Investigations of Bicknell's Thrush (*Catharus bicknelli*) in the Northeastern United States

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The Bicknell's Thrush, recognized as a subspecies of the Gray-cheeked Thrush since its discovery in 1881 on Slide Mountain in the Catskills of New York, has recently been given full species status (AOU 1995). Significant differences between the two taxa in morphology, vocalizations, genetics, and breeding and wintering distributions contributed to this designation (Ouellet 1993). With this classification Bicknell's Thrush has become recognized as one of the most at-risk passerine species in the eastern United States. Rosenberg and Wells (1995) ranked Bicknell's Thrush as number one on a conservation priority list of Neotropical migrant birds in the Northeast. The species has been proposed for "threatened" status in Canada (Nixon 1995).

The breeding range of Bicknell's Thrush in the United States is limited to subalpine spruce-fir forests of New England and New York (Atwood et al. 1996). In Canada it is found in highland spruce-fir forests in Quebec, Nova Scotia and New Brunswick (Erskine 1992, Ouellet 1993, Gauthier and Aubry 1995). It has also been found in mixed second-growth forest following clear cutting or burning in Quebec (Ouellet 1993) and New Brunswick (Nixon 1996). As the only breeding songbird endemic to high altitude and maritime spruce-fir forests of the northeastern United States and adjacent Canada, Bicknell's Thrush qualifies as a potentially valuable indicator of the health of subalpine avian populations and their associated forest habitat. Surveys aimed at clarifying the distribution and population status of Bicknell's Thrush in the Northeast were conducted from 1992-95 (Atwood et al. 1996, Rimmer et al. 1996) and are in progress in New Brunswick, Canada (Nixon 1996).

Many important questions about the ecology and stability of Bicknell's Thrush breeding populations require intensive monitoring of discrete habitat units and studies of known-identity individuals. Baseline data on population densities, territory size, movements, productivity, site fidelity, survivorship, and habitat use are needed to evaluate the conservation status of the species across its fragmented, high elevation breeding range. Studies conducted since 1992 on Vermont's Mt. Mansfield, the site of a large, dense breeding population, have established a solid foundation for future long and short-term research.

In 1996 research was expanded on Mt. Mansfield and on other peaks in the Northeast, using a variety of methods (Table 1). Primary research objectives in 1996 were: 1) to uniquely color-band all known breeding pairs of Bicknell's Thrushes on 5 Mt. Mansfield study plots for demographic investigations ; 2) to obtain estimates of population density on 4 Mt. Mansfield study plots, and single plots on Belvidere Mtn. in n. Vermont, Equinox Mtn. s. Vermont, and Plateau Mtn. in the Catskills by spot-mapping and tracking movements of known identity individuals; 3) to examine site fidelity, territorial turnover, survivorship, and population stability on 3 established plots by searching for previously color-banded thrushes; 4) to obtain productivity data by locating and monitoring nests on Mt. Mansfield study plots, and through combined mist-netting and observations of banded family groups; and 5) to establish point count stations on additional peaks and to complete censuses on as many of these sites as possible.

Research on the population ecology of Bicknell's Thrush *(Catharus bicknelli)* was continued on Mt. Mansfield and several other northeastern U.S. peaks in 1996. Our methods included the following (Table 1):

Table 1. Locations and summary descriptions of Bicknell's Thrush study areas in the northeastern United States.

Location	USGS 7.5 Quad	Study Plot ID	Elevation (m)	Plot Size (Ha)	Impacts [a] on/near Study Plot	Study [b] Methods	Study Years
Mt. Mansfield, VT	Mansfield	MANS	1,160 - 1,190	8.8	1,3,4	1,2,3,4,5,6	91-96
Mt. Mansfield, VT	Mansfield	RABR	914 - 1,070	20	3	1,2,3,4,5,6	95-96
Mt. Mansfield, VT	Mansfield	NDPO	885 - 1,070	20	2,3	2,3,4,5,6	95-96
Mt. Mansfield, VT	Mansfield	OCTA	1,070 - 1,130	6	1,2,3,4	3,4	92-96
Belvidere Mtn., VT	Hazens Notch	BELV	960 - 1,000	16.5	3	1,2,3,4,5,6	94-96
Mt. Equinox, VT	Manchester	EQUI	1,100 - 1,160	13.5	3,4	1,2,3,4,5,6	95-96
Plateau Mtn., NY	Hunter	PLAT	1,130 - 1,175	12.2	3	1,2,3,4,5,6	95-96
Burke, VT	Burke	BURK	915 - 985		1,2,3,4	1,4,6	94-96
Okemo Mtn., VT	Mt. Holly	OKEM	945 - 1,020		1,2,3,4	1,4,6	94-95
Haystack, VT	Wilmington	HAYS	930 - 1,040		3	1,4,6	94-96
Mt. Hunger, VT	Stowe	HUNG	1,005 - 1,080		3	1,6	95
Camel's Hump, VT	Huntington	CAME	1,130 - 1,230		3	1,6	91-96
Mt. Kearsarge, NH	Warner	KEAR	825 - 895		3,4	1,6	94-95
Whiteface, Mtn., NY	Lake Placid	WHIT	1,250 - 1,330		1,3	1,6	95

