Mountain Birdwatch 2.0: 2013

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Annual Report to the United States Fish and Wildlife Service
February 2014
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VERMONT CENTER FOR ECOSTUDIES
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Table of Contents

Executive Summary

Mountain Birdwatch (MBW) monitors songbirds that breed in fir and spruce forests of the northeastern United States and Canada. MBW's primary focus is Bicknell's Thrush, a montane fir specialist that breeds only in the Northeastern U.S. and adjacent portions of Canada. Initiated in 2000, MBW trained citizen scientists to conduct annual observations along survey routes in Massachusetts, New York, Vermont, New Hampshire, and Maine. In 2010, MBW launched a revised, improved program (MBW2), which includes a randomized selection of routes across the northeastern United States, a revised survey protocol to allow for more stringent statistical analyses, and an expansion into Canada to ensure consistent surveys across the entire breeding range of Bicknell's Thrush.

2013 marked the third year of full implementation of MBW2 in the U.S. Despite abnormal amounts of rain across much of the survey region, observers surveyed 635 points along 115 routes in June and early July. Bicknell's Thrush was detected at 156 points (25.6%) along 68 routes (59.1%). As in previous years, New York surveys yielded the highest percentage of points at which Bicknell's Thrush was detected (43%).

Despite its successful implementation in the US, low numbers of Bicknell's Thrush detections in Canada, especially within Québec, have led to a re-evaluation of MBW2's ability to effectively and efficiently monitor Bicknell's Thrush throughout its entire breeding range. While the US portion of MBW2 will continue unchanged, the International Bicknell's Thrush Conservation Group monitoring subcommittee is evaluating methods to refine its international strategies in order to meet local, provincial, and international monitoring goals.

Background and Rationale

The high-elevation forests of the northeastern United States provide habitat for a unique assemblage of breeding birds, several of which reach the southern limits of their distribution in these montane fir-spruce forests. Most notably, mountain forests provide habitat for Bicknell's Thrush (*Catharus bicknelli*), the region's only endemic songbird. However, due to the inaccessibility of Northeast's high-elevation forests, several montane avian breeders were not included in standardized state or federal bird monitoring schemes (e.g., the Breeding Bird Survey). As such, generating even rudimentary estimates of population trends or population size proved difficult historically for species in this habitat, and the development of scientifically-defensible conservation strategies lagged accordingly. Mountain Birdwatch (MBW) was created to fill these information gaps.

Mountain Birdwatch began under the auspices of the Vermont Center for Ecostudies (VCE; at the time part of the Vermont Institute of Natural Science) Forest Bird Monitoring Program. Volunteers and staff surveyed 12 mountains from 1993 to 1999 to monitor changes in the status of Bicknell's Thrush and other high-elevation songbirds. In 2000, VCE biologists launched MBW as an independent project with fifty additional routes in Vermont and offered observers the option to concentrate on five species: Bicknell's Thrush, Swainson's Thrush (*Catharus ustulatus*), Blackpoll Warbler (*Dendroica striata*), White-throated Sparrow (*Zonotrichia albicollis*), and Winter Wren (formerly *Troglodytes troglodytes;* designated *Troglodytes hiemalis* in 2010; Chesser et al, 2010). The survey region was expanded in 2001 to include over 100 new routes in New York, New Hampshire, Massachusetts, and Maine. The objectives of this original Mountain Birdwatch were to: 1) monitor the distribution and abundance of mountain-breeding birds in northern New England and New York; 2) describe the influence of landscape and habitat features on mountain bird distribution and abundance; and 3) guide stewardship of high-elevation forests.

Data collected under MBW have been put to a variety of uses: we have assessed the power of MBW to detect population trends (Lambert et al. 2001); examined the influence of landscape structure on high-elevation bird communities (Lambert et al. 2002); measured

habitat characteristics on 45 survey routes (Lambert 2003); quantified short-term population trends (Lambert 2005); produced and validated a Bicknell's Thrush distribution model (Lambert et al. 2005); and projected effects of climate change on Bicknell's Thrush distribution (Lambert and McFarland 2004). We have also identified key management units and conservation opportunities for Bicknell's Thrush (Lambert 2003). More recently, we have conducted a ten-year trend analysis of MBW's five target species (Scarl 2011) and assessed the relative contribution of local and landscape variables to Bicknell's Thrush habitat occupancy in Vermont (Frey et al. 2011). We are currently using ten years of MBW data to evaluate high-elevation bird abundance in relation to climate events, habitat, and competition. These analyses provide critical conservation tools for scientists, policymakers, and landowners.

Mountain Birdwatch remains integral to the ongoing efforts of the International Bicknell's Thrush Conservation Group (IBTCG; www.bicknellsthrush.org) and serves as the main tool to evaluate progress towards the group's goals. In 2010, the IBTCG unveiled a Conservation Action Plan for Bicknell's Thrush; analyses of population trends and occupancy based on MBW data informed development of the Bicknell's Thrush Conservation Action Plan (IBTCG, 2010).

