# High Elevation Landbird Program

## 2002 Report

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## Abstract

The High Elevation Landbird Program (HELP) was created by Bird Studies Canada (BSC) in 2002, to examine: 1) population trends of four migratory songbird species breeding at high elevations: Bicknell's Thrush (*Catharus bicknelli*), Fox Sparrow (*Passerella iliaca*), Swainson's Thrush (*C. ustulatus*) and Blackpoll Warbler (*Dendroica striata*); and 2) habitat preferences of the Bicknell's Thrush (a Species of Special Concern) in Atlantic Canada, especially on industrial forest land where the majority of the Atlantic population breeds.

To collect information on population change, trained volunteers and BSC employees surveyed 22 pre-selected routes in Nova Scotia and 45 routes in New Brunswick once between the 4$^{th}$ and 28$^{th}$ of June using a standardized protocol. Each route was 1 km in length, with 5 stops each 250m apart. At each stop, surveyors listened silently for 5 minutes, then played a 30-second playback tape consisting of Bicknell's Thrush songs and calls, finishing with an additional 5 minutes of silent listening. Surveyors kept track of each individual bird heard or seen within the 10-minute survey period, as well as the direction and distance to each bird.

BSC employees re-ran routes where Bicknell's Thrushes were not found during the first run to obtain a more precise indication of presence/absence of Bicknell's Thrush. In July and August, BSC employees measured habitat characteristics at all points where Bicknell's Thrush were detected, as well as at a random selection of points where Bicknell's Thrush were not detected (using only points from routes where no Bicknell's Thrush were detected on either of two runs).

Swainson's Thrush was the most common target species found on survey routes with a frequency of detection of 91% in NB and 82% in NS, and a relative abundance of 11.2 birds per route in NB and 3.55 birds per route in NS. Bicknell's Thrushes were found on about 60% of routes in NS and NB, with a relative abundance of 2.2 birds per route in NB, and 1.09 birds per route in NS. Fox Sparrow and Blackpoll Warbler were found on roughly 50% of routes with relative abundances of about 1 bird per route for both NS and NB.

Given the current number of routes (65), a preliminary power analysis revealed that it will take 30 years of annual surveys to detect a 3% decline in Bicknell's Thrush in New Brunswick and Nova Scotia. However, considering only surveys conducted in New Brunswick, it will take only 20 years of annual surveying to detect the same decline.

Bicknell's Thrush was found at sites with higher density and basal area of balsam fir or spruce compared to sites without Bicknell's Thrush. In NB, Bicknell's Thrush was found at sites that were higher in elevation, had a greater proportion of mossy ground cover, and more dead trees than sites without Bicknell's Thrush. In NS, sites with Bicknell's Thrush had a significantly lower canopy height and lower density of deciduous trees, than sites without Bicknell's Thrush.

The next step is to determine potential impacts of pre-commercial thinning on this species. Stem densities of spruce and fir at sites with Bicknell's Thrush are about 6000 stems/ha in NB and NS. Currently, thinning in NB is known to decrease balsam fir stem density to the range of that found at sites where Bicknell's Thrush are not present (2800 m2/ha), suggesting that thinning may impact this species' population. An indepth study of Bicknell's Thrush breeding biology on industrial forest land (planned for 2003) could better define the impact of thinning.

## Introduction

High elevation habitat is threatened by climate change (with serious declines in Red Spruce forecasted over the next century), forestry, ski-area development and possibly acidic deposition and heavy metal toxicity in eastern North America (reviewed in Lambert et al. 2002). Furthermore, relatively few birders and ornithologists visit this habitat type, leading to a lack of information on birds of high elevations.

One of the most interesting of Atlantic Canada's high elevation songbirds is the Bicknell's Thrush (*Catharus bicknelli*). The Bicknell's Thrush is one of the rarest songbirds in North America, with an estimated continental population of no more than 25,000 pairs (Rimmer et al. 2001). It is listed as a species of "High responsibility, High Concern" by Partners in Flight Canada (Downes et al. 2000), as a "Species of Special Concern" by the Committee on the Status of Endangered Wildlife In Canada (COSEWIC), as provincially "Vulnerable" by the Nova Scotia Department of Natural Resources and as "Globally Vulnerable" by the International Union for Conservation of Nature and Natural Resources (Stattersfield and Capper 2000). These designations are largely due to the species' fragmented population distribution, limited breeding range and lack of information about the species' population status and breeding biology because of its shy habits, remote breeding habitat, and recent designation as a full species (Ouellet 1992, American Ornithologists' Union 1995).

The breeding range of the Bicknell's Thrush is small for a migratory songbird, encompassing southern New York and New England, Nova Scotia, New Brunswick and Quebec. Within this range, the Bicknell's Thrush appears to be found primarily in high elevation areas (with the exception of several coastal areas at the tip of the Gaspe Peninsula, QC and Scaterie Island, NS), and even then only in small, scattered populations. In the US, Vermont's *Mountain Birdwatch* program reports local extirpations of Bicknell's Thrush from some high elevation areas in southern New Hampshire, southern Vermont, and western Massachusetts (Atwood et al. 1996, Lambert et al. 2002). Within Canada, reports of Bicknell's Thrush in some areas have also decreased; for example, within recent years in Nova Scotia, sightings of Bicknell's Thrush have been limited to northern sections of Cape Breton Island, although this species was once found in some coastal areas where the vegetation mimicked that of higher elevations due to the intense wind and harsh weather (Erskine 1992).

In Canada, Bicknell's Thrush inhabit montane fir (Ouellet 1993), maritime spruce-fir (Erskine 1992), and regenerating mixed forest (Nixon 1998, Seutin and Aubry 2000). In regenerating mixed coniferous forest, very little is known about the breeding behaviour or success of the Bicknell's Thrush, although research has shown that the species appears to inhabit only a specific range of age classes (e.g. about 10-15 years after clearcutting; Seutin and Aubry 2000, Nixon et al. 2001). Research in Quebec has also shown that birds are breeding successfully in this habitat type (Seutin and Aubry 2000), although questions remain about the impact of pre-commercial thinning on habitat use by Bicknell's Thrush. For example, while Bicknell's Thrushes in Quebec seem to be

occupying thinned habitat about 10 years after treatment (Seutin and Aubry 2000), whether they are breeding successfully in thinned stands remains to be determined.

While the Bicknell's Thrush is the least well-known of eastern Canada's high elevation landbirds, other species breeding at high elevations (e.g. Blackpoll Warblers, Fox Sparrows) are similarly threatened by habitat loss. Furthermore, many high elevation species are not well-surveyed by existing bird monitoring programs such as the Breeding Bird Survey.

In 2001, Bird Studies Canada initiated a preliminary study of high elevation landbirds (Bicknell's Thrush, Blackpoll Warbler, Fox Sparrow and Swainson's Thrush) in Nova Scotia, the goal of which was to develop a protocol for monitoring these species. While the Swainson's Thrush is not restricted to high elevation habitats, it is thought to possibly compete with Bicknell's Thrush for available habitat and is thus considered an important aspect of the survey. Factors which may influence monitoring success, including time of day, length of survey and response to playback, were examined (Whittam and Ball 2002) and a survey protocol was developed for the resulting High Elevation Landbird Program (H.E.L.P.).

Using the information provided from the preliminary study, we developed HELP in the hopes that it would become a successful volunteer-driven monitoring program for Bicknell's Thrush and other high-elevation bird species in Canada, similar to the *Mountain Birdwatch* program developed by the Vermont Institute of Natural Sciences (VINS 2001). Because much of the Bicknell's Thrush population (especially in New Brunswick) is found on industrial forest lands, we hoped to involve forestry companies in the monitoring program as much as possible. Due to limited funds and personnel, our surveys were restricted to New Brunswick and Nova Scotia in 2002. This report outlines the results from the first year of surveys and discusses what we need to continue the program in the future. The goals of our first year were to:

1. Complete the first year of monitoring of high-elevation landbirds in Nova Scotia and New Brunswick, using volunteers to as great an extent as possible;
2. Gather information on habitat characteristics of sites used by Bicknell's Thrush in this region, in order to better understand habitat use by this species.

## Methods

*Volunteer Recruitment and Training Workshops*

Volunteers were approached through the NB and NS nature listservs, forestry companies (Fraser/Nexfor Paper Inc., Bowater Forestry Inc., Stora-Enso Inc.), the Eskasoni Fish and Wildlife Commission, Parks Canada, the New Brunswick Department of Natural Resources and Energy, and word-of-mouth. The forestry companies and the Eskasoni Commission sponsored a total of three training sessions for interested employees and/or local naturalists. Each workshop included a 20-minute presentation

on Bird Studies Canada's programs, with emphasis on HELP, including background on the Bicknell's Thrush and instructions for running survey routes. After the presentation, volunteers were trained to identify the focal HELP bird species by vocalization, followed by a quiz (provided by the Vermont Mountain Birdwatch program). All volunteers were provided with an instruction manual, data sheets, a map of their route and a tape for training and playback.