[a] 1-road(s), 2-ski area, 3-foot trails, 4-communications equipment/buildings.

[b] 1-point counts, 2-spot mapping, 3-nest monitoring, 4-color banding, 5-constant effort mist netting, 6-habitat monitoring. Not all methods used during all years of study on each site.

Spot mapping. Mapping was conducted from 1992-96 on the MANS plot, from 1995-96 on the RABR and NDPO plots and in 1996 on FORE, EQUI, PLAT and BELV plots (Table 1). For each bird seen or heard a compass bearing and distance estimate were recorded from marked vantage points (MANS) or following a 25m grid system marked with blue survey flagging and metal tree tags (all others). Data were plotted on a base map of each study area. Simultaneous registration of two or more vocalizing birds was used as the primary means of discriminating between adjacent territories (Robbins 1970). Sightings and captures of color banded birds were mapped in an attempt to match each territory with a known identity bird.

Surveys were conducted on at least 8 different dates on each plot every year (Table 1). We calculated the number of territories on each study plot using the international spot mapping standards (Robbins 1970), where each territory that is at least 50% within the plot boundaries is counted as a full territory on the plot.

Color Banding. On 6 study plots (Table 1) we used strategically placed mist nets in combination with tape recorded playbacks of Bicknell's Thrush vocalizations and a life-like wooden decoy to attempt to capture and color band all known Bicknell's Thrushes. Up to 10 mist nets were used simultaneously to passively capture thrushes as a complement to the use of vocal and visual lures. This facilitated the capture of

females, which are not readily lured into nets. Detailed mensural (e.g., wing chord, weight, tarsus, culmen) and body condition (e.g., subcutaneous fat, molt, feather wear) data were recorded for all captured birds. Age and sex were determined using skull ossification, presence of terminal buffy shaft streak or spot on any greater coverts, outer retrice shape, cloacal protuburance and brood patch (Pyle et al. 1987, Collier and Wallace 1989). Capture locations were marked on study plot base maps. On plots where spot mapping was conducted we attempted to identify the color banded adults on each known territory. Concerted efforts were made to locate color banded birds throughout the season.

Nest Monitoring. From early June through mid-July in 1992-1996, 5 Mt. Mansfield study plots were searched to locate active and recently used nests. Nest were located through systematic searches, parental behavior and spot mapping data patterns. Each nest location was marked on a study plot base map. The chronology and success of all active nests were monitored every 2 to 4 days. Nestlings were banded at approximately seven days age. Nest monitoring was conducted according to guidelines established by the Breeding Biology Research and Monitoring Database Program (BBIRD) (Martin and Geupel 1993, Martin and Conway 1994). Nests that fledged at least one young were considered successful.

After termination of nesting activity, data on nest-site characteristics were collected in accordance with BBIRD protocols (Martin and Conway 1994). Nest height and nest tree height were measured with meter tape or clinometer. Nest distance from main stem and outer foliage were measured with centimeter tape from outer edge of nest. Orientation of nest in relation to main stem was recorded in 90° quadrants. Nest concealment was indexed by estimating percent foliage cover in a 25 cm circle centered on the nest from a distance of 1m from above and from the side in each cardinal directions.

Habitat characteristics were measured within a 5m radius circle around each nest, Bicknell's Thrush non-use sites (BTNU), and other species non-use sites (OSNU). BTNU and OSNU sites were selected by measuring at least 35m away from nest on same elevation and selecting a site that appears to most represent the nest site. OSNU sites represent a more complete coverage of the range of habitat sites available because other species choose different micro-habitat types. Shrub stem densities were counted for each species. Shrubs were defined as woody plants > 0.5 m high with a diameter at 10 cm high < 8 cm and placed into two classes, < 2.5cm diameter and > 2.5cm diameter for each species. Ocular estimates for ground coverage included: total green cover, moss, leaf litter, bare ground, water, grasses and sedges, shrubs (woody stems under 50cm height), ferns, all forbs, and downed logs > 12 cm diameter. Canopy density > 5m high and total was determined using a convex densiometer held waist high. Readings are taken at the center of the plot in four cardinal directions. An average of the four readings was used for analysis. Litter depth was measured at six sites east to west and six sites north to south across the plot with a centimeter ruler. Average depth was used for analysis.

