High Elevation Landbird Program

Mountain Birdwatch 2.0 2018 Report

April 2019

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This project was undertaken with the financial support of:
Ce projet a été réalisé avec l'appui financier de :

Environment and Climate Change Canada
Environnement et Changement climatique Canada

NB Wildlife Trust Fund
Fonds de Fiducie de la Faune du N.-B.

New Nouveau Brunswick

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TOP 2018 RESULTS

- A third year of good detections of Bicknell's Thrush on the New Brunswick Mountain BirdWatch routes that were established in 2016.

- We found Bicknell's Thrush in Cape Breton! We deployed Automated Recording Units at 13 sites in Cape Breton and detected Bicknell's Thrush on six of them.

EXECUTIVE SUMMARY

Since 2002, Bird Studies Canada (BSC) has been monitoring high elevation landbirds, focusing on the federally-threatened Bicknell's Thrush. The goals of this program are to promote conservation of Bicknell's Thrush breeding habitat and contribute to long-term, range-wide monitoring of Bicknell's Thrush populations.

In 2018, we completed our 16th year of Bicknell's Thrush monitoring in New Brunswick (NB) through conducting a 3rd year of Mountain Birdwatch 2.0 (MBW) on revised routes (previous monitoring was conducted using a different protocol). In 2016, 2017 and 2018, we selected routes using a refined habitat distribution model with the aim of improving Bicknell's Thrush detections. Bicknell's Thrush are notoriously difficult to detect during surveys, due to their secretive nature and occurrence at low density in highly fragmented, mountaintop patches.

We surveyed a total 49 routes (284 points) in NB in 2018. Frequency of occurrence of Bicknell's Thrush in was 11% (30/284 points), and Bicknell's Thrush were detected on 17 of 49 routes (35%). Using models that incorporate probability of detection, the estimated abundance of Bicknell's Thrush for NB was 0.18 per point, lower than in 2016 and 2017.

In Nova Scotia (NS), we did not conduct MBW routes in 2018. Instead, in collaboration with colleagues at Environment and Climate Change Canada, we deployed Automated Recording Units (ARU) at points on NS MBW survey routes where Bicknell's Thrush were most recently and/or most frequently detected. The ARUs recorded Bicknell's Thrush at six of 13 sites, confirming that Bicknell's Thrush are still present in NS, despite being absent from NS MBW routes in 2017. However, detection of Bicknell's Thrush at these sites required processing of at least 175 minutes of recordings at each site, suggesting that Bicknell's Thrush are not present in NS in the same numbers as previously.

In 2019, we plan to conduct a fourth year of surveys on the revised MBW routes in NB and we plan to deploy ARUs at more points on MBW routes where Bicknell's Thrush were detected previously. We also plan to expand our search for Bicknell's Thrush to Scatarie Island, off the coast of Cape Breton, NS.

INTRODUCTION

The Bicknell's Thrush breeds in high elevation coniferous forests in eastern Canada and the north-eastern United States (Atwood *et al*. 1996, Connolly *et al*. 2002). These forests are chronically disturbed by windthrows, ice and snow damage, and fire and insect outbreaks (Rimmer *et al*. 2001). They are also found on exposed peaks in stunted-tree stands sometimes characterized as krummholtz (Bredin and Whittam 2009). Rarely, the species is found in coastal areas where dense spruce-fir stands are maintained by cool sea breezes and a high precipitation regime (COSEWIC 2009). In Canada and Maine, Bicknell's Thrush are also found in regenerating clear cuts (Ouellet 1993, Nixon *et al*. 2001, Connolly *et al*. 2002, Gardiner 2006, Chisholm 2008, McKinnon 2009), where forestry operations mimic natural disturbance events, but often at a much larger scale. However, regenerating clearcuts are typically not left to re-grow but are instead subjected to precommercial thinning, a practice which reduces stem density to maximize growth of the remaining trees and renders this habitat unsuitable for Bicknell's Thrush. Following thinning, Bicknell's Thrush are mostly restricted to unthinned patches (Aubry *et al*. 2011, McKinnon *et al*. 2014).

Bird Studies Canada has been monitoring Bicknell's Thrush and other high elevation birds in NB and NS since 2002. The High Elevation Landbird Program (HELP) ran for 10 years, from 2002 to 2011, and was modeled after the U.S. program Mountain Birdwatch. Data from HELP showed a steep declining trend in Bicknell's Thrush populations over 10 years, with a 7.4% annual decrease in NS and 11.5% in NB (Campbell and Stewart 2012). Results from the second Maritimes Breeding Bird Atlas (www.mba-aom.ca) showed a 40% decrease in the distribution of the species since 1990 (Erskine 1992; Stewart et al. 2015). In addition, the Bicknell's Thrush is believed to be extirpated from some coastal sites where it was once found. As a result of these trends and indications of population declines in Quebec, Bicknell's Thrush and its critical habitat is listed as *Threatened* and is legally protected under the Species At Risk Act (SARA).

Following the release of "A Conservation Action Plan for Bicknell's Thrush" (IBTCG 2010), efforts were made to standardize monitoring protocols throughout the species' range by using the internationally-adopted Mountain Birdwatch 2.0 protocol. The program uses a Generalized Random Tessellation Stratified (GRTS) sampling design, which ensures a spatially balanced but randomized selection of survey routes throughout the whole breeding range. The main goals of Mountain Birdwatch 2.0 (MBW) are: 1) to measure the annual population status of target species in terms of distribution, abundance, and occupancy; 2) to measure changes in populations of target species over time; and 3) to relate population trend information to biotic and abiotic variables that may affect target species. Following the 2015 field season, analyses of the first four years of MBW showed that it would not be possible to detect any population change because of a lack of Bicknell's Thrush detections on the randomly selected routes. In order to detect the minimum 3% annual change over 30 years that is outlined in in the Conservation Action Plan, detections are needed on approximately 30% of points (F. Rivera, USGS, pers. comm.). Bicknell's Thrush were detected on approximately 5% of points in 2015. We concluded that the species' distribution model (including only elevation, latitude, and longitude) used to delineate MBW 2.0 survey routes was too broad to be used as a basis for population monitoring, due to extremely low density of Bicknell's Thrush in our study area. Using

a new distribution model that included habitat (tree species in dominant forest layer) and an elevation threshold, we re-distributed randomly-selected routes within that model and tested the routes in NB in 2016. Using this refined model, detection rates on selected routes were much improved over previous years, with Bicknell's Thrush detected on 13% of points (38% of routes). Therefore, the same NB routes were surveyed again in 2017 and in 2018.

Bicknell's Thrush numbers have been declining in NS in recent years, with only four birds heard in 2015 and two in 2016. There have been no Bicknell's Thrush detected at Money Point for the past four years, an area that was previously a stronghold for the species and hosted the highest density of Bicknell's Thrush in Atlantic Canada. There were 25 Bicknell's Thrushes detected in total on MBW routes in NS in 2013 (Campbell 2014), yet numbers declined to a new low of zero in 2017, despite an attempt to increase detections by using the new habitat distribution model to select survey routes. Unfortunately, the survey routes selected with the new habitat model were nearly identical to the survey routes selected with the old habitat model. Many of these routes had Bicknell's Thrush in the past but do not any longer. We did not continue MBW routes in NS in 2018, but instead deployed ARUs at points along MBW routes where Bicknell's Thrush were detected previously.

In this report, we provide an analysis of the frequency of occurrence and predicted abundance of Bicknell's Thrush based on MBW surveys conducted in NB in 2018. For comparison, the report also includes results from previous years of MBW NS and NB. We also include an appendix that describes in detail the results of the ARU deployments in NS.

