Mountain Birdwatch 2006

FINAL REPORT TO THE UNITED STATES FISH AND WILDLIFE SERVICE

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Julie A. Hart and J. Daniel Lambert

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Vermont Institute of Natural Science
6565 Woodstock Road, Quechee, VT 05059

Abstract

Mountain Birdwatch is a long-term monitoring program for songbirds that breed in high-elevation forests of the northeastern U.S. Since 2001, the Vermont Institute of Natural Science (VINS) has prepared skilled volunteers to conduct annual surveys along 1-km point count routes located in Massachusetts, New York, Vermont, New Hampshire, and Maine. Primary emphasis is placed on Bicknell's Thrush, a montane fir specialist that breeds only in the Northeast and adjacent portions of Canada. Other focal species include Blackpoll Warbler, Swainson's Thrush, White-throated Sparrow, and Winter Wren. In 2006, Mountain Birdwatchers gathered observations from 155 locations, with point count surveys completed on 119 routes. Bicknell's Thrush occurred at a frequency similar to 2005. It was detected by point count on 63% of the routes and by any means on 90% of the routes. However, the abundance index for this species fell from a 2005 high of 0.3 individuals per point to the 2001-2004 average of 0.25 individuals per point. Counts of Swainson's Thrush and Winter Wren reached record highs in 2006, continuing an increasing trend that began in 2003. Blackpoll Warbler exhibited similar gains during this period, following a sharp drop in 2002. White-throated Sparrow numbers remained low for the fourth consecutive year, compared to high counts made in 2001 and 2002. For the first time since Mountain Birdwatch began, counts of White-throated Sparrow were not the highest among focal species.

During the past year, we reported Mountain Birdwatch results to a variety of audiences in order to inform responsible stewardship of sensitive mountain habitat. We made several presentations to scientists, government agencies, conservation groups, and the general public. In addition, we substantially increased the program's reporting capacity by integrating the Mountain Birdwatch database with the Avian Knowledge Network, an online data management system featuring innovative data display and analysis tools. Enhanced data management is one of many measures recently undertaken to strengthen Mountain Birdwatch. Others include development of a more robust survey design and incorporation of new field and analytical techniques. Elements of a five-year plan to increase the scientific and conservation value of Mountain Birdwatch are introduced in a program evaluation appended to this report.

BACKGROUND AND RATIONALE

Bicknell's Thrush (*Catharus bicknelli*), once considered a subspecies of Gray-cheeked Thrush (*C. minimus*), was identified as a separate species in 1995 (American Ornithologists' Union 1995). Since then, it has been recognized as one of the most vulnerable passerines in eastern North America. Partners in Flight (PIF) identified Bicknell's Thrush as the highest conservation priority among neotropical-nearctic migrants in Northern New England (Hodgman and Rosenberg 2000) and the Eastern Spruce-Hardwood Forest (Rosenberg and Hodgman 2000). The PIF continental Watch List (Rich et al. 2004) places Bicknell's Thrush in the highest priority group due to multiple causes for concern across its entire range. The International Union for the Conservation of Nature classifies the songbird as vulnerable on its list of threatened species (BirdLife International 2000).

A number of factors contribute to the vulnerability of Bicknell's Thrush, including its limited breeding range. In the United States, Bicknell's Thrush breeds in montane spruce-fir forests of New York and northern New England (Atwood et al. 1996, Lambert et al. 2005) and is often associated with recently disturbed areas characterized by vigorous regrowth (Wallace 1939, Rimmer et al. 2001). In southeastern Canada, it inhabits montane fir (Ouellet 1993), maritime spruce-fir (Erskine 1992), and regenerating mixed forest (Nixon et al. 2001). The species is similarly restricted in its wintering distribution, occurring primarily in wet, broadleaf forests of the Dominican Republic (Rimmer et al. 2001). These forests have been reduced to less than 10% of their historic extent in the last 35 years (Stattersfield et al. 1998).

Loss of the Northeast's montane spruce-fir habitat may also threaten Bicknell's Thrush. Expansion of recreation areas, cell tower construction, and wind power development have received the most regulatory attention, as each can result in highly visible forest loss. Effects of airborne pollutants on Bicknell's Thrush are unclear, but potential threats include forest decline from acid deposition (Johnson et al. 1992) and heavy metal toxicity (Gawel et al. 1996), mercury poisoning by uptake in the food chain (Rimmer et al. 2005), and egg-laying irregularities associated with calcium limitation, a possible consequence of acidified soils (Graveland et al. 1994). A study in the eastern United States suggests that acid deposition may have contributed to recent Wood Thrush declines by reducing the abundance and size of prey. The authors found that negative effects of acid rain on the predicted probability of breeding were greatest in high-elevation zones with low pH soils (Hames et al. 2002). Climate change poses another threat to the species. A warming climate is expected to cause incremental, but widespread changes in the composition and structure of mountain forests. Forest ecologists predict that balsam fir (*Abies balsamea*) will be substantially diminished, if not lost from the Northeast if atmospheric concentrations of CO_2 double, as expected within the next century (Iverson and Prasad 2002). A moderate increase in summer temperatures (3 °C) could enable upslope encroachment by temperature-limited hardwoods and reduce Bicknell's Thrush habitat by as much as 98% (Lambert and McFarland 2004).

Volunteers for the Vermont Institute of Natural Science's Forest Bird Monitoring Program surveyed 12 mountains from 1993 to 1999 in order to monitor changes in the status of Bicknell's Thrush and other high-elevation songbirds. In 2000, VINS piloted Mountain Birdwatch in Vermont on fifty additional routes, offering 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 (*Troglodytes troglodytes*). The following year, we expanded the survey region to include over one hundred new routes in New York, New Hampshire, and Maine. Mountain Birdwatch objectives are to: 1) monitor the distribution and abundance of mountain-breeding birds in northern New England and New York; 2) to describe the influence of landscape and habitat features on mountain bird distribution and abundance; and 3) to guide stewardship of high-elevation forests

Since 2000, we have assessed Mountain Birdwatch's power 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).

During the 2006 breeding season, we monitored 119 routes and gathered observations of Bicknell's Thrush from 36 additional mountains. We present 2006 Mountain Birdwatch results in the body of this report. Appendix 4 contains our evaluation of the program, which is intended to identify strengths and areas for improvement.

METHODS

Volunteer engagement

We announced the opportunity to volunteer for Mountain Birdwatch on our web site (www.vinsweb.org/cbd/mtn_birdwatch.html) and in VINS publications. Cooperating conservation organizations publicized the project through electronic and print media. The Appalachian Mountain Club hosted a workshop for all of its hut naturalists. In all, about 175 people participated in the survey in 2006, including companions of the primary route monitors. Mountain Birdwatchers received maps, survey instructions, an identification guide to high-elevation songbirds, and a training tape with an auditory identification quiz. A perfect score on the quiz was a prerequisite for participation. Repeat surveyors were encouraged to review the written and recorded material in order to maintain a high level of proficiency. The Mountain Birdwatch listserv (http://groups.yahoo.com/group/MountainBirdwatch/) and volunteer newsletters (http://www.vinsweb.org/cbd/mbwpubs.html) help inform, coordinate, and engage participants in the survey.

