

COSEWIC
Assessment and Status Report

on the

Bicknell's Thrush
Catharus bicknelli

in Canada



THREATENED
2009

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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COSEWIC Assessment Summary

Assessment Summary – November 2009

Common name

Bicknell's Thrush

Scientific name

Catharus bicknelli

Status

Threatened

Reason for designation

This species has one of the most restricted breeding ranges among the forest birds of North America. It inhabits the forests of montane and cool coastal zones, as well as high elevation regenerating forests over 600m in Quebec, New Brunswick, Nova Scotia and the northeastern United States. It winters in the Greater Antilles, where the bulk of its population appears to be in the Dominican Republic. Despite the difficulty of adequately monitoring the species, all the available indices on trends point to significant declines in population and area of occupancy. Preliminary results from the Maritimes Breeding Bird Atlas project suggest a 40% decline in the area occupied over the last three generations, while the High Elevation Landbirds Program suggests more dramatic declines in the same regions. Recent surveys in Quebec also indicate declines in some locations. While reasons for the decline are unclear, habitat loss on the wintering grounds, management practices such as pre-commercial thinning in regenerating forests and climate change are leading to a reduction of suitable high-elevation habitat.

Occurrence

Quebec, New Brunswick, Nova Scotia

Status history

Designated Special Concern in April 1999. Status re-examined and designated Threatened in November 2009.



COSEWIC
Executive Summary

Bicknell's Thrush
Catharus bicknelli

Species information

The Bicknell's Thrush is the smallest of the northern *Catharus* thrushes. Both males and females have distinctive warm brown feathers on the back, with a chestnut-brown tint on the upper tail feathers and on the primaries when the wings are folded. It is similar to the other northern *Catharus* thrushes, particularly the Gray-cheeked Thrush.

Distribution

The Bicknell's Thrush has one of the most restricted breeding ranges among the forest birds of North America and has a fragmented breeding distribution. It is limited to high elevations of the mountain ranges of the northeastern United States and southeastern Canada, as well as to some coastal and lowland areas in Canada. The species may have disappeared from some sites previously occupied, mostly at the periphery of its range.

The Bicknell's Thrush winters in the Greater Antilles, where the bulk of its population appears to be in the Dominican Republic. The species also occurs in smaller numbers in southwestern and eastern Haiti and in the Sierra Maestra of southeastern Cuba.

Habitat

The Bicknell's Thrush is a habitat specialist, generally associated with undisturbed dense habitat or disturbed areas undergoing vigorous succession (mid-successional) of Balsam Fir-dominated habitat and high stem densities (>10,000–15,000 stems/ha). Three breeding habitat types have been identified: montane/high-elevation forests, coastal lowlands and highland-industrial forests. In montane/high-elevation areas, the Bicknell's Thrush selects undisturbed habitats and regenerating forests disturbed by fir waves, windthrows, ice and snow damage, fire, and insect outbreaks (e.g. spruce budworm infestation) and characterized by standing dead conifers and dense regrowth of Balsam Fir. The species also uses chronically disturbed, stunted-tree stands. In coastal areas it selects dense spruce-fir stands maintained by cool sea breezes and a high precipitation regime. In highland-industrial forests, the Bicknell's Thrush may be found in dense coniferous or sometimes dense mixed second-growth regenerating stands.

Biology

The Bicknell's Thrush has an unusual breeding system defined by multiple male and female partners. A single male may sire nestlings in different nests in a single season and may or may not provide food to those broods. Males are not territorial and home-ranges usually overlap. Male home-ranges may overlap two female home-ranges, which are usually discrete.

The Bicknell's Thrush has a highly skewed sex-ratio; 1 female: 1.49 to 3.0 males. Survivorship of summer-resident adults has been estimated at 0.65 ± 0.04 (\pm SE) in Vermont, and at 0.28 ± 0.11 for females and 0.63 ± 0.07 for males in Quebec. On the breeding grounds, predation may be a key limiting factor for Bicknell's Thrush productivity. The longevity record for the Bicknell's Thrush is 11 years while the annual mean age varies between 1.73 and 2.44 years. Generation time is estimated to be 2 to 3 years.

Population sizes and trends

The current population estimate for the Bicknell's Thrush in Canada is between 40,570 and 49,258 birds. Results from the second Maritime Breeding Bird Atlas show a greater than 40% decline in the distribution of the species over the last 10 years. Data from the High Elevation Landbird Program also show significant declines of 20.2%/year and 18.9%/year in New Brunswick and Nova Scotia, respectively, between 2002 and 2008, which amounts to population losses of over 70%. Similarly, data from the Mont Gosford Monitoring Program in Quebec show a significant decrease in occupancy rates between 2001 and 2007 at survey sites, although abundance in occupied sites did not differ significantly during this time.

Limiting factors and threats

On the breeding grounds, management practices, such as pre-commercial thinning, decrease breeding habitat in the medium term by significantly reducing Balsam Fir stem density. Increasing temperatures resulting from climate change are facilitating the progression in altitude of the Hardwood-Balsam Fir/Spruce-Mountain forest ecotone, thus reducing the amount of breeding habitat for the Bicknell's Thrush. The rapid expansion of communication towers, "green-energy"/ wind turbines and recreational projects in the Bicknell's Thrush breeding range also contributes to habitat loss and fragmentation.

On the wintering grounds major habitat losses have occurred on Hispaniola Island (Haiti and Dominican Republic), which is the stronghold of the species' wintering range. The conversion of those lands for human uses is likely the main driving factor of the species decline. There is no indication that this phenomenon is slowing down.

Special significance of the species

Finding Bicknell's Thrush is a challenge for birdwatchers and ornithologists because of their remote high elevation and impenetrable forest habitat. This species also qualifies as a potential, long-term indicator of the health of subalpine forest habitats and its avian populations.

Existing protection

The Bicknell's Thrush is protected in Canada under the *Migratory Birds Convention Act, 1994* and in the U.S. under the *Migratory Bird Treaty Act, 1918*. COSEWIC assessed this species as Special Concern in April 1999 and it is federally listed as Special Concern under Schedule 3 of the *Species At Risk Act*. It is designated as Vulnerable in Quebec, May Be at Risk in New Brunswick and Vulnerable in Nova Scotia.

In the United States, the species is on the Audubon Watchlist (Red) as well as the USFWS Birds of Conservation Concern (National concern). It is a Special Concern species and a Species of Greatest Conservation Need (SGCN) in New York, Vermont, New Hampshire, and Maine. Partners in Flight (PIF) has identified the species as the highest conservation priority among neotropical migrants in the Northeast. It appears on the World Conservation Union Red List (Vulnerable).



COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2009)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



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2009

TABLE OF CONTENTS

SPECIES INFORMATION.....	4
Name and classification.....	4
Morphological description.....	4
Genetic description.....	5
Designatable units.....	5
DISTRIBUTION.....	6
Global range.....	6
Canadian range.....	8
Changes in distribution in Canada.....	9
Changes in distribution in the United States.....	9
HABITAT.....	10
Habitat requirements.....	10
Habitat trends.....	12
Habitat protection/ownership.....	15
BIOLOGY.....	17
Life cycle and reproduction.....	17
Survival.....	17
Migration.....	18
Food.....	18
Predation.....	18
Physiology.....	19
Dispersal/migration.....	19
Interspecific interactions.....	19
Adaptability.....	20
POPULATION SIZE AND TRENDS.....	20
Search effort and monitoring programs.....	20
Abundance.....	23
Fluctuations and trends.....	25
Rescue effect.....	30
LIMITING FACTORS AND THREATS.....	31
Breeding habitat.....	31
SPECIAL SIGNIFICANCE OF THE SPECIES.....	33
EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS.....	33
TECHNICAL SUMMARY.....	35
ACKNOWLEDGEMENTS.....	38
AUTHORITIES CONSULTED.....	38
INFORMATION SOURCES.....	39
BIOGRAPHICAL SUMMARY OF REPORT WRITERS.....	44

List of Figures

Figure 1. Breeding and wintering range for the Bicknell's Thrush	7
Figure 2. Breeding range of the Bicknell's Thrush based on breeding season records, between 1998 and 2007, collected by the report authors.....	8
Figure 3. Number of ha of pre-commercially thinned forest in NB, NS and QC between 1990 and 2007, including both private and crown land	14
Figure 4. Bicknell's Thrush occurrences and absences in Canada and the U.S. from specific search and monitoring efforts between 1998 and 2007.....	21
Figure 5. Mean abundance plus 95% CI's in fir dominant and non-dominant habitats at Mont Gosford, Quebec, 2001-2007.....	25
Figure 6. Mean probability of occupancy plus 95% CI's for Bicknell's Thrush at Mont Gosford, Quebec, 2001-2007.....	26
Figure 7. Mean (+SE) number of Bicknell's Thrush per route in New Brunswick and Nova Scotia, 2002 - 2008.....	27
Figure 8. Mean (+SE) proportion of plots occupied per route by Bicknell's Thrush in New Brunswick and Nova Scotia, 2002-2008.	27
Figure 9. Breeding range of the Bicknell's Thrush in the Maritime Provinces according to the first three years (2006 - 2008) of the Maritime Breeding Bird Atlas project.	29

List of Tables

Table 1. Microsatellite genetic variation based on mean number of alleles (\bar{A})(SD) and expected heterozygosity (HE) (SD) for 5 loci that cross amplify in the following three species: Bicknell's Thrush (Cbi), Gray-cheeked Thrush (Cmi), and Swainson's Thrush (Cus)	5
Table 2. Area and percent of potential breeding habitat both within Canada and globally for Bicknell's Thrush based on a habitat model.....	6
Table 3. Total protected area of potential Bicknell's Thrush habitat within its Canadian breeding range	16
Table 4. Population estimates for the Bicknell's Thrush in Canada.	24
Table 5. Conservation status (NatureServe 2009) and state listings for Bicknell's Thrush in North America.	34

SPECIES INFORMATION

Name and classification

Class: Aves
Order: Passeriformes
Family: Emberizidae
Genus: *Catharus*
Species: *Catharus bicknelli* (Ridgway 1882)
English name: Bicknell's Thrush
French name: Grive de Bicknell

The Bicknell's Thrush was discovered in 1882 and was initially considered a subspecies of Gray-cheeked Thrush (*Catharus minimus*). It was elevated to the level of species in 1995 (*Catharus bicknelli*; AOU 1995) based on evidence from Ouellet (1993) showing differences in morphology, vocalizations, habitat selection, distribution and genetics. This decision was challenged by Marshall (2001), but is consistent with non-overlap of mtDNA (cytochrome oxidase I) sequences of 12 *C. bicknelli* and 3 *C. minimus* (Kerr *et al.* 2007).

Morphological description

The Bicknell's Thrush is the smallest of the northern *Catharus* thrushes (body length: 16-18 cm; body mass: 25-30 g). Its upperparts are mainly drab olive brown, with dark spots on the throat, breast, and flanks. Bicknell's Thrush has distinctive warm brown feathers on the back, with a chestnut-brown tint on the upper tail feathers and on the primaries when the wings are folded. In the breeding season its lower mandible is pale yellow on at least the proximal half. There is no clear sexual dimorphism; males can be slightly larger than females. The Bicknell's Thrush is similar to the other northern *Catharus* thrushes, particularly the larger Gray-cheeked Thrush. Compared to Bicknell's Thrush, the Gray-cheeked Thrush has more uniform gray-olive upperparts and a pinkish lower mandible, the Hermit Thrush (*C. guttatus*) has a richer cinnamon upper tail and bold breast spots, the Veery (*C. fuscescens*) has rich reddish-brown upperparts and a few faded breast spots, and the Swainson's Thrush (*C. ustulatus*) has a larger body size, with uniform olive to olive-brown upperparts and a distinctive pale eye-ring (Pyle 1997).

Genetic description

In mitochondrial DNA (mtDNA) analyses using a RFLP technique, Ouellet (1993) showed differentiation between *C. minimus* and *C. bicknelli*. The sequence divergence between these taxa was 1.7%, which is greater than between many sibling species pairs studied (Avice and Zink 1988). McEachen *et al.* (2004) revealed a divergence of 1.35% based on the sequencing of the mtDNA cytochrome b gene for the same pair of taxa, but it also showed a level of divergence of 0.74% between *C. bicknelli* and *C. fuscescens* and 1.15% between *C. minimus* and *C. fuscescens*. The analyses also found that these three species are more closely related among themselves compared to other northeastern *Catharus*. This was also found by Outlaw *et al.* (2003) and Ellison (2001). Work by Wilson *et al.* (2004) also confirmed that the Newfoundland “Gray-cheeked Thrush” birds are of *C. minimus* origin.