METHODS

NB Site Selection

From 2012 to 2015 we used a Bicknell's Thrush distribution model developed by the Vermont Center for Ecostudies (VCE 2008) to determine the area from which to randomly select survey points. The model was similar to that developed for the United States by Lambert *et al*. (2005), but also included longitude in order to make the model fit better in Canada. We then used the GRTS design to create a 1 km x 1 km grid over all the area defined by the model, and assigned a random number to each square. Routes were selected by creating a series of 4 to 6 points along roads or trails with the lowest randomly-assigned numbers. Each of the points was separated by 250 metres. In NS, random selection was further stratified to include only grid cells in protected areas (Cape Breton Highlands National Park and Polletts Cove Wilderness Area) as previous HELP surveys and MBW 2.0 pilot surveys detected no Bicknell's Thrushes south of Cape Breton Highlands National Park. Initially, we selected 30 routes in NB and 30 in NS for determining regional trends. In late 2012, analysis of 10 years of HELP data showed that detectability of Bicknell's Thrushes is higher in the evening than in the morning (in NB), so we added evening surveys to the protocol starting in 2013 which added an additional 20 randomly-selected routes to NB, for a total of 50 routes in NB and 30 routes in NS.

For 2016, we created a new distribution model for NB using only habitat and an elevation threshold. To determine the minimum elevation threshold, we examined all Bicknell's Thrush detections in the BSC Bicknell's Thrush database for NB, which includes 628 detections from 2002-2015 and ranked them by decreasing elevation. Then we removed the bottom 25% and used the lowest elevation that remained as the threshold, so that it included 75% of all Bicknell's Thrush detected from 2002-2015. This threshold elevation is 585 metres. Then we used the New Brunswick Forest Inventory Database and extracted all forest blocks at or above 585 m with a dominant forest layer of balsam fir or red spruce (referred to by L1FUNA in the forest inventory). Balsam fir and red spruce were identified by the Maritimes Breeding Bird Atlas as the dominant species influencing Bicknell's Thrush detection during the Atlas (Stewart *et al*. 2015). There is no dominant forest layer for many blocks in the Christmas Mountains of NB because they have recently been cut and have no forest canopy. For those blocks, we identified those with a secondary forest layer consisting of balsam or red spruce (the L2FUNA attribute in the inventory). See Appendix 1 for a list of tree species classes that were retained in the model. The new distribution model has a total area of approximately 28,000 ha, whereas the previous model covered over 176,000 ha.

Of the 50 MBW routes surveyed in NB from 2012 to 2015, only 10 remained in the revised NB distribution model. These were retained for 2016, and 40 new routes were selected using the same methodology as above, for a total of 50 routes in NB (Figure 1). We surveyed 48 of the same routes again in NB in 2017, and 49 of the same routes in 2018.

There were no changes to the NS MBW routes in 2016, but in 2017, we revised the distribution model for NS based on habitat (areas where the dominant forest layer is balsam fir or red spruce). As elevation does not vary greatly in areas where Bicknell's Thrush have been found previously in NS, elevation was not used to revise the NS model. Survey routes were selected using the revised distribution model, but unlike in NB, the revised model did not identify any new survey routes. Instead, 20 survey routes from the original model were retained and these routes were surveyed in 2017. None of these 20 routes were surveyed in 2018, but instead ARUs were deployed at points along MBW routes where Bicknell's Thrush were found most recently and/or most frequently in previous MBW surveys (Figure 2).

NB Survey Protocol

The MBW morning survey protocol consists of four consecutive 5-minute counts at each survey point, for a total sampling period of 20 minutes per point. Observers are asked to conduct repeated simple counts for all target species during each 5-minute period (see Table 1 for target species). During the first 10 minutes of the survey, observers also 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 species. Evening surveys are similar, but consist of only two consecutive 5-minute counts periods. All surveys are conducted starting 45 minutes before sunrise or 30 minutes before sunset, between 1 June and

30 June. Surveys are not conducted in temperatures below 0° C, or in wind above 4 on the Beaufort scale (> 30 km/h). Surveys are also not conducted in rain.

NB Data Analysis

A basic mark-recapture modelling framework was used to model 2018 MBW 2.0 data. Abundance and detection probability were modelled in R (R Core Team 2014) using the pcount function in the "unmarked" package, which uses a generalized N-mixture model of Royle (2004). This is the same method used in for 2016 and 2017 MBW 2.0 data, but different than the generalized N-mixture model for open populations (Dail and Madsen 2011) used to analyze 2012-2015 MBW 2.0 data. The single-year N-mixture model used in 2018 includes terms for estimates of abundance and detection rates.

General Model Structure:

$$\text{Population} = p + \lambda + \varepsilon$$

Where p = detection probability
λ = initial abundance
ε = error

Models were fit using a combination of time of day and survey date (Julian date). Habitat information was not included in the models because vegetation has not been sampled at all points. Models tested are listed in Appendix 2. Models were ranked according to Akaike's Information Criterion (AIC). Estimates of detection probability were generated with the best model (lowest AIC value) using the "predict" function in unmarked (Fiske and Chandler 2011). Annual abundance estimates were generated using the model random effects ("ranef" function) and Bayesian prior probability distributions to generate the annual best unbiased predictors (BUPs) of initial abundance.

Table 1: Species surveyed by Mountain Birdwatch 2.0.

Common Name	Scientific Name	Species Code
Bicknell's Thrush	*Catharus bicknelli*	BITH
Swainson's Thrush	*Catharus ustulatus*	SWTH
Hermit Thrush	*Catharus guttatus*	HETH
Winter Wren	*Troglodytes troglodytes*	WIWR
Black-capped Chickadee	*Poecile atricopilla*	BCCH
Boreal Chickadee	*Poecile hudsonica*	BOCH
Blackpoll Warbler	*Setophaga striata*	BLPW
Fox Sparrow	*Passerella iliaca*	FOSP
White-throated Sparrow	*Zonotrichia albicollis*	WTSP
Yellow-bellied Flycatcher	*Empidonax flaviventris*	YBFL

