Mountain Birdwatch 2.0: 2015

Photo © Judith Scarl

Annual Report to the United States Fish and Wildlife Service
15 September 2015
Dr. Jason M. Hill

VERMONT CENTER FOR ECOSTUDIES
UNITING PEOPLE & SCIENCE FOR CONSERVATION

Table of Contents

Executive Summary

Mountain Birdwatch (MBW) monitors songbirds that breed in fir and spruce forests of the northeastern United States. 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. MBW-trained citizen scientists conduct annual observations along approximately 130 survey routes in New York, Vermont, New Hampshire, and Maine. Initiated in 2000, MBW was revised and re-launched as MBW2 in 2010. MBW2 includes a randomized selection of routes across the northeastern United States. This enhanced survey protocol enables more robust statistical analysis, and also allows for the expansion of MBW2 routes further into Canada to ensure consistent surveys across the entire breeding range of Bicknell's Thrush.

2015 represented the fifth year of complete implementation of MBW2 in the U.S. In June and early July, observers surveyed at least 581 points in Bicknell's Thrush habitat along 103 routes across New York, Vermont, New Hampshire, and Maine. We are still receiving observation data from observers for the 2015 season, and we expect the final 2015 tallies to be closer to the 2014 summaries where observers counted birds along 123 routes. In 2015 observers detected 381 Bicknell's Thrushes across 152 points (26.2%) along 63 routes (61.2%). Vermont surveys yielded the highest percentage of points at which Bicknell's Thrush was detected (28.8%).

In 2015 MBW2 data played an instrumental role in evaluating the trends of spruce-fir birds in the northern United States (Ralston et al. 2015). By combining MBW2 data with 11 other point count datasets, Ralston et al. (2015) estimated that several indicator species of the spruce-fir zone (e.g., Bicknell's Thrush [*Catharus bicknelli*] and Yellow-bellied Flycatcher [Empidonax flaviventris]) experienced significant declines across their range. These results highlight the importance and ability of the MBW2 dataset to evaluate and monitor high-elevation forest bird populations in the northeastern U.S.

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 (*Setophaga striata*), White-throated Sparrow (*Zonotrichia albicollis*), and Winter Wren (*Troglodytes hiemalis*). 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), assessed the relative contribution of local and landscape variables to Bicknell's Thrush habitat occupancy in Vermont (Frey et al. 2011), and substantially contributed to a trend analysis for spruce-fir bird species across the northern United States (Ralston et al. 2015). We are currently using ten years of MBW data to evaluate high-elevation bird abundance in relation to climate events, habitat, predation, 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 MBW 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 researchers to draw 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 standardized target list with one protocol for all participants. This expanded focus, which also incorporates surveys of a common nest predator, the Red Squirrel, will allow us to draw conclusions about the broader ecosystem and predator-prey cycles.

Table 1: The 10 bird and one mammal species annually surveyed by MBW2 citizen scientists.

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	*Setophaga 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 2008):

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 2008.

United States Initiative

Mountain Birdwatch 2.0 (MBW2) was launched in the United States in 2010. In June and July, nine technicians and former Mountain Birdwatch director Judith Scarl established 96 routes across New York, Vermont, New Hampshire, and Maine; each route consists of 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 relatively small number of Mountain Birdwatch routes in New York and Vermont, the high-elevation regions of these two states merit further 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 suggest that unlike in other regions, Bicknell's Thrush detections have increased in the Adirondacks and Catskills over the past decade (Scarl 2011). More extensive future monitoring will elucidate whether Bicknell's Thrush population size is increasing in New York State, or whether this increase is a product of a short-term population spike or an artifact of improved 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 at VCE 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, for example, singlehandedly surveyed nine routes throughout central and western Maine.

To recruit and train volunteers, VCE 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, >90 volunteers have attended at least one training workshop. 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 participate in isolation.

2015 U.S. Season Results

Observers surveyed 581 points along 103 routes within potential Bicknell's Thrush habitat in 2015, and we continue to receive observation data from additional routes. Bicknell's Thrush was detected at 152 points (26.2%) and 63 routes (61.7%) in 2015 (Figure 1; Table 2). Unlike previous years, New York had the lowest percentage of points with BITH detections (25.5%). In past years points along routes in New York were the most likely to have BITH detections. In 2015, however, for the first time Vermont had the highest percentage of points with BITH detections (28.7%). We had an unusually challenging time finding volunteers for routes in the Adirondack Mountain region of New York in 2015, and this region experienced substantial rainfall and blowdowns in June. These conditions likely explain the decrease in route coverage compared to 2014. These data are uncorrected for observer skill, observer experience, or other factors that might influence the likelihood of detecting birds that are present, and thus must be interpreted with caution; however, New York's continually detection rates suggest that New York mountains continue to provide important habitat for this vulnerable species.