Within an 11.3m radius circle tree densities were counted. Trees were defined as woody stems > 8cm DBH and were placed in three classes: >8-23, >23-38, and >38 cm. Snags were defined as standing dead trees and were placed into two DBH classes: >12 cm - 23 cm and > 23 cm. Average tree canopy height was measured by choosing an average tree and calculating height with a clinometer.

Univariate comparisons were made between Bicknell's Thrush nest sites (n=21) and non-use sites (similar habitat ± 35 m from nest site), nest sites and random non-use sites (non-use sites of all other species) and Bicknell's nest sites and Swainson's nest sites using SYSTAT 5.0 (Wilkinson 1993). Ocular estimate variables (i.e., ground cover parameters) were placed in 5 classes (Table 5) (Barbour et al. 1987). These indices were compared with a Mann-Whitney test. All other comparisons were made with two-sample t-tests. When data failed to meet the equal variances assumption separate variances t test was used

to adjust the degrees of freedom to account for unequal variances (Wilkinson 1993). We pooled data from all Bicknell's Thrush nests found on Mt. Mansfield from 1992-96 due to small sample sizes (n=21). Sample sizes were small because of the difficulty in locating nests in the extremely dense habitat. We were unable to compare successful nest sites and unsuccessful sites due to this small sample size. At least 20 nests are needed to give a reliable estimate of nest success (Hensler and Nichols 1981). Nearly all nests were found after the onset of incubation, so nest success and mortality were calculated using the Mayfield method (Mayfield 1961, 1975) as modified by Johnson (1979) and Hensler and Nichols (1981). Half the number of days between the final visit and the depredation event or assumed fledging was added to the number of previous days the nest survived to arrive at the total number of days the nest survived while under observation. Initiation date is the day on which the first egg was laid. To calculate this date we assumed laying intervals of one day for each egg, an incubation period of 13 days and nestling periods of 11 days (Wallace 1939, Rimmer and McFarland, unpub. data). The small sample size should be kept in perspective when reviewing results.

The following results and discussion are presented in a preliminary fashion. Data collection and analysis are continuing. A full progress report will be available in Fall 1997 and will include 1997 breeding season data.

On Mt. Mansfield, spot mapping of territorial males on MANS and FORE ridgeline study plots yielded density estimates of 45.5 pairs/40 ha and 20 pairs/40 ha respectively, while estimates of 22 and 10 pairs /40 ha were obtained from two plots at lower elevations (Ranch Brook and Nose Dive Pod respectively). Other peaks generally had lower densities (EQUI = 6 pairs/40 ha, BELV = 14.5 pairs/40 ha, PLAT = 19.7 pairs/40 ha). Differences in densities could be related to habitat suitability and availability. However, this requires further habitat data analysis. Since 1992 several point count stations have been completed each year throughout the Northeast and more have been added each year. This monitoring methodology requires many years of data and will be analyzed in the future. Spot mapping data and point count data are being analyzed with statistical power analysis software to determine the number of years necessary to detected significant levels of change in population trends.

Efforts to capture and band thrushes on Mt. Mansfield resulted in a total of 231 birds being uniquely color-banded in 1992-96 (Table 2). Band returns of adults indicated high survivorship and site fidelity on most plots. Two juveniles banded on Mt. Mansfield in 1992-95 were recaptured in 1996. One originally banded in 1994 was recaptured on the OCTA plot and the other banded in 1995 was recaptured near the same site. Survivorship estimates based on capture-recapture data is being analyzed using SURGE software (Cooch et al. 1996).

Despite many hours of observations and systematic searches we found only 21 active or recently active nests in 1992-96 (9 MANS, 4 OCTA, 5 RABR, 1 NDPO, 2 FORE). Of these 21 nests: 9 were successful (fledging at least one), 4 were depredated, 3 failed due to nest abandonment, 1 failed due to unknown circumstances, 2 failed due to severe weather, and 2 were of unknown status because they were never occupied during observation. It remains unclear why three MANS nests were abandoned. Of the 18 active (status known) nests that we monitored, 8 fledged young (44.4%). We calculated the Mayfield predicted nest success as 26% (Table 3). Wallace (1939) reported that only 4 of 15 nests (26.7%) monitored during his study on Mt. Mansfield fledged young. One nest with eggs was abandoned and the remaining 10 were depredated.

