Bicknell's Thrush habitat in Nova Scotia's Industrial Forest

Final report to the Nova Forest Alliance
and Stora Enso Port Hawkesbury, Ltd.

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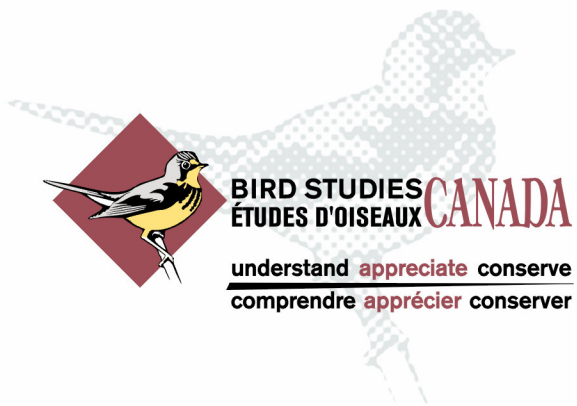

Executive Summary

The objective of this report is to provide a description of "optimal" Bicknell's Thrush habitat in industrial forest in Cape Breton in order to allow Stora Enso to manage highland industrial habitat in a way that benefits Bicknell's Thrush. Examination of habitat in New Scotia was accomplished by using habitat data obtained from two sources: 1) BSC data from the High Elevation Landbird Program (HELP) surveys conducted on industrial forest managed by Stora Enso; and 2) data collected from surveys done by the Canadian Wildlife Service from 1996 to 1998 in the same area.

BSC data revealed no significant differences between stands that had Bicknell's Thrush (BITH present) versus those that did not (BITH absent). However, four habitat characteristics were nearly significantly greater in BITH present stands ($0.5 < P \leq 0.105$). These were the number of White birch stems with a diameter of 2.5 – 5 cm, the proportion of stems that were White birch, the importance of conifers, and the percentage of ground covered by leaf litter.

Forest inventory data showed BITH present stands were generally younger in age and at higher elevation than BITH absent stands, although neither was statistically significant. A large proportion of BITH present stands were ≤ 15 years, a result which is similar to that observed in New Brunswick, before naturally regenerating stands are pre-commercially thinned. The majority of BITH present stands are dominated by Balsam fir (dominant = ≥70% of trees in the stand). However, this result was not significant as Balsam fir also comprised the majority of BITH absent stands, although in smaller proportions (57% of BITH present stands were dominated by BF vs. 45% of BITH absent stands).

The dearth of Bicknell's Thrush detections over 4 years of BSC surveys made it difficult to obtain significant results when comparing habitat characteristics between BITH present and BITH absent stands due to small sample sizes. However, our results suggest several conclusions which were also evident in BITH present stands New Brunswick (Nixon *et al*. 2001, Campbell *et al*. 2005, Chisholm 2005):

- conifers are important to Bicknell's Thrushes
- Bicknell's Thrushes prefer stands with a high density of small White birch stems, generally present in regenerating stands prior to pre-commercial thinning (≤ 15 years of age)
- Bicknell's Thrushes prefer stands with a high percentage of ground cover from leaf litter

Forest managers are encouraged to consider the following modifications to pre-commercial thinning operations. These recommendations are based on the best available knowledge of Bicknell's Thrush biology and habitat preferences to date:

1. When possible, schedule thinning in optimal Bicknell's Thrush stands either before June 1st or after July 31st, to reduce disruption during the breeding season. Bicknell's Thrushes have very low reproductive rates, so every breeding season is very important in maintaining healthy population numbers.

2. When optimal Bicknell's Thrush stands need to be thinned, leave un-thinned edges or patches of un-thinned habitat > 0.1 ha, and connect these "islands" to larger patches of un-thinned habitat whenever possible.

3. Manage industrial forest with a "no net loss" policy, by ensuring that for every optimal Bicknell's Thrush stand which is thinned, an un-thinned stand of equal size reaches optimal characteristics the following year.

4. Maintain close contact with organizations like Bird Studies Canada, Maritime universities, and the provincial Department of Natural Resources to remain aware of the most current research findings.

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Introduction

The Bicknell's Thrush is one of the rarest songbirds in North America, with a world-wide population of less than 25,000 pairs (Rimmer *et al*. 2001). Up to 25% of the world's population of Bicknell's Thrush breeds in Canada, with as much as 10% in Nova Scotia's Cape Breton Highlands. In 1999, the Bicknell's Thrush was designated a Species of Special Concern by COSEWIC. It received this designation primarily as a result of its low population numbers, patchy distribution, low reproductive potential, and pressures stemming from large-scale forestry operations on its habitat in Canada (Nixon 1999). It has also been designated as Sensitive in Nova Scotia, as Globally Vulnerable by the IUCN and as the landbird of highest conservation priority in Bird Conservation Region 14 (Atlantic Northern Forest) by Partners In Flight.

Surveys done by the Canadian Wildlife Service from 1996-1998 (Busby, unpubl. Data), the University of New Brunswick and the Canadian Forestry Service in the 1990's (Nixon *et al*. 2001), and by Bird Studies Canada (BSC) since 2002 have shown that Bicknell's Thrush inhabit two distinct habitat types at high elevations in Maritime Canada. Traditional "natural" breeding habitat is described as dense, stunted conifer stands, while non-traditional "industrial" habitat is comprised of relatively young, regenerating stands or plantations. A large proportion of the Maritime population of Bicknell's Thrush is found in industrial forest. Research conducted in New Brunswick by BSC and Dalhousie University has shown that the abundance of Bicknell's Thrush is significantly lower in forest stands after pre-commercial thinning (or release spacing; Chisholm 2005). It is therefore imperative that we understand what forest stand characteristics are important for Bicknell's Thrush and how silvicultural practices impact the species in Nova Scotia.

