2006 Report to the Vermont Monitoring Cooperative

Part I. Demographic Monitoring of Montane Forest Birds on Mt. Mansfield

Part II. Forest Bird Surveys on Mt. Mansfield and Lye Brook Wilderness Area

Part III. Mercury Burdens in Amphibians from Mt. Mansfield and Stratton Mountain

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Bicknell's Thrush by Barry Kent MacKay

Part I. Demographic Monitoring of Montane Forest Birds on Mt. Mansfield

Christopher C. Rimmer and Kent P. McFarland

We continued demographic monitoring and mercury sampling of Bicknell's Thrush *(Catharus bicknelli)*, Swainson's Thrush *(C. usutulatus)*, Blackpoll Warbler *(Dendroica striata)*, and Yellow-rumped (Myrtle) Warbler *(D. coronata)* on the Mt. Mansfield ridgeline in 2006, completing our 15th consecutive field season. This report presents a summary of data collected.

Methods

We used mist-netting and banding to sample breeding populations of the four target species on an established study plot on the Mt. Mansfield ridgeline between c. 1155-1190 m (3800-3900 ft) elevation. We conducted 8 banding sessions between 9 June and 6 July 2006, using 12-18 nylon mist nets (12 x 2.5-m and 6 x 2.5-m, 36-mm mesh) placed at sites that have been used annually since 1992, primarily on the Amherst, Lakeview, and Long trails. Nets were generally opened from late afternoon until dusk and from dawn until early afternoon on the following morning. Bicknell's Thrushes were captured both passively and through the use of vocal lures (tape recorded playbacks), while other species were passively captured. Each individual was fitted with a uniquely-numbered U.S. Fish and Wildlife Service (USFWS) leg band and a unique combination of 3 plastic colored leg bands. We recorded data on age, sex, breeding condition, fat class, ectoparasites, flight feather wear, and net site of capture. Standard morphometrics included wing chord, tail length, weight, tarsal length, culmen length, bill length from mid-nares, bill width, and bill depth. We collected a small blood sample (c. 50 µl) from the brachial vein of all adult Bicknell's Thrushes and selected individuals of other species for mercury analysis. Each sample was stored in a heparinized capillary tube, refrigerated in a vaccutainer in the field, and frozen within 12-48 hours. The fifth secondaries on both wings were clipped just above the follicle and stored in plasticine envelopes for mercury analysis. Both blood and feather samples were sent to Texas A&M University Trace Element Research Laboratory for analysis by element-specific cold vapor atomic absorption. We also collected the fifth tail feather on both sides for stable isotope and trace element analysis to track natal dispersal and population connectivity.

Results and Discussion

We operated mist nets on 8 days between 9 June and 6 July, accumulating 1,002.5 net-hours, with a mean of 125.3 ± 80.7 SD net-hours per day (range = 10 – 245). Inclement weather on several dates reduced the number of hours nets could be operated. A total of 72 individuals of the four target species were captured and banded (Table 1), for a capture rate of 7.18 new birds/100 net-hours. We obtained a total of 30 recaptures of 26 banded individuals, 12 of which were banded in a previous year, including 4 of the 5 recaptured Bicknell's Thrush. Blackpoll Warbler ranked first in abundance in new (n = 23) and total (n = 37) mist net captures, followed by Yellow-rumped Warbler (n = 18, 25), Bicknell's Thrush (n = 12, 18), and Swainson's Thrush (n = 7, 10). Of the 16 Bicknell's Thrush captured on Mansfield, 12 were males and 4 females.

We collected 14 blood samples from 13 individual Bicknell's Thrushes (10 males, 3 females) on Mt. Mansfield in 2006. We also collected 7 feather samples (2 contour feathers, 5 secondary feathers) from 5 individuals.

These results highlight both the high survivorship and strong breeding site fidelity of adult Bicknell's Thrushes, as well as the difficulty of obtaining complete population samples in a given year. It is clear that

multiple-year sampling is necessary to obtain accurate demographic data for individual birds. The difficulty of intensively sampling all montane forest habitat on this study plot, due to constraints of terrain, accessibility and weather, undoubtedly causes a significant portion of the breeding population to go undetected each year. This may be particularly true for females, with their smaller home ranges and more limited movements than males (Rimmer et al. 2001).

We obtained blood and feather samples from all Bicknell's Thrushes for ongoing mercury analyses in 2006. Our mercury data through 2004 have been analyzed and reported in the peer-reviewed journal Ecotoxicology (Rimmer et al. 2005). This paper can be viewed online at http://www.springerlink.com/media/m1b6vnlvxr7u11l4fatn/contributions/j/g/4/t/jg4tu3t421185k72.pdf or http://www.vinsweb.org/assets/pdf/songbirdHg.pdf. Our 2006 samples currently await analysis at the University of Texas A&M Trace Element Research Laboratory.

One of our most significant discoveries has been documentation of pervasive mercury burdens in terrestrial montane songbirds. We sampled 4 species (Bicknell's Thrush, Blackpoll Warbler, Yellow-rumped Warbler, and White-throated Sparrow *[Zonotrichia albicollis]*) on the Mansfield ridgeline in 2000-2004, and we documented mercury in every individual sampled (n = 91 individuals). Our data on Bicknell's Thrush provide the most comprehensive information available on mercury in a strictly terrestrial, insectivorous songbird. The results from our study indicate that songbirds in montane forests are bioaccumulating mercury, nearly 100% of which is sequestered in the toxic methylmercury form. Among the four species we sampled on Mt. Mansfield, blood mercury concentrations were highest in Bicknell's Thrush (0.08 to 0.38 ppm). Feather mercury levels were highest in Bicknell's Thrush older than two years, further suggesting that mercury in this species builds up over time. These results, which indicate that mercury is accumulating in food webs within high elevation forest environments, have surprised many ecologists and atmospheric scientists. Continued monitoring of mercury burdens in montane forest biota will be important to reveal both temporal and spatial patterns of mercury bioavailability. Updated data on burdens in Bicknell's Thrush, both on population and individual levels, will be available upon receipt of 2005 and 2006 laboratory analyses.

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Table 1. Banding totals for four target species on Mt. Mansfield, 2006.

Species	New Bandings	Return Captures
Bicknell's Thrush	12	4
Blackpoll Warbler	23	2
Yellow-rumped Warbler	18	3
Swainson's Thrush	7	3
Grand Total	60	12

Part II. Forest Bird Surveys on Mt. Mansfield and Lye Brook Wilderness Area

Steven D. Faccio and Christopher C. Rimmer

In 2006, the Vermont Institute of Natural Science (VINS) continued breeding bird surveys at 3 permanent study sites on Mt. Mansfield and on 1 site at the Lye Brook Wilderness Area (LBWA) of the Green Mountain National Forest. The Mt. Mansfield ridgeline was surveyed for the 16th consecutive year, while the Ranch Brook site was censused for the 11th year in 2006 (the 2004 survey was not completed due to inclement weather on attempted survey dates). Our permanent study site at Underhill State Park was surveyed for the 14th year in 2006. The LBWA was surveyed for the 6th consecutive year in 2005.

The Underhill State Park site consists of mature northern hardwoods at an elevation of 671 m (2200 ft), while the Mansfield ridgeline site, at 1158 m (3800 ft), consists of montane fir-spruce. The Ranch Brook site ranges between 975 and 1097 m (3200 and 3600 ft), and is dominated by a paper birch-fir canopy. The Lye Brook study site, located in Winhall, just north of Little Mud Pond, is characterized by mature northern hardwoods at an elevation of 701 m (2300 ft).