The three workshops were held at: Eskasoni NS (hosted by the Eskasoni Fish and Wildlife Commission on May 23/02), Edmundston NB (hosted by Fraser on May 30/02), and Dalhousie NB (hosted by Bowater on June 4/02). The Nova Scotia workshop included 13 people consisting of employees from the Eskasoni Fish and Wildlife Service, Stora Enso, and Cape Breton Highlands National Park. The Edmundston workshop included 12 people from Fraser Nexfor Paper and local birdwatchers. The Dalhousie workshop included 14 people from Bowater Paper Inc. as well as local birdwatchers.

*Site Selection, Route Placement and Coverage*

Site selection in Nova Scotia was based on a GIS model, developed by Joe Pomeroy (Environment Canada), which used previously collected presence/absence data for Bicknell's Thrush (D. Busby unpubl. data), extracted the elevation and habitat types (using land use models) associated with these areas, and then searched Nova Scotia for all areas containing similar elevation and habitat type (see Pomeroy et al. 2002).

Site selection in New Brunswick was based on Forest Inventory maps from the New Brunswick Department of Natural Resources and Energy (NB-DNRE), as well as maps provided by Nexfor Paper and Bowater Paper indicating elevation and habitat-type. All forest stands having an elevation of 350m or greater and vegetation type of at least 50% conifers were considered areas of potential habitat. We were unable to cover all such potential areas in NB during the initial year of study; as a result, we limited our coverage to Mount Carleton Provincial Park, the Christmas Mountains, the Naturalist Mountains, and the highlands of Madawaska and Restigouche Counties (see Figure 1).

In both provinces, for sites with appropriate habitat to be included in the survey, they also had to encompass at least 1 km of road or trail accessible by vehicle (preferred) or on foot. If there was more than one available trail in a suitable site, one was randomly chosen.

Surveyors were provided with a map of their selected site with instructions for setting up their route. Surveyors set up the routes by placing 5 stops, 250m apart along the road or trail. After a route was run, volunteers sent in results of the survey along with a detailed description of their route including georeferenced stop locations. If volunteers did not have access to a GPS, we encouraged them to contact us to borrow one.

*Survey Protocol*

Surveys were conducted starting between 1 hour to 30 minutes before sunrise or at sunset on any date between the 4th and 28th of June. Appropriate weather conditions for a survey included a wind level of 4 or less on the Beaufort scale and no more than trace precipitation. Surveyors listened for five minutes, played 30 seconds of standardized playback of Bicknell's Thrush songs and calls, then listened for another five minutes. Observers noted at what time each individual bird was seen and/or heard, whether it was singing and/or calling, and from which distance and direction it was detected. The data form included a "range map" which helped surveyors to mark the approximate position of all individual birds heard or seen in relation to the surveyor's standing point at the center of a 50 m radius.

Data from the first five minutes of the HELP protocol could potentially be directly compared with data collected for Vermont's *Mountain Birdwatch* program*;* in fact, the HELP survey protocol differs from the *Mountain Birdwatch* protocol only in that HELP volunteers conduct playback and an additional five minutes of silent listening (see VINS 2001). *Mountain Birdwatch* surveys are also only conducted in the morning, whereas HELP surveys can be conducted in the morning or the evening.

If no Bicknell's Thrushes were heard on the first run of a survey, interested volunteers were asked to do a follow up survey, and if unable, BSC employees attempted to run these routes a second time. While the information from the second survey run will not be used in the monitoring program, the goal of collecting this information was to better ensure the "absence" of Bicknell's Thrushes from a site, so that habitat data could be more clearly linked to sites where Bicknell's Thrushes were and were not present (see below).

*Habitat Measurements*

We measured habitat from July 5th-12th in New Brunswick and July 24th to 30th in Nova Scotia. We measured habitat at two types of sites: Bicknell's Thrush (BITH) Present, and BITH Absent. BITH Present sites were survey points where one or more Bicknell's Thrushes had been detected within a 75m radius on the first or second run of a route (from Nixon et al. 2001). Bicknell's Thrush Absent sites were selected by randomly choosing one survey point from every route where no Bicknell's Thrushes were found on two survey runs. Survey routes that were run only once but had no Bicknell's Thrushes detected were not measured as we were less sure that Bicknell's Thrushes were not present. At BITH Present sites, we went to the approximate point where the Bicknell's Thrush had been heard singing or calling from (based on the surveyor data sheets and range maps) and used that point as the mid-point of a 50-metre transect. At BITH Absent sites, we choose a transect midpoint by spinning around then throwing a stick as far as possible; the point was placed where the stick fell. This technique followed Connolly (2000) and was similar to that of Nixon et al (2001), who measured habitat 15 paces off the road or trailside.

Habitat measurements described below were based primarily on Connolly (2000).

We measured vegetation density at the midpoint of the 50 m transect by using a checkerboard with 13 alternating black and white 20 cm x 20 cm squares. We held the checkerboard at 5 and 10 m from the midpoint just above the ground in each of the four cardinal directions, and recorded the number of black squares that were more than 50% obscured by vegetative matter.

We counted the number of dead trees and branches found lying on or across the 50 m transect.

The 50 m transect was divided into ten, 5 m sections, five of which were randomly chosen for habitat sampling. Within each 5 m section (which extended 1 m out from the transect to form a 5 x 1 m box), we measured the following: canopy height, sub-canopy height, upper shrub height, lower shrub height (50 cm or higher), % ground cover of ferns, moss, lichens, bare rock, and litter (adding up to 100%), and number of trees with *Usnea* lichen. Also within the 5 x 1 m box, we identified all tree and shrub species over 50 cm in height to genus or species level, and placed them in 4 size categories (measured at diameter at breast height – DBH – or at midpoint where too small): A=0-2.5cm, B=2.5-5cm, C=5-10cm and D=greater than 10cm. We converted all stem data to basal area ($m^2$/ha) and stem density (stems/ha).

We measured elevation and noted the position of each point using a handheld GPS.

*Data Analysis: Distribution and Abundance*

We measured the Frequency of Occurrence and Relative Abundance for each of the four focal species, using data from only the first run of each route. Frequency of Occurrence is defined as the number of routes where the target species was detected divided by the total number of routes surveyed. Relative Abundance is defined as the average number of individuals of the target species found (total individuals/number of routes surveyed). These measures are useful for considering changes in the relative abundance of each species over time, although they are not so good for comparing between species due to the differences in detectability of each species (Lambert et al. 2002).

To determine the power of the survey to detect population changes, we conducted a power analysis with the program MONITOR, using data from this year as well as data from the preliminary study in Nova Scotia (Whittam and Ball 2002) and a previous study in New Brunswick (Nixon et al. 2001). Power analyses generally require a measure of variation from within the same points (i.e. the same surveys measured from year to year); however, since this was the first year of the program, we calculated power using the variation between individual routes. We ran a number of simulations varying the number of routes, the number of runs of a route and the number of years over which the

project would take place. Our goal was to have the ability to detect a 3% decline in the population at 90% power with a significance level of $\alpha = 0.15$ (Eagle et al. 2000).

*Data Analysis: Habitat*

In order to determine general patterns of differences between BITH Present and BITH Absent sites, we used Mann-Whitney U tests to compare habitat variables at sites with and without Bicknell's Thrush. For routes where Bicknell's Thrush were present along multiple points, we measured habitat characteristics at all these points, but then pooled the data from multiple points along the same route. While pooling results may mask some of the natural variation in the system, we felt that this was necessary to equalize the differences in sample sizes between BITH present and BITH absent sites and to avoid problems with pseudoreplication along routes.

## Results

*Routes run*

Volunteers and BSC employees ran 67 routes, 45 in New Brunswick and 22 in Nova Scotia. In New Brunswick, five of the pre-selected routes were not completed, and in Nova Scotia, 13 were not completed due to inaccessibility or inappropriate (i.e. primarily deciduous, non-regenerating) habitat.

A total of 15 volunteers ran 18 routes in 2002; the remaining 49 routes were run by BSC staff. Appendix 1 gives the numbers of each target species found for each route. Bicknell's Thrushes were found on 40 of the 67 routes in the first run. Sixteen of the 27 routes where Bicknell's Thrushes were not detected on the first run were re-run, but no Bicknell's Thrushes were detected on the second run of any of these routes (Appendix 1, "BITH2").