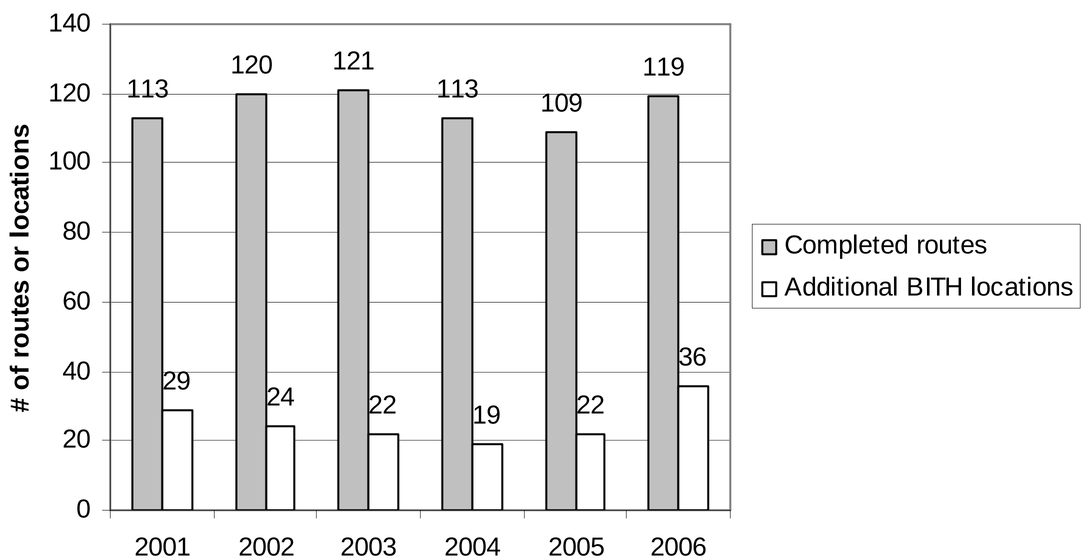
Site selection, route placement and coverage

Site selection was based on a GIS model of potential Bicknell's Thrush habitat that incorporates elevation, latitude, and forest type (Lambert et al. 2005). The model depicts conifer-dominated forests above an elevation threshold that drops 81.63 m for every one-degree increase in latitude (-81.63 m/1º latitude). The threshold's slope corresponds closely with the latitude-elevation relationship for treeline in the Appalachian Mountain chain, which is -83 m/1º latitude (Cogbill and White 1991). Four routes have been established on peaks lying below the elevation threshold, while forty routes cross the threshold due to the limited availability of trails or land area above the threshold. We made an attempt to randomize site selection by randomly assigning priority ranks to discrete units of high-elevation habitat. However, the choice of sites was constrained by the availability of volunteers and the location of existing trails.

When placing routes, we favored discrete starting points (e.g. trail junction), extensive conifer stands, and upper elevations. Volunteers establishing a route for the first time placed five points at 200- to 250-m intervals along a mapped course. Monitors submitted a detailed description of each station in order to facilitate its location in future years.

In 2006, Mountain Birdwatchers completed 119 surveys in New York (36), Vermont (46), New Hampshire (21), Maine (15), and Massachusetts (1). Observers recorded all species on approximately one-third of the routes and only the five focal species on the remainder. We gathered Bicknell's Thrush records from 36 additional mountains. The number of routes surveyed in 2006 exceeded the goal of 100 routes and was comparable to the number surveyed in previous years (Fig. 1).

Figure 1. Mountain Birdwatch survey effort 2001-2006.



Survey Methods

Surveys were conducted under acceptable weather conditions (no precipitation, temperature >2 °C, wind speed <32 km/h) from 1 to 25 June. Surveys were conducted between 04:30 and 08:00 EDT and most were completed by 06:30 EDT. Observers listened quietly for ten minutes at each of five stations.[1] They recorded the number of each focal species seen or heard during three time periods: 0-3 minutes, 3-5 minutes, and 5-10

[1] In 2003, we increased the 5-species point count length from five to ten minutes in order to gather more information and to achieve methodological consistency with the all-species protocols and with Canada's High-Elevation Landbird Program.

minutes. If Bicknell's Thrush was not detected during or between point counts, surveyors returned to each point and broadcast a one-minute recording of the bird's vocalizations, followed by a two-minute listening period.[2] We used audio playbacks to elicit responses from present, but silent birds. Audio playbacks were discontinued upon detection of one or more individuals. If no Bicknell's Thrushes responded to the broadcasts, the status of the species was classified as unknown. Monitors who completed their surveys without encountering Bicknell's Thrush were asked to conduct follow-up, audio playback surveys at dusk or dawn before 15 July (after Atwood et al. 1996). If no observations of Bicknell's Thrush were made during the second visit, the species was presumed to be absent from that site.

Data analysis: avian distribution and abundance

To include data from as many routes as possible, we subsampled records of the five focal species from the first five minutes of each ten-minute count. Where two point count series were conducted, we used results from the first survey only. We measured frequency of occurrence and relative abundance for each of the focal species. To calculate frequency of occurrence, we divided the number of routes on which a species was detected during point counts (first five minutes only) by the total number of routes surveyed. For Bicknell's Thrush, we also calculated the proportion of survey routes on which the species was detected by any means (10-minute point count, chance, playback, or follow-up).

For between-year comparisons, we calculated the average number of individuals per point on a route by route basis. This correction was necessary because close to 30% of the routes surveyed in 2001 contained fewer than five stations (mean = 2.87 stations). These routes were extended below the original elevation threshold in 2002 to meet the 5-point standard. For each focal species, we averaged per-point values across routes to produce an overall index of relative abundance for every year from 2001 to 2006. We did the same for the subset of routes that were surveyed in each of the six years (n = 31).

[2] Prior to 2003, the broadcast duration was three minutes.

RESULTS

Bicknell's Thrush was detected by five-minute counts on 56.3% of the survey routes (Table 1) and by ten-minute count on 63% of the routes. Chance observations and use of audio playbacks confirmed the species' presence on 88 of 98 routes (89.7%) that were thoroughly surveyed (point count, playback, and follow-up playback, as needed). The index of Bicknell's Thrush abundance fell from a 2005 high of 0.3 individuals per point to 0.25 individuals per point, a value corresponding to the 2001-2004 average (Figs. 2 & 3). Swainson's Thrush abundance reached the highest level recorded so far in the study. Blackpoll Warbler and Winter Wren numbers appear to have increased on the 31 routes surveyed continuously, but are similar to 2005 levels for all routes. White-throated Sparrow abundance remained low relative to a high in 2001 of more than one individual per point. Overall abundance of the five focal species showed a U-shaped pattern between 2001 and 2006 (Fig. 4).

Figure 2. Relative abundance of focal species on 31 routes surveyed each year, 2001-2006.