These four study sites are part of VINS' long-term Forest Bird Monitoring Program (FBMP). This program was initiated in 1989 with the primary goals of conducting habitat-specific monitoring of forest interior breeding bird populations in Vermont and of tracking long-term changes (Faccio et al. 1998). As of 2006, VINS had established 38 monitoring sites in 9 different forested habitats in Vermont, with additional montane sites in New York, New Hampshire, Maine, and Massachusetts. A complementary, volunteer-based, long-term monitoring program, called Mountain Birdwatch, was initiated in 2000 to collect census data on five common montane forest bird species throughout the Northeast. Also, through a cooperative agreement with the National Park Service, VINS is coordinating breeding bird monitoring at 8 National Parks in the Northeast, and in 2006, pilot surveys were conducted at 17 study sites in New Jersey, Connecticut, New York, Massachusetts, Vermont, New Hampshire, and Maine.

Methods

Surveys were conducted by VINS staff biologists at the Mt. Mansfield Ridgeline and Ranch Brook sites, and by volunteer biologists at the Lye Brook and Underhill sites. Survey methods consisted of unlimited distance point counts, based on the approach described by Blondel et al. (1981) and used in Ontario (Welsh 1995). The count procedure was as follows:

1) Counts began shortly after dawn on days where weather conditions were unlikely to reduce count numbers (i.e., calm winds and very light or no rain). Censusing began shortly (< 1 min) after arriving at a station.

2) Observers recorded all birds seen and heard during a 10-min sampling period, which was divided into 3 time intervals: 3, 2, and 5 mins. Observers noted in which time interval each bird was first encountered and were careful to record individuals only once. To reduce duplicate records, individual birds were mapped on standardized field cards, and known or presumed movements were noted. Different symbols were used to record the status of birds encountered (i.e., singing male, pair observed, calling bird, etc.).

3) Each site, consisting of 5 point count stations, was sampled twice during the breeding season: once during early June (ca. 2-12 June) and once during late June (ca. 14-30 June). Observers were encouraged to space their visits 7-10 days apart. For each site visit, all stations were censused in a single morning and in the same sequence.

Two separate analyses were conducted and are reported here. First, using simple linear regression, population trends were calculated for the 8 most commonly encountered species at the Mount Mansfield and Lye Brook study sites. For each species, the annual population trend was calculated by plotting the maximum count against year, and then calculating the mean annual rate of change of a linear trendline inserted through the points. Regression analyses were done using SYSTAT 10.2.

In addition, an overall population trend analysis was conducted utilizing the larger FBMP dataset. Point count data from 29 "low elevation" (<2,200 feet), hardwood-dominated forests, and 6 high elevation (>2,800 feet) montane-fir forests were analyzed over two time periods; 18 years (1989-2006 for low elevation sites), and 16 years (1991-2006) for montane-fir sites. In order for a species to be included in the trend analysis, a minimum of 20 individuals must have occurred on at least 6 low elevation study sites, and at least 4 individuals must have occurred on a minimum of 10 high elevation sites. Trend estimates were calculated using the program Estimating Equations, which produces an overall trend as a weighted average from trends seen on individual study sites. To account for observer bias, we only used data from the same observer in consecutive years at the same site. In addition, data were divided into subsets at sites where there were observer changes. In order to avoid type II errors (e.g. not detecting a trend when one may exist), alpha was set at P=0.10.

In summarizing data for both analyses, the maximum count for each species was used as the station estimate for each year. All birds seen or heard were each counted as 1 individual unless a family group or active nest was encountered, in which case they were scored as a breeding pair, or 2 individuals.

Results

A combined total of 49 avian species was detected during breeding bird surveys at three study sites on Mt. Mansfield from 1991-2006. Species richness was similar at both montane forest sites, with 30 species detected at the Mansfield ridgeline and 31 at Ranch Brook. Surveys at Ranch Brook averaged a greater number of individuals and species per year than the higher elevation and more exposed Mansfield ridgeline site (Tables 1 and 2). Surveys at the mid-elevation, northern hardwood study sites at Underhill State Park and Lye Brook Wilderness showed similar species composition, with each site averaging just over 18 species per year (Tables 3 and 4).

Mount Mansfield

On the Mt. Mansfield ridgeline plot in 2006, both species richness and numerical abundance were below the 16-year average, with 62 individuals of 13 species detected (Table 1). Of the 8 most commonly recorded species, half were below the 15-year average. Three species exhibited non-significant decreasing population trends, while 4 species showed non-significant increasing trends, and one (Dark-eyed Junco) showed no trend (Table 1). Bicknell's Thrush numbers increased for the second consecutive year, rebounding from the lowest count of 5 in 2004, to 8 in 2005 and 11 in 2006.

At the Ranch Brook study site in 2006, both species richness and numerical abundance were below the 10-year average, with 61 individuals of 15 species counted (Table 2). Among the 8 most common species, 4 were below the 10-year mean and 4 were above. Overall, 2 of these 8 species showed increasing trends, while 6 declined. The only significant population trend evident was for White-throated Sparrow, which declined at a rate of 6.60% per year ($r^2 = 0.509$; $P = 0.014$). Bicknell's Thrush numbers dropped from a count of 8 in 2005, to 2 in 2006.

At Underhill State Park in 2006, both species richness and total number of individuals were above the 14-year average, with 81 individuals of 22 species detected (Table 3). Among the 8 most common species at the site, seven were above the 14-year mean, with counts of Black-throated Blue and Black-throated Green warblers the highest ever recorded at the site. Overall, 7 species showed increasing population trends, while Canada Warbler declined significantly over the period at 6.10% per year ($r^2 = 0.587$, $P = 0.001$). Among

positive trends, Black-throated Green Warbler increased at 10.40% annually ($r^2 = 0.704$, $P = 0.0002$), and Black-throated Blue Warbler increased at 7.23% per year ($r^2 = 0.262$, $P = 0.061$).

Lye Brook Wilderness

Although the Lye Brook Wilderness site was apparently surveyed in 2006, data has yet to be submitted by the volunteer observer, despite repeated requests. We will include 2006 results in a subsequent report.

Population Trend Analyses

Low Elevation Sites

Trend estimates were produced for 46 species from low elevation forests. Of these, 25 (54%) species exhibited increasing trends, 4 (16%) of which were significant, while 21 (46%) species declined, 4 (19%) significantly (Table 5). Among the significant declines were 3 short-distance migrants, including Hermit Thrush declining at 6.3% annually (P=0.011), Blue-headed Vireo (-5.9%, P=0.089), and White-throated Sparrow (-4.6, P=0.096). Wood Thrush, a long-distance migrant, also declined significantly over the 18 year period at a rate of 6.0% per year (P=0.029) (Figure 1). Results from Vermont's 23 road-based Breeding Bird Survey routes corroborate 3 of these declines, with Hermit Thrush, Wood Thrush, and White-throat all declining significantly over the same time period (Sauer et al. 2006). As a group, short-distance migrants (consisting of 13 species) also showed a significant decline of 2.9% per year (P=0.062) (Figure 2).