*Distribution and Abundance*

In both NB and NS, Swainson's Thrush was the most common of the 4 focal species, followed by Bicknell's Thrush, Fox Sparrow, and Blackpoll Warbler (see Table 1). While Bicknell's Thrush were detected on close to the same proportion of routes in NB and NS (around 60%), the number of Bicknell's Thrush detected per route was nearly twice as great in NB compared with NS. The same pattern held true for Swainson's Thrush. Blackpoll Warbler and Fox Sparrow showed less dramatic differences between provinces, although both seemed to be slightly more abundant, and detected slightly more often, in Nova Scotia than in New Brunswick.

Figures 1a and 2a show survey routes where Bicknell's Thrushes were and were not detected on the first run in NB and NS, respectively. Figures 1b and 2b show the number of Bicknell's Thrush detected on each of the survey routes in NB and NS, respectively.

*Survey Power*

According to MONITOR, given our current survey protocol and using our hypothetical estimates of variation, it will take only 5 years to see a 3% decline (if present) in the Swainson's Thrush population. However, it will take 10 years to see the same magnitude of decline in Fox Sparrow and Blackpoll Warbler and over 30 years for the Bicknell's Thrush (Tables 2, 3, 4, 5). For Bicknell's Thrush, considering only New Brunswick routes, it would only take 20 years of yearly surveys to detect a 3% decline (Tables 6, 7).

*Habitat*

We measured a total of 53 points in NB, 41 BITH present, and 12 BITH absent, and 24 points in NS, 18 BITH present, and 6 BITH absent. We pooled BITH present data from points located along the same route, yielding a total number of BITH present data points of 21 in NB and 12 in NS. (For BITH absent routes, we randomly chose a single point at which to measure habitat, so that there was never more than one point per route measured).

The most prominent woody plant species at BITH present sites in NB were balsam fir (28% of stems), raspberry spp. (25% of stems) and white birch (18% of stems). In Nova Scotia, Balsam Fir (34% of stems), Spruce spp. (21% of stems), white birch (15% of stems) and sheep laurel (14% of stems) were prominent at BITH present sites.

Table 8 summarizes the habitat results for BITH present and absent sites in NB and NS. In NB, the density and total basal area of balsam fir stems were both significantly higher at BITH present sites compared with BITH absent sites. In NS, the density, basal area and proportion of spruce (red, white and black were combined) stems were all significantly greater for BITH present sites compared with BITH absent sites. There was no difference between BITH present and absent sites in the number, density, or proportion of white birch stems in either NB or NS, although in NB there was a tendency for more white birch stems and higher white birch basal area at BITH present sites, and in NS there was a tendency for more white birch stems and higher white birch basal area at BITH absent sites. Furthermore, in NS, the density and proportion of all deciduous stems were significantly lower at BITH present sites compared with BITH absent sites. In NB, the total number of stems did not differ between BITH present and absent sites, although the basal area of all stems was significantly greater at BITH present sites compared with BITH absent sites. Shrubs in NB were predominantly raspberry (*Rubus* spp.), and smaller numbers of Serviceberry (*Amelanchier* spp.), Mountain Holly (*Nemopanthus mucronatus*) , and Red Elderberry (*Sambucus racemosa*). In NS, while there were no significant differences between BITH present and absent sites in total stem density, BITH present sites tended to have more stems, but less total basal area, than BITH absent sites (although the variation among points was extremely high).

In NB, elevation was significantly higher at BITH present sites (616 ± 18 m) compared with BITH absent sites (513 ± 21 m); there was no significant difference in elevation at BITH present and absent sites in NS, although generally the elevation in NS (mean = 435 ± 22 m) was much lower than that in NB (mean = 580 ± 16 m).

NB had a significantly higher number of dead trees along the transect, and a significantly greater proportion of mossy substrate, at BITH present sites compared with BITH absent sites. NS had significantly lower canopy height at BITH present sites (5.1 ± 1.3 m) compared with BITH absent sites (8.1 ± 0.8 m), although there was no difference in canopy height between BITH present and BITH absent sites in NB (6.7 ± 0.9 m vs 5.8 ± 1.2 m, respectively).

## Discussion

*Distribution and Abundance*

By comparing our results to those obtained in the first two years of the Mountain Birdwatch program, HELP appears to be well-able to detect (and hopefully ultimately monitor) the four target species. It should be kept in mind, however, that protocol differences between the two programs mean that a direct comparison should only be made between the first five minutes of HELP and Mountain Birdwatch; such subsampling of HELP routes should be done in the future to compare data from these two similar programs (see also below under Future Goals).

Bicknell's Thrushes were found on nearly 60% of routes surveyed in both NS and NB. This is considerably higher than the Frequency of Occurrence of Bicknell's Thrushes in New York, Vermont, New Hampshire and Maine as determined by the Mountain BirdWatch program (0.45; Lambert et al. 2002). However, it should be noted that with additional visits, playback, and incidental encounters, Bicknell's Thrushes were detected on a total of 88% of Mountain Birdwatch routes.

The mean number of Bicknell's Thrushes per route was also quite high, at 2.2 in NB, and 1.09 in NS; this converts to 0.44 birds per point in NB, and 0.22 birds per point in NS, compared with 0.24 birds detected per point in the Mountain Birdwatch program (but again, this is not taking into consideration protocol differences between the two surveys). It appears as though NB may have relatively large densities of Bicknell's Thrushes, although the goal of HELP is to monitor trends in the population rather than attempt to calculate population density at any one site (partly because density is known to be difficult to estimate for this species because male Bicknell's Thrushes are known to have large, overlapping home ranges; Seutin and Aubry 2000).

Swainson's Thrushes were also extremely widespread and abundant, occurring on 92% of routes in NB, and 81% of routes in NS, compared with 72% of routes in the Mountain BirdWatch program. An average of 11.3 birds per route (2.26 birds/point) in NB, and 3.55 birds per route (0.71 birds/point) in NS, were detected, compared with 0.54 birds per point in Mountain Birdwatch. However, Blackpoll Warblers were much less

abundant in NS and NB compared with Mountain Birdwatch. They were detected on 50% and 44% of routes in NS and NB, respectively, compared with 94% of routes in Mountain Birdwatch; their relative abundance was only 1.0 birds/route (0.20 birds/point) and 0.91 birds/route (0.18 birds/point) in NS and NB, respectively, compared with 0.91 birds/point detected by Mountain BirdWatch. Blackpoll Warblers may be less detectable on evening surveys (which are currently allowed in HELP but not Mountain Birdwatch) compared with morning surveys. Fox Sparrows were slightly more widespread and abundant in NS and NB than Blackpoll Warblers; however, this species is not monitored by Mountain Birdwatch. Again, subsampling of HELP routes is required to more accurately compare data from these two programs.

*Survey Power*

Given that we were unable to examine power using variation from within the same survey routes over time (since this was the first year of the survey), these results should be considered a guideline only. Variation within routes from year to year is likely to be less than the variation seen among routes during a single season; therefore our power calculations are most likely very conservative. These power analyses should be redone after a second year of data has been collected along these same 67 routes in order to achieve a more precise estimate of survey power.

Preliminary power analyses suggest that in order to adequately monitor Bicknell's Thrush, the focal species of HELP, we will need to collect at least 30 years of data from 65 routes run every year. Considering only routes within New Brunswick, a 3% decline could be detected in only 20 years.

A decline in population of the other species covered by this survey would take less time to detect; Swainson's Thrush would take only 5 years and Fox Sparrow and Blackpoll Warblers only 10 years. However, because of the length of time required to detect a population trend in the limiting factor species, Bicknell's Thrush, which may be due in part to our very conservative estimates of variability, HELP may require a long-term commitment of about 20 years in order to accomplish our monitoring goals. A more accurate picture may develop after the second year of surveys.

*Involvement of forestry company "stewards" & other volunteers*

Employees from Stora-Enso in NS, and Fraser Nexfor Papers Inc. and Bowater in NB, attended HELP training sessions in May and June 2002. While only three routes were run by forestry company employees, our training workshops familiarized many more employees with the identification of Bicknell's Thrush, and the threats currently faced by this species. By educating employees of these companies, particularly in identification techniques for the Bicknell's Thrush, we may eventually obtain new and/or unusual records of this species in this region which can be followed up on by regional experts. Finally, Fraser, Bowater and Stora-Enso provided us with maps of their land delineating potential Bicknell's Thrush habitat which we used in the route-selection process, and

Stora-Enso employee Kevin Middel helped BSC staff to conduct habitat measurements on Stora-Enso lands in July.