Analysis of variation in mitochondrial control region sequences of 43 *C. bicknelli* from four sites in New England detected weak but statistically nonsignificant population differentiation (Ellison 2001). This subtle genetic structure would not warrant consideration of “genetically distinct units” in this area. The levels of genetic variation in five microsatellite loci in Bicknell’s Thrush are in the range detected for other related species for both allelic diversity and expected heterozygosity (Table 1; Wilson *et al.* unpubl. data).

Table 1. Microsatellite genetic variation based on mean number of alleles (\bar{A})(SD) and expected heterozygosity (H_E) (SD) for 5 loci that cross amplify in the following three species: Bicknell’s Thrush (Cbi), Gray-cheeked Thrush (Cmi), and Swainson’s Thrush (Cus)(Wilson *et al.* 2004).

Region	Species	n	\bar{A}	H_E
Cuba	Cbi	14	7.6 (3.9)	0.676 (0.237)
Mine Madeleine, QC	Cbi	30	10.4 (5.9)	0.612 (0.203)
Mont Gosford, QC	Cbi	22	10.6 (4.2)	0.561 (0.171)
Mount Carleton, NB	Cbi	7	5.6 (1.5)	0.627 (0.215)
Cape Breton, NS	Cbi	12	7.4 (3.2)	0.689 (0.236)
Zec des Martres, QC	Cbi	9	5.8 (3.6)	0.633 (0.319)
Gull Is, NL	Cmi	13	8.0 (2.1)	0.779 (0.276)
Mine Madeleine, QC	Cus	10	8.4 (3.1)	0.640 (0.195)
Mont Gosford, QC	Cus	19	8.6 (2.3)	0.643 (0.345)

Designatable units

There are no subspecies of the Bicknell’s Thrush and no known distinctions between populations that would warrant consideration of designatable units below the species level. The report is, therefore, based on the species as a whole.

DISTRIBUTION

Global range

The Bicknell's Thrush has one of the most restricted breeding ranges of North American forest birds and is found exclusively in the northeastern part of the continent. It occurs in western Maine, New Hampshire, Vermont, eastern New York State, southern Quebec, northcentral New Brunswick, and northern Nova Scotia (Figure 1; Erskine 1992; Gauthier and Aubry 1995).

Approximately 95% of the potential breeding habitat for the Bicknell's Thrush occurs in Canada, of which 95% occurs in Quebec (Table 2). These estimates are derived from a habitat model using the known occurrences of the species (>1,600 records) across its entire breeding range and habitat variables, including the occurrence of Balsam Fir (*Abies balsamea*) dominated forest stands, in addition to latitude, longitude and altitude variables (Hart *et al.* in prep., after Lambert *et al.* 2005).

Table 2. Area and percent of potential breeding habitat both within Canada and globally for Bicknell's Thrush based on a habitat model (Hart *et al.* in prep.).

Province/Country	Area (km ²)	Percent
Quebec	46,506	95
New Brunswick	1038	2
Nova Scotia	1307	3
Canada	48,851	(95)
United States	2110	(5)
Total	50,961	(100)

Migratory routes for the Bicknell's Thrush are poorly documented, but appear to be concentrated east of the Appalachian Mountains (Wilson and Watts 1997). Southbound migrants concentrate north of the Carolinas before an oceanic flight to their wintering grounds. Northbound migrants apparently travel through eastern Florida and northward along the coastal plain (Evans 1994; Rimmer *et al.* 2001).

During the winter the Bicknell's Thrush is found in the Greater Antilles, with the bulk of the population occurring in the Dominican Republic from sea level to 2200 m (Figure 1). The species also occurs in smaller numbers at high elevations in southwestern and eastern Haiti and in the Sierra Maestra of southeastern Cuba (Rompré *et al.* 2000; Rimmer *et al.* 2001). It is uncommon or rare in Jamaica and Puerto Rico (Vermont Center for Ecostudies (VCE), unpubl. data). Intensive efforts have been deployed over the past 10 years in the Dominican Republic, Haiti, Jamaica, Puerto Rico, and Dominica by VCE team members and local and international collaborators to visit known historical sites and potential new sites (VCE, unpubl. data). In Cuba, between 1999 and 2005, CWS-Quebec Region biologists and local collaborators (Bio-Eco, Instituto de Ecología y Sistemática, and Museo Nacional de Historia Natural, CWS-Atlantic Region) have visited and made altitudinal transect surveys in many areas across the island to locate the species.

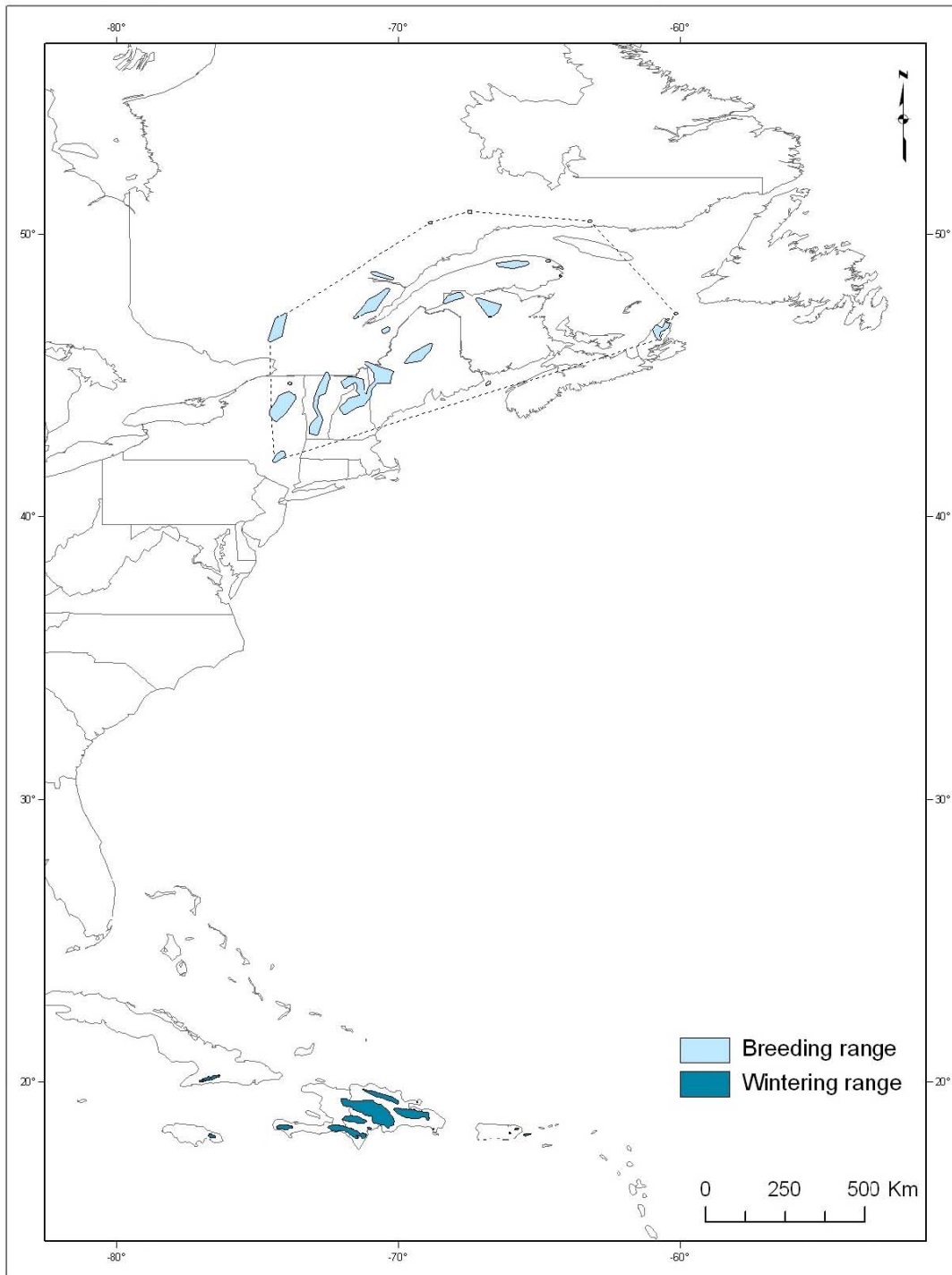


Figure 1. Breeding and wintering range for the Bicknell's Thrush. The shaded polygons represent clusters of locations where the species was observed between 1998 and 2007. The dashed line represents the extent of the breeding range (based on Rimmer *et al.* 2001 for the winter range and information collected by the authors).

Canadian range

In Quebec, the Bicknell's Thrush is restricted to high elevations in the Appalachian Mountains from the U.S. border to the Gaspé Peninsula, to limited coastal sites along the St. Lawrence estuary and gulf (Percé, Anse à Valteau, Forillon), and to the Laurentians at the southeastern edge of the Canadian Shield north of the St. Lawrence River. In New Brunswick, it is found in the interior in the northern half of the province. In Nova Scotia, it breeds in the Northern Highlands of Cape Breton Island as well as nearby St. Paul and Scaterie Islands (Maritimes Breeding Birds Atlas 2009) (Figure 2).

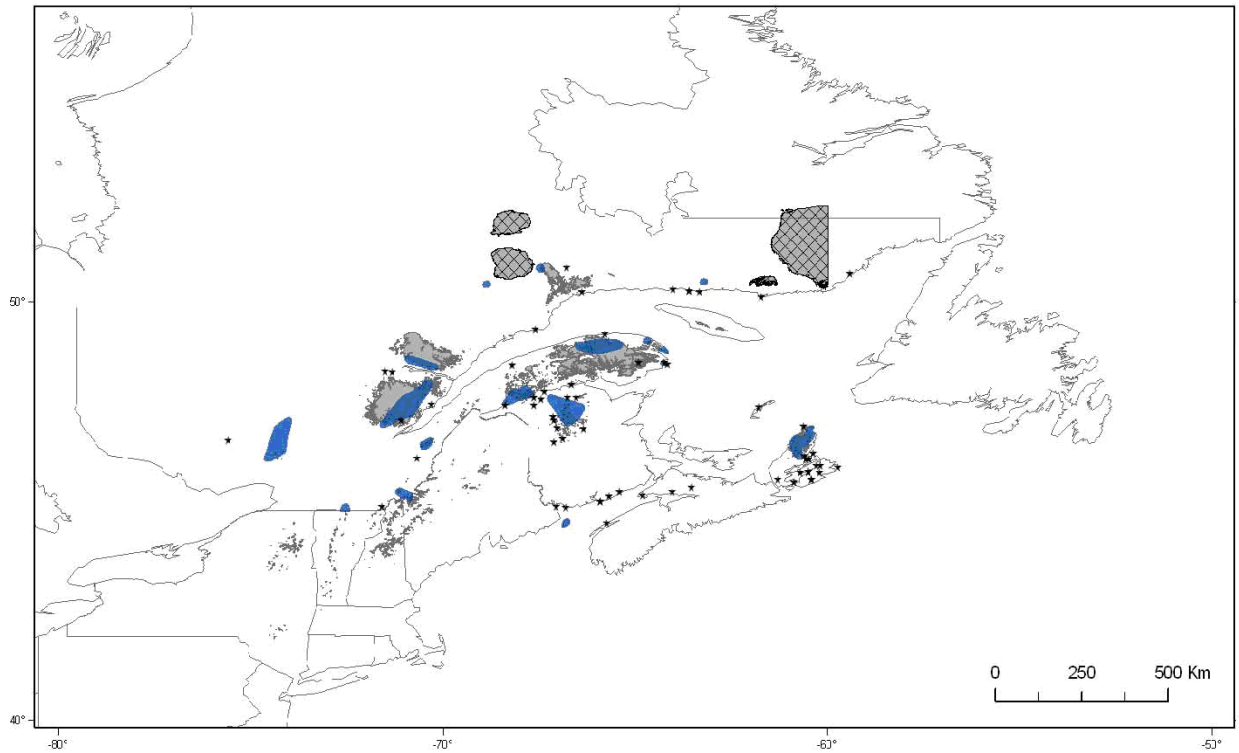


Figure 2. Breeding range of the Bicknell's Thrush based on breeding season records, between 1998 and 2007, collected by the report authors. The shaded polygons represent clusters of locations where the species was observed between 1998 and 2007. Stars represent sites where the species was detected at least once during a breeding season before 1998 and which have been checked at least once since that time without a detection. The solid grey areas represent areas of potential habitat based on the results of a habitat model (Hart *et al.* in prep.); the cross-hatched areas represent marginal habitat in Northern Quebec, which has been excluded from the habitat model.

