around their development footprint, falsely translates to an underestimate of only five acres of habitat loss. The Applicant's questionable assumptions about Bicknell's thrush observations and their limited search area also result

[21] Presentation to LURC by MAS, Susan Gallo, May 12, 2010, slides 9-11, and Pre-filed testimony, MAS, Susan Gallo, p. 11.
[22] Transcript of May 12, 2010, p. 107.
[23] Transcript of May 12, 2010, p. 108.
[24] Pre-filed testimony, Gallo, pp. 9-10, Pre-filed testimony,,Publicover, pp. 9-10

in additional underestimation of the adversely impacted suitable habitat. We testified previously that the loss of eight acres of suitable Bicknell's thrush habitat was enough to cause undue adverse impacts[25], and we believe the revised project still impacts almost twice that area (> 15 acres).

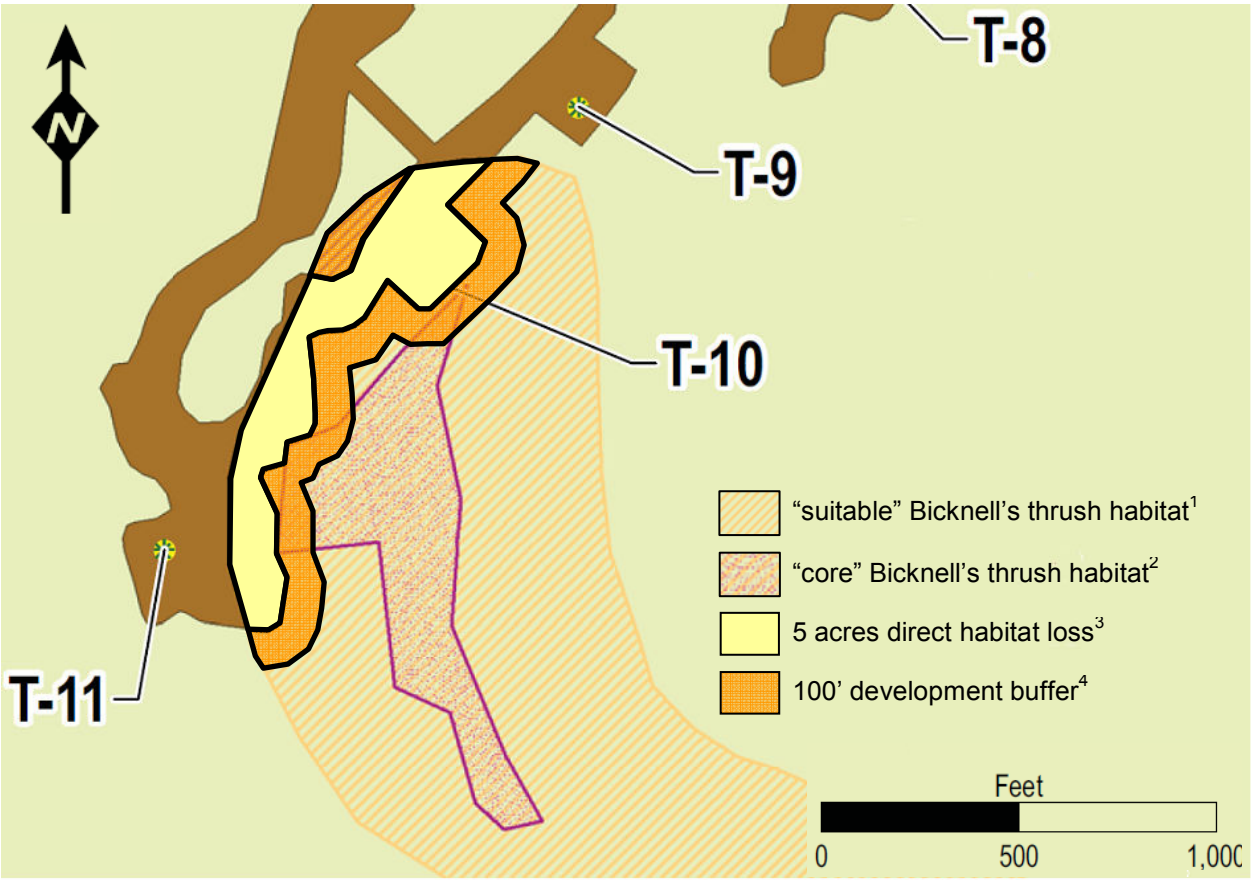

Figure 2. Habitat Loss: Habitat loss as outlined in the revised application (yellow) is limited to direct loss of habitat by the development footprint. Indirect habitat loss from edge effects (along the perimeter of clearings for roads and turbine pads) are conservatively estimated at 100' (orange), and lead to a doubling of habitat loss to at least 10 acres. (Figure modified from Revised Application, Exhibit 5).

[1] as determined by field surveys and aerial photo interpretation, Application Vol. II B.15-32
[2] as determined by spot mapping methodology, BRI, Breeding Bird Survey Report for the Sisk Mountain Wind Power Project, 2009, Figure 5, p. 31.
[3] Revised Application, page 4.
[4] Conservative estimate of 100' buffer based on scale of map.

[25] Consolidated Parties Legal Brief, p. 13.

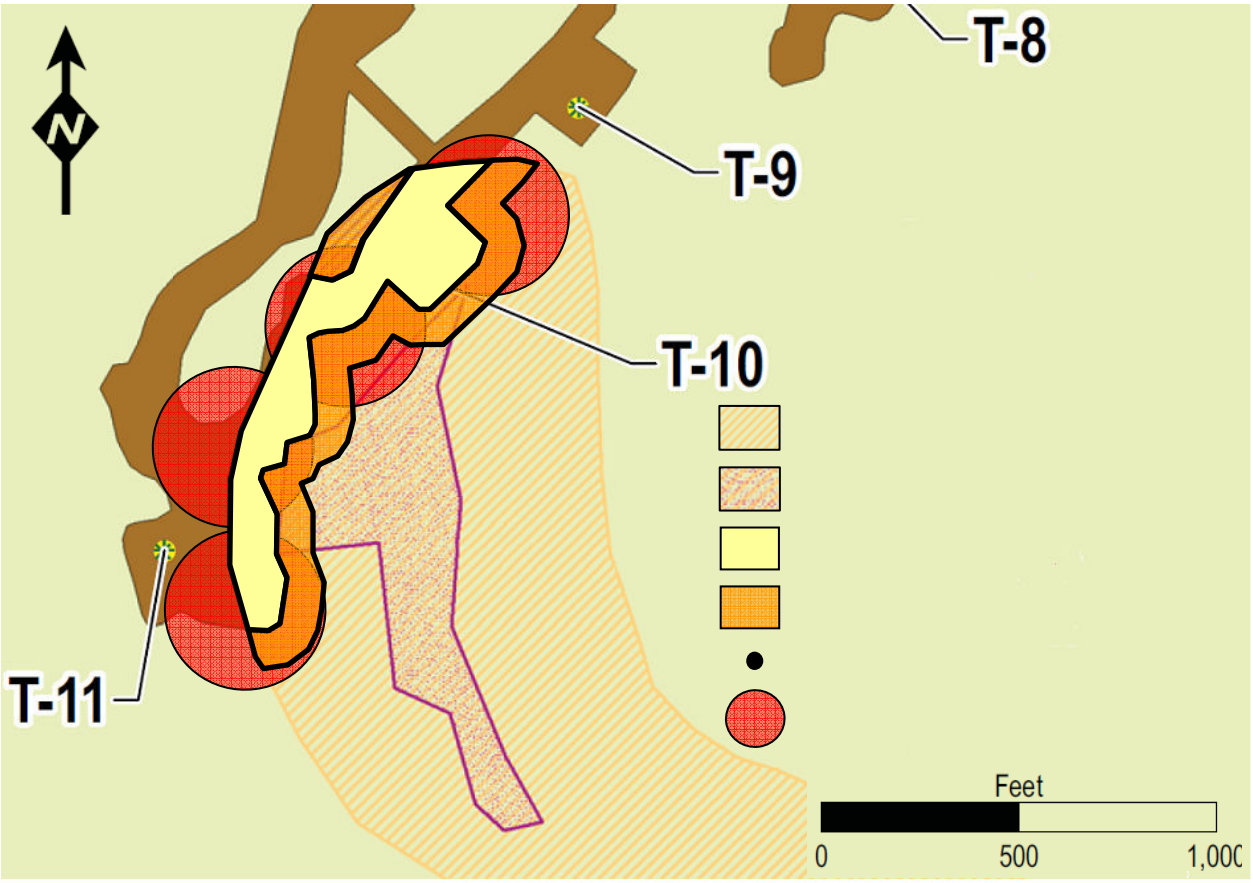

Figure 3. Additional Habitat Loss: Based on the mapped locations of Bicknell's thrush, and the area searched for Bicknell's thrush during spot-mapping efforts, it is very likely that Bicknell's thrush territories would extend beyond the designated "suitable" habitat, resulting in another 5+ acres of affected habitat. (Figure modified from Revised Application, Exhibit 5).

[1] as determined by field surveys and aerial photo interpretation, Application Vol. II B.15-32
[2] as determined by spot mapping methodology, Evers Report
[3] Revised Application, page 4.
[4] Conservative estimate of 100' buffer based on scale of map.
[5] as mapped by BRI, Breeding Bird Survey Report for the Sisk Mountain Wind Power Project, 2009, p. 31.
[6] possible locations of Bicknell's thrush territories, roughly 8 acres in size, as presented in Susan Gallo's testimony to LURC, May 12, 2010, slide 10.

Overestimate of Available Habitat

The Applicant has significantly overestimated the amount of potential habitat for Bicknell's thrush in Maine. As mentioned in previous testimony,[26] it is likely that regenerating clearcuts would provide lower quality habitat compared to naturally disturbed forests, and there is ample evidence in the scientific literature showing that lower quality habitat often attracts singing males with little or no chance of successful breeding. Additionally, to take one observation in the western mountains and jump to classifying 90,000 acres of regenerating clearcuts across the state of Maine as potential Bicknell's thrush habitat is ecologically unsound and misleading. There is no documentation in the scientific literature, by the staff at the Maine Department of Inland Fisheries and Wildlife (MDIFW), or by scientists at the Vermont Center for Ecostudies (VCE) of Bicknell's thrush breeding *successfully* in regenerating clearcuts in Maine. There are also no current studies by either MDIFW or VCE underway to further evaluate Bicknell's thrush use of regenerating clearcuts in Maine, largely we believe due to lack of support for the idea that this forest type offers any significant amount of breeding habitat for Bicknell's thrush.

Risks from Collisions in the Revised Project Area

We fully agree with the Applicant that risks of collision from the southernmost four turbines would be eliminated if those turbines were in fact not built.[27] However, the risk of collision from the remaining three turbines in documented Bicknell's thrush habitat still contributes to an undue adverse impact. As detailed in previous testimony, flight songs for male Bicknell's thrush typically consist of 10 to 15 second flights, 25 to 75 meters (82 to 246 feet) above the ground often in large circles.[28] Given that the turbine blades are 119 feet and higher off the ground, there is the potential for displaying males to fly directly into the rotor swept area, especially given their likelihood of displaying on windy days when turbine blades are turning. Given the inaccuracy of density estimates for this species,[29] and their unusual mating behavior (multiple males without territories

[26] Rebuttal Testimony of Susan M. Gallo, June 1, 2010, pp. 1-2.
[27] Revised Application, page 4.
[28] Pre-filed testimony of MAS, Susan Gallo, p. 13.
[29] Appendix A, p. 6.

mating with multiple females), it is difficult to impossible to estimate how many birds might be impacted by turning blades in or near the project area. Given the IBTCG's recommendation for conserving habitat for this species,[30] the risk for collisions from the revised project footprint rises to the level of undue adverse impacts.

The amended project, if approved, would cause an *undue adverse impact* on breeding Bicknell's thrush habitat. The Applicant has significantly underestimated the amount of direct and indirect impacts on Bicknell's thrush habitat, dismissed the potential for direct mortality and dramatically overestimated the amount of available habitat.

Southern Turbines Would Have an Unreasonable Adverse Impact on Scenic and Recreational Uses

On behalf of the consolidated environmental intervenors, Cathy Johnson from NRCM submitted direct testimony on scenic and recreational impacts from the original proposal for a 15-turbine project.[31] Much of that testimony remains completely relevant to the amended proposal, as it describes the significance of the scenic areas and their current character and existing uses. None of that has changed—the area remains a rugged, largely undeveloped landscape with important primitive recreational uses—therefore the following comments include only the briefest synopsis of that portion of the testimony. The balance of this section describes why our original findings and conclusions regarding the southern seven turbines remain relevant to the impacts of three of those turbines.

The turbines, particularly turbines 9, 10 and 11, would be prominently visible from Chain of Ponds and the Arnold Trail, resources of state and national significance, and would change the scenic character from a landscape with minimal evidence of human activity to one with wind turbines that would be widely visible by recreational paddlers and anglers on Chain of Ponds, and visitors along the Arnold Trail. (See attached simulation from the amended application, showing turbines 9 – 11, including the revised location for turbine

[30] Appendix A, p. 16.
[31] Testimony of Catherine B. Johnson, April 21, 2010.

11.) We conclude that these southern three turbines continue to constitute an *undue adverse impact* on scenic resources of state and national significance, and related uses, and should not receive a permit. We reiterate that we have concluded that the northern eight turbines can meet the legal criteria regarding the effect of the proposed project on scenic character and related existing recreational uses if certain conditions are included in the permit.

Significance & Character of the Potentially Affected Scenic Areas

In evaluating the impact of the project from a legal standpoint, it is important to think about both the visual profile of the proposed turbines and the value of the scenic resource and public uses being affected. Because wind turbines are inherently visible features it is largely the value of the affected resources and related uses that will distinguish the impacts of one set of wind turbine from another.

The areas of state or national significance that would be affected by the proposed turbines include Chain of Ponds—which is associated with the Chain of Ponds Public Land Unit, the Arnold Trail, Arnold Pond, Crosby Pond and Kibby Stream. All of the Great Ponds are Management Class 1A. The primary character of this region is its highly scenic undeveloped mountains and forests. The ponds, the stream, and the historic trail are all distinguished because of the very high scenic character of the surrounding area. Recreation in the area (e.g. camping, paddling and fishing) is primarily primitive in character, dependent on the natural scenic character of the surroundings.

The comments of the Bureau of Parks and Lands, particularly the comments of Kathy Eickenberg on May 12, 2010, provide further rebuttal of the Applicants claims that the Chain of Ponds is only meant to be managed for motorized uses—and a reminder that motorized users also seek and value scenic resources in this region.

Other than Route 27, some logging roads and a few camps along Chain of Ponds, the only major man-made features in the area are the Kibby I wind turbines and their associated road system. We contend that there is very limited visibility of Kibby I

turbines from the areas of state and national significance listed above, except Kibby Stream. However it is interesting to note that, in its revised submission, the Applicant epitomizes the slippery slope of cumulative impacts, saying repeatedly that the proposed project will only pose "incremental visual impact of turbines in a landscape that already hosts existing turbines." (Revised Kibby II proposal, p 6.)