Table 2. Number of individual Bicknell's Thrush captured each year (presented by age[a] and sex[b]).

	AGE:	1			1 Total	2	2 Total	4	4 Total	5			5 Total	6			6 Total	Grand Total
	SEX:	0	4	5		0		0		0	4	5		0	4	5		
LOC	YEAR																	
FORE	1996	0	1	1	2	1	1	4	4	0	0	0	0	0	5	2	7	14
	Total	0	1	1	2	1	1	4	4	0	0	0	0	0	5	2	7	14
MANS	1992	0	3	2	5	0	0	2	2	0	0	1	1	0	0	0	0	8
	1993	0	11	4	15	2	2	0	0	0	1	0	1	0	2	1	3	21
	1994	1	4	2	7	11	11	0	0	0	0	0	0	0	7	3	10	28
	1995	2	4	3	9	8	8	2	2	1	3	3	7	0	8	2	10	36
	1996	1	0	0	1	24	24	0	0	2	4	0	6	1	5	6	12	43
	Total	4	22	11	37	45	45	4	4	3	8	4	15	1	22	12	35	136
NDPO	1995	0	1	0	1	0	0	0	0	0	1	1	2	0	0	0	0	3
	1996	0	0	0	0	0	0	4	4	0	2	0	2	0	2	1	3	9
	Total	0	1	0	1	0	0	4	4	0	3	1	4	0	2	1	3	12
OCTA	1992	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3
	1993	0	3	2	5	0	0	0	0	0	0	0	0	0	0	0	0	5
	1994	0	2	0	2	1	1	0	0	0	1	0	1	0	1	1	2	6
	1995	0	1	2	3	0	0	0	0	0	0	0	0	0	2	0	2	5
	1996	1	1	1	3	1	1	4	4	0	1	0	1	1	2	1	4	13
	Total	1	10	5	16	2	2	4	4	0	2	0	2	1	5	2	8	32
RABR	1995	0	0	0	0	0	0	3	3	1	3	0	4	0	4	2	6	13
	1996	0	0	2	2	2	2	5	5	0	6	3	9	0	4	2	6	24
	Total	0	0	2	2	2	2	8	8	1	9	3	13	0	8	4	12	37
Grand Total		5	34	19	58	50	50	24	24	4	22	8	34	2	42	21	65	231

[a] Age codes: 1-after hatch year, 2-hatch year, 4- nestling, 5- second year adult, 6- older than second year.
[b] Sex codes: 0- unknown, 4- male, 5- female.

Table 3. Numbers of successful and unsuccessful nests and nesting success based on numbers of Bicknell's Thrush nests monitored on Mt. Mansfield, Vermont, 1992-96. Number of days those nests were observed to survive, daily mortalities (Standard Error) and predicted nest success calculated from the Mayfield method.

No. successful/ unsuccessful [a]	% Nests successful	Days observed	Daily mortality (SE)[b]	Predicted nest success (%) [c]
8/10	44.4	164.5	0.049 (0.017)	26.0

a Nests in following groups not included: 1- status unknown/occupied but fate unknown (n=1), 2- status unknown/nest not occupied but built in current year (n=2).
b Standard error as calculated under the methods of Hensler and Nichols (1981).
c Based on a 27 day average exposure period for each nest (Wallace 1938, Rimmer and McFarland, unpub. data).

Clutch sizes ranged from 3-4 eggs (n = 18 nests, x = 3.6, SD = 0.5). Wallace (1939) recorded the same clutch size range (n = 13 nests, x = 3.46, SD = 0.56). Initiation dates ranged from 7 June to 12 July (n = 18 nests, x = 17 June, SD = 9.4 days). The latest date represents a probable second attempt by a pair that failed during the egg laying period. Wallace (1939) reported clutch initiation dates from 9 June to 10

July (n = 11 nests, x = 18 June, SD = 8.9 days). His latest nest also represented a second attempt. It is unclear how he calculated these initiation dates.

