COSEWIC
Assessment and Status Report
on the
Bicknell’s Thrush
*Catharus bicknelli*
in Canada

THREATENED
2022

COSEWIC  
Committee on the Status of Endangered Wildlife in Canada

COSEPAC  
Comité sur la situation des espèces en péril au Canada
COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:


Previous report(s):


Production note:

COSEWIC would like to acknowledge Marc-André Villard for writing the status report on Bicknell’s Thrush (*Catharus bicknelli*) in Canada, prepared under contract with Environment and Climate Change Canada. Preparation of this report was overseen by Richard Elliot, Co-chair of the COSEWIC Birds Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat  
c/o Canadian Wildlife Service  
Environment and Climate Change Canada  
Ottawa, ON  
K1A 0H3  
Tel.: 819-938-4125  
Fax: 819-938-3984  
E-mail: ec.cosepac-cosewic.ec@canada.ca  
www.cosewic.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la Grive de Bicknell (*Catharus bicknelli*) au Canada.

Cover illustration/photo:  
Bicknell’s Thrush — Photo credit: Éric Deschamps

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<tr>
<th>Assessment Summary – December 2022</th>
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</thead>
<tbody>
<tr>
<td><strong>Common name</strong></td>
</tr>
<tr>
<td>Bicknell’s Thrush</td>
</tr>
<tr>
<td><strong>Scientific name</strong></td>
</tr>
<tr>
<td><em>Catharus bicknelli</em></td>
</tr>
<tr>
<td><strong>Status</strong></td>
</tr>
<tr>
<td>Threatened</td>
</tr>
<tr>
<td><strong>Reason for designation</strong></td>
</tr>
<tr>
<td>This songbird is now largely restricted to breeding in regenerating high-elevation forests in parts of southern Quebec, New Brunswick, Nova Scotia, and adjacent mountains of northeastern United States. Information from several survey sources confirms that breeding numbers continue to decline markedly, with the recent loss from coastal breeding sites and former strongholds on Cape Breton Island. Declines are expected to continue into the future in response to a range of threats. These include loss of forested wintering habitat on Caribbean islands, impacts of introduced Moose on Cape Breton and non-native rats on wintering grounds, habitat alteration from precommercial thinning and conversion of fir forests to spruce plantations, and impacts of climate change on forest composition.</td>
</tr>
<tr>
<td><strong>Occurrence</strong></td>
</tr>
<tr>
<td>Quebec, New Brunswick, Nova Scotia</td>
</tr>
<tr>
<td><strong>Status history</strong></td>
</tr>
<tr>
<td>Designated Special Concern in April 1999. Status re-examined and designated Threatened in November 2009. Status re-examined and confirmed in December 2022.</td>
</tr>
</tbody>
</table>
COSEWIC
Executive Summary

Bicknell’s Thrush
*Catharus bicknelli*

Wildlife Species Description and Significance

Bicknell’s Thrush (*Catharus bicknelli*) is a medium-sized thrush with a limited breeding distribution in northeastern North America. It is of high conservation concern due to its limited range, specific habitat requirements on breeding and wintering grounds, the naturally fragmented nature of its habitat, and the many threats it faces. It was first recognized as a full species in 1995, based on morphological, vocal, and genetic distinctiveness, and its disjunct geographic distribution in relation to the Gray-cheeked Thrush.

Distribution

Bicknell’s Thrush breeds in parts of Quebec, New Brunswick, and Nova Scotia in eastern Canada and New York, Vermont, New Hampshire, and Maine in the northeastern United States. It winters only on islands in the Caribbean Sea, including Cuba, Jamaica, Puerto Rico, Haiti, and the Dominican Republic.

Habitat

The breeding range of Bicknell’s Thrush is restricted to high elevations and areas subject to natural environmental stresses, such as high winds, winter ice accumulation, and cool sea breezes. It nests from elevations above 1150 m in the Appalachian Mountains to near sea level on scattered coastal sites. Bicknell’s Thrush usually breeds in stands dominated by Balsam Fir (with subdominant White Birch and Red Spruce), including clearcut harvest blocks, but avoids recently-thinned stands. Its strong association with Balsam Fir limits habitat availability on high plateaus. Bicknell’s Thrush winters primarily in mesic to wet broadleaf montane forests, with more than half of its inferred wintering habitat in the Dominican Republic. Worst-case climate change scenarios predict that breeding habitat may decline by more than half by about 2100.
**Biology**

Bicknell’s Thrush is unusual among thrushes in that it engages in dynamic female-defense polygynandry mating associations, in which most females are assisted by up to four males in provisioning at the nest, with some males feeding two broods simultaneously. The number of provisioning males is higher when prey abundance is low. Females regularly call, sing, and exclude conspecific females from their home ranges, whereas male home ranges overlap extensively. Both sexes defend small territories in dense vegetation on the wintering grounds, where there is evidence of sex-based habitat partitioning, with males tending to occur at higher elevations.

**Population Size and Trends**

The Canadian population of Bicknell’s Thrush is estimated to be about 21,300–91,000 mature individuals, based on a revised population estimate for Quebec and the results of the second breeding bird atlases of Quebec and the Maritime provinces, and factoring in evidence of recent population declines.

Very limited Breeding Bird Survey (BBS) results suggest that the number of Bicknell’s Thrush breeding in Canada declined by about -53.7% (95% CI: -90.2, -10.3) over 10 years. Longer-term trends (1970-2019) are also negative, equivalent to a cumulative decline of about -87.2% (95% CI: -98.8, -32.7) over 49 years. However, as relatively few BBS routes are located in Bicknell’s Thrush habitat, the 10-year trend estimate has broad uncertainty and low statistical reliability. It may therefore be better estimated by interpolation that is based on the long-term annual rate of decline, which yields an estimated decline of about -34.2% (95% CI: -59.6 to -7.8) over 10 years. The recent disappearance of Bicknell’s Thrush from some coastal sites in Quebec, southwestern Nova Scotia, and the Bay of Fundy, and recent loss of the species from former strongholds on Cape Breton Island, shows that breeding range continues to contract.

**Threats and Limiting Factors**

Bicknell’s Thrush is particularly vulnerable to anthropogenic threats, owing to its high degree of habitat specialization, its relatively low reproductive rate, and sex-specific habitat partitioning in winter, which may make females more vulnerable to human disturbance. Most of the important threats affect habitat, including alteration of breeding habitat quality by precommercial thinning and conversion of fir forests to spruce plantations, and loss of wintering habitat on Caribbean islands due to local forest clearing for agriculture. Introduced Moose have slowed forest habitat regeneration on Cape Breton Island. Other threats include predation by non-native rats on wintering grounds and degradation and habitat loss through wind farm construction on high-elevation breeding habitat. Many of these impacts may be compounded by the ongoing effects of climate change on forest composition.
Protection, Status, and Ranks

Bicknell’s Thrush was listed as Threatened in Canada under the *Species at Risk Act* in 2012. The species and its nests are protected in Canada under the *Migratory Birds Convention Act* (1994). It is considered Vulnerable in Quebec, Threatened in New Brunswick, and Endangered in Nova Scotia. Bicknell’s Thrush is considered Apparently Secure by NatureServe (G4), and it is listed as Vulnerable on the IUCN Red List. It is identified by the US Fish and Wildlife Service as a Bird Species of National Concern, and it is on the Red Watch List of Partners in Flight as a Species of Conservation Concern. Four large protected areas, including Cape Breton Highlands National Park, Parc national de la Gaspésie, Parc national des Monts-Valins, and Parc national des Hautes-Gorges-de-la-Rivière-Malbaie, appear to host substantial areas of good quality breeding habitat for Bicknell’s Thrush.
**TECHNICAL SUMMARY**

*Catharus bicknelli*

Bicknell’s Thrush  
Grive de Bicknell  
Range of occurrence in Canada (province/territory/ocean): Quebec, New Brunswick, Nova Scotia

**Demographic Information**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation time (usually average age of parents in the population)</td>
<td>2.32 years</td>
<td>Bird et al. (2020)</td>
</tr>
<tr>
<td>Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?</td>
<td>Yes</td>
<td>Inferred decline, based on BBS, Mountain Birdwatch, and ÉPOQ and eBird trend estimates</td>
</tr>
<tr>
<td>Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations, whichever is longer up to a maximum of 100 years].</td>
<td>(a) -31.9% (95% CI: -68.7%, +5.0%) over 5 years, or: (b) -18.9% (95% CI: -36.5, -4.0) over 5 years</td>
<td>Estimated decline from 2014–2019, derived from limited BBS results: (a) based on BBS data over 5 years; (b) inferred by applying long-term BBS rate of decline to the 5-year period</td>
</tr>
<tr>
<td>[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations, whichever is longer up to a maximum of 100 years].</td>
<td>(a) -53.7% (95% CI: -90.2, -10.3) over 10 years, or: (b) -34.2% (95% CI: -59.6, -7.8) over 10 years</td>
<td>Estimated decline from 2009–2019, derived from limited BBS results: (a) based on BBS data over 10 years; (b) inferred by applying long-term BBS rate of decline to the 10-year period (see Fluctuations and Trends).</td>
</tr>
<tr>
<td>[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next 10 years.</td>
<td>Projected continuing decline at similar rates</td>
<td>Inferred from anticipated effects of threats with High-Medium impact</td>
</tr>
<tr>
<td>[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over 10 years, including both the past and the future.</td>
<td>Projected continuing decline at similar rates</td>
<td>Recent decline projected to continue into future at similar rates, inferred from anticipated effects of threats with High-Medium impact</td>
</tr>
<tr>
<td>Are the causes of the decline clearly understood?</td>
<td>Yes, for most causes</td>
<td>Primarily loss and degradation of forested breeding and wintering habitat</td>
</tr>
<tr>
<td>Have the causes of the decline ceased?</td>
<td>No</td>
<td>Forest management on the breeding grounds and habitat degradation on wintering grounds are continuing</td>
</tr>
<tr>
<td>Are the causes of the decline clearly reversible?</td>
<td>No, many are not reversible over the short term</td>
<td>Direct human-caused habitat impacts may be reversible in the longer term, but those related to climate change may not be</td>
</tr>
<tr>
<td>Are there extreme fluctuations in number of mature individuals?</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
### Extent and Occupancy Information

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated extent of occurrence (EOO)</td>
<td>311,985–427,065 km²</td>
<td>Calculated using a minimum convex polygon around known (minimum) and potential (maximum) breeding areas</td>
</tr>
<tr>
<td>Index of area of occupancy (IAO), reported as 2x2 km grid value.</td>
<td>968–54,208 km²</td>
<td>Range is based on known (minimum) and potential (maximum) breeding sites; actual value may be closer to maximum estimate</td>
</tr>
<tr>
<td>Is the population &quot;severely fragmented&quot; i.e., is &gt;50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?</td>
<td>a. No</td>
<td>b. No</td>
</tr>
<tr>
<td>Number of &quot;locations&quot;* (use plausible range to reflect uncertainty if appropriate)</td>
<td>Unknown, but likely &gt;10</td>
<td></td>
</tr>
<tr>
<td>Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?</td>
<td>Yes</td>
<td>Observed and projected decline, with reduction documented by breeding bird atlases (Whittam 2015; Aubry and Shaffer 2019)</td>
</tr>
<tr>
<td>Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?</td>
<td>Yes</td>
<td>Observed and projected decline, with reduction documented by breeding bird atlases in the Maritime provinces (Whittam 2015).</td>
</tr>
<tr>
<td>Is there an [observed, inferred, or projected] continuing decline in number of subpopulations?</td>
<td>No</td>
<td>Not applicable; no subpopulations</td>
</tr>
<tr>
<td>Is there an [observed, inferred, or projected] continuing decline in number of &quot;locations&quot;*?</td>
<td>No</td>
<td>Based on threats from forestry activities, which affect many relatively small areas differently, and shifts across the landscape over time</td>
</tr>
<tr>
<td>Is there an [observed, inferred, or projected] continuing decline in [area, extent, and/or quality of] habitat?</td>
<td>Yes, inferred and observed continuing decline in area and quality of breeding and wintering habitat</td>
<td>Inferred from climate change modelling and observed habitat alterations associated with forest management and clearing for agriculture</td>
</tr>
<tr>
<td>Are there extreme fluctuations in number of subpopulations?</td>
<td>No</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Are there extreme fluctuations in number of &quot;locations&quot;*?</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Are there extreme fluctuations in extent of occurrence?</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Are there extreme fluctuations in index of area of occupancy?</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

* See Definitions and Abbreviations on [COSEWIC website](http://www.cosewic.gc.ca) for more information on this term.
### Number of Mature Individuals (in each subpopulation)

<table>
<thead>
<tr>
<th>Subpopulations (no subpopulations; provincial estimates provided here)</th>
<th>N Mature Individuals</th>
<th>Notes on individual estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quebec</td>
<td>14,000–59,700</td>
<td>Based on revised estimate (Aubry pers. comm. 2021)</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>5,100–21,800</td>
<td>Based on revised estimate for Quebec, and proportion of squares occupied in recent breeding bird atlas (Stewart et al. 2015)</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>2,200–9,500</td>
<td>Based on revised estimate for Quebec, and proportion of squares occupied in recent breeding bird atlas (Stewart et al. 2015)</td>
</tr>
<tr>
<td>Total</td>
<td>21,300–91,000</td>
<td>Based on revised estimate for Quebec and the relative number of occupied atlas squares, and accounting for recent rates of decline shown by the BBS</td>
</tr>
</tbody>
</table>

### Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, whichever is longer up to a maximum of 100 years, or 10% within 100 years]? Unknown Analysis not conducted

### Threats and Limiting Factors

<table>
<thead>
<tr>
<th>Was a threats calculator completed for this species?</th>
<th>Yes, on 7 September 2021</th>
<th>Overall threat impact: High-Medium</th>
</tr>
</thead>
</table>

The following contributing threats were identified, listed in decreasing order of impact, and excluding those of negligible impact (see Appendix 1):

- IUCN 5. Biological resource use (Medium-Low threat impact)
- IUCN 8. Invasive and other problematic species and genes (Medium-Low threat impact)
- IUCN 1. Residential and commercial development (Low threat impact)
- IUCN 2. Agriculture and aquaculture (Low threat impact)
- IUCN 3. Energy production and mining (Low threat impact)
- IUCN 7. Natural system modifications (Unknown threat impact)
- IUCN 9. Pollution (Unknown threat impact)
- IUCN 11. Climate change and severe weather (Unknown threat impact)

What additional limiting factors are relevant? Specialized ecological requirements on breeding and wintering grounds, sex-specific habitat segregation on the wintering grounds, relatively low productivity, being single-brooded with a relatively small clutch size, and a male-biased sex ratio. Sex-specific habitat use on the wintering grounds may place females at higher risk of habitat loss.
### Rescue Effect (natural immigration from outside Canada)

<table>
<thead>
<tr>
<th>Status of outside population(s) most likely to provide immigrants to Canada</th>
<th>Generally declining</th>
<th>Most potential source populations in northeastern US are declining but may be stable to slightly increasing in Vermont (Hill 2020).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is immigration known or possible?</td>
<td>Possible</td>
<td>Yes, interpopulation movement is likely, based on evidence of extensive natal dispersal (Studds et al. 2012).</td>
</tr>
<tr>
<td>Would immigrants be adapted to survive in Canada?</td>
<td>Yes</td>
<td>Conditions in Canada are similar to those in US source areas.</td>
</tr>
<tr>
<td>Is there sufficient habitat for immigrants in Canada?</td>
<td>Yes</td>
<td>Areas of potential breeding habitat are apparently available in Quebec (Aubry et al. 2018, Aubry pers. comm. 2020).</td>
</tr>
<tr>
<td>Are conditions deteriorating in Canada?†</td>
<td>Yes</td>
<td>Ongoing decline in extent and quality of breeding habitat due to forestry operations, Spruce Budworm outbreak, and climate change.</td>
</tr>
<tr>
<td>Are conditions for the source (i.e., outside) population deteriorating?‡</td>
<td>Yes</td>
<td>Habitat quality is decreasing in northeastern US, with dieback of high-elevation conifer stands and predicted effects of climate change.</td>
</tr>
<tr>
<td>Is the Canadian population considered to be a sink?‡</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>Is rescue from outside populations likely?</td>
<td>No, unlikely</td>
<td>Most source populations in northeastern US are declining.</td>
</tr>
</tbody>
</table>

#### Occurrence Data Sensitivity

| Are occurrence data of this species sensitive?                               | No |

#### Status History

**COSEWIC:** Designated Special Concern in April 1999. Status re-examined and designated Threatened in November 2009. Status re-examined and confirmed in December 2022.