The Extent of Occurrence for the Bicknell's Thrush in Canada is 297,000 km² based on the minimum convex polygon method. The species Area of Occupancy in Canada is estimated at 48,850 km² (Table 2), based on the breeding habitat predictive model (see Global range section for description). The corresponding Index of Area of Occupancy (IAO) in Canada, although not calculated, would be similar. Because the smallest area essential to the survival of the Bicknell's Thrush is on the wintering grounds (Figure 1), however, these areas are used to calculate IAO. The Index of Area of Occupancy on the wintering grounds based on a 2X2 km² grid is approximately 25,000 km².

Changes in distribution in Canada

In Canada, there is some evidence for local changes in distribution over the last few decades.

In Quebec, the Bicknell's Thrush has not been observed in the last 10 years on Montagne Noire, on Mont Sir-Wilfrid, on Mont des Éboulements, at some previously occupied sites in the zec des Martres, on mont Comi, in Métis-sur-Mer, on Mont St-Pierre, on Bonaventure Island, and on the Magdalen Islands. This despite regular visits by local birdwatchers and biologists from the Canadian Wildlife Service.

In New Brunswick, the species may be absent as a breeder from the southern half of the province compared to the 1980s. Recent Grand Manan Island records from the Breeding Bird Atlas almost certainly involved transient birds in early season (B. Stewart pers. comm.). Similarly, an observation of one or possibly two singing males at Rapidly Brook on the Fundy coast was made too late in the season (July 14, 2009, with none found July 22-23 during a follow-up visit) to be certain that the birds were breeding and not transients (J. Wilson pers. comm.; G. Campbell pers. comm.).

In Nova Scotia, for at least the last 10 years, the species has not been reported from the mainland, Seal and Mud Islands and parts of Cape Breton Island.

Changes in distribution in the United States

Since 1990, the Bicknell's Thrush has been extirpated from Mount Greylock in Massachusetts, from Mounts Bromley, Ascutney, Aeolus, and Glebe in Vermont, and from Mount Monadnock in New Hampshire (Atwood *et al.* 1996; VCE unpubl. data). Occasionally, single individuals are reported from some of those sites, but only for a few days suggesting that they are transients (VCE unpubl. data).

HABITAT

Habitat requirements

Breeding habitat

In general, the Bicknell's Thrush is a coniferous habitat specialist, often associated with undisturbed dense habitats or disturbed areas undergoing vigorous succession (mid-successional). The highest densities are typically found in chronically and naturally disturbed stands (e.g. fir waves (Sprugel 1976), exposed ridges, slides, windthrows, etc.). Altitude is also an important parameter of Bicknell Thrush habitat (Sabo 1981; Noon 1981; Connolly 2000; Nixon *et al.* 2001; Whittam and Ball 2003; Lambert *et al.* 2005). The species ranges from altitudes of 1,000 m elevation at the southern end of the range to 450 m asl (above sea level) at the northern end of its range. This altitudinal gradient closely matches the inland spruce-fir/deciduous forest ecotone habitat distribution in eastern North America (Cogbill and White 1991).

More specifically, there are three breeding habitat types that can be identified for the Bicknell's Thrush: montane/high-elevation forests, coastal lowlands and highland-industrial forests. Here industrial is defined as forest used for lumber and wood production that could be treated or untreated (e.g. thinned or any other type of silvicultural practices). In those habitat types, high Balsam Fir/Red Spruce stem density is an important habitat component (Wallace 1939; Sabo 1981; Connolly 2000; Nixon *et al.* 2001; Whittam and Ball 2003; Frey 2008; Y. Aubry, unpubl. data).

In montane/high-elevation areas, the Bicknell's Thrush selects undisturbed habitats and regenerating forests disturbed by fir waves, windthrows, ice and snow damage, fire, and insect outbreaks (e.g. spruce budworm (*Choristoneura fumiferana*) infestations), with standing dead conifers and dense regrowth of Balsam Fir (Wallace 1939; Rimmer *et al.* 2001). The species also uses chronically disturbed, stunted-tree stands (Rimmer *et al.* 2001). At high elevations, perturbations are generally limited in size and forest regeneration is rather slow (Rimmer *et al.* 2004), thus perpetuating a mosaic of suitable and regenerating habitats.

In coastal areas, such as along the Gaspé Peninsula (QC), Cape-Breton, St. Paul and Scaterie Islands (NS), cool sea breezes and higher precipitation levels maintain dense spruce-fir stands selected locally by Bicknell's Thrush.

In highland-industrial forests, the species may also be found in dense coniferous forest and in stands of dense second-growth, regenerating from anthropogenic (e.g. clearcut) or natural (e.g. fire, insect outbreaks) disturbances, with White Birch (*Betula papyrifera*) being a significant component of the stand, at least in the short term (Whittam and Ball 2003; D. Busby, pers. comm.). Both in Quebec and New Brunswick, the species has also been reported in older stands thinned or not, where the canopy is closed and the stem density lower (Chisholm and Leonard 2008; Y. Aubry unpubl. data).

The amount of habitat required locally by the species can be quite variable, depending on the number of birds at a site. Female home ranges usually do not overlap, while those of males are significantly larger and can overlap substantially. Individual breeding home ranges of females vary from <1 ha to 23 ha and from <1 ha to 22 ha for males (Rimmer *et al.* 2001; McFarland *et al.* 2008; Y. Aubry unpubl. data). The minimal amount of habitat required to support at least one social group (see Biology section), consisting of one female and two to four males, is likely >20 ha.

Post-breeding habitat

Little information is available on post-breeding movements and habitat use. In Vermont, Collins (2007) observed birds in similar habitat to that used during breeding, although some birds moved to lower altitudes (<110 m; n = 3), and others were found in less dense habitat, though always within the montane forest communities (Collins 2007). In Vermont, individuals used the same habitat during and following breeding (VCE, unpubl. data).

Migration habitat

Bicknell's Thrush have been found in upland shrub and dune scrub habitats that had regenerated to forest stands mostly dominated by Loblolly Pine (*Pinus taeda*), different oak species (*Quercus* spp.) and Wax Myrtle (*Myrica cerifera*) (Wilson and Watts 1997). The species has also been observed in urban woodlots (Y. Aubry pers. obs.) and bottomland forest, 80-100 years old, consisting of 90% deciduous and 10% coniferous trees (S. Petzinger pers. comm. 2009). There is no evidence that montane habitats are preferentially selected by migrants (Rimmer *et al.* 2001).

Wintering habitat

The Bicknell's Thrush exhibits less specialized habitat preferences on its winter range than on its breeding range. Occupied winter habitats span a series of successional and disturbance regimes, from undisturbed primary forest to moderately disturbed secondary forest (Rimmer *et al.* 2001). A general characteristic of the Bicknell's Thrush winter habitat, however, is the presence of a dense, mesic to wet, broadleaf understory (C. Rimmer and J. Townsend unpubl. data; Y. Aubry unpubl. data).

On the island of Hispaniola (comprised of the Dominican Republic and Haiti), which is estimated to support most of the species' global wintering population, Bicknell's Thrush occurs primarily in wet montane broadleaf forests above 1,000 m elevation (Rimmer *et al.* 2001; Latta *et al.* 2003, 2006). However, in the Dominican Republic the species inhabits suitable moist broadleaf forest at all elevations from sea level to as high as 2,200 m asl (Rimmer *et al.* 2001). In Haiti, the Bicknell's Thrush appears to be restricted to localized patches of mesic to wet karst limestone broadleaf forests in the Massif de la Hotte, at elevations from 1,175 - 2,175 m (Rimmer *et al.* 2006), and to broadleaf forest fragments in the Massif de la Selle from 1,575 - 2,025 m elevation (Rimmer *et al.* 2005). In Cuba, it has been found at high elevations (1,356 -1,970 m) in the wet broadleaf forest of Sierra Maestra in the southeastern part of the island (Rompré *et al.* 2000).

Habitat trends

Breeding habitat

The habitat preferred by the Bicknell's Thrush is continuously created and destroyed by both natural and anthropogenic perturbations. The impact of these perturbations on Bicknell's Thrush habitat is related to the extent in the landscape, speed of habitat regeneration, and the number of intact patches remaining locally following the perturbation. Natural mountain top perturbations are usually of smaller size than industrial forest perturbations, but take more time to regenerate than industrial perturbations, which are often at lower altitude. As a result, the landscape in mountainous regions is usually characterized by a mosaic of small patches in various stages of regeneration. In lower altitude industrial landscape, deciduous species sometimes dominate following clearcutting, contributing to variation in stand types in a landscape mosaic of very large patches of regenerating forest leading toward local uniformity.

Forestry results in a short-term increase in Bicknell's Thrush habitat, where dense regenerating stands with a significant proportion of balsam fir replace mature stands. The latter typically lack the layer of high-stem density or thick understory that would be a key feature in site selection by the thrush. This gain in quality habitat as trees grow in following forest harvest is not long term; as the regenerating forest stands mature they becoming increasingly poorer habitat for Bicknell's Thrush. The period for which regenerating stands represent quality habitat is reduced by the practice of pre-commercial thinning (cutting in young stands to increase spacing between trees, roughly 15 years after clearcutting).

In New Brunswick, the amount of suitable breeding habitat (i.e. young and regenerating forest dominated by conifers) available to Bicknell's Thrush has increased in the last 20 years. For example, in the 1980s and considering only the potential habitat (222,866 ha) identified by the Bicknell's Thrush habitat model (Hart *et al.* in prep.), there were approximately 22,700 ha of forest stands that were regenerating (<3 m tall) or at the sapling (2-7 m tall) development stage and dominated by softwood (i.e. preferred by Bicknell's Thrush). Currently there are 82,630 ha of regenerating or sapling softwood-dominated forest in New Brunswick that fall within the Bicknell's Thrush habitat model, representing a 3.6-fold increase in the amount of forest potentially used by this species (S. Makepeace NB DNR unpubl. data). This change is because of the increase in forestry operations in high elevation habitat in New Brunswick over the last 20 years (S. Makepeace pers. comm.). However, the amount of young and regenerating forest habitat will decline over the next 20-30 years, as the current forest matures.

In Nova Scotia, much of the habitat (82,384 ha, or 55% of the potential habitat model) falls within protected areas (Cape Breton Highlands National Park and Nova Scotia Protected Natural Areas) and thus changes only through natural perturbations (i.e. fire and insect outbreaks, which are more controlled than historically). Most of the remaining 45% of habitat within the model is crown land managed for forestry. In Nova Scotia, the amount of suitable breeding habitat (i.e. young and regenerating forest dominated by conifers, stand age 3-23 years old) preferred by Bicknell's Thrush has decreased in the last 20 years, from 29,236 ha to 20,162 ha (A. Doucette, New Page Inc., unpubl. data). In addition, the majority of the current habitat (85%) is in the 19-23 years age category, and thus has recently (within the last 4-7 years) undergone pre-commercial thinning (A. Doucette, New Page Inc., unpubl. data), resulting in very little suitable habitat for Bicknell's Thrush.

In both New Brunswick and Nova Scotia, industrial forest covered by the Bicknell's Thrush model is currently dominated by young age classes, with 69% of conifer-dominated stands in Nova Scotia currently 29 years old or less (A. Doucette, New Page Inc., unpubl. data), and 37% of conifer-dominated stands in New Brunswick in the regenerating or sapling development stages (S. Makepeace NB DNR unpubl. data). This is of concern for Bicknell's Thrush as highland stands in these jurisdictions will mature, be cut and then thinned all within a relatively short time frame.