The objective of this report is to provide a description of "optimal" Bicknell's Thrush habitat in industrial forest in Cape Breton in order to allow Stora Enso to manage highland industrial habitat in a way that benefits Bicknell's Thrush. A description of optimal Bicknell's Thrush habitat in New Brunswick has already been completed (Campbell *et al*. 2005) and recommendations were presented to New Brunswick forest industry companies. Examination of habitat in New Scotia will be accomplished by using habitat data obtained from two sources: 1) BSC data from the High Elevation Landbird Program (HELP) surveys conducted on industrial forest managed by Stora Enso; and 2) data collected from surveys done by the Canadian Wildlife Service from 1996 to 1998 in the same area. Habitat data will include measurements obtained from on-the-ground vegetation sampling by BSC in 2005 and data from the Nova Scotia Forest Resource Inventory and the Stora Enso inventory.

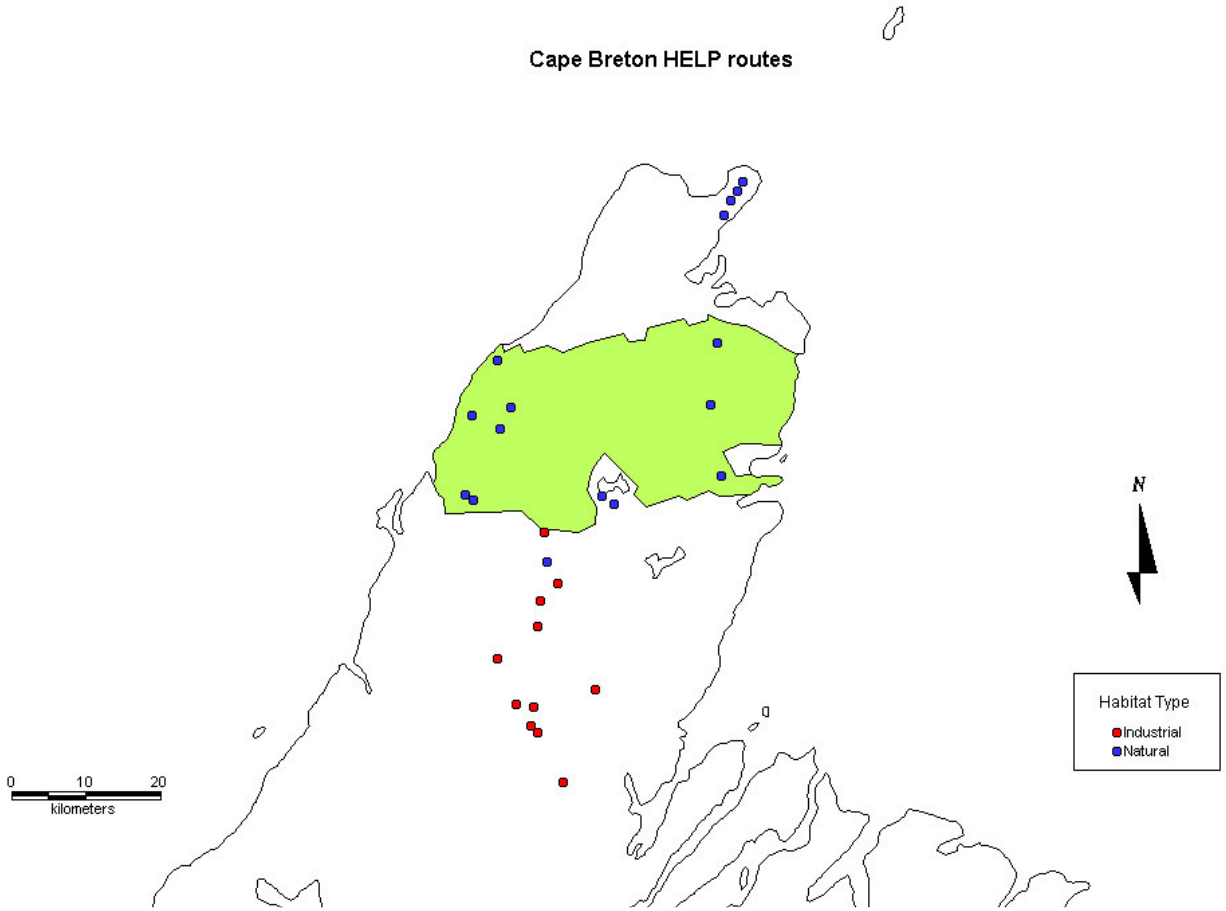

Figure 1: Location of HELP routes in Cape Breton. Industrial routes (red) were the ones considered in this project. Green background represents Cape Breton Highlands National Park.

Methods

Bird data

1. BSC surveys

Surveys for the HELP program are conducted on 11 survey routes in Stora industrial forest (Figure 1. An additional three HELP routes on Stora land are classified as Taiga, which we considered natural and therefore did not include in this research. The protocol for determining route site selection is described in the 2002 HELP report (Whittam and Ball, 2003). Survey routes are located along roads or trails, and are one kilometer in length with five point count stops spaced 250 meters apart. Surveys are run on every route once per year between the 4th and 25th of June. They start approximately 45 minutes before sunrise and/or 30 minutes before sunset. Surveys are not conducted in wind levels greater than four on the Beaufort scale or in conditions of more than trace amounts of precipitation. A 10 minute point count is conducted at each of the five points along the route. Presence of Bicknell's Thrush (and other high elevation landbirds) is noted, as well as estimated distance and direction from the observer.

2. CWS surveys

The Canadian Wildlife Service surveys were conducted from 1996 to 1998 using a haphazard sampling technique while driving along forest roads throughout Stora Enso's industrial land (D. Busby, pers. comm.). Surveys were conducted in a wide variety of stand types and elevations during the first year (1996). The following two years were more focused on higher elevation conifer-dominated stands. The protocol consisted of roadside playback of Bicknell's Thrush calls in order to elicit responses from the birds. The geographic locations of all playback points were recorded, and whether Bicknell's Thrushes had been detected or not.

