FOREST BIRD SURVEYS ON MOUNT MANSFIELD AND UNDERHILL STATE PARK

1997 REPORT TO THE VERMONT MONITORING COOPERATIVE

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Abstract: Using data from the first 8 years (1989-1996) of the Vermont Forest Bird Monitoring Program (FBMP), we conducted a statistical analysis of birds censused during the breeding season at 17 study sites located in mature, forested habitats in Vermont. A route regression model was used to produce population trends for 67 species and for 3 groups of species categorized by wintering range. We also developed baseline indices for species richness, relative abundance, and distribution, by both study site and on a landscape level. We conducted power analyses from the 8-year data set to evaluate whether our sample sizes were adequate to accurately monitor trends.

FBMP trend analyses of the 8-year data set showed significant declines in breeding populations of Black-capped Chickadee, Solitary Vireo, Canada Warbler, and year-round residents, but showed significant increases for Rose-breasted Grosbeak and Neotropical migrants. The negative trend for Canada Warbler, corroborated by similar trends from the Breeding Bird Survey (BBS) and migration monitoring data from Long Point Bird Observatory in Ontario, suggests that this species is experiencing widespread declines over a significant portion of its breeding range. While the declines noted for Black-capped Chickadee and Solitary Vireo were corroborated by Vermont BBS data during the same period, long-term BBS data from northern New England showed significant positive trends for both species. This suggests that the declines over the 8-year period resulted either from short-term population fluctuations or from sampling biases between the off-road FBMP census and the road-side BBS. A comparison of FBMP population trends for 22 selected woodland species revealed that 68% agreed with trends from the Vermont BBS during the same time period. We showed a significant positive correlation between the relative abundance of Brown Creepers counted at FBMP sites and Vermont's average winter temperature, indicating that severe winters may limit breeding populations of this species. Moreover, this correlation suggests that the FBMP is accurately tracking population changes of at least some forest-dwelling breeding birds.

Power analyses conducted for 4 species using the 8-year data set revealed that the FBMP adequately samples species which occur at 9 or more of our 17 study sites and that our ability to detect small (=2%) population changes will increase dramatically after 15 years of monitoring. The results also indicated that the statistically significant population trends for the species and groups of species reported above had a high probability of actually occurring during the time period analyzed.

INTRODUCTION

Numerous recent studies have documented declines in populations of Neotropical migratory songbirds inhabiting highly fragmented landscapes (Terborgh 1989, Hagan and Johnston 1992, Robinson et al. 1995, Donovan et al. 1995). These studies have typically focused on forest-dwelling species in regions where formerly extensive, contiguous tracts of forest habitat have been broken and isolated into increasingly smaller patches. Accelerated rates of fragmentation are thought to have resulted in increased rates of nest predation and brood parasitism, which have contributed to declines in many breeding populations (Wilcove 1985, Robinson et al. 1993, Paton 1994). In addition, Hagan et. al. (1996) demonstrated that while Ovenbird densities increased soon after forest stands were fragmented, their populations were less productive than Ovenbirds in nonfragmented forests. While it has been widely accepted that healthy populations of forest-dwelling songbirds require healthy forests, only recently have studies shown that songbirds appear to play a vital role in maintaining the health and productivity of forest ecosystems (Marquis and Whelan 1994).

To more clearly understand the effects of habitat fragmentation, it is critical to collect long-term avian population trend data from both impacted areas and from protected, non-fragmented habitats (Temple and Wiens 1989). Data from protected sites serve as controls with which to assess population changes due to local or widespread environmental changes.

In 1989 the Vermont Institute of Natural Science (VINS) initiated the Vermont Forest Bird Monitoring Program (FBMP). The program was modeled after the Ontario FBMP, which the Canadian Wildlife Service (CWS) launched in 1987 (Welsh 1995). The FBMP was designed to detect changes in breeding populations over time for all forest-dwelling songbirds, and to collect habitat-specific baseline data on species composition and relative abundance at undisturbed, interior forest sites in Vermont. The scope of the FBMP is unique in the Northeast, in that no other long-term avian census in the region collects baseline data across such a broad range of unmanaged, permanently protected forest types. More importantly, since the FBMP samples breeding bird populations in undisturbed forests, it provides essential "control" information which is not distorted by human-induced habitat changes.