The 4 species showing significantly increasing trends were not well-surveyed by the FBMP, and consequently our confidence in these results, along with their biological significance, is reduced. These included Baltimore Oriole (an edge species which was only found at 7 study sites at low densities), Common Yellowthroat (a wetland species that was abundant only at a handful of study sites in forested wetlands), and White-breasted Nuthatch (a resident species whose early breeding season likely reduced its detectability on FBMP counts) (Table 5). In addition, Tufted Titmouse, a relative newcomer to Vermont, showed a 12.4% annual increase during the 18-year period at 6 study sites located in the Champlain Valley, reflecting how this southern species has expanded it abundance and distribution in Vermont over the last 25 years.

High Elevation Sites

Population trend estimates were produced for 20 species detected at high elevation montane-fir sites. Of these, 7 (35%) increased (none significantly), while 13 (65%) declined (Table 6). One species, White-throated Sparrow, declined significantly at a rate of 1.8% per year (P=0.10).

Discussion

Ongoing, standardized bird surveys on Mt. Mansfield continue to show interesting patterns, and the population fluctuations evident for some species underscore the need for continued monitoring and development of a long-term database. The significant decline of White-throated Sparrow at the Ranch Brook site is corroborated by results from the larger FBMP dataset from both high and low elevation study sites. When combined with declines of 2 other short-distance migrants (Blue-headed Vireo and Hermit Thrush), as well as that migratory group as a whole, these results suggest that overwintering habitat may be limiting breeding populations. The majority of short-distance migrants breeding in Vermont overwinter in the southeastern U.S., from the mid-Atlantic states to the Gulf coast. Data from the U.S. Census Bureau indicate that the 6-state region from Virginia to Florida, had the largest population growth in the country between 1990 and 2000. While these data do not provide a direct link to bird declines, the habitat loss and fragmentation that would inevitably accompany such a population surge suggest that it may be a contributing factor.

Additionally, the long-term declines for Wood Thrush and Hermit Thrush from low elevation FBMP study sites are troubling. Several studies have shown a strong relationship between acid precipitation,

calcium depletion in the soil, and steep declines of numerous European songbirds (Graveland et al. 1994, Graveland and Drent 1997). In the U.S., Hames et al. (2002) showed that Wood Thrush were less likely to attempt to breed at sites receiving highly acidic precipitation. Acid rain leaches calcium from the soil, thereby reducing the abundance of calcium-rich prey such as snails and millipedes, upon which many songbirds depend in order to obtain sufficient calcium for eggshell production.

The significant decline of Canada Warbler at the Underhill study continues to be of concern. Canada Warbler is a species of high conservation concern within the bioregion (Rich et al. 2004), and results from the North American Breeding Bird Survey indicate that it has exhibited significant population declines throughout the northeastern portion of its breeding range (Sauer et al. 2005). Although the species has declined at a rate of 6.7% annually on Vermont Forest Bird Monitoring sites between 1989-2006, the result is not statistically significant ($P = 0.28$; Table 5).

The site-specific trend estimates presented for Mt. Mansfield study sites must be interpreted carefully as these are preliminary trends from a limited geographic sample with low power. Changes in survey counts may simply reflect natural fluctuations, variable detection rates, and/or a variety of dynamic factors, such as prey abundance, overwinter survival, and habitat change. Several years of additional data collection, their correlation with other VMC data, and comparison with census data from other ecologically similar sites will be necessary to elucidate meaningful population trends of various species at these sites.

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Table 1. Maximum counts of individual birds, and population trends from linear regression analysis for the 8 most common species (bold type) at Mt. Mansfield Ridgeline, 1991-2006.

Common Name	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	Mean	SD	r^2	Annual Trend (%)
Red Squirrel											1						0.06	0.06		
Sharp-shinned Hawk										1							0.06	0.06		
Hairy Woodpecker				1													0.06	0.06		
Northern Flicker			1														0.06	0.06		
Yellow-bellied Flycatcher			1		1	2	3		1	1	1	1	2	1		1	0.94	0.94		
Alder Flycatcher							1										0.06	0.06		
Red-eyed Vireo									1								0.06	0.06		
Blue Jay		1												1		1	0.19	0.19		
Common Raven			1			1			1	1		1	1	1		2	0.56	0.56		
Red-breasted Nuthatch	1	2	3	1	3	1		1	2		1				1		1.00	1.00		
Winter Wren	**10**	**9**	**7**	**4**	**5**	**2**	**4**	**10**	**8**	**4**	**4**	**7**	**3**	**7**	**8**	**12**	**6.50**	**6.50**	**0.01**	**0.87**
Golden-crowned Kinglet										1							0.06	0.06		
Ruby-crowned Kinglet		2			1							1	1				0.31	0.31		
Bicknell's Thrush	**6**	**15**	**11**	**8**	**10**	**11**	**9**	**9**	**8**	**7**	**9**	**9**	**6**	**5**	**8**	**11**	**8.88**	**8.88**	**0.13**	**-1.74**
Swainson's Thrush	**3**	**8**	**1**	**1**	**3**	**6**	**7**	**5**	**4**	**3**	**3**	**2**	**2**	**1**	**2**	**5**	**3.50**	**3.50**	**0.06**	**-2.48**
Hermit Thrush											1		1				0.13	0.13		
American Robin	1	4	1	2	2	2	2	1	1	3	3	2	6	3	1	3	2.31	2.31		
Cedar Waxwing		1	4				9							1			0.94	0.94		
Nashville Warbler	2					2	3	1	1		1		1			1	0.75	0.75		
Magnolia Warbler	1	2				3	1	1			1		3	1	4		1.06	1.06		
Yellow-rumped Warbler	**9**	**11**	**8**	**9**	**8**	**12**	**10**	**13**	**11**	**9**	**11**	**14**	**10**	**13**	**9**	**9**	**10.38**	**10.3**	**0.07**	**0.96**
Blackpoll Warbler	**8**	**9**	**9**	**7**	**7**	**15**	**10**	**10**	**9**	**8**	**8**	**3**	**3**	**9**	**8**	**8**	**8.19**	**8.19**	**0.09**	**-1.75**
Ovenbird			1						1								0.13	0.13		
Canada Warbler							1										0.06	0.06		
Lincoln's Sparrow	2					1											0.19	0.19		
White-throated Sparrow	**6**	**14**	**14**	**12**	**14**	**13**	**20**	**14**	**19**	**14**	**18**	**11**	**13**	**11**	**10**	**14**	**13.56**	**13.5**	**0.01**	**0.46**
Dark-eyed Junco	**3**	**9**	**6**	**2**	**5**	**5**	**9**	**8**	**7**	**2**	**7**	**6**	**5**	**7**	**4**	**5**	**5.63**	**5.63**	**0.00**	**0**
Purple Finch	**2**	**4**	**1**	**2**	**3**	**2**	**2**	**1**	**4**	**2**	**3**	**4**	**4**	**2**	**1**	**2**	**2.44**	**2.44**	**0.00**	**0.28**
White-winged Crossbill					8		1	1									0.63	0.63		
Pine Siskin		1			1		2	1			11						1.00	1.00		
Evening Grosbeak		2															0.13	0.13		
Species Richness [a]	13	16	15	11	14	15	17	14	15	13	15	12	15	14	11	13	13.94	13.9		
Number of Individuals [a]	54	94	69	49	71	78	94	76	78	56	80	61	61	63	56	62	67.94	67.9		

[a] Does not include counts of Red Squirrel

Table 2. Maximum counts of individual birds, and population trends from linear regression analysis for the 8 most common species (bold type) at Ranch Brook, 1995-2006.