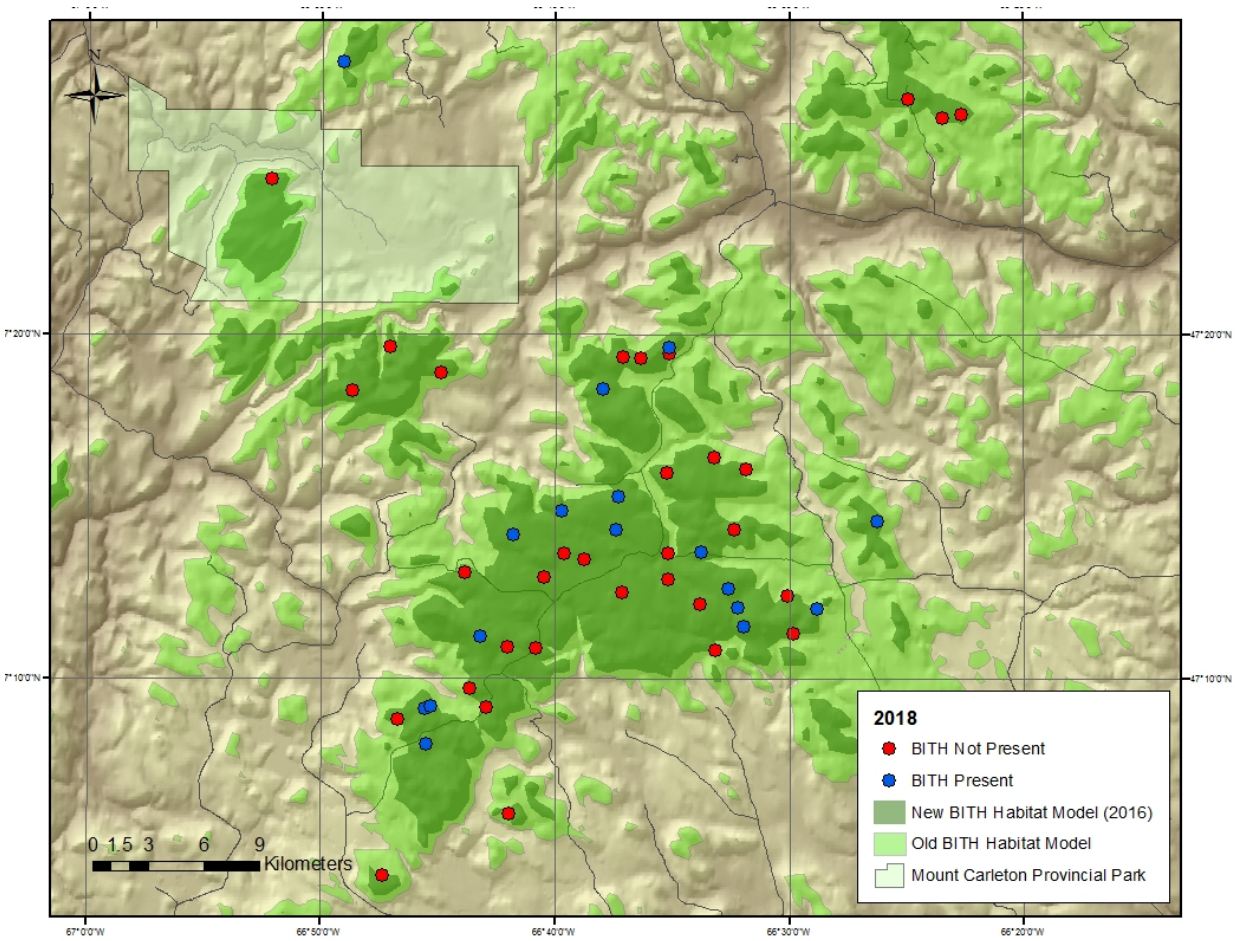

Figure 1: Mountain Birdwatch 2.0 routes surveyed in New Brunswick in 2018.

NS ARU Deployment

BSC and Environment and Climate Change Canada (ECCC) deployed 13 ARUs (Wildlife Acoustics Song Meter SM4) at sites in Cape Breton Highlands National Park. ARUs were deployed at points where Bicknell's Thrush were found most recently and/or most frequently during annual MBW surveys conducted by BSC (2011-2017; Figure 2). ARUs were retrieved in July and August, in a collaborative effort by staff from Parks Canada, ECCC, and BSC.

Each of the 13 ARUs was attached to a tree with zip ties or bungee cords and secured with a cable lock and a padlock. ARUs were placed beside a trail or road, but to discourage tampering, they were not visible from the road/trail. All ARUs were set to record for 1.5 hrs before sunrise to 3.5 hrs after sunrise, and 1.75 hrs before sunset to 1.5 hrs after sunset (total of 8.25 hrs per day) for a minimum of three weeks. Channel was set to "Stereo", Sample Rate was 24000Hz, Gain:Left and Right were both 16.00 dB, and PreAmp: Left and Right were both 26 dB. Latitude and longitude were set individually at each site using a handheld GPS.

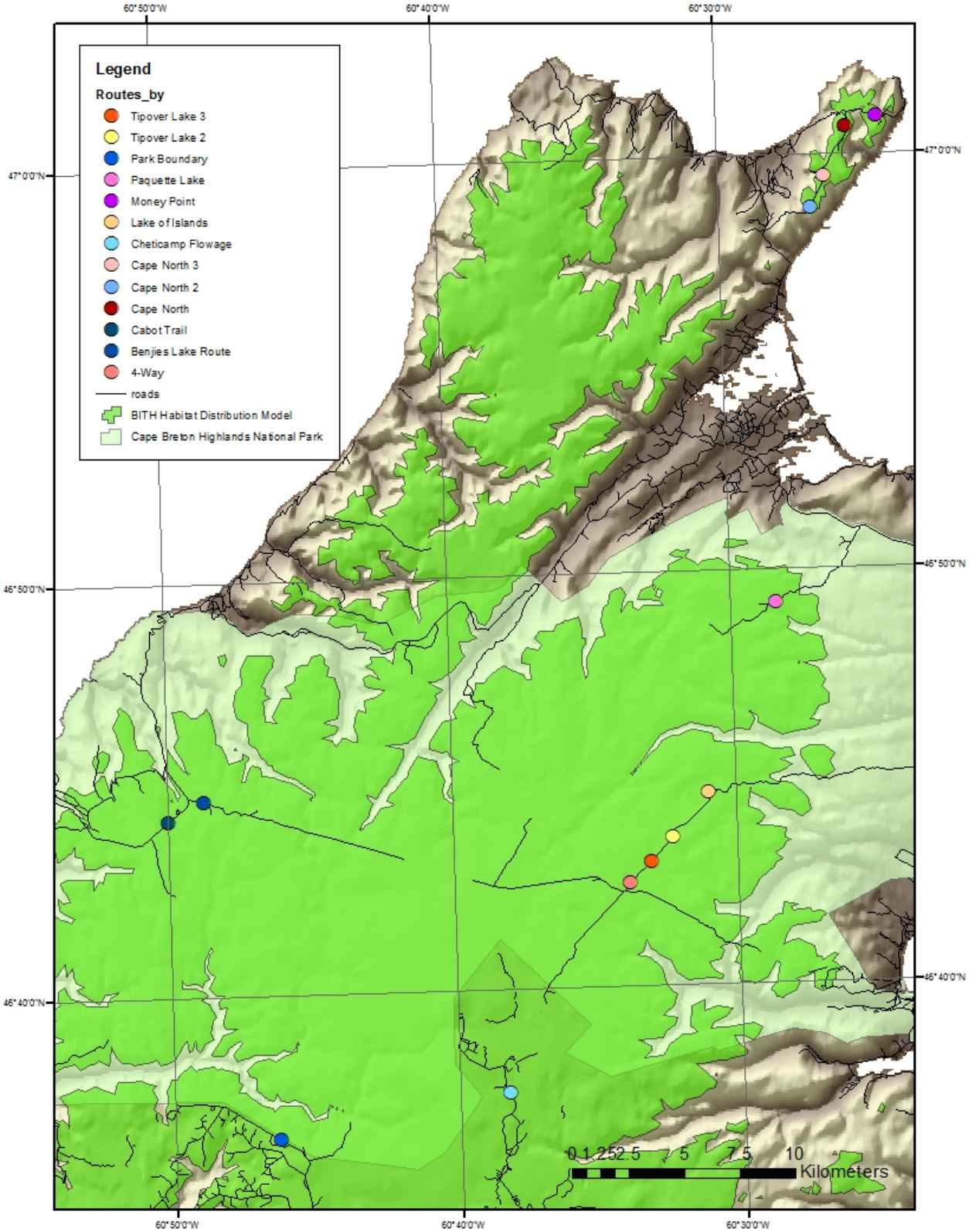

Figure 2: Automated Recording Units (ARU) deployed in Nova Scotia in 2018. Bicknell's Thrush were detected at 6 of 13 ARUs deployed.