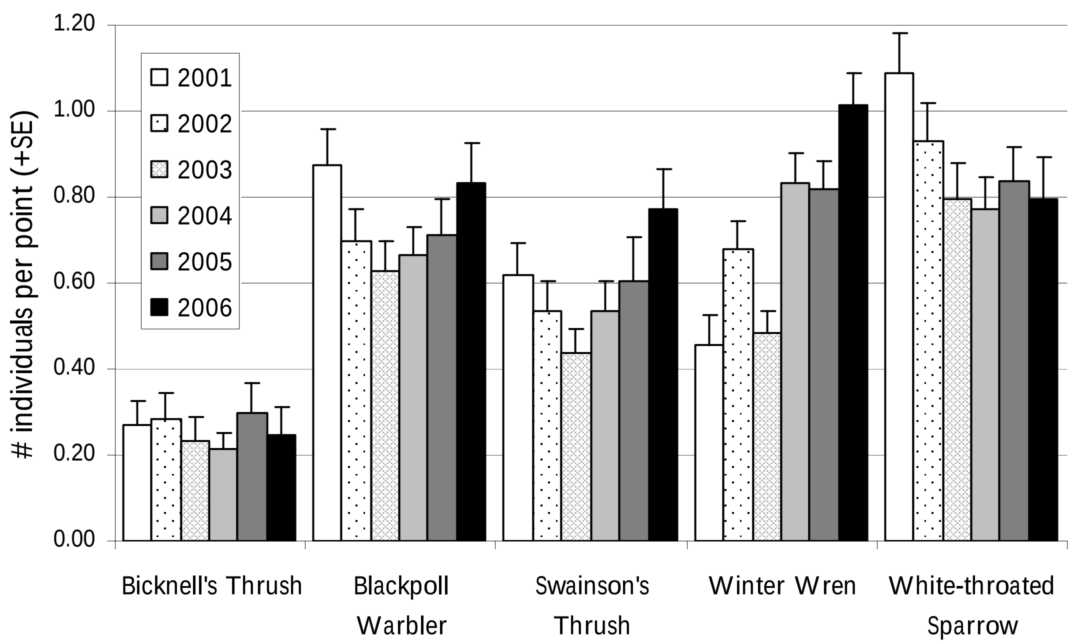


Figure 3. Relative abundance of focal species in 2001 (n = 113 survey routes), 2002 (n = 120), 2003 (n = 121), 2004 (n = 113), 2005 (n = 109), and 2006 (n=119).

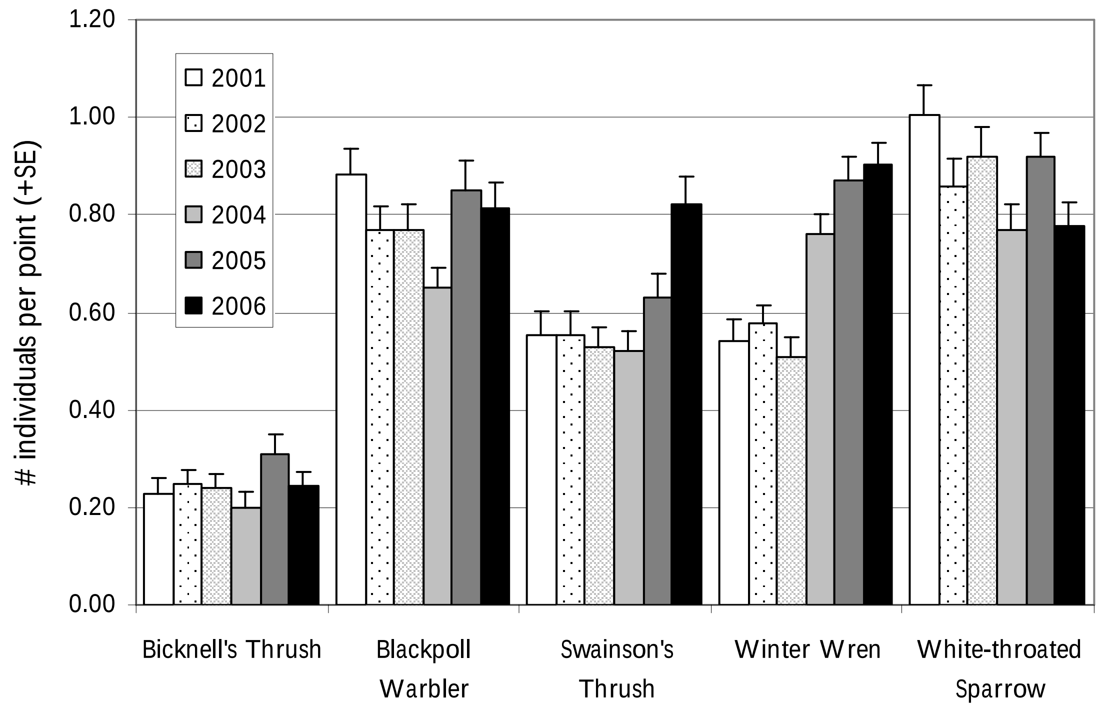
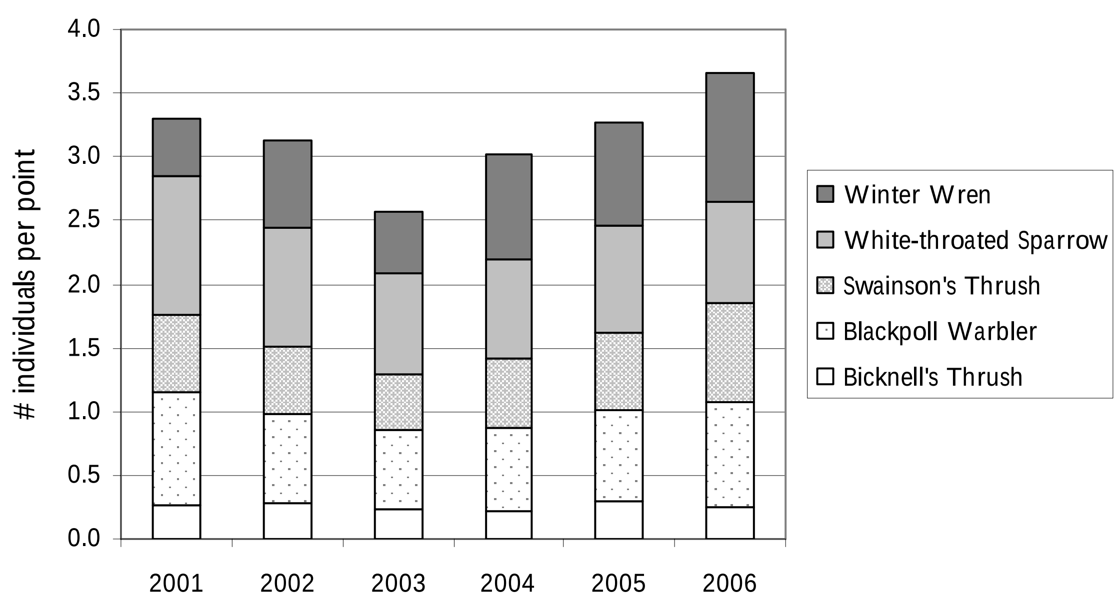


Figure 4. Relative abundance of focal species on 31 routes surveyed each year (2001-2006), based on five-minute counts.



During the six years of regional monitoring, frequency of occurrence has fluctuated by as little as 0.06 (Blackpoll Warbler) and as much as 0.29 (Winter Wren) (Table 1).

Table 1. Occurrence frequency of focal species, 2001-2006, based on five-minute point counts.