#### Status and Reasons for Designation

**NOTE:** Recommended status is changed to Current status after a Wildlife Species Assessment Meeting when the report is finalized.

<table>
<thead>
<tr>
<th>Current Status:</th>
<th>Threatened</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha-numeric codes:</td>
<td>A2bce+3bce+4bce</td>
</tr>
</tbody>
</table>

† See Table 3 (Guidelines for modifying status assessment based on rescue effect).
Reasons for designation (2022):
This songbird is now largely restricted to breeding in regenerating high-elevation forests in parts of southern Quebec, New Brunswick, Nova Scotia, and adjacent mountains of northeastern United States. Information from several survey sources confirms that breeding numbers continue to decline markedly, with the recent loss from coastal breeding sites and former strongholds on Cape Breton Island. Declines are expected to continue into the future in response to a range of threats. These include loss of forested wintering habitat on Caribbean islands, impacts of introduced Moose on Cape Breton and non-native rats on wintering grounds, habitat alteration from precommercial thinning and conversion of fir forests to spruce plantations, and impacts of climate change on forest composition.

<table>
<thead>
<tr>
<th>Reason for change of status</th>
<th>Not applicable</th>
</tr>
</thead>
</table>

Applicability of Criteria

A: Decline in total number of mature individuals
Meets Threatened, A2bce+3bce+4bce, based on estimates of declines in the number of mature individuals exceeding 30% over the past 10 years. These estimates of declines come from limited Breeding Bird Survey data, are supported by results of species-specific surveys, and are expected to continue into the future at similar rates over the next 10 years, together with declines in IAO, EOO, and quality of habitat, with the effects of introduced mammals contributing to the decline.

B: Small distribution range and decline or fluctuation
Not applicable. Estimated EOO exceeds thresholds; although the minimum estimate of IAO is <2000 km², with a continuing inferred decline in EOO and IAO, area, and quality of habitat and an observed decline in number of mature individuals, the population occurs at more than 10 locations and is not severely fragmented or subject to extreme fluctuations.

C: Small and declining number of mature individuals
Not applicable. Minimum population estimate of 21,300 mature individuals is higher than thresholds.

D: Very small or restricted population
Not applicable. Minimum population estimate of 21,300 mature individuals and IAO are higher than thresholds.

E: Quantitative analysis
Not applicable. Analysis not done.
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

(2022)

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.
COSEWIC Status Report

on the

Bicknell’s Thrush
*Catharus bicknelli*

in Canada

2022
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Figure 2. Modelled breeding range of Bicknell’s Thrush in northeastern North America (from ECCC 2020). Black dots indicate 10 x 10 km² atlas squares in which Bicknell’s Thrush breeding evidence was reported in recent breeding bird atlases of the Maritime provinces (Stewart et al. 2015) and Quebec (Robert et al. 2019). The maximum estimated extent of occurrence in Canada is shown within a minimum convex polygon around the modelled breeding range (courtesy of S. Allen, COSEWIC secretariat). ................................................ 9

Figure 3. Modelled wintering range of Bicknell’s Thrush on islands of the Greater Antilles in the Caribbean Sea (from ECCC 2020). Red triangles indicate sites known to be occupied (McFarland et al. 2013). .......................................................... 10

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Figure 5. Bicknell’s Thrush breeding distribution in the Maritime provinces (New Brunswick, Prince Edward Island, and Nova Scotia) during 2006–2010 from the Second Atlas of the Breeding Birds of the Maritime provinces (Stewart et al. 2015). Black dots (n = 60) depict 10 x 10 km squares in which Bicknell’s Thrush was recorded during the first atlas (1986-1990) but not the second. Yellow dots depict squares (n = 13) where it was recorded during the second atlas but not the first. ........................................................................................................ 12

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific name: *Catharus bicknelli*

English name: Bicknell's Thrush

French name: Grive de Bicknell

Classification: Class: Aves

Order: Passeriformes

Family: Turdidae

Relatively small and slender compared to its congeners, Bicknell’s Thrush is a sister species of Gray-cheeked Thrush (*C. minimus*), from which it was only distinguished in 1995 (A.O.U. 1995). It was recognized as a full species on the basis of morphometric, acoustic, behavioural, genetic, and distributional evidence compiled by Ouellet (1993). One case of hybridization with Veery (*C. fuscescens*) has been inferred from vocalizations and genetic data (Martinsen *et al.* 2018), and a putative hybrid with Gray-cheeked Thrush was reported by Fitzgerald *et al.* (2017) based on genetic data.

Morphological Description

Bicknell's Thrush is a small *Catharus* thrush species in which sexes are similar, except for the fact that females have a slightly shorter wing chord (Frey *et al.* 2008). Males average 28.2 g in mass and females average 32.0 g (Townsend *et al.* 2020). Mean wing chord is 92.9 mm for males and 87.8 mm for females (Townsend *et al.* 2020). Bicknell’s Thrush has olive-brown to brownish upperparts (head, nape, and back) that contrast slightly with the chestnut-tinged tail (cover picture; Townsend *et al.* 2020). The breast is pale with a buffy wash, with greyish flanks and dusky spots that become diffuse toward the sides and the lower breast. It has grey cheeks, a faint grey eye-ring, a bicoloured bill, and pink legs.

Although differences in plumage colouration are used to distinguish between Bicknell’s and Gray-cheeked Thrush (e.g., Todd 1963), reliable identification in the field is difficult (Townsend *et al.* 2020). The species is best distinguished by its song, which is high-pitched and flute-like, usually made up of four phrases and rising slightly at the end. Wing length can be used to distinguish most individuals in the hand as the Gray-cheeked Thrush generally has a wing chord of >95 mm, whereas 85% of Bicknell’s Thrush have a wing chord of <95 mm (Ouellet 1993). However, wing length measurements of young female Gray-cheeked and adult male Bicknell’s Thrush may overlap (Townsend *et al.* 2020).
Population Spatial Structure and Variability

No subspecies of Bicknell’s Thrush have been described (Townsend et al. 2020). Todd (1963) suggested that birds from New York and New England were tawnier brown than those in the Maritime provinces and southeastern Quebec, which the author described as a colder olive-brown. It is unclear whether this possible north-south trend in plumage colour represents a true cline or whether these colour types are intermixed throughout the species’ range (Townsend et al. 2020).

Designatable Units

Bicknell’s Thrush was considered as one Designatable Unit (DU) in Canada in previous status assessments (e.g., COSEWIC 2009). With no subspecies (Townsend et al. 2020), an extensive mixing of breeding populations on the wintering grounds suggested by deuterium ratios (Hobson et al. 2001), and no evidence for discrete genetic or morphological differences of evolutionary significance among Bicknell’s Thrush within Canada, the species is again considered here as one Designatable Unit.

Special Significance

Bicknell’s Thrush is considered by McFarland et al. (2018) to be one of the species at highest risk of extinction among Nearctic-Neotropical migrant songbirds due to its restricted range and habitat requirements, unusual breeding structure, and threats related to declining habitat availability. Overall Canadian conservation responsibility for Bicknell’s Thrush is high. No publicly available Aboriginal Traditional Knowledge was identified for Bicknell’s Thrush. However, this species is part of Canadian ecosystems that are important to Indigenous people who recognize the interconnectedness of all species within these ecosystems.

DISTRIBUTION

Global Range

Bicknell’s Thrush is a North American endemic species, breeding in the northeastern part of the continent and wintering in the Caribbean. It breeds in southern Quebec, northern New Brunswick, and northern Nova Scotia (Cape Breton Island) in eastern Canada, and northern portions of New York, Vermont, New Hampshire, and Maine in the northeastern United States (Figures 1, 2). It winters only in the Greater Antilles in the Caribbean Sea, including Cuba, Jamaica, Puerto Rico, Haiti, and the Dominican Republic (Figures 1, 3).

Most fall migrating Bicknell’s Thrush move south along the Atlantic coast of the United States to Virginia (Bégin-Marchand et al. 2020). They then depart from the southeastern United States on an overwater flight to the Greater Antilles. Northbound spring migrants appear to follow a coastal trajectory from Florida to Virginia, with twice as many birds reported from this area in spring as in fall (Townsend et al. 2020).
Figure 1. Global breeding, wintering, and migrating range of Bicknell’s Thrush (from Townsend et al. 2020). Breeding range is shown in salmon, wintering range in blue, and main migratory pathways in yellow.
Figure 2. Modelled breeding range of Bicknell’s Thrush in northeastern North America (from ECCC 2020). Black dots indicate 10 x 10 km² atlas squares in which Bicknell’s Thrush breeding evidence was reported in recent breeding bird atlases of the Maritime provinces (Stewart et al. 2015) and Quebec (Robert et al. 2019). The maximum estimated extent of occurrence in Canada is shown within a minimum convex polygon around the modelled breeding range (courtesy of S. Allen, COSEWIC secretariat).
Canadian Range

According to model predictions, Canada is thought to host about 95% of the breeding habitat currently available for Bicknell's Thrush (ECCC 2020). In Quebec, Bicknell's Thrush breeds in dense fir-dominated stands at high elevations in the Appalachian Mountains, from Mont Sutton to the Gaspé Peninsula. North of the St. Lawrence River, Bicknell's Thrush has been reported from Mont Tremblant to the high plateau northwest of Sept-Îles. The breeding range is naturally fragmented by lowland areas and breaks in the occurrence of Balsam Fir (\textit{Abies balsamea}), with large gaps between Appalachian peaks, and between Mont Tremblant and the Laurentian Highlands. There is also a large distribution gap between the Monts Valin region, north of the Saguenay River, and the Sept-Îles/Port-Cartier plateau. Bicknell's Thrush has not been reported during the breeding season in the Magdalen Islands in the Gulf of St. Lawrence since 1989. It has also disappeared from some coastal sites that were occupied during the first Quebec breeding bird atlas (Figure 4).
In New Brunswick, Bicknell’s Thrush mainly breeds in the Highlands ecoregion, with scattered breeding individuals in the Northern Uplands ecoregion. The most recent summer sighting along the Bay of Fundy coast was of a singing individual at Fundy National Park in July 2009 (eBird 2021). Breeding habitat in Nova Scotia is concentrated in the Cape Breton Highlands, with scattered sightings on St. Paul Island (none since 2010) and Scatarie Island (automated recording units—ARUs—deployed in 2018 and 2019 recorded one “probable” detection in 2019; L. Achenbach, unpubl. data). Bicknell’s Thrush has not been reported during the breeding season from coastal sites in southwestern Nova Scotia (Cape Forchu, Seal, and Bon Portage Islands) since 1935, and the last report from West Advocate in the Bay of Fundy was in 1988 (eBird 2021). It has disappeared from other sites on the Bay of Fundy coast in Nova Scotia and New Brunswick that were occupied during the first Maritimes breeding bird atlas (1986–1990; Figure 5).
Figure 5. Bicknell’s Thrush breeding distribution in the Maritime provinces (New Brunswick, Prince Edward Island, and Nova Scotia) during 2006–2010 from the Second Atlas of the Breeding Birds of the Maritime provinces (Stewart et al. 2015). Black dots (n = 60) depict 10 x 10 km squares in which Bicknell’s Thrush was recorded during the first atlas (1986-1990) but not the second. Yellow dots depict squares (n = 13) where it was recorded during the second atlas but not the first.

Extent of Occurrence and Area of Occupancy

The current extent of occurrence (EOO) for Bicknell’s Thrush is estimated as 311,985–427,065 km², calculated as a minimum convex polygon around current known breeding areas in Canada (Figure 2). The minimum value is based on a polygon drawn around those 10 km x 10 km squares with breeding evidence in the latest Quebec (Robert et al. 2019) and Maritimes (Stewart et al. 2015) breeding bird atlases. The maximum value is based on a polygon drawn around areas modelled as suitable breeding habitat in the Bicknell’s Thrush recovery strategy (ECCC 2020). The actual EOO value is likely closer to the minimum estimate, which is based on observations rather than the habitat-based maximum as not all apparently suitable habitat is occupied.