Common Name	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	Mean	SD	r^2	Annual Trend (%)
Red Squirrel					4		1		7				1.09	2.30		
Sharp-shinned Hawk				1							1		0.18	0.40		
Mourning Dove						1	1						0.18	0.40		
Ruby-throated Hummingbird						1							0.09	0.30		
Hairy Woodpecker	1												0.09	0.30		
Pileated Woodpecker							2						0.18	0.60		
Yellow-bellied Flycatcher	**4**	**4**	**4**	**3**	**3**	**4**	**2**	**4**	**4**		**3**	**2**	**3.36**	**0.81**	**0.256**	**-2.96**
Blue-headed Vireo												1	0.09	0.30		
Red-eyed Vireo				1									0.09	0.30		
Blue Jay	1										1	1	0.27	0.47		
Common Raven		4	3	4		4	2						1.55	1.86		
Black-capped Chickadee	1												0.09	0.30		
Red-breasted Nuthatch	7		2		6		2		2		4		2.09	2.55		
Winter Wren	**8**	**3**	**7**	**10**	**9**	**10**	**5**	**5**	**9**		**10**	**11**	**7.91**	**2.59**	**0.186**	**5.40**
Golden-crowned Kinglet				1	3	1		3			2	1	1.00	1.18		
Ruby-crowned Kinglet	3		3			3			1		1	1	1.09	1.30		
Bicknell's Thrush	**5**	**6**	**7**	**5**	**5**	**6**	**2**	**8**	**1**		**8**	**2**	**5.00**	**2.41**	**0.064**	**-3.46**
Swainson's Thrush	**6**	**15**	**9**	**5**	**3**	**4**	**8**	**11**	**10**		**8**	**5**	**7.64**	**3.53**	**0.014**	**-1.38**
Hermit Thrush	1		3										0.36	0.92		
American Robin		2	2	2	1	1	1	1	3		4	5	2.00	1.48		
Cedar Waxwing				1			1				1		0.27	0.47		
Nashville Warbler		1	3	2	1	3		3	4		3	2	2.00	1.34		
Northern Parula									1				0.09	0.30		
Magnolia Warbler	2	4	4	2	3	5	4	2	4		2	3	3.18	1.08		
Black-throated Blue Warbler	1												0.09	0.30		
Yellow-rumped Warbler	**5**	**6**	**4**	**5**	**7**	**11**	**9**	**11**	**8**		**4**	**8**	**7.09**	**2.55**	**0.113**	**4.23**
Blackpoll Warbler	**9**	**9**	**15**	**8**	**3**	**8**	**7**	**8**	**8**		**8**	**10**	**8.45**	**2.81**	**0.022**	**-1.11**
White-throated Sparrow	**22**	**11**	**12**	**9**	**8**	**7**	**7**	**10**	**10**		**7**	**4**	**9.73**	**4.65**	**0.509**	**-6.60****
Dark-eyed Junco	**9**	**5**	**3**	**2**	**5**	**2**	**5**	**4**	**4**		**7**	**5**	**4.73**	**2.10**	**0.000**	**-0.19**
Purple Finch	2	1	4	4	2	4	4		6				2.45	2.07		
White-winged Crossbill	8		2		1		6						1.55	2.81		
Pine Siskin	12		1		7								1.82	3.97		
Species Richness a	19	13	18	17	16	17	18	12	15		17	15	16.09	2.17		
Number of Individuals a	107	71	88	65	67	75	69	82	82		74	61	76.45	12.96		

[a] Does not include counts of Red Squirrel

** $P = 0.014$

Table 3. Maximum counts of individual birds, and population trends from linear regression analysis for the 8 most common species (bold type) at Underhill State Park, 1991-2006.

Common Name	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	Mean	SD	r^2	Annual Trend (%)
Eastern Chipmunk							3		5					1			0.64	1.50		
Red Squirrel							1		3		1					1	0.43	0.85		
Broad-winged Hawk							1										0.07	0.27		
Mourning Dove									1					1			0.14	0.36		
Yellow-bellied Sapsucker		2		1	1		1	1	1		3			2		2	1.00	0.96		
Downy Woodpecker							1										0.07	0.27		
Hairy Woodpecker				1			1	1	2								0.36	0.63		
Northern Flicker			1														0.07	0.27		
Pileated Woodpecker	2	1	1			1											0.36	0.63		
Eastern Phoebe												1					0.07	0.27		
Blue-headed Vireo	1	2				1	1			1				1		2	0.64	0.74		
Red-eyed Vireo	**3**	**4**	**4**	**6**	**9**	**8**	**7**	**6**	**10**	**8**	**8**	**7**		**5**		**7**	**6.57**	**2.03**	**0.183**	**3.65**
Blue Jay	2	1		1		2	2		1	1	2	1		1			1.00	0.78		
American Crow																1	0.07	0.27		
Common Raven				4	1				1		1			1			0.57	1.09		
Black-capped Chickadee		1	1		2	3	3		3	1	1					2	1.21	1.19		
Red-breasted Nuthatch							1										0.07	0.27		
White-breasted Nuthatch							1							1			0.14	0.36		
Brown Creeper				1					1	1		1		1		1	0.43	0.51		
Winter Wren		**6**	**2**	**1**	**5**	**3**	**4**	**6**	**4**	**4**	**3**	**3**		**3**		**4**	**3.43**	**1.70**	**0.057**	**2.76**
Golden-crowned Kinglet								1								1	0.14	0.36		
Veery	1	1								1							0.21	0.43		
Swainson's Thrush		1		2	4	3		1	4	2	2					1	1.43	1.45		
Hermit Thrush		**4**	**1**	**6**	**7**	**3**	**4**	**4**	**2**		**4**	**5**		**4**		**4**	**3.43**	**2.06**	**0.036**	**2.53**
Wood Thrush	1	1															0.14	0.36		
American Robin	1				3	3	3	4	2	1	2	1		2			1.57	1.34		
Magnolia Warbler	1				1											1	0.21	0.43		
Black-th. Blue Warbler	**4**	**9**	**5**	**6**	**7**	**8**	**6**	**5**	**6**	**5**	**5**	**5**		**11**		**15**	**6.93**	**3.00**	**0.262**	**7.23***
Yellow-rumped Warbler			2	2		2	3	3	1	1	3	2				1	1.43	1.16		
Black-th. Green Warbler	**5**	**7**	**6**	**7**	**7**	**7**	**9**	**5**	**8**	**10**	**10**	**8**		**13**		**15**	**8.36**	**2.87**	**0.704**	**10.40****
Blackburnian Warbler											1	1				1	0.21	0.43		
Blackpoll Warbler						1	2										0.21	0.58		
Black-and-White Warbler		3	2	2	4	2	3	2	1	3	4	2		1		2	2.21	1.12		
American Redstart		4			1	1											0.43	1.09		

cont.