Twelve of 18 nest trees were balsam fir (*Abies balsamea*), 2 nests were located in a red spruce (*Picea rubens*), and one was situated in the junction of a balsam fir leaning on a white birch (*Betula papyrifera* var. *cordifolia*). Wallace (1939) found 7 nests in balsam fir, 5 in red spruce and 1 in a white birch. Nests were invariably found in a live portion of the tree and in healthy trees, except in one case where a nest tree's top quarter was gnarled and dead. Nest trees were small (1.8-7.2 m tall and 1 - 19.1 cm DBH), and nests were located between 1 and 4.3 m above ground (Table 4). Wallace (1939) found nests to be 0.9 - 3.7 m above the ground (Table 4). Nests were most often on the east to south quadrant of the nest tree ($n = 21$, $x^2 = 11.105$, $P < 0.025$).

Table 4. Bicknell's Thrush nest placement and concealment (n = 21) on Mt. Mansfield, Vermont. Nest heights for this study and Wallace (1939) compared. Wallace did not record other pertinent measurements for comparison.

Parameter	Range	Mean	± SD
Nest height (m)	1 - 4.3	1.79	0.82
Nest height (Wallace 1939)	0.9 - 3.7	2.1	0.87
Nest plant height (m)	1.5 - 7.2	3.08	1.54
Nest plant DBH (cm)	1 - 19.1	5.32	4.25
Concealment:			
west side	0 - 100	68.2	27
east side	5-100	68.1	25.5
south side	10 - 100	71.4	27.8
north side	5 - 100	59.8	29.3
above	50 - 100	85.3	16.9
No. of nest support branches	1 - 5	2.8	1.0
Diameter. of nest support branches (cm)	0.3 - 2.5	1	0.5
Nest distance from main stem (cm)	0 - 190	19.1	48.5
Nest distance from outer foliage of plant (cm)	0 - 110	49.6	29.6

Despite our small sample size (n = 21) of nests, we conducted a preliminary analysis of vegetation at nest sites versus non-use sites to examine possible selection features by Bicknell's Thrush. We suspected a priori that nest site selection was based primarily on woody stem density, as nest sites seemed to be characterized by high densities of balsam fir trees. We compared vegetation surrounding Bicknell's Thrush (BITH) nest sites (n = 21) with non-use sites (BTNU) (n = 21), Bicknell's Thrush nest sites with other species non-use sites (OSNU) (n=65), and Bicknell's Thrush nest sites with Swainson's Thrush (SWTH) nest sites (n=9). We found no statistical differences between BITH nest sites and BTNU sites.

Bicknell's Thrush nest sites were distinctly different than OSNU sites (Table 5). BITH nest sites had significantly higher densities of shrub stems, (particularly balsam fir, white birch and dead stems), small white birch tree stems as well as lower densities of medium class (DBH >23-38 cm) trees (particularly balsam fir and white birch). Nest sites had higher shrub and downed log cover while OSNU sites had higher fern and grass/sedge cover. The average top canopy height and high (>5m) canopy cover was considerably lower around thrush nests. Bicknell's Thrush and Swainson's Thrush nest sites were located in different microhabitats (Table 6). BITH nest sites contained significantly higher densities of small shrub stems (especially balsam fir and white birch), large shrub stems (especially balsam fir), and standing dead trees. SWTH nest sites had higher fern and grass/sedge cover. Average top canopy height and high (>5m) canopy cover were significantly lower over BITH nest sites.

Possible nest predators of adults or nests observed from 1992-1996 on Mt. Mansfield included: Blue Jay, Northern Raven, *Accipiter* species, red squirrel *(Tamiasciurus hudsonicus)*, eastern chipmunk (*Tamias striatus*; observed only on RABR and NDPO), raccoon *(Procyon lotor)*, and long-tailed weasel *(Mustela frenata)*. Wallace (1939) reported that red squirrels and a Blue Jay preyed on Bicknell's Thrush nests on Mt. Mansfield. We strongly suspect red squirrels to be the major nest predator. We began to map red squirrel territories in 1995 to obtain yearly population indices and found 10 squirrel territories on RABR and 5 territories on NDPO. In 1996 we found none on RABR and 3 territories on NDPO. We believe that extremely high cone production in 1994 may have resulted in high numbers of red squirrels on Mt. Mansfield in 1995. Lower numbers of Red Squirrels in 1996 may reflect the poor cone crop noted in 1995. Future indices of red squirrel populations and their correlation with annual nest predation rates may reveal the influence of this species on Bicknell's Thrush and other bird species productivity.

Table 5. Comparison of microhabitat variables at Bicknell's Thrush nest sites with other species non-use sites on Mt. Mansfield Vermont, 1992-96. Coverage indices were compared with a Mann-Whitney U-test; all other comparisons made with a two-sample *t*-test.