RESULTS

New Brunswick

Frequency of occurrence in 2018

We surveyed 49 routes (284 points) in NB. Of these, 29 routes (169 points) were surveyed in the morning. Bicknell's Thrush was detected on 17 routes (31 total points) in NB (Table 2). Swainson's Thrush and White-throated Sparrow were most common (found at 92% and 89% of points), while Black-capped Chickadee was observed at only 2% of points (Table 2).

Table 2. Frequency of occurrence (% survey points with species) for MBW 2.0 target species in 2018.

Species	NB (n=284 points surveyed)
Bicknell's Thrush	11% (31)
Swainson's Thrush	92% (262)
Hermit Thrush	19% (55)
Winter Wren	12% (35)
Black-capped Chickadee	2% (5)
Boreal Chickadee	17% (47)
Blackpoll Warbler	52% (149)
Fox Sparrow	77% (220)
White-throated Sparrow	89% (254)
Yellow-bellied Flycatcher	11% (32)

Abundance 2012-2015 and 2016-2018

The best fit model for Bicknell's Thrush included only start time as a covariate in the detection term of the model (Appendix 3).

Estimated Bicknell's Thrush abundance was lower in NB in 2018, compared to 2016 and 2017 (Table 3), but it will take another few years of surveys to begin to calculate any trends. Over four years of surveys prior to 2016, for which routes were chosen using the non-revised distribution model, abundances in NB ranged from a low of 0.11 Bicknell's Thrush per point (± 0.02 SE) to 0.25 (± 0.07 SE). Survey routes chosen using the revised distribution model yielded the highest Bicknell's Thrush abundance in NB ever recorded (2017), and the third-highest

(2016) and fourth-highest (2018) recorded. No abundance estimate was calculated in NS in 2018 because MBW surveys were not conducted in NS.

Table 3: Estimated yearly abundance (number of birds per point ± standard error) for 10 focal species in New Brunswick and Nova Scotia from 2012 to 2018. In years with grey shading, a revised habitat model was used to choose survey routes, so these results are not directly comparable to 2012-2015..

Species	2012	2013	2014	2015	2016	2017	2018
New Brunswick							
Bicknell's Thrush	0.25 ± 0.07	0.11 ± 0.03	0.12 ± 0.02	0.11 ± 0.02	0.22 ± 0.04	0.34 ± 0.03	0.18 ± 0.03
Swainson's Thrush	3.77 ± 0.11	3.39 ± 0.13	3.37 ± 0.11	3.78 ± 0.11	3.50 ± 0.10	2.52 ± 0.09	3.07 ± 0.11
Hermit Thrush	0.97 ± 0.05	0.92 ± 0.06	0.58 ± 0.05	0.48 ± 0.04	0.41 ± 0.04	0.11 ± 0.02	0.28 ± 0.04
Winter Wren	0.98 ± 0.05	0.86 ± 0.05	0.39 ± 0.03	0.17 ± 0.02	0.75 ± 0.04	0.56 ± 0.04	0.13 ± 0.02
Black-capped Chickadee	0.38 ± 0.01	0.07 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.08 ± 0.02	0.03 ± 0.01	0.01 ± 0.01
Boreal Chickadee	0.32 ± 0.06	0.38 ± 0.02	0.38 ± 0.02	0.40 ± 0.02	0.09 ± 0.02	0.28 ± 0.02	0.45 ± 0.03
Blackpoll Warbler	0.36 ± 0.03	0.31 ± 0.04	0.35 ± 0.04	0.30 ± 0.04	0.77 ± 0.05	0.27 ± 0.03	0.72 ± 0.05
Fox Sparrow	1.32 ± 0.07	1.33 ± 0.08	0.85 ± 0.05	0.83 ± 0.05	1.27 ± 0.07	0.83 ± 0.05	1.55 ± 0.07
White-throated Sparrow	3.66 ± 0.10	3.49 ± 0.13	2.24 ± 0.09	2.45 ± 0.10	1.87 ± 0.08	1.53 ± 0.07	2.15 ± 0.10
Yellow-bellied Flycatcher	0.21 ± 0.02	0.29 ± 0.03	0.28 ± 0.02	0.26 ± 0.02	2.42 ± 0.17	0.27 ± 0.02	3.07 ± 0.11
Nova Scotia							
Bicknell's Thrush	0.27 ± 0.03	0.30 ± 0.07	0.22 ± 0.04	0.14 ± 0.02	0.04 ± 0.02	--- ± ---	--- ± ---
Swainson's Thrush	4.23 ± 0.17	3.92 ± 0.13	3.47 ± 0.09	3.48 ± 0.08	0.58 ± 0.07	0.84 ± 0.13	--- ± ---
Hermit Thrush	1.47 ± 0.08	1.13 ± 0.09	0.83 ± 0.08	0.43 ± 0.05	1.34 ± 0.10	2.00 ± 0.17	--- ± ---
Winter Wren	0.22 ± 0.03	0.23 ± 0.02	0.23 ± 0.02	0.14 ± 0.01	0.25 ± 0.04	0.53 ± 0.03	--- ± ---
Black-capped Chickadee	0.25 ± 0.06	0.05 ± 0.01	0.04 ± 0.00	0.04 ± 0.00	0.08 ± 0.01	0.03 ± 0.01	--- ± ---
Boreal Chickadee	0.29 ± 0.06	0.38 ± 0.02	0.43 ± 0.03	0.35 ± 0.01	0.09 ± 0.02	0.27 ± 0.02	--- ± ---
Blackpoll Warbler	0.42 ± 0.04	0.40 ± 0.04	0.33 ± 0.02	0.30 ± 0.02	1.99 ± 0.16	0.23 ± 0.03	--- ± ---
Fox Sparrow	0.37 ± 0.04	0.43 ± 0.04	0.39 ± 0.04	0.47 ± 0.05	0.53 ± 0.07	0.09 ± 0.04	--- ± ---
White-throated Sparrow	2.90 ± 0.12	2.55 ± 0.11	2.54 ± 0.10	2.00 ± 0.11	2.20 ± 0.14	2.74 ± 0.15	--- ± ---
Yellow-bellied Flycatcher	0.39 ± 0.04	0.33 ± 0.04	0.28 ± 0.02	0.18 ± 0.02	0.06 ± 0.02	0.29 ± 0.04	--- ± ---

Nova Scotia

Upon retrieval, ARUs from Cape Breton were delivered to Peter Thomas at ECCC (Sackville), who downloaded data and began analysis with call recognition software developed by Yves Aubry (ECCC Quebec). Unfortunately, preliminary analysis indicated that the call recognizer returned a larger number of false positives for Bicknell's Thrush. Work to refine the call recognizer continues, with the help of annotated Bicknell's Thrush call files from Cape Breton provided by BSC and ECCC.

ECCC technician, Doug Hynes, manually processed the Cape Breton sound files, doing point counts at intervals within the recordings. He detected Bicknell's Thrush on 6 of the 13 ARUs. The full details of the results of ARU processing and results thereof are given in Doug Hynes' report, which is entitled "Acoustic documentation of Bicknell's Thrush on Cape Breton Island, Nova Scotia" (Appendix 4).