In addition to the 3 routes run by forestry company employees, an additional 15 routes were run by volunteers consisting of local naturalists and birdwatchers, and Parks Canada employees (from Cape Breton Highlands National Park). Volunteers seemed to be satisfied with the survey protocol and some expressed great pleasure at the opportunity to detect and observe a species as secretive and uncommon as the Bicknell's Thrush.

More volunteers are needed if this program is to be run every year; hiring BSC staff to run most of the routes, while efficient, is expensive and logistically difficult. Many routes can only be accessed with a four-wheel drive vehicle, and require camping overnight on crown land with no amenities. These facts, however, also make it difficult to recruit new volunteers to conduct the surveys, as only a handful of qualified volunteers (i.e. those that have demonstrated an ability to identify the target species) would likely have the necessary vehicles and camping equipment to take on such a rigorous project. Special volunteer incentives (t-shirts or other gifts, the ability to reimburse expenses) may be necessary.

*Bicknell's Thrush Habitat Characteristics*

We found that the stem density and basal area of balsam fir (in NB) and spruce (in NS) were particularly important features of Bicknell's Thrush habitat, with approximately 7,000-8,000 stems/ha at sites where Bicknell's Thrushes were present. Atwood et al. (1996) also found balsam fir and red spruce to be extremely important in Bicknell's Thrush habitat in New England and New York, and in Quebec Bicknell's Thrushes are found in sites dominated by balsam fir (Connolly 2000).

Nixon et al. (2001) conducted an in-depth study of Bicknell's Thrush use of regenerating clear cuts in New Brunswick, concluding that deciduous stems (especially white birch) were of significant importance to Bicknell's Thrush. In fact, the proportion of white birch stems differed significantly between Bicknell's Thrush occupied and unoccupied points, while the proportion of balsam fir stems did not (Nixon et al. 2001). This result was unique among studies of Bicknell's Thrush habitat; in fact, research in Quebec has shown that stands with greater components of hardwoods are not used by Bicknell's Thrush (Connolly 2000). Our results with respect to deciduous trees in NB fell somewhere in between; while white birch did appear to be somewhat more common at BITH present sites compared with BITH absent sites, this result was not significant, and the proportion of white birch stems in our study at BITH present sites (18%) was considerably less than that found by Nixon et al (45%). The density and basal area of all deciduous stems combined did not differ in BITH present and absent sites. Also of interest, in NS, BITH present sites had significantly fewer deciduous stems than BITH absent sites.

The differences in habitat results in NB between our study and that of Nixon et al. (2001) may be a result of different sampling techniques. We located our survey routes only in areas that contained >50% conifers. Nixon et al.'s choice of sampling locations was not constrained by forest type, but rather sampled young, regenerating clear cuts. Many of these sites had not been thinned and therefore had high stem densities, especially of white birch. Nixon et al.'s BITH present sites averaged 38,000 total stems/ha and their non-BITH sites averaged 45,000 total stems/ha. In our study, all sites contained about 25,000 total stems/ha. Furthermore, canopy height at Nixon et al.'s sites was 4.4 m for BITH present and 5.4 m for BITH absent. Canopy height at our sites was 6.65 m for BITH present and 5.75 m for BITH absent, suggesting that we were sampling sites that were a little older.

It is likely that our study and that of Nixon et al. (2001) were sampling slightly different types of habitat. Nixon et al. (2001) focused on young, regenerating clearcuts, most of which had not been thinned (and thus had a relatively high density of white birch). Our survey routes likely tended to be in older stands, a small number of which were relatively undisturbed (e.g., four routes in Mount Carleton Provincial Park). It would be important to include stand age in further analyses of habitat. Nevertheless, despite these likely sampling differences, both studies found Bicknell's Thrush, suggesting that the species can occupy a relatively wide range of habitat types.

As has been found in previous studies (Connolly 2000, Lambert et al. 2002, Nixon et al. 2001), elevation appeared to be an important factor in Bicknell's Thrush habitat, at least in NB, where BITH present sites were on average about 100 m higher than BITH absent sites. The lack of a significant difference in elevation between BITH present and absent sites in NS may be due to the fact that elevation is generally lower in NS than NB, such that "prime" sites for Bicknell's Thrushes are defined not by highest elevation but rather by some feature of the habitat itself (e.g. density and/or height of spruce trees).

We also found that the percent of ground cover dominated by mosses was significantly higher in BITH present than BITH absent sites in NB. This corresponds with the results of Connolly (2000), who suggested that moss may be common at sites occupied by Bicknell's Thrush because it is an important component of the Bicknell's Thrush nest (Wallace 1939). High percent mossy ground cover may also be indicative of other important habitat features (e.g., moist, conifer dominated sites).

Habitat differences between NB and NS could potentially be explained by the fact that the majority of routes in NS (except for some of those on Stora Enso lands) are found in traditional, "natural" habitat, whereas the majority of routes in NB (except for those in Mount Carleton Provincial Park) are found in non-traditional, regenerating industrial forest. This could account for some of the differences seen in species composition between the two provinces (with spruce being of greater importance than fir in NS), the relative dearth of deciduous stems in NS compared with NB, and perhaps the shorter height of trees at BITH present sites in NS compared with NB.

One of the greatest limitations of the habitat aspect of our study is the fact that, while we used the term "BITH absent" to denote sites where we did not find Bicknell's Thrush, these sites are perhaps better defined as "status unknown" (Lambert et al. 2002) because in reality, we could not be sure that there were no Bicknell's Thrushes at these sites. Nixon et al. (2001) found that new Bicknell's Thrushes were still being detected on surveys after six visits to the same site; in fact, they showed that only 40% of all Bicknell's Thrush detections occurred on the first visit. However, Nixon et al. started their morning surveys at dawn and finished their evening surveys at dusk, taking about three hours to complete each survey. It is likely, then, that the last hour or so of their morning surveys, and the first hour or so of their evening surveys, underestimated the number of Bicknell's Thrushes detected, considering that other studies (Whittam and Ball 2002, Lambert et al. 2002, Ball 2000) have found that vocal behaviour peaks just before dawn and just after dusk. Therefore our study, because surveys were restricted to the peak period of Bicknell's Thrush vocal behaviour, may not have underestimated the number of routes on which Bicknell's Thrushes were present to as large a degree as might be expected based on Nixon et al. (2001).

Bicknell's Thrush habitat might also be better characterized by finding nests and measuring habitat around nests, rather than simply measuring habitat around sites where Bicknell's Thrushes were detected while surveying. However, finding nests is time-consuming and expensive (e.g. Seutin and Aubry 2000), and thus was not logistically feasible for this study. Future studies in NB and NS, however, should consider finding nests in order to better delineate habitat use by this species.

*Ongoing work & future goals*

- BSC is currently working with Joe Pomeroy of the Landscape Analyses Group of Environment Canada in Dartmouth, NS, to develop a GIS-based habitat model for Bicknell's Thrush in NB and NS. While this work is still in its infancy, we ultimately hope to use all Bicknell's Thrush data from the Maritimes to model current and potential habitat for this species in this region, allowing us to better target appropriate habitat in any new survey routes that are developed. Connolly (2000) used GIS layers along with habitat data from the field to classify habitat with an accuracy of 89-90%. Lambert et al. (2001) has also shown great success with their GIS model, predicting Bicknell's Thrush presence along survey routes 89% of the time. A habitat model could also be used to predict long-term habitat supply, if it incorporated a succession component.

- An indepth study of Bicknell's Thrush breeding biology on industrial forest land would allow us to determine whether or not this species is actually breeding at these sites and, if so, how well they are doing. Given that they are known to breed in industrial forest in Quebec (Seutin and Aubry 2000), there is no reason to suspect that they are not breeding in this habitat type in NB, although this type of habitat could still be a population sink, if reproductive success is below the threshold level needed to replace the breeders. However, there is a great need for information on breeding success of this species in relation to past and future

forestry practices (e.g. pre-commercial thinning, see below, under *Conservation significance*), especially in NB where the bulk of the Atlantic population breeds on managed land. Furthermore, by determining more specifically what type of habitat these birds require for breeding, we can help the New Brunswick Department of Natural Resources and Energy (NB-DNRE) and the Nova Scotia Department of Natural Resources (NS-DNR) to set guidelines outlining how crown land is to be managed (if at all) to maintain the Bicknell's Thrush population. Finally, further work on nest-site habitat would further refine the usefulness of a GIS model, providing a more precise estimate of habitat preferences by breeding individuals.

- It would be valuable to follow-up the univariate analyses presented in this report with a multivariate analysis of habitat differences between BITH present and BITH absent sites, to better define the habitat requirements of the Bicknell's Thrush.

- We will continue annual monitoring at all 67 HELP routes established in New Brunswick and Nova Scotia.