Because the previous EOO estimate of 297,000 km² (COSEWIC 2009) was calculated using different methods and included birds breeding in the United States, these estimates cannot be directly compared. However, EOO has likely declined slightly over that period, with losses documented in several areas by breeding bird atlases (Whittam 2015; Aubry and Shaffer 2019), such as in southern Cape Breton Island (Figure 5).
The index of area of occupancy (IAO) for Bicknell’s Thrush in Canada was obtained by overlaying a 2 x 2 km grid over possible breeding sites. A minimum IAO estimate of 484 km² can be determined by counting a single 2 x 2 km square for each occupied 10 x 10 km square in the most recent Quebec (Robert et al. 2019) and Maritimes (Stewart et al. 2015) breeding bird atlases. This approach underestimates the IAO as each occupied atlas square likely contains more than one occupied 2 x 2 km square, given that Bicknell’s Thrush tend to aggregate in suitable habitat and not all squares with potential habitat were surveyed. The minimum estimate for the Canadian population of 21,300 mature individuals represents a density of about 44 individuals/km² (0.44/ha), approximately twice the densities estimated by Aubry in several regions of Quebec (Table 1). To account for this likely underestimation, the minimum estimate of IAO was doubled to 968 km². The maximum IAO estimate of 54,208 km² was obtained by overlaying the 2 x 2 km grid on the entire modelled habitat area (ECCC 2020; Figure 2). The actual IAO value may be close to the mid-range of the estimate as the maximum of 54,208 km² is based on the availability of suitable habitat, much of which is apparently unoccupied.

Table 1. Bicknell’s Thrush density estimates (mature individuals/ha) derived from point count surveys conducted in Quebec, New Brunswick, and Nova Scotia.

<table>
<thead>
<tr>
<th>Province</th>
<th>Site/region</th>
<th>Density (n)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quebec</td>
<td>Mégantic/Gosford</td>
<td>&lt;800 m above sea level: 0.16 (57)–0.50 (131)</td>
<td>Aubry (unpubl. data, 2003, 2008)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;800 m above sea level: 0.16³</td>
<td>Aubry (unpubl. data, 2013)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Appalaches sud</td>
<td>0.05 (60)</td>
<td>Aubry (unpubl. data, 2013)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Massif du Sud</td>
<td>0.07 (111)–0.16 (26)</td>
<td>Aubry (unpubl. data, 2008, 2010, 2011)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Rimouski</td>
<td>0 (60)</td>
<td>Aubry (unpubl. data, 2013)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Gaspésie</td>
<td>0.01 (379)–0.11 (40)</td>
<td>Aubry (unpubl. data, 2001, 2005)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Mont Tremblant</td>
<td>0.002⁴</td>
<td>eBird</td>
</tr>
<tr>
<td>Quebec</td>
<td>Plateau Laurentien</td>
<td>0.03⁵</td>
<td>Aubry (unpubl. data, 2013, 2014)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Monts Valin</td>
<td>0.03 (208)–0.08 (92)</td>
<td>Aubry (unpubl. data, 2012, 2013)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Sept-Îles/Port-Cartier</td>
<td>0.002 (401)</td>
<td>Aubry (unpubl. data, 2006)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Massif du Sud</td>
<td>0.14 (210)</td>
<td>Aubry et al. (2016)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Mont Gosford</td>
<td>0.22 (129)–0.50 (129)</td>
<td>Aubry et al. (2016)</td>
</tr>
<tr>
<td>Quebec</td>
<td>Mont Sutton</td>
<td>--</td>
<td>eBird</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>New Brunswick Highlands</td>
<td>0.16</td>
<td>Nixon et al. (2001)</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>New Brunswick Highlands⁶</td>
<td>0.04–0.08</td>
<td>Kouwenberg (2020)</td>
</tr>
</tbody>
</table>
1Number of distinct mature individuals/ha, based on detections within a 100 m radius. Calling and singing individuals were weighted equally. n = number of point count stations (Y. Aubry unpubl. data). Density estimates from other references listed are presumed to be derived using similar procedures.

2No Balsam Fir-dominated potential Bicknell’s Thrush habitat available.

3No point count data at that elevation; extrapolation using Mégantic/Gosford density >800 m.

4Extrapolation using Sept-Îles/Port-Cartier density.

5Extrapolation using Monts Valin density <800 m.

62012–2015

72016–2019

IAO was estimated at 48,850 km² in the previous status assessment (COSEWIC 2009), based on a breeding habitat predictive model, and the same estimate was cited in the Bicknell’s Thrush recovery strategy (ECCC 2020). This value cannot be compared directly with the current estimate of IAO as different methods were used to calculate them. However, the actual IAO has likely declined in the Maritime provinces, as suggested by the large number of atlas squares where the species was detected during the first atlas but not the second one (Figure 5), despite increased search effort (Whittam 2015). In Quebec, a more intensive search effort resulted in an increase of 21 occupied atlas squares between the first and second atlas, but occupied area is thought to have decreased in much of Quebec, considering that Bicknell’s Thrush was not detected during the second atlas in the Magdalen Islands nor in several formerly occupied sites in the Gaspé Peninsula and Cote-Nord region (Aubry and Shaffer 2019; Figure 4).

**BIOLOGY AND HABITAT USE**

Bicknell’s Thrush ecology is poorly known due to the remoteness of the areas it occupies, the dense vegetation and the steep slopes it selects, and the challenges involved in the observation of its behaviour once detected.

Bicknell’s Thrush breeding biology has been intensively studied on some of the highest mountains in New England by the Vermont Center for Ecostudies, with long-term data from Mount Mansfield, Vermont (Wallace 1939; Hill et al. 2019; Townsend et al. 2020). Most research in Quebec has focused on populations at Mont Gosford, Massif du Sud, Mine Madeleine, Mont Copper, and the Laurentian Highlands (e.g., Aubry et al. 2011, 2016, 2018). Populations in the New Brunswick Highlands ecoregion received the most attention...
in the Maritime provinces (e.g., Nixon et al. 2001; Chisholm and Leonard 2008; McKinnon et al. 2014). Researchers from the Vermont Center for Ecostudies have conducted considerable research on wintering grounds, especially in the Dominican Republic (e.g., Townsend et al. 2010, 2011; McFarland et al. 2013, 2018).

Although mating associations involving one female and several males have been reported in other Catharus thrushes (e.g., Veery; Hailey et al. 2016), this unusual mating system of female-defense polygynandry appears to be the norm for Bicknell’s Thrush (Goetz et al. 2003). These highly dynamic mating associations include one female and up to four males, with some males feeding two broods simultaneously (Askanas 2012; Townsend et al. 2020; Y. Aubry unpubl. data). The number of provisioning males is negatively related to prey abundance (Strong et al. 2004). Males are not territorial in the classic sense, instead occupying home ranges that overlap extensively, whereas females defend territories against conspecific females, especially during nest-building and egg-laying (Townsend et al. 2020).

**Life Cycle and Reproduction**

The longevity record for Bicknell’s Thrush is 11 years and 11 months (Lutmerding and Love 2013). Birds reach sexual maturity in their second calendar year, when they are just under 1 year old. Bird et al. (2020) estimated generation time to be 2.32 years on the basis of an annual survival rate of 0.58, age at first breeding of 1 year, and maximum longevity of 8.77 years.

The Bicknell’s Thrush nests in dense conifer patches dominated by Balsam Fir, with White Birch (Betula papyrifera) as a secondary species, in both New Brunswick (n = 12; McKinnon et al. 2014) and Vermont (n = 103; Townsend et al. 2020). In Vermont, 87% of nests were built in Balsam Fir trees or shrubs (average height: 3.2 m ± 1.6 SD), on steep ground with slopes averaging 18.7° ± 10.4 SD. The nest is a bulky open cup, usually built against the trunk and supported by horizontal branches, and constructed by the female alone. New nests are built each year, and re-nesting following nest failure is frequent (Townsend et al. 2020). Although Bicknell’s Thrush tends to have a clumped distribution owing to overlap of male home ranges, there is no evidence of active clustering of nests, based on minimal overlap among female territories (Townsend et al. 2020). In New Brunswick, female territories averaged 18.1 ± 5.3 ha (n = 9; Ward 2020), whereas in Quebec they averaged 13.9 ± 2.4 ha (n = 16; Aubry et al. 2011).

In Vermont, male Bicknell’s Thrush return from spring migration in mid-May at the earliest, with females arriving about a week later (Townsend et al. 2020). Earliest nest construction was observed there on 1 June, with 71% of 89 clutches initiated during the first three weeks of June. Clutch size is 3–4 (mean: 3.6 ± 0.49 SD, n = 59), and incubation lasts 9–14 days (mean: 12 ± 1.6 SD, n = 8; Wallace 1939). Incubation and brooding are assumed by females only, whereas both sexes feed nestlings and fledglings. Males may feed two broods concurrently or consecutively (Goetz et al. 2003; Y. Aubry unpubl. data). In Vermont, nestlings fledged 9–13 days after hatching (mean 11.4 d ± 1.3 SD, n = 17), and young fledged from 70% of nests by 14 July (n = 53; Wallace 1939; Townsend et al. 2020). In Quebec, young fledged between 8 and 24 July (n = 6; Y. Aubry unpubl. data in Townsend et al. 2020).
et al. 2020). Re-nesting is common in Vermont, but only one case of a successful second brood has been reported (Townsend et al. 2020).

Apparent annual survival rate of adults in a Vermont population of Bicknell’s Thrush was 0.61 (CI: 0.54–0.68; n = 178 adults) over a 14-year period (Hill et al. 2019). An apparent survival rate of 0.34 ± 0.06 for second-year birds and 0.48 ± 0.07 for adult (after second-year) birds was reported in the Gaspé Peninsula, Quebec (Townsend et al. 2020). In Sierra de Bahoruco, Dominican Republic, Townsend et al. (2020) derived a Cormack-Jolly-Seber survival estimate of 72.9% (± 14.3% SE), with mean parameter estimates for all models ranging from 68.4% to 79.7%. No data are available on juvenile survival rate owing to the challenge of resighting returning individuals. Philopatry is low in Vermont, based on a 2.6% return rate of individuals banded as nestlings or dependent fledglings (n = 115; Townsend et al. 2020).

Breeding productivity is relatively low. The average number of young fledged/nest was 2.1 ± 1.37 SD (range 0–4, n = 30) on Stratton Mountain, Vermont, and 1.5 ± 1.59 SD (range 0–4, n = 46) on Mount Mansfield, Vermont. Although these are minimum estimates, annual reproductive success of Bicknell’s Thrush generally appears to be low. Townsend et al. (2020) indicate that “of 21 males with known paternity at nests in 1998 and 1999, 13 (62%) sired only one chick, 4 (19%) sired two chicks, 3 (14%) sired three chicks, and 1 (5%) sired four chicks”.

Red Squirrel (Tamiasciurus hudsonicus) is a key nest predator of Bicknell’s Thrush, and its numbers vary directly with the magnitude of cone crops, especially that of Balsam Fir. Daily nest survival rates in Vermont were 0.92 (14.7% for 12-day incubation and 11-day nestling periods) in years with low densities of Red Squirrel, and 0.79 (0.44% for 23-day breeding periods) in years with high squirrel densities (Townsend et al. 2020). The same phenomenon has been observed in Quebec (Aubry pers. comm. 2020). Nest predation and relatively wet weather in December-March influenced nest success and adult apparent survival on Mount Mansfield (Hill et al. 2019). These authors hypothesized that high Balsam Fir cone crops in late summer and early fall resulted in the high winter survival of squirrels, which in turn resulted in lower site fidelity by adult Bicknell’s Thrush the following year as a consequence of lower nesting success. They further hypothesized that overwinter survival of adult Bicknell’s Thrush was higher following wet winters, as a result of greater food abundance. Finally, nestlings may die from exposure during severe weather events (Townsend et al. 2020).

Habitat Requirements

Breeding habitat

Bicknell’s Thrush is a habitat specialist that nests in dense, Balsam Fir-dominated stands subject to frequent natural disturbance (high winds, accumulation of winter ice, cool temperatures) or human activities creating similar forest characteristics (Townsend et al. 2020). Most breeding habitat occurs on high plateaus (e.g., Laurentian Highlands, New Brunswick’s Highlands, Cape Breton Highlands) or at high elevations where forest stands
dominated by Balsam Fir have not recently (<10 years) been altered by forest management (Connolly et al. 2002; Aubry et al. 2016, 2018; ECCC 2020). Locally, some individuals may occasionally breed near sea level in coastal spruce-fir stands in Quebec (Ouellet 1995), New Brunswick (Wilson pers. comm. 2021), and Nova Scotia (Erskine 1992; Whittam 2015).

Typical Bicknell’s Thrush breeding habitat is characterized by dense dwarf Balsam Fir stands, or “krummholz”, accompanied by White Birch primarily but also Red Spruce (Picea rubens), Black Spruce (Picea mariana), Mountain Ash (Sorbus americana), and Pin Cherry (Prunus pensylvanica). Forest stands with these characteristics are found at high elevations, on exposed ridgelines, or in areas altered by recurring natural disturbances (heavy winds, winter ice accumulation, cool sea breezes). Areas altered by human activities may also be used by Bicknell’s Thrush >10 years after disturbance (e.g., by forest management) or along habitat edges (e.g., alpine skiing trails) (ECCC 2020; Townsend et al. 2020) and possibly access roads to wind farms (Artuso pers. comm. 2022).

Bicknell’s Thrush has been reported in sites above 1100 m in elevation at the southern edge of its range, in the Catskills Mountains of New York. In Quebec’s Laurentian Highlands, it was rarely detected below 800 m. In New Brunswick’s Highlands, 67% of the birds detected by Nixon et al. (2001) occupied sites above 600 m, but some were detected at elevations as low as 457 m. In Cape Breton, Nova Scotia and along the Bay of Fundy, in New Brunswick, Bicknell’s Thrush is occasionally found in coastal spruce-fir stands close to sea level (Erskine 1992; Stewart et al. 2015). Some birds were also detected in coastal habitat in Quebec (e.g., Percé and Île Bonaventure; eBird 2021; Figure 6).

Bicknell’s Thrush radio-sexed in managed forests used some pre-commercially thinned areas within their home range, although unthinned stands dominated use (Aubry et al. 2011). Chisholm and Leonard (2008) reported the highest abundance in regenerating stands 11–13 years after clear-cutting in New Brunswick, where pre-commercial thinning had a negative effect on breeding numbers at both local and stand levels. In Cape Breton, Nova Scotia, 78% of Bicknell’s Thrush were detected in unmanaged fir-dominated stands, with the remainder in regenerating industrial forest (Busby pers. comm. in Townsend et al. 2020). In the Laurentian Highlands, Bicknell’s Thrush showed a preference for 20–25 year-old, post-harvest stands on hilltops with no recent signs of timber harvesting or silvicultural treatments (Desrochers et al. 2017; Aubry et al. 2018). Elsewhere in Quebec (Charlevoix, Gaspé Peninsula, and the Eastern Townships), the species has been reported in stands with average canopy heights of 7.5, 5.3, and 9.0 m, respectively (Rompré et al. 1999), suggesting that it also occupies relatively old forest stands. In New Brunswick, Bicknell’s Thrush occupied sites with significantly higher densities of Balsam Fir stems in the 5–10 cm dbh class (Nixon et al. 2001; Chisholm and Leonard 2008) and has been reported in older, unthinned stands on mountain tops in the Christmas Mountains and Kedgwick Highlands (Torrenta 2021a).
Figure 6. Records of detections of Bicknell’s Thrush by amateur birdwatchers in Quebec during the period 1970–2020, from 10 June to 10 August each year from eBird (2021) and ÉPOQ (J. Larivée and Regroupement QuébecOiseaux). Only observations made east of 76.5°W and south of 51°N are shown. Warmer colours (increasing from purple to green to yellow) indicate the proportion of years in which Bicknell’s Thrush was detected for each 10 x 10 km square visited by observers. Squares with no observations are not shown. Dot size is proportional to the number of bird lists submitted per square (A. Desrochers unpubl. data).