DISCUSSION

NB MBW surveys yielded a third year of improved detection of Bicknell's Thrush since survey routes were revised in 2016. Detections were the lowest since 2016, but still higher than the pre-2016 MBW surveys. Bicknell's Thrush were detected on 11% of points (31% of routes), significantly greater than the pre-2016 high of 5% of points (11% of routes; Campbell 2015), but lower than 2017, when Bicknell's Thrush were detected at 16% of points (44% of routes). This relatively high number of detections should allow us to meet the goal outlined in the Conservation Action Plan of being able to detect a minimum 3% annual change over 30 years with a coefficient of variation of 0.2, and should provide a method for evaluating Bicknell's Thrush recovery efforts in NB. In 2019, we will conduct a fourth year of MBW surveys in NB, using the same routes as in 2016, 2017 and 2018

In NS, we detected Bicknell's Thrush on 6 of the 13 ARUs deployed on NS MBW routes were Bicknell's Thrush were detected previously. A full report and discussion of this project is given in Appendix 4. Overall, the ARU method was much more successful at detecting Bicknell's Thrush compared to NS MBW surveys from previous years. However, it appears that extended listening periods are necessary to detect Bicknell's Thrush in Cape Breton, as any sites where they were detected required at least 175 minutes of listening to recordings. This is far greater than the usual 10-20 minute point count conducted at each point on an MBW route. Therefore, we plan to continue the ARU project in 2019, deploying ARUs in more locations and re-deploying in locations where listening times were lower due to extended wind/rain noise on the recordings. Additionally, working collaboratively with an expedition to census Leach's Storm Petrels, we are planning to survey for Bicknell's Thrush on Scatarie Island, off the coast of NS. A previous survey of part of Scatarie Island detected no Bicknell's Thrush, but they have been reported on several coastal NS islands, where ocean breezes re-create the windthrown, regenerating forests that Bicknell's Thrush prefer.

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APPENDICES

Appendix 1 – Habitat classes from New Brunswick Forest Inventory included in Bicknell's Thrush distribution model.

Code	Description
BFIH	balsam fir and shade intolerant hardwood
BFIR	softwood with greater than 60% balsam fir
BFMX	mixed wood with ≥ than 50% softwood with ≥ 30% balsam fir
BFSP	balsam fir and spruce
BFTH	balsam fir and shade tolerant hardwood
BSBF	softwood with ≥ 40% black spruce and ≥ 10% balsam fir
RSBF	softwood with ≥ 40% red spruce and ≥ 10% balsam fir
RSMX	mixed wood with ≥ than 40% red spruce
RSPR	softwood with ≥ 70% red spruce
SPBF	softwood with ≥ 40% spruce and ≥ 10% balsam fir
SPMX	mixed wood with ≥ 50% softwood with ≥ 30% spruce
SPRC	softwood with ≥ 60% spruce
WSPR	softwood with ≥ 70% white spruce

Appendix 2 – Models tested for each target species using Mountain Birdwatch 2.0 data from 2018.

Model Number	Model
M1	pcount(~1 ~1)
M2	pcount(~start time ~1
M3	pcount(~julian date ~1

Appendix 3 - Best fit model for each target species using Mountain Birdwatch 2.0 data from 2018.

Species	Model
Bicknell's Thrush	pcount(~start time ~1)
Swainson's Thrush	pcount(~julian date ~1)
Hermit Thrush	pcount(~julian date ~1)
Winter Wren	pcount(~1~1)
Black-capped Chickadee	pcount(~1~1)
Boreal Chickadee	pcount(~start time ~1)
Blackpoll Warbler	pcount(~1 ~1)
Fox Sparrow	pcount(~1 ~1)
White-throated Sparrow	pcount(~1 ~1)
Yellow-bellied Flycatcher	pcount(~start time ~1)

Appendix 4

Acoustic documentation of Bicknell's Thrush on Cape Breton Island, Nova Scotia

March 2019
Doug Hynes

Bicknell's Thrush inhabits remote forests across a fragmented breeding range that includes parts of northeastern United States, Quebec, and the Maritimes. In Nova Scotia, breeding is restricted to Cape Breton Island, and the latter's outlying smaller islands. However, reports of the thrush on Cape Breton Island have dwindled (e.g., there are only two documented reports–with photos or audio–on eBird since 2016), and there is a growing fear that the species may be close to extirpation. In 2018, an effort was made to detect Bicknell's Thrush on Cape Breton Island with Song Meters (SM4s). Song Meters were deployed at 13 strategically selected locations and were run about eight hours per day, from the first week of June through to the second week of July. A sample of the collected acoustic data was examined for the presence of Bicknell's Thrush by manually listening to recordings while viewing spectrograms. Subsequently, I used CallSeeker (a semi-automated tool designed to scan recordings for Bicknell's Thrush calls) on recordings from sites where Bicknell Thrush was determined to be present via the manual point counts. This exercise help to test CallSeeker by providing new data for its call recognisers, and hence aid in its development. Further, verifying the output from CallSeeker also facilitated the discovery of several new vocalizations and individuals.

Manual point counts–Five minute point counts were made on the half hour starting at 20:30 hrs and ending at 22:00 hrs (= 20 minutes of point counts within a 95 minute period). The protocol was repeated every second evening. When wind and rain rendered recordings unusable, additional evenings were added. I did point counts from 15 June–10 July. The sampling regime was developed to increase the chances of detecting Bicknell's Thrush, based on seasonal phenology (i.e., dates that reflect the height of breeding activity) and known diurnal patterns of vocal behaviour (e.g., the dusk peak for both songs and calls). At Cheticamp Flowage, I scanned spectrograms of morning recordings, and made an additional point count at 05:50 hrs to help confirm presence of the thrush.

I made a total of 534 five-minute point counts (=2670 minutes). Bicknell's Thrush was present during 15 of these counts, at four of the 13 sites (Table 1). Interesting vocalizations of other species included a "pwee-pwee-pwee" of a possible Solitary Sandpiper (Cabot Trail, 2 July), a Gray Catbird "whine" (Lake of Islands, 10 July), and Common Nighthawk "peents" (Cheticamp Flowage, 24 June).

Table 1. Total listening times of point counts performed on Song Meter (SM4) recordings at 13 sites on Cape Breton Island, 15 June–10 July, 2018. Bicknell's Thrush was detected at six sites during point counts; detections at Tipover 2 and 3a (in red) were subsequently made with CallSeeker.

Location	Listening Time (min)	Dates Detected
Benjies Lake	225	–
Cabot Trail	220	–
Cape North	180	–
Cape North 2	195	–
Cape North 3	205	16 June
Cheticamp Flowage	250	4 July
Lake of Islands	180	–
Money Point	240	–
Paquette Lake	165	–
Park Boundary	200	16, 18, 20, 24 June; 2 July
Tipover Lake 2	190	7, 8, 9, 10, 11,
Tipover Lake 3a	175	4 July
Tipover Lake 3b	245	4, 7, 10 July

Using CallSeeker to detect Bicknell's Thrush–64,620 minutes of audio, from the four sites (Cape North 3, Cheticamp Flowage, Park Boundary, Tipover Lake 3b) which produced Bicknell's Thrush vocalizations during manual point counts, were subjected to CallSeeker's classification algorithms (protocols for running CallSeeker are outlined in the document "Step-by-step guide for verification of CallSeeker results").

Call Seeker recognised 303,352 call candidates. The program is designed to label calls as either Bicknell's Thrush, Gray Check Thrush or "Others". One hundred and fifty-seven candidates were true positives (i.e., verified to be Bicknell's Thrush), one Bicknell's Thrush call was misclassified as Gray-cheeked Thrush, and 17 candidates were false negatives (i.e., were calls of Bicknell's Thrush but were labelled as "Others"). All other calls were labelled as "Others", or were false positives of Gray-cheeked and Bicknell's Thrush. While verifying candidate vocalizations from the four sites, a further 501 Bicknell's Thrush calls were identified. I subsequently scanned the nine other sites using CallSeeker, which led me to discover the thrush at Tipover Lake 2 and 3a.