Habitat data

1. BSC on-the-ground sampling

Vegetation structure and composition was measured in 12 stands on 10 different routes in July 2005. For routes which had never had a Bicknell's Thrush, one of the five survey points was randomly chosen for habitat sampling. For routes which had Bicknell's Thrush at least once in the four years of surveys, the point(s) which had Bicknell's Thrush were chosen. For each point, a 100 meter transect was placed starting at the point count location and continuing in a direction randomly selected by spinning the degree dial on a compass. Only directions greater than 10° from the bearing of the road were accepted. Three 1 m x 5 m plots that were separated by 40 m were sampled and placed alternately on opposite sides of the transect. Between transects the location of the first plot was alternated between 5 m, 10 m, and 15 m from the point. In each plot, trees and shrubs were identified to species, the number of stems were counted, and trees were classified based on their diameter at 20 cm above the ground into one of four size

categories (A: 0-2.5 cm, B: 2.5-5 cm, C: 5-10 cm, D: >10 cm). The numbers of tree stumps and fallen trees or branches in the plots were also counted and classified each into these size categories. The height of the four trees and four shrubs closes to each corner of the plot was also measured. Two 1m² quadrats were placed at each end of the plot where the percent ground cover of mosses, forbs, shrubs, ferns, lichens, bare rock/soil and leaf litter were estimated. The average stem density per stand (stems/ha) as well as average basal area per stand (m²/ha) was calculated.

Data from BSC ground sampling were used to compare habitat between Bicknell's Thrush present stands (BITH present) versus Bicknell's Thrush absent stands (BITH absent). Mann-Whitney U tests were then used to determine whether significant differences existed between habitat characteristics in BITH present and BITH absent stands.

2. Forest resource inventories

Habitat data for the CWS surveys were obtained through the Nova Scotia Forest Resource Inventory and the Stora Enso inventory. Ron Taylor of Stora Enso used a GIS algorithm to compile information from the forest inventories for stands situated within a 100 meter radius of all BSC and CWS survey stops (58 BSC and 237 CWS). The stands in which the Bicknell's Thrushes were observed during BSC surveys were determined by looking at the distance and direction taken when the birds were observed in the field. For BSC surveys which never had a Bicknell's Thrush, and also for the CWS surveys, the largest stand surrounding the survey point was assumed to be the stand of interest. Data were obtained for elevation, stand composition, stand age and stand treatment for most of the stands where Bicknell's Thrushes had been detected. The data were not always complete and some stands had to be omitted from certain analyses because of a lack of information in some key categories. In order to give a greater power to the results of the analyses, BSC stands were combined with the CWS stands. Mann-Whitney U tests were used to determine if differences for age and elevation were significant between BITH present and absent stands. Chi-square tests were used for stand treatment and species composition. Only variables for which the expected frequencies were ≥ 5 were considered.

Stand treatments were classified according to the following categories: CT = commercial thinning; NAT≤15 = natural regeneration 15 years old or younger; NAT>15 = natural regeneration older than 15 years; PL = plantation; RS = release spacing; RSP = release spacing of plantation.

Stands were classified into the following categories according to stand composition: BF = Balsam fir; BS = Black spruce; IH = intolerant hardwood, IHSW = intolerant hardword-softwood; NS = Norway spruce; SWD = softwood; SWMXWD = softwood-mixedwood; TH = tolerant hardwood; WS = White spruce; XS = Black spruce – Red spruce.

Certain assumptions were made regarding the forest inventories. The forest inventories were considered to be updated up to 2005. This had to be considered when calculating

stand age at the time the surveys were conducted. This also influenced the treatment variable for some stands. For example, if a stand was listed in the inventory as having undergone release spacing within the past five years and the bird survey was conducted in 1995, the stand was considered to be in the natural regeneration stand treatment category when the bird survey was conducted. This leads to another assumption, that release spacing (RS) and plantation release spacing (RSP) were considered to take place in regenerating stands of 15 years of age (Ron Taylor, pers. comm.). In cases where it was unclear what the age or treatment would have been at the time of the survey, the stand was omitted from analyses.

Results

BSC habitat sampling

A total of 12 stands were sampled in industrial habitat, 5 of which were in BITH present stands and 7 were in BITH absent stands. Results are summarized in Appendix 1. Only four habitat characteristics showed nearly significant ($P \leq 0.1$ but ≥ 0.05) variation between BITH present and absent stands. These were the number of white birch stems between 2.5 and 5 cm (2.6 ± 1.517 BITH present vs. 0.714 ± 0.756 BITH absent, P = 0.0615), the proportion of white birch stems (0.253 ± 0.109 vs. 0.14 ± 0.179, P = 0.105), percent ground covered by leaf litter (55.467 ± 12.949 vs. 37.905 ± 14.592, P = 0.0735) and conifer importance (0.604 ± 0.216 vs. 0.393 ± 0.226, P = 0.105). The importance value represents the proportion of total stem density and total basal area occupied by the species (mean of the percentage of total basal area and the percentage of total number of stems).

Other variables which did not vary significantly but had P values between 0.1 and 0.2 were the total stumps/ha (2400 ± 1861.899 vs. 1142.857 ± 1913.472, P = 0.1936), percent ground covered by moss (7.8 ± 5.162 vs. 18.524 ± 17.152, P = 0.196) and the proportion of conifer stems (0.454 ± 0.307 vs. 0.234 ± 0.219, P = 0.196).

Forest inventory data: BSC and CWS data

Data were obtained from the forest inventories for 23 BITH present and 272 BITH absent stands, using data from BSC's HELP survey and CWS surveys. No significant differences were observed for age (18.591 ± 9.236 years vs. 22.108 ± 14.909 years, P = 0.322) or elevation (437 ± 37.065 m vs. 422 ± 58.65 m, P = 0.254) between BITH present or absent stands. For results according to treatment type, the proportion of NAT≤15 (see Methods section or Figure 2 for treatment descriptions) stands was not significantly higher for BITH present stands ($X^2 = 1.927$, P = 0.16). Results for the NAT>15 treatment are not significant between BITH present and absent stands ($X^2 = 0.387$, P = 0.534). Sample sizes were considered too small for the other treatments.

In terms of species composition (see Figure 3), only Balsam fir (BF) had sufficient data for interpretation of results, which were not significant between BITH present and BITH absent ($X^2 = 0.631$, $P = 0.427$).