- It would be valuable to determine whether or not HELP could be expanded to Quebec, where the bulk of the Canadian Bicknell's Thrush population is found. We will approach our partners in this region to determine their level of interest in the monitoring program.

- It would be interesting, within a few years, to combine data from HELP and Mountain Birdwatch to allow a more range-wide estimate of population trends for high elevation landbirds, especially the Bicknell's Thrush. By combining data from Canada and the U.S., we may be able to overcome current problems with low statistical power.

*Conservation Significance of this study*

- With HELP, we have begun a long-term monitoring project for high elevation landbirds that will provide population trend information for several little-known species. The North American Bird Conservation Initiative (NABCI) identifies bird population monitoring as one of the greatest needs for continental bird conservation; without knowledge of bird population trends, we can't know which species require conservation, or how best to conserve them.

- We have initiated contact with three major forestry companies in the Maritimes (Stora-Enso, Bowater, Fraser), two of which provided staff (and vehicles) to conduct survey routes (and habitat measurements) on their land. In addition, all forestry companies in NB have agreed to work with us in developing our GIS model by giving permission for us to use GIS data covering the land they

manage (with the exception of Irving, who has refused access to their data but who have offered to complete any necessary analyses for us). Because the bulk of the Bicknell's Thrush population in Atlantic Canada nests on industrial forest land, it is extremely important to involve these companies in the early stages of research and monitoring; by involving and thus educating these companies we are paving the way for informed forest management decisions to be made and implemented in the future which will ultimately benefit the Bicknell's Thrush and other high elevation landbirds.

- We have conducted the first indepth study of habitat use by Bicknell's Thrush in NS, and the second study of habitat use by this species in NB. By determining that the density of balsam fir and spruce stems are important to Bicknell's Thrushes, and clearly defining the range of densities used by this species, we are now in a position to determine how practices such as pre-commercial thinning (which greatly lowers the density of conifer stems in a forest stand) might impact Bicknell's Thrushes. Currently, pre-commercial thinning in NB is known to decrease balsam fir stem density to the range of that found in BITH absent sites (2800 m2/ha; Scott Makepeace, NB-DNRE, pers. comm.), suggesting that this practice, when carried out in stands that are otherwise favourable to Bicknell's Thrush, may be impacting this species' population in NB. An indepth study of breeding biology of Bicknell's Thrush on industrial forest land (see above) could help to better define the impact (if any) of thinning.

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Figure 1a. Routes where Bicknell's Thrush were and were not detected on the first run of H.E.L.P. survey routes in north-central and northwestern NB in 2002. Ten of the "absent" routes were re-run a second time but no additional Bicknell's Thrush were detected.

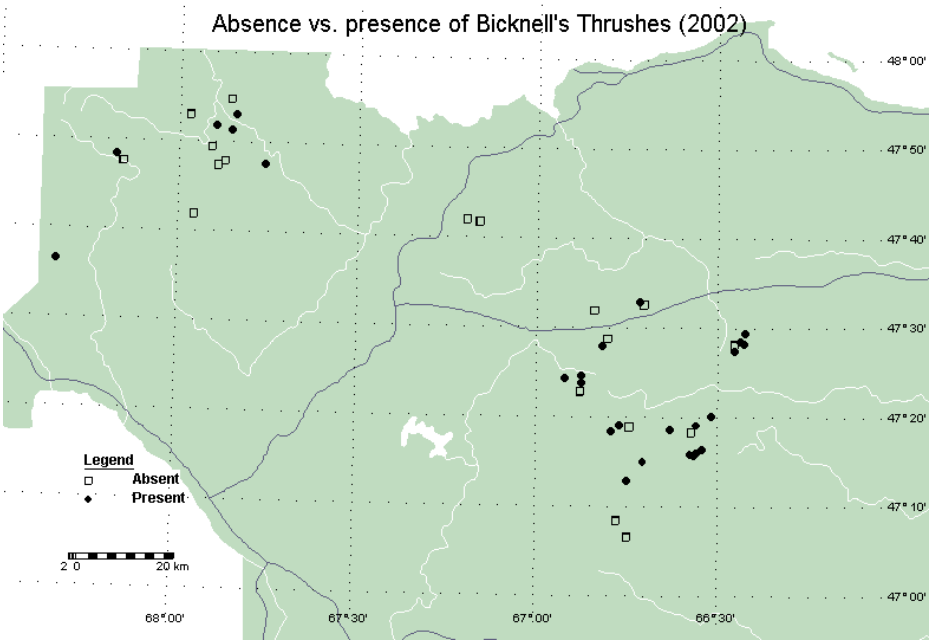


Figure 1b. Number of Bicknell's Thrushes detected on the first run of H.E.L.P. survey routes in north-central and northwestern NB in 2002.

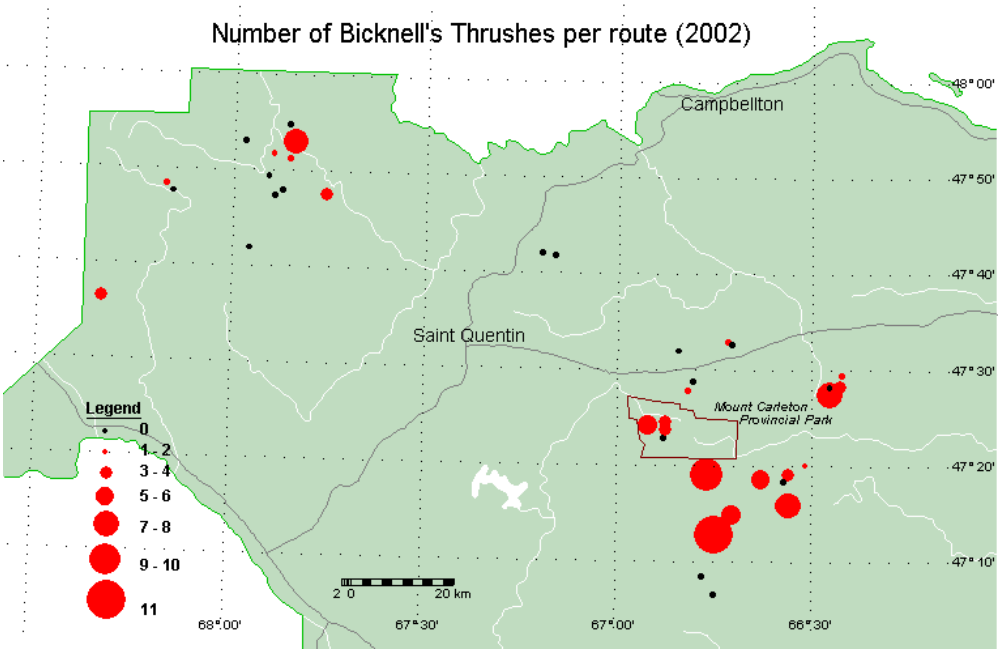

Figure 2a. Routes where Bicknell's Thrush were and were not detected on the first run of H.E.L.P. survey routes in Cape Breton, NS in 2002. Six of the routes where Bicknell's Thrushes were not detected were re-run a second time but no additional Bicknell's Thrushes were detected.

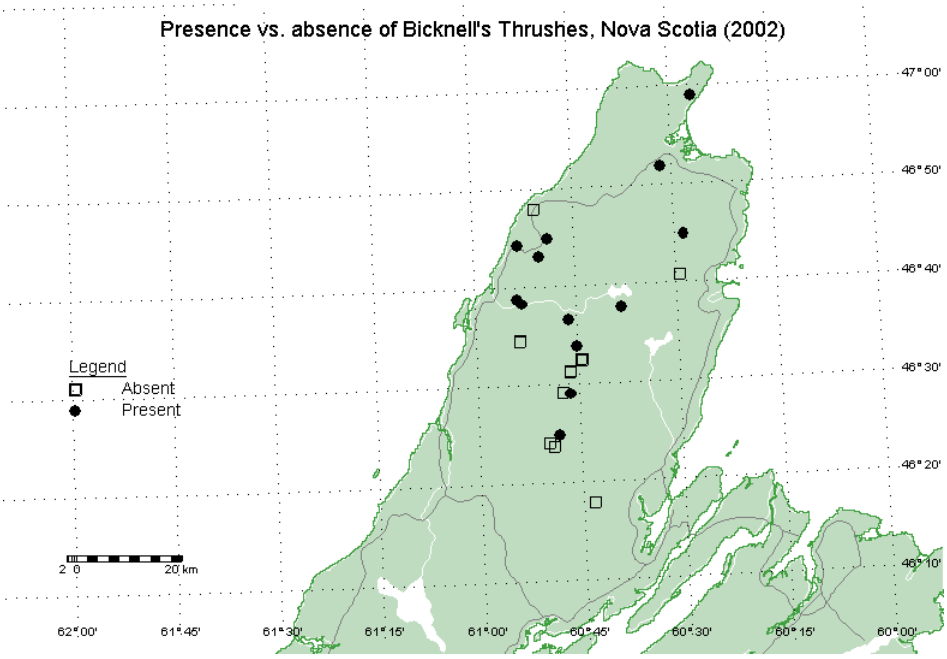


Figure 2b. Number of Bicknell's Thrushes detected on the first run of H.E.L.P. survey routes in Cape Breton, NS in 2002.