Bicknell's Thrush vocalizations–Thrushes uttered the characteristic shrill call, known mnemonically as "beer" or "veer", described by Ouellet (1993) and Townsend et al. (2015). Calls often showed a rapid, near vertical rise in frequency during the first 50 ms or less, reaching 6 kHz or more, before descending gradually over the remainder of the call (Figure 1A–C). A long bout of vocalizations delivered over several minutes exhibited noteworthy variation, and included calls with apparent non-linear complexity (Figure 2). A bird was also recorded uttering "chatter" calls; noisy sounds that consist of multiple simultaneous whistles on different frequencies (Figure 3). Bicknell's Thrush was recorded singing on 7 and 16 June (Tipover Lake

2), 29 June (two individuals heard in apparent counter song at ~21:32 at Cheticamp Flowage), 1 July (Cape North 3), 2 July (Park Boundary), and 10 July (Tipover Lake 3b). The structure of most songs were consistent with descriptions of Bicknell's Thrush song from elsewhere, i.e., several complex ringing phrases that terminate with a final phrase that ascends, or is constant, in frequency (Figure 4).

Most spectrograms of calls recorded by the Song Meters were of relatively low quality, i.e., birds were calling from a distance (but also several high quality bouts; Figure 1A–C). Nonetheless, the distinctive audile and spectrographic qualities of calls made them distinguishable. Calls were uttered consistently though out the study period (Figure 5A) but were almost two times as likely to be uttered during evening recording sessions (i.e., ~19:00–23:00 hrs) than during morning sessions (~03:30–08:00 hrs; Figure 5B). Measurements from two individuals (n=48 calls; grand means in parentheses), characterized minimal (2274 Hz), maximal (5857 Hz), and duration (310 ms) of calls' fundamental frequencies (Table 2). Some calls that overlapped or had differing intensities suggested that at least two individuals were present within earshot of the recorder (6 June at Tipover Lake 2, ~21:12:40 hrs, 6 and 16 June, Park Boundary, at ~20:57 and ~21:02 hrs, respectively; also see note on counter song, above).

Table 2. Means of low and high frequencies, and duration, of two Bicknell's Thrush, recorded on Cape Breton Island in 2018. **(I)** The first individual was recorded at "Park Boundary" on 4 June, 21:22 hrs; **(II)** the second at "Cape North 3" on 28 June at 05:40 hrs.

	$I_{n=20}$		$II_{n=18}$	
	range	*mean*	*range*	*mean*
Low Frequency (Hz)	1568–2194	1908	1514–3430	2641
High Frequency (Hz)	5038–6754	6040	4806–6463	5675
Duration (ms)	221–380	292	195–459	327

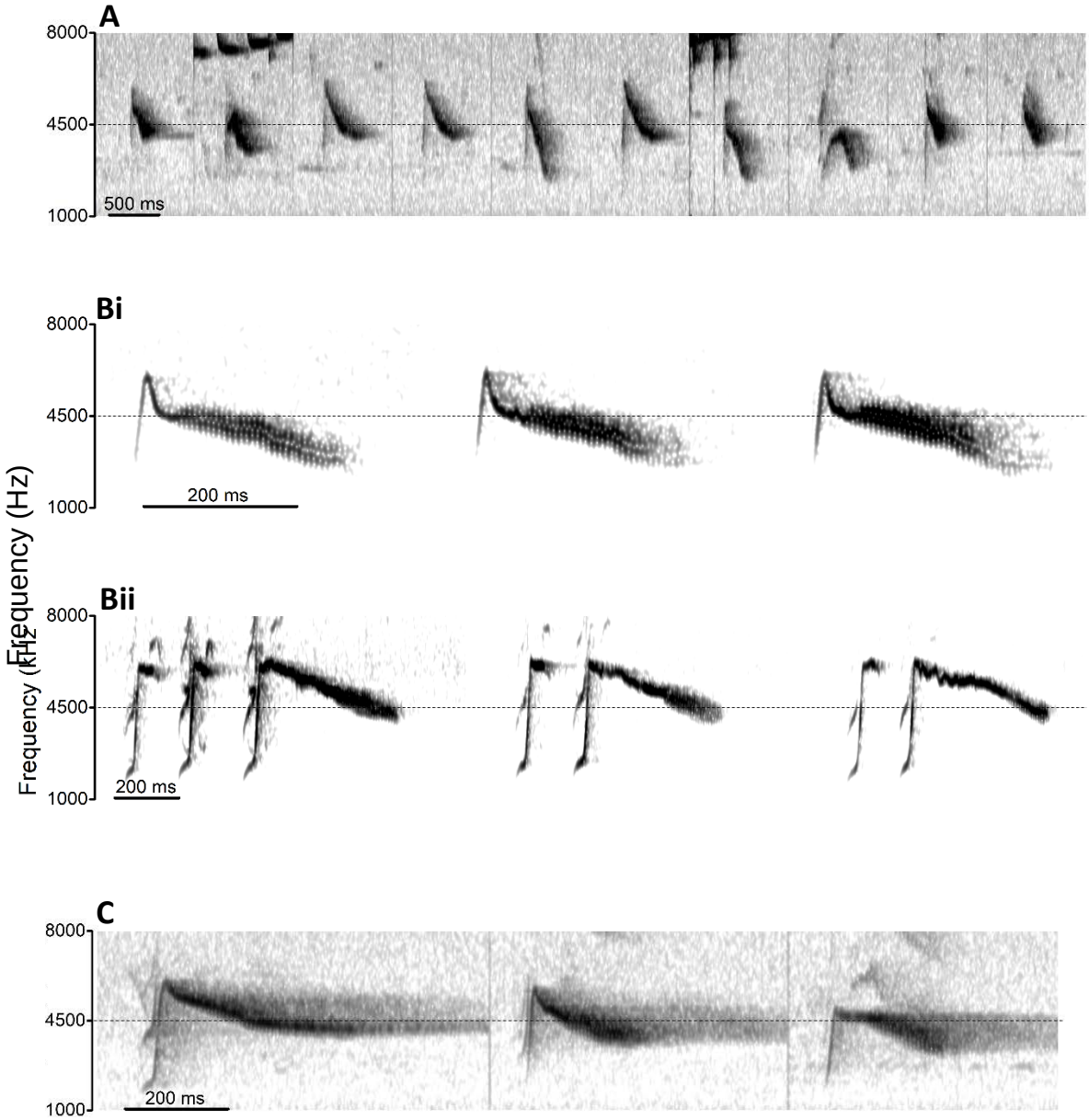

Figure 1. Exemplars of characteristic diurnal "veer" calls uttered from Bicknell's Thursh. All calls were recorded with SM4 Song Meters on Cape Breton Island, Nova Scotia, 2018. **(A)** Song-like sequence of calls from a single individual at study site "Cape North 3". Recorded 28 June, 05:50 hrs. **(Bi)** An individual at "Park Boundary" coupled typical monosyllabic calls with **(Bii)** an atypical polysyllabic form. Such "double" calls are known to be uttered by highly stressed

individuals (e.g., uttered from an adult thrush while a worker banded its nestlings; Yves Aubry, pers. comm.). Recorded 7 July, 05:51 hrs. **(C)** Variation in veer calls from an individual recorded at Cheticamp Flowage. Recorded 6 June 2018, 06:24 hrs. (Note: calls do not represent natural sequences, i.e., times between calls, or inter-call intervals, have been reduced for display purposes).