In Quebec, patterns are similar to those in New Brunswick in that habitat for Bicknell's Thrush is created by forestry cutting, but then approximately 10 to 15 years later when the habitat is ideal for Bicknell's Thrush, it is exposed to pre-commercial thinning. At a minimum, 20 to 40% of the area that is clear-cut in Quebec will be exposed to this treatment and lost as breeding habitat for the birds, at least on the medium term (see threats section; National Forestry Database 2009).

Pre-commercial thinning plays a significant role in reducing the time period in which habitat remains suitable for Bicknell's Thrush. Thus, trends in pre-commercial thinning are relevant to the discussion of habitat trends for this species. The amount of forest undergoing this treatment in Quebec and New Brunswick increased between 1990 and 1999 and, despite a decline between 2000 and 2007, remained high compared to 1990 levels (Figure 3). In Nova Scotia, the amount of forest undergoing PCT also increased between 1990 and 2005 (Figure 3; National Forestry Database 2009). In Quebec, more than 86,000 ha were treated annually between 2002 and 2007 (Ministère des Ressources naturelles et de la faune 2009) and in total over 860,000 ha were treated between 1998 and 2007 (Canadian Council of Forest Ministers 2009). Of this, 70% is in regions where the Bicknell's Thrush occurs. This management practice was rarely used before 1987, but by 1994 it was common and widespread (Legris and Couture 1999). In New Brunswick, 22,000 to 27,000 ha were thinned annually on crown land between 2004 and 2007 (Department of Natural Resources 2007).

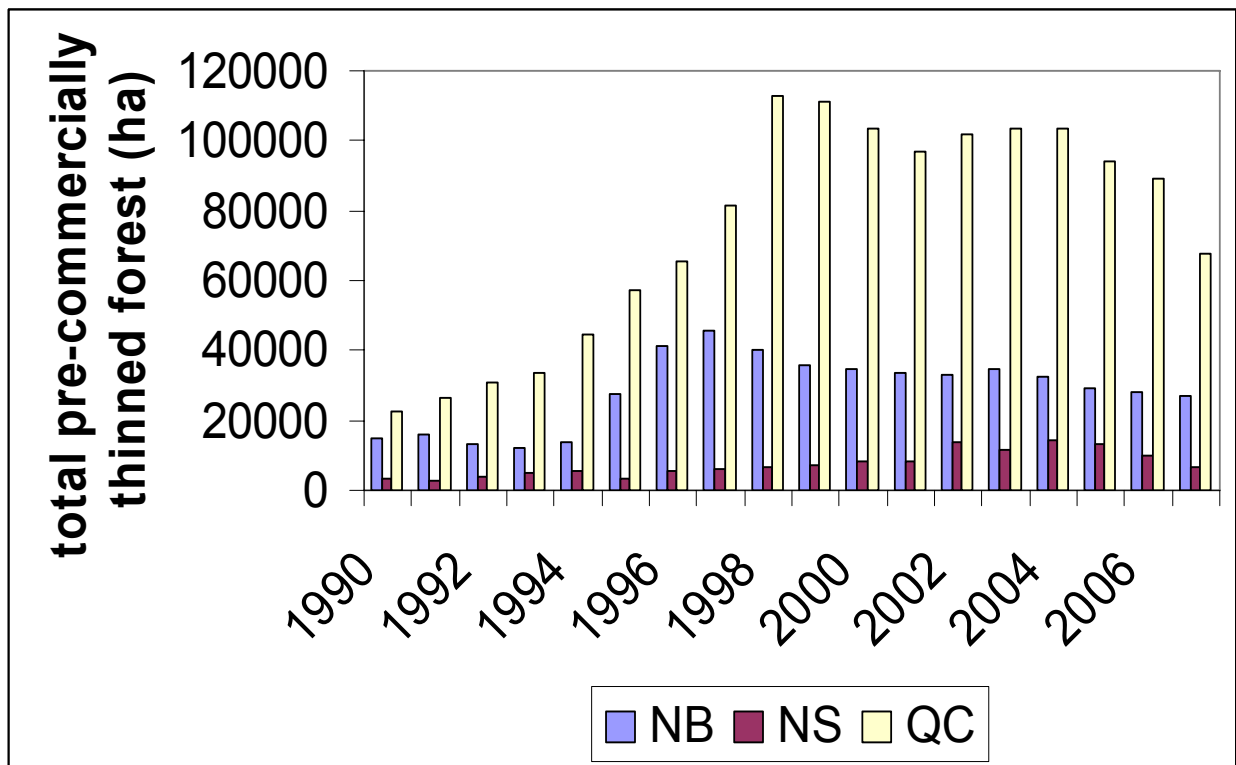


Figure 3. Number of ha of pre-commercially thinned forest in NB, NS and QC between 1990 and 2007, including both private and crown land (National Forestry Database 2009; <http://nfdp.ccfm.org/silviculture/jurisdictionale.php>, accessed Sept. 24 2009).

Millions of hectares of Balsam Fir forests in Quebec and New Brunswick were destroyed by spruce budworm in the mid 1970s and early 1980s, which reduced habitat for Bicknell's Thrush (Nixon 1999). Following this outbreak, however, habitat was likely created as the Balsam Fir regenerated. Subsequent forest management (pre-commercial thinning and replacement of Balsam Fir by spruce) may, however, reduce the amount of regenerating habitats suitable for the species. In the last decade, no major outbreaks of spruce budworm have occurred in Quebec and the Maritimes, though increases in defoliation attributed to spruce budworm have been detected in Quebec since 2004 (Government of Quebec 2009).

Habitat loss resulting from climate change has also occurred in New England (Beckage *et al.* 2008; Rodenhouse *et al.* 2008), where a 91-119 m upslope shift of the northern hardwood-boreal ecotone was reported in the Green Mountains of Vermont (Beckage *et al.* 2008). Climate models suggest that a 1°C warming will reduce Bicknell's Thrush habitat by more than 50% (Rodenhouse *et al.* 2008).

Wintering habitat

On Hispaniola, where the Bicknell's Thrush overwinters, forests have been reduced dramatically. In Haiti, in 1923, forests covered nearly 60% of the country, today they cover less than 2% (Anonym 2006), while in the Dominican Republic only 10% of forests remain, and in Jamaica, 25% remain (Stattersfield *et al.* 1998). In the Dominican Republic, ongoing forest loss and degradation have reduced mesic to wet broadleaf forests to 20% or less of their former extent (Stattersfield *et al.* 1998; Rimmer and McFarland unpubl. data). Habitat trends on other Greater Antillean islands, such as Cuba and Puerto Rico are less well documented but broadleaf forests are known to have experienced heavy human pressures across the Bicknell's Thrush wintering range, particularly at low altitude. The primary causes of forest loss and modification on Hispaniola include subsistence agriculture, clearing for livestock, charcoal production, and timber extraction. The loss of remaining forests appears to be continuing (Stattersfield *et al.* 1998).

Habitat protection/ownership

Based on a recent habitat model for Bicknell's Thrush in Canada (Hart *et al.* in prep.), approximately 94% of Bicknell's Thrush habitat is located on public lands. Just over 5 percent (2,613 km²) of potential breeding habitat is protected federally under the *National Parks Act* or *Canada Wildlife Act*, or provincially under the *Quebec Parks Act* and *Natural Heritage Conservation Act*, the *New Brunswick Protected Natural Areas Act*, and the *Nova Scotia Wilderness Protection Act* (Table 3). The species has been reported in less than half of those protected areas. The most significant protected areas for the species are Parc National de la Gaspésie and Parc National du Mont-Mégantic (QC), Mount Carleton Provincial Park (NB), and Cape Breton Highlands National Park (NS).

Table 3. Total protected area of potential Bicknell's Thrush habitat within its Canadian breeding range (based on Hart *et al.* in prep.).

Province	Location	Potential habitat (ha)	Total area (ha)	Species reported
Quebec	Parc national d'Anticosti	334	57 350	
Quebec	Parc national de la Gaspésie	57 550	80 167	X
Quebec	Parc national de la Jacques-Cartier	50 894	67 460	X
Quebec	Parc national des Grands-Jardins	30 846	31 268	X
Quebec	Parc national des Hautes-Gorges-de-la-Rivière-Malbaie	9294	22 825	X
Quebec	Parc national des Monts-Valin	7864	15 512	X
Quebec	Parc national du Canada de Forillon	4927	24 134	X
Quebec	Parc national du Mont-Mégantic	2280	5680	X
Quebec	Parc national du Mont-Orford	18	6038	
Quebec	Parc national du Mont-Tremblant	1949	15 4700	X
Quebec	Parc national du Saguenay	584	32 048	
Quebec	Réserve Écologique Charles-B.-Banville	22	992	
Quebec	Réserve Écologique Claude-Mélançon	447	537	X
Quebec	Réserve Écologique de la Grande-Rivière	5520	17 305	
Quebec	Réserve Écologique de la Matamec	41	18 439	
Quebec	Réserve Écologique de Tantaré	196	1471	X
Quebec	Réserve Écologique des Grands-Ormes	670	933	
Quebec	Réserve Écologique Ernest-Lepage	395	809	
Quebec	Réserve Écologique Fernald	410	728	
Quebec	Réserve Écologique G.-Oscar-Villeneuve	144	566	
Quebec	Réserve Écologique Irène-Fournier	198	452	
Quebec	Réserve Écologique Samuel-Brisson	428	836	
Quebec	Réserve Écologique Thomas-Fortin	109	109	
Quebec	Réserve Écologique du mont Gosford (project)	323	323	X
Quebec	Propriété Bélanger (mont Sutton)	40	120	X
New Brunswick	Mount Carleton Provincial Park	3226	29 651	X
New Brunswick	Kennedy Lakes Protected Natural Area	305	20 324	
Nova Scotia	French River Wilderness Area	564	7273	
Nova Scotia	Jim Campbells Barren Wilderness Area	1701	1747	
Nova Scotia	North River Wilderness Area	123	4357	
Nova Scotia	Polletts Cove-Aspy Fault Wilderness Area	15 412	28 563	
Nova Scotia	Margaree River Wilderness Area	2898	8005	X
Nova Scotia	Middle River Wilderness Area	186	5977	
Nova Scotia	Cape Breton Highlands National Park of Canada	61 500	97 850	X
	Total	261 400 ha	744 549 ha	
	Total	2614 km ²	7445 km ²	

BIOLOGY

Life cycle and reproduction

The Bicknell's Thrush has an unusual breeding system, defined by multiple male and female partners. A single male may sire nestlings in different nests and may or may not provide food to those broods (Goetz *et al.* 2003). The Bicknell's Thrush also has a highly skewed sex-ratio; 1 female: 1.49 to 2.29 males in Vermont (n = 986; VCE; unpubl. data) and 1 female: 3.00 males in Gaspé, Quebec (n = 189; Y. Aubry unpubl. data). Analyses from capture-recapture data with MARK software suggest that these skews are not an artefact of the capture techniques.

Nest building, incubation, and brooding are done by the female only. The nest is made mostly of twigs and moss and is placed at the base of 1-4 horizontal branches near or against the trunk. Nests are usually in Balsam Fir and occasionally in Red Spruce, White Birch, or alder (*Alnus* sp.) and usually at a height of 2 m (range 0.46-10.0 m; Rimmer *et al.* 2001). Generally, the female lays a single clutch of 3-4 eggs per season, but may lay a second clutch if the first one fails. Incubation usually begins with the penultimate egg and lasts for 9-14 days. Nestlings fledge 9-13 days after hatching. The female and one or two of the attending males split the brood and fledglings may remain with an adult for another 14 days. Both sexes can breed at one year of age, but monitoring work indicates that some yearlings do not breed (Rimmer *et al.* 2001).

Survival

Based on a Mayfield index, nest survival in Vermont was estimated at 0.980 ± 0.014 (\pm s.e.) (Stratton Mountain; n = 39 nests) and 0.960 ± 0.007 (Mt. Mansfield; n = 56 nests). Nest survival rates vary biennially, apparently in response to Balsam Fir and spruce cone production and Red Squirrel (*Tamiasciurus hudsonicus*) population cycles (two years). Nest success could be as high as 90% some years or as low as 0% in others years (Rimmer *et al.* 2001; Y. Aubry unpubl. data). On average, 1.5-2.1 young fledge per successful nest (range 0-4, n = 76 nests; Rimmer *et al.* 2001). Data on fledgling survival are limited; in Vermont 2 of 11 (18.2%) radio-tagged fledglings survived beyond 30 days (Rimmer *et al.* 2001).