Figure 1. Locations of U.S. Mountain Birdwatch routes where observers either detected (purple) or did not detect (white) Bicknell's Thrush in 2015.

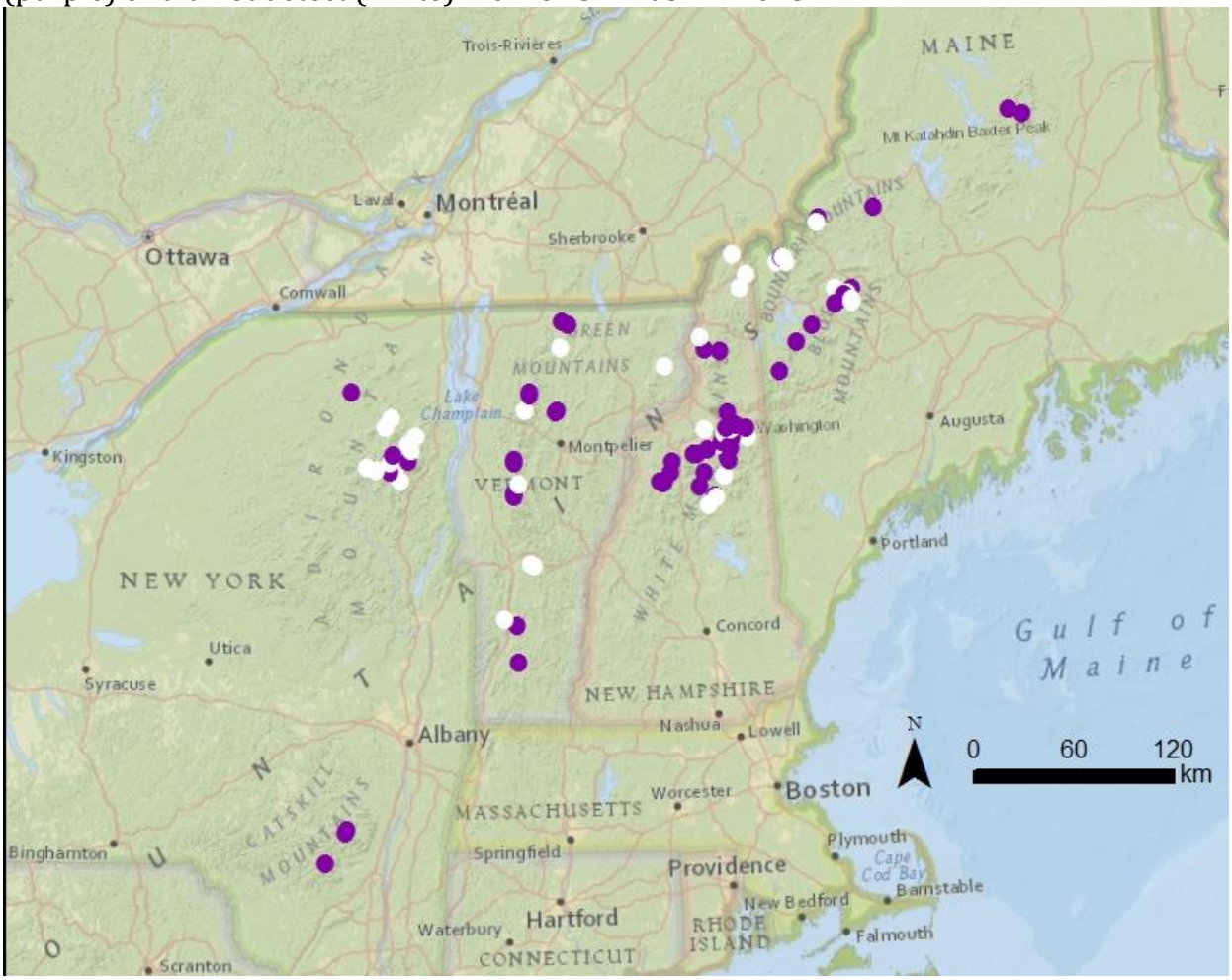


Table 2: Regional U.S. sampling effort for Bicknell's Thrush (BITH) in 2015 including the number and percent of Mountain Birdwatch points surveyed in BITH habitat, and the number and percent of routes surveyed with at least one point located in BITH habitat.