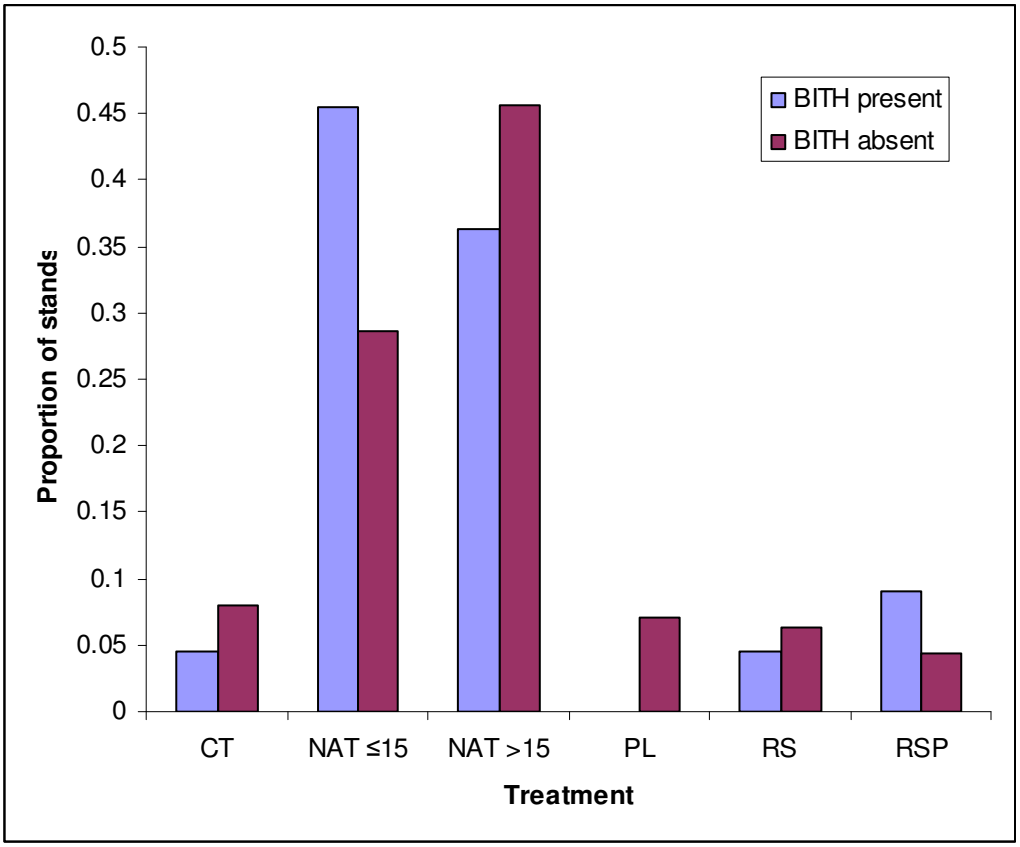

Figure 2: Comparison between BITH present (n = 20) and absent stands (n = 252) according to the proportion of stands in each treatment. (CT = commercial thinning, NAT≤15 = natural regeneration 15 years old or younger, NAT>15 = natural regeneration older than 15 years, PL = plantation, RS = release spacing, RSP = release spacing of plantation).

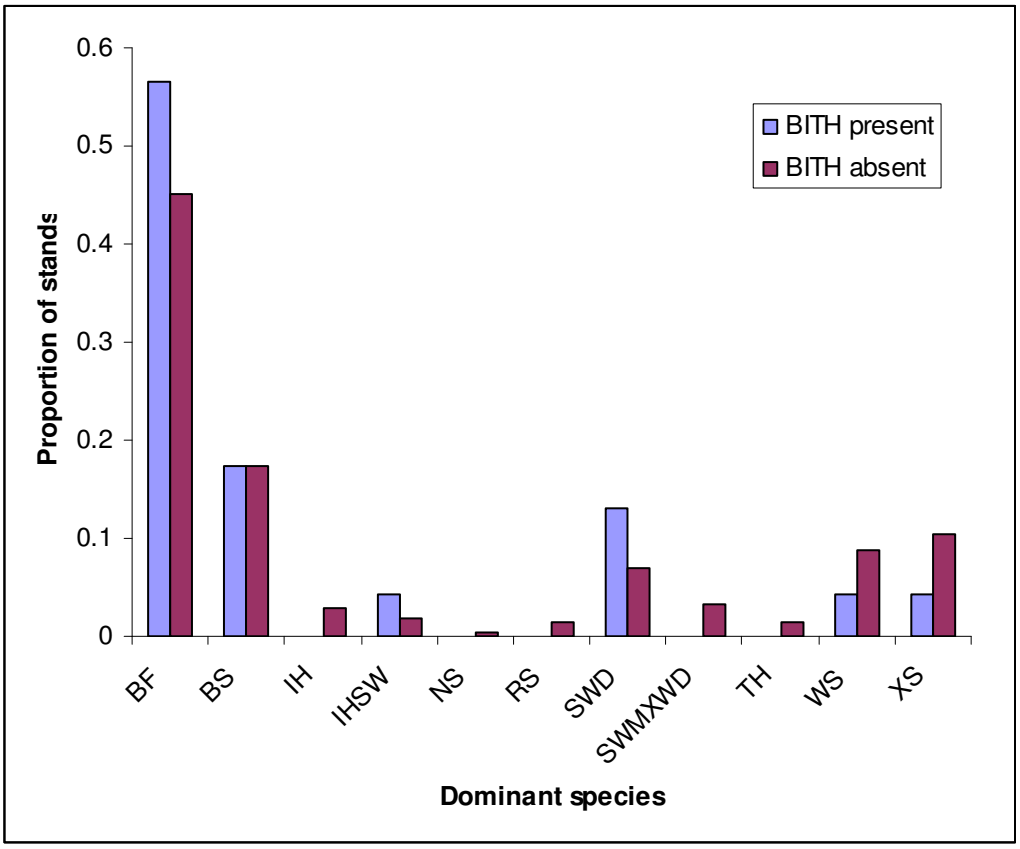

Figure 3: Comparison between BITH present (n = 23) and absent stands (n = 271) according to the proportion of stands for each species composition. (BF = Balsam fir, BS = Black spruce, IH = Intolerant hardwood, IHSW = Intolerant hardword-softwood, NS = Norway spruce, SWD = softwood, SWMXWD = softwood-mixedwood, TH = Tolerant hardwood, WS = White spruce, XS = Black spruce – Red spruce).