Adult survivorship based on constant and intensive mist-netting and banding of adult birds has been estimated at different locations using the program MARK (White and Burnham 1999). Model parameters include survivorship (ϕ), recapture probability (p), time and sex. For the period 1994-2003, Rimmer *et al.* (2004) estimated the survivorship of summer-resident adults (ASY-after-second-year birds) at 0.65 ± 0.04 (\pm s.e.) on Stratton and Mansfield Mountains, Vermont. No difference was detected between the sexes, but power analysis did suggest a non-significant lower annual survivorship of males in ski-slope edge habitats. At Mine Madeleine, Gaspé, Quebec, similar analyses indicated sex-biased survivorship; female: 0.28 ± 0.11 , males: 0.63 ± 0.07 . The recapture rate was similar for both sexes (female: 0.75 ± 0.09 , males: 0.76 ± 0.10 ; 1998-2003; Y. Aubry unpubl. data). Annual survivorship of wintering adults in montane forest in the Sierra de Bahoruco, Dominican Republic was estimated at 0.73 ± 0.14 (Rimmer *et al.* 2001).

The longevity record for Bicknell's Thrush based on banded birds is 11 years for both sexes (VCE unpubl. data). Banding data from Vermont and Quebec (1992-2007) suggest that the mean age varies between 1.73 and 2.44 years (including transient individuals; $n=1175$). Generation time is estimated to be 2-3 years based on those results.

Migration

The Bicknell's Thrush is a nocturnal migrant. Most birds arrive on the breeding grounds by mid-May. In autumn, they leave the breeding grounds by mid-September to early-October (Rimmer *et al.* 2001).

Food

The Bicknell's Thrush feeds mostly on invertebrates during the breeding period (ants, spiders, beetles, lepidoptera larvae and other arthropods). Fruit may represent a regular food source outside the nesting period on the breeding grounds, as well as on migration and on the wintering grounds (Y. Aubry and VCE pers. obs.).

Predation

Video-monitoring of nest activities and direct observations reported in the literature reveal that nest predators include the Red Squirrel, Sharp-shinned Hawk (*Accipiter striatus*), American Marten (*Martes americana*), Long-tailed Weasel (*Mustela frenata*), and Deer Mouse (*Peromyscus maniculatus*). The discovery of the remains of a radio-tagged bird cached underground also suggests weasel depredation (*Mustella* spp.). Other potential predators include the Northern Saw-whet Owl (*Aegolius acadicus*), Boreal Owl (*A. funereus*), Mink (*Neovison vison*), Eastern Chipmunk (*Tamias striatus*), and Gray Jay (*Perisoreus canadensis*; Rimmer *et al.* 2001; VCE and Y. Aubry unpubl. data).

On the wintering grounds, possible predators include the Sharp-shinned Hawk, Ridgway's Hawk (*Buteo ridgwayi*), Mongoose (*Herpestes auro punctatus*), feral cats, and rats (*Rattus* sp.) (Rimmer *et al.* 2001).

Red Squirrel predation may be a key limiting factor for Bicknell's Thrush productivity in some areas. The abundance of this mammal shows a strong biennial pattern, which follows Balsam Fir/spruce mast production. Following a good cone crop year, squirrel abundance increases as does depredation of songbird nests. In those years, Bicknell's Thrush productivity can be as low as 0%.

Physiology

Bicknell's Thrush appears to have a lower rate of oxygen consumption with decreasing air temperature than the four other thrush species that occur in northeastern North America (Holmes and Sawyer 1975). This may be a metabolic adaptation to more stringent climates prevailing in summer in subalpine habitats where the species occurs.

Dispersal/migration

Early season re-nesting attempts are common for the species; females will usually re-nest within 100 m of the failed nest (Rimmer *et al.* 2001; Collins 2007). Adults, either alone or accompanied by fledglings, will move away from the breeding site presumably to forage and/or to moult. Post-breeding movements of up to 3.5 km locally or to nearby mountaintops have been documented, but most are <1000 m from the natal site (Collins 2007; Rimmer *et al.* 2001). Adults will nest close to previously successful nests in consecutive years. Evidence from stable-isotope analyses suggests that juveniles captured in Mont Gosford, Quebec came from outside the area, suggesting post-fledging movements (Hobson *et al.* 2004). In Vermont, 3 of 115 (2.6%) nestlings and dependent fledglings and 9 of 62 (14.5%) independent juveniles returned to breeding sites (Rimmer *et al.* 2001).

Only one case of long-distance dispersal has been documented and that was of an individual banded as a yearling and recaptured two years later 17.5 km from its original capture site (Rimmer *et al.* 2001).

Interspecific interactions

Agonistic encounters have been observed between the Bicknell's Thrush and the Swainson's Thrush, American Robin (*Turdus migratorius*), and White-throated Sparrow (*Zonotrichia albicollis*) on the breeding grounds (Rimmer *et al.* 2001; VCE and Y. Aubry pers. obs.).

Adaptability

The Bicknell's Thrush appears to have some tolerance for human disturbance as shown by its presence in ski areas, along roadways and in commercially exploited forests (Rimmer *et al.* 2004).

POPULATION SIZE AND TRENDS

Search effort and monitoring programs

Modern surveys for the Bicknell's Thrush began in 1992 in the U.S. (Atwood *et al.* 1996) and 1997 in Canada (Rompré *et al.* 1999). Since then considerable effort has been deployed in both countries to monitor the species' status (Figure 4), with many sites surveyed regularly or even yearly.

Between 1997 and 2008, 1,716 point counts (for a total of 2444 visits) were conducted for Bicknell's Thrush in Quebec, which covered over 9,390 ha of potential habitat. In New Brunswick and Nova Scotia, 229 and 135 point counts, representing 1,634 and 979 visits, were conducted, which covered 719 and 424 ha respectively.

Over the last nine years, in the U.S., 1,187 point counts were conducted on mountain tops, many annually, which represent 3,729 ha of surveyed habitat. Also, between 1992 and 1995, 430 localities (mountain tops) were surveyed intensively for the presence of Bicknell's Thrush. In the same period, 294 points counts were conducted in north Maine. Coastal Maine was also intensively searched (not shown on Figure 4), with a total of 50 sites surveyed between Mount Desert Island, Maine and Grand Manan Island, New Brunswick between 1993 and 1995 (Rimmer and McFarland 1996).

The amount of surveyed habitat reported above is conservative because observers also recorded the species as they moved between point count stations. This would considerably increase the amount of habitat surveyed.

The Breeding Bird Survey (BBS)

The Breeding Bird Survey is an annual roadside survey that is conducted in mid-June in Canada and the U.S. Although the BBS provides limited sampling of the highland and mountain habitat of the Bicknell's Thrush, it can provide trend information over the long-term (1968 – 2008) and at sites in Quebec and the Maritimes that are not well sampled (i.e. lower altitudes) by the other surveys.

Mont Gosford, Quebec, monitoring project

A network of 131 permanent point count stations was set up in 2001 in Mont Gosford, Quebec to study the relationship between forest management practices and Bicknell's Thrush habitat use and movements. The survey protocol includes 3 x 5-min. passive listening periods at each station, 1 min of song and call playback followed by a 5-min. listening period. The surveys are conducted in the early morning (0300 - 0700) and in the evening before sunset (1830-2130) when *Catharus* vocal activity is at its peak (Ball 2000). This specific protocol yields a high probability of detecting the species at least once ($n = 131$ stations; maximum 95.9 ± 1.1 in 2003; minimum: 88.3 ± 2.8 in 2007; Y. Aubry and M. Mazzerolle unpubl. data).

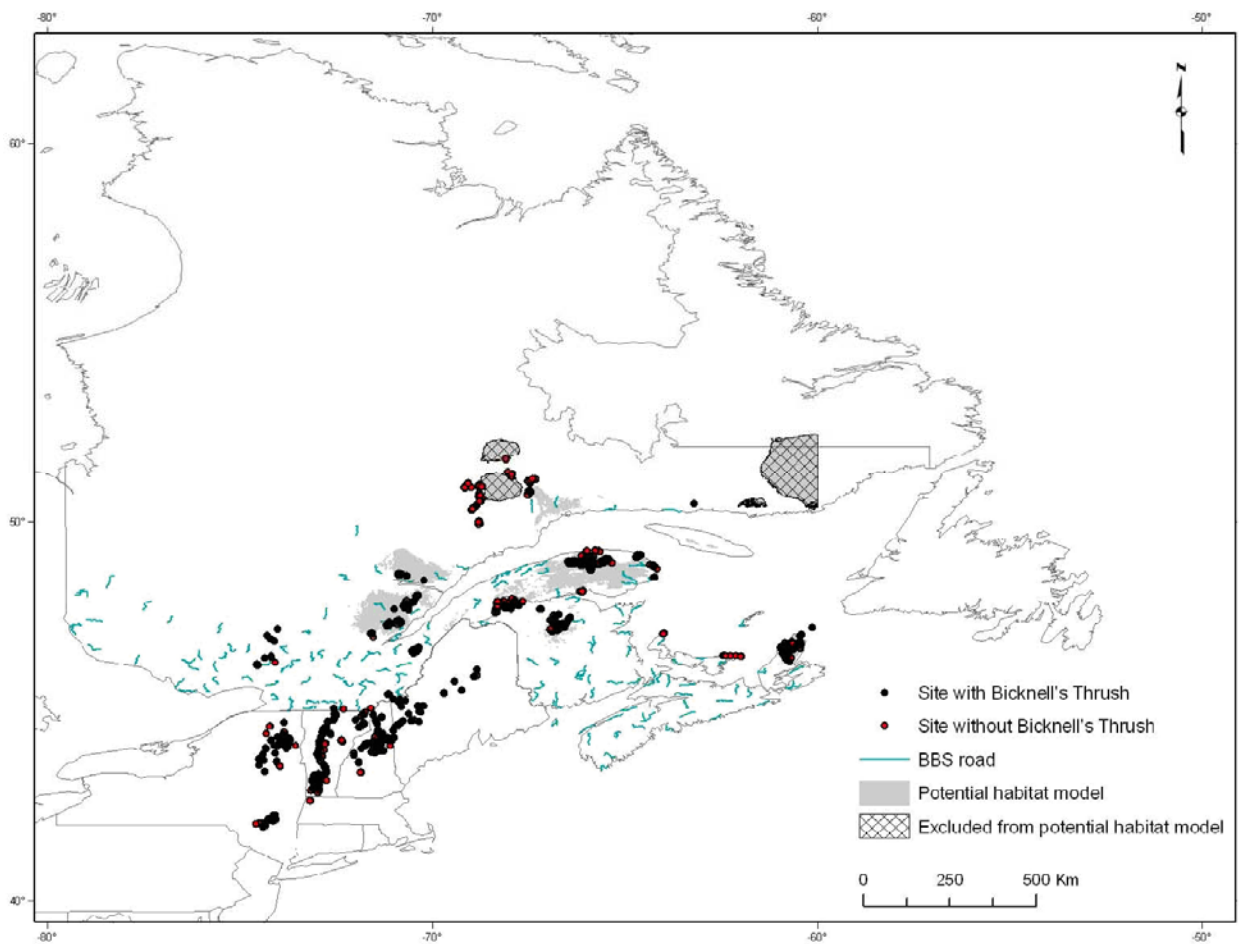


Figure 4. Bicknell's Thrush occurrences and absences in Canada and the U.S. from specific search and monitoring efforts between 1998 and 2007 (Data from the authors and Canadian BBS databases). The solid grey areas represent areas of potential habitat based on the results of a habitat model (Hart *et al.* in prep.); the cross-hatched areas represent marginal habitat in Northern Quebec, which has been excluded from the habitat model.

High Elevation Landbird Program (HELP)

This multi-species monitoring program, active in the Maritimes provinces since 2002, is based on the Mountain Birdwatch protocol (see below, Lambert *et al.* 2001) and is coordinated by Bird Studies Canada. Survey routes consist of five stops of 10 minutes spaced 250 m apart, run once annually an hour before dawn or at dusk between 4 June and 26 June. A protocol change occurred between 2002 (playback after the first five minutes followed by five more minutes of silent listening) and 2003 (no playback during 10 min count). Therefore trend analyses are based on data from the first five minutes of surveys across years. Survey routes were randomly selected from potential habitat in Nova Scotia, while haphazard sampling (>350 m elevation, >50% conifer and unthinned habitat) was used in New Brunswick. Forty-three routes are run annually in New Brunswick and 28 routes in Nova Scotia. Two survey routes have also been run annually in Prince Edward Island since 2003, although Bicknell's Thrush has never been detected.