In order to evaluate the effectiveness of the FBMP and to determine the project's future goals and objectives, we undertook a statistical analysis of data collected from 17 study sites between 1989 and 1996. This included population trend analyses, a comparison of FBMP trends to those from other long-term data sets, and assessments of species richness and relative abundance by study site. In addition, we conducted power analyses of the 8-year data set to determine whether FBMP sample sizes were adequate to detect meaningful trends. This report summarizes these analyses and discusses future goals of the FBMP.

METHODS

Site and Observer Selection

Several criteria were used to select FBMP study sites. Minimum requirements were that sites: 1) consist of mature, contiguous stands of homogeneous forest type, 2) be 100 acres or larger in order to avoid "edge effects", and 3) be permanently protected from human-induced habitat changes. These criteria ensured that the study sites were located in relatively undisturbed, interior forest habitats that will remain relatively stable over the long-term, and in which bird populations should be little affected by the problems associated with forest fragmentation.

At each study site, 5 sampling "stations" (point counts) were established at least 100 meters from the nearest forest edge and 200 meters apart. Each station was clearly marked and labeled with flagging and an aluminum tree tag.

Volunteer observers were encouraged to participate in the project if they possessed a high degree of competency in both aural and visual bird identification, and could make a multi-year commitment.

Survey Methods

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 (<1min.) after arriving at a station.
2) Observers recorded all birds seen and heard during a 10-minute sampling period, which was divided into 3 time intervals: 3, 2, and 5 minutes. 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 noted. Different symbols were used to record the status of birds encountered (i.e., singing male, pair observed, calling bird, etc.).
3) Each site was sampled twice during the breeding season; once during early June (ca. 2-12 June) and once during late June (ca. 14-25 June). Observers were encouraged to space their visits 7-10 days apart. All stations for each site visit were censused in a single morning.
4) Following each survey, field data were transcribed by the observer from the field cards onto data coding sheets. The level of breeding evidence determined whether a bird was assumed to indicate a pair or a single bird: Singing males, observed pairs, occupied nests, and family groups were considered to represent a pair and counted as 2 birds. All other individuals seen or heard were counted as singles.

In 1989, 11 sites (55 stations) were established and censused by VINS staff and volunteers. Two additional sites were added in 1990, 3 in 1991, and 1 in 1992, bringing the total number of study sites to 17 (85 stations) (Fig.1). Six sites were in northern hardwood forests, 2 were in oak-hickory forests, 2 were in lowland spruce-fir forests, 2 in subalpine spruce-fir forests, and 1 each in a red maple swamp, a floodplain forest, a hemlock-pine-hardwood forest, a maple-beech-oak community, and a cedar-fir swamp (Table 1).

Table 1. Vermont Forest Bird Monitoring Sites, 1989-1996.

Site #	Site Name	Town	Ownership	Habitat	Years Censused	Observer Changes
1	Sandbar	Milton	VT Fish & Wildlife	Floodplain	8	1
2	Pease Mt.	Charlotte	University of Vermont	Oak-hickory	8	0
3	Cornwall Swamp	Cornwall	VT Fish & Wildlife	Maple Swamp	8	3
4	Shaw Mt.	Benson	The Nature Conservancy	Oak-hickory	8	3
5	Bald Mt.	W. Haven	The Nature Conservancy	Hemlock/pine/hrdwds	8	1
6	Sugar Hollow	Pittsford	The Nature Conservancy	N. Hardwoods	8	2
7	The Cape	Chittenden	Green Mt. National Forest	N. Hardwoods	8	2
8	Dorset Bat Cave	Dorset	The Nature Conservancy	N. Hardwoods	7	4
9	Roy Mt.	Barnet	VT Fish & Wildlife	Cedar-fir	8	0
10	Concord Woods	Concord	University of Vermont	N. Hardwoods	8	0
11	May Pond	Barton	The Nature Conservancy	N. Hardwoods	6	3
12	Moose Bog	Ferdinand	VT Fish & Wildlife	Spruce-fir	8	2
13	Bear Swamp	Wolcott	Cntr for Northern Studies	Spruce-fir	7	1
14	Underhill	Underhill	VT Forest, Parks & Rec.	N. Hardwoods	6	1
15	Mt Mansfield	Stowe	University of Vermont	Subalpine spruce-fir	6	0
16	Camel's Hump	Huntington	VT Forests, Parks & Rec.	Subalpine spruce-fir	6	0
17	Merck Forest	Rupert	Merck Forest & Farmland	Maple-beech-oak	5	2