Common Name	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	Mean	SD	r^2	Annual Trend (%)
Ovenbird	**4**	**10**	**11**	**11**	**13**	**12**	**12**	**10**	**13**	**10**	**13**	**6**		**11**		**11**	**10.50**	**2.59**	**0.038**	**1.09**
Canada Warbler	**3**	**4**	**4**	**6**	**2**	**4**	**4**	**2**	**2**	**3**	**2**	**2**					**2.71**	**1.64**	**0.587**	**-6.10****
Scarlet Tanager					1				1							1	0.21	0.43		
White-throated Sparrow	2		2	1	1		1					1				1	0.64	0.74		
Dark-eyed Junco		**3**	**1**	**3**	**4**	**3**	**5**	**2**	**2**	**1**	**2**	**2**		**1**		**5**	**2.43**	**1.50**	**0.031**	**3.00**
Rose-breasted Grosbeak	4	2		1	3	1	2		1							1	1.07	1.27		
Purple Finch						1		1			1					1	0.29	0.47		
White-winged Crossbill											2						0.14	0.53		
Pine Siskin					1						1						0.14	0.36		
American Goldfinch	1													1			0.14	0.36		
Species Richness a	15	19	14	18	20	20	23	16	21	16	20	16		17		22	18.36	2.76		
Number of Individuals a	35	66	43	62	77	69	77	54	67	53	70	48		60		81	61.57	13.58		

[a] Does not include counts of Red Squirrel or Eastern Chipmunk

* $P = 0.061$

** $P \leq 0.001$

Table 4. Maximum counts of individual birds, and population trends from linear regression analysis for the 8 most common species (bold type) at Lye Brook Wilderness Area, 2000-2005.

Common Name	2000	2001	2002	2003	2004	2005	Mean	SD	r^2	Annual Trend (%)
Eastern Chipmunk	2			1			0.75	0.96		
Red Squirrel	1	1					0.50	0.58		
Ruffed Grouse	1					2	0.50	0.84		
Mourning Dove		1					0.17	0.41		
Barred Owl	1						0.17	0.41		
Chimney Swift	2						0.33	0.82		
Yellow-bellied Sapsucker	**5**	**6**			**2**		**2.17**	**2.71**	**0.531**	**-16.6**
Downy Woodpecker	1		1				0.33	0.52		
Hairy Woodpecker	2	1	2				0.83	0.98		
Unidentified Woodpecker	3						0.50	1.22		
Pileated Woodpecker	1		3	1	4	1	1.67	1.51		
Eastern Wood-Pewee				1			0.17	0.41		
Least Flycatcher	2						0.33	0.82		
Great Crested Flycatcher				1			0.17	0.41		
Blue-headed Vireo		1	4	1		1	1.17	1.47		
Red-eyed Vireo	**10**	**6**	**9**	**4**	**6**	**6**	**6.83**	**2.23**	**0.360**	**-7.09**
Blue Jay		3		1		1	0.83	1.17		
Common Raven					1	1	0.33	0.52		
Black-capped Chickadee	1	1		2			0.67	0.82		
White-breasted Nuthatch						1	0.17	0.41		
Brown Creeper	1						0.17	0.41		
Winter Wren	**7**		**1**		**3**	**1**	**2.00**	**2.68**	**0.192**	**-14.82**
Ruby-crowned Kinglet						1	0.17	0.41		
Veery					1		0.17	0.41		
Swainson's Thrush	2		1	3	2		1.33	1.21		
Hermit Thrush	**4**	**2**	**6**	**5**	**4**	**4**	**4.17**	**1.33**	**0.040**	**2.63**
American Robin	1		1		3		0.83	1.17		
Cedar Waxwing	1						0.17	0.41		
Northern Parula				3	1		0.67	1.21		
Magnolia Warbler	1		3				0.67	1.21		
Black-throated Blue Warbler	**9**	**7**	**10**	**9**	**8**	**12**	**9.17**	**1.72**	**0.278**	**4.58**
Yellow-rumped Warbler	2	1				0	0.50	0.84		
Black-throated Green Warbler	**8**	**10**	**4**	**6**	**8**	**9**	**7.50**	**2.17**	**0.001**	**0.21**
Blackburnian Warbler	5						0.83	2.04		
American Redstart	2	1	3	1		4	1.83	1.47		
Ovenbird	**15**	**13**	**19**	**11**	**14**	**13**	**14.17**	**2.71**	**0.087**	**-2.41**
Canada Warbler	1						0.17	0.41		
Scarlet Tanager	1		3	2	2	2	1.67	1.03		
White-throated Sparrow	2		2	4		2	1.67	1.51		
Dark-eyed Junco	**2**	**3**	**1**	**1**	**1**	**4**	**2.00**	**1.26**	**0.029**	**4.29**
Rose-breasted Grosbeak	2	1					0.50	0.84		
Species Richness [a]	28	15	17	17	16	17	18.33	4.80		
Number of Individuals [a]	126	73	90	57	60	65	68.50	15.60		

[a] Does not include counts of Red Squirrel or Eastern Chipmunk

Table 5. Population trends of 46 breeding birds at low elevation sites from Vermont FBMP data, 1989-2006. Species in boldface type indicate significant trends at $P \leq 0.10$.

Species	Number of Sites	Annual Trend (%)	Lower CI	Upper CI
Mourning Dove	10	8.9	-1.5	20.5
Yellow-bellied Sapsucker	23	-0.5	-6.5	5.9
Downy Woodpecker	16	-0.4	-11.7	12.4
Hairy Woodpecker	25	-0.8	-8.6	7.5
Northern Flicker	9	-10	-23.8	6.3
Pileated Woodpecker	21	-6.7	-16.8	4.7
Eastern Wood Pewee	19	-1.5	-9.2	6.9
Least Flycatcher	10	-9.5	-30.8	18.4
Great Crested Flycatcher	17	0.9	-15.0	19.7
Blue-headed Vireo	**20**	**-6.0 ***	**-12.2**	**0.7**
Red-eyed Vireo	28	0.8	-2.9	4.6
Blue Jay	28	0.3	-9.1	10.6
American Crow	18	-1.1	-18.0	19.3
Common Raven	9	5.0	-10.1	22.6
Black-capped Chickadee	27	2.7	-6.7	12.9
Eastern Tufted Titmouse	**6**	**12.4 ****	**5.1**	**20.1**
Red-breasted Nuthatch	8	0.0	-11.4	12.9
White-breasted Nuthatch	**22**	**9.6 ****	**3.7**	**15.8**
Brown Creeper	18	1.5	-10.4	14.9
Winter Wren	22	2.7	-0.5	5.9
Veery	22	-4.4	-15.1	7.6
Swainson's Thrush	7	-4.0	-11.8	4.4
Hermit Thrush	**25**	**-6.3 ****	**-10.6**	**-1.8**
Wood Thrush	**17**	**-6.0 ****	**-10.7**	**-1**
American Robin	24	1.8	-4.7	8.8
Cedar Waxwing	12	6.4	-12.8	29.9
Northern Parula	6	5.3	-17.4	34.2
Chestnut-sided Warbler	10	5.8	-5.4	18.4
Black-throated Blue Warbler	22	2.0	-7.7	12.8
Yellow-rumped Warbler	15	-4.2	-15.9	9.2
Black-throated Green Warbler	25	-3.5	-8.8	2.1
Blackburnian Warbler	13	5.5	-7.1	19.8
Black-and-White Warbler	19	6.4	-4.9	19.2
American Redstart	20	-7.1	-15.5	2
Ovenbird	28	-1.5	-5	2.2
Common Yellowthroat	**14**	**10.5 ***	**-1.2**	**23.5**
Canada Warbler	12	-6.7	-17.6	5.6
Scarlet Tanager	27	3.0	-6.1	13.1
Song Sparrow	7	2.2	-17.1	26
White-throated Sparrow	**10**	**-4.6 ***	**-9.2**	**0.4**
Dark-eyed Junco	15	6.7	-1.3	15.3
Rose-breasted Grosbeak	22	-4.9	-11.8	2.5
Red-winged Blackbird	7	-1.3	-26.4	32.3
Brown-headed Cowbird	6	1.2	-9.9	13.7
Baltimore Oriole	**7**	**38.2 ****	**15.4**	**65.4**
American Goldfinch	10	3.7	-10.7	20.6

* $P < 0.10$

** $P < 0.03$

Table 6. Population trends of 20 breeding birds at montane-fir sites from Vermont FBMP data, 1991-2006. Species in boldface type indicate significant trends at $P \leq 0.10$.