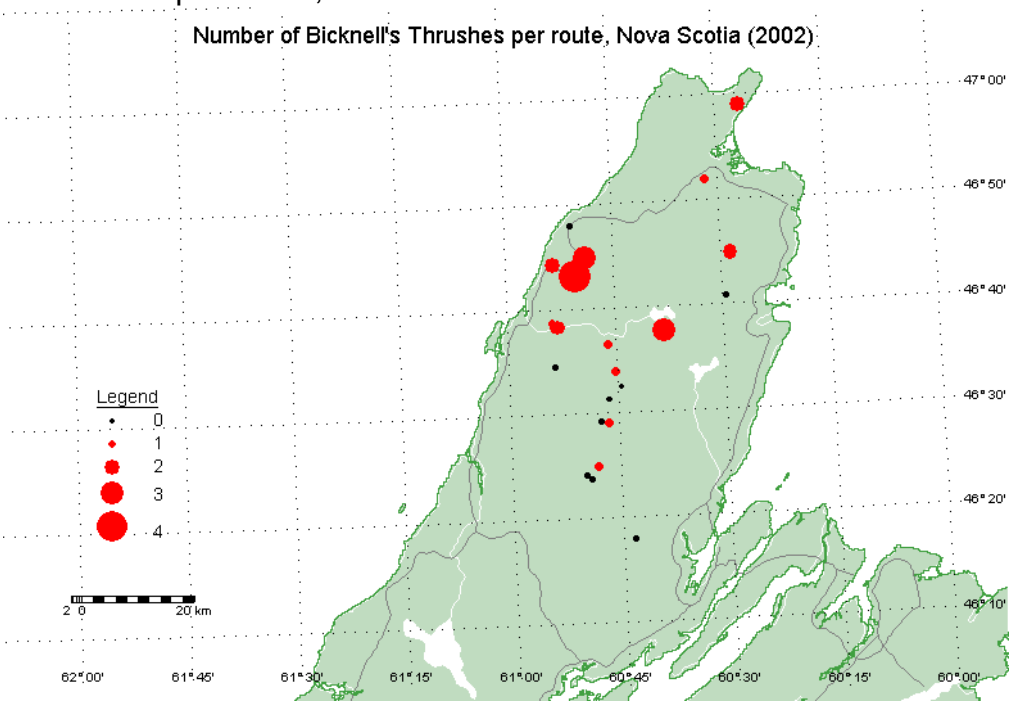

Table 1. Frequency of Detection (number of routes detected/total routes run) and Relative Abundance (mean number of birds per route) for each of the four target species in NB and NS in 2002. A total of 22 routes were run in NS, and 45 routes in NB.

| | | Bicknell's Thrush | Swainson's Thrush | Blackpoll Warbler | Fox Sparrow |
|---|---|---|---|---|---|
| Frequency of Detection | NS | 0.59 | 0.82 | 0.50 | 0.59 |
| | NB | 0.60 | 0.91 | 0.44 | 0.51 |
| Relative Abundance | NS | 1.09 | 3.55 | 1.00 | 1.27 |
| | NB | 2.2 | 11.3 | 0.91 | 1.27 |

Table 2. Summary of results of preliminary power analysis for Bicknell's Thrush in Nova Scotia and New Brunswick.

| Routes | Years | Interval | % Increase | Power | % Decrease | Power |
|---|---|---|---|---|---|---|
| 65 | 10 | 1/year | 5 | 0.93 | 10 | 0.87 |
| 65 | 15 | 1/year | 4 | 0.90 | 7 | 0.90 |
| 65 | 20 | 1/year | 4 | 0.99 | 5 | 0.94 |
| 65 | 25 | 1/year | 3 | 0.99 | 4 | 0.95 |
| 65 | 30 | 1/year | 2 | 0.94 | 3 | 0.93 |

Table 3. Summary of results of preliminary power analysis for Swainson's Thrush in Nova Scotia and New Brunswick.

| Routes | Years | Interval | % Increase | Power | % Decrease | Power |
|---|---|---|---|---|---|---|
| Routes | 5 | 1/year | 2 | 0.90 | 2 | 0.92 |
| 65 | 5 | 1/2 years | 4 | 0.90 | 2 | 0.90 |
| 65 | 5 | 1/5 years | 6 | 0.92 | 7 | 0.90 |
| 65 | 10 | 1/year | 2 | 0.99 | 3 | 1.00 |
| 65 | 10 | 1/2 years | 2 | 0.97 | 2 | 0.96 |
| 65 | 10 | 1/5 years | 4 | 0.93 | 4 | 0.94 |
| 65 | 15 | 1/year | 1 | 1.00 | 1 | 0.99 |
| 65 | 15 | 1/2 years | 1 | 0.96 | 1 | 0.94 |
| 65 | 15 | 1/5 years | 2 | 0.90 | 2 | 0.91 |

Table 4. Summary of results of preliminary power analysis for Fox Sparrow in Nova Scotia and New Brunswick.

| Routes | Years | Interval | % Increase | Power | % Decrease | Power |
|---|---|---|---|---|---|---|
| 65 | 5 | 1/year | 4 | 0.93 | 4 | 0.90 |
| 65 | 5 | 1/2 years | 6 | 0.91 | 7 | 0.90 |
| 65 | 5 | 1/5 years | 8 | 0.90 | 10 | 0.86 |
| 65 | 10 | 1/year | 1 | 0.90 | 1 | 0.90 |
| 65 | 10 | 1/2 years | 2 | 0.90 | 2 | 0.90 |
| 65 | 10 | 1/5 years | 5 | 0.90 | 6 | 0.91 |
| 65 | 15 | 1/year | 1 | 0.93 | 1 | 0.93 |
| 65 | 15 | 1/2 years | 1 | 0.90 | 2 | 0.92 |
| 65 | 15 | 1/5 years | 3 | 0.90 | 4 | 0.90 |

Table 5. Summary of results of preliminary power analysis for Blackpoll Warblers in Nova Scotia and New Brunswick.

| Routes | Years | Interval | % Increase | Power | % Decrease | Power |
|---|---|---|---|---|---|---|
| 65 | 5 | 1/year | 1 | 0.88 | 5 | 0.91 |
| 65 | 5 | 1/2 years | 2 | 0.90 | 3 | 0.87 |
| 65 | 5 | 1/5 years | 5 | 0.95 | 4 | 0.87 |
| 65 | 10 | 1/year | 2 | 0.93 | 2 | 0.92 |
| 65 | 10 | 1/2 years | 3 | 0.95 | 3 | 0.94 |
| 65 | 10 | 1/5 years | 7 | 0.91 | 7 | 0.91 |
| 65 | 15 | 1/year | 1 | 0.94 | 1 | 0.90 |
| 65 | 15 | 1/2 years | 2 | 0.96 | 2 | 0.94 |
| 65 | 15 | 1/5 years | 3 | 0.90 | 4 | 0.90 |

Table 6. Summary of results of preliminary power analysis for Bicknell's Thrush in Nova Scotia, varying the number of routes run.

| Routes | Years | Interval | % Increase | Power | % Decrease | Power |
|---|---|---|---|---|---|---|
| 25 | 10 | 1/year | 8 | 0.91 | 10 | 0.51 |
| 25 | 15 | 1/year | 5 | 0.96 | 10 | 0.67 |
| 25 | 20 | 1/year | 4 | 0.99 | 10 | 0.80 |
| 25 | 25 | 1/year | 2 | 0.97 | 6 | 0.92 |
| 25 | 30 | 1/year | 2 | 1.00 | 4 | 0.94 |
| 25 | 35 | 1 years | 2 | 0.99 | 4 | 0.95 |
| 30 | 35 | 1/year | 1 | 0.85 | 4 | 0.96 |
| 35 | 35 | 1/year | 1 | 0.87 | 4 | 0.98 |
| 40 | 35 | 1/year | 1 | 0.90 | 3 | 0.90 |
| 45 | 35 | 1/year | 1 | 0.91 | 3 | 0.91 |
| 50 | 35 | 1/year | 1 | 0.95 | 3 | 0.91 |