Data Analysis

In preparing the data for population trend analyses, we used the higher of the 2 values recorded for each species as the station estimate for each year. Due to differences in the ability of observers to census birds, resulting in biased trend estimates (Sauer et. al. 1994), only data from the same observer in consecutive years at the same site were used. To improve the comparability of observations at sites that experienced a change in observer, data were divided into subsets corresponding to observers (Table 1). Since trends cannot be calculated from subsets of a single year, the data were discarded from trend analyses if an observer surveyed a site for just one year. Kendall et. al. (1996) recommend count data from an observer's first year of observation be removed from trend analyses due to a novice effect which was demonstrated to bias BBS trend results. We chose not to eliminate these data for this analysis in order to avoid further reducing sample sizes and the precision of our trend estimates. To produce FBMP trend analyses, we used a route regression technique with several weighting factors to produce robust estimators of trend from a multiplicative model. The route regression program that we used was generously provided by the CWS and used to produce trend analyses for both the Ontario FBMP and the Breeding Bird Survey in Canada (Collins and Wendt 1989).

In addition to calculating trends for individual species, we categorized species by wintering range as either Neotropical migrants (Latin America or Caribbean winter range), short-distance migrants (southeastern U.S.), or residents (northeastern U.S.). We then examined population trends for these three groups at all 17 study sites and in hardwood forest sites only.

FBMP trend results were compared to those from the North American Breeding Bird Survey (BBS), a continent-wide, road-based census conducted once per year since 1966 (Robbins et al. 1986, Droege 1990). We used BBS data from Vermont and northern New England (BBS physiographic strata 27, defined in Robbins et. al. 1986) for two different time periods, short-term (1989-1995) and long-term (1966-1995/96) (BBS trends through 1996 were only available for Vermont) (Sauer et. al. 1996). In addition, we compared FBMP trend results to those from the Ontario FBMP for data collected between 1988 and 1994 (Anonymous 1995).

RESULTS AND DISCUSSION

Trend Analysis

A population trend analysis was performed on data collected between 1989 and 1996. We examined trends for 67 species recorded at 2 or more sites for at least 2 years (Table 2). Twenty-eight of these species were recorded on 2-5 sites during the 8-year period, 20 were found on 6-10 sites, and 19 were found on 11-16 sites. No species was recorded on all 17 sites for 2 or more years.

These trends must be interpreted with caution as 8 years is a relatively short period over which to assess meaningful changes in bird populations. At this temporal scale, it is impossible to determine whether increases or decreases in relative abundance are due to normal population fluctuations or whether they reflect long-term trends. Sample size must also be considered when interpreting trends, since small sample sizes can result in misleading trends. In most cases a small sample size indicates that the species was poorly represented on FBMP study sites. For some species, such as Bicknell's Thrush and Blackpoll Warbler, this was due to inadequate coverage of certain habitats, such as subalpine spruce-fir. For others, including Gray Catbird and Yellow Warbler, small sample sizes reflect the species' primary association with nonforest habitat types. Trend results for species reported from fewer than 10 FBMP sites must be interpreted carefully in this light.

Another important consideration when interpreting population trends is distinguishing between statistical and biological significance. Statistical significance refers to the magnitude of a trend relative to the variability of the results and the sample size (Collins and Wendt 1989). Although biological significance is more qualitative and difficult to measure, it can be referred to as "a change that is of importance to a species' long-term prospects" (Collins and Wendt 1989). While 9 species showed statistically significant trends (Table 2), several of these may lack real biological significance over the 8-year FBMP sampling period.

Of 29 forest-dwelling species with suitable sample sizes (N=7; Table 2), 13 showed no trend or an increase, while 16 showed declines. Only one positive trend, an 18.6% annual increase by Rose-breasted Grosbeak, was statistically significant (P=0.02). Among the declining trends, only those of Black-capped Chickadee, Solitary Vireo, and Canada Warbler were statistically significant.

An especially noteworthy result is that Canada Warbler, declining at 13.2% per year according to the FBMP, may be experiencing serious problems. Although FBMP sample size for Canada Warbler was small (N=7), the decline is nevertheless disturbing since it is strongly corroborated by data from other sources. Long-term BBS data (1966-96) show Canada Warbler declining significantly at 3.4% per year in Vermont (Table 3). Over the short-term (1989-95), the BBS showed a non-significant decline for Canada

Warbler in Vermont as well as across the entire northern New England region (NNE) (Table 3). In addition, long-term BBS data show Canada Warbler declining significantly in New Hampshire, Ontario,

Table 2. Population trends of breeding birds from Vermont FBMP data, 1989-1996. **N** = sample size (# of FBMP sites at which species was recorded); **TREND** = % population change per year; ***P* Value** = probability of trend occurring; **CI** = Confidence Interval (95% probability that the trend lies between the 2 confidence intervals); * trend is statistically significant at $P < 0.05$; species in bold are forest-interior species that are well represented in the data set (N = 7); species are listed in taxonomic order.