Parameter	Nest Site				Random Site				P
	n	mean	SD	range	n	mean	SD	range	
5m radius woody stem density < 2.5 cm diameter at 10 cm height:									
Dead	21	4.76		0-23	65	1.12	2.69		
	21	44.81							
		0.14							
			11.99						
	21	0.71							
	21	0.67							
Mt. Maple	21								
Mt. Holly	21								
Hobblebush	21				65	0.63	4.26	0.34	
Pin Cherry					65	0.15	1.24	0-10	
Total Small Stems	21	80.05				38.29	22.24	9-108	
cm diameter at 10 cm heig									
Dead	21	5.24	6.34	0-29	65	1.98	2.58	0-10	0.03
Balsam Fir		52.33	33.23						
Red Spruce			0.86						
White Birch	21	11.33							
Mt. Ash	21	1.38	2.09	0-7	65	2.32	4.66	0-25	
Mt. Shadbush	21	0.67	3.06	0-14	65	0.03	0.25	0-2	
Mt. Maple	21	0.33	1.53	0-7	65	0.17	0.12	0-6	
Mt. Holly	21	0.86	3.28	0-15	65	0.14	0.63	0-3	
Pin Cherry	21	0	0	0	65	0.12	0.76	0-6	
Elderberry	21	0.1	0.44		65	0	0	0	
Black Spruce	21	0				0.02	0.12	0-1	
Total Large Stems	21	64.62	46.06		65	38.74	32.74		
Total Stems (small + large)	21	144.67	91.43		65	77.03	44.1	14-199	0.003
11.3m radius tree density >8-23 cm DBH:									
Balsam Fir	21			2-89	65	21.3	13.3		
Red Spruce	21	0.57	1.21	0-5	65	0.9	1.7	0-11	
White Birch	21	1.29	2.08	0-6	65	4.94	6.69	0-36	<0.001
Mt. Ash	21	0.48	1.12	0-4	65	0.4	0.8	0-4	
		0	0	0	65	0.03	0.17	0-1	
					65	27.54	14.05	0-75	
	21	10.48		1-26	65		6.5	0-24	
DBH:									
Balsam Fir	21	1.14	1.42				2	0-8	0.04
Red Spruce	21	0.05	0.22						
White Birch		0.14	0.48	0-2	65	0.8			
Mt. Ash				0	65	0.02			
Total Medium Trees	21			0-5	65	2.92	2.42	0-11	0.001
Dead (> 23 cm DBH)	21					2.1	2.1	0-9	

Table 5. Continued.

Parameter	Nest Site				Random Site				P
	n	mean	SD	range	n	mean	SD	range	
11.3m radius tree density > 38 cm DBH:									
Balsam Fir	21	0	0	0	65	0.14	0.4	0-2	
White Birch	21	0	0	0	65	0.14	0.4	0-2	
Total Large Trees	21	0	0	0	65	0.28	0.63	0-3	
Total Live Trees (all 3 size classes)	21	31.67	22.31	7-90	65	30.74	14.37	0-81	
Total Snags (both size classes)	21	12.29	6.75	3-27	65	9.65	7.4	0-33	
Total Tree Stems	21	43.95	22.38	15-93	65	40.39	17.2	7-96	
5m radius ground cover[a] (%):									
Total Green	21	4.76	1.09	3-6	63	4.94	0.82	2-6	
Shrubs	21	2.33	1.2	1-5	64	1.75	0.64	1-3	0.045
Forbs	21	2.14	0.65	1-4	64	2.44	0.89	1-5	
Ferns	21	1.76	0.83	1-4	64	2.61	1.15	1-5	0.003
Grass/sedge	21	1	0		64	1.42	0.75	1-4	0.007
Leaf litter	21	2.9	1.17	1-5	64	2.59	0.89	1-5	
Downed Logs (>12cm dia)	21	1.57	0.6	1-3	65	1.31	0.47	1-2	0.058
Water	21	1	0		65	1.03	0.17	1-2	
Moss	21	3.19	1.12	2-5	65	2.71	0.46	1-3	
Bare ground	21	1.29	0.56	1-3	65	1.23	1.11	1-6	
Litter depth (cm)	21	3.97	1.36	1.8-6.5	64	4.17	1.58	0.2-7.4	
Aspect (degrees)	21	144.7	75.6	40-315	64	152.84	59.05	0-340	
Slope (degrees)	15	20.93	12.83	8-46	64	18.92	9.04	0-39	
Average Top Canopy Height (m)	21	4.26	2.13	2-9.8	64	8.17	3.95	1.5-20	< 0.001
Canopy Cover >5m (%)	15	16.84	25.44	0-86	64	47.12	34.77	0-97.24	0.001
Total Canopy Cover (%)	15	76.46	24.4	13.26-99.84	64	74.56	24.89	17.94-99.84	

[a] Index of percent coverage: 1=0-4, 2=5-24, 3=25-49, 4=50-74, 5=75-94, 6=95-100.