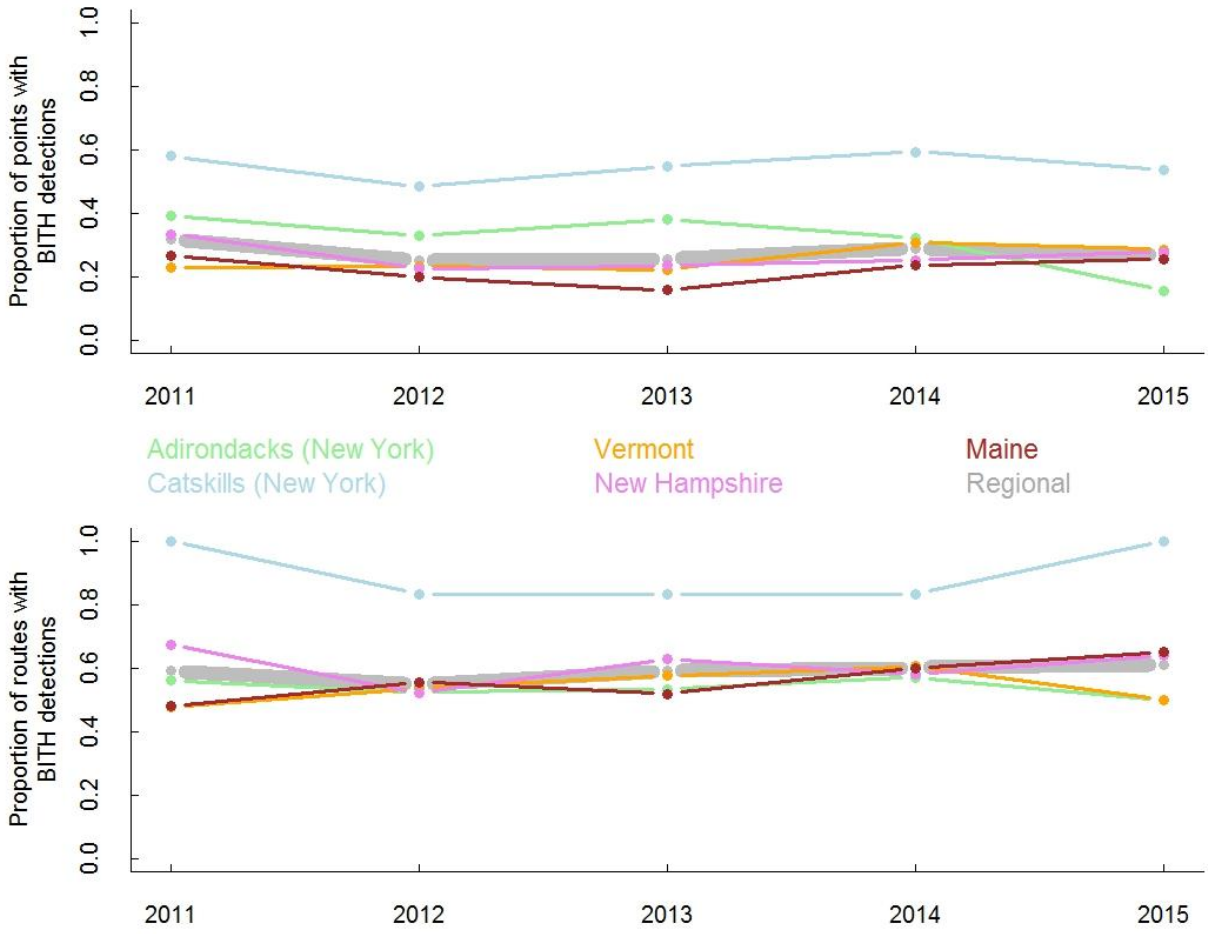
Region	No. surveyed points	No. points with BITH detections	No. surveyed routes	No. routes with BITH detections
Adirondacks (NY)	76	12 (15.8%)	14	7 (50.0%)
Catskills (NY)	26	14 (53.8%)	5	5 (100.0%)
New York (all)	102	26 (25.5%)	19	12 (63.2%)
Vermont	122	35 (28.7%)	22	11 (50.0%)
New Hampshire	212	59 (27.8%)	39	25 (64.1%)
Maine	125	32 (25.6%)	23	15 (65.2%)
Total	**561**	**152 (27.1%)**	**103**	**63 (61.2%)**