Despite the enormous potential of this monitoring project, the original MBW design exhibited several limitations. First, MBW investigated breeding birds in the high-elevation regions of New York, Vermont, New Hampshire, and Maine, yet birds are not constrained by state and country borders. High-elevation spruce-fir forests extend northward into Canada, as does the breeding range of Bicknell's Thrush (IBTCG, 2010). While Canadian-based Bicknell's Thrush distribution surveys and the High Elevation Landbird Program monitored this species in Québec and the Canadian Maritimes, respectively, differences in survey protocols and timing hindered integration of results across regions. Second, while initial route selection made an attempt at randomization across the available habitat, limitations in volunteer effort and the addition of new, non-randomly selected routes created a non-random MBW survey sample. This limits inferences that can be drawn across an entire population or habitat. Third, the original MBW allowed observers to choose between two survey protocols: while one protocol focused on five species of high-elevation birds, the other protocol recorded all species observed during a survey.

Differences in observer attention or effort may have influenced results, even for detections of the five species surveyed by all volunteers. Finally, in recent years, scientists have recognized that detectability is an essential consideration in bird monitoring programs (MacKenzie et al. 2005); detectability measures the probability of detecting a species if that species is present. Analyses that account for detectability tend to more accurately represent population trends than those that do not consider this variable, especially for difficult-to-detect species (Rota et al. 2011). Although estimates of detectability are possible with MBW data, important variables that may influence detectability were not measured, and thus accuracy of detectability estimates may be poor.

Mountain Birdwatch 2.0

VCE and the IBTCG developed Mountain Birdwatch 2.0 (MBW2) to address the shortcomings of the original MBW and provide a long-term, international monitoring program that surveyed high-elevation birds across the entire breeding range of the Bicknell's Thrush. MBW2 incorporates the following improvements:

1. MBW2 is a partnership between government, non-government, and academic institutions in the U.S. and Canada. Using a Bicknell's Thrush potential habitat model (McFarland and Hart, 2009; based on Lambert et al. 2005) to identify a survey frame, we randomly selected MBW2 routes across all potential Bicknell's Thrush habitat in both countries. A Generalized Random Tessellation Stratified (GRTS) sampling design ensured a spatially balanced but randomized selection of survey stations while also allowing for randomized subsampling in specific regions of interest. With randomly selected routes and systematic surveys conducted across the entire breeding range of the Bicknell's Thrush, MBW2 was designed to enable strong conclusions about abundance, occupancy, trends, and distribution across an entire habitat.
2. MBW2 incorporates a new survey protocol that focuses on a broader array of montane species while allowing for improved calculations of detectability. All MBW2 participants collect data on 11 species (Table 1), yielding an expanded and

consistent target list with one protocol for all participants. This expanded focus, which also incorporates surveys of a common avian montane nest predator, will allow us to draw conclusions about the broader ecosystem and predator-prey cycles as well as standardize volunteer effort.

Table 1: Species surveyed by all MBW2 participants.

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

Goals

Mountain Birdwatch 2.0 identifies these monitoring and programmatic goals (reproduced from Hart and Lambert 2010):

Monitoring

Monitoring Goal 1: To measure the annual population status of target species in terms of distribution, abundance/density, and occupancy

Monitoring Goal 2: To measure changes in the population status of target species over time

Monitoring Goal 3: To relate population status and trend information to biotic and abiotic variables that may affect the target species

Programmatic

Programmatic Goal 1: To make observational data (date, location, count, etc.) and associated metadata publicly available for visualization and download through the Avian Knowledge Network (AKN), while recognizing legal, institutional, proprietary, and other constraints.

Programmatic Goal 2: To provide decision-makers with tools and analyses to conserve high-elevation birds in the Northern Appalachian and Laurentian Regions

Programmatic Goal 3: To increase public understanding of the ecology, status, and conservation requirements of high-elevation songbirds in the Northern Appalachian and Laurentian Regions.

For a detailed description of Mountain Birdwatch 2.0 protocols, history, and more specific target goals, please see Hart and Lambert 2010.

United States Initiative

Mountain Birdwatch 2.0 was launched in the United States in 2010. In June and July, nine technicians and Mountain Birdwatch director Judith Scarl established 96 routes across New York, Vermont, New Hampshire, and Maine; each route contains between 3-6 survey stations for a total of 529 U.S. survey points. Technicians mapped and documented these routes using GPS waypoints, written descriptions, and photographs. Since MBW2 aims to assess how avian population trends relate to habitat characteristics, technicians measured habitat variables at up to three subplots around each survey station. Technicians conducted point counts at 410 of these stations in June and July of 2010. By 2012, the full complement of 131 routes had been established in the northeastern United States. These efforts set the stage for decades of future surveys.