	Bicknell's Thrush		Blackpoll Warbler		Swainson's Thrush		Winter Wren		White-throated Sparrow	
Year	All routes	31 routes	All routes	31 routes	All routes	31 routes	All routes	31 routes	All routes	31 routes
2001	0.43	0.42	0.93	0.87	0.71	0.81	0.73	0.71	0.91	0.94
2002	0.51	0.45	0.88	0.87	0.76	0.81	0.91	0.97	0.93	0.97
2003	0.50	0.39	0.91	0.84	0.76	0.74	0.80	0.84	0.89	0.84
2004	0.47	0.55	0.88	0.97	0.82	0.81	0.91	0.97	0.88	0.87
2005	0.58	0.55	0.87	0.81	0.87	0.81	0.97	0.97	0.95	0.97
2006	0.56	0.52	0.87	0.87	0.87	0.84	0.94	1.00	0.95	0.97

DISCUSSION

Population Change

Bird population levels change in response to a wide variety of natural and anthropogenic factors (Askins et al. 1990). Often, data gathered over brief periods belie long-term trends (Holmes and Sherry 2001). As a result, it is difficult to interpret short-term results with accuracy. Reaching meaningful conclusions may require many years of continuous effort and a thorough assessment of factors that influence bird populations. Nonetheless, short-term changes in abundance warrant some consideration. Most notable in 2006 were increased counts of Blackpoll Warbler, Swainson's Thrush, and Winter Wren based on data from the 31 routes that have been monitored every year since 2001. For two of these species, Swainson's Thrush and Winter Wren, the counts were the highest ever recorded during the six-year period. Blackpoll Warbler abundance was the highest it has been since 2002, and reached a similar level to that detected in the first year. White-throated Sparrow counts still have not rebounded from a high in 2001. At 0.25 individuals per point, Bicknell's Thrush counts were down from the 2005 high of 0.3 individuals per point. Overall, the 2001-2006 survey results provide no evidence for consistent decline of Bicknell's Thrush in the sampled area. This finding stands in contrast to results of trend analyses conducted for Bicknell's Thrush in Atlantic Canada (2003-2006) and the White Mountain National Forest (1993-2003).

Results from the High Elevation Landbird Program (Bird Studies Canada) revealed a 7% annual decline in Bicknell's in New Brunswick and a 9% annual decline in Nova Scotia between 2003 and 2006 (Campbell et al. 2007). A short-term decline of similar magnitude was detected by Mountain Birdwatch between 2001 and 2004 (Lambert 2005). From 1993 to 2003, Bicknell's Thrush declined at a rate of 7% per year in New Hampshire's White Mountains, which lie at the core of the species' breeding range. It was one of three management indicators for montane spruce-fir habitat that declined significantly during that period. The others were Yellow-bellied Flycatcher and Magnolia Warbler (King et al. *In Review*).

The rising concern for the status of Bicknell's Thrush has spurred the organization of an International Bicknell's Thrush Technical Working Group. This group, to be led by VINS and Bird Studies Canada, will meet for the first time in November of 2007. Along with applied research and conservation, coordinated monitoring is a major focus of this group. Continuing surveys throughout the northeastern U.S. and Atlantic Canada will further illuminate the spatial and temporal characteristics of population change in this rare species.

Information Sharing

We disseminated information on mountain bird trends to several key audiences over the last year, including scientists, government agencies, conservation groups, and the general public. We reported recent results at the Maine Mountain Conference in Saddleback, ME (October 2006), the Audubon New York Fall Council Meeting in Saranac Lake, NY (October 2006), the Appalachian Trail Environmental MEGA-Transect Symposium in Shepherdstown, WV (November 2006), the first meeting Mountain Bird Working Group of the Northeast Coordinated Bird Monitoring Partnership in Quechee, VT (January 2007), and during the inaugural teleconference of the International Bicknell's Thrush Technical Working Group (May 2007). At these meetings, we reached approximately 350 prominent wildlife biologists, bird conservationists, and natural resource administrators. Mountain Birdwatch data were featured in a poster on Bicknell's Thrush population modeling at the IV North American Ornithological Conference in Veracruz, Mexico (October 2006; Frey et al. 2006). The Union of Concerned Scientists' (UCS) Northeast Climate Impact Assessment will feature Mountain Birdwatch results in a projection of climate change effects on northeastern bird populations. The scientific manuscript providing the basis for the UCS report (Rodenhouse et al. *In Press*) is scheduled for publication in *Mitigation and Adaptation Strategies of Global Change* in July of 2007. Finally, a manuscript currently in preparation will use data from Mountain Birdwatch to demonstrate a relationship between annual predation risk and occupancy of small habitat patches by Bicknell's Thrush (McFarland et al. *In Prep*).

In addition, we published popular articles highlighting mountain bird ecology in *Field Notes*, the VINS Conservation Biology Department's newsletter (circulation 4,000). We worked with the New York State Breeding Bird Atlas to provide all Bicknell's Thrush records gathered by Mountain Birdwatch from 2000 to 2005. Nearly 40% of all Bicknell's Thrush records in the atlas are attributable to Mountain Birdwatch. Since May 2006, we have responded to 14 separate requests for trend information, habitat maps, site-specific bird records, management recommendations, and/or information about mountain bird ecology. Requests were made by government agencies (local, state, and federal), conservation organizations, ski areas, and windfarm developers (Appendix 3).

Delivering useful information to land stewards remains a high priority for Mountain Birdwatch. To increase the program's reporting capacity, we integrated the Mountain Birdwatch database with the Avian Knowledge Network. This online data management system features innovative display options (tables, graphs, and maps) and powerful tools for analyzing the relationship between observational data and nearly 200 environmental variables. Enhanced data management is one of several goals of an ongoing effort to increase the scientific and conservation value of Mountain Birdwatch. Others include development of a more robust survey design and incorporation of new field and analytical techniques to measure detection rates and occupancy. Elements of a five-year plan to strengthen Mountain Birdwatch appear in Appendix 4, which discusses the program's strengths and areas for improvement.

ACKNOWLEDGMENTS

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APPENDIX 1. *Off-route observations of Bicknell's Thrush made during the 2006 breeding season. High count is presented where more than one record was received for a given location.*

State	Mountain	# of BITH
ME	Avery Peak	1
ME	Old Speck	1
ME	The Horns	1
ME	West Peak	1
NH	Cannon Mountain	1
NH	Middle Tripyramid	1
NH	Mount Flume	2
NH	Mount Jefferson	3
NH	Mount Liberty	3
NH	Mount Madison	9
NH	Mount Tom	3
NH	Mount Washington	1
NH	Mount Waumbek	1
NH	North Tripyramid	3
NH	Sandwich Mountain	3
NH	South Tripyramid	1
NY	Algonquin	1
NY	Basin Mountain	1
NY	Blackhead Mountain	3
NY	Boundary Peak	1
NY	Little Haystack	1
NY	Mount Skylight	1
VT	Bear Head	1
VT	Bickford Hollow	2
VT	Bolton Mountain	2
VT	Boyce-Battell	4
VT	Camel's Hump	1
VT	Hogback Mountain	4
VT	Jay Peak	3
VT	Madonna Peak	11
VT	Middle Mountain	1
VT	Morse Mountain	1
VT	Mount Ellen	3
VT	Unnamed by Boullard Br.	1
VT	White Rocks	2
VT	Worcester	3