Discussion

BSC habitat sampling

Four variables showed a near-significant difference between BITH present and absent sites. White birch stems with a diameter of 2.5 to 5 cm and leaf litter were more abundant in present versus absent sites. White birch stems were also found to be an important component of BITH present stands in New Brunswick (Nixon et al. 2001, Chisholm 2005) and Québec (Connolly *et al*. 2002). White birch is generally one of the dominant early second-growth species, and is usually removed during pre-commercial thinning in Bicknell's Thrush habitat. A corollary of this is that leaf litter tends to be greater in stands before thinning (or release spacing) takes place (Chisholm 2005). The importance of conifers was nearly significantly higher (P = 0.105) in BITH present stands than in BITH absent stands. While this may seem at odds with the greater presence of white birch, nearly all white birch stems found in BITH present stands were of the same diameter class (2.5 to 5 cm), while there was generally a greater variety of a diameter class for

conifer stems, leading to a higher total basal area and importance. The presence of conifers is widely recognized as one of the important features of Bicknell's Thrush habitat and is a characteristic of high elevation habitat (Rimmer *et al*. 2001).

The higher total stump basal area in BITH present stands is not easily explained, but may be influenced by sample size, as the number of stumps in both present and absent stands was very small (18 in BITH present and 11 in BITH absent). The lower percent of moss ground cover in BITH present stands is also difficult to explain. The opposite was observed on Mont Mégantic in Québec (Connolly *et al*. 2002) where it is thought the greater moss cover at BITH present sites may be related to nest construction. In our case, one BITH absent stand had over 50% of moss ground cover, while the moss cover for the other BITH absent sites varied from 0.167% to 30%. The low sample size is likely the cause for the inflated effect observed from one stand having a value much higher than the others. This is also reflected in the standard deviation, which is nearly as high as the average in this case.

Forest inventory data

Detailed habitat sampling was not undertaken during the CWS bird surveys. Therefore, we had to use information from the forest inventories in order to be able to use the CWS data. Unfortunately, much of these data are primarily qualitative rather than quantitative and lack detail in most habitat features measured on the ground by BSC. However, the inventories are the only sources of information that are relatively easily available. Since the surveys were conducted nearly 10 years ago, doing habitat measurements now where the birds were originally detected was deemed to be of no value as the composition and structure of the habitat would have changed during that period. The only variables that were considered usable in the inventory in our situation were the elevation and stand age, which were measurable, and species composition and treatments applied, which were categorical.

BITH present stands were generally younger in age and at higher elevation than BITH absent stands, although neither was statistically significant. A large proportion of BITH present stands were NAT≤15, a result which is similar to that observed in New Brunswick, where naturally regenerating stands are pre-commercially thinned at approximately 15 years of age (Martin 2003, Chisholm 2005, Campbell et al. 2005), after which Bicknell's Thrush abundance drops dramatically. No comparison can be made however with New Brunswick for un-thinned regenerating stands of greater than 15 years of age as virtually all stands in New Brunswick undergo pre-commercial thinning at that age. It is not surprising however than Bicknell Thrush persists after 15 years in Nova Scotia if there is no sudden dramatic change in habitat, like that resulting from pre-commercial thinning.

A few BITH present stands fell into the RS and RSP categories. This was also observed in New Brunswick, where Bicknell's Thrush abundance appears to increase once again 4 to 8 years after pre-commercial thinning (Campbell et al. 2005). This might be explained by the shrub layer growing higher to form a dense understory of small stems over several

years to replace the thick vegetation which is greatly reduced by thinning (Chisholm 2005).

The majority of BITH present stands are dominated by Balsam fir (dominant = ≥70% of trees in the stand). However, this result was not significant as Balsam fir also comprised the majority of BITH absent stands, although in smaller proportions (57% of BITH present stands were dominated by BF vs. 45% of BITH absent stands). The sampling methods used for the BSC and CWS surveys likely influenced these results. HELP surveys were originally placed in habitat that was primarily coniferous, and CWS surveys were skewed toward coniferous habitat after the first year. That said, it is worth repeating that the presence of conifers is widely recognized as one of the important features of Bicknell's Thrush habitat across the species' range (Rimmer *et al*. 2001).

Conclusions

Very few Bicknell's Thrushes have been detected in industrial forest in Cape Breton since 2002. This may be due to a lack of adequate breeding habitat for the species in industrial land as Bicknell's Thrush abundance in Cape Breton Highlands National Park and in Cape North, though declining (BSC, unpubl. data), remains much higher. It is possible that the uneven distribution of regenerating stands over space and time may be partly responsible for the present lack of industrial breeding habitat in Nova Scotia. In New Brunswick, there is currently an abundance of regenerating stands, although a serious shortfall is projected to occur within the next few decades (Nixon 1999). In Cape Breton, the shortfall of young regenerating stands appears to be occurring now (Kari Easthouse pers. comm.). In order to conserve Bicknell's Thrush in industrial forest, it may be necessary to assure a more stable distribution of regenerating stands over space and time, and reduce large expanses of even-aged forest.