New York and Vermont Subsample

MBW2 route selection procedure assigned routes largely in proportion to the available habitat in a given region. We further narrowed route selections by eliminating areas that did not have road or trail access. Based on these criteria, Vermont and New York were assigned fewer routes than Maine and New Hampshire. In Vermont, high-elevation spruce-fir habitat is limited largely to the spine of the Green Mountains and a few high peaks in the Northeast Kingdom, and thus the total area of spruce-fir forest is small compared to other regions. New York's Catskill Mountains have an even smaller area of high-elevation spruce-fir forest. The Adirondacks of New York contain a large percentage of the potential Bicknell's Thrush habitat in the United States; however, large portions of this habitat are difficult to access due to lack of roads or trails or overly long hike durations.

Despite the small number of routes initially selected for New York and Vermont, the high-elevation regions of these two states merit closer attention. The Catskills and the southern Green Mountains of Vermont represent the southernmost extent of the high-elevation spruce-fir forest in which Bicknell's Thrush breeds. Climate-related changes in species' ranges often manifest as expansions or contractions at range edges (Parmesan 2006) and a regional increase of 1 degree Celsius may be enough to eliminate all Bicknell's Thrush breeding habitat from these regions (Rodenhouse et al. 2008). To detect early warning signs of global climate change, the southernmost limits of Bicknell's Thrush breeding habitat warrant careful monitoring. Second, data from the original MBW surveys indicate that unlike in other regions, Bicknell's Thrush detections have increased in the Adirondacks and Catskills over the past decade (Scarl 2011). More extensive monitoring will elucidate whether Bicknell's Thrush population size is increasing in New York State, or whether these trends represent a short-term population spike or an artifact of sampling effort. Third, the greatest numbers of Mountain Birdwatch volunteers have historically conducted surveys in New York and Vermont, demonstrating a potential for closer monitoring in those states.

In 2011 and 2012, 27 of the newly established routes in Vermont and New York represented part of a regional subsample to more closely explore trends in these areas. Our randomized, statistically rigorous subsampling will allow us to draw conclusions about Bicknell's Thrush and other high-elevation breeding birds at international, national, and regional scales.

Re-Launching a Volunteer Program

Mountain Birdwatch has always been a citizen science program at its core, and in 2011 MBW2 welcomed volunteers onto its new routes. In 2011, volunteers surveyed 64 out of 116 routes (54.2%). Volunteer participation increased by 50% in 2012; volunteers surveyed 96 of 126 available routes (76.2%). For the first time since 2010, in 2013, no paid technicians were hired to cover "leftover" United States routes; a volunteer intern and New York State Department of Environmental Conservation technicians assisted with routes that were not adopted. Citizen science volunteers also increased their participation levels

to fill in the gaps in coverage; Maine-based volunteers Mike and Barb Zimmermann singlehandedly surveyed 9 routes throughout central and western Maine!

To recruit and train volunteers, MBW director Judith Scarl presents annual volunteer training workshops at locations throughout the Northeast. At training sessions, volunteers learn about the history of the MBW program, applications of the original MBW data, the benefits of the revised monitoring program, and identification characteristics of the target species. Volunteers also participate in a practice point count using recorded bird songs and calls. Since 2011, 68 volunteers have attended at least one training workshop, with 13 volunteers attending two or more training sessions. These workshops serve both to strengthen volunteer bird identification and point count skills and also to create a sense of community among volunteers who otherwise work in isolation.

2013 U.S. Season Results

Observers surveyed 610 points along 115 routes within potential Bicknell's Thrush habitat in 2013; 16 routes were not surveyed or data was not submitted. Bicknell's Thrush was detected at 153 points (25.1%) and 68 routes (59.1%) in 2013 (Table 2). As in 2011 and 2012 (Table 3), in 2013 Maine had the lowest percentage of routes (52.0%) and points (15.9%) with BITH detections. As in 2011, New Hampshire and New York tied for highest percentage of routes with BITH detections (NH- 62.8%; NY- 61.9%). Surveyed points in New York had a higher percentage of BITH detections (43.0%) than all other states; this was partially driven by the percentage of points with BITH detections in the Catskills, which was more than double the rate in any other region. These data are uncorrected for observer skill, observer experience, or other factors that might influence the chance of detecting birds that are present, and thus must be interpreted with caution; however, New York's continually high detection rates suggest that New York mountains continue to provide important habitat for this vulnerable species.