APPENDIX 2. *2006 Mountain Birdwatch results summarized by route.*

State	Mountain	# of BITH	# of BLPW	# of SWTH	# of WIWR	# of WTSP
MA	Mount Greylock	0	3	1	1	3
ME	Baldpate Mountain	3	7	8	5	4
ME	Big Squaw Mountain	1	6	7	5	3
ME	Blueberry Mountain	0	7	1	1	3
ME	Cranberry Peak	0	9	4	7	5
ME	East Royce Mountain	4	5	10	4	6
ME	Little Bigelow Mountain	0	4	7	1	1
ME	Little Jackson Mountain	1	0	4	1	7
ME	Mount Abraham	1	5	2	11	10
ME	Mount Blue	0	3	1	6	4
ME	Mount Katahdin	0	8	4	5	10
ME	North Traveler Mountain	0	3	3	1	4
ME	Spaulding Mountain	3	5	9	10	5
ME	Surplus Mountain	0	4	9	7	5
ME	West Kennebago Mountain	1	2	0	0	1
ME	White Cap Mountain	5	3	5	4	4
NH	Crescent Ridge	0	0	4	5	6
NH	Dixville Peak	3	8	12	5	4
NH	Kinsman Mountain (North Peak)	2	6	6	5	4
NH	Mount Cardigan	0	5	6	6	13
NH	Mount Carrigain	3	7	13	11	5
NH	Mount Chocorua	2	6	2	4	9
NH	Mount Clay	2	5	3	6	1
NH	Mount Cube	0	12	13	7	6
NH	Mount Hale	1	7	7	3	9
NH	Mount Kearsarge	0	0	2	0	4
NH	Mount Lafayette	1	12	2	5	16
NH	Mount Moosilauke (South Peak)	1	2	2	3	4
NH	Mount Passaconaway	0	5	4	7	3
NH	Mount Pierce	1	4	6	1	5
NH	Mount Starr King	2	7	0	5	6
NH	Mount Tecumseh	1	5	7	5	3
NH	Mount Wolf	2	8	8	6	4
NH	South Twin Mountain	4	7	2	7	14
NH	Stairs Mountain	2	3	2	5	3
NH	Sugarloaf	1	1	10	1	0
NH	Wildcat Ridge	2	6	4	6	6
NY	Ampersand Mountain	4	3	4	5	6
NY	Big Crow Mountain	0	1	3	4	1

State	Mountain	# of BITH	# of BLPW	# of SWTH	# of WIWR	# of WTSP
NY	Blue Mountain	7	7	12	7	6
NY	Catamount Mountain	0	0	3	2	5
NY	Cornell Mountain	0	8	0	0	4
NY	Debar Mountain	0	2	3	6	0
NY	Esther Mountain	4	4	5	2	8
NY	Giant Mountain	3	1	5	7	7
NY	Hamilton Mountain	3	1	2	3	2
NY	Hopkins Mountain	0	2	1	2	5
NY	Hunter Mountain	6	5	5	7	1
NY	Hurricane Mountain	3	3	2	7	3
NY	Little Whiteface Mountain	0	4	3	5	7
NY	Lyon Mountain	1	6	3	4	1
NY	McKenzie Mountain	4	5	8	9	5
NY	Mount Adams	8	3	5	5	4
NY	Mount Colden	8	0	0	1	3
NY	Mount Marcy	2	0	2	4	2
NY	Noonmark Mountain	0	1	5	5	6
NY	Pillsbury Mountain	2	7	7	4	6
NY	Pitchoff Mountain	0	3	4	4	5
NY	Plateau Mountain	6	7	9	6	1
NY	Porter Mountain	3	6	13	9	13
NY	Santanoni Peak	1	7	8	4	6
NY	Slide Mountain	1	3	0	4	5
NY	Snowy Mountain	4	0	0	1	3
NY	Sugarloaf Mountain	4	4	6	1	4
NY	Sunrise Mountain	0	4	1	3	3
NY	Table Mountain	3	7	1	1	4
NY	Twin Mountain	1	9	2	4	1
NY	Vanderwhacker Mountain	0	0	7	4	3
NY	Wakely Mountain	2	4	1	5	4
NY	West Kill Mountain	4	11	0	4	1
NY	Whiteface Mountain	5	2	10	7	11
NY	Wittenberg Mountain	1	3	0	2	3
NY	Wright Peak	3	2	5	5	7
VT	Bald Mountain	1	5	5	9	5
VT	Belvidere Mountain	1	1	7	10	10
VT	Bloodroot Mountain	0	9	9	7	8
VT	Blue Ridge Mountain	0	5	1	3	3
VT	Bromley Mountain	0	2	0	9	2
VT	Brousseau Mountain	0	0	5	7	7
VT	Buchanan Mountain	0	9	10	9	4

State	Mountain	# of BITH	# of BLPW	# of SWTH	# of WIWR	# of WTSP
VT	Burke Mountain	0	3	0	7	4
VT	Burnt Rock Mountain	1	3	8	6	4
VT	Cape Lookoff Mountain	0	10	9	8	9
VT	Deerlick	0	4	12	3	1
VT	Dewey Mountain	2	8	6	8	5
VT	Domey's Dome	0	7	8	6	10
VT	East Mountain	2	3	10	7	3
VT	Gilpin Mountain	0	2	7	3	2
VT	Glastenbury Mountain	2	10	8	5	4
VT	Gore Mountain	3	3	7	10	5
VT	Haystack Mountain	0	8	5	4	3
VT	Killington Peak	4	5	1	12	1
VT	Laraway Mountain	0	8	7	6	8
VT	Molly Stark Mountain	0	6	4	7	6
VT	Monadnock Mountain	1	4	7	6	3
VT	Mount Abraham	2	7	5	3	1
VT	Mount Ascutney	0	3	3	5	12
VT	Mount Carmel	1	4	1	5	0
VT	Mount Equinox	1	5	6	8	7
VT	Mount Grant	2	5	6	6	4
VT	Mount Hunger	2	3	5	5	3
VT	Mount Ira Allen	0	7	2	11	7
VT	Mount Mansfield	11	8	5	8	8
VT	Mount Mansfield (The Forehead)	2	10	5	11	4
VT	Mount Mayo	1	1	1	3	2
VT	Mount Snow	4	14	13	7	10
VT	Mount Wilson	1	2	5	7	5
VT	North Glastenbury	2	8	8	5	7
VT	North Jay Peak	6	4	4	6	7
VT	Ricker Mountain	0	7	10	9	8
VT	Romance Mountain	0	7	6	9	6
VT	Seneca Mountain	2	6	12	7	9
VT	Shrewsbury Peak	2	6	5	8	6
VT	Spruce Mountain	0	0	2	3	2
VT	Stark Mountain	0	6	2	7	4
VT	Stratton Mountain	2	8	4	4	7
VT	Tillotson Peak	0	11	9	8	8
VT	West Ridge	0	2	6	2	7
VT	Worth Mountain	1	1	3	6	3

APPENDIX 3. Information requests fielded by Mountain Birdwatch in 2006 and 2007.