Table 6. Comparison of habitat variables at Bicknell's Thrush nest sites with Swainson's Thrush nest sites on Mt. Mansfield, Vermont, 1992-96. Coverage indices were compared with a Mann-Whitney U-test; all other comparisons made with a two-sample *t*-test.

Parameter	Nest Site				Random Site				P
	n	mean	SD	range	n	mean			
5m radius woody stem density < 2.5 cm diameter at 10 cm height:									
Dead	21	4.76	6.07	0-23	9	1.78	3.03	0-9	
Balsam Fir	21	44.81	39.08	0-140	9	19	10.68	6-35	0.01
Red Spruce	21	0.14	0.48	0-2	9	1.11	1.54	0-4	
White Birch	21	11.33	11.99	0-39	9	2.22	3.23	0-10	0.003
Mt. Ash	21	0.71	1.01	0-4	9	2.56	3.94	0-11	
Mt. Shadbush	21	0.67	2.42	0-11	9	1.89	5.67	0-17	
Mt. Maple	21	0.29	1.31	0-6	9	0.44	1.33	0-4	
Mt. Holly	21	9.81	22.42	0-89	9	0	0	0	
Wild Raisin	21	0	0	0	9	1.33	4	0-12	
Total Small Stems	21	80.05	49.94	11-187	9	37.22	13.94	18-58	0.001
5m radius woody stem density >2.5 cm diameter at 10 cm height:									
Dead	21	5.24	6.34	0-29	9	2.33	2.78	0-9	
Balsam Fir	21	52.33	33.23	6-154	9	25.89	10.76	12-44	0.003
Red Spruce	21	0.38	0.86	0-3	9	1.67	1.66	0-4	0.053
White Birch	21	11.33	11.99	0-39	9	6.22	9.11	0-25	
Mt. Ash	21	1.38	2.09	0-7	9	1.11	1.76	0-5	
Mt. Shadbush	21	0.67	3.06	0-14	9	0.11	0.33	0-1	
Mt. Maple	21	0.33	1.53	0-7	9	0.56	1.67	0-5	
	21	0.86	3.28	0-15	9	0	0	0	
	21	0	0	0	9	0.11	0.33	0-1	
	21	0.1	0.44	0-2	9	0	0	0	
	21	0	0	0	9	1.11	3.33	0-10	
Total Large Stems	21	64.62	46.06	6-159	9	32.22	13.01	9-51	0.007
Total Stems (small + large)	21	144.67	91.43	28-290	9	72	24.06	30-102	0.002
11.3m radius tree density >8-23 cm DBH:									
Balsam Fir	21	28	22.22	2-89	9	23.67	15.12	8-57	
	21	0.57	1.21	0-5	9	1.11	1.54	0-5	
	21	1.29	2.08	0-6	9	5.78	6.32	0-21	
	21	0.48	1.12	0-4	9	0.44	0.73	0-2	
Total Small Trees	21	30.33	22.46	7-89	9	31	16.21	11-59	
Dead (>12-23 cm DBH)		10.48	6.71	1-26	9	4.44	2.13	0-7	0.001
11.3m radius tree density >23-38 cm DBH									
Balsam Fir	21	1.14	1.42	0-4	9	1.67	1.22	0-4	
Red Spruce	21	0.05	0.22				0	0	
White Birch	21	0.14	0.48	0-2	9	1	0.71	0-2	0.007
Mt. Ash		0	0	0	9	0.11	0.33	0-1	
Total Medium Trees	21		1.59	0-5	9	2.78	1.39	2-6	0.023
Dead (> 23 cm DBH)	21		1.75	0-6	9	2.67	1.8	0-5	

Table 6. Continued.