Migration habitat

Although habitat used by Bicknell’s Thrush during migration remains poorly documented, scattered reports suggest that it uses a wider range of vegetation types, as observed in many songbirds. For example, Bicknell’s Thrush is frequently captured by bird banders in coastal Virginia in upland shrub and dune scrub forest (Wilson and Watts 1997). In Montreal, habitat used by three fall migrating individuals at the McGill Bird Observatory included dense shrubland dominated by hawthorn (Crataegus sp.), buckthorn (Rhamnus cathartica and R. frangula), and Staghorn Sumac (Rhus typhina), with small patches of

**Winter habitat**

Bicknell’s Thrush winter habitat is generally characterized as mesic or wet mountain broadleaf montane forest, and the Dominican Republic comprises more than half of its predicted wintering habitat (Townsend *et al.* 2020). Both sexes defend small territories in dense vegetation on the wintering grounds, with only 2.7–5.6% of individuals moving amongst different areas (Townsend *et al.* 2010). Evidence exists for sexual habitat segregation, with male-biased sex ratios (74% males) in high-elevation cloud forests and a nearly even ratio (53% males) in rainforest at lower elevations (Townsend *et al.* 2012). McFarland *et al.* (2013) mapped potential habitat in the Greater Antilles and found that sites used by Bicknell’s Thrush had a higher and denser forest canopy, as well as a denser understorey, than unused sites. Most sites (85%) used by wintering birds were in broadleaf forest, with 12% in mixed forest. Occupancy was higher in more mature seral stages and at wetter sites. Townsend *et al.* (2009) noted that birds foraging in cloud forest roosted in nearby pine forest (within 100 m), apparently to avoid arboreal predators (mainly introduced rats).

**Movement, Dispersal, and Migration**

Bicknell’s Thrush is a Neotropical, nocturnal migrant. Southbound migrants tracked with geolocators departed between 30 September and 12 October from several sites between the Catskill Mountains and the Gaspé Peninsula (Townsend *et al.* 2020). At Forêt Montmorency in the Laurentian Highlands, radio-tagged individuals departed as late as 7 October (Desrochers *et al.* 2017), which is broadly consistent with dates when fall migrants have been reported in Montreal.

Most fall migrating Bicknell’s Thrush move south along the Atlantic coast of the United States to Virginia. They then follow an elliptical trajectory between the southeastern United States and the Greater Antilles, departing on an overwater flight to the Greater Antilles. Northbound spring migrants appear to move directly up the east coast from Florida to Virginia, with twice as many birds reported along that segment of the Atlantic coast during the spring than in the fall (Townsend *et al.* 2020). Bicknell’s Thrush fall migrants tagged in the Laurentian Highlands and radio-tracked with Motus (Taylor *et al.* 2017) flew closer to the Atlantic coast than either Swainson’s (*C. ustulatus*) or Gray-cheeked Thrush (Bégin-Marchand *et al.* 2020). Mean duration of fall migration was 29 ± 10 days, including stopovers varying between 6 and 33 days in duration, in late October and early November (Townsend *et al.* 2020). Spring migrants depart the Greater Antilles between 28 April and 7 May, with a mean duration of northbound migration of 17 ± 4 days (Townsend *et al.* 2020). No key spring stopover sites have been reported (Townsend *et al.* 2020).
As with most songbird species, post-natal dispersal likely accounts for most Bicknell’s Thrush inter-population movements. Studds et al. (2012) mapped deuterium ratios in tail feathers and estimated that nearly 70% of post-natal dispersal movements of 114 individuals captured at 25 montane sites were less than 200 km in distance, with a few juvenile individuals dispersing as far as 700 km. A yearling male dispersed 17.2 km between breeding seasons (Townsend et al. 2020), although most dispersal movements by adults were considerably shorter. The mean distance between nests used by 26 banded females in successive years in Vermont was 182.9 m (± 267.8 SD; Townsend et al. 2020).

Physiology

Bicknell’s Thrush appears to have a lower rate of oxygen consumption with decreasing air temperature than the other Catharus thrush species that occur in northeastern North America (Holmes and Sawyer 1975). This may be a metabolic adaptation to more severe weather conditions prevailing in summer in subalpine breeding habitats. Levels of mercury acquired from atmospheric deposition in Bicknell’s Thrush blood sampled at Mount Mansfield, Vermont, are below those reported to negatively impact physiology or reproduction in other invertivorous passerines (Rimmer et al. 2005, 2019).

Diet

Bicknell’s Thrush forages on arboreal invertebrates during the breeding season, including ants, beetles, and Lepidopteran larvae (Wallace 1939), likely including Spruce Budworm (Choristoneura fumiferana). As with other migratory Catharus thrushes, this species may be frugivorous in late summer and during fall migration, although this is not confirmed in the literature. Bicknell’s Thrush feeds on both arthropods and fruits on the wintering grounds. Males tend to favour habitat rich in arthropods, whereas lower-elevation habitat selected by females is richer in soft-bodied fruit (Townsend et al. 2012).

Interspecific Interactions

Predators

Predation of adult Bicknell’s Thrush is relatively rare on Canadian breeding grounds, although Townsend et al. (2020) documented predation of adults by Sharp-shinned Hawk (Accipiter striatus) and possibly Long-tailed Weasel (Mustela frenata). Northern Saw-whet Owl (Aegolius acadicus) may depredate fledglings or adults, as suggested by the fact that it is actively mobbed by adult Bicknell’s Thrush (Townsend et al. 2020).

Both direct (McFarland and Rimmer 2002) and indirect evidence indicates that Red Squirrel is a key Bicknell’s Thrush nest predator, especially in years following large Balsam Fir cone crops (Hill et al. 2019). Nest monitoring with cameras at Mine Madeleine and Mont Gosford, Quebec, revealed predation by Red Squirrel, Sharp-shinned Hawk, American Marten (Martes americana), and Deer Mouse (Peromyscus maniculatus) (Y. Aubry unpubl. data). Other nest predators include Long-tailed weasel, Northern Saw-whet Owl, Boreal...

Nocturnal predation by the introduced Black (*Rattus rattus*) and Norway Rat (*R. norvegicus*) is thought to represent a significant cause of mortality of wintering adults in the Dominican Republic (Townsend *et al.* 2009; see Threats).

**Non-predatory interspecific interactions**

Aggressive interactions have been documented between Swainson’s and Bicknell’s Thrushes (Able and Noon 1976), and the latter has been displaced from song perches by American Robin (*Turdus migratorius*) and White-throated Sparrow (*Zonotrichia albicollis*; Townsend *et al.* 2020). In contrast, Aubry *et al.* (2016) found extensive co-occurrence of Bicknell’s and Swainson’s Thrushes at Mont Gosford and Massif-du-Sud, Quebec. Recent population trends (2011–2019) from the US Mountain Birdwatch Program (n = 750 point count stations spread across the range in the United States) suggest a downward shift in the elevational range occupied by Swainson’s Thrush and a 24.6% decline in abundance across New England (J.M. Hill unpubl. data). A playback experiment suggested asymmetrical interspecific aggression by Swainson’s Thrush towards Bicknell’s Thrush (Freeman and Montgomery 2016), but this was based on a small sample size.

Fitzgerald (2017) compared the ecological niches of Bicknell’s and Gray-cheeked Thrushes and concluded that Bicknell’s Thrush nested in warmer, wetter sites with a high abundance of Balsam Fir, whereas Gray-cheeked Thrush was more often found in Black Spruce.

There is no evidence of non-predatory interspecific interactions during the nonbreeding season.

**Adaptability**

As a habitat specialist, Bicknell’s Thrush appears to be highly affected by forest management practices such as those applied in the Maritime provinces (Whittam 2015). It has been shown to nest in post-harvest conifer stands, especially mid-age (11–13 year) clear-cuts with dense Balsam Fir regeneration (Chisholm and Leonard 2008). Among boreal bird species, Bicknell’s Thrush is considered one of the most vulnerable to climate change (Stralberg *et al.* 2019) owing to the projected decline of its habitat and its demographic sensitivity (low population size and high variability in reproductive success). Individuals defending territories in cloud forest on the wintering grounds tend to roost in nearby pine stands, apparently in response to predation risk from arboreal rats (Townsend *et al.* 2009).
Limiting Factors

The main limiting factors for Bicknell’s Thrush appear to be its highly specialized ecological requirements that limit habitat availability on both breeding and wintering grounds, and its relatively low productivity (Townsend et al. 2012, 2020). Low productivity and the female-defense polygynandry mating system (Goetz et al. 2003) probably stem from the short breeding season associated with the harsh weather conditions experienced by this species.

The breeding habitat of Bicknell’s Thrush is geographically restricted to high elevations and areas subject to certain chronic natural disturbances (strong winds, heavy ice, or cool sea breezes). The species’ strong association with Balsam Fir also limits habitat availability on high plateaus, where spruces often dominate (Aubry pers. comm. 2020). Bicknell’s Thrush appears to be associated with relatively narrow successional windows in New Brunswick (Chisholm and Leonard 2008) and the Laurentian Highlands (Aubry et al. 2018), although recent data from Torrenta (pers. comm. 2021) suggest that they may use older stands. The fact that the number of provisioning males at nests decreases with food abundance (Strong et al. 2004) suggests that abiotic conditions (short breeding season, inclement weather) may also be limiting. Finally, nest predation by Red Squirrel can be very intense every second year, as a function of the periodicity of Balsam Fir masting (Hill et al. 2019). Red Squirrel populations are also influenced by spruce masting, whose cones can be stored in middens, unlike fir cones (Aubry pers. comm. 2021). Wintering habitat is spatially limited (about 33,000 km²; McFarland et al. 2013), and only about 30% is protected.

The current and emerging outbreak of Spruce Budworm in Eastern Canada has the potential to severely reduce Bicknell’s Thrush habitat quality over the short term. Spruce Budworm is a defoliating insect whose main host is Balsam Fir (Hennigar et al. 2008), and severe outbreaks may kill both regenerating and mature fir trees, as observed on the north shore of the St. Lawrence River (Poulin pers. comm. 2021). Bicknell’s Thrush habitat near Monts Valin and in the Gaspé Peninsula suffered severe budworm outbreaks in 2020 (MFFP 2020; Figures 4, 7). Over the longer term, the effects of this outbreak will depend on the vigour of future Balsam Fir regeneration, which will itself be influenced by climatic changes.
Figure 7. Intensity of forest defoliation by Spruce Budworm in Quebec in 2020, based on aerial surveys by the Quebec Ministère des Forêts, de la Faune et des Parcs (MFFP 2020). Green indicates areas of light defoliation, orange indicates moderate defoliation, and red indicates severe defoliation.

POPULATION SIZES AND TRENDS

Data Sources, Methods, and Uncertainties

It is challenging to survey breeding Bicknell’s Thrush, because its breeding areas are remote and its vocal activity is mostly crepuscular (Ball 2000; Townsend et al. 2020). Bouts of calling and singing are normally of short duration, about 15–20 min (Townsend et al. 2020). This makes it difficult to monitor the species using standardized roadside count protocols that rely on morning vocalization. In addition, calls are much more frequent than songs (Aubry pers. comm. 2021), and response to conspecific playbacks has been shown to be inconsistent when compared with Automatic Recording Unit (ARU) recordings for the same sites (Torrenta pers. comm. 2021). Complex mating associations and singing by females further complicate interpretation of vocalisations in estimating numbers of pairs. The male-biased sex ratio of Bicknell’s Thrush might suggest that populations are somewhat buffered against male-biased declines, but the observation that more provisioning males are present at nests when food abundance is lower (Strong et al. 2004) suggests that several provisioning males may be required for successful reproduction in such circumstances. Hence, isolated individuals likely represent nonbreeding males or females.
The North American Breeding Bird Survey

The North American Breeding Bird Survey (BBS) is a North America-wide citizen science program that monitors population trends for birds in North America (Hudson et al. 2017; Sauer et al. 2017). Skilled volunteers are assigned to a roadside route 39.2 km long, composed of fifty 3-minute point counts located at 0.8-km intervals. All birds heard or seen within 400 m are recorded at each stop (Hudson et al. 2017).

As relatively few roads reach high-elevation sites where most Bicknell’s Thrush habitat occurs, roadside surveys such as the BBS do not sample much of the habitat used by this species. Bicknell’s Thrush population trends are estimated from observations on 14 BBS routes in Canada with long-term data and 9 routes with short-term data (2009–2019), including 3 routes in Quebec and 6 in Nova Scotia (Table 2; Smith et al. 2020). Only 5 routes in the United States recorded Bicknell’s Thrush in 2009–2019. BBS data were insufficient to document provincial population trends in New Brunswick (Smith pers. comm. 2021). The relatively low statistical reliability of the resulting Bicknell’s Thrush population trend estimates is attributable to these low sample sizes. Short-term (5- and 10-year) trends may therefore be better estimated by interpolation based on the long-term annual rate of decline, in line with IUCN guidelines (IUCN Standards and Petitions Committee 2022). Results of both analytical approaches are presented below.