Information Requested By	Purpose of Request
Adirondack Council	Assess Bicknell's Thrush habitat and population in the Adirondacks
Audubon New York	Assess status of Bicknell's Thrush within Moose River Plains IBA
Burke, VT, town planning committee	Assess status of Bicknell's Thrush on Burke Mountain for town planning
Canadian Wildlife Service and Bird Studies Canada	Assess rangewide population status of Bicknell's Thrush
Maine Audubon	Guide wind power development in Maine
New York Natural Heritage Program	Include Bicknell's Thrush records in the New York Heritage database
New York State Dept. of Environmental Conservation	Include Bicknell's Thrush records in the New York Breeding Bird Atlas
New York State Dept. of Environmental Conservation	Review Boreal Chickadee records for New York Breeding Bird Atlas
Northwoods Stewardship Center	Assess status of Bicknell's Thrush on Hardscrabble Mountain for proposed wind farm
Private individual	Assess status of Bicknell's Thrush on Snow Mountain
State University of New York graduate student	Assessment of Mountain Birdwatch coverage in New York
University of Vermont graduate student	Model detection probability and occupancy for Vermont population of Bicknell's Thrush
Vermont Fish and Wildlife Department	Evaluate ecological significance of mountain forest tracts in the Worcester Range
Vermont Institute of Natural Science	Include mountain bird data in Vermont Breeding Bird Atlas
West Mountain Alliance	Guide wind power development in Maine

APPENDIX 4. An evaluation of Mountain Birdwatch with notes on strategies for improvement

Introduction

According to a recent assessment by the North American Bird Conservation Initiative, bird monitoring in the U.S. is hampered by widespread deficiencies in survey design, implementation, and data management. "Opportunities for Improving Avian Monitoring" called for major improvements in effectiveness, scope, utility, and efficiency following a thorough evaluation of current programs (U.S. NABCI 2007). Here, we apply evaluation criteria to Mountain Birdwatch in order to document its limitations and strengths. We also introduce measures that are being taken to enhance the program's scientific and conservation value. Evaluation criteria were drawn from an early draft of the NABCI report.

1. Existence of clearly articulated survey objectives providing a management and/or conservation context for the program.

Mountain Birdwatch was designed 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.

These objectives have appeared on the website and in slide presentations since the program's inception. Annual reports have consistently expressed these aims, though not necessarily in the ordered format.

The Mountain Bird Working Group of the Northeast Coordinated Bird Monitoring Partnership has developed a more detailed set of objectives, which guide the ongoing development of an enhanced monitoring program. The emphasis on applied outcomes is intended to increase the usefulness of Mountain Birdwatch results.

Our long-term monitoring objectives are:

- To measure changes in distribution and abundance of mountain-breeding birds with an emphasis on species in greatest need of conservation;
- To examine and describe the influence of habitat, climate, topography, mercury exposure, and calcium availability on avian distribution and abundance;
- To predict effects of climate change on future bird distribution and abundance;
- To examine whether changes in distribution and abundance are associated with changes in climate, habitat or other factors;
- To estimate population size for rare species; and
- To produce population and habitat models to guide stewardship and conservation.

This approach will generate the information necessary to assess and reduce threats to mountain birds in the eastern U.S. and Atlantic Canada. We will pilot the new program in Bird Conservation Region 14 (the Atlantic Northern Forest) during the 2009 breeding season. We will then work with central and southern Appalachian partners to replicate the program in Bird Conservation Region 28 (the Appalachian Mountains). A unique set of target species will be selected for each survey region.

2. Primary response variables are measures of abundance or population performance (i.e. demographics) serving as reliable indicators of population status and/or trends.

Mountain Birdwatch's primary response variable is an index of abundance, unadjusted for detectability. The reliability of abundance indices in estimating population trends is a matter of considerable debate. Advocates assert that the use of abundance indices is a cost-effective approach that can produce reliable trend information. They maintain that current density estimation methods violate key assumptions and fail to ensure unbiased results (Bart et al. 2004). Others believe that estimating density is essential to account for biases associated with site characteristics (e.g. habitat structure) or survey characteristics (e.g. time of season, time of day, weather, skill, experience, and hearing ability of observers) (Farnsworth et al. 2002). This can be done through the estimation of detection rates by distance-sampling, double-observer methods, and time-removal models. Multi-species surveys present a special challenge because the most suitable approach may vary among species. As field and analytical methods evolve, monitoring practitioners must apply sufficiently flexible survey techniques to adapt to emerging information. The Mountain Bird Working Group is developing point count procedures that will incorporate two or three methods of measuring detectability to transform raw counts into density estimates. We are working in conjunction with an effort by the Fish and Wildlife Service and the National Park Service to standardize land bird counting methods in the Northeast and Midwest regions.

We will also develop protocols to estimate occupancy, or the probability that a given site is occupied by the target species. This new technique addresses the problem of false negatives, or the failure to detect a species that is present. False negatives can present a significant problem in surveys of rare and cryptic birds. Occupancy models present a robust alternative to traditional approaches, producing valid results with small data sets, and providing the most direct measure of species distribution. They are thus well suited to studies of range changes induced by changing climate or land use practices. Occupancy estimates enable maximum flexibility for modeling populations and are especially useful for metapopulation studies. For some rare species, measuring changes in occupancy over time may be the most powerful way to detect a trend.

Because of logistical and financial constraints, it is not possible to monitor mountain bird demographics over a large geographic area. However, VINS conducts long-term demographic monitoring on Stratton Mountain and Mount Mansfield to complement Mountain Birdwatch. This annual study produces information on sex and age structure, productivity, and survivorship. A collaboration with the University of Vermont has recently enabled integration of regionally extensive and locally intensive monitoring results, revealing a relationship between predation risk, nesting success, and occupancy of small, isolated habitat patches by Bicknell's Thrush (McFarland et al. *In Prep*).

3. Geographic scope and spatial sampling unit are explicitly defined.

We have established Mountain Birdwatch's geographic scope as the native U.S. range of Bicknell's Thrush, including the montane spruce-fir forests of New York, Massachusetts, Vermont, New Hampshire, and Maine. This area includes the Catskill and Adirondack Mountains in New York, the Green Mountains and Northeast Highlands in Vermont, the White Mountains in New Hampshire, and the northern Appalachian summits that stretch from Coos County New Hampshire north and east through northwestern and north-central Maine.

During Mountain Birdwatch's pilot season in Vermont (2000), the sampling frame encompassed the state's 95 habitat units with > 5 ha of conifer-dominated forest above 823 m (2700 ft) in elevation. Site selection for the expanded survey, begun in 2001, was based on a preliminary GIS model of Bicknell's Thrush distribution that incorporated latitude, in addition to elevation and forest type. This model has since been updated to include nearly 50 additional vertical meters of mountain slope habitat (Lambert et al. 2005). It will serve as the basis for developing a new and more explicit sampling frame for 2009. Unlike its predecessors, the new sampling frame will be restricted to trailside habitat since the pilot approach of sampling off-trail habitat presented insurmountable challenges. The new frame may include upper reaches of the northern hardwood forest zone in order to maximize the potential for detecting upslope shifts in the avian community, projected to occur if forest composition changes in response to a warming climate. We will work with Canadian collaborators to apply consistent sampling frame criteria on both sides of the border.