The Maritimes Breeding Bird Atlas

The Maritime Breeding Bird Atlas is a volunteer-based survey that involves observers recording evidence of breeding for a prescribed amount of time (e.g. 20 hours) in a 10 km x 10 km square during the breeding season. The first Maritime Breeding Bird Atlas was conducted between 1986 and 1990 and the second atlas has now completed the third year of a five year sampling period (2006-2010). Differences between the two periods can provide information on changes in Bicknell's Thrush distribution over time. Unlike the first atlas, in which there was no effort to target Bicknell's Thrush, the species has had a higher degree of targeted effort in the second atlas, particularly through the High Elevation Landbird program.

Mountain Birdwatch Program

The Mountain Birdwatch Program is conducted by volunteers and staff from the Vermont Center for Ecostudies. It surveys Bicknell's Thrush in its preferred habitat in New York, Vermont, Massachusetts and Maine. Surveys are conducted between 0430 and 0800 between 1 and 25 June. Observers listen quietly for ten minutes at each of five stations and record the number of each focal species seen or heard during three time periods: 0-3 minutes, 3-5 minutes, and 5-10 minutes. If Bicknell's Thrush is not detected during or between point counts, surveyors return to each point and broadcast a one-minute recording of the bird's vocalizations, followed by a two-minute listening period.

Other surveys in Quebec

Other surveys have also been conducted in various regions of Quebec. Using a 20-minute protocol (see Mont Gosford section above), Bicknell's Thrush surveys were conducted in habitat dominated by Balsam Fir at high elevation (>450m) and in some coastal areas. In 2005, 389 stations were surveyed in north-central Gaspé Peninsula (Appalachian range). The Bicknell's Thrush was detected at 18 stations (for a total of 21 individuals), while in 2006, the survey of 404 stations in the Manicouagan remote back country (Laurentian shield) yielded five individuals at four stations (Y. Aubry, unpubl. data). Between 1999 and 2006, the Bicknell's Thrush was reported from an additional 15 sites in high altitude, coniferous dominated habitat in Charlevoix and Saguenay regions by a team who recorded the presence of Bicknell's Thrush while surveying for Barrow's Goldeneye (*Bucephala islandica*) (C. Marcotte and M. Robert, CWS, pers. comm.).

Irrespective of survey method, because both females and males call and sing (Ball, 2000), and because of the highly skewed sex-ratio and the non-territorial behaviour of males, any abundance estimate based on territoriality and the detection of singing birds should be interpreted with caution.

Abundance

Extensive field work has been conducted in both Canada and United States since the last status report for this species, which estimated a global population of 5,000 pairs or 10,000 Bicknell's Thrush (Nixon 1999). This work has helped to clarify the population estimate for this species.

Rimmer *et al.* (2001a) estimated the global population of the Bicknell's Thrush at 25,000 to 50,000 birds after nearly 10 years of intensive research in the United States. This estimate was based on the amount of breeding habitat from remote-sensing data, mean home range area in Vermont and dual assumptions of non-overlapping home-ranges and the saturation of all potential habitat. Later estimates by Rimmer *et al.* (2001b) suggested a crude estimate of 67,000-131,000 thrushes in the U.S. based on 1) a total habitat area of 111,000 ha, 2) a 2:1 (male:female) sex ratio, and 3) densities estimated from intensive mark-recapture of 16-32 males per 40 ha. No other independent global estimates have been attempted since, thus all other published estimates are based on this source, with some minor adaptations (Rich *et al.* 2004; Birdlife International 2009).

A current estimate of the global population of Bicknell's Thrush was established for this report by extrapolating bird densities calculated from survey point counts, across the available Bicknell's Thrush habitat as determined from a new range-wide breeding habitat model (VCE unpubl. report).

Specifically, point count data were collected during the 2008 breeding season from Mountain Bird Watch 2.0 (Hart and Lambert 2007) across the U.S. breeding range (n=456 points), the HELP in Nova Scotia (n=130 points) and New Brunswick (n=191 points), and three datasets from Quebec at Massif du Sud (n=77 points), Gaspesie (n=391 points, collected in 2005 because data were not available for 2008) and Mont Gosford (n=57 points). The density of thrushes/ha for Canada was then determined by dividing the number of thrushes detected per count by the count area (100 m radius).

The amount of available breeding habitat was determined using Lambert *et al.*'s (2005) habitat model extended across the entire breeding range of the Bicknell's Thrush (Hart *et al.* in prep.). The model used Shuttle Radar Topographic Mission (SRTM; <http://srtm.usgs.gov/>) raster elevation data (VCE unpubl. report), Earth Observation for Sustainable Development of Forests (EOSD) land cover maps of the forested areas in Canada (Wulder and Nelson 2003) and the National Land Cover Database for the United States (Homer *et al.* 2004) to identify areas with dense conifer stands at preferred elevations, and secondarily, areas of open conifer, where the thrush density was assumed to be 20% of that in the primary habitat.

Based on this methodology, the current population size for Bicknell's Thrush in Canada is estimated at between 40,570 and 49,258 (Table 4) and in the U.S. at between 57,480 and 76,640 thrushes for a maximum global population of between 98,050 and 125,898. In considering Bicknell's Thrush abundance it is important to recognize the skewed sex-ratio of 2-3 males per female. Based on the above estimates of 40,570 to 49,258 birds for Canada, there would be an estimated 10,142 to 16,419 females in the Canadian population. This represents the maximum reproductive population size for the species.

Table 4. Population estimates for the Bicknell's Thrush in Canada.

	Coniferous - dense ^a	Coniferous - open ^{b,c}	Total	BITH/ha	
Quebec					
	>800 m	24,906-32,923	2,084-2,755	26,990-35,678	0.16-0.21
	<800 m	11,436	1,002	12,438	0.017
New Brunswick	366	212	578	0.035	
Nova Scotia	425	139	564	0.025	

^a Coniferous dense: > 60% crown closure and coniferous trees are 75% or more of total basal area

^b Coniferous open: 26-60% crown closure and coniferous trees are 75% or more of total basal area.

^c Population estimates for coniferous open were calculated as 20% of thrush density.

Fluctuations and trends

Breeding Bird Survey

Long-term BBS data from 1968 to 2008 show a significant decline of 9.0%/year ($n = 16$ routes, $P = 0.048$) for the Bicknell's Thrush in Canada (P. Blancher pers. comm.)

Mont Gosford, Quebec, monitoring project

The mean number of Bicknell's Thrush per point count went from a maximum of 1.57 birds per point count in 2003, to 0.63 in 2007 at the Mont Gosford site (Paradis and Aubry 2008). Similarly, densities dropped from 0.29 birds/ha in 2001 to 0.15 birds/ha in 2008. Royle count models (Royle 2004) were performed to model the abundance (λ) and detectability (p) of Bicknell's Thrush between 2001 and 2007. A model averaged estimate of abundance was calculated across all models for each year. The results showed no significant difference across years in Bicknell's Thrush abundance (Figure 5), but a significant change in the rate of occupancy (number of stations or stops where a thrush was detected), with a decrease in occupancy after 2003 (Figure 6).

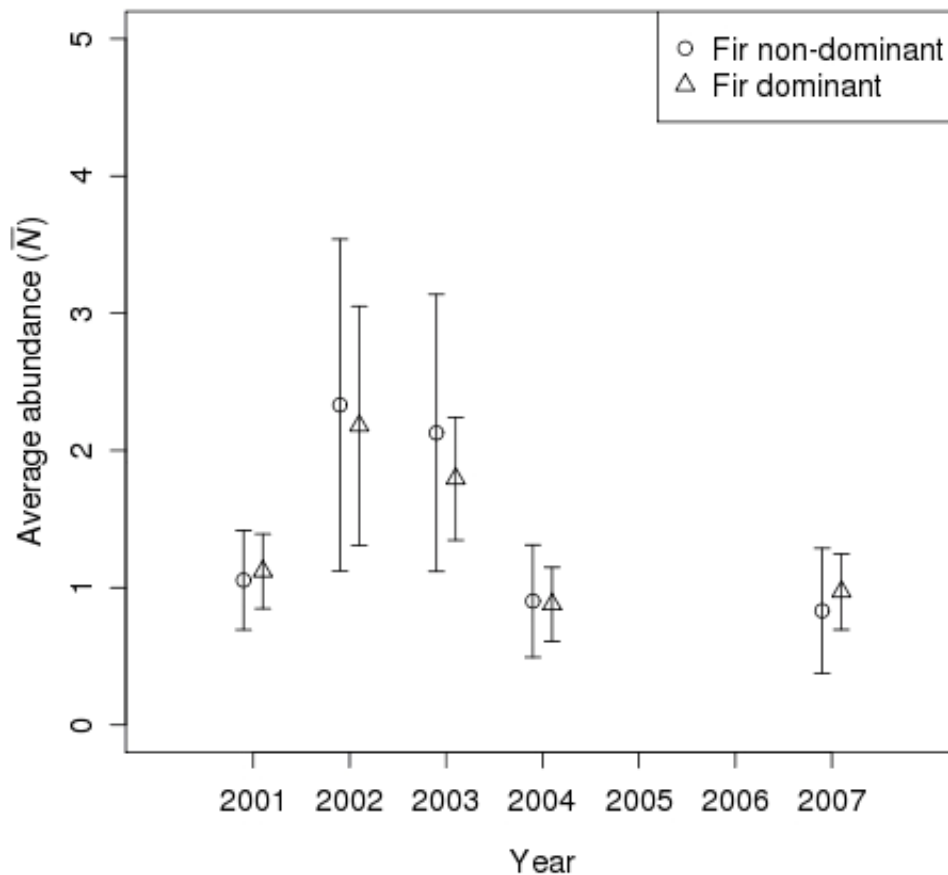


Figure 5. Mean abundance plus 95% CI's in fir dominant and non-dominant habitats at Mont Gosford, Quebec, 2001-2007 ($n = 131$ point counts; Y. Aubry and M. Mazerolle unpubl. data).

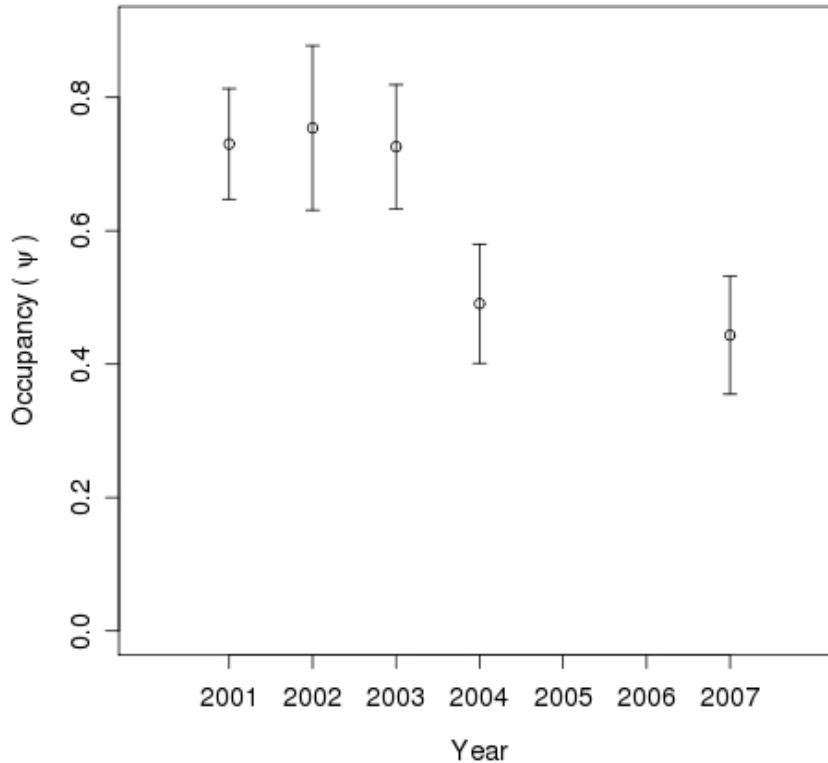


Figure 6. Mean probability of occupancy plus 95% CI's for Bicknell's Thrush at Mont Gosford, Quebec, 2001-2007 (n = 131 point counts; Y. Aubry and M. Mazerolle unpubl. data).