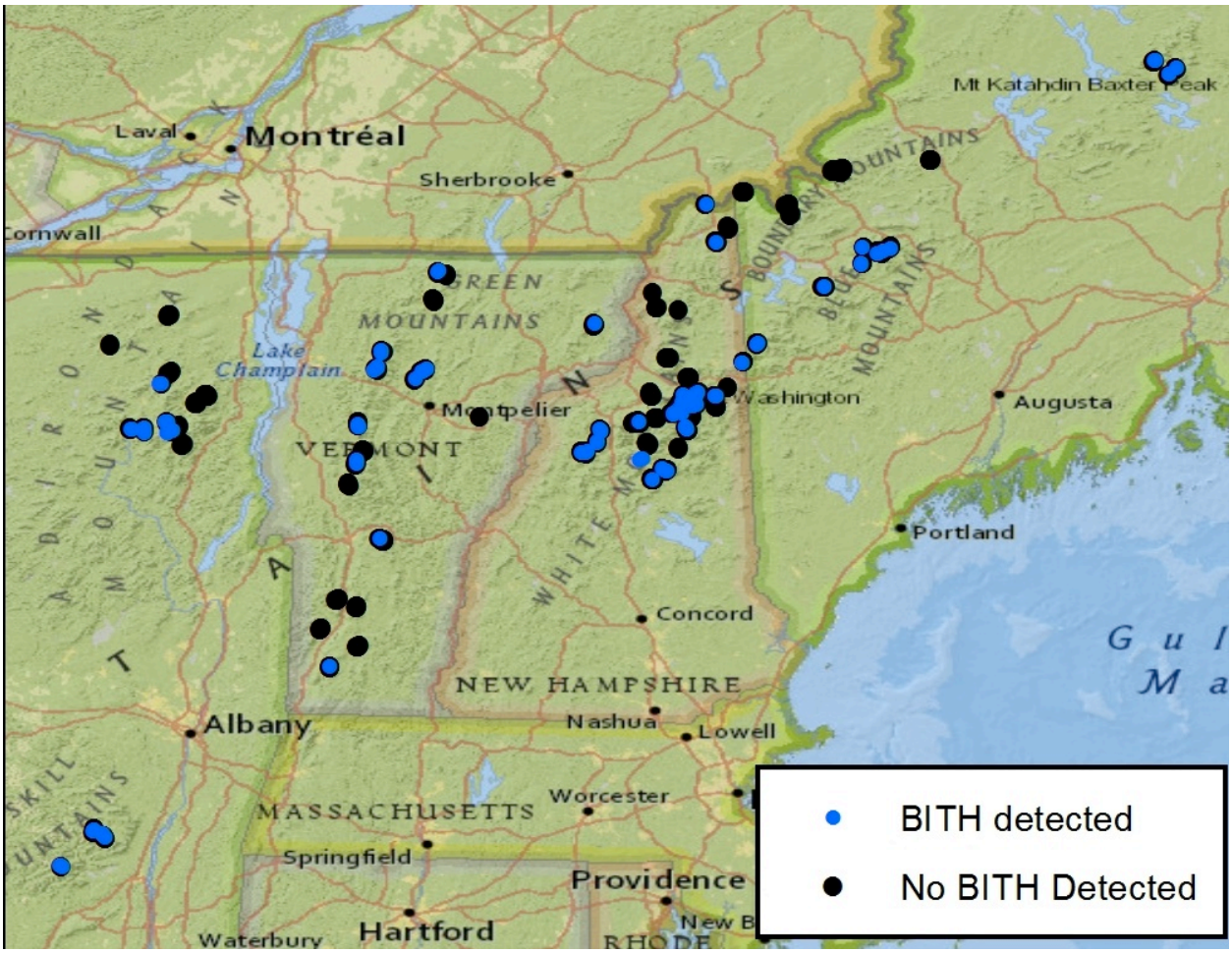

Figure 1: All non-confidential points surveyed within Bicknell's Thrush potential habitat in the U.S. in 2013. Bicknell's Thrush was detected at 25.1% of points surveyed within Bicknell's Thrush habitat.

Table 2: U.S. sampling effort and detections in 2013.

Region	Points Surveyed In Habitat	Points w/BITH Detections	Routes Surveyed	Routes w/BITH
Adirondacks (NY)	76	29 (38.2%)	15	8 (53.3%)
Catskills (NY)	31	17 (54.8%)	6	5 (83.3%)
NY (all)	107	46 (43.0%)	21	13 (61.9%)
VT	143	32 (22.4%)	26	15 (57.7%)
NH	228	54 (23.7%)	43	27 (62.8%)
ME	132	21 (15.9%)	25	13 (52.0%)
TOTAL	**610**	**153 (25.1%)**	**115**	**68 (59.1%)**

Examining the raw data from 2013 provides heartening evidence both of a strong mountain bird presence and a dedicated volunteer effort. Unusually severe snowstorms pummeled some areas of the Adirondacks and Green Mountains in late May of 2013, yielding concern that the extreme weather could negatively affect newly-returned avian migrants. However, Bicknell's Thrush breeding populations appear largely unscathed; in most states, observers recorded Bicknell's Thrush at more survey stations in 2013 than in 2012. In addition, several Northeastern regions experienced record-high daily or monthly rainfall. The north country of Vermont and parts of northern New York experienced record-high rainfall in June of 2013, with May-June representing the wettest two-month consecutive period recorded in Burlington, VT (source: http://www.nws.noaa.gov/climate/). The Mount Washington Observatory in the White Mountains recorded 12.4 inches of precipitation in June of 2013 (source: http://www.mountwashington.org/weather/f6/2013/06.pdf), 4 inches higher than normal, and the highest monthly June precipitation amount since 2006. Such record rainfalls made conducting surveys challenging, since trails throughout the region experienced washouts, and since the MBW2 protocol limits the range of weather conditions within which a survey can be conducted. Despite this, observers conducted surveys at 115 routes in 2013, only eight fewer than in 2012, a much drier year.