2011-2015 Comparisons

Although an attempt is made to survey all established points within Bicknell's Thrush habitat each year, weather, observer availability, and changing land permissions and availability of access preclude a number of points from being surveyed in any given year. As of 2015, Mountain Birdwatch volunteers and staff have completed five full seasons of MBW2 data collection in the United States. Overall, the level at which MBW2 volunteers detected Bicknell's Thrush remained fairly consistent from year to year (Figure 2). Mountain Birdwatch data suggest that the population of Bicknell's Thrush in the northeastern United States has not significantly declined; it is only with the inclusion of high-elevation surveys from the White Mountains of New Hampshire that Bicknell's Thrush show a significant decline in the New York and New England region overall (Ralston et al. 2015). The Bicknell's Thrush population in the Adirondack Mountains, however, may warrant closer examination. The proportion of points in appropriate habitat where Bicknell's Thrush was detected by observers in 2015 declined to its lowest level (0.16) since MWB2 began in 2011. This represents a decline in detection at points from 2014 when observers detected Bicknell's Thrush at 32.1% of points in appropriate habitat. Interpretation of this result is hampered by the greatly decreased level of volunteer participation in the Adirondacks in 2015. This region experienced substantial rainfall and storm-related trail closures in 2015, which greatly hindered completion of the surveys by volunteers. For one volunteer in particular it took five attempts (spaced over two weeks)

before the weather allowed him to survey all six point count locations on his route in a single day.

Figure 2. The proportion of surveyed points (upper panel) and routes (lower panel) in Bicknell's Thrush (BITH) habitat where observers detected BITH in 2015 across the Northeast U.S. The gray lines represent the mean proportion for the entire region.



MBW International

The Launch

2011 marked the international launch of Mountain Birdwatch 2.0 and the first full year of MBW2 surveys in the U.S. Observers surveyed a total of 1038 points in potential Bicknell's Thrush habitat across the northeastern U.S. and Canada; approximately 469 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 within the U.S. In 2011, observers surveyed 612 points along 116 routes in the United States, and Bicknell's Thrush was detected at 196 points (32%) along 70 routes in the U.S. alone (Scarl 2012). 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 (10 in New Brunswick and 5 in Nova Scotia), and Bicknell's Thrush was detected at 7 (8%) of these points, all in New Brunswick (Figure 3). Overall, BITH was detected at 6% of international survey stations (see Table 3).

Figure 3: Mountain Birdwatch 2.0 points surveyed in Canada in 2011 where observers detected (red triangles) or did not detect (open circles) Bicknell's Thrush.