Nature and scope of impacts on users and scenic resources of state and national significance[32]

Evaluating the scenic impact of a project is not an easily quantifiable exercise. Almost all of the proposed 11 turbines will be visible from Long Pond, even seven of the eight turbines which we previously concluded did not incur an undue adverse impact (although they deserved some form of mitigation.) In principle, it can be difficult to find a bright dividing line between the last turbine in a string which does not present an undue adverse impact and the first one that does. However in this case, as in the original proposal, there is a grouping of southern turbines that loom larger and advance closer to viewers on Chain of Ponds. In the terms of the law, their "scope and scale" is greater. If anything, the effect of these three turbines is greater with the adjustment in location of Turbine 11, which brought the turbine considerably down the slope toward viewers on Chain of Ponds.[33]

Some of the turbines are within approximately 3.5 miles of the Chain of Ponds and the Arnold Trail. The viewscape as seen from the south end of Long Pond is framed on the northwest by Mount Pisgah and on the southeast by Sisk Mountain. The two peaks are connected by a long ridge, on which the turbines are proposed. The viewer's eye is drawn

[32] 35-A M.R.S.A.§3(E) and (F) evaluation criteria read as follows: "E. The extent, nature and duration of potentially affected public uses of the scenic resource of state or national significance and the potential effect of the generating facilities' presence on the public's continued use and enjoyment of the scenic resource of state or national significance; and F. The scope and scale of the potential effect of views of the generating facilities on the scenic resource of state or national significance, including but not limited to issues related to the number and extent of turbines visible from the scenic resource of state or national significance, the distance from scenic resource of state or national significance and the effect of prominent features of the development on the landscape."

[33] To our knowledge there was no revision to the visual simulations following this adjustment until the revised application for 11 turbines was submitted. We recognize the intention of this move to reduce ecological impacts, however it does noticeably increase the visual impact of this turbine.

upward from the pond by the two peaks. Turbines on the ridge between the two peaks would be squarely in front of the viewer. This is most true of turbines 9-11.

Visitors who enjoy the public lands and waters at Chain of Ponds because of their "accessible remoteness" and their sense of naturalness would either have to tolerate this compromise of their recreational experience, or go elsewhere.

The user experience of the Arnold Trail would also be compromised. This particular stretch of the Arnold Trail is the area where the wilderness closed in on the troops and they experienced problems resulting from being in the wilderness. Because of the very few changes to the landscape in this area, visitors today can get a good sense of the wilderness that Arnold's men faced. If the experience from this stretch of the Trail is compromised, there is no place for visitors who wish to experience that sense of wilderness along the Arnold Trail to go, since the Trail is unique and fixed on the face of the earth.

In his revised evaluation of the visual impact assessment, Jim Palmer provides the rather mystifying conclusion that the project's visual impacts are adverse but "within the range of impacts that the Wind Energy Act anticipates."[34] We do not know what that really means. The Wind Energy Act anticipates that there may be impacts to scenic resources of statewide significance, that these impacts should be carefully evaluated to ensure they are not "unreasonably adverse," and if they are unreasonably adverse, the project should not be granted a permit. The Wind Energy Act does not describe that threshold any further, except to say that being highly visible is not enough. Given this relatively undeveloped landscape which is used and managed for recreational use, much of which is related to the rugged scenery, our conclusions do not rest on the mere visibility of turbines.

We continue to believe that the northern eight turbines cause fewer adverse impacts to the ponds, public lands and the Arnold Trail. The northern eight turbines are generally further away and less dominant on the landscape. While the northern part of the project

[34] (Palmer, September 24, 2010, p 8.)

would have some impacts on the scenic resources and related recreational uses, we believe those impacts would not significantly compromise the scenic resources or uses and do not rise to the level of "unreasonable adverse effect."

Conclusion

Despite the reduction in the number of turbines, the amended project will cause *undue and unreasonable adverse impacts* not simply because of the number of turbines but because of the location of the southern three turbines.

The rare natural community, the Fir-Heart-leaved Birch Subalpine Forest, found in the southern portion of the project area is very limited in the state and would suffer an *undue adverse impact* if the project is approved. The Sisk community is ecologically significant. The subalpine forest on Sisk Mountain is a good quality example of a rare natural community that has retained an undisturbed and natural condition and provides valuable habitat to one of the state's rarest wildlife species.

The southern portion of the project area comprises breeding Bicknell's thrush habitat. Such habitat is severely limited and Bicknell's thrush is one of the most rare, range-restricted breeding birds in the Northeast and ranks high on the region's conservation priority list. Experts recommend avoiding development in areas such as this with high quality Bicknell's habitat. Locating turbines and their accompanying roads within and adjacent to this habitat would cause direct loss of this habitat, degrade additional habitat, and result in direct mortality to singing males, therefore comprising an *undue adverse impact*.

The southern turbines would have an *unreasonable and undue adverse impact* on the scenic resources and related uses of state or national significance. This region is recognized for its outstanding scenic beauty and possesses multiple individual scenic resources of state and national significance. The southern turbines would compromise the expectations of users and visitors in the region. The turbines and associated road

would be prominent, dominant and permanent – forever altering the scenic beauty of the region.

Thank you for your consideration.

Sincerely,

David Publicover
Appalachian Mountain Club

Susan Gallo
Maine Audubon

Dylan Voorhees
Natural Resources Council of Maine

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
696 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

REPLY TO:
ATTENTION OF:

Regulatory Division
CENAE-R-51

March 8, 2010

Dana Valleau
TRC Solutions
14 Gabriel Drive
Augusta, Maine 04330

Dear Mr. Valleau:

This concerns your client's application for a Department of the Army permit to place temporary and permanent fill in numerous waterways and wetlands at Kibby and Chain of Ponds Township, Maine in order to develop a 45 MW mountain top wind energy project. It has been assigned number NAE-2009-00892 to which all future correspondence should refer.

The application form is complete, however we require additional information to process your application. (See attached sheet for information required.)

This additional information is necessary so that we can properly evaluate your proposed activity and reach a decision on your application. Hence, no further action will be taken until you have complied with our request. Failure to provide this information within thirty days will result in your application being considered withdrawn.

Please do not begin any work in our jurisdiction without the required Corps of Engineers permit. It is illegal to do so, and will only delay your project and may subject you to civil or criminal liability; fines can be as high as $10,000 or $25,000 per day of violation respectively.

If a permit is to be issued, a $100 fee will be required. Do not send the fee at this time. A separate request will be made after we have made our decision.

If you have any questions, please contact me at our Manchester, Maine Project Office at 207-623-8367. Your reply should be addressed to this office at: US Army Corps of Engineers, 675 Western Avenue #3, Manchester, Maine 04351.

Sincerely,

Jay L. Clement
Senior Project Manager
Maine Project Office

ADDITIONAL INFORMATION REQUIRED
FOR DEPARTMENT OF THE ARMY PERMIT
APPLICATION NO. NAE-2009-00892

1. Thank you for assisting in the preparation of a preliminary jurisdictional determination form for the project. Could you please email a copy of the draft in word format so that it can be slightly revised prior to final signature. Also, please verify which tables from the LURC application you intended to reference in the JD form.

2. We have received a copy of the adverse effect finding of the Maine Historic Preservation Commission ("MHPC") for a portion of the Benedict Arnold Trail to Quebec Historic District. Please submit information that thoroughly documents your efforts to avoid and minimize impacts to this resource. If MHPC determines that mitigation, and by association a Memorandum of Agreement ("MOA"), is required, please include the Corps in your coordination with MHPC. As you know, any MOA must be cosigned by the Corps and requires a number of formal steps be taken between MHPC, the Advisory Council on Historic Preservation, and the Corps.

3. For the Kibby project you assisted in the preparation of our environmental assessment ("EA"). It would be equally helpful if you did the same for this project. I ask that you pay particular attention to the cumulative impact section since this project is linked to Kibby. As you know, the cumulative impact of windpower development is gaining a lot of press.

4. Alternatives Analysis.

a. Although at a number of points in your alternatives analysis, you incorporate the Section 404(b)(1) Guidelines, you do not do so consistently. The Corps encourages that all alternatives be analyzed and dismissed in accordance with the Section 404(b)(1) Guidelines. With a minimum of additional wording, the language in the guidelines could be added to make the analysis more fully compatible with the requirements of the Corps, the Maine DEP, and the federal resource agencies (US EPA, USFWS, and NMFS). Rather than rewrite the analysis at this time, I suggest that you do so in the EA.

b. The discussion of the no action alternative needs to be expanded. What are the consequences of no action? The fact that it doesn't meet state goals and policies is interesting but not really germane.

c. Beyond expanding the capacity of the Kibby project, isn't the project purpose to provide additional wind energy in the region? The alternatives analysis needs to include an analysis of stand alone project alternatives.

d. The analysis could be improved by adding a map of alternative sites/alignments and a comparative table.

5. Plans. The plans for the Corps application should follow the format of the Kibby project to include location map, schematic plan views, utility corridor sheets, and typical detail sheets.

6. For purposes of the public notice, please provide the Corps with two sets of standard size mailing labels for the project abutters.

7. Table 1.1. The 4.4 acres of wetland affected is not the sum of the 0.8 acres filled and the 3.5 acres cleared as temporary impact. Was there some rounding up?

8. Exhibit B8. What percent of the affected area is currently in active forest management. Provide any available details on the history of this activity – last cut, % removed, projection for next cut, etc. Presumably your goal would be to demonstrate that your clearing is not unlike past and ongoing practices and is expected to have minimal short-term, long-term, and cumulative impact (for determining mitigation burdens).

9. It is our understanding that LURC will hold a public information meeting or a public hearing or both for the project. Please let us know when these have been scheduled so that we can attend if possible. This may allow us to avoid a similar Corps meeting/hearing later in the process.

10. Mitigation. It is our understanding that you are preparing a draft mitigation plan for the project. Please be aware that we'll need this before we are able to go out for public notice. Mitigation will be required for permanent wetland impacts over 20,000 s.f. and for temporary and clearing impacts. For the latter, please refer to the updated indirect impact mitigation table in the following web link (http://www.nae.usace.army.mil/reg/2009Guidance10Dec09PN.pdf) For any mitigation other than in lieu fee, please include a location map of the mitigation site(s) so that it can be included in a public notice.

11. Table B15-1. It seems appropriate that this table should be included in the Corps public notice. For our purposes, it would be cleaner to either remove reference to LURC wetland designators or to add Cowardin references. This is equally important if you intend to attach this table to the preliminary JD form.

A Conservation Action Plan for Bicknell's Thrush

(Catharus bicknelli)

July 2010

International Bicknell's Thrush Conservation Group

A Conservation Action Plan for Bicknell's Thrush
(Catharus bicknelli)

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Executive Summary

Background

Bicknell's Thrush *(Catharus bicknelli)* is a rare, range-restricted passerine breeding in the northeastern U.S. and southeastern Canada and wintering in the Greater Antilles, primarily on the island of Hispaniola. On its breeding grounds, Bicknell's Thrush is a habitat specialist restricted to coastal and montane forests dominated by balsam fir *(Abies balsamea)*. Winter habitat consists of mesic to wet broadleaf forests with dense understory, over a broad range of elevations. Bicknell's Thrush is one of only two passerines in North America that exhibits a polygynandrous mating system, in which multiple males assist one or more females with feeding nestlings, and paternity is mixed. Bicknell's Thrush also exhibits a male-biased breeding sex ratio of >2:1 males:females, and recent research indicates the existence of habitat segregation by sex on the wintering grounds.

Population Status

Bicknell's Thrush is considered a Nearctic-Neotropical migrant of high conservation concern, and the International Union for the Conservation of Nature (IUCN) has classified the species as globally "Vulnerable". The Committee on the Status of Endangered Wildlife in Canada has recommended a Canadian status of Threatened. Recent analyses have yielded global population estimates of 95,000–126,000 birds. Population trend data show mixed results, but documented annual declines of 7-19% in parts of the species' breeding range are cause for concern.

Population Threats

The following anthropogenic threats have been identified as having known or potential negative effects on Bicknell's Thrush populations:

- Direct loss and degradation of habitat
- Climate change effects on habitat
- Increased mortality rates from migration hazards, introduced mammals, and other factors
- Atmospheric pollution at high-elevation breeding and wintering sites (e.g., mercury deposition, acid precipitation)

In addition, several demographic and ecological characteristics of Bicknell's Thrush (e.g., male-biased sex ratio, clumped distribution of habitat, winter habitat sexual segregation, small population size) may render the species more vulnerable to anthropogenic threats and stochastic events; however, these characteristics do not themselves pose direct threats to Bicknell's Thrush populations.

Population and Conservation Goals

The International Bicknell's Thrush Conservation Group (IBTCG) has established an overall goal of increasing the global population of Bicknell's Thrush by 25% over the next 50 years (2011-2060), with no further net loss of distribution.

Addressing the threat of habitat loss and degradation will lead to the most immediate positive effects in terms of achieving IBTCG's overall conservation goal. Thus, specific sub-goals of protecting, managing and restoring breeding and winter habitat are identified. Since the magnitude of effects of threats and limiting factors is not well understood, specific research actions to address gaps in knowledge are also identified.

Conservation and Research Actions

The following actions will address identified threats, either by direct conservation (i.e., protection of habitat), or by research that will lead to future direct conservation actions for Bicknell's Thrush.

- Partner with timber companies and management agencies to develop and implement Best Management Practices (BMPs).
- Maintain a target amount of breeding habitat in industrial forests.

- Improve protection of currently occupied winter habitat.
- Strengthen and expand the Bicknell's Thrush Habitat Protection Fund.
- Develop winter habitat management plans and secure implementation funding.
- Pilot winter habitat restoration projects.
- Develop strong links with local partners in the Caribbean.
- Identify important migratory stopover sites, routes, and patterns.
- Determine impacts of forestry practices on demography.
- Clarify distribution and winter habitat use on islands other than Hispaniola.
- Document overwinter survival and demography relative to local habitat condition and quality.
- Predict and monitor effects of climate change
- Assess the effects of calcium depletion.

Evaluating Accomplishments

As a critical step to determine the success of conservation actions in halting declining trends and increasing Bicknell's Thrush populations over time, a range-wide monitoring program, Mountain Birdwatch 2.0, will be implemented. This program will produce estimates of breeding density, abundance, distribution, and occupancy at both international and national scales. Mountain Birdwatch 2.0 will also yield refined global population estimates of Bicknell's Thrush over time, and elucidate how specific threats influence observed population trends.

Metrics and explicit targets to evaluate the success of each identified priority action have been developed as a means to assess progress toward IBTCG goals. Actions will be evaluated in terms of these specific metrics at annual IBTCG meetings, when members will report on the extent to which discrete actions have been implemented or completed. As new information comes to light through ongoing and future research, additional or modified conservation actions and associated evaluation metrics will be developed to apply research findings directly to conservation.