2011-2013 Comparisons

As of 2013, Mountain Birdwatch volunteers and staff have completed three full seasons of MBW2 data collection in the United States. Across all regions, 2011 was a banner year for Bicknell's Thrush detections; this species was detected at 31.9% of all points, compared with 25.2% and 25.1% of points in 2012 and 2013, respectively (Table 3). Individual states exhibited little variation in detection rates between 2012 and 2013, although total NY detections were slightly higher in 2013 than in 2012, and Maine detections were somewhat elevated in 2012 compared with 2013. Examining route-level data, 2011 and 2013 both yielded BITH detections at ~59% of surveyed routes, with 2012 detection rates slightly lower at 54.8% (Table 4).

Table 3: Percentage of all surveyed points at which observers detected Bicknell's Thrush.

Region	2011	2012	2013
Adirondacks (NY)	39.3	33.0	38.2
Catskills (NY)	58.1	48.4	54.8
NY (total)	44.3	36.4	43.0
VT	23.0	23.4	22.4
NH	33.5	22.6	23.6
ME	26.7	20.1	15.9
TOTAL	**31.9**	**25.2**	**25.6**

Table 4: Percentage of surveyed routes at which observers detected Bicknell's Thrush.

Region	2011	2012	2013
Adirondacks (NY)	56.3	52.4	53.3
Catskills (NY)	100.0	83.3	83.3
NY (total)	68.2	59.3	61.9
VT	47.8	53.8	57.7
NH	67.4	52.2	62.8
ME	48.1	55.6	52.0
TOTAL	**59.3**	**54.8**	**59.1**

Although an attempt is made to survey all established points within Bicknell's Thrush habitat each year, weather and observer availability preclude a number of points from being accessed in any given year. However, 501 points along 98 routes within Bicknell's Thrush habitat were surveyed every year from 2011-2013. Of these sites, observers detected Bicknell's Thrush during at least one of the three surveys at 214 (42.7%) points. Within this subset of 501 points, Bicknell's Thrush detection rates were similar in 2012 and 2013 (111 and 108 points with BITH detections, respectively) but slightly higher in 2011 (135 points), mirroring the results for the complete dataset. Consistency in Bicknell's Thrush detection at points was low; observers detected Bicknell's Thrush in more than one year at only 98 points (19.6%), and Bicknell's Thrush was observed during all three years at only 42 points (8.4%). However, route-level observations of Bicknell's Thrush exhibited strong consistency. Observers detected Bicknell's Thrush in all three years at a third of all routes (33 routes; 33.7%), and Bicknell's Thrush was never detected between 2011 and 2013 on another third (31 routes; 31.6%). More than half of all routes yielded Bicknell's Thrush detections in at least two of the three survey years (50 routes; 51%). The difference

in detection consistency at points compared to routes may represent large Bicknell's Thrush male home ranges and the changing mosaic of local habitat used by Bicknell's Thrush. In addition, detectability for a given species is rarely 100%, so it is likely that Bicknell's Thrush was present at some points in multiple years but was missed by observers.

MBW International

The Launch

2011 marked the international launch of Mountain Birdwatch 2.0. Observers surveyed a total of 1063 points across the northeastern U.S. and Canada (Figure 2); approximately 475 of these points were part of the original international sample, while the remaining points represented U.S. and statewide subsamples designed to more closely evaluate critical Bicknell's Thrush habitat in the U.S. In 2011, 613 points along 116 routes were correctly surveyed in the United States (23 points were excluded due to improperly conducted surveys), and Bicknell's Thrush was detected at 196 points (32%) along 70 routes in the U.S. alone. In Québec, 338 points along 58 routes were surveyed in 2011, with BITH detected at only 3% of these points. In the Maritimes, 88 points were surveyed along 15 routes, and Bicknell's Thrush was detected at 7 (8%) of these points. All of the BITH detections in the Maritimes occurred in New Brunswick; no BITH were detected in Nova Scotia. Overall, BITH was detected at 6% of international survey stations (see Table 5).