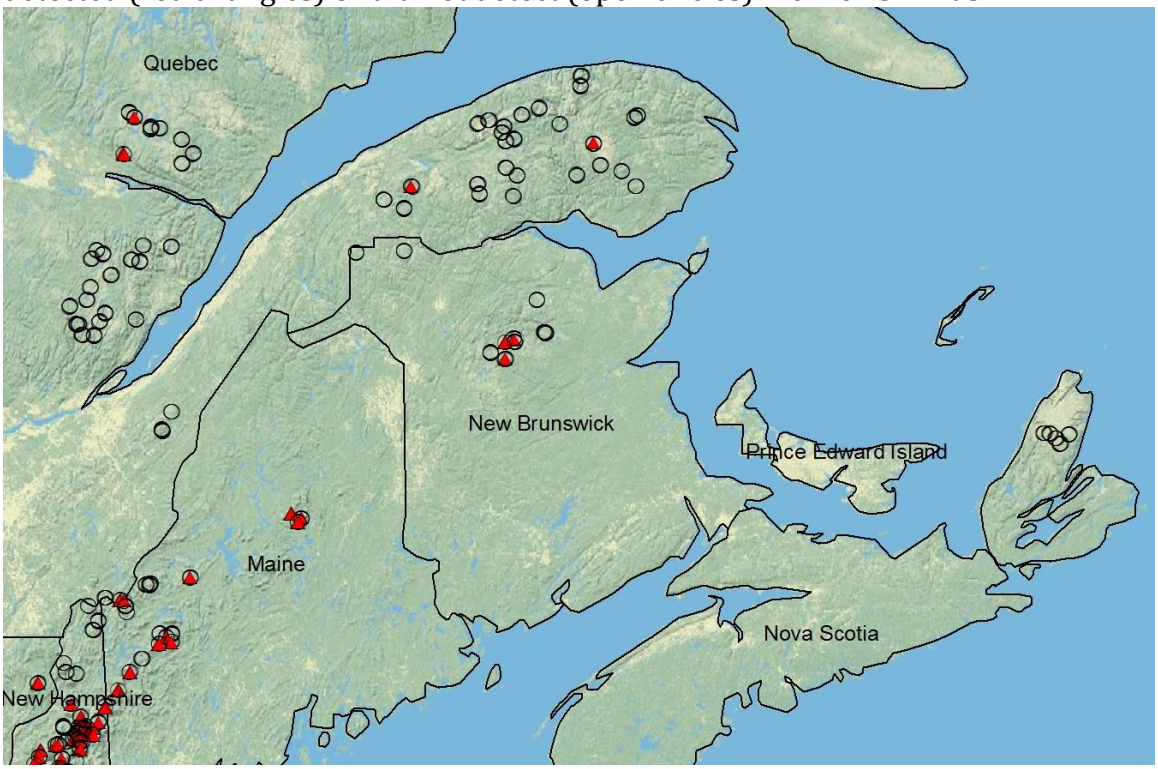


Table 3: International MBW2 sampling effort in 2011. Data from the U.S. represent points surveyed as part of the international sample only.

Region	No. routes surveyed	No. points surveyed	No. points with BITH detections
Québec	58	338	11 (3%)
Maritimes	15	88	7 (8%)
U.S. (Int'l Sample)	8	43	10 (23.3%)
TOTAL	**81**	**469**	**28 (6.0%)**

Such low BITH detection rates in Canada necessitated a reevaluation of the international MBW2 program and its ability to achieve national and international monitoring goals. Based on analysis of MBW2 pilot data, this program requires 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, 2008), a critical goal documented in the Mountain Birdwatch Standard Operating Procedures. While the U.S. subsample achieved this 30% detection target, international survey detections fell well

below this goal. This raised concerns that MBW2 would be unable to detect and evaluate changes in target species populations over the desired timescale. In addition, such low detection rates will not allow efficient, cost-effective monitoring of the Canadian population of Bicknell's Thrush and will therefore not meet provincial monitoring requirements for BITH.

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, between 2012 and 2014, MBW2 partners at VCE, the Canadian Wildlife Service (CWS), BSC, and the Regroupement QuébecOiseaux (RQO) explored several methods to refine our monitoring scheme and conducted surveys to help better understand the current distribution of Bicknell's Thrush in each region.

For a description of 2012-2014 surveys for Bicknell's Thrush in Canada, as well as a detailed discussion of the challenges to successful implementation of a unified BITH monitoring program across the US and Canada, see Scarl (2015), which also poses a series of questions that must be answered in order to move forward with international monitoring plans for Bicknell's Thrush.

Conclusions

The past five 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, tested an international initiative 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 close to 100 volunteers each year to collect extensive data that are critical for conservation. The launch of Mountain Birdwatch 2.0 strengthens and broadens an already-successful conservation initiative by increasing its species focus and by enabling scientists to draw more accurate conclusions

about trends in abundance, occupancy, and density across the U.S. 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.

In the coming years we will continue to explore ways to increase participation in MBW2, and we will seek out additional opportunities for shared data analysis. Mountain Birdwatch 2.0 data in 2015 have already played a pivotal role in elucidating the trends of spruce-fir forest birds in the most data-rich and geographically extensive analysis yet (Ralston et al. 2015). We expect this publication to help guide conservation strategies for Bicknell's Thrush and other high elevation species 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 state-specific trends and patterns in Bicknell's Thrush distribution, abundance, and occupancy. The first five 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 data from this program play a critical role in conserving high-elevation songbirds in this region.

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 was generously provided by the U.S. Fish and Wildlife Service. Additional past funders include 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.

References

COSEWIC 2009. COSEWIC assessment and status report on the Bicknell's thrush *Catharus bicknelli* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. V + 44 pp.