Jeff Nadler

Preface

Steve Faccio

This Plan highlights the priority conservation actions needed to address factors contributing to the global vulnerability of Bicknell's Thrush. It is not an exhaustive review or assessment of the species' status. Rather, the Plan summarizes salient life history characteristics of Bicknell's Thrush, identifies factors that may limit its populations, proposes desired population and habitat goals for conservation, and describes critical activities needed to achieve those targets. This Plan is intended to provide an explicit road map for major conservation actions, including research and monitoring, as part of an iterative and strategic approach to conservation. The Plan's fundamental goal is to prevent population declines of a magnitude that could lead to endangerment of the species. The recommendations proposed are not definitive or all-inclusive, but reflect the best available knowledge and are meant to be adaptive, as new information comes to light. Not all details necessary to implement conservation actions have been fully articulated; this Plan attempts to identify those issues for which additional resources must be marshaled to achieve conservation of Bicknell's Thrush.

Patrick Johnson

Field training of Hispaniolan and Cuban conservation partners in the Dominican Republic

I. Background: Bicknell's Thrush

Introduction

Bicknell's Thrush *(Catharus bicknelli)*, classified as a subspecies of Gray-cheeked Thrush *(C. minimus)* following its 1881 discovery in New York's Catskill Mountains, gained full species status in 1995 (American Ornithologists' Union 1995). It is among North America's most rare, range-restricted breeding passerines. Detailed information on the life history characteristics of Bicknell's Thrush is available in the *Birds of North America Online* species account (Rimmer et al. 2001). Below, this Plan summarizes pertinent information on the species' biology and ecology, highlighting new findings or those directly relevant to conservation.

Distribution

Breeding range

Bicknell's Thrush occupies a restricted and highly fragmented breeding range (Figure 1). Northern-most breeding sites include southeastern Québec, inland and coastal localities along the St. Lawrence River and Gaspé Peninsula, northwestern and north-central New Brunswick, and Cape Breton Island, Nova Scotia. Southern breeding limits are reached in the Catskill Mountains of New York, the Green Mountains of southern Vermont, and the White Mountains of central New Hampshire.

Winter range

The known wintering distribution of Bicknell's Thrush is confined to the Greater Antilles (Figure 2; summarized in Rimmer et al. 2001). Recent survey data indicate that the majority of wintering birds occur in the Dominican Republic, where the species is widely distributed and locally common from sea level to 2220 m. Remnant populations in Haiti are restricted to forest patches at higher elevations, mainly in the southwest (Massif de la Hotte) and east (Massif de la Selle). Bicknell's Thrush is uncommon and local in Jamaica, mainly in the Blue Mountains from 1200–2225 m elevation. The species is likely a regular winter resident in eastern Cuba, where it has been recorded at 1600–1960 m in Sierra Maestra. Overwintering birds are rare in eastern and southeastern Puerto Rico, known only from the Luquillo Mountains at 450-720 m elevation and Sierra de Cayey at 720 m. There are no confirmed winter records elsewhere.

Migration

Little information exists on migration routes of Bicknell's Thrush, but it is generally assumed that individuals follow the eastern flyway along the east coast of North America. Banding records suggest that Bicknell's Thrush follow an over water route on fall migration, from the southeastern U.S. coast directly to the Caribbean. In contrast, spring banding and nocturnal flight call recordings indicate that Bicknell's Thrush migrate over land in spring (Evans 1994, Rimmer et al. 2001).

Figure 1

Typical Bicknell's Thrush montane forest breeding habitat.

Habitat

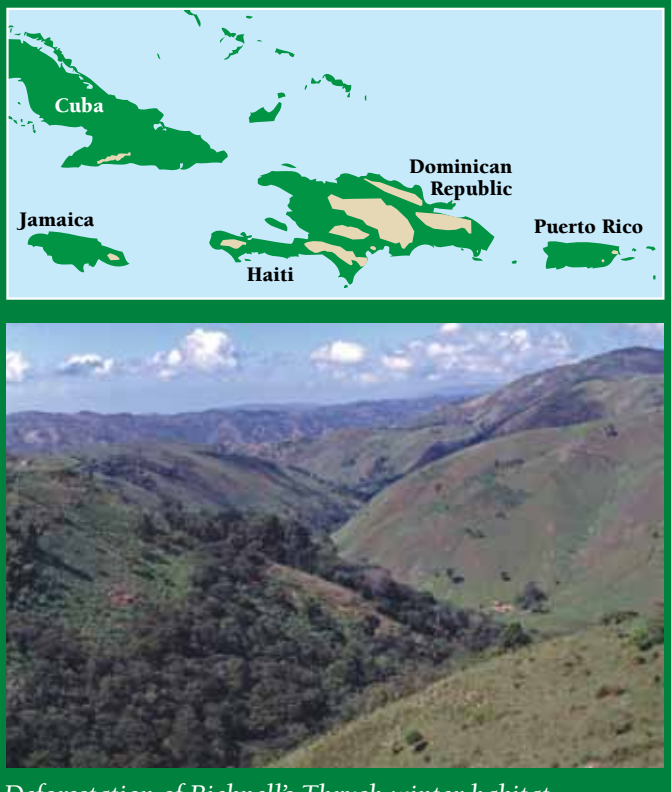
Breeding range

Bicknell's Thrush is a habitat specialist restricted to montane forests dominated by balsam fir *(Abies balsamea)*, with lesser amounts of spruce (*Picea rubra* and *P. mariana*), white birch *(Betula papyrifera)*, mountain ash *(Sorbus* sp.*)*, and other hardwood species. Bicknell's Thrush generally breeds above 1100 m elevation at the southern extent of its range in the Catskills Mountains of New York and as low as 380 m on several mountains in Canada (BSC/EOC unpubl. data). Bicknell's Thrush is often associated with disturbed areas undergoing vigorous succession, characterized by standing dead conifers and dense regrowth of balsam fir (Wallace 1939, Rimmer et al. 2001). Highest densities are typically found in chronically-disturbed (high winds, heavy winter ice accumulation) stands of dense, stunted fir on exposed ridgelines or along edges of human-created openings (e.g., ski trails), or in regenerating fir waves (Sprugel 1976).

Bicknell's Thrush also occupies regenerating stands of relatively mixed forest following forest fires or clear cutting in industrial highlands in Québec, New Brunswick, Nova Scotia, and Maine (Ouellet 1993, Nixon et al. 2001, Connolly et al. 2002, Chisholm and Leonard 2008).

The species was previously found in coastal maritime spruce-fir forests near sea level in New Brunswick, Nova Scotia (Erskine 1992), and Québec (Atlas of the Breeding Birds of Québec 1996) where cool sea breezes and higher precipitation levels maintain dense spruce-fir stands selected locally by Bicknell's Thrush. However, the species may now be extirpated from several of these sites (COSEWIC 2009).

Figure 2



Deforestation of Bicknell's Thrush winter habitat.

Winter range

Bicknell's Thrush primarily inhabits mesic to wet broadleaf montane forests in the Dominican Republic (Rimmer et al. 2001), Haiti (Rimmer et al. 2005b), Cuba (Rompré et al. 2000), Jamaica (VCE, unpubl. data), and Puerto Rico (J. Wunderle, University of Puerto Rico, unpubl. data). In the Dominican Republic, the species is found from sea level to 2200 m, although >60% of occupied sites were in forests >1000 m elevation, likely due to habitat loss at lower elevations (Rimmer et al. 2001). The majority (75%) of occupied sites were in broadleaf-dominated forests at all elevations, 19% were in mixed broadleaf-pine forests, and 6% occurred in pine-dominated forests. The use of regenerating secondary forests (22% of occupied sites) in the Dominican Republic may indicate winter habitat flexibility or a recent shift from preferred primary broadleaf forest habitat, much of which has been lost or degraded from human activities.

In the Dominican Republic, evidence exists for sexual habitat segregation (Townsend et al. 2009a). In the Sierra de Bahoruco, in predominantly undisturbed broadleaf montane forests, males outnumber females by a 4:1 ratio, whereas a population at a mid-elevation, moderately disturbed wet forest site in the Cordillera Septentrional shows a nearly 1:1 sex ratio. No significant differences exist between male and female mean territory size at either site, but research has found that females in the Cordillera Septentrional are in better physiological condition relative to females in the Sierra de Bahoruco (J. Townsend, SUNY ESF, pers. obs.). These results suggest that females may be at a disadvantage in the high-elevation, broadleaf forest site.

Migratory stopover

There is little published information on habitat selection during migration, but migrants have been documented at an array of coastal and inland sites, suggesting little specificity of habitat use (Rimmer et al. 2001).

Life History and Demography

Mating system and sex ratio

The mating system of Bicknell's Thrush is unusual and appears closest to "female-defense polygynandry", in which both males and females mate with multiple partners, multiple paternity is common, and nestlings are most often fed by more than one male (Goetz et al. 2003). In Vermont, most broods (>75%) have mixed paternity and some males sire offspring in multiple nests during the same breeding season. This unusual mating system results in a lack of territoriality among males. Consequently, estimation of breeding densities by traditional methods is difficult, since males do not sing regularly to defend territories and may be present when no singing is heard (Ball 2000).

Based on mist net capture data, the mean sex ratio among breeding adults in Vermont over eight years was >2 males for every female (Townsend et al. 2009a). However, the sex ratio of nestlings and fledglings was nearly 1:1, with a slight skew toward females. In two separate Québec breeding populations studied over four years (2002–2005), sex ratios of adults and nestlings were similar to those in Vermont (Y. Aubry, CWS/SCF, unpubl. data). The cause of a range-wide male-biased sex ratio is not known, but may relate to differential natal dispersal patterns and survivorship, survival of first-year birds, or survival related to segregation of sexes into winter habitats of different quality.

Reproductive success

Of 171 Bicknell's Thrush nests monitored in Vermont from 1993–2007, 48% were successful in fledging at least one chick (McFarland et al. 2008). The major cause of nest failure (accounting for 75% of failed nests) was depredation of eggs or chicks. Rates of nest predation are strongly linked to a widespread biennial masting cycle in montane coniferous forests, in which alternating years of high cone crops result in high red squirrel (Tamiasciurus hudsonicus) populations during the following spring and summer. Squirrels are a major nest predator of Bicknell's Thrush and other open-cup nesting birds. In years following low autumn cone yields, spring and summer squirrel populations are invariably reduced, and Bicknell's Thrush nesting success is markedly higher, relative to years following high autumn cone yields, when squirrels are abundant. The species' demographic response to this pulsed resource system, which can deviate from a strictly biennial pattern, needs to be considered in the evaluation of population trend data.

Life span and survivorship

The species' longevity record, based on band returns at a Vermont breeding site, is of an 11-year old male (VCE, unpubl. data). A banded male recaptured in Cape Breton in 2009 was at least seven years old (BSC/EOC, unpubl. data). Using mark-recapture analysis, the annual survival estimate of adult birds captured at Vermont breeding sites was 65%, independent of year or sex (Rimmer et al. 2004). In Québec, male annual survival was higher (63%) than female survival (28%; COSEWIC 2009).

Survival rates of juveniles are poorly known and difficult to assess due to apparent natal dispersal: only 6% of fledglings and 19% of independent juveniles banded in Vermont from 1992–2004 returned to their natal mountain. Like other songbirds, survival rates of juvenile Bicknell's Thrush are probably low. On Mt. Mansfield, Vermont in 2000, only 18% of radio-tagged fledglings were known to have survived beyond 30 days.

The annual survival rate of wintering individuals captured at a montane broadleaf forest site in the Sierra de Bahoruco, Dominican Republic, from 1994–1999, was 73% (Rimmer et al. 2001). Overall recapture rates for Bicknell's Thrush in the Dominican Republic are much lower than for birds banded at breeding sites in Vermont (28% vs. 65%).

Population Status

Estimated Population Size

The first estimate of the global population size of Bicknell's Thrush was made in the early 1990s, when Tony Erskine, CWS/SCF biologist, estimated that only 5,000 breeding pairs existed in North America (Nixon 1999). Since then, extensive fieldwork across the breeding range has helped to refine population estimates for the species.

While regional population estimates have been published for Bicknell's Thrush (Hale 2006), IBTCG recently used range-wide data on densities and extent of potential habitat to develop an improved global population estimate. Applying region-specific density data (derived from point count surveys) to a model of potential habitat (Vermont Center for Ecostudies [VCE] 2009) yielded estimates of 57,000 to 77,000 Bicknell's Thrushes in the U.S. and 37,000 to 49,000 individuals in Canada, resulting in a global population of 95,000 to 126,000 birds.

Population trends

High-elevation songbird monitoring programs generally indicate declining populations of Bicknell's Thrush, especially in core and northern parts of the breeding range. The most comprehensive trend data to date are derived from surveys (point counts) conducted by volunteers and field technicians across the northeastern U.S. (Mountain Birdwatch), in the White Mountains National Forest (King et al. 2008), and in the Maritime provinces (High Elevation Landbird Survey [HELP]; Campbell et al. 2009). Government and university researchers have monitored sites in Québec since the late 1990s (Y. Aubry, CWS/SCF, unpubl. data), although no formal survey program is in place. Bicknell's Thrush is poorly represented on survey routes of the North American Breeding Bird Survey (BBS); however, data are available from 16 Canadian BBS routes. The following trend summaries are derived from these aural surveys and represent the best available trend estimates for breeding Bicknell's Thrush.

United States

- 7% decline in White Mountain National Forest (WMNF; New Hampshire), from 1993–2003 (King et al. 2008, Lambert et al. 2008)
- Stable overall trend from 2001–2009 across the U.S., based on Mountain Birdwatch data (VCE, unpubl. data)
- Regionally, abundance appeared to increase in the Adirondack Mountains (New York), while showing no statistical trend in the Catskills (New York), Green Mountains (Vermont), and the White Mountains (New Hampshire). A disruption of the biennial cone masting cycle in montane forests during this 9-year period may have influenced these results, masking longer-term trends (McFarland et al. 2008).

Canada

- 17% annual decline in New Brunswick, from 2002-2009 (BSC/EOC, unpubl. data)
- 15% annual decline in Nova Scotia, from 2002–2009 (BSC/EOC, unpubl. data)
- 29% decrease in probability of occupancy at Mont Gosford, Québec from 2001–2007, with no change in detection probability (Y. Aubry, CWS/SCF, unpubl. data)
- 60% fewer individuals detected at Mont Gosford, Québec, from 2001–2007 (Y. Aubry, CWS/SCF, unpubl. data)
- 9% annual decline in abundance across Canada (BBS) from 1966–2008 (P. Blancher, Environment Canada, unpubl. data).

Legal Status

Conservation managers initially assessed Bicknell's Thrush when it gained species status in 1995. Little information was available at the time on population size, trends or distribution. Government researchers and conservation organizations have since collected trend, distribution, demographic, and habitat association data that have led to range-wide evaluations of the species' conservation status.

Federal and global status:

- Species of continental conservation concern. Partners in Flight (Pashley et al. 2000, Rich et al. 2004, Wells 2007)
- Vulnerable. IUCN (IUCN 2009).
- Threatened. Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2009).
- N3 in Canada (nationally vulnerable). NatureServe Conservation Status (www.natureserve.org)
- Red. Audubon Watchlist (Butcher et al. 2007)
- Bird Species of National Concern. Division of Migratory Bird Management (U.S. Fish and Wildlife Service 2008).