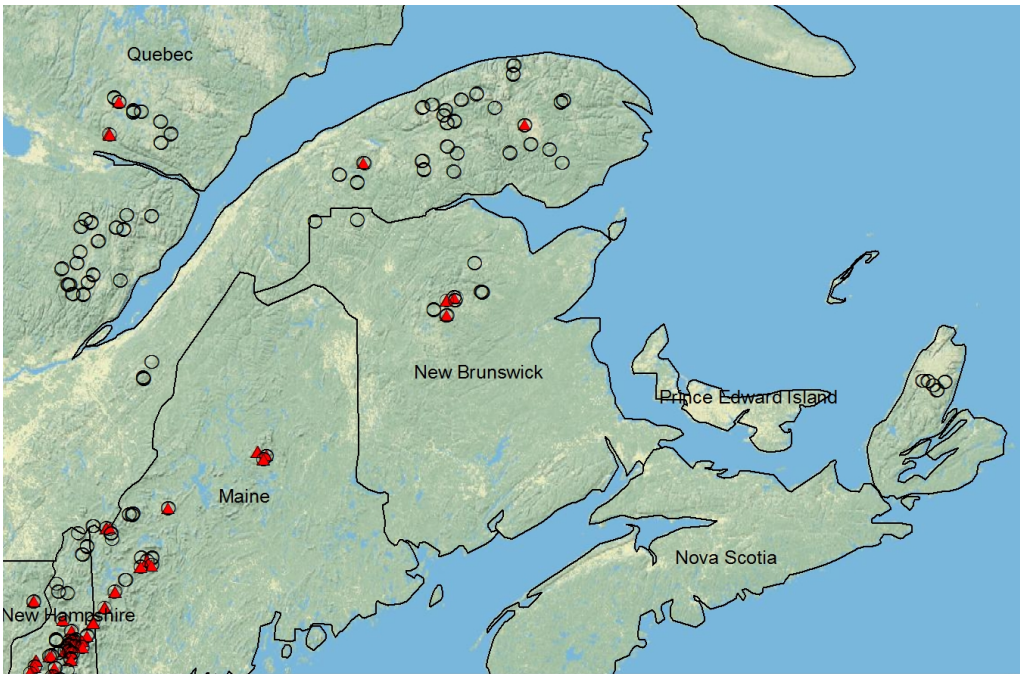

Figure 2: MBW2 points surveyed in Canada in 2011. Red triangles represent points with BITH detections; open circles represent points where no BITH was detected.

Table 5: International MBW2 sampling effort in 2011. Data from the U.S. represent points surveyed as part of the international sample only.

Region	Routes Surveyed	Points Surveyed	Points with BITH detections
Québec	58	338	11 (3%)
Maritimes	15	88	7 (8%)
U.S. (Int'l Sample)	8	46	10 (21.7%)
TOTAL	**81**	**472**	**28 (5.9%)**

Such low detection rates in Canada necessitated a reevaluation of the international MBW2 program and its ability to achieve national and international monitoring goals. Overall programmatic goals require a ~30% Bicknell's Thrush detection rate across the entire survey area in order to "estimate population trends with 80% power to detect a minimum 3% annual change in target species abundance/density over 30 years at a significance level of 0.1" (Hart and Lambert, 2010), a critical goal documented in the Mountain Birdwatch Standard Operating Procedures. While the U.S. subsample achieves this 30% detection target, international survey detections fall well below this goal. This raises concerns that MBW2 will be unable to detect and evaluate changes in target species populations over a

desirable timescale. In addition, such low detection rates will not allow efficient, cost-effective monitoring of the Canadian population of Bicknell's Thrush.

On one hand, randomized sampling across all potential breeding habitat is essential in order to draw conclusions that generalize across the entire Bicknell's Thrush population. On the other hand, an all-inclusive sampling frame combined with low densities of Bicknell's Thrush across much of Canada yields low detection rates that do not enable us to effectively gather and analyze information about current Bicknell's Thrush breeding areas. Thus, in 2012 and 2013, Mountain Birdwatch 2.0 partners at VCE, the Canadian Wildlife Service (CWS), BirdStudies Canada (BSC), and the Regroupment QuébecOiseaux (RQO) conducted surveys to help better understand the current distribution of Bicknell's Thrush in each region and explored several methods to refine our monitoring scheme.

Canadian Effort: 2012

In Nova Scotia, BSC surveyed 28 randomly selected routes (156 points) using the original MBW2 international GRTS sampling frame. Although these routes were randomly selected, the selection frame was limited to protected or unmanaged habitat in order to determine whether excluding forestry-influenced areas would affect Bicknell's Thrush detection rates. Bicknell's Thrush was detected at 9 points (5.8% of all points) along 5 routes (17.9% of routes), a slight improvement from 2011. In New Brunswick, 27 routes (160 points) were surveyed using the Mountain Birdwatch 2.0 protocols. Unlike in Nova Scotia, with such extensive areas of industrial forestry in New Brunswick, only one route was set within a protected area. Bicknell's Thrush was detected at 13 points (8.1%) along 6 routes (22.2%).

In Québec, Yves Aubry of the Canadian Wildlife Service and a colleague surveyed 99 points along 18 routes. Although the MBW2 protocols were followed, none of these routes were randomly selected, and distance between points was not standardized. At many of these locations, Bicknell's Thrush surveys had been conducted in 1998-1999. If no BITH were detected using the MBW protocol, the observer used playback followed by a 4-minute listening period. BITH was detected at 27 points (27.3%). The purpose of these surveys was to evaluate how Bicknell's Thrush detections had changed, compared to prior surveys

at the same locations, and to find Bicknell's Thrush within a concentrated region by focusing on habitat that is assessed to be suitable by experienced observers.

RQO also conducted a separate series of 16 MBW2 surveys in Québec in 2012; 10 of these routes were randomly selected. Of the 6 non-random routes, 4 were set in what was visually determined to be "good" BITH habitat, as noted by observers in the field. Two were nearby randomly selected MBW routes that were moved either because of a very loud river or because the habitat on the ground consisted of deciduous forest. In total, 92 points were surveyed in 2012. 6 of these points (6.5%) had BITH detections.