Parameter	Nest Site				Random Site				P
	n	mean	SD	range	n	mean	SD	range	
11.3m radius tree density > 38 cm DBH:									
Balsam Fir	21	0	0	0	9	0.22	0.44	0-1	
Red Spruce	21	0	0	0	9	0.22	0.44	0-1	
White Birch	21	0	0	0	9	0.33	0.5	0-1	
Total Large Trees	21	0	0	0	9	0.78	0.83	0-2	
Total Live Trees (all 3 size classes)	21	31.67	22.31	7-90	9	34.56	16.43	15-62	
Total Snags (both size classes)	21	12.29	6.75	3-27	9	7.11	2.76	2-11	0.006
Total Tree Stems	21	43.95	22.38	15-93	9	41.67	16.16	25-71	
5m radius ground cover[a] (%):									
Total Green	21	4.76	1.09	3-6	8	4.75	0.71	4-6	
Shrubs	21	2.33	1.2	1-5	9	1.67	0.5	1-2	
Forbs	21	2.14	0.65	1-4	9	2.33	0.87	1-4	
Ferns	21	1.76	0.83	1-4	9	2.44	0.53	2-3	0.017
Grass/sedge	21	1	0		9	1.22	0.44	1-2	0.028
Leaf litter	21	2.9	1.17	1-5	9	3	1.12	2-5	
Downed Logs (>12cm dia)	21	1.57	0.6	1-3	9	1.44	0.53	1-2	
Water	21	1	0		9	1.11	0.33	1-2	
Moss	21	3.19	1.12	2-5	9	2.44	0.88	1-4	
Bare ground	21	1.29	0.56	1-3	9	1.33	0.71	1-3	
Litter depth (cm)	21	3.97	1.36	1.8-6.5	9	4.12	1.63	2-6.6	
	21	144.7	75.6	40-315	9	150.11	49.54	89-220	
	15	20.93	12.83	8-46	9	19.11	5.78	13-31	
	21	4.26	2.13	2-9.8	9	8.72	2.73	3.15-12.5	0.001
Canopy Cover >5m (%)	15	16.84	25.44	0-86	9	58.43	34.48	6.76-95.68	0.012
Total Canopy Cover (%)	15	76.46	24.4	13.26-99.84	9	87.68	12.42	65.76-99.84	

[a] Index of percent coverage: 1=0-4, 2=5-24, 3=25-49, 4=50-74, 5=75-94, 6=95-100.

Table 6. Continued.

Parameter	Nest Site				Random Site				P
	n	mean	SD	range	n	mean	SD	range	
11.3m radius tree density > 38 cm DBH:									
Balsam Fir	21	0	0	0	9	0.22	0.44	0-1	
Red Spruce	21	0	0	0	9	0.22	0.44	0-1	
White Birch	21	0	0	0	9	0.33	0.5	0-1	
Total Large Trees	21	0	0	0	9	0.78	0.83	0-2	
Total Live Trees (all 3 size classes)	21	31.67	22.31	7-90	9	34.56	16.43	15-62	
Total Snags (both size classes)	21	12.29	6.75	3-27	9	7.11	2.76	2-11	0.006
Total Tree Stems	21	43.95	22.38	15-93	9	41.67	16.16	25-71	
5m radius ground cover[a] (%):									
Total Green	21	4.76	1.09	3-6	8	4.75	0.71	4-6	
Shrubs	21	2.33	1.2	1-5	9	1.67	0.5	1-2	
Forbs	21	2.14	0.65	1-4	9	2.33	0.87	1-4	
Ferns	21	1.76	0.83	1-4	9	2.44	0.53	2-3	0.017
Grass/sedge	21	1	0		9	1.22	0.44	1-2	0.028
Leaf litter	21	2.9	1.17	1-5	9	3	1.12	2-5	
Downed Logs (>12cm dia)	21	1.57	0.6	1-3	9	1.44	0.53	1-2	
Water	21	1	0		9	1.11	0.33	1-2	
Moss	21	3.19	1.12	2-5	9	2.44	0.88	1-4	
Bare ground	21	1.29	0.56	1-3	9	1.33	0.71	1-3	
Litter depth (cm)	21	3.97	1.36	1.8-6.5	9	4.12	1.63	2-6.6	
Aspect (degrees)	21	144.7	75.6	40-315	9	150.11	49.54	89-220	
Slope (degrees)	15	20.93	12.83	8-46	9	19.11	5.78	13-31	
Average Top Canopy Height (m)	21	4.26	2.13	2-9.8	9	8.72	2.73	3.15-12.5	0.001
Canopy Cover >5m (%)	15	16.84	25.44	0-86	9	58.43	34.48	6.76-95.68	0.012
Total Canopy Cover (%)	**15**	**76.46**	**24.4**	**13.26-99.84**	**9**	**87.68**	**12.42**	**65.76-99.84**	

[a] Index of percent coverage: 1=0-4, 2=5-24, 3=25-49, 4=50-74, 5=75-94, 6=95-100.

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