State and provincial status (U. S. and Canada):

- Species of Special Concern in Maine, New York, and Vermont
- Species of Special Concern Category B (Responsibility Species) in New Hampshire
- Vulnerable under the Nova Scotia Endangered Species Act
- May be at risk in New Brunswick and Québec

Bicknell's Thrush has been assigned the following rankings by state and provincial Natural Heritage Programs (www.natureserve.org):

- S1 (Critically Imperiled) in Nova Scotia
- S2 (Imperiled) in New Hampshire and New York
- S3 (Vulnerable) in Maine, New Brunswick, Québec, and Vermont.

Associated Species

Conservation actions aimed at Bicknell's Thrush are likely to benefit co-occurring species, some of which are also conservation priorities. Tables 1 and 2 list at-risk or endemic species that occupy the same habitats as Bicknell's Thrush and would likely benefit from conservation efforts on the species' breeding and/or wintering grounds. Some species may co-occur with Bicknell's Thrush only in parts of their range, and thus be of regional conservation interest, while others have broad range overlap.

Ralph Hocken

The Olive-sided Flycatcher will benefit from actions aimed at Bicknell's Thrush.

Table 1.

North American at-risk breeding bird species that co-occur with Bicknell's Thrush at breeding *(VCE and BSC/EOC unpubl. data)* **or wintering** *(Latta et al. 2003, 2006)* **sites**

Species	Scientific Name	Site*	U.S. Status (State)	Canadian Status
Sharp-shinned Hawk	*Accipiter striatus*	B	Special Concern (NY)	
Spruce Grouse	*Falcipennis canadensis*	B	Endangered (VT)	
Black-backed Woodpecker	*Picoides arcticus*	B	Special Concern (VT)	
Olive-sided Flycatcher	*Contopus cooperi*	B		Threatened
Gray Jay	*Perisoreus canadensis*	B	Special Concern (VT)	
Louisiana Waterthrush	*Seiurus motacilla*	W		Special Concern
Wilson's Warbler	*Wilsonia pusilla*	B	Special Concern (VT)	

** B = breeding sites, W = wintering sites*

Eladio Fernandez

J. Brian Patteson

Endangered Hispaniolan endemics such as La Selle Thrush (left) and Black-capped Petrel (right) stand to benefit from conservation actions targeted at Bicknell's Thrush.

Table 2.

Caribbean endemic or resident species at risk that co-occur with Bicknell's Thrush during the boreal winter *(Latta et al. 2003, 2006 for Hispaniola; Y. Aubry, CWS/SCF, unpubl. data for Cuba)*

Species	Scientific Name	Island*	Global Status *(IUCN 2009)*	Endemic?
Black-capped Petrel	*Pterodroma hasitata*	H/C?	Endangered	N
Sharp-shinned Hawk	*Accipiter striatus striatus*	H		Y – subspecies *striatus*
Plain Pigeon	*Patagioenas inornata*	H	Near-threatened	N
Hispaniolan Quail-Dove	*Geotrygon leucometopia*	H	Vulnerable	Y
Hispaniolan Parakeet	*Aratinga chloroptera*	H	Vulnerable	Y
Hispaniolan Parrot	*Amazona ventralis*	H	Vulnerable	Y
Hispaniolan Emerald	*Chlorostilbon swainsonii*	H		Y
Hispaniolan Trogon	*Priotelus roseigaster*	H	Near-threatened	Y
Broad-billed Tody	*Todus subulatus*	H		Y
Narrow-billed Tody	*Todus angustirostris*	H		Y
Hispaniolan Woodpecker	*Melanerpes striatus*	H		Y
Hispaniolan Pewee	*Contopus hispaniolensis*	H		Y
La Selle Thrush	*Turdus swalesi*	H	Endangered	Y
Green-tailed Ground-Tanager	*Microligea palustris*	H		Y
Hispaniolan Highland-Tanager	*Xenoligea montana*	H	Vulnerable	Y
Greater Antillean Elaenia	*Elaenia fallax cherriei*	H		Y – subspecies *cherriei*
Rufous-throated Solitaire	*Myadestes genibarbis montanus*	H		Y – subspecies *montanus*
Black-crowned Palm-Tanager	*Phaenicophilus palmarum*	H		Y
Gray-crowned Palm-Tanager	*Phaenicophilus poliocephalus*	H	Near-threatened	Y
Bananaquit	*Coereba flaveola bananivora*	H		Y – subspecies *bananivora*
Eastern Chat-Tanager	*Calyptophilus frugivorus*	H	Vulnerable	Y
Western Chat-Tanager	*Calyptophilus tertius*	H	Vulnerable	Y
Hispaniolan Spindalis	*Spindalis dominicensis*	H		Y
Antillean Euphonia	*Euphonia musica musica*	H		Y – subspecies *musica*
Greater Antillean Bullfinch	*Loxigilla violacea affinis*	H		Y – subspecies *affinis*
Hispaniolan Crossbill	*Loxia megaplaga*	H	Endangered	Y
White-crowned Pigeon	*Patagioenas leucocephala*	C	Near-threatened	N
Bare-legged Owl	*Otus lawrencii*	C		Y
Cuban Pygmy-Owl	*Glaucidium siju*	C		Y
Cuban Trogon	*Priotelus temnurus*	C		Y
Cuban Tody	*Todus multicolor*	C		Y
Cuban Green Woodpecker	*Xiphidiopicus percussus*	C		Y
Cuban Vireo	*Vireo gundlachii*	C		Y
Cuban Solitaire	*Myadestes elisabeth*	C	Near-threatened	Y
Oriente Warbler	*Teretistris fornsi*	C		Y

II. The International Bicknell's Thrush Conservation Group

In response to range-wide conservation concerns for Bicknell's Thrush, the Vermont Center for Ecostudies (VCE) and Bird Studies Canada/Études d'Oiseaux Canada (BSC/EOC) convened a coalition with a common interest in setting priorities for research and conservation needs for this species. Composed of scientists, natural resource managers, and conservation planners, this group, the International Bicknell's Thrush Conservation Group (IBTCG), is flexible and inclusive, with no requirement for membership beyond a shared interest in advancing Bicknell's Thrush conservation. The IBTCG's overarching goal is to develop a broad, scientifically sound approach to conservation of Bicknell's Thrush, in order to prevent further declines and to increase current populations to a sustainable level. The group aims to address threats to Bicknell's Thrush throughout its entire migratory range.

The administrative structure of IBTCG consists of a Coordination Committee, subgroups, and members. The role of the Coordination Committee is to oversee implementation of this Conservation Action Plan, seek funding, maintain momentum, set meetings and agendas, and identify next steps. The following IBTCG subgroups have been defined: Breeding and Migration Research, Monitoring, Forestry, and Wintering Grounds. Chairs of each subgroup facilitate activities and maintain momentum within their focused area of expertise and interest.

The IBTCG held its inaugural meeting in Woodstock, Vermont in November 2007. The 25 meeting participants included representatives from academia, federal and state/provincial wildlife agencies, and non-governmental organizations, from five northeastern states and two Canadian provinces. Since then, the group has met yearly.

With members spanning the hemisphere, communication and information sharing are critical to the success of this group. The IBTCG developed a website (www.bicknellsthrush.org) to serve as an accessible clearinghouse for information related to Bicknell's Thrush conservation and to publicize the group's activities. The website hosts a summary of Bicknell's Thrush research conducted across the species' migratory range, as well as a growing bibliography of relevant publications and reports. This Conservation Action Plan and associated non-technical outreach documents are also available for viewing or downloading on the IBTCG web site.

An immediate objective is to hire an IBTCG coordinator to lead implementation of this Conservation Action Plan. The coordinator will be responsible for overseeing implementation of this Plan, setting and meeting IBTCG deadlines, helping to secure funding for IBTCG-related activities, maintaining group momentum, and managing communication and outreach efforts.

III. Population Threats

Numerous anthropogenic threats affect Bicknell's Thrush, including habitat loss and degradation, climate change, and pollution. Collectively, these threats are believed to exert strong regulatory effects on the species' populations by limiting resources necessary for population growth. Several demographic and ecological characteristics of Bicknell's Thrush may also act synergistically with anthropogenic threats to compromise the species' population stability. For example, the small global population size, clumped distribution of habitat (and thus individuals) at breeding and wintering sites, apparent limited dispersal, skewed adult sex ratio, and potential winter habitat sex-segregation are all characteristics that increase the species' vulnerability to threats or stochastic events. Although these attributes may not directly limit population growth, they may combine with anthropogenic threats to regulate Bicknell's Thrush populations.

An initial goal upon formation of the IBTCG was to quantify and describe the major threats to Bicknell's Thrush populations. The group has identified five broad categories of threats (below), identified several specific threats in each category, and ranked the relative extent to which these threats are believed to negatively affect populations (Table 3). The IBTCG has also identified research actions to address knowledge gaps in understanding the relative effects of threats on population stability and how to reduce their impacts (see Section V).

Habitat Loss and Degradation

Forestry practices

Forestry practices, such as precommercial thinning (PCT) and clear-cutting, could be altering the amount and suitability of breeding habitat in Canada (Chisholm and Leonard 2008) and northern Maine, where Bicknell's Thrush are often found in managed forests. Forest managers use PCT to reduce tree density by 85-95% (Chisholm and Leonard 2008, Ordre des ingénieurs forestiers du Québec 2009). Bicknell's Thrush abundance drops locally immediately following the process of PCT (Chisholm and Leonard 2008), but the effects of this practice on productivity or survival are unknown.

Clear-cutting in industrial highlands may affect Bicknell's

Sarah Chisholm

Recently-thinned industrial forest in New Brunswick.

Thrush by temporarily removing forest habitat. Little information is available on Bicknell's Thrush use of mature forest prior to clear-cutting, making it difficult to assess immediate impacts on the species. It has been observed that birds may move to uncut/unthinned remnant forest nearby, and for at least the first few years after the perturbation (McKinnon 2009; D. Busby, CWS/SCF, pers. comm.). In addition, the use of thinning in forests prior to harvest may obscure impacts of clear-cutting; effects of clear-cutting would be greater in stands never subjected to PCT since these may still be used by Bicknell's Thrush.

Vegetation succession

Control of vegetation succession may also alter the availability or quality of Bicknell's Thrush breeding habitat. The species often breeds in dense regenerating forests that originate from anthropogenic disturbance, such as a clearcut, or natural disturbance, such as fires or insect outbreaks. Suppression of natural disturbance events may result in fewer stands regenerating to a stage where they are used by Bicknell's Thrush for breeding. In the industrial highlands in NB, harvesting of wood has declined recently due to market pressures. In NS and NB, a decline in the amount of young, regenerating stands within Bicknell's Thrush habitat is currently occurring or predicted to occur over the next 20 years (COSEWIC 2009). This will result in fewer dense forest stands at the stage where Bicknell's Thrush is most abundant.

Industrial and recreational development (wind, telecommunication, ski)

Bicknell's Thrush breeding habitat is at risk of development from activities such as construction and operation of wind power and telecommunications facilities, and recreational skiing. These industries threaten to remove, fragment or alter habitat.

Human disturbance (recreation)

Recreational use of high-elevation areas may also pose a threat. Many protected high-elevation areas in the U.S, such as the WMNF and Adirondack Park, are annually visited by tens of thousands of hikers. The impacts of direct disturbance to breeding Bicknell's Thrush from recreational use of these forests is not well documented, although some evidence suggests that birds can adapt to moderate levels of human disturbance (Rimmer et al. 2001).

Subsistence farming and logging; human-caused fires

Forest habitat loss from subsistence farming and logging has been severe on the island of Hispaniola. Fires caused by people in the Dominican Republic and Haiti are an additional threat to winter habitat. Only 10% of original forest cover remains in the Dominican Republic (Stattersfield et al. 1998), while < 2% persists in Haiti (Paryski et al. 1989, Sergile 2008). High-elevation cloud forest is the only habitat that consistently supports Bicknell's Thrush in the Dominican Republic's Sierra de Bahoruco (Latta et al. 2003), and is one of the most endangered habitats on Hispaniola (Latta and Lorenzo 2000). Current estimates are lacking, but only 1,100 km2 of cloud forest and 3,150 km2 of wet broadleaf forest remained island-wide in the late 1990s (Tolentino and Peña 1998). Current rates of deforestation are unlikely to abate given continuing socio-economic pressures in both countries (Stattersfield et al. 1998, Perdomo and Arias 2008, Sergile 2008). Continuing deforestation in the Dominican Republic, both inside and outside of officially protected areas, may have significant conservation implications for Bicknell's Thrush, particularly if winter habitat segregation disproportionately affects the susceptibility of males and females to forest loss (see Habitat section p.7). In Cuba, relatively more Bicknell's Thrush habitat is available, since 21% of the island retains forest cover, partly as a result of reforestation since 1960 (Mugica 2008). However, the distribution and size of Bicknell's Thrush populations wintering in Cuba are not well documented.

Feral animals

Dense forest understory is an important characteristic of winter habitat for Bicknell's Thrush. Feral pigs and free-ranging cattle severely damage forest understory at some wintering sites on Hispaniola, degrading habitat quality for Bicknell's Thrush, although the demographic impacts of such degradation are unknown (VCE, unpubl. data).

Coastal development

Currently, spring and fall migration of Bicknell's Thrush is believed to follow the East Coast flyway of North America from the Caribbean to the Maritimes. Although specific migratory habitat of Bicknell's Thrush has not been studied, coastal development, development of wind power, and communications towers are known to affect migration habitat for other Nearctic-Neotropical migrants using the eastern flyway (Moore et al. 1995, Moore 2000).

Atmospheric Pollution

Atmospherically-deposited heavy metals and acid precipitation are threats of unknown magnitude. For Bicknell's Thrush populations inhabiting high-elevation breeding or winter habitats, risks may be higher, as deposition of heavy metals and other pollutants is known to be greater than at lower elevations (e.g., Rimmer et al. 2005a).

Mercury bioaccumulation

Mercury, which is released into the atmosphere from coal burning and waste incineration, is of particular concern. Researchers have found elevated levels of toxic methylmercury in Bicknell's Thrush tissues sampled at multiple breeding sites and Greater Antillean wintering sites (Rimmer et al. 2005a). Mercury enters the montane forest food web from the abiotic environment and bioaccumulates at successive trophic levels (Rimmer et al. 2009). Mercury's physiological or behavioral effects on Bicknell's Thrush, and their impacts on individual fitness, are not known.

Nitrogen deposition

Atmospheric reactive nitrogen (nitrates and/or ammonia), derived from vehicle and electric utility emissions, is deposited at high elevations as acid precipitation, which can adversely affect forest and watershed health. High-elevation forests where Bicknell's Thrushes breed are affected directly by reactive nitrogen pollution through foliage damage and, indirectly, by reduced stress tolerance (Driscoll et al. 2003).

Calcium depletion

During the past 50 years, acid deposition has accelerated the loss of large amounts of available calcium from soil in acid-sensitive areas in the northeastern U.S, including breeding sites of Bicknell's Thrush in the Adirondacks (New York), the Green Mountains (Vermont), the White Mountains (New Hampshire), and in Maine (Driscoll et al. 2001). Recent studies from northern Europe have found that songbirds breeding in acidified areas may be unable to obtain sufficient high-calcium foods (such as land snails) for eggshell production (Graveland and Drent 1997, Mand et al. 2000). Land snails rely on calcium in leaf litter and live vegetation, which has decreased due to the leaching effects of acid deposition.