The dearth of Bicknell's Thrush detections over 4 years of BSC surveys also made it difficult to obtain significant results when comparing habitat characteristics between BITH present and BITH absent stands due to small sample sizes. However, our results suggest several conclusions which were also evident in BITH present stands New Brunswick (Nixon *et al*. 2001, Campbell *et al*. 2005, Chisholm 2005):

- conifers are important to Bicknell's Thrushes
- Bicknell's Thrushes prefer stands with a high density of small White birch stems, generally present in regenerating stands prior to pre-commercial thinning (≤ 15 years of age)
- Bicknell's Thrushes prefer stands with a high percentage of ground cover from leaf litter

One surprising result from July 2005 habitat measurements is that tree stem density did not appear to be important for Bicknell's Thrush. However, this is almost certainly due to the low sample size for BITH present stands, as stem density is usually one of the most important factors in Bicknell's Thrush stands and is considered to be the main reason

why Bicknell's Thrush abundance declines drastically after pre-commercial thinning (Campbell et *al*. 2005, Chisholm 2005). Indeed, average stem density in Bicknell's Thrush stands is known to reach over 49,000 stems/ha in the Christmas Mountains of north-central New Brunswick (Campbell *et al*. 2005). It is obvious that more Bicknell's Thrush detections are necessary to obtain a more accurate picture of this species' habitat requirements in Nova Scotia. Finding nests and measuring breeding success in stands of varying ages and treatments would also be an extremely valuable undertaking. However, considering the very low numbers of Bicknell's Thrush currently present in Nova Scotia's industrial forest, this would likely require a great deal of effort, with uncertain results.

Recommendations for future research

- Continue HELP surveys annually in Cape Breton. HELP has been ongoing since 2002 and four years of data have been collected. The project provides the necessary backbone for studies of habitat use by these otherwise poorly monitored species.
- Examine the feasibility of using another high elevation landbird as an indicator of forest management practices on highland forest. The Fox Sparrow would be a good candidate given that it shares similar habitat with Bicknell's Thrush yet is considerably more common than Bicknell's Thrush. The HELP database currently includes 61 Fox Sparrow detections on industrial forest routes. This may make the Fox Sparrow a practical indicator species along with Bicknell's Thrush.

Recommendations to Stora Enso for management of crown lease to benefit Bicknell's Thrush

The following recommendations are based on more detailed research conducted in New Brunswick (Campbell *et al*. 2005, Chisholm 2005) as well as the results of this study which suggests that Bicknell's Thrushes prefer forest stands in the years prior pre-commercial thinning (release spacing).

Forest managers are encouraged to consider the following modifications to pre-commercial thinning operations. These recommendations are based on the best available knowledge of Bicknell's Thrush biology and habitat preferences to date:

1. When possible, schedule thinning in optimal Bicknell's Thrush stands either before June 1st or after July 31st, to reduce disruption during the breeding season. Bicknell's Thrushes have very low reproductive rates, so every breeding season is very important in maintaining healthy population numbers.

2. When optimal Bicknell's Thrush stands need to be thinned, leave un-thinned edges or patches of un-thinned habitat > 0.1 ha, and connect these "islands" to larger patches of un-thinned habitat whenever possible.

3. Manage industrial forest with a “no net loss” policy, by ensuring that for every optimal Bicknell’s Thrush stand which is thinned, an un-thinned stand of equal size reaches optimal characteristics the following year.

4. Maintain close contact with organizations like Bird Studies Canada, Maritime universities, and the provincial Department of Natural Resources to remain aware of the most current research findings.

Acknowledgments

Thanks to the Nova Forest Alliance for supporting this work. We thank the Nova Scotia Department of Natural Resources and Stora Enso for the use of their forest inventories. Ron Taylor of Stora Enso provided invaluable help with the GIS work and interpretation of the forest inventories. Kari Easthouse and Andrea Doucette of Stora Enso also provided advice and guidance in interpreting the forest inventories. Dan Busby of the Canadian Wildlife Service provided us with data from Bicknell’s Thrush surveys. The Government of Canada Habitat Stewardship Program for Species At Risk and the Canadian Wildlife Service, Environment Canada and Human Resources and Skills Development Canada provided funding for the High Elevation Landbird Program in Nova Scotia. Thanks to the following people who have conducted surveys for the HELP program on Stora lands over the last four years: Ramsey Hart, Ande Coles, Brian Farewell, Pierre Goulet, Beth Flanigan, Mike Russell, Margie Amos, Chris Stratton and Clark Brander. Robert Gardiner and Becky Harris collected habitat data in July 2005.

References cited

Campbell, G. and B. Whittam. 2005. High Elevation Landbird Program, 2004 report. Unpublished report, Bird Studies Canada, Sackville, NB.

Campbell, G., B. Whittam and S. Chisholm. 2005. Bicknell’s Thrush in New Brunswick Forests: What we know, what we need to know, and how the forestry industry can help. Unpublished report, Bird Studies Canada, Sackville, NB.

Chisholm, S.E. 2005. The impact of precommercial thinning on abundance of Bicknell’s Thrush and other high elevation birds. M.Sc. Thesis, Dalhousie University, Halifax, Nova Scotia, Canada.

Connolly, V., G. Seutin, J.-P. L. Savard and G. Rompré. 2002. Habitat use by the Bicknell’s Thrush in the Estrie region, Québec. Wilson Bulletin: 114 (3): 33-341

Martin, G. 2003. Management of New Brunswick’s Crown Forest. New Brunswick Department of Natural Resources, Fredericton, New Brunswick, Canada.

Nixon, E.A. 1999. Status report on Bicknell's Thrush *Catharus bicknelli* in Canada. Unpublished report to the Committee on the Status of Endangered Wildlife in Canada, Environment Canada, Ottawa.

Nixon, E.A., S.B. Holmes and A.W. Diamond. 2001. Bicknell's Thrushes (*Catharus bicknelli*) in New Brunswick clear cuts: their habitat associations and co-occurrence with Swainson's Thrushes (*Catharus ustulatus*). Wilson Bulletin: 113 (1): 33-40

Rimmer, C.C., K.P. McFarland, W.G. Ellison and J.E. Goetz. 2001. Bicknell's Thrush (*Catharus bicknelli*). *In* The Birds of North America, No. 592 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Whittam, B. and M. Ball. 2003. High Elevation Landbird Program, 2002 report. Unpublished report, Bird Studies Canada, Sackville, NB.

Appendix 1: Summary of BSC habitat data for Bicknell's Thrush present and absent sites. P-values indicate significance of Mann-Whitney U test.