Species	Number of Sites	Annual Change (%)	Lower CI	Upper CI
Mourning Dove	4	3.9	-40.4	81.3
Yellow-bellied Flycatcher	5	0.1	-3.5	3.4
Blue Jay	6	3.6	-17.4	30.0
Common Raven	5	-4.0	-34.1	39.8
Black-capped Chickadee	4	-24.6	-48.2	9.7
Red-breasted Nuthatch	6	-8.0	-17.9	3.1
Winter Wren	6	2.2	-2.5	7.2
Golden-crowned Kinglet	4	6.3	-4.4	18.1
Ruby-crowned Kinglet	4	-9.2	-28.5	15.2
Bicknell's Thrush	5	-1.8	-13.3	11.1
Swainson's Thrush	6	5.6	-6.3	19.0
Hermit Thrush	5	-8.8	-28.2	15.9
American Robin	5	2.9	-0.9	6.9
Nashville Warbler	6	-8.8	-18.6	2.2
Magnolia Warbler	6	-3.5	-10.3	3.8
Yellow-rumped Warbler	6	-1.5	-4.4	1.5
Blackpoll Warbler	5	-0.6	-3.2	2.0
White-throated Sparrow	**6**	**-1.8***	**-3.6**	**0**
Dark-eyed Junco	6	-2.2	-8.1	4.0
Purple Finch	6	-3.7	-15.7	9.9

* $P = 0.10$

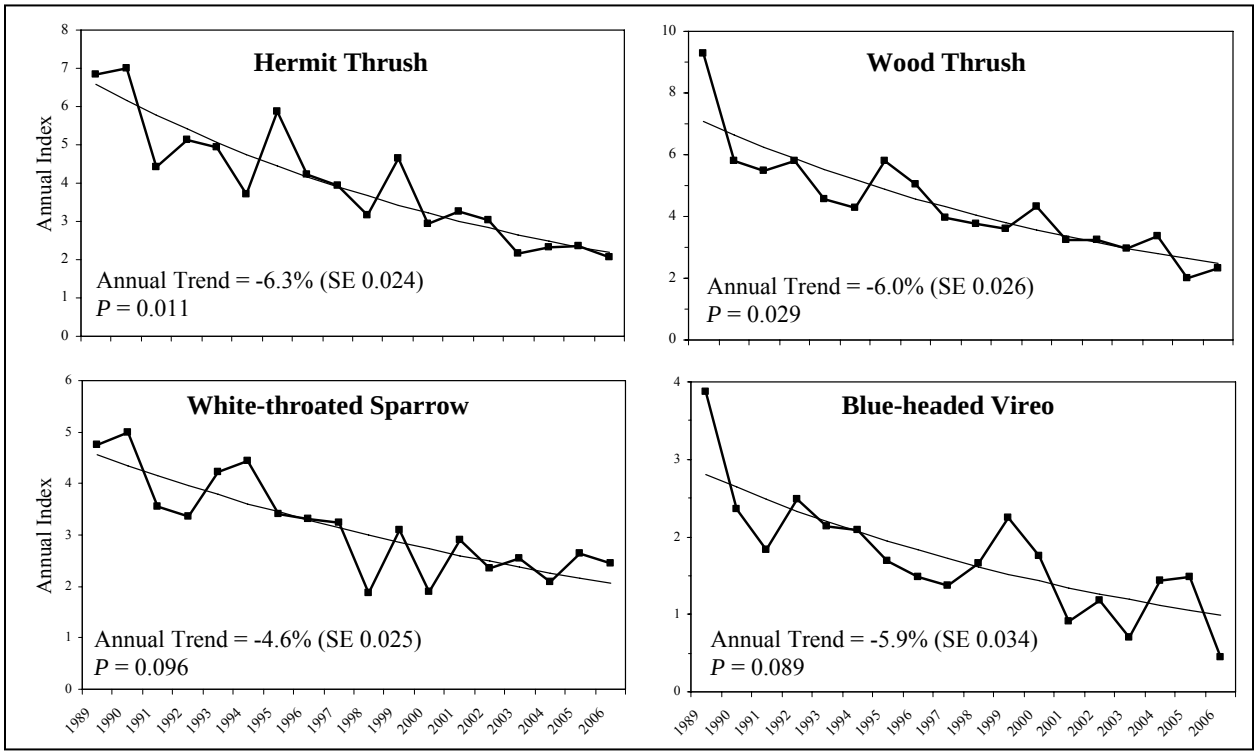

Figure 1. Population trends of four declining species from Vermont FBMP data, 1989-2006.

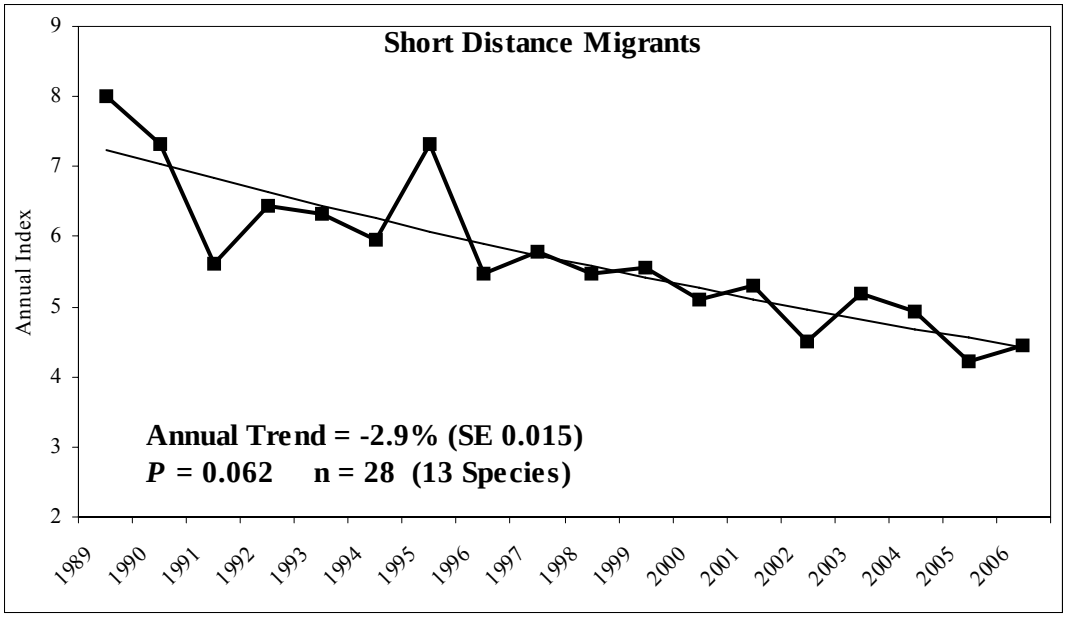

Figure 2. Population trend of 13 species of short-distance migrants from Vermont FBMP data, 1989-2006.