Acid deposition also affects Bicknell's Thrush habitat directly. Since the 1960s, significant growth declines and increased winter injury to red spruce have been observed across much of the species' range (Eager and Adams 1992), and recent research suggests that red spruce decline is linked to leaching of calcium from needles by acid rain, mist, and fog (DeHayes et al. 1990, 1999). The loss of calcium in needles reduces their tolerance to low temperatures and increases the occurrence of winter injury and subsequent tree damage or death. Increased mortality of spruce may result in encroachment of less suitable trees (such as hardwoods) into Bicknell's Thrush habitat, which may decrease the quality of foraging or nesting areas.

Effects of lead or other trace elements

Despite recent dramatic decreases in atmospheric inputs of lead from gasoline, levels of lead in high-elevation soils in the Northeast remain high (Kaste et al. 2006). Lead concentrations known to cause sub-lethal effects have been found in urban populations of some songbirds, despite near-zero atmospheric contributions of lead (Scheifler et al. 2006). Research is needed to determine if exposure of Bicknell's Thrush to elevated levels of or other trace elements in montane forest soils could cause sub-lethal physiological or behavioral effects.

Climate Change

Increasing temperature and forest conversion

Climatic warming's most significant impact on Bicknell's Thrush may be an upward shift in elevational distribution of its breeding habitat. Because the extent of fir-dominated montane forests is controlled primarily by climate, projected warming has the potential to alter distribution and abundance of these forests (Rodenhouse et al. 2008). Changes in vegetation communities along elevational gradients in the Northeast are strongly influenced by temperature (Spear 1989, Botkin et al. 1972). Warmer growing seasons could gradually elevate forest ecotones and confine high elevation plant and animal communities to progressively higher, smaller, and more isolated patches. An upward shift in the lower spruce-fir ecotone may already be underway on northeastern U.S. mountains (Hamburg and Cogbill 1988, Beckage et al. 2008), where warming is resulting in the encroachment of northern hardwoods into areas previously dominated by red spruce and balsam fir (Lee et al. 2005, Beckage et al. 2008).

Warming of as little as 1°C is predicted to reduce potential Bicknell's Thrush habitat by more than half, while an increase of 2°C may eliminate all breeding sites from

the Catskill Mountains of New York and most of Vermont (Rodenhouse et al. 2008). A 3°C increase in growing season temperatures could eliminate nearly all Bicknell's Thrush habitat in the Northeast. By the end of the century, summer temperatures are projected to rise on average by 2.8 °C under a lower-emissions scenario and 5.9 °C under a higher-emissions scenario (Union of Concerned Scientists 2006).

Disruption of cone-red squirrel cycle; Change in prey base emergence; Increased interspecific competition

Climate change has the potential to affect a variety of environmental and ecological parameters that determine viability of Bicknell's Thrush populations, including timing of predator population cycles (e.g., McCarty 2001), timing of spring prey emergence (e.g., Sillett et al. 2000, Sanz et al. 2003, Both et al. 2006), and occurrence of competing species (Wormworth and Mallon 2006). These effects are currently not well understood for Bicknell's Thrush and require further research to assess their relative and combined impacts.

Increased precipitation/wind storms

Most Bicknell's Thrush nest failures are caused by predation; however, climate change scenarios predict an increase in the frequency of precipitation and wind. More frequent rain or wind during the breeding season could reduce productivity directly by increasing rates of nest failure. More frequent wind or rain at wintering sites could decrease survival by limiting foraging opportunities, reducing roosting cover, or impairing thermoregulation of wintering birds and or destroy lower altitude habitats.

Increased frequency of tropical storms (erratic weather)

In general, more frequent tropical storms and erratic weather caused by climate change (Angeles et al. 2007) could affect Bicknell's Thrush throughout its annual cycle by directly or indirectly increasing mortality of individual birds. Fall hurricanes could prove catastrophic to actively migrating birds and damaging to winter habitats, while extreme weather events during the wintering period could impair physiological condition and lead to reduced fitness.

Increase or changes in forest pests/pathogens

The distributions of some forest pests, such as the balsam wooly adelgid (Adelges piceae), are controlled by climate. Warmer temperatures could allow expansion of these pests into high-elevation forests previously outside their ranges (Iverson et al. 2008), with potentially deleterious effects on Bicknell's Thrush breeding habitat quality (Lambert et al. 2005).

Increased Rates of Direct Mortality

Catastrophic weather events; Introduced predators (rats and cats); Disease, parasites and decreased immune function; Migration hazards; Incidental take during research.

Because Bicknell's Thrush populations are relatively small, increased rates of mortality could have large effects on the persistence of the species. The restricted geographic range of Bicknell's Thrush also increases the species' vulnerability to catastrophic weather events, since a relatively large proportion of the population could be affected at one time. Introduced rats are known to depredate Bicknell's Thrush on Hispaniola (Townsend et al. 2009b); other introduced predators, such as feral cats, may impact survivorship of wintering birds. Migration hazards (e.g., windows, telecommunication towers, wind turbines), disease, parasites, and research activities (i.e. handling, banding, telemetry) may result in direct mortality of Bicknell's Thrush. Mortality from research activities is believed to be very low; however, further investigation is required to determine the magnitude of direct mortality from this and other causes.

Incidental take during forestry

Another potential source of direct mortality is incidental take during forestry operations. Industrial highlands are generally accessible for PCT only between June and October; the bulk of PCT activity in New Brunswick, Nova Scotia and Québec occurs from June to August (S. Makepeace, NB DNR; A. Doucette, NewPage Port Hawkesbury; and Y. Aubry, CWS/SCF, unpubl. data). Thus, PCT may directly destroy nests or harm individuals, or otherwise disturb nesting attempts by Bicknell's Thrush and other birds in these forests.

Demographic and Ecological Characteristics

Male-biased sex ratio

The highly skewed breeding adult sex ratio of Bicknell's Thrush (>2 males: 1 female; Townsend et al. 2009a) may be linked to sexual habitat segregation during winter and supports the need for more in-depth demographic studies on the wintering grounds.

Seasonal interactions and migratory connectivity

Elucidating how anthropogenic threats (e.g., habitat loss

or degradation, climate change) impact populations across the species' annual cycle and how they might interact to regulate populations constitutes a pressing conservation need. Migratory connectivity is defined as the extent of mixing between summer (breeding) and winter (non-breeding) populations, as well as the stop-over and migratory pathways between them (Webster et al. 2002). Determining how populations are connected throughout the annual cycle is integral to understanding how anthropogenic threats influence population dynamics.

Table 3.

Threats to Bicknell's Thrush populations, their IBTCG priority rankings for conservation action, and the season(s) of the annual cycle in which they operate

Threats	Priority*	Season(s)**
Habitat Loss and Degradation		
Subsistence farming and logging	High	Winter
Forestry practices	High	Breeding
Coastal development	Medium	Migration
Vegetation succession	Medium	Breeding
Feral animals	Medium	Winter
Human-caused fires	Medium	Winter
Industrial development (wind, telecommunication, ski)	Medium	Breeding, Migration
Human disturbance (from recreation)	Low	Breeding
Atmospheric Pollution		
Calcium depletion	Medium	Breeding
Mercury bioaccumulation	Medium	Breeding, Winter
Effects of lead or other trace elements	Low	Breeding, Winter
Nitrogen deposition	Low	Breeding, Winter
Climate Change		
Increasing temperature and forest conversion	High	Breeding
Disruption of cone-red squirrel cycle	Medium	Breeding
Increased precipitation/wind storms	Medium	Breeding, Winter
Change in prey base emergence	Medium	Breeding
Increase or changes in forest pathogens/pests	Medium	Breeding
Increased frequency of tropical storms	Medium	All
Increased interspecific competition	Low	Breeding
Increased Rates of Direct Mortality		
Incidental take during forestry	High	Breeding
Introduced predators	Medium	Winter
Catastrophic weather events	Medium	All
Disease, parasites, and decreased immune function	Low	All
Incidental take during research	Low	All
Migration hazards (towers, lights)	Low	Migration
Demographic and Ecological Characteristics		
Male-biased sex ratio	Medium	Winter
Seasonal interactions and migratory connectivity	Medium	All

** Rankings reflect a combined score based on estimated magnitude of effect and level of certainty for each identified threat, as agreed upon by the IBTCG.** Indicates season(s) of the annual cycle during which each threat is likely to affect populations*

IV. Population and Conservation Goals and Actions

The following section outlines range-wide conservation goals set by the IBTCG. Progress towards the goals will be evaluated every five years.

Although current trend data are inconsistent across the breeding range, the overall indication of declines in northern and core portions of the species' range, combined with steep rates of winter habitat loss, has created high levels of conservation concern for Bicknell's Thrush. Although a reliable estimate of historical population levels is lacking, recent declines suggest that populations have decreased overall during the past 20 years or more. Steep rates of winter habitat loss further suggest that current populations are likely below historic levels due to the reduced carrying capacity of these habitats. Local extirpations and disproportionately steep declines of some peripheral breeding populations, such as in the Canadian Maritimes, indicate that conservation efforts and approaches may need to be tailored to regional conditions and contexts. These conclusions support establishment of an ambitious population objective that seeks to increase the population beyond its current levels.

This goal equates to increasing the species' overall numbers while simultaneously sustaining viable populations at the current periphery of the breeding range, such as in the Catskill Mountains of New York and the Cape Breton Highlands of Nova Scotia. The goal similarly applies to extent of occurrence on the wintering grounds, although more information is needed to clarify the species' distribution outside of Hispaniola. We believe that a 25% increase over 50 years, while ambitious, is achievable, if the actions recommended in this Plan are fully implemented.

Based on current knowledge of Bicknell's Thrush ecology, the most feasible actions to promote population increases are habitat management, protection, and restoration. The following conservation actions, as well as the research actions presented in Section V, have been identified by the IBTCG and its component subgroups as priorities within the next five years (2010–2014). The conservation actions should be undertaken immediately in order to advance population and habitat goals, and the research actions should be undertaken to inform conservation action. In the future, IBTCG working groups will develop specific, detailed implementation plans to achieve each priority conservation and research action; these will include justification for the action(s), anticipated measurable outcomes, cooperating parties, estimated costs, a timeline for successful implementation, and criteria by which to evaluate success.

Conservation Goal:
The overall conservation goal of the IBTCG is to increase the global population of Bicknell's Thrush by 25% over the next 50 years (2011-2060), and to maintain or increase the species' current (as of 2010) extent of breeding occurrence.

Protect or manage known and potential breeding habitat.

On its North American breeding range, Bicknell's Thrush habitat is restricted to higher elevations, where ecological constraints limit possibilities for creating additional habitat. Habitat management is a more practical approach to increasing breeding populations of Bicknell's Thrush. The majority of U.S. breeding habitat is protected because it coincides with fragile high-elevation areas; however, in Maine and Canada, a large portion of Bicknell's Thrush habitat is subject to timber management ("industrial forest"). In these areas, sustainable forestry practices can be implemented on a landscape scale to provide suitable breeding habitat through time, and to ensure no net loss of available breeding habitat.

Conservation Action:
Partner with timber companies and management agencies to develop and implement Best Management Practices (BMPs) for Bicknell's Thrush.

Table 4.

Summary of habitat conservation goals and highest priority conservation actions identified by the IBTCG to achieve the overall goal of increasing Bicknell's Thrush populations by 25% over the next 50 years. Primary threats addressed by each conservation action are identified.

Habitat Conservation Goal	Conservation Actions	Threat(s) Addressed
Protect or manage known and potential breeding habitat.	• *Partner with timber companies and management agencies to develop and implement Best Management Practices (BMPs) for Bicknell's Thrush.*	Habitat Loss and Degradation – forestry practices; also Direct Mortality – incidental take
	• *Maintain a target amount of Bicknell's Thrush habitat in industrial forests.*	Habitat Loss and Degradation – forestry practices
Protect, manage, and restore known and potential winter habitat.	• *Improve protection of current winter habitat.* • *Expand Bicknell's Thrush Habitat Protection Fund.* • *Develop habitat management plans and secure implementation funding.* • *Pilot winter habitat restoration projects.* • *Develop strong links with Caribbean partners.*	All of the winter habitat actions help address threats from Habitat Loss and Degradation – including subsistence farming and logging, human-caused fires, feral animals, habitat quality and quantity

The development of management guidelines for land managers working in Bicknell's Thrush habitat addresses the threat of direct mortality from incidental take (including nests, eggs, and young) during forestry operations, as well as the threat of habitat loss and degradation, which occur when forest stand structure is drastically changed through thinning, clear cutting, and cutting for trails used by harvesting equipment. Preliminary work has been done toward producing management guidelines for industrial highland forest in the Maritimes and Québec (Bredin and Whittam 2009, Rioux and Poulin 2009). Suggested practices include:

- avoiding logging infrastructure development and precommercial thinning (PCT) in areas occupied by Bicknell's Thrush.
- employing mitigation measures where PCT cannot be avoided, such as reducing the areas treated, and if no other solution is available, conducting PCT only outside of the breeding season.
- leaving unthinned patches within thinned stands.
- employing a "No Net Habitat Loss" policy such that the amount of Bicknell's Thrush habitat in the area of management does not decrease.

Best management practices aim to minimize the risk of impacts, and mitigate any unavoidable impacts on Bicknell's Thrush, including nests, eggs, young, and adults. To best address region-specific management regimes, BMPs will need to be developed independently by jurisdiction. The following actions are required in order to develop and implement BMPs range-wide:

- Quantify industrial highland forest used or potentially used by Bicknell's Thrush in ME and identify the landowners (this is already completed for Quebec, New Brunswick and Nova Scotia).
- On public lands, develop partnerships and stewardship

with management agencies and incorporate BMPs for Bicknell's Thrush into legislation or public land management practices whenever possible.

- On private land, develop partnerships with landowners to implement BMPs.
- Continually evaluate and adapt BMPs to reflect the most up-to-date research and incorporate target amounts of habitat to be supplied within each jurisdiction.

Conservation Action:
Maintain a target amount of Bicknell's Thrush habitat in industrial forests.

It is necessary to identify the amount of habitat needed to maintain and increase populations of Bicknell's Thrush currently nesting on forestry lands in Quebec, New Brunswick, Nova Scotia, and Maine. (Note that almost all Bicknell's Thrush habitat in New Hampshire, Vermont, and New York is under government ownership and is not managed for timber harvest.) Establishing explicit target levels of habitat will provide a basis by which to encourage land managers to protect that amount of habitat on an annual basis. Such protection could be achieved by adjusting the amount of habitat that is cut and thinned annually. Regenerating forest requires 10-20 years or more post-harvest to reach a stage that supports Bicknell's Thrush (trees > 2 m height), and PCT generally occurs 15-20 years post-harvest (or when stands reach 2-3 m in height). By rotating harvests across the range of Bicknell's Thrush habitat and creating a heterogeneous distribution of stand ages, which will undergo PCT and cutting at different times, a consistent amount of suitable habitat should be maintained across the landscape over time.