<table>
<thead>
<tr>
<th>Region</th>
<th>Annual % rate of change (95% lower, upper CI)</th>
<th>Cumulative % change (95% lower, upper CI)</th>
<th>Probability of decline &gt;30%</th>
<th>No. of routes</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td><strong>2009–2019</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>-7.40 (-20.73, 0.99)</td>
<td>-53.65 (-90.20, -10.34)</td>
<td>0.79</td>
<td>9</td>
<td>Low</td>
</tr>
<tr>
<td>Quebec</td>
<td>-7.63 (-20.73, 1.34)</td>
<td>-54.78 (-90.20, 14.21)</td>
<td>0.79</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>-7.79 (-21.50, 1.74)</td>
<td>-55.55 (-91.11, 18.78)</td>
<td>0.79</td>
<td>6</td>
<td>Low</td>
</tr>
<tr>
<td><strong>1970–2019</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Canada</td>
<td>-4.10 (-8.67, -0.80)</td>
<td>-87.17 (-98.83, -32.66)</td>
<td>0.98</td>
<td>14</td>
<td>Low</td>
</tr>
<tr>
<td>Quebec</td>
<td>-4.09 (-8.73, -0.59)</td>
<td>-87.07 (-98.86, -25.15)</td>
<td>0.97</td>
<td>8</td>
<td>Low</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>-4.40 (-9.05, -0.72)</td>
<td>-88.96 (-99.04, -29.73)</td>
<td>0.97</td>
<td>6</td>
<td>Low</td>
</tr>
</tbody>
</table>
Species-specific monitoring programs

Specific survey methods designed to monitor birds in high-elevation habitat, including the High Elevation Landbird Program (HELP; Campbell and Stewart 2012) and Mountain Birdwatch (MBW; Hill and Lloyd 2017), have proven useful in surveying Bicknell’s Thrush. HELP surveys were initially undertaken following predetermined 1 km routes, stopping every 250 m to conduct a 10-minute point count (Campbell and Stewart 2012). HELP was later modified to meet the standardized protocol of the range-wide Mountain Birdwatch 2.0 and was combined with that program in 2016 (Kouwenberg 2020). The MBW morning survey protocol was designed to detect the minimum annual change of 3% over 30 years identified in the 2010 Bicknell’s Thrush Conservation Action Plan (IBTCG 2010). The MBW protocol consists of four consecutive 5-minute counts at each survey point, for a total sampling period of 20 minutes per point. During the first 10 minutes of the survey, observers track individual Bicknell’s Thrush within four distance categories on a minute-by-minute basis. For the final 10 minutes, Bicknell’s Thrush are counted using the same method as the other MBW focal species (Kouwenberg 2020). The MBW 2.0 protocol was first applied in New Brunswick in 2016, and then in Nova Scotia in 2018 and 2019 (Kouwenberg 2020), precluding its use in calculating meaningful 10-year population trends here. From 2018 to 2020, Birds Canada also deployed automated recording units (ARUs) on Cape Breton and Scatarie Islands, Nova Scotia, and in northern New Brunswick (Kouwenberg 2020; Torrenta 2021a). In Quebec, the MBW 2.0 protocol was applied for a pilot year but was replaced by point count surveys at focal sites because the MBW yielded too few detections (Aubry pers. comm. 2021). However, recent ARU data suggest that several sites where conspecific playbacks had yielded no response may actually host breeding individuals (Torrenta pers. comm. 2021).

Trends from ÉPOQ and eBird databases

In Quebec, population trend data can be derived from observation checklist data from amateur birdwatchers in ÉPOQ (Étude des populations d'oiseaux du Québec; J. Larivée and Regroupement QuébecOiseaux, ÉPOQ 2021) and eBird. eBird is an online checklist program widely used by birders for reporting field observations (eBird 2021). The program was established in 2002, and its use has increased markedly in recent years. Data from ÉPOQ databases have been incorporated into eBird, and although data remain weighted to recent years, eBird records are informative regarding recent distribution patterns and notable concentrations of individuals.

ÉPOQ and eBird can be subsampled to reflect the breeding period of Bicknell’s Thrush, and latitudinal and longitudinal limits of its breeding range. André Desrochers performed such an analysis for the purposes of this report (A. Desrochers unpubl. data). Although records of rare species are validated by regional ÉPOQ coordinators and eBird volunteer reviewers, mistakes in identifying Bicknell’s Thrush are still possible, as with all survey methods presented here.
Breeding Bird Atlases

Breeding Bird Atlases are large-scale citizen science projects that document the distribution and relative abundance of breeding birds at provincial or regional scales. Each atlas is composed of a contiguous grid of 10 x 10 km atlas squares. Surveys are volunteer-based, with skilled birders recording evidence of breeding (possible, probable, or confirmed) for all bird species within each atlas square sampling unit of 100 km². During atlassing, volunteers are also encouraged to perform point counts and to document nest records.

Quebec (Robert et al. 2019) and the Maritime provinces (Stewart et al. 2015) have each completed a second breeding bird atlas since the last status report (COSEWIC 2009), allowing for regional estimations of change in Bicknell’s Thrush distribution and probability of occurrence between 1984–1989 and 2010–2014, and between 1986–1990 and 2006–2010, respectively. However, large portions of potential Bicknell’s Thrush habitat may be under-sampled by these atlases owing to difficulty of access, especially in parts of Quebec (Figure 3.1 in Robert et al. 2019).

Abundance

COSEWIC (2009) provided an estimate of the Canadian Bicknell’s Thrush population of 40,570–49,258 mature individuals, developed by extrapolating bird densities calculated from survey point counts across Bicknell’s Thrush habitat, as determined from a range-wide breeding habitat model. A more recent analysis of HELP results provided population estimates of about 2851 (95% CI: 1137–10,652) mature individuals in New Brunswick and 3848 (95% CI: 1823–7049) in Nova Scotia (Campbell and Stewart 2012). For the United States, a population estimate for 2016 (71,318 individuals; 95% CI: 56,788–90,219) was calculated using data from the Mountain Birdwatch program, and a global estimate of ~120,000 mature individuals was proposed (Hill and Lloyd 2017).

An updated Bicknell’s Thrush population estimate for Quebec was developed for this report by Y. Aubry, based on point count survey data and estimated areas of habitat above or below 800 m in each major habitat patch or region (Table 1; Aubry pers. comm. 2021). This estimate was obtained by extrapolating from densities estimated based on point counts in the corresponding patch or region (COSEWIC 2009). For each patch or region, minimum and maximum density estimates from distinct point count surveys were used to obtain an estimated range of population numbers (see Table 1). Where no survey data were available, but Bicknell’s Thrush was known to be present, the density recorded in the closest patch or region with comparable habitat quality was used. Using this approach, the Bicknell’s Thrush population in Quebec was initially estimated to be 27,986–119,347 mature individuals (Aubry pers. comm. 2021). However, the point count data used to produce these estimates were 7–20 years old (Table 1), necessitating a correction to the short-term declining trend reported by the BBS (-54.78%; Table 2). Across Canada, 10-year rolling trends showed a mean rate of decline exceeding -30% by 2008 and -50% by 2017 (Figure 8). Applying a reduction of about 50% resulted in a final population estimate of about 14,000–59,700 mature individuals in Quebec (Table 3).
Figure 8. Rolling 10-year trends of Bicknell’s Thrush population change across Canada from 1970–1980 through to 2009–2019, based on Breeding Bird Survey data (A. Smith unpubl. data 2020). The vertical axis represents the average annual percent change in population size over a 10-year period. The horizontal axis represents the last year of the 10-year rolling trends (e.g., 2019 is the trend for 2009–2019). Orange and red horizontal lines depict 30% and 50% cumulative short-term decline rates, which represent COSEWIC thresholds for listing a species as Threatened and Endangered, respectively. Vertical bars represent the 50% (broad, dark blue) and 95% (narrow, light blue) credible intervals.

Table 3. Estimated number of mature Bicknell’s Thrush individuals in Canada by province, based on point count data from Quebec (see Table 1), the relative number of occupied squares reported in the second breeding bird atlases of Quebec (Robert et al. 2019) and the Maritime provinces (Stewart et al. 2015), and accounting for a 50% decline since 2009 (see Figure 8).

<table>
<thead>
<tr>
<th>Province</th>
<th>Number of mature individuals</th>
<th>% of the Canadian population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quebec</td>
<td>14,000–59,700</td>
<td>65.6%</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>5,100–21,800</td>
<td>24.0%</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>2,200–9,500</td>
<td>10.4%</td>
</tr>
<tr>
<td>Canada total</td>
<td>21,300–91,000</td>
<td>100%</td>
</tr>
</tbody>
</table>
Bicknell’s Thrush was recorded in 30 breeding bird atlas squares in New Brunswick (24% of atlas squares occupied in Canada), 13 in Nova Scotia (10.4%; Stewart et al. 2015; Figure 5), and 82 in Quebec (65.6%; Robert et al. 2019; Figure 4). Assuming no significant differences in the density of breeding adults among provinces and equal probability of detection in each province, this produced population estimates of 5,100–21,800 mature individuals for New Brunswick and 2,200–9,500 for Nova Scotia. However, the assumption of equal densities across provinces does not seem to hold for Nova Scotia (Table 1), so the estimate of the number breeding in that province is very likely to be an overestimate. Totalling these figures yields a Canadian Bicknell’s Thrush population estimate of about 21,300–91,000 mature individuals (Table 3). Partners in Flight does not provide a population estimate for this species, and the proportion of the global population that occurs in Canada is unknown but may be between one-third and one-half (based on Aubry and Shaffer 2019).

Fluctuations and Trends

Population fluctuations

Hill et al. (2019) have shown that the apparent survival rate of Bicknell’s Thrush on Mount Mansfield, Vermont, fluctuated with cycles in annual cone production by Balsam Fir (see Life Cycle and Reproduction), but Bicknell’s Thrush is not known to exhibit extreme population fluctuations.

Long-term historical trends

For breeding Bicknell’s Thrush in Canada, the BBS indicates a long-term (1970–2019) annual rate of decline of 4.1% (95% CI: -8.67, -0.80) (Table 2; Figure 9), which corresponds to a cumulative decline of 87.17% (95% CI: -98.83, -32.66) over that 49-year period (Smith pers. comm. 2020). This long term-trend is one of a continuing gradual decline, with occasional small peaks in numbers counted (e.g., in 2002, 2007; Figure 9). ÉPOQ and eBird data suggest a more complex long-term trend in percent detections in Quebec (Figure 10; A. Desrochers unpubl. data), with an initial period of relatively numerous detections (1970–1977), then a period with relatively few detections until the mid-1990s, followed by a period with more numerous detections and another decline starting in 2013. However, as Bicknell’s Thrush was first recognized as a separate species in 1995, identification of birds recorded prior to that date may have been inconsistent, and interest after 1995 may have driven birdwatchers to search for this “new” species, contributing to the increase in sightings.
Figure 9. Annual index of population abundance for Bicknell’s Thrush in Canada, based on Breeding Bird Survey data from 1970 to 2019 (n = 14 routes). The GAM (generalized additive model) trend represents the best curvilinear fit of data. Blue shading shows 95% credible intervals for the GAM trend (A. Smith unpubl. data).
Figure 10. Trends in number of Bicknell’s Thrush detections by amateur birdwatchers in Quebec during the period 1970–2020, from 10 June to 10 August each year, from eBird (2021) and ÉPOQ (J. Larivée and Regroupement QuébecOiseaux) databases. Only birds detected east of 76.5°W and south of 51°N were included. Points represent the percentage of 10 x 10 km squares visited by observers in which Bicknell’s Thrush were present in each year, out of all squares in which Bicknell’s Thrush were recorded at least once during the 50-year period (A. Desrochers unpubl. data).

Short-term trends

Bicknell’s Thrush population trends are not available for the past 10-year period (2009–2019) from species-specific survey programs as HELP surveys in the Maritime provinces were replaced by MBW surveys beginning in 2013 (Kouwenberg 2020). However, HELP surveys showed marked annual decreases of 7.4% in Nova Scotia and 11.5% in New Brunswick over the latest 10-year period for which data are available (2002–2011; Campbell 2014). Bicknell’s Thrush numbers have continued to decline in Nova Scotia in recent years, with only four birds detected on MBW surveys in 2015, two in 2016, and none in 2017, the last year that surveys were conducted (Kouwenberg 2020), although 25 had been detected on these routes in 2013 (Campbell 2014). During the period 2016–2019, none were recorded at Money Point in extreme northern Cape Breton Island, previously the regional stronghold with the highest breeding density in Atlantic Canada (Kouwenberg 2020). However, numbers recorded on MBW surveys in northern New Brunswick appear to have been relatively stable over the period 2016–2020 (Torrenta 2021b), following sharp declines detected there by HELP surveys (above).
In Quebec, an analysis of ÉPOQ and eBird data indicates a slight decline in detections of Bicknell’s Thrush over the period 2013–2020, following a period of increase that seemed to begin in the mid-1990s (Figure 10). However, ÉPOQ and eBird data are collected from sighting records of amateur birdwatchers who were not specifically surveying for Bicknell’s Thrush in appropriate habitat and may be specifically searching for this species (see also Long-term Trends, above), so they must be considered with caution.

In Canada, the annual rate of decline recorded by the BBS over 2009–2019, was -7.4% (95% CI: -20.73, 0.99), corresponding to a cumulative decline calculated using that annual rate of -53.7% (95% CI: -90.20, -10.34) (Smith et al. 2020; Table 2, Figure 11). The comparable rate of decline over the 5-year period of 2014–2019 was -31.9% (95% CI: -68.7%, +5.0%; Smith et al. 2020). Similar rates of decline were reported for Quebec, Nova Scotia, and adjacent northeastern United States (Smith et al. 2020), but as BBS trends at the provincial or national level were not statistically significant and were based on small sample sizes, they should be interpreted with caution. Indeed, no Bicknell’s Thrush were detected on Canadian BBS routes in 7 out of the 10 years during the period 2009–2019. Interpolation of the 10-year trend based on the 4.1% long-term annual rate of decline yields an alternate short-term decline estimate of -34.2% (95% CI: -59.6, -7.8) over 2009–2019.

![Bicknell’s Thrush Trajectory Canada](image)

Figure 11. Short-term (2007–2019) annual rates of population change estimated from Breeding Bird Survey data, for those Bird Conservation Regions within provinces that had sufficient data to estimate trends for Bicknell’s Thrush. Blue shading shows 95% credible intervals for the GAM (generalized additive model) trend (A. Smith unpubl. data).
Summary

Considering the limitations of relatively sparse BBS trend data for Bicknell’s Thrush, and possible sampling biases inherent in databases such as eBird, it is useful to take a weight-of-evidence approach to evaluating population trends. Two estimates of the rate of decline over the past 10-year period, derived from BBS data, are 34.2% and 53.7%, depending on the analytical method used. eBird observations (eBird 2021; Figure 10) and Mountain Birdwatch (e.g., Kouwenberg 2020; Torrenta 2021b) records indicate recent declines of similar magnitude (eBird: ca. 39%), with several of the most important breeding areas in Nova Scotia having been abandoned during the past 10-year period. Canadian BBS data indicate a 79% probability that the population declined by at least 30% over the period 2009–2019 and a 55% probability that it decreased by at least 50% over that same period, although this is based on few data (Smith et al. 2020; Figure 8). Atlas results show that Bicknell’s Thrush has now disappeared from some coastal sites in Quebec (Robert et al. 2019) and from coastal islands of southwestern Nova Scotia and the Bay of Fundy (Stewart et al. 2015), and the species no longer occurs in former strongholds on Cape Breton Island (Kouwenberg 2020), confirming that breeding range and numbers continue to contract.