Part III. Mercury Burdens in Amphibians from Mt. Mansfield and Stratton Mountain

Steven D. Faccio

In 2006, VINS conducted pilot sampling to determine the mercury (Hg) burdens in terrestrial Redback Salamanders along an elevational gradient on Mt. Mansfield and Stratton Mountain, and in Wood Frog tadpoles from the summit of Stratton Mountain. It is well established that elevated levels of atmospheric mercury (Hg) deposition and methylmercury (MeHg) bioavailability in the northeastern United States influence wildlife populations (Evers and Clair 2005, Driscoll et al. 2007). Although investigations have primarily focused on freshwater ecosystems where converted MeHg biomagnifies through the aquatic foodweb (Bank et al. 2005, Chen et al. 2005), Rimmer et al. (2005) demonstrated that Hg was prevalent in strictly terrestrial, insectivorous montane songbirds, as well as in a variety of insects and spiders sampled in montane-fir forests on Mt. Mansfield and Stratton Mountain (C. Rimmer et al. unpublished data). Mercury loading is significantly (2–5x) higher in montane areas of the Northeast than in surrounding low elevation areas (Lawson, 1999; Miller et al., 2005) due to pollutant-laden cloud water that frequently bathes montane forests, acidic soil conditions, and other local and regional factors. The goals of this pilot project were to determine the baseline levels of Hg in a completely terrestrial amphibian species (Redback Salamander) along an elevational gradient from hardwood forest to montane-fir forest, and determine baseline Hg burdens in a pool-breeding amphibian (Wood Frog) from montane-fir habitat.

Methods

Active searches for Redback Salamanders were conducted in forested habitat on Stratton Mountain and Mt. Mansfield by turning over objects (logs, rocks, etc) where salamanders often hide. All salamanders were captured by hand and placed in a moistened plastic bag and measured (snout-to-vent, and total length). A tissue sample for Hg analysis was collected from each individual by clipping a small (~ 5mm) portion of their tail tip using surgical scissors. Mercury levels in salamander tail tips have been shown to provide a good correlation with whole body Hg burdens (D. Evers, personal comm.). Salamanders were then immediately released at their point of capture. Wood Frog tadpoles were collected using a dipnet from a small breeding pool at the summit of Stratton Mountain (3,928 feet elevation) and measured (snout-to-vent, and total length). All samples were immediately stored in Whirl-pak sample bags and zip locks, then frozen to prevent dehydration. Each sampling location was spatially referenced using GPS, and forest cover type was noted. Once all samples were obtained they were shipped overnight to the Texas A&M Trace Element Research Lab for mercury analysis.

Results and Discussion

A total of 32 Redback Salamanders (20 from Mt. Mansfield, 12 from Stratton) and 6 Wood Frog tadpoles from Stratton Mt. were sampled (Figure 1). Overall, the mean Hg level was higher in Wood Frogs (0.193 ppm dry ±0.032 SD; range = 0.149-0.228) than in salamanders (0.098 ppm ±0.033 SD; range = 0.059-0.206). Redback Salamander Hg burdens averaged slightly higher in montane-fir forests (0.108 ±0.038 ppm; n=13) than in northern hardwoods (0.088 ±0.021 ppm; n=15), and a weak but increasing trend of Hg accumulation was evident along an elevational gradient from 2,100 to 3,600 feet (Figure 2). In addition, salamanders from Stratton had slightly higher mean Hg burdens than those from Mansfield (Figure 3), a pattern that is also evident in Bicknell's Thrush feather and blood samples (Rimmer et al. 2005).

Hg burdens in terrestrial Redback Salamanders from Mansfield and Stratton are comparable to blood Hg levels (0.11 ±0.04 ppm) taken from Bicknell's Thrush at the same study sites (Rimmer et al. 2005). The invertebrate diet of both species likely contributes to their susceptibility to mercury bioaccumulation, but thrushes occupy a higher trophic level and might be expected to accumulate higher mercury burdens. However, Redback Salamanders live and forage in moist soils, often near stream edges where total sediment Hg and

MeHg levels are highest (Morel et al., 1998). Hg burdens in Wood Frog tadpoles however, are comparatively high, and owing to their herbivorous diet, are likely due to female Wood Frogs depurating Hg during egg-laying. Further sampling of adult Wood Frogs would help better understand mercury burdens in this species, and whether Hg sequestering during egg deposition is occurring. The results presented here must be evaluated in light of the small samples sizes involved. We recommend that additional sampling of amphibians along an elevational gradient, as well as within and outside of ski areas should be undertaken. These data will provide a more complete picture of atmospheric Hg deposition and bioaccumulation among terrestrial and aquatic species in montane forests.

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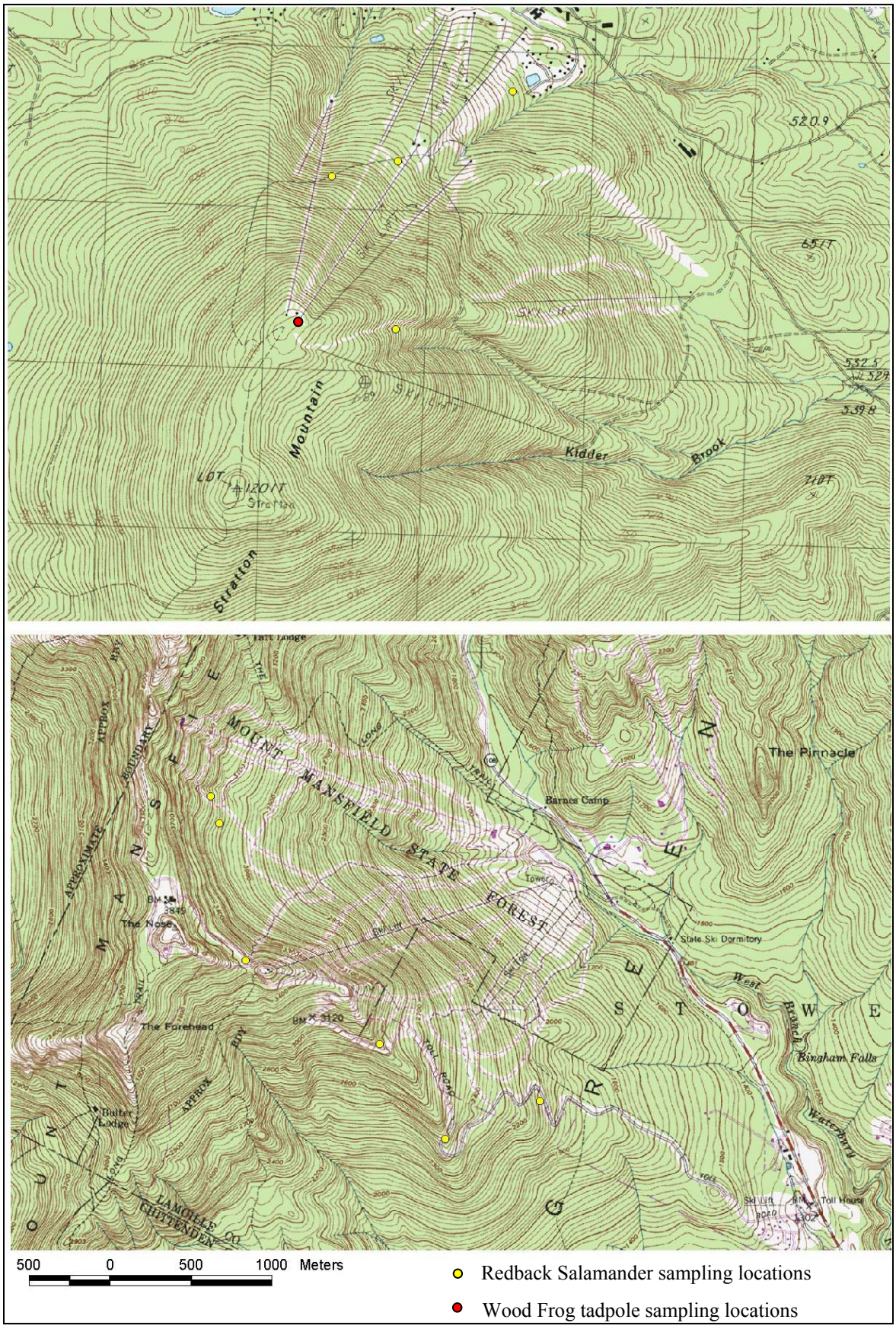