Table 7. Summary of results of preliminary power analysis for Bicknell's Thrush in New Brunswick, varying the number of routes run.

| Routes | Years | Interval | % Increase | Power | % Decrease | Power |
|---|---|---|---|---|---|---|
| 40 | 10 | 1/year | 5 | 0.97 | 5 | 0.91 |
| 40 | 10 | 1/2 years | 6 | 0.94 | 8 | 0.93 |
| 40 | 10 | 1/5 years | 10 | 0.92 | 10 | 0.78 |
| 50 | 10 | 1/year | 5 | 0.96 | 5 | 0.90 |
| 60 | 10 | 1/year | 5 | 0.99 | 5 | 0.91 |
| 70 | 10 | 1/year | 4 | 0.87 | 5 | 0.94 |
| 40 | 15 | 1/year | 4 | 0.91 | 4 | 0.89 |
| 40 | 15 | 1/2 years | 4 | 0.88 | 4 | 0.94 |
| 40 | 15 | 1/5 years | 7 | 0.94 | 9 | 0.91 |
| 50 | 15 | 1/year | 4 | 0.93 | 4 | 0.96 |
| 60 | 15 | 1/year | 4 | 0.94 | 4 | 0.98 |
| 70 | 15 | 1/year | 4 | 0.96 | 4 | 0.99 |
| 40 | 20 | 1/year | 3 | 0.88 | 3 | 0.87 |
| 40 | 20 | 1/2 years | 4 | 0.95 | 4 | 0.99 |
| 40 | 20 | 1/5 years | 5 | 0.94 | 7 | 0.93 |
| 50 | 20 | 1/year | 3 | 0.89 | 3 | 0.88 |
| 60 | 20 | 1/year | 3 | 0.91 | 3 | 0.89 |
| 70 | 20 | 1/year | 3 | 0.95 | 3 | 0.90 |
| 40 | 25 | 1/year | 3 | 0.98 | 3 | 0.97 |
| 40 | 25 | 1/2 years | 3 | 0.88 | 3 | 0.84 |
| 40 | 25 | 1/5 years | 4 | 0.80 | 5 | 0.88 |
| 50 | 25 | 1/year | 3 | 1.00 | 3 | 0.98 |
| 60 | 25 | 1/year | 2 | 0.90 | 3 | 0.89 |
| 70 | 25 | 1/year | 2 | 0.93 | 2 | 0.92 |
| 40 | 30 | 1/year | 1 | 0.99 | 1 | 0.96 |
| 40 | 30 | 1/2 years | 2 | 1.00 | 2 | 0.99 |
| 40 | 30 | 1/5 years | 3 | 0.93 | 4 | 0.92 |
| 40 | 35 | 1/year | 1 | 1.00 | 1 | 0.97 |
| 40 | 35 | 1/2 years | 2 | 1.00 | 2 | 0.99 |
| 40 | 35 | 1/5 years | 3 | 0.98 | 4 | 0.98 |

Table 8. Summary of habitat data for Bicknell's Thrush present and absent sites in New Brunswick and Nova Scotia in 2002.

| | NB | | | | NS | | | |
|---|---|---|---|---|---|---|---|---|
| | Present (n = 21) | | Absent (n = 11) | | Present (n = 12) | | Absent (n = 7) | |
| Variable | Mean | St.Error | Mean | St.Error | Mean | St. Error | Mean | St. Error |
| Balsam Fir stems/ha | 6380* | 1272 | 2833 | 1098 | 2790 | 713 | 4000 | 1141 |
| Balsam Fir basal area m2/ha | 9.64** | 1.92 | 3.47 | 1.40 | 5.22* | 1.46 | 12.52 | 2.61 |
| Proportion balsam fir stems | 0.28 | 0.04 | 0.15 | 0.06 | 0.34 | 0.10 | 0.51 | 0.13 |
| Spruce stems/ha | 883 | 309 | 1167 | 373 | 5744* | 2492 | 67 | 67 |
| Spruce basal area m2/ha | 1.92 | 0.88 | 3.76 | 2.60 | 2.05* | 0.58 | 0.008 | 0.08 |
| Proportion spruce stems | 0.06 | 0.02 | 0.07 | 0.04 | 0.21* | 0.06 | 0.004 | 0.004 |
| White Birch stems/ha | 4053 | 1057 | 2467 | 809 | 662 | 343 | 933 | 470 |
| White Birch basal area m2/ha | 2.86 | 0.72 | 1.30 | 0.40 | 0.11 | 0.05 | 0.25 | 0.14 |
| Proportion white birch stems | 0.18 | 0.04 | 0.12 | 0.04 | 0.15 | 0.10 | 0.12 | 0.07 |
| Conifer stems/ha | 7263 | 1179 | 4000 | 1213 | 8626 | 2240 | 4067 | 1129 |
| conifer basal area m2/ha | 11.57 | 1.93 | 7.22 | 2.76 | 7.33 | 1.41 | 12.53 | 2.61 |
| Proportion conifer stems | 0.34 | 0.04 | 0.23 | 0.07 | 0.55 | 0.08 | 0.52 | 0.13 |
| Deciduous stems/ha | 6750 | 1078 | 6500 | 1606 | 656* | 213 | 1667 | 431 |
| deciduous basal area m2/ha | 5.11 | 1.23 | 3.11 | 0.85 | 0.60 | 0.40 | 0.65 | 0.18 |
| Proportion deciduous stems | 0.34 | 0.05 | 0.31 | 0.07 | 0.08* | 0.03 | 0.22 | 0.06 |
| Shrub stems/ha | 11247 | 3334 | 14567 | 4390 | 11077 | 4922 | 3067 | 1931 |
| shrub basal area m2/ha | 1.63 | 0.44 | 2.52 | 0.78 | 1.39 | 0.60 | 0.51 | 0.23 |
| Proportion shrub stems | 0.32 | 0.07 | 0.46 | 0.11 | 0.37 | 0.07 | 0.26 | 0.11 |
| Total stems/ha | 25260 | 3383 | 25067 | 2889 | 20359 | 6542 | 8800 | 1786 |
| Total basal area m2/ha | 18.31* | 2.01 | 12.86 | 2.71 | 9.32 | 1.45 | 13.69 | 2.28 |
| Elevation (m) | 616* | 18 | 513 | 21 | 426 | 32 | 452 | 21 |
| # of dead trees along transect | 33.13* | 9.77 | 10.45 | 4.13 | 12.03 | 3.0 | 7.43 | 1.91 |
| Canopy Height (m) | 6.65 | 0.93 | 5.75 | 1.21 | 5.09* | 1.26 | 8.10 | 0.77 |
| Subcanopy Height (m) | 1.13 | 0.311 | 1.31 | 0.33 | 0.69 | 0.24 | 0.75 | 0.33 |
| Upper Shrub Height (m) | 0.73 | 0.07 | 0.80 | 0.10 | 0.58 | 0.09 | 0.49 | 0.14 |
| Lower Shrub Height (m) | 0.18 | 0.05 | 0.41 | 0.26 | 0.26 | 0.03 | 0.22 | 0.05 |
| Ferns (%) | 7.06 | 1.57 | 3.77 | 1.91 | 16.68 | 4.65 | 19.63 | 6.13 |
| Moss (%) | 18.87* | 2.91 | 11.41 | 4.74 | 15.72 | 4.68 | 9.23 | 2.49 |
| Lichens (%) | 1.02 | 0.42 | 2.00 | 1.27 | 1.13 | 0.71 | 1.71 | 1.41 |
| Bare Rock (%) | 0.43 | 0.22 | 0.18 | 0.18 | 2.96 | 2.21 | 1.14 | 0.70 |
| Litter (%) | 72.27 | 3.76 | 82.36 | 5.54 | 63.35 | 4.78 | 67.57 | 6.72 |
| # of trees in plot with Usnea lichen | 2.15 | 1.29 | 0.18 | 0.18 | 0.11 | 0.10 | 5.14 | 5.14 |
| Vegetation Density 5m (prop'n squares >50% obscured) | 0.17 | 0.03 | 0.20 | 0.04 | 0.16 | 0.04 | 0.17 | 0.03 |
| Vegetation Density 10m (prop'n squares >50% obscured) | 0.09 | 0.02 | 0.09 | 0.02 | 0.13 | 0.04 | 0.08 | 0.04 |

* = P<0.05, **= P < 0.005 for Mann-Whitney U test comparing presence/absence in either of the two provinces.