Separate targets are likely required for each jurisdiction where Bicknell's Thrush breed on forestry lands, including Quebec, New Brunswick, Nova Scotia, and Maine, because each jurisdiction has different management regimes and goals. Within these jurisdictions, targets may need to be developed separately for public and private lands.

The following actions are needed before targets can be set. These actions can only be achieved through strong engagement of both provincial/state/private forest management partners and federal agencies responsible for migratory bird conservation.

- Determine Bicknell's Thrush density in industrial forest stands in the various jurisdictions within which the species occurs.
- Acquire data on the size, growth stage and management (especially PCT) plans for stands that coincide with potential Bicknell's Thrush habitat.
- Using Bicknell's Thrush density information, forest stand condition information, and a description of the habitat used by Bicknell's Thrush, estimate the current population of Bicknell's Thrush breeding on forestry lands and set a target population as a management goal. This target population could be based on current populations, or on the amount of pre-industrial forest habitat which would have been historically present due to fire, blowdown, and insect outbreak (most of which are now controlled
- Determine the amount of habitat required to support the target population and model the production of this habitat over time.

Protect, manage, or restore known and potential winter habitat.

Habitat loss and degradation are widely recognized as a major cause of population declines in birds worldwide. In the Caribbean, forests have been extensively cleared for agriculture and subsistence living. Almost all natural forest in Haiti has been cleared with < 2% of original forest remaining (Paryski et al. 1989, Sergile 2008). While forested habitat covers 27.5% of the Dominican Republic's land base (Tolentino and Pena 1998), 21% in Cuba (Mugica 2008), and 25% in Jamaica (Stattersfield et al. 1998), much of the

Chris Rimmer

Severe deforestation along the Dominican-Haitian border

extant forest in each country has been dramatically altered from its original state. Of four bird communities analyzed over an elevational gradient in the Dominican Republic's Sierra de Bahoruco by Latta et al. (2003), montane forest was the only habitat shown to support Bicknell's Thrush. Montane forests have been identified as one of the most endangered habitats on Hispaniola (Latta and Lorenzo 2000) with only 1100 km2 of cloud forest and 3150 km2 of wet broadleaf forest remaining island-wide (Tolentino and Peña 1998).

While additional research is needed to better understand Bicknell's Thrush winter habitat selection, including on islands other than Hispaniola, enough is known to implement actions that will strengthen protection of core habitat, develop management plans, and begin pilot restoration of degraded habitat. There are indications that conservation efforts can be successful. Efforts in Haiti to promote biodiversity conservation and sustainable development have met with some success, despite a high rate of poverty and low public appreciation for natural resources (Sergile and Woods 2001). An analysis of forest recovery in a Dominican riparian forest showed similar canopy height and stem density to original, old-growth forests 40 years post-agriculture; however, secondary forests had a lower basal area and a greater percentage of basal area was comprised of invasive species (Martin et al. 2004). This was a natural recovery, suggesting that active efforts to plant native species and remove invasives may speed recolonization. Bicknell's Thrush has been documented to occur in recovering secondary forests similar to those studied by Martin et al. (2004), with two banded individuals recaptured between 2004 and 2007 suggesting the existence of winter philopatry to such habitats (J. Townsend and C. Rimmer, unpubl. data).

Habitat protection and restoration in the Caribbean could significantly enhance overwinter survival of Bicknell's Thrush, in turn leading to population increases. Current research suggests that regenerating forests in Hispaniola do not support Bicknell's Thrush for 15–20 years post-recovery (C. Rimmer, VCE, pers. obs.). Thus, a 50-year population recovery goal allows adequate time to identify candidate sites for habitat restoration, develop relationships with local partners, secure needed funding, implement on-the-ground restoration measures, and document habitat occupancy patterns of Bicknell's Thrush. Concurrent efforts will focus on strengthening protection and management of existing intact habitat.

Conservation Action:
Improve protection of currently occupied winter habitat.

Bicknell's Thrush habitat on Hispaniola, both inside and outside of formally protected areas, is not well safe-guarded due to lack of resources, including trained staff, and lack of knowledge of priority areas for habitat conservation. To improve protection of currently suitable winter habitat, we propose to:

- Improve enforcement capacity for existing protected areas through increased staffing, training and infrastructure.
- Identify priority areas for protection (both currently protected and unprotected) taking into account immediacy and severity of threats, potential local conservation partners, and likelihood of success.

Conservation Action:
Develop winter habitat management plans and secure implementation funding.

Legally protected forest areas on Hispaniola require the development of management plans to ensure protection and suitability of habitat for Bicknell's Thrush, based on known habitat preferences. Sustainable funding mechanisms will be needed to implement management plans. Management plans for winter habitat should include:

- Initiatives to acquire or manage buffer zones around protected forests.
- Development of community-based, sustainable agriculture, such as cacao or shade coffee agro-forestry.
- Guidance for invasive species control measures.
- Reference to broader landscape-level conservation initiatives. By using Bicknell's Thrush as an umbrella species, watersheds or other appropriate ecological units can be protected via sustainable management and restoration of wet broadleaf forest habitats; this approach will also target specific suites of migrant and resident species that benefit from such habitat management.
- Promoting the use of local, sustainably-grown cocoa and coffee products in North America to raise funds for management of winter habitat.

Conservation Action:
Pilot winter habitat restoration projects.

The majority of historical Bicknell's Thrush habitat on Hispaniola has been degraded or destroyed; thus habitat recovery, via active restoration and passive regeneration, is critical for increasing populations to attain our overall conservation goal. Habitat recovery efforts should include a range of elevations and geographic areas to address the needs of all sex and age classes. Haitian reforestation should focus on currently protected high-elevation areas in the Massif de la Hotte and Massif de la Selle. To begin the process of habitat restoration, we propose to:

- Assess extent and condition of habitats (i.e, from optimum to badly degraded) to evaluate potential for restoration.
- Secure and distribute funds locally to obtain needed resources (e.g., paid staff, infrastructure, equipment) to implement habitat restoration efforts.
- Develop explicit strategies to restore areas of degraded forest to conditions suitable for Bicknell's Thrush and associated forest endemic birds.
- Establish standardized protocols to monitor occupancy/use by Bicknell's Thrush (and other species) over time, and evaluate success of efforts to guide future restoration projects.

Conservation Action:
Develop strong links with local partners in the Caribbean.

Close collaboration with local partners, both in governmental agencies and non-governmental organizations, is critical to the success of any conservation effort. To increase participation of Caribbean partners in IBTCG activities and forge stronger connections with local partners throughout the winter range, we propose to:

- Form new partnerships, strengthen existing relationships, develop opportunities, and provide outreach to local biologists, students, government officials, NGOs, and community members for implementation of conservation activities.
- Develop strong alliances and working partnerships with government agencies in each country that supports wintering Bicknell's Thrush populations.
- Recruit additional IBTCG members from the Caribbean.
- Regularly host IBTCG meetings in the Dominican Republic or other Caribbean countries (i.e. every 3 years), to show commitment of North American agencies to conservation efforts on the winter range
- Develop funding mechanisms to ensure participation of Caribbean IBTCG members in annual meetings held in North America and in biennial meetings of the Society for the Conservation and Study of Caribbean Birds
- Work with identified partners to develop local outreach, training, ecotourism, and other capacity building projects.
- Develop partnerships and projects with a specific focus on environmental education, to build needed local community support for conservation of birds and their habitats.

Conservation Action:
Expand the Bicknell's Thrush Habitat Protection Fund.

Inadequate funding to support conservation projects on Hispaniola is identified as a limiting factor by the IBTCG and others (e.g., Sergile and Woods 2001, Latta 2005). The Bicknell's Thrush Habitat Protection Fund (BITH Fund) was created in 2005 by a consortium of U.S. conservation partners, as a recommended mitigation strategy to offset ski area or related development of breeding habitat (Rimmer et al. 2004). The primary purpose of the BITH Fund is to disburse monies via grants to local partners in the Dominican Republic or Haiti for on-the-ground conservation projects that target Bicknell's Thrush habitat and related conservation efforts on Hispaniola. The Fund is administered by the Adirondack Community Trust (ACT), with a stipulation that monies cannot be dispersed until the Fund reaches $10,000. Expanding resources of the BITH Fund has significant potential to provide revenue to local partners, thereby strengthening their investment and involvement in Bicknell's Thrush conservation on Hispaniola.

The BITH Fund's Advisory Committee is composed of representatives from VCE, Adirondack Nature Conservancy, Adirondack Council, Audubon New York, Wildlife Conservation Society, and Fundación Loma Quita Espuela. The role of the Advisory Committee is to advise ACT in developing and managing the Fund, and to oversee a grant-

making process.

While the BITH Fund is formally established and recently exceeded the $10,000 threshold for disbursement, time constraints on the part of Advisory Committee members have limited progress on implementation. The IBTCG recognizes the potential value of the BITH Fund and wishes to help advance the Advisory Committee's efforts.

The IBTCG proposes to increase the BITH Fund to US $50,000 by the end of 2010, and to expand the long-term influence of the Fund by:

- Actively promoting the BITH Fund within North American ski, telecommunications, wind power, and forest products industries, and to carbon sequestering organizations.
- Suggesting the BITH Fund as a method of compensatory mitigation to be applied by the Canadian federal government when issuing permits for Incidental Take (due to forestry operations).
- Establishing an explicit structure and grant-making process to deliver money from the BITH Fund to conservation partners on Hispaniola
- Ensuring balanced representation on the BITH Fund's Advisory Committee from both the Dominican Republic and Haiti.
- Working closely with a forthcoming "Sister" BITH Fund (Hispaniolan BITH Fund) in the Dominican Republic to coordinate synergistic fundraising and implementation efforts.
- Assist Dominican partners to secure > $50,000 in the Hispaniolan BITH Fund by the end of 2010 and > $100,000 by the end of 2011.
- Expanding the reach of the BITH Fund to other Caribbean islands.
- Increasing awareness of the BITH Fund among potential donors, grantors and corporations.
- Expanding the use of local, sustainably grown cocoa and coffee products in North America to raise funds and awareness of conservation issues in Hispaniola.

Charles Kerchner

Mid-elevation wet broadleaf forest in Cordillera Septentrional, Dominican Republic

V. Research Actions

Conservation of Bicknell's Thrush is the driving force behind the work of the IBTCG, yet many threats and limiting factors remain poorly understood. While conservation goals will be targeted by specific conservation actions (section IV, above), an important component of conservation of Bicknell's Thrush is to conduct further research on the threats believed to be negatively impacting populations, so that the threats can be addressed by well-informed conservation action in the future. The following research actions have been identified by the IBTCG as priorities within the next five years (2010–2014).

Research Action:
Identify important migratory stopover sites, routes, and patterns.

Conservation Action Informed:
Identify, protect, and manage important migration habitat, especially along the highly developed Atlantic coast

For a migratory animal like Bicknell's Thrush, understanding its full array of threats and how they interact throughout the annual cycle is integral to guide conservation planning. Determination of migratory patterns, stopover ecology, and population connectivity of Bicknell's Thrush between its breeding and wintering grounds has proved an intractable challenge to date. Elucidating how anthropogenic threats (e.g., habitat loss or degradation, climate change) operate in different parts of the species' annual cycle and how they influence population regulation constitutes a pressing conservation need.

Migratory connectivity is defined as the extent of mixing between summer (breeding) and winter (non-breeding) populations, as well as the stop-over and migratory pathways between them (Webster et al. 2002). Although understanding space-use strategies and habitat preferences of Nearctic-Neotropical migratory songbirds has grown substantially over the last 20 years, knowledge of migratory connectivity remains poor (Remsen 2001, Marra and Webster 2005). Many migratory songbirds cross distances of over 5,000 km between breeding and wintering sites, yet the exact timing, pathways followed, and degree of connectivity remain speculative. Information from bird banding has been limited by the scattered and irregular nature of banding returns (Webster et al. 2002). Although stable- hydrogen isotope analyses have yielded latitudinal and altitudinal gradients of habitat occupancy and a first step towards assessing migratory connectivity (Rubenstein et al. 2002), this technique generally provides only coarse resolution.

The critical importance of connectivity to understanding the ecology of migratory birds has spurred a long history of research. Mark-recapture analyses of bird-banding data appear to have been the first and most broadly-used technique to address this issue for songbirds. However, despite the banding of millions of individuals, extremely low recapture rates have limited the technique's utility (Webster et al. 2002). For example, only two Bicknell's Thrushes (Catharus bicknelli) have been recaptured on their Hispaniolan wintering grounds despite the banding of over 3,000 individuals throughout the species' North American breeding range (Rimmer and McFarland 2001, Townsend and Rimmer 2006).


Kent McFarland

Bicknell's Thrush with solar geolocator backpack harness

Understanding the timing and extent of avian population limitation and regulation is complicated for migratory populations that spend different periods of their annual cycle in ecologically disparate regions. The "seasonal interaction hypothesis" was first put forth by Fretwell (1972), who argued that breeding density is determined by winter survival, which in turn is related to events

Table 5.

Summary of research actions, the threat each will address, the conservation actions to be informed, and the ultimate habitat conservation goal to be achieved

Research Action	Threat Addressed	Conservation Action Informed	Habitat Conservation Goal
Identify important migratory stopover sites, routes, and patterns.	*Habitat Loss and Degradation*	**Protection of important migration habitat**	*Protect or manage migration habitat.*
Determine impacts of forestry on demography.	*Habitat Loss and Degradation/Increased Rates of Direct Mortality*	**Development of forestry BMPs for Bicknell's Thrush**	*Protect or manage known and potential breeding habitat.*
Clarify winter distribution and habitat use on islands other than Hispaniola.	*Habitat Loss and Degradation*	**Protection of winter habitat**	*Protect, manage, and restore known and potential winter habitat.*
Assess the effects of calcium depletion.	*Atmospheric Pollution*	**Mitigation of impacts from atmospheric pollution**	*Protect or manage known and potential breeding habitat.*
Predict and monitor effects of climate change.	*Climate Change*	**Mitigation of impacts from climate change**	*Protect or manage known and potential breeding habitat.*
Determine winter survival and demography relative to local habitat condition and quality.	*Other Population Ecology Factors/Habitat Loss and Degradation*	**Protection and restoration of winter habitat**	*Protect, manage, and restore known and potential winter habitat.*

that occur during the breeding cycle. Recent studies of American Redstarts (Setophaga ruticilla) support the seasonal interaction hypothesis (e.g., Marra et al. 1998). In this species, winter habitat quality determined physical condition and timing of spring migration departure, which influenced arrival date and physical condition on the breeding grounds. Subsequent monitoring of redstart breeding demographics revealed a profound interaction between seasons. Robust tests of the seasonal interaction hypothesis such as this require detailed knowledge of migratory connectivity.