Figure 1. Amphibian sampling locations on Stratton Mountain (top) and Mt. Mansfield (bottom).

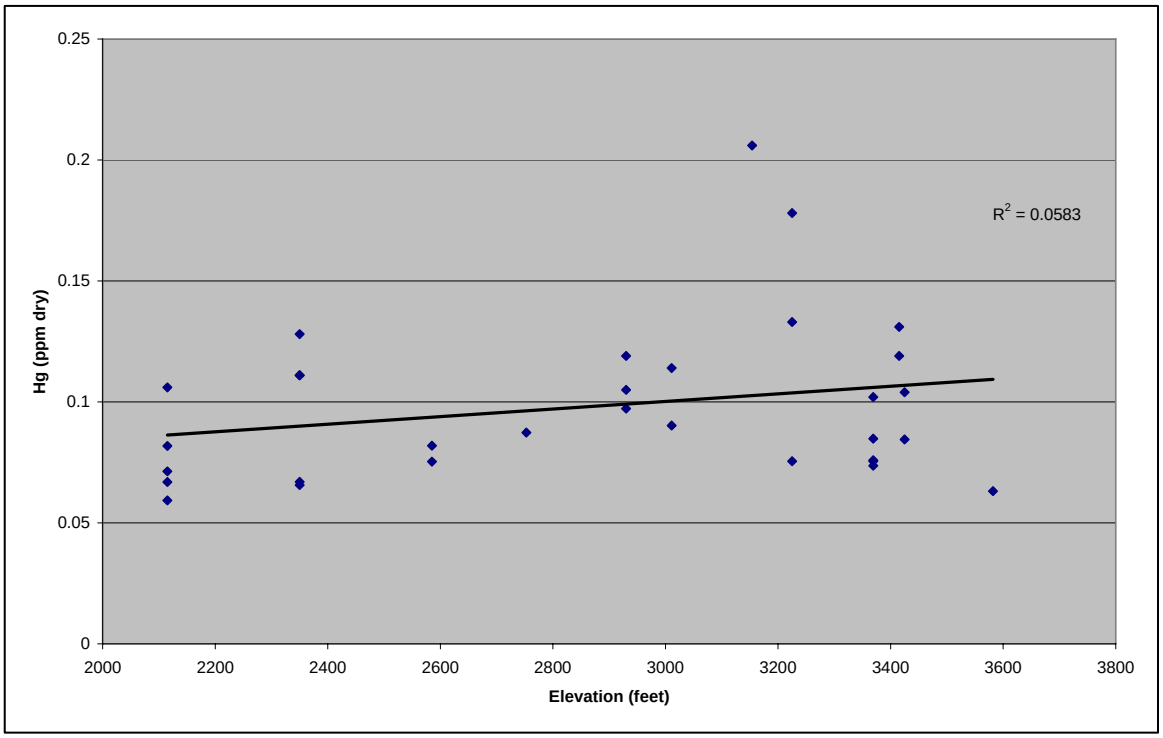

Figure 2. Hg burdens from Redback Salamanders sampled along an elevational gradient on Stratton Mountain and Mt. Mansfield.

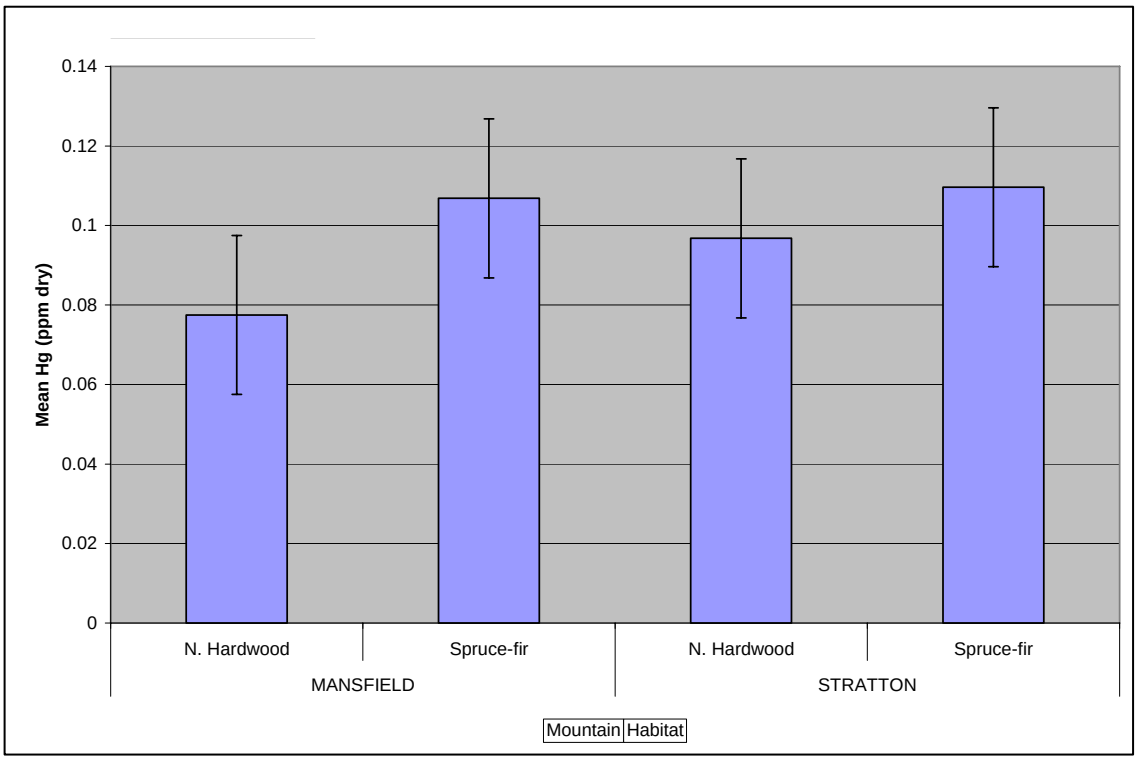

Figure 3. Mean (±SD) Hg burdens in Redback Salamanders by habitat and mountain.