Variable	BITH present (n=5)		BITH absent (n=7)		P-value
	Average	SD	Average	SD	
Elevation (m)	436.8	20.717	428.857	40.839	0.6241
branches/ha	7333.33	5792.72	6190.48	6082.33	0.749
stumps/ha	2400	1861.899	1142.857	1913.472	0.1936
Tree height (m)	5.034	1.815	4.474	1.486	0.5157
% Ferns	9.433	9.235	10.238	8.613	0.749
% Moss	7.8	5.162	18.524	17.152	0.1936
% Forbs	25.067	12.844	29.976	20.543	0.749
% Shrubs	1.4	1.321	1.571	2.767	0.749
% Lichens	0.167	0.373	0.238	0.358	0.6818
% Rock/Soil	0.667	1.491	1.548	2.903	0.8103
% Leaf Litter	55.467	12.949	37.905	14.592	0.0735
Balsam fir stems/ha	5200	2764.859	4666.667	3548.604	0.6818
Balsam fir basal area (m²/ha)	14.36637	7.735835	17.04038	12.483	1
Proportion Balsam fir stems	0.408384	0.355712	0.233694	0.219598	0.332
Balsam fir importance	0.517	0.303	0.393	0.226	0.4179
White birch B stems	2.6	1.517	0.714	0.756	0.0615
White birch stems/ha	4266.667	2290.075	2761.905	2839.629	0.3735
White birch basal area (m²/ha)	3.943387	3.345067	4.347724	6.220861	0.6241
Proportion White birch stems	0.253312	0.109135	0.140056	0.17869	0.1052
White birch importance	0.201	0.055	0.136	0.118	0.5157
Conifer stems/ha	6000	1333.333	4666.667	3548.604	0.3735
Conifer basal area (m²/ha)	16.00264	5.14879	17.04038	12.483	0.8729
Proportion conifer stems	0.454538	0.307406	0.233694	0.219598	0.1936
Conifer importance	0.604118	0.215753	0.392964	0.225796	0.1052
Deciduous stems/ha	5866.667	4531.372	9619.048	12072.97	0.4179
Deciduous basal area (m²/ha)	5.939627	6.132351	6.907229	5.915393	0.749
Proportion deciduous stems	0.218247	0.174307	0.266634	0.135639	0.4179
Deciduous importance	0.280794	0.187005	0.300594	0.198829	0.749
Shrub stems/ha	6666.667	12463.28	19333.33	28189.83	0.332
Shrub basal area (m²/ha)	0.818	1.529244	2.55921	3.471036	0.2543
Proportion shrub stems	0.202122	0.323211	0.431752	0.374175	0.332
Shrub importance	0.115088	0.18263	0.306442	0.29072	0.2543
Total stems/ha	18533.33	12012.96	33619.05	25472.88	0.2543
Total basal area (m²/ha)	22.76027	10.35058	26.50682	16.63094	0.6241

Appendix 2: Bird Survey coordinates.

BSC HELP survey:

BITH present

Stop	Latitude	Longitude	Stop	Latitude	Longitude
19-5	46.54169	-60.7481	42-4	46.44044	-60.8412
21-4	46.52228	-60.7724	42-5	46.43934	-60.8444
24-3	46.39411	-60.8169	43-1	46.38865	-60.7806
29-2	46.48228	-60.7729	44-5	46.36647	-60.7991
35-1	46.29890	-60.7294	45-1	46.35696	-60.7744
42-1	46.44682	-60.8446	46-3	46.41239	-60.6766

BITH absent

Stop	Latitude	Longitude	Stop	Latitude	Longitude
10-4	46.60908	-61.1017	29-4	46.47667	-60.7719
19-1	46.53539	-60.7389	29-5	46.47444	-60.7731
19-2	46.53736	-60.7405	30-1	46.57433	-60.8875
19-3	46.53967	-60.7422	30-2	46.57578	-60.8900
19-4	46.54094	-60.7449	30-3	46.57469	-60.8930
19-5	46.54169	-60.7481	30-4	46.57250	-60.8937
21-1	46.48711	-60.7738	35-1	46.29890	-60.7294
21-2	46.51764	-60.7713	35-3	46.29747	-60.7229
21-3	46.52017	-60.7722	35-4	46.29864	-60.7201
21-4	46.52228	-60.7724	42-2	46.44458	-60.8439
23-3	46.48417	-60.7915	43-1	46.38865	-60.7806
23-4	46.48208	-60.7903	43-3	46.38405	-60.7813
23-5	46.48006	-60.7889	43-5	46.37928	-60.7806
24-1	46.39089	-60.8124	44-1	46.36585	-60.7858
24-4	46.39578	-60.8191	44-2	46.36532	-60.7892
24-5	46.39744	-60.8213	44-3	46.36494	-60.7926
25-1	46.38067	-60.8292	44-4	46.36547	-60.7960
25-2	46.38283	-60.8293	45-1	46.35696	-60.7744
25-3	46.40017	-60.8302	45-2	46.35842	-60.7717
25-4	46.38717	-60.8320	45-5	46.36266	-60.7636
25-5	46.38917	-60.8337	46-1	46.40846	-60.6732
26-2	46.41494	-60.8009	46-2	46.41043	-60.6748
26-3	46.41278	-60.8021	46-3	46.41239	-60.6766
26-4	46.41044	-60.8024	46-4	46.41449	-60.6782
26-5	46.40828	-60.8029	46-5	46.41650	-60.6797
29-3	46.47917	-60.7725			

CWS:

BITH present

ID	Latitude	Longitude	ID	Latitude	Longitude
30	46.373	-60.876	97	46.502	-60.833
45	46.504	-60.984	136	46.486	-60.858
55	46.517	-60.825	143	46.464	-60.780
59	46.517	-60.819	167	46.475	-60.832
60	46.519	-60.816	169	46.472	-60.817
61	46.520	-60.810	178	46.485	-60.845
62	46.518	-60.800	252	46.608	-60.770
69	46.516	-60.795			