Compared to Québec, the Bicknell's Thrush habitat model shows very little potential habitat in New Brunswick and Nova Scotia. As a result, the international MBW2 sample places few routes in the Maritimes. Thus, the cost of monitoring a few low-yield routes as part of an international sample is not prohibitive in this region, and BSC is able to collect additional data within each Maritimes province to meet region-specific goals. However, since the vast majority of potential BITH breeding habitat falls within Québec's boundaries, extensive randomized surveys throughout this province are required to satisfy the current international sampling regime. Although Aubry's non-random samples demonstrate that higher concentrations of Bicknell's Thrush still exist in small pockets of Québec habitat, RQO's efforts suggest that randomized sampling across regions without historical Bicknell's Thrush detections is unlikely to yield high rates of detection under the current sampling scheme.

Canadian Effort: 2013

In the Maritimes, BSC surveyed 67 routes in total across Nova Scotia and New Brunswick in 2013. As in 2012, in New Brunswick BSC surveyed 10 routes randomly selected under the original MBW2 sampling scheme as part of the international sample, using the international MBW2 protocols. The additional 57 routes served to increase their sample size and satisfy local requirements for monitoring Bicknell's Thrush populations. Once again, in New Brunswick, routes were selected across all potential habitat, while in Nova Scotia they were limited to natural or unmanaged habitat. Except for the 10 international routes, sampling protocols for 2013 Maritimes surveys were modified slightly

from the international protocols; for these routes, BSC allowed evening surveys and shortened point counts to 10 minutes to enable a greater number of surveys.

Bicknell's Thrush detections remained low in New Brunswick, with BITH detected on 5 of 49 routes (10%) and 11 of 287 points (4%). Once again, Nova Scotia's protected areas yielded higher BITH detections; this species was detected on 9 of 28 routes (32%) at 29 of 156 points (18%).

Québec efforts in 2013 were two-fold. RQO surveyed 24 non-randomly selected routes (114 points) within potential habitat across three regions: Capitale Nationale, Bas-St-Laurent, and Gaspesie. The goal of these efforts was to investigate previously unsurveyed areas in order to help validate a new Bicknell's Thrush habitat model. Bicknell's Thrush was detected on 9 routes (37.5%) at 27 points (23.7%).

Once again, Yves Aubry led a team to conduct additional surveys in areas of Québec where few prior Bicknell's Thrush surveys had been conducted. This team surveyed 54 non-random routes with 310 points across three regions. Overall, BITH was detected along 36 points (11.6%), but these detections were not evenly distributed throughout the survey areas. In the Rimouski Wildlife Reserve, for example, none of the 37 points surveyed yielded any Bicknell's Thrush detections, because although the habitat surveyed fell within the potential Bicknell's Thrush habitat model, the area has been converted to a Norway Spruce plantation and is not suitable Bicknell's Thrush habitat. On the other hand, the Saguenay River Region, which is a potential windfarm site, yielded 34 of 196 points (17.3%) with BITH detections. The disparity in detection rates in Québec highlights one of the main challenges to randomized surveys in this region; many areas that are designated as potential BITH habitat in a predictive model have been anthropogenically modified and are currently unsuitable for breeding Bicknell's Thrush.

Moving Forward: International Plans

Three factors present significant challenges to implementing a unified monitoring program across all potential Bicknell's Thrush habitat: BITH density differences between regions, vast expanses of inaccessible forest, and management practices. Although Canada contains ~95% of all potential Bicknell's Thrush breeding habitat (COSEWIC, 2009), the current

Canadian BITH population is estimated between 37,000 and 49,000 individuals, while the U.S. population is estimated between 57,000 and 77,000 individuals (IBTCG 2010). Thus, Canada hosts a comparatively small population of Bicknell's Thrush distributed across a very large area; these density differences are reflected in disparate detection numbers throughout the international MBW2 sample.

Compounding the low-density issue in Canada is this region's vast expanse of inaccessible forest. For both safety and practicality, MBW2 surveys are limited to roads and trails. While the U.S. has an extensive network of trails throughout much of the potential Bicknell's Thrush breeding habitat, Canadian access is largely limited to logging roads, which do not penetrate the majority of Canada's spruce-fir forests. Survey sites are thus disproportionately established within actively managed habitat in Canada, creating a bias towards sampling in human-altered habitat. In addition, logging roads are more likely to be constructed at lower elevations (Y. Aubry, personal communication), which biases surveys towards habitat which may already have a lower probability of being suitable for Bicknell's Thrush.