Appendix 1. HELP results summarized by route. BITH1 = number of Bicknell's Thrushes detected on the first run of the route. BITH2 = number of Bicknell's Thrushes detected on the second run of the route. n/a = no second run was completed. SWTH = Swainson's Thrush, BLWA = Blackpoll Warbler, FOSP = Fox Sparrow.

| Prov. | Route # | Route name | Surveyor | # of surveys | BITH1 | BITH2 | SWTH | BLWA | FOSP |
|---|---|---|---|---|---|---|---|---|---|
| NB | 1 | White's Brook | M. G. Doyle | 2 | 0 | 0 | 3 | 0 | 0 |
| NB | 2 | White's Brook 2 | M. Lushington | 2 | 0 | 0 | 10 | 0 | 0 |
| NB | 3 | William's Brook | B. Whittam | 1 | 0 | n/a | 16 | 0 | 0 |
| NB | 4 | Bowater 4 | M. Lushington | 1 | 1 | n/a | 11 | 0 | 1 |
| NB | 5 | Rovin Grey's Gulch | M. G. Doyle | 1 | 0 | n/a | 8 | 0 | 0 |
| NB | 6 | Mt. Villebon | B. Whittam | 1 | 2 | n/a | 18 | 2 | 2 |
| NB | 7 | Mt. Villebon North | B. Flanigan | 2 | 0 | 0 | 22 | 3 | 0 |
| NB | 8 | Mt. Cox | B. Whittam | 1 | 7 | n/a | 19 | 0 | 2 |
| NB | 9 | Upsalquitch Lk. | B. Whittam | 1 | 0 | n/a | 8 | 0 | 0 |
| NB | 10 | Devil's Elbow Brook | B. Flanigan | 1 | 1 | n/a | 18 | 0 | 0 |
| NB | 14 | Halfway Depot | R. LaPointe | 2 | 3 | 0 | 0 | 0 | 0 |
| NB | 15 | Bear Brook Rd. | R. LaPointe | 1 | 1 | n/a | 7 | 2 | 0 |
| NB | 16 | Wild Goose Brook | R. LaPointe | 1 | 0 | n/a | 12 | 0 | 2 |
| NB | 22 | Old Shanty Brook | B. Whittam | 1 | 0 | n/a | 20 | 0 | 2 |
| NB | 25 | Thigh Master Hill | B. Whittam | 2 | 0 | 0 | 22 | 0 | 0 |
| NB | 27 | States Brook #2 | B. Flanigan | 2 | 0 | 0 | 10 | 0 | 2 |
| NB | 28 | States Brook #1 | B. Whittam | 2 | 6 | 2 | 13 | 2 | 9 |
| NB | 29 | Fogs Brook | B. Flanigan | 1 | 1 | n/a | 18 | 2 | 1 |
| NB | 30 | Rapids Depot | B. Whittam | 1 | 1 | n/a | 22 | 0 | 3 |
| NB | 32 | Fogs Brook | B. Whittam | 2 | 0 | 0 | 20 | 2 | 2 |
| NB | 33 | Lavoid Gulch | B. Flanigan | 1 | 0 | n/a | 3 | 0 | 0 |
| NB | 34 | Camp 69 Rd #2 | B. Flanigan | 2 | 0 | 0 | 11 | 3 | 2 |
| NB | 37 | Fraser37 | J. Sébastien | 1 | 3 | n/a | 4 | 1 | 0 |
| NB | 39 | Fraser39 | D.Landry and L.Cyr | 1 | 0 | n/a | 3 | 4 | 0 |
| NB | 40 | Mt. Carleton | B. Whittam | 1 | 4 | n/a | 11 | 0 | 0 |
| NB | 41 | Mt. Head | J. Pellerin | 1 | 2 | n/a | 0 | 1 | 0 |
| NB | 42 | Mt. Sagamook | R. LeBlanc | 1 | 4 | n/a | 0 | 1 | 1 |

| Prov. | Route # | Route name | Surveyor | # of surveys | BITH1 | BITH2 | SWTH | BLWA | FOSP |
|---|---|---|---|---|---|---|---|---|---|
| NB | 48 | Mount Ed. Alternative | B. Flanigan | 2 | 0 | 0 | 12 | 2 | 1 |
| NB | 49 | Mt. Edward | B. Flanigan | 1 | 10 | n/a | 6 | 0 | 1 |
| NB | 50 | Lower Mt. Edward | B. Whittam | 2 | 2 | 2 | 17 | 0 | 0 |
| NB | 51 | View of Mt. Nalaisk | B. Flanigan | 1 | 11 | n/a | 14 | 0 | 0 |
| NB | 52 | Sweat Hill | B. Whittam | 1 | 7 | n/a | 10 | 2 | 1 |
| NB | 53 | Wilkinson Mtn. | B. Whittam | 1 | 0 | n/a | 2 | 0 | 0 |
| NB | 54 | Mt. McNair | B. Flanigan | 2 | 0 | 0 | 4 | 0 | 0 |
| NB | 55 | Mt.Chandler | B. Whittam | 1 | 5 | n/a | 19 | 1 | 7 |
| NB | 56 | Tilley Ridge | B. Whittam | 1 | 3 | n/a | 13 | 0 | 1 |
| NB | 57 | Tilley Ridge B | B. Whittam | 1 | 0 | n/a | 18 | 1 | 5 |
| NB | 58 | Mt. Adams | B. Flanigan | 1 | 1 | n/a | 10 | 0 | 1 |
| NB | 59 | Mt. Mitchell West | B. Flanigan | 1 | 1 | n/a | 5 | 4 | 1 |
| NB | 60 | Mt. Mitchell Centre | B. Flanigan | 1 | 7 | n/a | 6 | 0 | 0 |
| NB | 61 | Mt. Mitchell East | B. Whittam | 1 | 2 | n/a | 13 | 1 | 3 |
| NB | 62 | Mt. Mitchell Centre #2 | B. Whittam | 1 | 3 | n/a | 15 | 5 | 6 |
| NB | 63 | Mt. Perley A | B. Flanigan | 1 | 1 | n/a | 11 | 1 | 0 |
| NB | 64 | Mt. Perley B | B. Whittam | 1 | 4 | n/a | 23 | 0 | 1 |
| NS | 2 | Halfway Lake | M. Russell | 1 | 2 | n/a | 0 | 3 | 3 |
| NS | 3 | Benji's Lake | M. Ball | 1 | 3 | n/a | 0 | 0 | 0 |
| NS | 4 | Old Cabot Trail | C. LeBlanc | 1 | 2 | n/a | 2 | 1 | 1 |
| NS | 5 | Cape North2 | M. Ball | 1 | 2 | n/a | 3 | 0 | 2 |
| NS | 6 | Cabot Trail | M. Russell | 2 | 0 | 0 | 8 | 0 | 3 |
| NS | 9 | Fishing Cove Lk. | M. Russell | 1 | 4 | n/a | 0 | 2 | 2 |
| NS | 10 | Park Boundry-STO | M. Russell | 1 | 1 | n/a | 1 | 1 | 5 |
| NS | 11 | Simeon Lk. | J. Hudson | 1 | 1 | n/a | 2 | 4 | 1 |
| NS | 12 | Cheticamp River | C. LeBlanc | 1 | 2 | n/a | 9 | 0 | 0 |
| NS | 15 | Paquette Lk. | J. Hudson | 1 | 1 | n/a | 6 | 0 | 0 |
| NS | 16 | Franey Mtn. | C. Robbins | 1 | 0 | n/a | 2 | 0 | 0 |
| NS | 17 | Cheticamp Lake | M. Russell | 1 | 3 | n/a | 4 | 1 | 3 |
| NS | 19 | Parks Spur Rd. | M. Russell | 2 | 0 | 0 | 2 | 2 | 2 |

| Prov. | Route # | Route name | Surveyor | # of surveys | BITH1 | BITH2 | SWTH | BLWA | FOSP |
|---|---|---|---|---|---|---|---|---|---|
| NS | 21 | STO | M. Ball | 2 | 0 | 0 | 3 | 4 | 3 |
| NS | 23 | Second Forks Brook North Rd.-STO | M. Russell | 2 | 0 | 0 | 8 | 0 | 0 |
| NS | 24 | Centre Rd.#8-STO | M. Russell | 2 | 0 | 0 | 8 | 2 | 0 |
| NS | 25 | STO | M. Ball | 2 | 0 | 0 | 1 | 0 | 1 |
| NS | 26 | STO | M. Ball | 1 | 1 | n/a | 8 | 0 | 1 |
| NS | 29 | STO | M. Ball | 1 | 1 | n/a | 5 | 1 | 0 |
| NS | 30 | Jim Campbell's Lake -STO | M. Ball | 2 | 0 | 0 | 4 | 1 | 0 |
| NS | 35 | Bell Lake NE | C. Brander | 1 | 0 | n/a | 2 | 0 | 0 |