Population Fragmentation

Although the montane breeding habitat used by Bicknell’s Thrush is naturally quite fragmented (Figure 2), the species appears to be well-adapted to bridging gaps among groups of breeding birds through its relatively extensive natal dispersal movements (Studds et al. 2012; Townsend et al. 2020; see Movement, Dispersal, and Migration).

Rescue Effect

There is evidence for extensive movement and interchange among Canadian and U.S. populations, based on an analysis of feather deuterium ratios (Studds et al. 2012), which provided evidence for connections between the Gaspé Peninsula and northern New England through natal dispersal.

Long-term U.S. BBS trends (1970–2019) show an ongoing annual rate of decline of 4.06% (95% CI: -8.83, -0.34), similar to the Canadian annual rate of decline over the same period. Short-term U.S. BBS declines (-7.19%, 95% CI: -20.91, 2.55) are also similar to rates calculated for Canadian populations. Recent trends (2011–2019) from the Mountain Birdwatch Program (Hill 2020) indicate an annual rate of decline of -2.41% for all states combined, with a relatively tight 95% CI (-4.44, -0.45). Annual rates of decline estimated by the Mountain Birdwatch Program from 2011 to 2019 for individual states were highest in New York (-6.35) and New Hampshire (-5.00), whereas Vermont showed a slightly positive rate of change (1.61). Potential source populations in the northeastern United States are declining, with the possible exception of Vermont (Hill 2020). In addition, although there appear to be relatively extensive areas of potential breeding habitat available in some parts of Quebec (e.g., Aubry et al. 2018), the extent and quality of breeding habitat in Canada continue to decline due to forest management activities. The effects of climate change are likely also impacting habitat quality (see Habitat Trends). As a consequence, the probability of rescue from the United States is considered to be very low.
THREATS

Current and Future Threats

Bicknell's Thrush is vulnerable to the cumulative impact of various threats. These are categorized below and in Appendix 1, following the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system (based on Salafsky et al. 2008). The evaluation assesses impacts for each of 11 main categories of threats and their subcategories, based on the scope (proportion of population exposed to the threat over the next 10-year period), severity (predicted population decline among those exposed to the threat during the next 10 years or three generations, whichever is longer), and timing of each threat. The overall threat impact is calculated by taking into account the separate impacts of all threat categories and can be adjusted by the species experts participating in the evaluation.

For Bicknell’s Thrush, the overall threat impact is considered to be High-Medium, corresponding to an anticipated further decline of between 3% and 70% over the next 10 years (see Appendix 1 for details). Threats with an impact score greater than negligible are discussed below in order of decreasing severity of impact (greatest to least), ending with those for which scope or severity is unknown.

IUCN 5. Biological resource use (Medium-Low impact):

Description of threat:

Timber harvesting and forest management (IUCN 5.3) alter and may sometimes help to maintain breeding habitat across much of the Canadian breeding range (ECCC 2020). Bicknell’s Thrush nests in stands dominated by dense Balsam Fir regeneration (Rompré et al. 1999), especially in the 5–10 cm dbh class (Nixon et al. 2001; Chisholm and Leonard 2008). Such stands are generally managed with precommercial thinning, often undertaken during the breeding season (ECCC 2020). Precommercial thinning reduces stem density in the densest regenerating conifer stands and has been shown to cause a three-fold decrease in abundance of breeding Bicknell’s Thrush (Chisholm and Leonard 2008). These authors reported that Bicknell’s Thrush abundance was highest in unthinned, clear-cut stands aged 11–13 years, about the age at which they are normally subject to precommercial thinning. At the stand level, Bicknell’s Thrush abundance was positively correlated with the area of unthinned patches (Chisholm and Leonard 2008), and individual home ranges include greater proportions of unthinned stands than expected by random (Aubry et al. 2011). Poor natural regeneration following precommercial thinning may promote the use of plantation silviculture, which favours the growth of spruce (Picea spp.). Spruce plantations occur at elevations occupied by Bicknell’s Thrush in both New Brunswick (Hadley pers. comm. 2021) and Quebec (Aubry pers. comm. 2021). Timber harvesting for charcoal production (IUCN 5.3) impacts habitat on the wintering grounds (Lloyd and MacFarlane 2017). No information is available on the incidence of shooting or trapping of Bicknell’s Thrush (IUCN 5.1), which is thought to be rare.
**Scope:**

Large-restricted. Approximately 90% of Bicknell’s Thrush breeding habitat in Canada is located on lands managed for forest harvesting (ECCC 2020), and precommercial thinning is widely used in the Highlands ecoregion of New Brunswick (Diamond pers. comm. 2021) and in some parts of the Quebec range (Aubry et al. 2011, 2018). Charcoal production is a relatively localized phenomenon on the wintering grounds (Lloyd and McFarland 2017).

**Severity:**

Moderate. Bicknell’s Thrush tends to avoid recently thinned stands within its home range (Aubry et al. 2011) or at the stand level (Chisholm and Leonard 2008; Aubry et al. 2016). Thinning treatments may also cause direct mortality through the destruction of nests or post-fledging habitat (ECCC 2020). However, Bicknell’s Thrush can persist at lower densities in landscapes where thinned stands are interspersed with dense Balsam Fir regeneration (Chisholm and Leonard 2008; Aubry et al. 2011). It can also persist in areas disturbed by charcoal production, as long as this practice is restricted to small patches (Lloyd and McFarland 2017).

**IUCN 8. Invasive and other problematic species and genes (Medium-Low impact):**

**Description of threat:**

Introduced mammalian predators (IUCN 8.1), including Black and Norway Rats (Townsend et al. 2009), domestic cat (*Felis catus*), and mongoose (family Herpestidae; Lloyd and McFarland 2017) may cause direct mortality of Bicknell’s Thrush on its wintering grounds. Feral pig (*Sus scrofa*) may also cause habitat degradation on the wintering grounds as they disturb understorey vegetation (Lloyd and McFarland 2017).

Poor natural regeneration following precommercial thinning may promote the use of spruce plantations in forest management. The resulting replacement of fir-dominated stands by Black Spruce plantations may result in higher densities of cone-hoarding Red Squirrels (IUCN 8.2) as spruce cones contain seeds for several years, whereas fir cones rarely persist from year to year (Burns and Honkala 1990; McDermott et al. 2020). Spruce plantations provide a more stable food source for squirrels, and higher squirrel populations may increase predation on Bicknell’s Thrush nests.

Severe outbreaks of Spruce Budworm (IUCN 8.2), such as those occurring on the north shore of the St. Lawrence River and the Gaspé Peninsula in Quebec (Figure 7), may kill Balsam Fir over large areas (see Limiting Factors). The intensity and extent of outbreaks are influenced by forest management practices that favour even-aged, Balsam Fir-dominated stands, making them susceptible to outbreaks that may be both more extensive and more intense than those occurring in naturally heterogeneous forest landscapes (Robert et al. 2018). The current outbreak is affecting large portions of Bicknell’s Thrush breeding range (Figure 7), and in the most severely-affected stands, regenerating Balsam Fir is often killed (Poulin pers. comm. 2021).
In recent years, Moose (*Alces americanus*) was overabundant in northern Cape Breton island and has caused extensive habitat degradation, locally replacing dense Balsam Fir regeneration by grassy clearings (Smith *et al.* 2010).

**Scope:**

Pervasive. The scope of impacts of introduced mammalian predators (UCN 8.1) was considered pervasive as two rat species pose a threat in all wintering habitat used by Bicknell’s Thrush on Hispaniola (Rimmer pers. comm. 2021). The scope related to the effects of Spruce Budworm outbreaks (IUCN 8.2) was also considered pervasive as it affects extensive areas of breeding habitat and is likely to continue for many years (Figure 7). Impacts of spruce plantations on Red Squirrel populations are expected to be more localized, as are those of Moose in the Cape Breton Highlands.

**Severity:**

Moderate-slight. Overall severity of impacts of introduced mammalian predators (IUCN 8.1) on Bicknell’s Thrush is considered slight. Impacts of increased Red Squirrel populations may be regionally important as a function of the area planted with spruce. Short- and long-term effects of Spruce Budworm (IUCN 8.2) on habitat quality, occurrence, or productivity have not been well documented but are anticipated to be locally significant, as is the case for habitat degradation by Moose, hence a severity of moderate-slight.

**IUCN 1. Residential and commercial development (Low impact):**

**Description of threat:**

Bicknell’s Thrush generally occurs in habitats far from areas of residential and commercial development. However, mortality by collision with buildings has been documented during migration, mainly in urban areas (IUCN 1.1; Georgia Museum of Natural History in Townsend *et al.* 2020), and may also occur in commercial or industrial areas (IUCN 1.2).

**Scope:**

Small. A relatively small proportion of birds is likely to be impacted, and some individuals may be at risk of collisions with buildings as they pass through dense urban developments and resorts when migrating along the Atlantic coast of the United States (Bégin-Marchand *et al.* 2020). The development of backcountry skiing (e.g., at Massif du Sud and in the Chic-Choc mountain range; IUCN 1.3) causes some direct habitat loss, and trail development can remove as much as 70% of forest cover (Lemaître pers. comm. 2021).
Severity:

Slight. It is likely that most Bicknell’s Thrush that strike buildings are killed instantly or die shortly thereafter, but the proportion of the population affected was estimated to be much less than 10%. The development of backcountry skiing trails may affect relatively limited areas, mainly in Quebec’s Gaspé Peninsula.

IUCN 2. Agriculture and aquaculture (Low impact):

Description of threat:

Forest loss and degradation as a result of shifting (slash-and-burn) and industrial agriculture (IUCN 2.1) can be a considerable threat on the wintering grounds, especially for female Bicknell’s Thrush, whose habitat in rainforests at lower elevations is particularly vulnerable to the expansion of farming (McFarland et al. 2018).

Scope:

Restricted. Impacts are concentrated in limited portions of the wintering grounds.

Severity:

Moderate. Severity is considered moderate owing to limitations on the availability of alternate habitat. However, current negative habitat effects on the wintering grounds may decrease as forest is regenerating on abandoned agricultural land used in winter (Townsend et al. 2020).

IUCN 3. Energy production and mining (Low impact):

Description of threat:

The primary threat in this category is the effect of wind energy development (IUCN 3.3) in breeding areas on high-elevation montane ridges, which may cause habitat loss through clearing for turbine pads and access roads, with potential for some mortality through direct strikes. Effects of ongoing wind power generation are thought to be much lower.

Scope:

Restricted-small. Relatively small areas of Bicknell’s Thrush habitat are directly affected by wind energy development, and Lemaître and Lamarre (2020) reported that Bicknell’s Thrush probability of occurrence did not increase with distance from turbine pads. However, the scope of this threat may increase as areas with potential for wind energy development often overlap with Bicknell’s Thrush habitat (Lloyd and McFarland 2017; Aubry pers. comm. 2020) and new wind energy projects are being developed in Quebec and the Maritime provinces.
Severity:

Slight. The precise duration of construction effects on occurrence is unknown but likely to be short, although this conclusion is based on point counts conducted during and after the construction of a single wind farm (Lemaître and Lamarre 2020).

IUCN 7. Natural system modifications (Unknown impact):

Description of threat:

The frequency and intensity of wildfires (IUCN 7.1) were modelled by Cadieux et al. (2019) under different climate change scenarios. Bicknell’s Thrush habitat is sensitive to effects of wildfire as fire tends to favour those tree species that are better adapted to regenerate after burning than Balsam Fir, such as Black Spruce and Jack Pine (*Pinus banksiana*) (Burns and Honkala 1990).

Scope:

Unknown. The analysis conducted by Cadieux et al. (2019) did not indicate the relative contribution of wildfire to projected Bicknell’s Thrush habitat reduction as a result of climate change.

Severity:

Moderate-slight.

IUCN 9. Pollution (Unknown impact):

Description of threat:

Atmospheric deposition of mercury and other airborne pollutants, such as lead, nitrogen, and sulphur oxides, may have direct effects on health of Bicknell’s Thrush, as well as indirect effects through habitat degradation as a result of soil acidification (IUCN 9.5). Methylation and biomagnification of mercury is known to take place in high-elevation forests of the northeastern United States, and methyl mercury is neurotoxic (Rimmer et al. 2005). Although lead concentrations in soils are decreasing in New England, acidity of precipitation in northeastern North America has not decreased (Townsend et al. 2020 and references therein). In the Adirondack Mountains, *Catharus* thrushes (including Bicknell’s) had some of the highest blood concentrations of mercury recorded among 15 songbird species (Sauer et al. 2020). Apart from one individual sampled on the wintering grounds (Townsend et al. 2013), levels of mercury in blood samples of Bicknell’s Thrush (0.05–0.180 µg/g; Rimmer et al. 2019; Sauer et al. 2020) were below concentrations known to negatively impact physiology or reproduction in other songbird species (Whitney and Cristol 2017). In Canada, mercury deposition remained relatively stable in coastal ecosystems between 1972 and 2008 (Burgess et al. 2013). Feather mercury concentrations in songbirds show a longitudinal gradient in Canada, reaching their highest levels in eastern Canada (Ma et al. 2021).
Spraying of the bacterial insecticide Btk (\textit{Bacillus thuringiensis} var. \textit{kurstaki}) to control Spruce Budworm and Hemlock Looper (\textit{Lambdina fiscellaria}) may reduce food abundance through its effects on many Lepidopteran larvae (IUCN 7.3). Nonetheless, the literature on the effects of Btk spraying on songbirds themselves is inconclusive. Sopuck \textit{et al.} (2000) reported no significant effects on the relative abundance of nearly all songbird species monitored, whereas Awkerman \textit{et al.} (2011) found that adults altered their nest provisioning behaviour in Btk plots, resulting in lower nestling mass.

Spraying of glyphosate is rare in the New Brunswick stronghold of Bicknell’s Thrush (Highlands ecoregion) because spruce plantations are not widely used at those elevations, and hardwood regeneration is not as vigorous as it is at lower elevations.

\textbf{Scope:}

Pervasive. Mercury deposition likely occurs throughout the Canadian breeding range of Bicknell’s Thrush, with concentrations increasing with elevation. Mercury has also been detected in blood samples of individuals wintering in cloud forests of Hispaniola, the latter exhibiting blood Hg concentrations two to three times higher than those reported from the breeding grounds (Townsend \textit{et al.} 2013). Large areas of eastern Canada are affected by Spruce Budworm infestations (Figure 7), many of which are sprayed with Btk, likely including Bicknell’s Thrush breeding habitat.