Frey, S.J.K., A.M. Strong, and K.P. McFarland. 2011. The relative contribution of local habitat and landscape context to metapopulation processes: a dynamic occupancy modeling approach. *Ecography, 34:*1-9.

Hart, J.A. and J.D. Lambert. 2008. Mountain Birdwatch: Protocol and Standard Operating Procedures for Monitoring High-elevation Landbirds in the Northern Appalachian and Laurentian Regions. Version 2.0.

IBTCG. 2010. A Conservation Action Plan for Bicknell's Thrush (*Catharus bicknelli*). J.A. Hart, C.C. Rimmer, R. Dettmers, R.M. Whittam, E.A. McKinnon, and K.P. McFarland, Eds. International Bicknell's Thrush Conservation Group. Available at www.bicknellsthrush.org.

Lambert, J.D., 2003. Mountain Birdwatch 2002: Final Report to the U.S. Fish and Wildlife Service. Unpublished report. Vermont Institute of National Science, Woodstock, VT.

Lambert, J.D., K.P. McFarland, C.C. Rimmer, and S.D. Faccio. 2001. Mountain Birdwatch 2000: Final Report to the U.S. Fish and Wildlife Service. Unpublished report. Vermont Institute of National Science, Woodstock, VT.

Lambert, J.D., S.D. Faccio, and B. Hanscom. 2002. Mountain Birdwatch 2001: Final Report to the U.S. Fish and Wildlife Service. Unpublished report. Vermont Institute of National Science, Woodstock, VT.

Lambert, J. D., and K. P. McFarland. 2004. Projecting effects of climate change on Bicknell's Thrush habitat in the northeastern United States. Unpublished report by the Vermont Institute of Natural Science, Woodstock, VT.

Lambert, J.D., K.P. McFarland, C.C. Rimmer, S.D. Faccio, J.L Atwood. 2005. A practical model of Bicknell's Thrush distribution in the northeastern United States. *Wilson Bulletin, 117*: 1-11.

Lima, 2009. Predators and the breeding bird: behavioral and reproductive flexibility under the risk of predation. *Biological Reviews of the Cambridge Philosophical Society, 84(3),* 485-513.

MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, L.L. Bailey, and J.E. Hines. 2005. Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence. Elsevier, San Diego, USA.

McFarland, K.P. and J. Hart. 2009. Production of a Bicknell's Thrush Global Breeding Distribution Model based on Known Occurrence and Potential Habitat. Unpublished report. Vermont Center for Ecostudies, Norwich, VT.

McFarland, K.P. and C. Rimmer. 2001. The relationship between cone mast, red squirrel populations and migratory songbird demographics in montane fir forests. Unpublished report. Vermont Institute of National Science, Woodstock, VT.

Parmesan, C. 2006. Ecological and Evolutionary Reponses to Recent Climate Change. *The Annual Review of Ecology, Evolution, and Systematics, 37*, 637-669.

Ralston, J., D.I. King, W.V. DeLuca, G.J. Niemi, M.J. Glennon, J.C. Scarl, J.D. Lambert. 2015. Analysis of combined data sets yields trend estimates for vulnerable spruce-fir birds in northern United States. Biological Conservation, 187, 270-278.

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

Rodenhouse, N.L., S.N. Matthews, K.P. McFarland, J.D. Lambert, L.R. Iverson, A. Prasad, T.S. Sillett, and R.T. Holmes. 2008. Potential effects of climate change on birds of the Northeast. Mitigation and Adaptation Strategies for Global Change 13(5-6):517-540.

Rota, C.T., R.J. Fletcher, J.M. Evans, and R.L. Hutto.2011. Does accounting for imperfect detection improve species distribution models? *Ecography, 34*: 659-670.

Scarl, J.C. 2011. Mountain Birdwatch 2010-2011: Annual Report to the United States Fish and Wildlife Service. Unpublished report. Vermont Center for Ecostudies, Norwich, VT.

Scarl, J.C. 2012. Mountain Birdwatch 2011: Annual report to the United States Fish and Wildlife Service. Unpublished report. Vermont Center for Ecostudies, Norwich, VT. 20 pp.

Scarl, J.C. 2015. Mountain Birdwatch 2.0: Implementation, challenges, and future directions of an international monitoring initiative. Unpublished report, Vermont Center for Ecostudies. 20pp.