High Elevation Landbird Program (HELP)

Negative binomial regressions, with route as a random effect, show significant declines of $20.2 \pm 3.5\%/year$ (\pm SE) and $18.9 \pm 5.0\%/year$ ($P < 0.05$) between 2002 and 2008 for HELP sites in New Brunswick and Nova Scotia, respectively (Figure 7; B. Whittam unpubl. data). At these rates of decline, the population of Bicknell's Thrush in New Brunswick decreased by 76% and in Nova Scotia by 72% over the last seven years. Given the generation time for the species is between 2 and 3 years, these population losses approximate losses over three generations.

Logistic regressions of stop occupancy regressed on year, with stop treated as a repeated measure over the same period, show that the proportion of stops occupied by Bicknell's Thrush has declined significantly ($P < 0.05$) in both New Brunswick (slope = -0.2182) and in Nova Scotia (slope = -0.2100) (Figure 8). These declines appear to be occurring independently in both natural and industrial areas (Campbell *et al.* 2008).

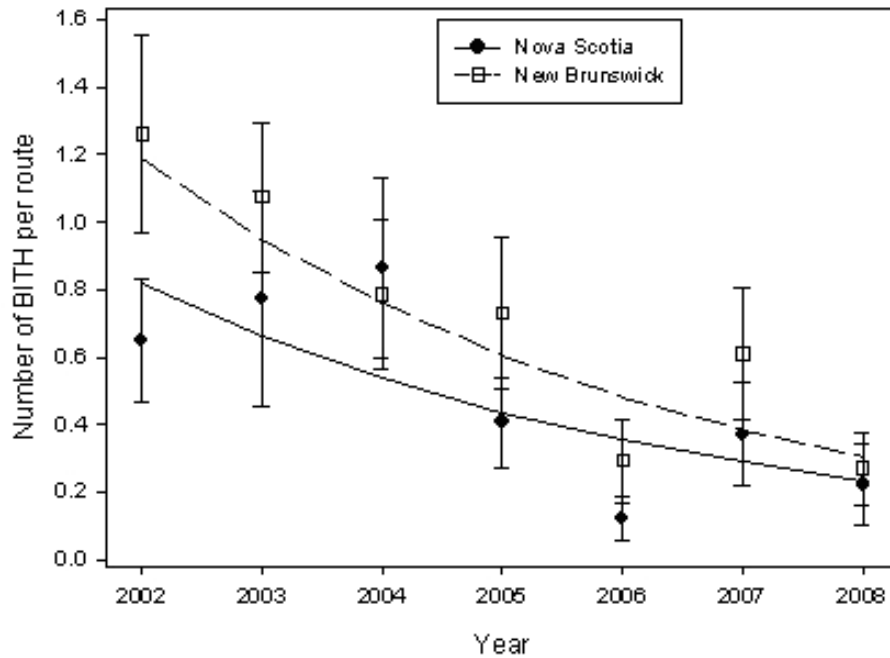


Figure 7. Mean (\pm SE) number of Bicknell's Thrush per route in New Brunswick and Nova Scotia, 2002-2008. The predicted lines are fitted based on the regression model. (Source: Bird Studies Canada, High Elevation Landbird Program.)

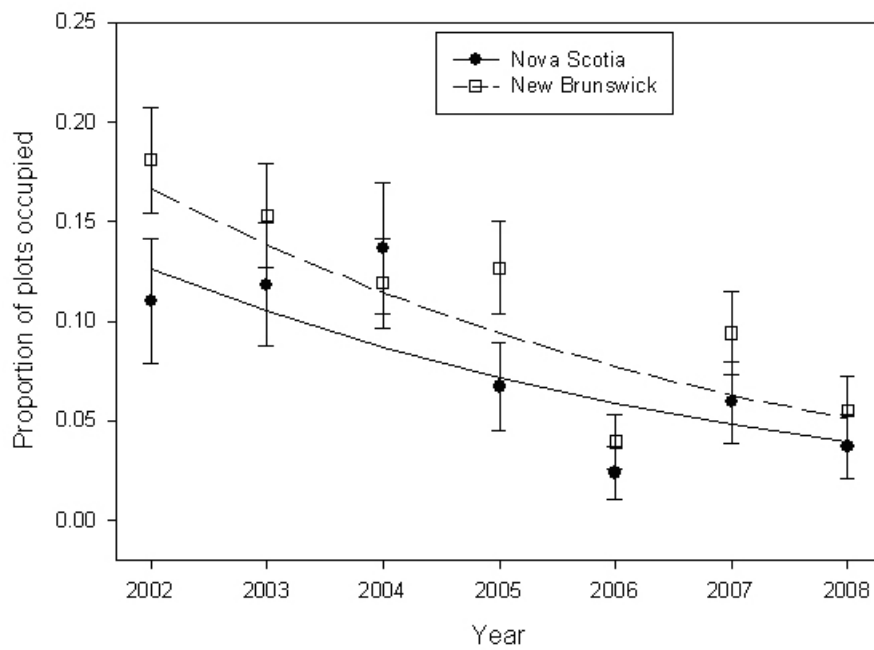


Figure 8. Mean (\pm SE) proportion of plots occupied per route by Bicknell's Thrush in New Brunswick and Nova Scotia, 2002-2008. The predicted lines are fitted based on the regression model. (Source: Bird Studies Canada, High Elevation Landbird Program.)

The Maritimes Breeding Bird Atlas

Data from the first three years of the second Maritime Breeding Bird Atlas (2006-2008) suggest a reduction in the total number of squares occupied by Bicknell's Thrush since the first atlas (1986-1990) (Figure 9). In the first atlas, the Bicknell's Thrush was found in 88 of the 1,539, 10 x 10 km squares. Of these 88 squares, 78 have been checked in the second atlas and Bicknell's Thrush have been found in only 19. Of the 78 squares, 55 have had equal or more survey effort in the second atlas compared to the first, and 23 have had fewer hours of effort, however, the surveys in these squares were conducted by observers specifically instructed to target Bicknell's Thrush habitat. Thus, although fewer hours were spent in the second atlas in these squares, the quality of the search effort was higher.

In addition to the potential declines noted in some areas, there were also 11 squares that had Bicknell's Thrush in the second atlas but not the first (three of which had zero effort in the first atlas). Eight of the 11 squares are in areas with the highest densities of Bicknell's Thrush (i.e. Christmas Mountains, NB and Cape Breton Highlands) and where the effort as whole has been greater in the second atlas, hence potentially explaining the "new" squares.

To summarize, of the 86 total squares reporting Bicknell's Thrush in either atlas and that have been checked in both atlases, there is a decrease from 78 squares reporting the bird in the first atlas to 27 reporting the bird in the second atlas. This amounts to a loss in distribution of 65% over approximately 20 years or a greater than 40% loss over the last 10 years.

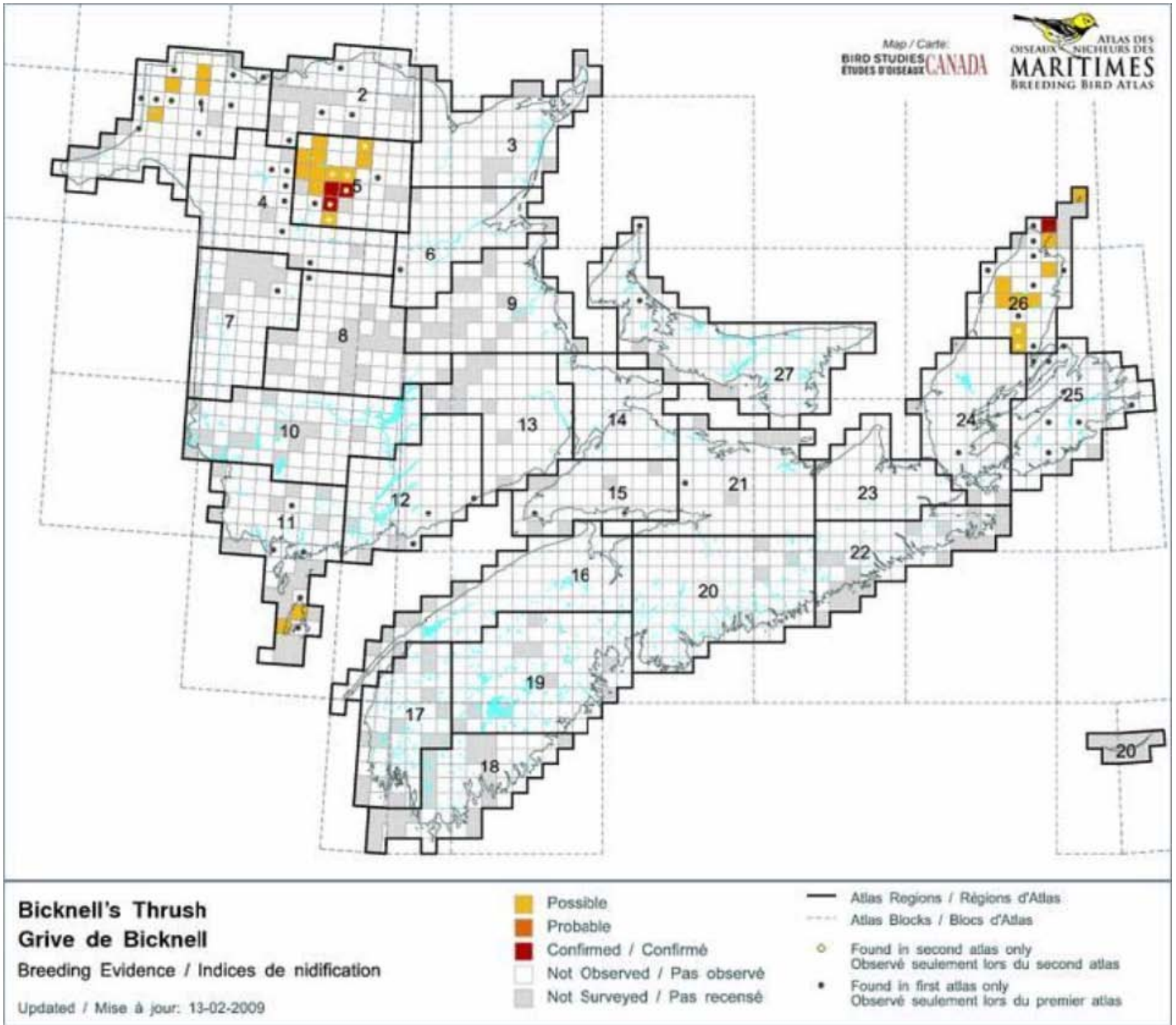


Figure 9. Breeding range of the Bicknell's Thrush in the Maritime Provinces according to the first three years (2006-2008) of the Maritime Breeding Bird Atlas project. Black dots represent squares where the species was reported in the first atlas (1986-1990), but not in the second.

Mountain Birdwatch Program

Data from the Mountain Birdwatch Program in the U.S. found the species on 62% of their point count routes in 2007 and 60% in 2008, which were similar frequencies to those observed in previous years (Lloyd and Hart 2009). A record high count was set on a subset of routes in 2008 (Lloyd and Hart 2009). Together these results suggest that the U.S. population has been stable over the last seven years.

Regionally, in New Hampshire, King *et al.* (2007) and Lambert *et al.* (2008) report an annual decline of 7% (trend: 0.93 ± 0.033 ; $P < 0.10$) from 1993 to 2003 for the White Mountain National Forest. Additionally, a small route of point counts ($n=10$) on Mt. Mansfield, Vermont that have been surveyed annually from 1991 to 2008 showed a non-significant annual decline of 1.1% ($r^2 = 0.06$, $P=0.33$) (McFarland *et al.* 2008; VCE unpubl. data).