\textbf{Severity:}

Unknown. Long-term effects of reported blood mercury levels on the health of Bicknell’s Thrush are uncertain, although modelling suggests that songbird reproduction can be impaired at higher blood mercury concentrations than recorded in this species (≥0.7 micrograms/g; Jackson \textit{et al.} 2011).

\textbf{IUCN 11. Climate change and severe weather (Unknown impact):}

\textit{Description of threat:}

Changes in the extent and quality of breeding habitat are predicted by climate change modelling, especially through reductions in the extent of Balsam Fir stands at high elevations or on plateaus as a result of warming temperatures (Rodenhouse \textit{et al.} 2008; Cadieux \textit{et al.} 2019). Models suggest that Bicknell’s Thrush habitat will be lost through changes in forest composition that favour temperate deciduous tree species (see \textbf{Habitat Trends}; Cadieux \textit{et al.} 2019). Balsam Fir is expected to suffer from warmer and drier conditions, whereas temperate deciduous trees are expected to expand their distribution northward (or upward in elevation; Savage and Vellend 2014) under those climatic conditions. Climate-driven 50\% habitat loss is expected to occur earlier (ca. 2038) in the northeastern United States (Rodenhouse \textit{et al.} 2008) than in Canada (ca. 2100; Cadieux \textit{et al.} 2019). The frequency of severe weather events, especially fall tropical storms over the Caribbean, is predicted to increase with climate change, potentially reducing the survival rate of individuals during migration or on the wintering grounds, or indirectly through habitat
degradation. Climate change may also disrupt the biennial masting cycle of Balsam Fir and lead to more regular incursions of Red Squirrel into Bicknell’s Thrush habitat and, therefore, maintain consistently high nest predation rates (Rimmer pers. comm. 2021). A drying trend already occurring in wintering habitat on Hispaniola may have severe negative effects on fitness and possibly survival, as suggested through an upgrade experiment on another species of Neotropical migrant (Studds and Marra 2005).

**Scope:**

Pervasive. Effects of changing climate are anticipated to affect the entire Bicknell’s Thrush breeding range and most of its wintering range.

**Severity:**

Unknown. The severity of predicted habitat changes is anticipated to be quite high and the frequency of severe weather events is expected to increase, with most impacts likely to occur beyond 10 years.

**Habitat Trends**

Approximately 90% of Bicknell’s Thrush habitat in Canada is located on lands managed for forest harvesting (ECCC 2020). Precommercial thinning has been shown to have negative effects on the occurrence and abundance of the species (e.g., Chisholm and Leonard 2008; Aubry et al. 2016, 2018). Hence, intensive forest management influences habitat quality, but no study has provided a before-after test of such effects or investigated the potential interactions between specific timber harvesting regimes and changing climate (Lloyd and McFarland 2017). Cadieux et al. (2019) simulated such interactions and concluded that clear-cutting without precommercial thinning could partly offset the loss of breeding habitat.

The combined, direct and indirect effects of airborne pollutants (including toxic heavy metals such as lead and mercury), atmospheric deposition of acidic ions (NOx, SOx), and increased frequency of winter freezing injury of spruce have been linked to the widespread dieback of Red Spruce at high elevations in the northeastern United States (DeHayes et al. 1999). Effects of these factors on Balsam Fir are not as clear. Lead concentrations on the forest floor are decreasing, but there is no indication of a reduction in the acidity of precipitation in spite of the reduction in emissions (US EPA 2014; Lawrence et al. 2015).

Cadieux et al. (2019) modelled climate change effects in the Boreal Shield and Atlantic Maritime ecozones of Quebec and New Brunswick. They predicted the loss of over 50% of the current Bicknell’s Thrush habitat by 2100 under the worst climate change scenario, as a consequence of warmer and drier conditions favouring deciduous species over Balsam Fir. Iverson et al. (2008) predicted that Balsam Fir and Red Spruce would be among the tree species whose range would contract in the eastern United States as a result of anticipated climate change scenarios. Rodenhouse et al. (2008) further predicted that a 1°C increase in temperature would result in the loss of more than half of the habitat of tree species currently occupying high elevations (e.g., Balsam Fir, Red Spruce, White Birch).
Of major concern is the drying trend that is already affecting wintering habitat on Hispaniola with unknown but presumed negative effects, especially at lower elevations, where female Bicknell’s Thrushes predominate (Townsend et al. 2012).

Other sources of habitat change include loss of potential breeding habitat through wind energy development and construction of telecommunication towers on mountaintops (Townsend et al. 2020), as well as browsing by Moose in Cape Breton Highlands (see Threats). Wintering habitat continues to be lost and degraded through industrial and shifting (slash-and-burn) agriculture, although past habitat trends may be reversed as forest regenerates on abandoned agricultural land (Lloyd and McFarland 2017).

Number of Threat-based Locations

Bicknell’s Thrush occupies naturally fragmented breeding habitat, largely restricted to high elevations and plateaus, which is connected through natal dispersal movements (see Movement, Dispersal, and Migration). Most of the main threats are unlikely to affect all occurrences at the same time, except for airborne pollutants and climate change, which are anticipated to occur gradually over the next several decades (Rodenhouser et al. 2008; Cadieux et al. 2019). Timber harvesting and forest management (IUCN 5.3) are taken as the most serious plausible threat affecting Bicknell’s Thrush. Forestry-related impacts affect relatively small areas over the period considered and shift across the landscape over time. Each such area is considered to be a different location, and the resulting number of locations is unknown but is much greater than 10.

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

Bicknell’s Thrush was listed as Threatened in Canada under Schedule 1 of the Species at Risk Act in 2012, and the species and its nests are protected in Canada under the Migratory Birds Convention Act (1994). Bicknell’s Thrush is considered Threatened in New Brunswick (2013) and Endangered (2013) in Nova Scotia (Table 4). In Quebec, it is listed as Vulnerable under the Act respecting threatened or vulnerable species (CQLR, c E-12.01) and is afforded protection under the Act respecting the conservation and development of wildlife (CQLR, c. C-61.1).

In the United States, Bicknell’s Thrush is nationally listed as Apparently Secure (US FWS 2017) and, therefore, it is not protected under the Endangered Species Act. At the state level, it is designated as Special Concern in New York, Vermont, and Maine, as Special Concern (Category B) in New Hampshire, and presumed Extirpated in Massachusetts (Table 4).

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>NatureServe¹</th>
<th>Status²</th>
</tr>
</thead>
<tbody>
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<td>Global</td>
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<td>Canada</td>
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</table>

¹ Status levels: G = Global; N (at start of rank) = National; S = Subnational; B = Breeding; N (at end of rank) = Non-breeding. 1 = Critically Imperilled; 2 = Imperilled; 3 = Vulnerable; 4 = Apparently Secure; 5 = Secure; NA = Not Applicable; NR = Not Ranked; U = Unrankable (due to lack of information or conflicting information); ? Inexact numeric rank

² Listing as Endangered, Threatened, Special Concern, or equivalent designations, at jurisdictional level.

Non-Legal Status and Ranks

The IUCN Red List classifies Bicknell’s Thrush as globally Vulnerable (BirdLife International 2021). NatureServe (2021) ranks the species as: Apparently Secure (G4); N2B,N2M in Canada; N4B in the United State; S1B in Nova Scotia; S2B in New Brunswick, Quebec, and Vermont; S2S3B in New Hampshire and New York; S3B in Maine; and S3N in New Jersey (NatureServe 2021).

Bicknell’s Thrush is on the Red Watch List of Partners in Flight owing to its high degree of habitat specialization and its limited range in both summer and winter (Partners in Flight 2021) and is identified by the US Fish and Wildlife Service as a Bird Species of National Concern (Lloyd and McFarland 2017).

Land Tenure and Ownership

Bicknell’s Thrush has been detected in eight national or provincial parks in Quebec, one in New Brunswick, and one in Nova Scotia since 2010 (Table 5), as well as in nearby Baxter State Park in Maine. It has also been reported in several Important Bird Areas (IBAs; some of which are in national or provincial parks), including Mont Gosford, Mont Mégantic, Charlevoix, Île Bonaventure, Péninsule de Forillon, and Île Brion IBAs in Quebec; Nepisiguit Highlands and Grand Manan Archipelago IBAs in New Brunswick; and Cape
Breton Highlands National Park, Cape North and Money Point, St. Paul Island, and Scatarie Island IBAs in Nova Scotia. However, the species has not been reported from Île Brion IBA since 1989, from Grand Manan Archipelago IBA since the second breeding bird atlas (Stewart et al. 2015), nor from St. Paul Island IBA since 2010. The latest observation from Scatarie Island IBA is a “probable” detection based on ARU recordings (Achenbach unpubl. data). The only record from Anticosti Island IBA, Quebec, is now suspected to belong to a Gray-cheeked Thrush (ÉPOQ data, J. Larivée and Regroupement QuébecOiseaux). Finally, Bicknell’s Thrush has been reported at several sites within land set aside in the Chic-Choc mountain range of Quebec for the creation of a future protected area (Jean-St-Laurent pers. comm. 2021).

<table>
<thead>
<tr>
<th>Name</th>
<th>Province or State</th>
<th>Potential habitat (ha)</th>
<th>Latest detection (yr)</th>
<th>Information source</th>
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<tr>
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</table>

¹ Forillon and Fundy National Parks are shown even though the latest confirmed sightings were made prior to 2010 on the basis of post-2010, unconfirmed eBird records.

²A single detection deemed “probable” based on an ARU recording.
Recovery Activities

The International Bicknell’s Thrush Conservation Group published an initial Action Plan in 2010 (IBTCG 2010) and a revised version in 2017 (Lloyd and McFarland 2017). Models have been developed to estimate habitat quality in Quebec (Broeckaert 2011), and Critical Habitat has been partially identified on the basis of the best available knowledge (ECCC 2020). Priority sites have been identified for conservation (Julien et al. 2014) in Quebec and recommendations formulated to plan habitat management and protection (Bussière and Julien 2012a,b). The Gouvernement du Québec (2014) identified high elevation and coastal Balsam Fir stands with high potential to host Bicknell’s Thrush and sites where its presence has been confirmed. It imposed a maximum of 33% habitat disturbance by forest management in areas characterized as having high potential, with no disturbance permitted in areas where Bicknell’s Thrush has been confirmed.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

Acknowledgements

Funding for the preparation of this report was provided by Environment and Climate Change Canada. The writer wishes to thank the writers of the previous status report (COSEWIC 2009): Yves Aubry, Sébastien Paradis, Julie Hart, Kent McFarland, Chris Rimmer, Julie Paquet, and Becky Whittam. Richard Elliot, Co-chair of the COSEWIC Birds Specialist Subcommittee (SSC), provided helpful feedback throughout the preparation of this report. Yves Aubry compiled and shared substantial amounts of data, calculated population estimates for Quebec, and provided valuable insights on Bicknell’s Thrush ecology and conservation status in that province. François Landry, Mathieu Allard, and Véronique Connolly measured habitat areas used to develop a new population estimate for Quebec. André Desrochers kindly performed analyses of ÉPOQ trend data to produce Figures 7 and 8. Adam Smith assisted in the interpretation of Breeding Bird Survey population trends. The draft report was improved by comments from Christian Artuso, Andrew Horn, and Jean-Pierre Savard, as well as other colleagues from various agencies across Canada. The authorities listed below provided valuable data and/or advice.

Authorities contacted


Aubry, Yves. Biologist – Migratory Birds, Canadian Wildlife Service, Environment and Climate Change Canada, Quebec City, Quebec.


Desrochers, André. Professor. Département des sciences du bois et de la forêt, Université Laval, Quebec City, Quebec.
Diamond, Anthony. Professor *emeritus*, Faculty of Forestry and Environmental Management, University of New Brunswick, Fredericton, New Brunswick.

Dubeau, Benoit. Responsable du service de la conservation et de l’éducation, parc national de la Jacques-Cartier, Stoneham-et-Tewksbury, Quebec.

Gauthier, Isabelle. Coordonnatrice provinciale des espèces fauniques menacées ou vulnérables du Québec, Ministère de l’Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs, Quebec City, Quebec.

Gauthier, Yves. Amateur ornithologist. Montreal, Quebec.


Jean-St-Laurent, Étienne. Direction de la conservation des habitats, des affaires législatives et des territoires fauniques, Ministère de l’Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs, Quebec City, Quebec.

Lamoureux, Stéphane. Ministère des Forêts, de la Faune et des Parcs, Quebec City, Quebec.

Lemaître, Jérôme. Direction de l’expertise sur la faune terrestre, l’avifaune et l’herpétofaune, Ministère de l’Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs, Quebec City, Quebec.


Morales, Ana. Ornithologist. McGill Bird Observatory, Montreal, Quebec.

Poulin, Jean-François. Biologist and Team Leader-Environment, WSP Ltd., Baie-Comeau, Quebec.


Tremblay, Junior. Research Scientist, Wildlife and Landscape Science Directorate, Environment and Climate Change Canada, Quebec City, Quebec.


INFORMATION SOURCES


Desrochers, A., unpublished data 2020. Professor, Département des sciences du bois et de la forêt, Université Laval, Quebec City, Quebec.

Desrochers, A., unpublished. data 2021. Professor, Département des sciences du bois et de la forêt, Université Laval. Quebec City, Quebec.


**BIOGRAPHICAL SUMMARY OF REPORT WRITER**

Marc-André Villard is an avian ecologist focusing on population response to forest management and landscape-level processes. His PhD research investigated the effects of habitat fragmentation on the distribution and pairing success of focal passerine species including Wood Thrush (Hylocichla mustelina) and Ovenbird (Seiurus aurocapilla). More recently, he examined the effects of intensive forest management on demographic parameters of focal species, including Swainson’s Thrush, through large-scale field experiments, as well as trophic relationships linking mast-seeding trees, rodents, and songbird reproduction. His field research has mainly been conducted in temperate and boreal forests of Quebec, New Brunswick, and Alberta. Dr. Villard was a founding co-editor of Avian Conservation and Ecology. He works in Quebec as a Conservation Biologist with Sépaq on projects addressing species at risk, invasive species, and the effects of outdoor recreation on biodiversity.