BITH absent

ID	Latitude	Longitude	ID	Latitude	Longitude
1	46.300	-60.821	127	46.478	-60.774
2	46.321	-60.858	128	46.500	-60.820
3	46.329	-60.775	129	46.497	-60.813
4	46.271	-60.825	130	46.498	-60.811
5	46.292	-60.829	131	46.496	-60.807
6	46.317	-60.817	132	46.473	-60.888
7	46.325	-60.842	133	46.473	-60.884
8	46.274	-60.831	134	46.477	-60.881
9	46.335	-60.820	135	46.477	-60.864
10	46.365	-60.792	137	46.489	-60.856
11	46.373	-60.771	138	46.491	-60.853
12	46.381	-60.783	139	46.456	-60.771
13	46.344	-60.754	140	46.454	-60.785
14	46.347	-60.852	141	46.473	-60.777
15	46.571	-60.632	142	46.467	-60.781
16	46.586	-60.640	144	46.462	-60.775
17	46.603	-60.642	145	46.465	-60.784
21	46.612	-60.643	146	46.459	-60.788
22	46.382	-60.819	147	46.370	-60.901
23	46.502	-60.763	148	46.368	-60.911
24	46.541	-60.642	149	46.364	-60.929
25	46.550	-60.608	150	46.366	-60.820
26	46.380	-60.841	151	46.350	-60.805
27	46.370	-60.904	152	46.354	-60.811
28	46.373	-60.897	153	46.355	-60.819
29	46.374	-60.894	154	46.353	-60.844
31	46.378	-60.861	155	46.352	-60.849
32	46.379	-60.856	156	46.354	-60.832
33	46.379	-60.852	157	46.355	-60.827
34	46.379	-60.848	158	46.447	-60.809
35	46.393	-60.807	159	46.443	-60.804
36	46.545	-60.756	160	46.437	-60.794
38	46.608	-60.769	161	46.482	-60.843
39	46.611	-60.776	162	46.477	-60.848
40	46.441	-60.992	163	46.480	-60.840
41	46.454	-60.978	164	46.489	-60.840
42	46.467	-60.985	165	46.486	-60.837
43	46.493	-60.971	166	46.476	-60.835
44	46.496	-60.983	168	46.471	-60.827
47	46.504	-60.986	170	46.476	-60.820

48	46.502	-60.993	171	46.470	-60.811
49	46.503	-60.997	172	46.467	-60.815
50	46.504	-60.999	173	46.469	-60.804
51	46.506	-61.001	174	46.461	-60.810
52	46.507	-61.002	175	46.458	-60.795
53	46.509	-61.006	176	46.456	-60.792
56	46.515	-60.830	177	46.492	-60.851
57	46.518	-60.832	179	46.443	-60.790
58	46.517	-60.823	180	46.438	-60.791
63	46.538	-60.804	181	46.426	-60.807
64	46.533	-60.807	182	46.424	-60.808
65	46.536	-60.784	183	46.414	-60.803
66	46.528	-60.775	184	46.399	-60.805
67	46.517	-60.771	185	46.410	-60.741
68	46.520	-60.799	186	46.407	-60.738
70	46.516	-60.790	187	46.406	-60.734
71	46.516	-60.771	188	46.401	-60.737
72	46.508	-60.811	189	46.398	-60.739
73	46.511	-60.794	190	46.390	-60.734
74	46.511	-60.786	191	46.446	-60.701
75	46.515	-60.780	192	46.403	-60.772
76	46.516	-60.773	193	46.439	-60.704
77	46.514	-60.765	194	46.426	-60.710
78	46.523	-60.795	195	46.421	-60.715
79	46.392	-60.884	196	46.415	-60.736
80	46.385	-60.882	197	46.414	-60.743
81	46.381	-60.882	198	46.409	-60.745
82	46.381	-60.892	199	46.409	-60.750
83	46.304	-60.920	200	46.402	-60.767
84	46.309	-60.922	201	46.434	-60.695
85	46.341	-60.878	202	46.413	-60.753
86	46.330	-60.875	203	46.252	-60.868
87	46.351	-60.870	204	46.254	-60.861
88	46.358	-60.890	205	46.255	-60.857
89	46.357	-60.878	206	46.251	-60.855
90	46.367	-60.882	207	46.253	-60.850
91	46.373	-60.879	208	46.253	-60.836
93	46.376	-60.885	209	46.255	-60.821
94	46.376	-60.862	210	46.269	-60.825
95	46.508	-60.860	211	46.256	-60.819
96	46.505	-60.836	212	46.214	-60.823
98	46.498	-60.832	213	46.206	-60.835
99	46.501	-60.828	214	46.171	-60.843
100	46.455	-60.699	215	46.597	-60.835
101	46.468	-60.716	216	46.548	-60.876
102	46.474	-60.700	217	46.511	-60.927
103	46.479	-60.698	219	46.230	-61.041
104	46.488	-60.697	220	46.229	-61.036
105	46.448	-60.688	221	46.216	-61.016
106	46.507	-60.763	222	46.209	-61.021
107	46.497	-60.765	223	46.202	-61.030
108	46.488	-60.774	224	46.199	-61.040
109	46.508	-60.745	225	46.231	-61.177
110	46.461	-60.886	227	46.357	-60.584
111	46.435	-60.889	233	46.290	-60.609
112	46.437	-60.869	234	46.348	-60.657

113	46.421	-60.853	235	46.344	-60.655
114	46.423	-60.848	236	46.339	-60.654
115	46.414	-60.875	237	46.326	-60.648
116	46.403	-60.830	240	46.297	-60.644
117	46.395	-60.818	242	46.278	-60.640
118	46.389	-60.810	245	46.596	-60.400
119	46.375	-60.847	246	46.625	-60.830
120	46.385	-60.809	247	46.624	-60.822
121	46.388	-60.852	248	46.624	-60.816
122	46.400	-60.848	249	46.624	-60.809
123	46.388	-60.832	250	46.622	-60.801
124	46.381	-60.829	251	46.621	-60.798
125	46.490	-60.794	253	46.607	-60.768
126	46.479	-60.785	254	46.606	-60.765