Marshall (2001) postulated that loss of Bicknell's Thrush breeding populations at several sites in Nova Scotia was directly related to extensive deforestation of wintering habitat in Haiti, implying strong population connectivity. However, Hobson et al. (2001) used stable isotope analyses of δD and δ13C to investigate patterns suggesting migratory connectivity between breeding and wintering populations of Bicknell's Thrush. They found considerable overlap and high variance in δD values of feathers among all breeding populations sampled, suggesting high natal dispersal, considerable movement of birds among disjunct habitat patches on the breeding grounds, or both. Thrushes sampled on the wintering grounds yielded higher variances in feather δD values than birds sampled on breeding areas of similar size, suggesting that different breeding populations mix in winter.

Rimmer et al. (2001) summarized the scant data on spring and fall migratory routes of Bicknell's Thrush; many gaps in knowledge remain. Further, little information exists on timing of departure from the wintering grounds, rates of spring or fall migration, the existence of stopover sites, or stopover ecology itself. To better understand migratory patterns and ecology of Bicknell's Thrush, as well

as breeding-winter population connectivity, the following research activities are recommended:

Attach solar geolocators to birds of different age and sex cohorts from discrete regions across the breeding and winter range. Engineers at the British Antarctic Survey recently developed a miniature daylight level data recorder (geolocator) for tracking animals over long periods of time (Afanasyev 2004, see http://www.antarctica.ac.uk/bas_research/instruments/instrument7.php e). These devices, weighing as little as 1.2 g, can be attached to birds by methods similar to long-standing VHF radio-transmitters used in radio-tracking songbirds over short distances and durations. These loggers take consistent readings of daylight timing for up to two years. Recovered data are then interpreted to determine latitude and longitude of the individual bird for every day the logger was attached and exposed to suitable sunlight. Geolocators have returned highly accurate and detailed location information on large pelagic birds (e.g., Phillips et al. 2007, Takahashi et al. 2008), and their utility for small migrating songbirds has recently been demonstrated with Wood Thrush (Hylocichla mustelina) and Purple Martin (Progne subis) using new miniaturized designs (Stutchbury et al. 2009). One limitation of this technology is that tags must be retrieved before data are acquired, and their current cost may prohibit broad-scale deployment and large sample sizes. Despite these constraints, geolocator tags present an unparalleled opportunity to discover how distant breeding and non-breeding areas connect in space and time. A preliminary rangewide study in 2009 resulted in the attachment of 71 geolocators to adult male Bicknell's Thrushes (22 in New York, 15 in Vermont, 25 in Québec, 5 in New Brunswick, 4 in Nova Scotia).

Conduct intensive sampling efforts along migratory pathways indicated by geolocator studies to identify specific stopover sites that may support concentrations of individuals and/or are used consistently across years.

Investigate demography, habitat use, length-of-stay, diet, and physiological condition of individuals at any identified key stopover sites.

Implement standardized banding protocols, including non-invasive tissue sampling, and establish a coordinated database for the Bicknell's/Gray-cheeked Thrush complex at migration banding stations in eastern North America.

Kent McFarland

Banding studies yield important data on Bicknell's Thrush population biology and ecology.

Research Action:
Determine impacts of forestry on demography.

Conservation Action Informed:
Development of best management practices for the industrial highland forests, including the pattern, amount, timing, and landscape configuration of silvicultural treatments that are likely to sustain local Bicknell's Thrush populations.

Nixon et al. (2001), Gardiner (2005), and Chisholm and Leonard (2008) documented Bicknell's Thrush in regenerating clear cuts in New Brunswick. Chisholm and Leonard (2008) found the species to be less abundant in stands immediately following thinning, while Gardiner (2005) found some (albeit non-significant) evidence for an increase in abundance 9–20 years after thinning. McKinnon (2009) documented the first evidence of confirmed breeding in managed NB forests; Bicknell's Thrush nests were located in unthinned and strip-thinned patches, although sample sizes were too small to document any impact of PCT on productivity. Bicknell's Thrush continue to inhabit forest stands in the years following thinning (Chisholm and Leonard 2008, McKinnon 2009, Y. Aubry unpubl. data), but relatively little is known about the birds' use of these stands, including whether they contain nests or are used only for foraging, or whether they constitute high- or low-quality habitat. Current knowledge, while limited, suggests that the long-term impacts (up to 20 years) of PCT on breeding habitat are negative. The availability of suitable unthinned habitat, both nearby and more broadly across the landscape, likely drives the use of unthinned habitat, probably for activities not directly related to breeding (Y. Aubry, CWS/SCF, pers. comm.) Research on how forestry practices affect spatial use patterns of Bicknell's Thrush in industrial highlands should include the following actions:

- Create a GIS model(s) of historic and currently

available habitat across the industrial highland forest landscape. This could be done in conjunction with the habitat supply analysis detailed under Conservation Actions above, and may guide the setting of a target population/habitat goal.

- Conduct a large-scale, landscape-based study of habitat use and home range size in managed forest. This would: a) provide information on birds' activity budgets and (ideally) nesting habits and success within stands of varying ages and silvicultural treatments (pre-thinned, recently thinned, post-thinned, unthinned); and b) allow for an assessment of the landscape-level impacts of PCT and clear cutting on Bicknell's Thrush populations, which would in turn guide the development of best management practices and habitat supply.
- Continue demographic studies of banded populations at several sites over at least five years to determine survivorship and site fidelity in intensively-managed forests; relate findings to stand characteristics and forest management practices such as PCT.
- Refine the current draft Bicknell's Thrush habitat model (Vermont Center for Ecostudies 2009) by incorporating forest composition parameters, including, ultimately, forest management regimes.
- Analyze current research results investigating the impacts of thinning on Bicknell's Thrush productivity.
- Determine how Bicknell's Thrush uses small, isolated, and residual unthinned patches within larger thinned stands.
- Determine the minimal patch size required to retain breeding Bicknell's Thrush (assessed by aural surveys before and after harvest) in a harvested landscape.
- Conduct a retrospective analysis to determine if habitat harvested 30 or more years ago has regenerated to pre-harvest composition and structure, and assess use by Bicknell's Thrush by surveys and habitat assessment based on known vegetation associations.

Research Action:
Clarify winter distribution and habitat use on islands other than Hispaniola.

Conservation Action Informed:
Protection and management of winter habitat.

A clear understanding of the distribution of Bicknell's Thrush and its habitat requirements throughout the Greater Antilles is crucial to prioritize and direct conservation planning. This addresses winter habitat loss and degradation, and is needed to accurately evaluate the occurrence of Bicknell's Thrush outside Hispaniola. The current working assumption of the IBTCG is that the majority of Bicknell's Thrush habitat (and thus wintering individuals), occurs on Hispaniola. If Bicknell's Thrush is found to be more widely distributed and abundant on other Greater Antillean islands than is currently known, this may justify redirecting conservation efforts.

Implementation of the following actions will provide the necessary information to develop spatially explicit distribution maps for each island, assess the protected status of occupied and potential habitat, and refine island population estimates:

- Establish standardized protocols to monitor occupancy/use by Bicknell's Thrush (and other species)
- Assess specific habitat requirements of Bicknell's Thrush throughout the Greater Antilles and determine relative importance of different habitat types to overall viability of wintering populations.
- Conduct focused surveys on other islands, including: southeastern Cuba (Sierra Maestra and other potential areas), Jamaica (Blue and John Crow Mountains), Puerto Rico, Vieques, and others (if results of geolocator studies indicate that winter distribution extends beyond the Greater Antilles).
- Use known occurrences and remote sensing data to identify potential Bicknell's Thrush habitat on each island, generate island-specific population estimates, and assess habitat protection and restoration needs.

Research Action:
Assess the effects of calcium depletion on Bicknell's Thrush.

Conservation Action Informed:
Develop and implement policies aimed at reducing acid deposition and habitat management actions to counteract impacts of calcium depletion.

During the past 50 years, acid deposition has accelerated the loss of large amounts of available calcium from soil at acid-sensitive areas in the northeastern U.S. Calcium depletion has been documented at more than a dozen

study sites throughout the region, including sites in the Adirondacks, the Green Mountains, the White Mountains, and in Maine (Driscoll et al. 2001). Depletion occurs when base cations (such as calcium and magnesium) are displaced from the soil by acid deposition at a rate faster than they can be replenished by the slow breakdown of parent material (i.e., underlying bedrock) or deposition from the atmosphere.

Despite the U.S. federal government's 1990 passage of the Clean Air Act Amendments, recent research in the northeastern U.S. demonstrates that the effects of acid deposition are pervasive (Driscoll et al. 2001), with effects more complex than those initially identified in the early 1970s. Scientists now know that acids and acidifying compounds move through soil, vegetation, and surface waters, setting off a cascade of adverse ecological effects (Likens et al. 1998). These may directly and indirectly impact Bicknell's Thrush. Recent studies from northern Europe have found that passerines breeding in acidified areas may be unable to obtain sufficient calcium for eggshell production, due to declines of land snails (Mand et al. 2000, Graveland and Drent 1997). Land snails rely on calcium in leaf litter and living vegetation, and this has decreased due to the leaching effects of acid deposition.

Acid deposition has been shown to directly impact Bicknell's Thrush habitat. Since the 1960s, significant growth declines and increased winter injury to red spruce have been observed throughout much of its range (Eager and Adams 1992). Recent research suggests that red spruce decline is linked to the leaching of calcium from cell membranes in needles by acid rain, mist, and fog (DeHayes et al. 1990, 1999). The loss of calcium in needles reduces their tolerance to low temperatures and increases the occurrence of winter injury and subsequent tree damage or death. This phenomenon also impacts balsam fir needles, although it rarely causes damage because this species has a higher freeze tolerance than red spruce.

Acid deposition and associated calcium depletion have been linked with population declines of Wood Thrush (Hylocichla mustelina; Hames et al. 2002) and may pose a potential threat to Bicknell's Thrush (Rimmer et al. 2001). To better understand the significance of this threat, we propose to implement studies that investigate the effect of calcium depletion on Bicknell's Thrush and its habitat through one or several of the following approaches at the individual, population, and landscape levels:

- Experimental supplementation of calcium in the diet of individual females.
- Comparison of reproductive parameters at calcium-poor and calcium-rich sites.
- Terrestrial liming (to reduce acidity) using a before–after, control–impact study design.
- Examination of calcium depletion across the entire breeding range of Bicknell's Thrush through GIS modeling, and comparison of data with results from standardized monitoring programs.

Research Action:
Predict and monitor effects of climate change.

Conservation Action Informed:
Develop and implement policies aimed at reducing and mitigating impacts of climate change, particularly in regard to Bicknell's Thrush habitat.

Climate change has the potential to affect a variety of environmental and ecological parameters that determine Bicknell's Thrush population viability, including distribution of vegetation (Iverson et al. 2008), timing of spring prey emergence (e.g., Sillett et al. 2000, Sanz et al. 2003, Both et al. 2006), timing of predator population cycles (e.g., McCarty 2001), location of favorable climatic envelopes (Hilbert et al. 2004), and occurrence of competing species (Wormworth and Mallon 2006).

The most significant potential change may be upslope migration of breeding habitat. Because the extent of Bicknell's Thrush breeding habitat is primarily controlled by climate, projected warming has the potential to alter the species' distribution and abundance (Rodenhouse et al. 2008). Changes in vegetation communities along elevational gradients in the Northeast are strongly influenced by temperature (Spear 1989, Botkin et al. 1972). Air heat sums form a near-perfect linear relationship with elevation in the northern Appalachian region (Richardson et al. 2004), and mean July temperature correlates well with forest ecotones throughout the Appalachian Mountains (Cogbill and White 1991). Mean growing season temperature (May-September) was the highest ranked of 36 climatic, soil, elevation, and land-use variables in an assessment of balsam fir importance values in forest inventory plots across the region (Iverson et al. 2008).

Warmer growing seasons could gradually elevate forest ecotones and confine high elevation plant and animal communities to progressively higher, smaller, and more isolated patches. An upward shift in the lower spruce-fir

ecotone may be underway on northeastern U.S. mountains (Hamburg and Cogbill 1988, Beckage et al. 2008), where warming enables northern hardwoods to encroach on red spruce and balsam fir (Lee et al. 2005, Beckage et al. 2008). Such ecotone shifts have occurred in the past. Pollen and macrofossils from a high elevation lake on Mt. Washington, NH provide evidence that treeline moved upslope during warming about 3,500 years ago, possibly as high as 1700 m (Spear 1989; Miller and Spear 1999). Neoglacial cooling began in the White Mountains about 2,500 years ago, lowering treeline to present levels (Miller and Spear 1999).

A recent modeling simulation of the effects of increasing regional temperatures on distribution of montane fir forests in the U.S. showed that warming of as little as 1°C will reduce potential Bicknell's Thrush habitat by more than half, while an increase of 2°C may eliminate all breeding sites from the Catskill Mountains of New York and most of Vermont (Rodenhouse et al. 2008). A 3°C increase in growing season temperatures has the potential to eliminate nearly all Bicknell's Thrush habitat in the Northeast. Summer temperatures are projected to rise on average by 2.8 °C under a lower-emissions scenario and 5.9 °C under a higher-emission scenario by the end of the century (Union of Concerned Scientists 2006).

Rising treelines worldwide (Kullman 2001) suggest that the spatial location of ecotones delimiting spruce-fir habitat can shift measurably within decades; however, the precise amount of warming required to shift ecotones is subject to debate (Spear 1989), and it is highly likely that ecotonal shifts will lag at least decades behind climate changes (Kullman 2001). Lag times may be as long as centuries (Woodward 1992) or span decades (Beckage et al. 2008). Such lags occur due to slowly changing soil characteristics, interactions among tree species and the disturbance required for one forest type to replace an adjacent one under variable climate conditions (Hamburg and Cogbill 1988). The Bicknell's Thrush model projects the amount of habitat that will remain after habitat changes have reached equilibrium with climate changes. The temperature envelope approach should be interpreted to present the range of possible changes in Bicknell's Thrush habitat.

Upslope encroachment of northern hardwoods has already been documented in Vermont's northern Green Mountains, where Beckage et al. (2008) reported an upward shift of 91-119 m in the northern hardwood-boreal forest ecotone at two high-elevation sites over the last 40 years. In the northern, less mountainous portion of Bicknell's Thrush breeding range, the spruce-fir habitat may be more likely to move northward. Northward expansion of ranges in response to warmer temperatures has been widely documented in birds (Hitch and Leberg 2007, Thomas and Lennon 1999), as well as in other taxa (Parmesan and Yohe 2003, Hickling et al. 2006).