4. Taxa and inferential populations are defined.

Mountain Birdwatch concentrates on five species: Bicknell's Thrush, Swainson's Thrush, Blackpoll Warbler, Winter Wren, and White-throated Sparrow. Qualified observers record all species seen and heard during point counts. The inferential populations were defined at the beginning as those inhabiting the original sampling frame (Vermont sites >823 m with > 5 ha of conifer-dominated forest). Since then, inferential populations have not been explicitly defined because the sampling frame, itself, lacked clear definition. Biases affecting point placement and route completion have also hampered the definition of inferential populations. Future analyses of data gathered during Mountain Birdwatch's first decade will need to define inferential populations narrowly (e.g. as comprising all birds of the target species occurring within the sampled area of the routes being analyzed).

Clarification of inferential populations is a main goal of the effort to strengthen Mountain Birdwatch's design. An ongoing study by Mountain Birdwatch collaborators in the White Mountain National Forest will help determine whether trails influence count results. Their investigation will shed light on the limits of inference from surveys conducted on foot paths.

5. **Availability of published survey protocols defining temporal sampling frame and measurement procedures.**

We have provided detailed descriptions of the temporal sampling frame and measurement procedures in each annual report to the Service. The main elements of the protocol also appear in a peer-reviewed manuscript (Lambert et al. 2005) and in project metadata submitted to the Avian Knowledge Network's Bird Monitoring Data Registry. In the coming months, we plan to document Mountain Birdwatch protocols for the Natural Resources Monitoring Partnership's Protocol Library. Within two years, we will publish a peer-reviewed survey design and standard operating procedures for the updated survey, observing documentation guidelines presented by Oakley et al. (2003).

6. **Survey protocols address issues of precision and bias.**

There are three main sources of bias in Mountain Birdwatch. First, routes are confined to foot paths and may not provide a representative sample of mountain habitat. Second, routes were not randomly or systematically placed within the sampling frame. They were located to: accommodate observer access (e.g. within four miles from a road); ease relocation of unmarked points (e.g. favoring distinguishable features such as trail junctions); and maximize the probability of Bicknell's Thrush encounters (e.g. with bias in favor of upper elevations). Third, the assignment of routes to volunteers was based on random priority ranks, however route completion is influenced by variance in volunteer effort. The reliance on an abundance index also introduces the potential for bias associated with differences in site characteristics and survey characteristics (refer to evaluation criterion 2, above). The modified survey design will minimize these sources of bias through a combination of design-based and model-based solutions. Data from Mountain Birdwatch and other high-elevation surveys provide the information necessary to evaluate design and analysis options. In particular, we are well equipped to analyze power and set precision targets, using simulated trend analyses that compare options for sampling frequency and intensity. Experience gained during the first decade of Mountain Birdwatch will also help us refine strategies for implementing surveys of remote, mountain-breeding populations.

7. **Consistency in geographic coverage and survey protocols ensure collecting comparable data.**

Survey protocols are consistently executed, except in rare instances when observers misunderstand written procedures. In each of these cases, and in cases where identification skills are suspect, the Mountain Birdwatch coordinator makes direct contact in order to prevent future errors. Mountain Birdwatch has been active in five states since it grew from a Vermont-wide program, piloted in 2000. Although the survey's geographic scope has consistently encompassed high-elevation forests from the Catskills of New York to the Katahdin region of Maine, coverage of individual routes has varied considerably. On average, we gather count data from 116 routes and ancillary Bicknell's records from an additional 25 sites. However, between 2001 and 2006, only 35 routes have been monitored in all years or in all but one. We have redoubled our efforts to achieve high completion rates, with an emphasis on routes that have been consistently surveyed.

8. Continuity in survey operations to allow achieving program objectives.

We have been able to sustain annual survey operations since the program began in 2000. In accordance with the project's five-year plan, we will continue annual surveys on fixed routes through 2009 and complete annual surveys on randomly located routes each year between 2009 and 2011. We believe that survey frequency should be assessed at the end of this three-year period.

9. Training programs established for survey protocols.

Observers for Mountain Birdwatch study a detailed field manual and an audio recording that were created to build observer skills. Since the program's inception, we have offered 1-3 training courses each year and have used the Mountain Birdwatch listserv as another forum for enhancing volunteer skill and knowledge. Training courses have taken place in New York, Vermont, New Hampshire, and Maine. We are currently working with the National Park Service to develop an online birder certification program that would use interactive modules to train and evaluate identification skills. In the development of the new program, we aim to incorporate a simple screening for hearing loss.

10. Survey protocols include data collection on environmental covariates to help explain population changes.

We developed a habitat sampling program in 2002 and sampled 45 routes. Funding in recent years has not been sufficient to expand on this effort. As part of the effort to strengthen Mountain Birdwach, we will examine: elevation, aspect, surficial geology, a topographical index, forest composition and structure, habitat patch size, and precipitation. Previous studies have revealed these to be significant factors underlying distribution of mountain birds. Other variables that warrant examination include: foliar calcium (which reflects available calcium, a nutrient essential for egg-laying), exposure to mercury (a neurotoxin that accumulates in mountain food webs), growing-season temperature (which influences forest zonation), and night-time low temperature (which may play a role in separating cold-tolerant, upper-slope species from less hearty mid-slope nesters). Trend analyses will incorporate these parameters, as appropriate, as well as: red squirrel abundance index (which measures predation risk), an index of cone mast (which regulates red squirrel numbers), El Nino Southern Oscillation index (which influences avian survival during winter and migration), and winter habitat availability in Hispaniola (where over 90% of the world's Bicknell's Thrushes are thought to winter). We have already begun to build a library of GIS files that can be incorporated into the modeling exercises.

11. Appropriate analytical procedures are identified or developed.

Like most active bird monitoring programs, Mountain Birdwatch was developed without due consideration for appropriate trend analysis procedures. The lack of randomization is especially problematic, precluding application of the most flexible and informative analytical techniques. Despite this problem, VINS has identified an appropriate trend analysis procedure with the assistance of Dr. John Buonaccorsi, a University of Massachusetts statistician who specializes in analysis of time-series data. This technique uses non-linear regression on aggregate counts (with LOESS fit) to quantify changes in abundance. Unfortunately, this approach requires a complete data set with no missing values (e.g. no missing points or years for those routes entered into the analysis). Although a core set of routes has been surveyed in every year, severe mountain weather has hampered the completion of annual surveys on most routes. After the first decade of monitoring is complete, we plan to analyze two subsets of the data, one representing those routes monitored in every year (maximizing temporal coverage) and one representing more routes, but with some number of years excluded from the analysis (maximizing geographic coverage). In both cases, the area of inference will be limited to the forests that border these fixed routes.

Mountain Birdwatch data have been well suited for the development of habitat and population models. We used observations from the survey to generate a GIS model of Bicknell's Thrush distribution. The publication describing the model received The Wilson Ornithological Society's Edwards Prize for best major scientific article in 2005. Collaborators have used our records to model Bicknell's Thrush occurrence in New York and to model the relationship between cone mast, red squirrel abundance, and occupancy of small habitat patches by Bicknell's Thrush.

12. Program reports and summaries are routinely published and accessible.

Mountain Birdwatch has published volunteer newsletters and annual reports each year since 2000. They are available online, together with technical reports and peer-reviewed publications that incorporate project data.