**COLLECTIONS EXAMINED**

No collections were examined in the preparation of this report.
Appendix 1. Threats Calculator results for Bicknell’s Thrush

<table>
<thead>
<tr>
<th>Species or Ecosystem</th>
<th>Scientific Name</th>
<th>Elcode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species and Ecosystem</td>
<td>Bicknell’s Thrush Catharus bicknelli</td>
<td></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Date (Ctrl + ;” for today’s date):</th>
<th>2021-09-07</th>
</tr>
</thead>
</table>

| Assessor(s): | David Fraser (facilitator), Marc-André Villard (writer), Richard Elliot (Birds SSC co-chair), Sydney Allen (COSEWIC Secretariat), Christian Artuso, Yves Aubry, Louise Blight, Greg Campbell, Pete Davidson, Tony Diamond, Marcel Gahbauer, Adam Hadley, Andrew Horn, Tara Imlay, Mary Sabine, Jean-Pierre Savard, Peter Thomas, Junior Tremblay, Rémi Torrenta, Chris Rimmer, Liana Zanette, Erin Whidden, Chris Ward |

| References: | Draft threats calculator, draft Bicknell’s Thrush status report, threats spreadsheet from the Bicknell’s Thrush Recovery Strategy (ECCC 2020). |

<table>
<thead>
<tr>
<th>Overall Threat Impact Calculation Help:</th>
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<table>
<thead>
<tr>
<th>Threat Impact</th>
<th>high range</th>
<th>low range</th>
</tr>
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<tbody>
<tr>
<td>A Very High</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B High</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C Medium</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>D Low</td>
<td>3</td>
<td>5</td>
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</tbody>
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<thead>
<tr>
<th>Calculated Overall Threat Impact:</th>
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<tr>
<th>Assigned Overall Threat Impact:</th>
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<tr>
<th>Impact Adjustment Reasons:</th>
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<tr>
<th>Overall Threat Comments</th>
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</table>

Generation time for Bicknell’s Thrush is approximately 2.3 years (Bird et al. 2020), so the time frame for considering severity and timing is 10 years. Threats are considered on breeding grounds in QC, NB, and NS, on migration through the eastern United States, and on wintering grounds in the Greater Antilles islands in the Caribbean Sea, where impacts of many threats may be highest.

<table>
<thead>
<tr>
<th>Threat</th>
<th>Impact (calculated)</th>
<th>Scope (next 10 Yrs)</th>
<th>Severity (10 Yrs or 3 Gen.)</th>
<th>Timing</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Residential &amp; commercial development</td>
<td>D</td>
<td>Low</td>
<td>Small (1–10%)</td>
<td>Slight (1–10%)</td>
</tr>
<tr>
<td>1.1</td>
<td>Housing &amp; urban areas</td>
<td>D</td>
<td>Low</td>
<td>Small (1–10%)</td>
<td>Slight (1–10%)</td>
</tr>
<tr>
<td>Threat</td>
<td>Impact (calculated)</td>
<td>Scope (next 10 Yrs)</td>
<td>Severity (10 Yrs or 3 Gen.)</td>
<td>Timing</td>
<td>Comments</td>
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</tr>
<tr>
<td>1.2</td>
<td>Commercial &amp; industrial areas</td>
<td>D Low</td>
<td>Small (1–10%)</td>
<td>Slight (1–10%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>1.3</td>
<td>Tourism &amp; recreation areas</td>
<td>D Low</td>
<td>Small (1–10%)</td>
<td>Slight (1–10%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>2</td>
<td>Agriculture &amp; aquaculture</td>
<td>D Low</td>
<td>Restricted (11–30%)</td>
<td>Moderate (11–30%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>2.1</td>
<td>Annual &amp; perennial non-timber crops</td>
<td>D Low</td>
<td>Restricted (11–30%)</td>
<td>Moderate (11–30%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>2.2</td>
<td>Wood &amp; pulp plantations</td>
<td>D Low</td>
<td>Restricted (11–30%)</td>
<td>Moderate (11–30%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>2.3</td>
<td>Livestock farming &amp; ranching</td>
<td>D Low</td>
<td>Small (1–10%)</td>
<td>Slight (1–10%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>2.4</td>
<td>Marine &amp; freshwater aquaculture</td>
<td>D Low</td>
<td>Restricted – Small (1–30%)</td>
<td>Slight (1–10%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>3</td>
<td>Energy production &amp; mining</td>
<td>D Low</td>
<td>Restricted – Small (1–30%)</td>
<td>Slight (1–10%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>3.1</td>
<td>Oil &amp; gas drilling</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Moderate (Possibly in the short term, &lt;10 yrs/3 gen)</td>
</tr>
<tr>
<td>3.2</td>
<td>Mining &amp; quarrying</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>No significant interaction expected between Bicknell’s Thrush and quarry or mining activity, at any time of year.</td>
</tr>
<tr>
<td>Threat</td>
<td>Impact (calculated)</td>
<td>Scope (next 10 Yrs)</td>
<td>Severity (10 Yrs or 3 Gen.)</td>
<td>Timing</td>
<td>Comments</td>
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</tr>
<tr>
<td>3.3</td>
<td>Renewable energy</td>
<td>D</td>
<td>Restricted – Small (1–30%)</td>
<td>Slight (1–10%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>4</td>
<td>Transportation &amp; service corridors</td>
<td>Negligible</td>
<td>Restricted – Small (1–30%)</td>
<td>Negligible (&lt;1%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>4.1</td>
<td>Roads &amp; railroads</td>
<td>Negligible</td>
<td>Restricted – Small (1–30%)</td>
<td>Negligible (&lt;1%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>4.2</td>
<td>Utility &amp; service lines</td>
<td>Negligible</td>
<td>Negligible (&lt;1%)</td>
<td>Slight (1–10%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>4.3</td>
<td>Shipping lanes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>Flight paths</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>Biological resource use</td>
<td>CD</td>
<td>Large – Restricted (11–70%)</td>
<td>Moderate (11–30%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>5.1</td>
<td>Hunting &amp; collecting terrestrial animals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Gathering terrestrial plants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threat</td>
<td>Impact (calculated)</td>
<td>Scope (next 10 Yrs)</td>
<td>Severity (10 Yrs or 3 Gen.)</td>
<td>Timing</td>
<td>Comments</td>
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<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5.3 Logging &amp; wood harvesting</td>
<td>CD</td>
<td>Medium – Low</td>
<td>Large – Restricted (11–70%)</td>
<td>Moderate (11–30%)</td>
<td>High (Continuing) Approximately 90% of breeding habitat occurs within managed forest lands. Broad-scale precommercial thinning in dense regenerating spruce-fir forests results in recently thinned stands, which are avoided by breeding Bicknell’s Thrush for several years. Recent research in New Brunswick suggests that Bicknell’s Thrush may prefer older conifer stands, adding to its vulnerability to intensive forest management. Wide-spread replanting of harvested Balsam Fir with spruce in Quebec and the Maritimes results in conversion of forest type and loss of primary fir breeding habitat. Resulting extensive spruce plantations likely support much higher densities of cone-hoarding Red Squirrel, with consequent increases in nest predation pressure (see 8.2 Problematic Native Species/Diseases). On the wintering grounds, timber harvesting for charcoal production may cause habitat loss on a local scale.</td>
</tr>
<tr>
<td>5.4 Fishing &amp; harvesting aquatic resources</td>
<td></td>
<td></td>
<td></td>
<td>High (Continuing)</td>
<td></td>
</tr>
<tr>
<td>6 Human intrusions &amp; disturbance</td>
<td>Negligible</td>
<td>Small (1–10%)</td>
<td>Negligible (&lt;1%)</td>
<td>High (Continuing)</td>
<td></td>
</tr>
<tr>
<td>6.1 Recreational activities</td>
<td>Negligible</td>
<td>Small (1–10%)</td>
<td>Negligible (&lt;1%)</td>
<td>High (Continuing)</td>
<td>Most nest sites and wintering areas are in dense woodlands far from trails and human access routes. Increasing outdoor recreation (e.g., hiking, mountain biking, downhill and cross-country ski trails) may impose some pressure on breeding habitat and may occasionally be heavy along trails in some protected areas, although a study on the effects of hiking trail use in the White Mountains of New Hampshire (DeLuca and King 2014) suggests that impacts on occurrence and abundance are minimal.</td>
</tr>
<tr>
<td>Threat</td>
<td>Impact (calculated)</td>
<td>Scope (next 10 Yrs)</td>
<td>Severity (10 Yrs or 3 Gen.)</td>
<td>Timing</td>
<td>Comments</td>
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</tr>
<tr>
<td>6.2 War, civil unrest &amp; military exercises</td>
<td></td>
<td>Negligible</td>
<td>Negligible (&lt;1%)</td>
<td>High</td>
<td>Research on Bicknell’s Thrush may have limited effects on abundance on a local scale. However, the absence of effects of radio-transmitters on apparent survival reported by Townsend et al. (2012) suggests that the species is fairly robust to such disturbance.</td>
</tr>
<tr>
<td>6.3 Work &amp; other activities</td>
<td>Negligible</td>
<td>Negligible (&lt;1%)</td>
<td>Negligible (&lt;1%)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>7   Natural system modifications</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Moderate – Slight (1–30%)</td>
<td>High</td>
<td>Climate change models (Cadieux et al. 2019) predict increased frequency of wildfires within the boreal forest. Scope is unknown as additional impact of such wildfires compared to other factors has not been estimated and as fire can have positive effects by stimulating natural succession. Fire suppression is unlikely to have a significant effect in the remote areas occupied by this species.</td>
</tr>
<tr>
<td>7.1 Fire &amp; fire suppression</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Moderate – Slight (1–30%)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>7.2 Dams &amp; water management/use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No large-scale water management projects are expected within the boreal breeding range over the next decade, and most projects have little direct effect on Bicknell’s Thrush, which breeds at relatively high elevations.</td>
</tr>
<tr>
<td>7.3 Other ecosystem modifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Other human activities that modify habitats in the breeding or wintering areas, other than those related to changing climates considered in section 11.1 (Habitat shifting &amp; alteration), are unlikely to affect Bicknell’s Thrush or its food resources.</td>
</tr>
<tr>
<td>8   Invasive &amp; other problematic species &amp; genes</td>
<td>CD</td>
<td>Medium – Low</td>
<td>Pervasive (71–100%)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Threat</td>
<td>Impact (calculated)</td>
<td>Scope (next 10 Yrs)</td>
<td>Severity (10 Yrs or 3 Gen.)</td>
<td>Timing</td>
<td>Comments</td>
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</tr>
<tr>
<td>8.1</td>
<td>Invasive non-native/alien species/diseases</td>
<td>D Low</td>
<td>Pervasive (71–100%)</td>
<td>Slight (1–10%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>8.2</td>
<td>Problematic native species/diseases</td>
<td>CD Medium – Low</td>
<td>Pervasive (71–100%)</td>
<td>Moderate – Slight (1–30%)</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>8.3</td>
<td>Introduced genetic material</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.4</td>
<td>Problematic species/diseases of unknown origin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.5</td>
<td>Viral/prion-induced diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.6</td>
<td>Diseases of unknown cause</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Pollution</td>
<td>Unknown</td>
<td>Pervasive (71–100%)</td>
<td>Unknown</td>
<td>High (Continuing)</td>
</tr>
<tr>
<td>9.1</td>
<td>Domestic &amp; urban waste water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threat</td>
<td>Impact (calculated)</td>
<td>Scope (next 10 Yrs)</td>
<td>Severity (10 Yrs or 3 Gen.)</td>
<td>Timing</td>
<td>Comments</td>
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</tr>
<tr>
<td>9.2 Industrial &amp; military effluents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Spraying forests with Btk to control Spruce Budworm and Hemlock Looper numbers may reduce food abundance by killing Lepidopteran larvae, including Spruce Budworm, which are eaten by Bicknell’s Thrush.</td>
</tr>
<tr>
<td>9.3 Agricultural &amp; forestry effluents</td>
<td>Unknown</td>
<td>Restricted – Small (1–30%)</td>
<td>Unknown</td>
<td>High (Continuing)</td>
<td></td>
</tr>
<tr>
<td>9.4 Garbage &amp; solid waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.5 Airborne pollutants</td>
<td>Unknown</td>
<td>Pervasive (71–100%)</td>
<td>Unknown</td>
<td>High (Continuing)</td>
<td>Atmospheric deposition of mercury and other pollutants, such as lead, nitrogen, and sulphur dioxides, may have direct effects on health of Bicknell’s Thrush, although impacts have not been documented and recorded contaminant levels are relatively low. Acid precipitation may have negative effects, especially at high elevations, through calcium depletion and increased uptake of aluminum, lead, and other heavy metals in invertebrate food.</td>
</tr>
<tr>
<td>9.6 Excess energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>10 Geological events</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>10.1 Volcanoes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>10.2 Earthquakes/tsunamis</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>10.3 Avalanches/landslides</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Climate change &amp; severe weather</td>
<td>Unknown</td>
<td>Pervasive (71–100%)</td>
<td>Negligible (&lt;1%)</td>
<td>High (Continuing)</td>
<td>Reductions in the extent and quality of breeding habitat are predicted by climate change modelling, especially through reductions in the extent of Balsam Fir stands at high elevations or on plateaus as temperatures rise, resulting in suitable habitat moving upislope and northwards, and decreasing in overall extent. Many effects may take place beyond 10 years, especially in higher habitats.</td>
</tr>
<tr>
<td>11.1 Habitat shifting &amp; alteration</td>
<td>Negligible</td>
<td>Pervasive (71–100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threat</td>
<td>Impact (calculated)</td>
<td>Scope (next 10 Yrs)</td>
<td>Severity (10 Yrs or 3 Gen.)</td>
<td>Timing</td>
<td>Comments</td>
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</tr>
<tr>
<td>11.2 Droughts</td>
<td>Unknown</td>
<td>Pervasive (71–100%)</td>
<td>Unknown</td>
<td>High (Continuing)</td>
<td>Projecting drying trend has already begun in moist forests used on wintering grounds, with uncertain but presumed negative effects on Bicknell's Thrush.</td>
</tr>
<tr>
<td>11.3 Temperature extremes</td>
<td>Unknown</td>
<td></td>
<td></td>
<td>High (Continuing)</td>
<td>No evidence of impacts of increasing temperatures on breeding or wintering grounds.</td>
</tr>
<tr>
<td>11.3 Storms &amp; flooding</td>
<td>Unknown</td>
<td>Pervasive (71–100%)</td>
<td>Unknown</td>
<td>High (Continuing)</td>
<td>Increased frequency and intensity of storms throughout the year, and hurricanes during fall migration, may increase mortality. More severe and frequent hurricanes are already significantly modifying lower and higher elevation wintering habitats in the Dominican Republic.</td>
</tr>
<tr>
<td>12 Other impacts</td>
<td>Unknown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Classification of Threats adopted from IUCN-CMP, Salafsky et al. (2008).