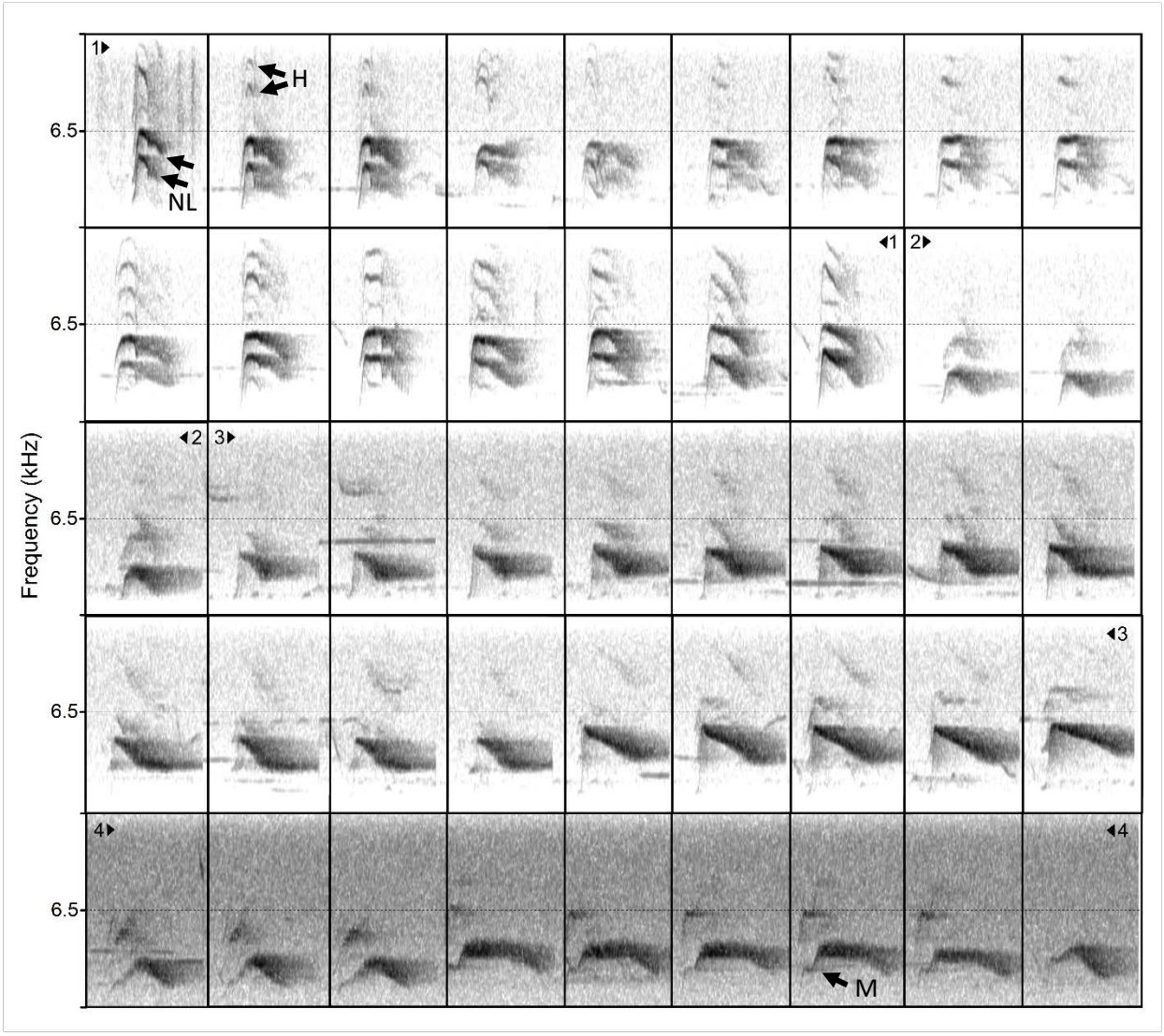

Figure 2. Call variants from a Bicknell's Thrush recorded at Tipover Lake 2, 16 June 2018 at ~05:19 hrs. (1) apparent non-linear (NL) acoustic complexity (i.e., "two-voiced") in calls with harmonic structures (H); (2) relatively short chevron-shaped calls; (3) typical "beer" calls, rising sharply in frequency before descending gradually; (4) calls that exhibit fine-scale modulation (M) during the initial rise in frequency. Horizontal lines of boxes represent ~250 ms in duration.

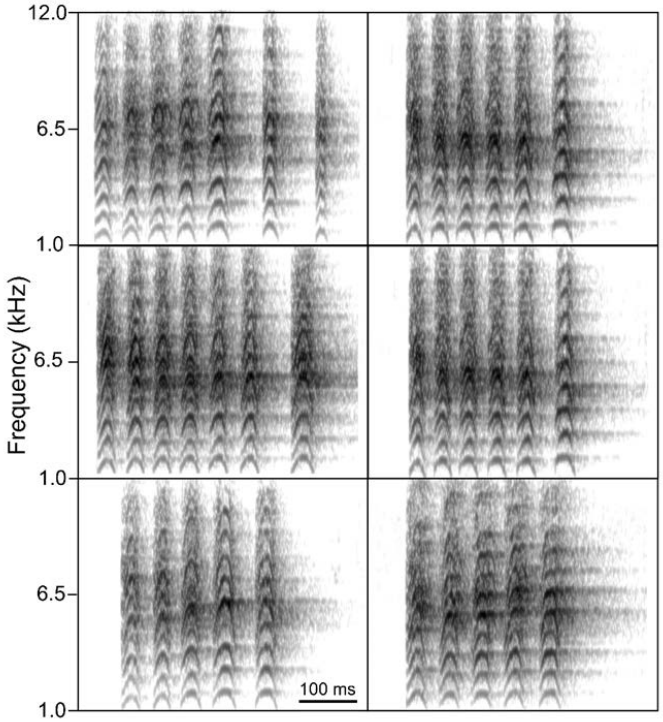

Figure 3. Noisy “chatter” calls from a bird recorded at Tipover Lake 2, 11 June, 05:52 hrs. These calls are thought to be uttered by agitated, alarmed, or aggressive adults (Wallace 1939).