13. Data are stored in accessible data repositories.

Mountain Birdwatch data (2001-2004) are available in spreadsheet form and also in an interactive map at the Mountain Birdwatch website. Downloadable maps and associated GIS files are also served to the public online. Mountain Birdwatch data (2000-2006) have recently been uploaded to the Avian Knowledge Network, permitting online query and analysis of nearly 18,000 bird records. To view these data, log on to the Avian Knowledge Network data download page (http://aknapp.ornith.cornell.edu/akn/akn?cmd=start) and submit a query for the target species (e.g. *Catharus bicknelli*).

14. Roles and responsibilities are clearly defined.

Cooperative agreements between VINS and funding institutions have provided clear definition of primary roles and responsibilities. The formation of the Mountain Bird Working Group and its three subcommittees (Design, Implementation, and Fundraising) has added additional structure to this collaborative enterprise.

VINS Research Associate Dan Lambert directs Mountain Birdwatch, overseeing program improvements, scientific publications, and fundraising. He is assisted by Mountain Birdwatch Coordinator, Julie Hart, who recruits, trains, and supports volunteers. Julie also manages Mountain Birdwatch's database and GIS files. Cooperating agencies, such as USFWS, the US Forest Service (USFS), the National Park Service (NPS), the Canadian Wildlife Service (CWS) and Bird Studies Canada (BSC), provide technical assistance on matters of survey design, implementation, and analysis. University researchers also help address design and analysis problems. Several conservation organizations, such as the Adirondack Mountain Club, the Green Mountain Club, the Appalachian Mountain Club, the Appalachian Trail Conservancy, and Audubon New York, host outreach and training events and raise the project's profile through their membership publications. State and federal agencies and private landowners use Mountain Birdwatch data to develop management plans, review permits, and plan the siting of high-elevation development projects.

A January 2007 meeting of the Mountain Bird Working Group generated the following action items, organized by committee.

Design Committee
Dan Lambert (chair), Yves Aubry (CWS), John Buonaccorsi (University of Massachusetts), Therese Donovan (University of Vermont), Bill DeLuca (UMass), Brian Mitchell (NPS)

- Define goals, deliverables, responsible parties, and timeline
- Evaluate trend analysis options
- Recommend precision target(s) for trend estimation based on confidence intervals
- Assess power of leading alternative(s) at varying levels of sampling frequency and intensity
- Determine whether a Generalized Random Tessellation Survey Design can be applied to a trail-based forest bird survey
- Define how sample units will be selected; if a stratified random approach is to be applied, develop factors entered into stratification
- Develop standards for delineating Canadian sample frame
- From Aubry and DeLuca data, summarize information on how count length, density, time of survey (dusk/dawn), and use of playbacks affect detectability of Bicknell's Thrush
- Determine which approach to building a standard occupancy model best suits the project: spatial replication (treating each point as a replicate sampling occasion), temporal replication by serial counts (conducting three fresh counts at each point in direct succession), or temporal replication by repeated surveys (e.g. 3 or 4 separate sampling occasions in single visit)
- Recommend count length and number of sampling occasions for occupancy estimation; consider need to maintain continuity with legacy data sets that have used 3-min & 2-min or 3-, 2- & 5-min intervals
- Develop a list of questions for consultation with biometricians at October Northeast Coordinated Bird Monitoring Workshop
- Use the survey design and implementation worksheet to recommend a unified approach
- Lead effort to publish survey design

Implementation Committee
Julie Hart (chair), Leighlan Prout (USFS), Dave King (UMass), Becky Whittam (BSC)

- Define goals, deliverables, responsible parties, and timeline

- Invite High Elevation Landbird Program representative to join implementation committee
- Seek input from Ted Simons on observer capabilities and optimal number of target species
- Recommend and provide justification for final list of target species
- Evaluate capacity of two sample frame alternatives (current Bicknell's elevation mask and current mask minus 50 m) to capture balance of hardwood associates and Bicknell's Thrush
- Develop, pilot, and evaluate (as appropriate) standard operating procedures for route documentation, field methods (birds and covariates), and data management
- Gather and catalog existing data sources that may prove useful in modeling exercises (Forest Inventory and Analysis, LANDSAT imagery, mercury and acid deposition models, calcium availability model, climate, elevation, topography, etc.)
- Include temporal parameters that account for survey-wide differences in phenology and sunrise
- Analyze Mountain Birdwatch data for time-of-day and time-of-count effects on Bicknell's Thrush detection frequency; report results to design committee
- Incorporate practical point count recording methods that will enable estimation of detection rates through temporal removal model and standard occupancy model, while maintaining consistency with historic 3-min and 5-min point count data sets; provide clear guidance on how to track bird movements during count
- Produce, pilot, and revise data forms and observer manual
- Build and seek feedback on a coordinated database; negotiate relationship with Avian Knowledge Network
- Produce GIS and map products (sample frame, trails layer, layer depicting all possible stations, layer of stations to be sampled, route maps)
- Identify overlap between sample stations and historically surveyed sites; propose decision rules to resolve differences
- Prepare project metadata for the Natural Resources Monitoring Partnership's Monitoring Locator and Protocol Library (USGS National Biological Information Infrastructure)
- Use survey design and coordination worksheet pages to report options and recommendations
- Work with design committee on publication of survey design for peer review

Funding Committee
Dan Lambert (chair), Randy Dettmers (USFWS), Joe Racette (New York State Department of Environmental Conservation)

- Gather goals, deliverables, responsible parties, and timeline information from design and implementation committees
- Develop 3-5 year funding strategy
- Develop proposal template and budget
- Solicit comments on proposal and seek opportunities to engage partners and identify new funding sources

- Submit funding proposals as opportunities arise

Summary

Although its current design is not suited to estimating detectability or occupancy, Mountain Birdwatch has substantially improved our understanding of mountain bird communities in the Northeast. The program has: described the influence of landscape structure on high-elevation bird populations (Lambert et al. 2002); identified key management units and conservation opportunities (Lambert 2003); produced and validated a GIS distribution model for Bicknell's Thrush (Lambert et al. 2005); enabled projection of climate change impacts on montane spruce-fir habitat (Lambert and McFarland 2004, Rodenhouse et al. *In Press*); and measured short-term population changes for five species of songbird (Lambert 2005).

Continuing fixed-route surveys through the next three years (2007-2009) will yield a decade-long northeastern mountain bird dataset, with over 20,000 georeferenced bird records. Integration of these data into the Avian Knowledge Network will provide extensive opportunities for data display and exploratory analysis. For trend analysis, we will use nonlinear regression on aggregate counts to estimate population change at a variety of spatial scales, from the route level to the region.

During the transition to a more robust survey, we will seek opportunities to maintain continuity with legacy data sets. We will also sustain monitoring activity at certain Mountain Birdwatch sites that fall outside the new random design in order to meet previously identified information needs and/or capitalize on the commitment of long-time observers. Such determinations will be made on a case by case basis.

Planning for an improved survey is on schedule for launch in 2009. Advances in statistical design and field methodology will enable: stronger inferences in trend estimation; GIS occupancy models that measure the significance of habitat and climatic variables; projections of future mountain bird distribution under different climate change scenarios; and a regional risk assessment for mountaintop wind farms. Additional details of our five-year plan are available upon request.

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