Summary

In summary, for Canada, data from the first three years of the Maritime Breeding Bird Atlas indicate a greater than 40% loss in distribution of the Bicknell's Thrush in New Brunswick and Nova Scotia over the last 10 years. Similarly, trends from the HELP surveys in these provinces show significant population declines of over 70% for the Bicknell's Thrush between 2001 and 2008. Data from the Mont Gosford Monitoring project in Quebec, although limited in the range surveyed, show significant declines in the probability of occupancy at point counts between 2001 and 2007, but not so in population abundance. These patterns are supported by long-term data from the Breeding Bird Survey showing significant declines for the species in Canada.

Rescue effect

Trends from the U.S. suggest that populations are relatively stable overall and so could provide a source of rescue for Bicknell's Thrush in Canada. Rescue, however, would only be anticipated if source populations were close to the extirpated site because current evidence suggests that these birds do not disperse great distances (see Dispersal/migration section).

LIMITING FACTORS AND THREATS

Breeding habitat

Pre-commercial thinning is a management technique used by timber companies to reduce stem density in forest stands (from ~40,000 stems/ha to ~5,700 stems/ha in New Brunswick and to <2,500 stems/ha in Quebec; Chisholm and Leonard 2008; Ordre des ingénieurs forestiers du Québec 2009), which allows the remaining trees to maximize growth. Bicknell's Thrush abundance drops in stands immediately following the treatment (Chisholm and Leonard 2008; Y. Aubry unpubl. data) and breeding has not been documented in thinned stands in either Quebec or New Brunswick (Chisholm and Leonard 2008; E. McKinnon unpubl. data; Y. Aubry, unpubl. data). In New Brunswick, birds appear to return to thinned stands approximately 7 to 12 years following the treatment, although in numbers lower than reported before thinning (Chisholm and Leonard 2008). There was no effort to locate nests in these stands in the latter study, so it is not clear whether the birds, although present, are breeding. In Quebec, where breeding can be determined, there is no evidence that it occurs in these stands, even 10-20 years after treatment (Y. Aubry, unpubl. data). Nests have, however, been found immediately adjacent to thinned stands and strip-thinned patches (2-m wide strips cut through a stand to facilitate access for thinning crews the following year; E. McKinnon unpubl. data.; Y. Aubry unpubl. data.). In summary, current evidence suggests that Bicknell's Thrush does not breed in stands following thinning, although they may attempt to breed in nearby patches that have not been thinned. Given the area exposed to pre-commercial thinning (see Habitat trends section), this treatment results in a significant loss of habitat for this species, at least on the medium term.

Pre-commercial thinning could also directly destroy the nest and eggs of the Bicknell's Thrush because thinning usually occurs between June and August when the birds are breeding (S. Makepeace and Y. Aubry, unpubl. data).

The practice of clearcutting in industrial highlands may also impact Bicknell's Thrush by temporarily removing forest habitat; however, over time, clearcutting can create habitat for the species if suitable forest is allowed to regenerate (stem density >10,000-15,000 stems/ha, height >2 m, minimum patch size requirement met; Y. Aubry pers. comm.). Little work has been done on the use of mature forest stands by Bicknell's Thrush just before clearcutting, making it difficult to assess the immediate impact of clearcutting on the species. Birds may, however, move to uncut/unthinned remnants left nearby, at least for the first few years after the perturbation (D. Busby, pers. comm.). In addition, the use of thinning in forest stands ≥ 20 years before harvest may obscure impacts of clearcutting; such impacts are likely to be greater in stands that were never subjected to pre-commercial thinning as these may still be used by Bicknell's Thrush.

The close correlation between Bicknell's Thrush and Balsam Fir make this thrush potentially sensitive to the impacts of climate change on the distribution of their preferred tree species (Lambert *et al.* 2005). Increases in temperature could lead to the retreat of the Balsam Fir/Spruce-Mountain forest ecotone to higher altitudes (Iverson *et al.* 2008; Rodenhouse *et al.* 2008), thus reducing the amount of potential breeding habitat for this species. Such a change has already been documented in the Green Mountains of New England, where there has been an estimated 91-119 m upslope shift of the northern hardwood-boreal forest ecotone between 1964 and 2004 (Beckage *et al.* 2008). This change corresponded with a 1°C increase in temperature over the same period.

Acid deposition has been shown to have a direct impact on Bicknell's Thrush habitat. Since the 1960s, significant declines in growth and increases in winter injury in Red Spruce and Balsam Fir have been observed throughout much of the Bicknell's Thrush range (Eager and Adams 1992). Recent research suggests that the decline of Red Spruce is linked to the leaching of calcium from cell membranes in spruce needles by acid rain, mist, and fog (DeHayes *et al.* 1990; DeHayes *et al.* 1999). The loss of calcium in the needles reduces their tolerance to low temperatures and increases the occurrence of winter injury and subsequent tree damage or death. These effects appear less severe in the Balsam Fir.

Current and past industrial developments for energy and communication as well as recreational activities at high elevations may have direct negative effects on the amount of available habitat for this species. The loss of breeding habitat has been observed in Quebec with the new wave of "green energy" projects. Bicknell's Thrush favour habitats characterized by high wind, so wind farm projects that are currently being proposed and developed (e.g. Massif du Sud, Murdochville, Anse à Valteau) in Bicknell's Thrush habitat pose a threat. The rapid growth and popularity of such projects have a direct impact on the species through net habitat loss due to clearings of habitat for the turbine setup. Habitat fragmentation also occurs from the creation of road networks and energy corridors associated with the turbines. In New Brunswick at least one wind farm site (Caribou Mountain) is being built in Bicknell's Thrush habitat. Birds may also be affected by collisions with standing turbines (up to 400 m high) and noise, although these effects have not been documented.

Bicknell's Thrush habitats in some areas are also threatened by clearing for recreational development such as trails and areas for skiing, hiking and biking.

Wintering habitat

Important Bicknell's Thrush habitat losses and degradation from subsistence farming and logging have been reported for Haiti and the Dominican Republic. (Stattersfield *et al.* 1998; Rimmer *et al.* 1999; Rimmer *et al.* 2005a). Introduced predators (rats and feral cats) may also reduce habitat quality. The continuing destruction of habitat on the wintering grounds is likely a major threat to the Bicknell's Thrush.

Contaminants

Airborne contaminants like Hg and MeHg have been documented in Bicknell's Thrush feathers and blood on the breeding and wintering grounds (Rimmer *et al.* 2005b). The levels were not high enough to raise concerns, although bio-accumulation has been reported in older birds (Rimmer *et al.* 2005b).

Collision with structures

Collision with human-made structures such as communication towers, buildings and other vertical structures have been reported occasionally (Rimmer *et al.* 2001).

SPECIAL SIGNIFICANCE OF THE SPECIES

The remote and impenetrable forests inhabited by this species confer an emblematic status to the Bicknell's Thrush. This is amplified in pristine and foggy forests on mountain tops. This species also qualifies as a potential, long-term indicator of subalpine forest habitat and its avian populations. It is a secretive species for ornithologists and birdwatchers.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The Bicknell's Thrush is protected under the *Migratory Birds Convention Act, 1994* in Canada and the *Migratory Bird Treaty Act, 1918* in the U.S. Because of its rarity, selective habitat use, and restricted breeding and wintering ranges, the Bicknell's Thrush appears on the World Conservation Union Red List (Vulnerable; BirdLife International 2004). Partners In Flight (PIF) includes the species on the North American Watch List for Landbirds (Rich *et al.* 2004) and has identified the species as the highest conservation priority among neotropical migrants in the Northeast (Rosenberg and Wells 1995). Table 5 summarizes the Natural Heritage Program rankings.

COSEWIC assessed this species as Special Concern in April 1999 and it is federally listed as Special Concern under Schedule 3 of the *Species At Risk Act*. Provincially, it is designated as Vulnerable in Quebec, and is currently listed as May Be at Risk in New Brunswick and Vulnerable in Nova Scotia.

In the United States, the species is on the Audubon Watchlist (Red) as well as the USFWS Birds of Conservation Concern (National concern). It was a Category 2 Candidate Species under the *Endangered Species Act* before that category was eliminated in 1995. Category 2 candidates were species that may have warranted listing but for which knowledge was insufficient to support a final conclusion. It is a Special Concern species and a Species of Greatest Conservation Need (SGCN) in New York, Vermont, New Hampshire, and Maine.

Table 5. Conservation status (NatureServe 2009) and state listings for Bicknell's Thrush in North America.

State/province	Status	State/province listing so
World rank	G4	Apparently secure (1996)
Canada	N3B	Vulnerable / Species of concern
Quebec	S3B	Vulnerable
New Brunswick	S3B	Imperiled / May be at risk
Nova Scotia	S1S2B	Vulnerable/Critically imperiled
United States	N4B	Species of National Conservation concern
Connecticut	SNA	
Delaware	SNA	
Georgia	SNA	
Maine	S3B	Special concern species and SGCN*
Maryland	SNA	
Massachusetts	SXB	Extirpated
New Hampshire	S2S3B	Imperiled/Special concern species and SGCN*
New Jersey	SNA	
New York	S2S3B	Imperiled/Special concern species and SGCN*
North Carolina	SNA	
Pennsylvania	SNA	
Rhode Island	SNA	
South ICarolina	SNA	
Vermont	S3B	Special concern species and SGCN*
Virginia	SNA	

* SGCN = Species of Greatest Conservation Need

TECHNICAL SUMMARY

Catharus bicknelli

Bicknell's Thrush

Grive de Bicknell

Range of Occurrence in Canada : QC, NB, NS

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2008) is being used)	2-3 Yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. Based on trend information from the High Elevation Landbird Program in the Maritimes	> 70% reduction in NB and NS.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	Not reversible, particularly on wintering grounds; generally understood and not ceased
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	297,000 km ²
Index of area of occupancy (IAO) - Wintering grounds	Approx. 25,000 km ²
Is the total population severely fragmented?	No
Number of "locations*"	N/A
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	Possible decline
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	Yes
Is there an [observed, inferred, or projected] continuing decline in number of populations?	N/A
Is there an [observed, inferred, or projected] continuing decline in number of locations?	N/A
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Yes
Are there extreme fluctuations in number of populations?	N/A
Are there extreme fluctuations in number of locations*?	N/A
Are there extreme fluctuations in extent of occurrence?	No

* See definition of location.

Are there extreme fluctuations in index of area of occupancy?	No
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Number of Mature Individuals (in each population)

Population	N Mature Individuals
Total:	40,570 – 49,258

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not done
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Threats (actual or imminent, to populations or habitats)

- Habitat loss, fragmentation and degradation on both wintering and breeding grounds - Impact of climate change on habitat

Rescue Effect (immigration from outside Canada)

Status of outside population(s)?	Generally stable in the U.S.
Is immigration known or possible?	No, but possible
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	Yes, but may be limited by distance birds will disperse

Current Status

COSEWIC: Threatened (November 2009) Quebec: Vulnerable New Brunswick: May be at Risk Nova Scotia: Vulnerable

Status and Reasons for Designation

Status: Threatened	Alpha-numeric code: A4b
<p>Reasons for Designation: This species has one of the most restricted breeding ranges among the forest birds of North America. It inhabits the forests of montane and cool coastal zones, as well as high elevation regenerating forests over 600m in Quebec, New Brunswick, Nova Scotia and the northeastern United States. It winters in the Greater Antilles, where the bulk of its population appears to be in the Dominican Republic. Despite the difficulty of adequately monitoring the species, all the available indices on trends point to significant declines in population and area of occupancy. Preliminary results from the Maritimes Breeding Bird Atlas project suggest a 40% decline in the area occupied over the last three generations, while the High Elevation Landbirds Program suggests more dramatic declines in the same regions. Recent surveys in Quebec also indicate declines in some locations. While reasons for the decline are unclear, habitat loss on the wintering grounds, management practices such as pre-commercial thinning in regenerating forests and climate change are leading to a reduction of suitable high-elevation habitat.</p>	

Applicability of Criteria

Criterion A (Declining Total Population): Meets Threatened A4b if based on trends from the Maritimes showing declines of more than 70% over a seven-year period, which are expected to continue, based on an appropriate index of abundance (b).
Criterion B (Small Distribution, and Decline or Fluctuation): Not applicable. Does not meet criterion.
Criterion C (Small Total Population Size and Decline): Not applicable. Does not meet criterion.
Criterion D (Very Small Population or Restricted Distribution): Not applicable. Does not meet criterion.
Criterion E (Quantitative Analysis): None conducted.

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