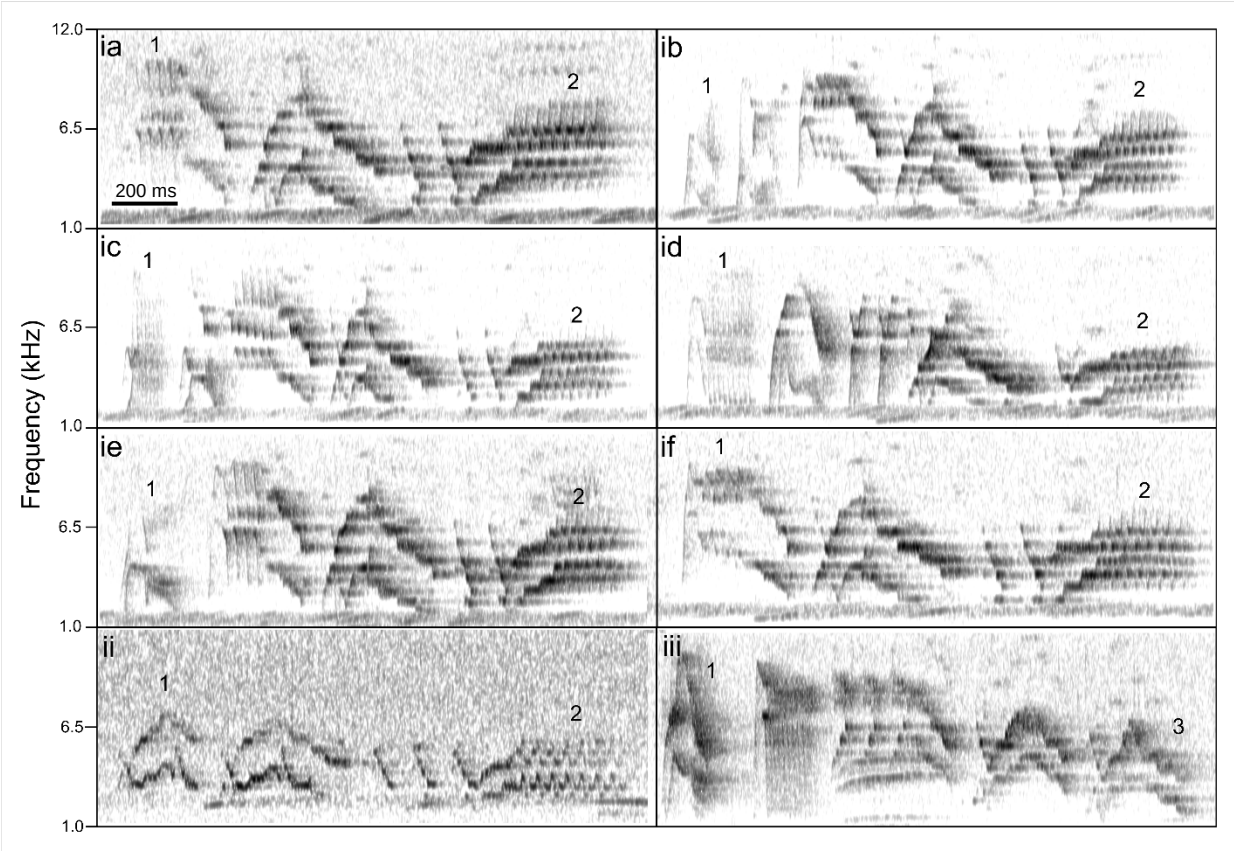

Figure 4. Song exemplars from three individuals (i–iii). (i) An individual sang several bouts (a–f), with some variability in the introductory notes (1) but kept final trill element (2) generally constant in frequency, as did individual “ii”. Final song phrases that either are constant or ascending in frequency are typical of Bicknell’s Thrush (Ouellet 1993). Individuals (i) and (ii) recorded at Tipover Lake 2, 6 June 2018, ~21:12 hrs, and Cheticamp Flowage on 29 June 2018, 21:32 hrs, respectively. (iii) Atypical song with a descending final phrase (3) is reminiscent of Gray-cheeked Thrush song. Recorded at Park Boundary, Cape Breton Island, 4 June 2018, 21:22 hrs.

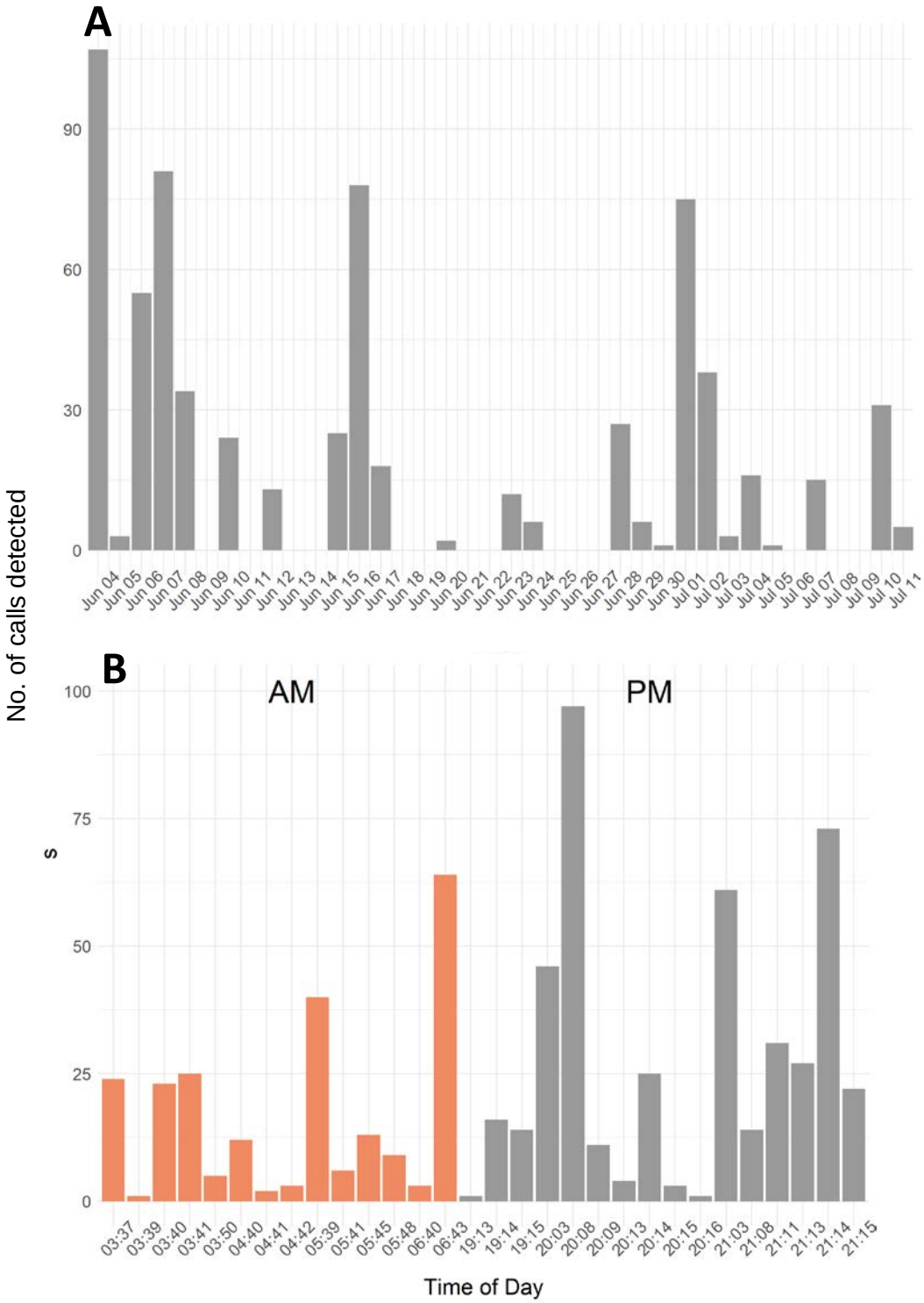

Figure 5. **(A)** Thrush uttered calls throughout the study period, between 4 June and 11 July, 2018, Cape Breton Island. Low numbers of detections between 17–22 June are likely due in part to bad weather. Conversely, high levels of detections (e.g., 4 June; 20:03 hrs in **B**) are due long calling bouts by individual birds. **(B)** More detections were made during evening recording sessions (n=446) than morning sessions (n=230). Note: Time of day indicates the time the Song Meter initiated a recording for a given track, not the actual time of the call itself. Tracks were generally one hour in length; i.e., bars represent ~1 hour time bins.

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