Unlike in the United States, where the majority of potential Bicknell's Thrush habitat falls within protected or unmanaged areas (IBTCG, 2010), 94% of potential Bicknell's Thrush habitat in Canada is located on public lands and is thus subject to management (COSEWIC 2009). Only 2614 km^2 of the estimated 48,851 km^2 of potential habitat in Canada is protected (McFarland and Hart, 2009). However, if randomized sites are selected within recently clear-cut or thinned areas, the program risks expending large amounts of time and money on surveying areas that are not currently suitable for Bicknell's Thrush. Such low detection rates in Canada may partially reflect the challenge of surveying in "potential" habitat that is not currently suitable for Bicknell's Thrush due to anthropogenic disturbance.

Currently, the IBTCG monitoring subcommittee is investigating two simultaneous strategies to develop appropriate and efficient monitoring schemes within Bicknell's Thrush habitat. Beginning in 2014, we will create a stratification of the existing GRTS

sampling framework; this subsample will represent potential BITH habitat exclusively within protected or unmanaged areas. From within this subsample, we will randomly select a set of survey points that will allow us to monitor Bicknell's Thrush exclusively within unmanaged habitat. In the United States, ~85% of points already fall within national or state parks or forest, so route and point locations will remain the same. Partners in Québec, New Brunswick, and Nova Scotia will evaluate the logistics of establishing these randomly selected points in order to monitor population trends within unmanaged areas of Bicknell's Thrush potential habitat.

Meanwhile, we continue to evaluate how to effectively monitor Bicknell's Thrush within managed habitat and across the vast expanse of potential habitat in Canada. Partners in Québec and the Vermont Center for Ecostudies are using existing forestry data to develop a new habitat model for this species, which assesses remotely sensed, on-the-ground habitat conditions in order to identify areas that may currently be suitable for Bicknell's Thrush. Regardless of model extent or characteristics, however, monitoring within the vast, difficult to access, and ever-changing managed areas will likely remain a challenge. In the coming months and years, VCE and partners will seek additional creative solutions to thoroughly yet efficiently monitor Bicknell's Thrush across its entire breeding range.

Conclusions

The past four years have marked an important transition for Mountain Birdwatch: we concluded a decade of data collection across the mountains of NY, VT, NH, and ME, launched an international collaboration to monitor high-elevation birds throughout the spruce-fir forests of the northeastern U.S. and Canada, and in the U.S. once again engaged citizen scientists as the mainstay of this volunteer-based program. With a dual focus on high-elevation conservation and citizen science, Mountain Birdwatch engages and trains more than 100 volunteers to collect extensive data that are critical for conservation. The launch of Mountain Birdwatch 2.0 expands an already-successful conservation initiative across state and country borders, creating a powerful initiative that will allow us to draw broader conclusions across the breeding range of Bicknell's Thrush. Engaging volunteers in

this new program since 2011 ensures that MBW2 will continue to represent a strong citizen science presence in the northeastern U.S.

Looking forward, Mountain Birdwatch is poised for several major accomplishments over the next several years. By the end of 2014, we expect to complete a major analysis exploring the first decade of Mountain Birdwatch data. This analysis will link changes in high-elevation songbird abundance to climate events and inter-species competition; it will guide conservation strategies for Bicknell's Thrush and demonstrate to citizen scientists how individual efforts yield wide-scale results. In addition, data collected under the more rigorous Mountain Birdwatch 2.0 can be used to explore current trends in Bicknell's Thrush distribution, abundance, and occupancy. The first three years of MBW2 suggest some consistent patterns of regional distribution, and consistent monitoring over time will allow us to detect how conservation strategies and environmental disturbances influence long-term high-elevation bird trends. Despite the challenges of monitoring this species internationally, Mountain Birdwatch remains the only consistent, region-wide source of information on birds that breed in the high-elevation spruce-fir forests of the Northeast, and its data will play a critical role in conservation.

Acknowledgements

We gratefully acknowledge the hundreds of volunteers who participate in Mountain Birdwatch. This dedicated group was recruited with assistance from the Adirondack Mountain Club, the Appalachian Mountain Club, the Appalachian Trail Conservancy, Audubon New Hampshire, Audubon New York, Maine Audubon, the Maine Department of Inland Fisheries and Wildlife, and the Wildlife Conservation Society. We are thankful to the following landowners/land managers for allowing Mountain Birdwatch volunteers and staff to conduct surveys on their land: American Ski Corporation, Carthusian Monastery, Plum Creek Timber Company, Inc., Green Mountain Club, Maine Department of Inland Fisheries and Wildlife, National Park Service, New York State Department of Environmental Conservation, U.S. Forest Service, Vermont Agency of Natural Resources, Wagner Forest

Management, American Forest Management, Dallas Company LLC, Seven Islands Land Company, Maine Department of Conservation, Sugarloaf Mountain Corporation, and Dartmouth College.

Funding for Mountain Birdwatch in the United States is generously provided by the U.S. Fish and Wildlife Service, the National Park Service, the Canadian Wildlife Service, the Vermont Agency of Natural Resources, the U.S. Forest Service, Plum Creek, the Cullman Foundation, and private donors. The 2010-2011 Mountain Birdwatch initiative in New York State was funded by a New York State Wildlife Grant administered through the New York State Department of Environmental Conservation. A generous software grant from ESRI made GIS analysis and mapping possible.

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