The areal extent of Bicknell's Thrush habitat will decline over time with predicted increases in growing season temperatures. Rather than focusing solely on monitoring the effects of climate change over time, we propose to examine the adaptability of Bicknell's Thrush to predicted ecological changes, and ultimately to guide planning to mitigate those changes, through the following research projects:

- Improve understanding of the underlying environmental and ecological factors that determine the species' current breeding distribution and how it may be altered by climate change.
  a. Test the assumption that Bicknell's Thrush distribution will continue to be determined by mean July temperature, latitude, longitude, and elevation as temperatures increase.
  b. Identify and compare the climatic envelopes of regional Bicknell's Thrush populations and track their stability over time.
- Examine the ability of Bicknell's Thrush to cope with increasingly adverse conditions through stress-based research involving natural experiments.
  a. Collect and compare demographic metrics, such as chick weight and nest success, in years with different weather conditions.
  b. Determine major prey items throughout the breeding season and predict both phenological and abundance changes in relation to climate and weather patterns.
  c. Monitor prey abundance, phenological changes, and avian reproductive success in relation to differing weather conditions.
  d. Monitor changes in the frequency and abundance of conifer cone crop cycles, associated red squirrel population fluctuations, and avian nesting success.
  e. Examine habitat characteristics in areas with documented colonizations and extinctions to create predictive models. Numerous local Bicknell's Thrush extirpations have been documented, mainly from sites at the periphery of the species' breeding range (Rimmer et al. 2001). The species' core U.S. range, however, appears to have remained stable overall, as

Bicknell's Thrush was confirmed on 63 of 73 historic (pre-1992) breeding sites surveyed in 1992–1995 (Atwood et al. 1996).

f. Develop demographic models for Bicknell's Thrush using existing data from long-term breeding and wintering studies and the results of climate change-related field studies to assess potential impacts on population growth rates.

g. Conduct food supplementation experiments (e.g., timing and abundance) to investigate sensitivity of breeding Bicknell's Thrush to simulated changes in food supply.

- Examine adaptive traits of Bicknell's Thrush in different elevational and climatic zones.
  a. Document food availability along elevational, weather, and climate gradients.
  b. Determine if adaptive differences exist in phenotypic populations or among individuals at different elevations.
  c. Investigate the potential for interspecific interactions (competition) among co occurring Catharus species.
- Re-survey elevational transects completed in 1973 and 1974 (Able and Noon 1976) and repeated by the U. S. Forest Service Northeast Research Station in the 1990s (unpub. data).
  a. Track altitudinal shifts in bird communities.
  b. Establish georeferenced, long-term monitoring sites for future replication.
  c. Create a predictive model for bird community composition, elevation and vegetation that can be tested and modified with each repeat census.
- Establish georeferenced, long-term sites to monitor changes in bird populations and habitat (vegetation composition and structure).

Research Action:

Document overwinter survival and demography relative to local habitat condition and quality.

Conservation Action Informed:

Protect, restore, and manage key winter habitat for both male and female Bicknell's Thrush in order to improve their survivorship and overwinter condition.

A basic understanding of survivorship and demographics in all phases of a species' annual cycle is necessary to develop scientifically-sound conservation plans. Improving our knowledge of the degree of migratory connectivity (Webster and Marra 2002) between known breeding and wintering sites can help to appropriately direct conservation action where it would be most effective. If for example, Bicknell's Thrush show strong connectivity between specific breeding and wintering areas, this may indicate less population mixing and greater conservation risk to these populations or the species as a whole. An enhanced understanding of migratory connectivity may help to direct IBTCG's habitat protection and restoration efforts.

Mapping migratory connections may also allow us to determine how the effects of events in one season carry over to subsequent seasons, e.g., how survivorship and fitness are impacted by winter habitat quality. Population dynamics for migratory birds are greatly influenced not just by breeding success (fecundity), but also by overwinter survival and demographics (Marra and Holmes 2001). A seasonal carry-over effect was demonstrated in another neotropical migrant species, American Redstart (Setophaga ruticilla). Norris et al. (2004) found a reduction in the number of young fledged by redstarts occupying poor-quality wintering habitat, which arrived at the breeding ground later and in poorer condition. The highly skewed sex ratio of Bicknell's Thrush (>2 males: 1 female; Townsend et al. 2009a) may be linked to sexual habitat selection and supports the need for more in-depth demographic studies on the wintering grounds. More than 15 species of migratory songbirds have been reported to show sexual habitat segregation (Runge and Marra 2005).

Current knowledge based on feather isotope analyses indicates high natal dispersal and mixing of breeding populations on the wintering grounds (Hobson et al. 2001). It has been suggested that the majority of birds sampled in the Dominican Republic's Sierra de Bahoruco may breed in central Québec and the Canadian Maritimes (Hobson et al. 2004). Current work in eastern Canada, Vermont, and New Hampshire is using stable isotopes to determine the non-breeding source populations for these breeding areas.

Research priorities include:

- Use stable isotope analysis to determine the effects of winter habitat quality on breeding arrival condition and survivorship in the Canadian Maritimes, New Hampshire, Vermont, and other areas of the breeding range.

- Examine within-season effects of habitat quality on physiological condition of overwintering Bicknell's Thrush.
- Determine the extent to which over-winter factors, such as habitat segregation by sex and age, may result in disproportionately limited female survival.
- Examine the ecology and demographics of Bicknell's Thrush occurring in low densities in habitat types that have received less research attention to date (e.g., low elevation, coastal wet forests).
- Examine survivorship of sex and age classes at sites in both high- and low-elevation wet forests.
- Continue to monitor arthropod and fruit abundance at high- and low-elevation sites to detect any differences in food resource availability to wintering thrushes.
- Analyze stable carbon and nitrogen isotopes in blood samples to determine dietary differences between low- and high-elevation wintering thrushes.

Patrick Johnson

International partnerships will be crucial to achieve lasting conservation of Bicknell's Thrush and its habitats

VI. Evaluating Accomplishments

This Plan provides an adaptive framework to guide Bicknell's Thrush conservation efforts and is intended to be updated on a regular basis. As goals are achieved and information gaps filled, results will be used to refine this Plan and develop increasingly effective strategies to increase the population size of Bicknell's Thrush.

Evaluating progress toward the IBTCG's overall population goal, to increase populations of Bicknell's Thrush by 25% over 50 years with no net loss of distribution, will depend on a rigorous, range-wide monitoring program that will allow estimation of breeding population size and trends at multiple geographic scales. Mountain Birdwatch 2.0 (MBW 2.0) is a peer-reviewed, statistically rigorous, field-tested survey program based on three years of planning by VCE, BSC/EOC, CWS/SCF, USFWS, and the WMNF. This survey program is designed to be implemented on the breeding grounds, where it is currently most feasible to monitor Bicknell's Thrush. Breeding birds frequently vocalize (and are thus easily detected by aural surveys), and there is greater capacity to conduct a large-scale, volunteer-based monitoring program on the breeding grounds. Hart and Lambert (2008) describe the goals, objectives, and survey protocol for MBW 2.0; details are summarized at http://www.vtecostudies.org/MBW/MBW2.html. MBW 2.0 must be implemented annually across the breeding range on a long-term basis so that population status and trends, as well as the species' responses to environmental changes, can be monitored at international, national and regional scales. Specifically, implementation of MBW 2.0 will allow the IBTCG to:

- Document changes in the breeding distribution of Bicknell's Thrush over time.
- Estimate an overall population trend, with 80% power to detect a minimum 3% annual change in abundance/density over 50 years.
- Document changes in occupancy of breeding sites through estimates of site colonization and extinction rates.
- Estimate regional population trends.
- Relate data on Bicknell's Thrush population trends and demographics to potential threats.

A parallel need exists to establish standardized protocols to monitor occupancy and habitat use by Bicknell's Thrush (and other species) in wintering areas over time, in order to guide and evaluate the success of restoration projects. Monitoring trends of wintering Bicknell's Thrush populations would also be useful to assess the species' status in different parts of its winter range and to evaluate conservation actions being implemented in different countries.

Table 6 summarizes the actions described in this Plan and lists the IBTCG subgroups with primary responsibility for their implementation. The IBTCG will meet formally at least once annually to track progress on priority actions, discuss funding needs, and revise this Plan as appropriate. Research will lead to new conservation actions that can directly address threats and limiting factors. Research updates and progress toward attaining conservation goals will be documented on the IBTCG website on an annual basis. The Plan will be reviewed and updated at least every five years. Progress toward implementing conservation, research, and monitoring actions will be assessed using a variety of metrics identified in Table 6.

In order to obtain statistically robust measures of population and habitat increases, it is likely that more than five years of data collection and analyses will be required. However, preliminary results will allow us to evaluate the trajectory of progress toward reaching our goals and adjust actions as necessary.

Every effort will be made to ensure that emerging information is used to inform groups working to conserve Bicknell's Thrush throughout the species' migratory range, and to strengthen links between these groups. Peer-reviewed publication of research and monitoring results will be encouraged as an important means to guide science-based conservation planning, management, and policy.

Table 6.

Summary of conservation, research, and monitoring actions, the IBTCG subgroups primarily responsible for their implementation, and metrics that will be used to evaluate success of each identified action. Acronyms listed in Appendix A

Conservation, Research, and Monitoring Actions	IBTCG Subgroup Responsible For Implementation	Evaluation Metrics And Targets
Partner with timber companies and management agencies to develop and implement Best Management Practices (BMPs) for Bicknell's Thrush.	*Forestry*	1. Number of BMPs developed for harvesting and pre-commercial thinning (target = 5) 2. Number of forestry companies and land managers operating on BITH habitat in QC, NB, NS and ME with whom BMPs are shared (target = 100% by 2012) 3. Proportion of industrial forest lands within the BITH habitat model on which BMPs are applied (target = 80% by 2015)
Maintain a target amount of Bicknell's Thrush habitat in industrial forests.	*Forestry*	Target population goals (number of birds) for industrial forest (by jurisdiction) - set by 2011 and reached by 2015
Improve protection of winter habitat in currently protected areas.	*Wintering Grounds*	1. Number of protected areas with demonstrably enhanced infrastructure and patrols. 2. Number of parks with enforcement of bans on illegal activities (e.g., agriculture, logging, charcoal production). 3. Number of protected areas with clear demarcation of boundaries, including GIS coverage and physical signage.
Expand Bicknell's Thrush Habitat Protection Funds.	*Wintering Grounds*	1. Increase both Funds to a minimum $50K by end of 2010 and $100K by end of 2011. 2. Establish an explicit grant-making process for the Funds. 3. Issue a minimum of one grant to a Hispaniolan conservation partner in 2011 and a minimum of two grants in 2012.
Develop winter habitat management plans and secure implementation funding.	*Wintering Grounds*	1. Identify all protected areas with BITH habitat and communicate with responsible agency/NGO to develop or review management plans. 2. Number of individual protected area plans with explicit documentation of known status of BITH and other priority species. 3. Number of explicit needs assessments and management plans with identified funding needs. 4. Amount of funding secured to implement formal management plans.

Conservation, Research, and Monitoring Actions	IBTCG Subgroup Responsible For Implementation	Evaluation Metrics And Targets
Pilot winter habitat restoration projects.	*Wintering Grounds*	1. Spatially explicit identification and mapping of degraded habitats within individual protected areas. 2. Identification of plant species appropriate for restoration; development of specific protocols. 3. Number of pilot restoration plots established, using local people to plant, caretake and monitor plots.
Develop strong links with Caribbean partners.	*Wintering Grounds*	1. Hold fall 2010 IBTCG meeting in DR; plan future meeting for Haiti. 2. Secure funding for 3 Caribbean nationals outside Hispaniola to attend 2010 meeting in DR and 2011 meeting in North America. 3. Add at least 1 Cuban, 1 Jamaican, 1 Puerto Rican to IBTCG by end of 2010.
Identify important migratory stopover sites, routes, and patterns.	*Breeding and Migration Research*	1. Number and location of routes and stop-overs identified via geolocators recovered from 2009 and 2010 field studies. 2. Development of new studies deploying geolocators. 3. Publication and other dissemination of geolocator results 4. Development of demographic and ecological research at identified stop-over sites
Determine impacts of forestry on demography.	*Forestry/ Breeding and Migration Research*	Completion of a research project to quantify relationship between forest stand type (early regeneration, pre-thinning, post-thinning, pre-harvest) and BITH productivity
Clarify winter distribution and habitat use on islands other than Hispaniola.	*Wintering Grounds*	1. Implement targeted surveys on Cuba during 2011, expand to Jamaica and Puerto Rico by 2013 2. Formally assess BITH conservation needs on other islands; work with local conservation groups to develop conservation strategies.
Assess the effects of calcium depletion.	*Breeding and Migration Research*	Initiate or refine research on: 1. Dietary calcium supplementation in individual BITH females. 2. Comparing reproductive parameters at calcium-poor and calcium-rich sites. 3. Terrestrial liming using a before–after, control–impact study design. 4) Calcium depletion across the entire breeding range of BITH through GIS modeling, and comparison of data with results from standardized monitoring programs.

Conservation, Research, and Monitoring Actions	IBTCG Subgroup Responsible For Implementation	Evaluation Metrics And Targets
Predict and monitor effects of climate change.	*Breeding and Migration Research/ Monitoring*	Initiate or refine research on: 1) Underlying environmental and ecological factors determining BITH breeding distribution and how it may be altered by climate change. 2. The ability of BITH to cope with increasingly adverse conditions through stress-based research involving natural experiments. 3. Adaptive traits of BITH in different elevational and climatic zones . 4. Resurvey elevational transects completed in 1973, 1974, and the 1990s. 5. Establish georeferenced, long-term sites to monitor changes in bird populations and habitat
Determine winter survival and demography relative to local habitat condition and quality.	*Wintering Grounds*	Conduct habitat-specific survivorship analyses. If current sample sizes deemed insufficient, design studies to achieve this goal.
Document changes in the distribution of Bicknell's Thrush over time.	*Monitoring*	1. Produce site-specific occurrence information that can be aggregated to map the breeding distribution. 2. Assess breeding distribution changes at 5-year intervals. 3. Utilize spatial analysis of available habitat (MaxEnt) to determine winter vs. summer spatial limitations
Estimate global and regional population trends.	*Monitoring*	1. Produce estimates of BITH density and abundance with coefficients of variation (CV) ≤ 0.20. 2. Estimate population trends with 80% power to detect a minimum 3% annual change in target species abundance/density over 30 years at a significance level of 0.1. 3. Maintain a CV about the regression line ≤ 0.40 for each trend estimated over a period 30 years or more.
Document changes in occupancy through estimates of breeding site colonization and extinction rates.	*Monitoring*	1. Produce an overall estimate of occupancy of breeding sites with a 95% confidence interval width ≤ 0.20

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North American montane forests are well-protected overall, but face numerous ecological stressors, including the threat of climate change.

Appendix A: Key To Acronyms

BITH . . . . . Bicknell's Thrush
BMP . . . . . Best Management Practice
BSC/EOC . . . . . Bird Studies Canada-Études d'Oiseaux Canada
CWS/SCF . . . . . Canadian Wildlife Service-Service Canadien de la Faune
DR . . . . . Dominican Republic
GIS . . . . . Geographic Information Systems
IBTCG . . . . . International Bicknell's Thrush Conservation Group
IUCN . . . . . International Union for the Conservation of Nature
ME . . . . . Maine
NB . . . . . New Brunswick
NB DNR . . . . . New Brunswick Department of Natural Resources
NS . . . . . Nova Scotia
PCT . . . . . Precommercial Thinning
QC . . . . . Québec
SUNY ESF . . . . . State University of New York College of Environmental Studies and Forestry
UNB . . . . . University of New Brunswick
USFWS . . . . . United States Fish and Wildlife Service
VCE . . . . . Vermont Center for Ecostudies
WMNF . . . . . White Mountain National Forest

International
Bicknell's Thrush
Conservation Group