SPECIES	N	Trend	P Value	Lower CI	Upper CI
Common Snipe (*Gallinago gallinago*)	3	35.5*	0.03	22.2	50.1
Mourning Dove (*Zenaida macroura*)	5	-16.8	0.51	-50.0	38.5
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	10	11.6	0.32	-9.6	37.8
Downy Woodpecker (*Picoides pubescens*)	12	-18.1	0.22	-39.7	11.1
Hairy Woodpecker (*Picoides villosus*)	13	-15.2	0.13	-30.9	4.0
Black-backed Woodpecker (*Picoides articus*)	2	-31.6	0.37	-50.2	-5.9
Yellow-shafted Flicker (*Colaptes auratus*)	8	-21.2	0.17	-42.1	7.4
Pileated Woodpecker (*Dryocopus pileatus*)	11	2.9	0.81	-17.9	28.9
Olive-sided Flycatcher (*Contopus cooperi*)	2	-29.0	0.29	-58.5	21.5
Eastern Wood Pewee (*Contopus virens*)	10	-2.2	0.46	-7.6	3.6
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	5	0.1	0.99	-16.9	20.4
Least Flycatcher (*Empidonax minimus*)	5	46.4	0.11	1.3	111.7
Eastern Phoebe (*Sayornis phoebe*)	3	-15.0	0.46	-40.4	21.2
Great Crested Flycatcher (*Myiarchus crinitus*)	9	4.2	0.30	-3.3	12.3
Blue Jay (*Cyanocitta cristata*)	16	7.1	0.23	-4.0	19.4
American Crow (*Corvus brachyrhynchos*)	11	-26.1*	0.037	-42.4	-5.0
Common Raven (*Corvus corax*)	7	-3.9	0.56	-15.7	9.4
Black-capped Chickadee (*Parus atricapillus*)	14	-15.8*	0.04	-27.8	-1.8
Eastern Tufted Titmouse (*Parus bicolor*)	2	136.8	0.45	76.5	217.8
Red-breasted Nuthatch (*Sitta canadensis*)	7	-13.7	0.087	-25.2	-0.3
White-breasted Nuthatch (*Sitta carolinensis*)	11	-9.7	0.31	-25.5	9.4
Brown Creeper (*Certhia americana*)	11	-4.9	0.38	-14.8	6.1
Winter Wren (*Troglodytes troglodytes*)	12	-7.4	0.12	-15.4	1.4
Golden-crowned Kinglet (*Regulus satrapa*)	5	-13.7	0.14	-26.6	1.5
Ruby-crowned Kinglet (*Regulus calendula*)	5	-1.2	0.92	-20.9	23.4
Veery (*Catharus fuscescens*)	13	-9.7	0.43	-29.7	16.0
Bicknell's Thrush (*Catharus bicknelli*)	2	10.9	0.29	-5.9	30.7
Swainson's Thrush (*Catharus ustulatus*)	5	-4.1	0.51	-14.7	7.7
Hermit Thrush (*Catharus guttatus*)	15	1.0	0.90	-13.0	17.1
Wood Thrush (*Hylocichla mustelina*)	8	0.2	0.98	-16.1	19.8
American Robin (*Turdus migratorius*)	16	22.8	0.06	0	50.8
Gray Catbird (*Dumetella carolinensis*)	2	53.4	0.31	-13.8	173.2
Cedar Waxwing (*Bomycilla cedrorum*)	8	-6.2	0.73	-34.2	33.5
Solitary Vireo (*Vireo solitarius*)	10	-21.7*	0.048	-36.8	-3.0

Table 2. continued.

SPECIES	N	Trend	P Value	Lower CI	Upper CI
Yellow-throated Vireo (*Vireo flavifrons*)	4	-6.2	0.82	-43.8	56.5
Red-eyed Vireo (*Vireo olivaceus*)	15	-5.8	0.45	-19.4	10.0
Nashville Warbler (*Vermivora ruficapilla*)	5	-0.3	0.93	-5.6	5.3
Northern Parula Warbler (*Parula americana*)	3	1.2	0.78	-6.1	9.0
Yellow Warbler (*Dendroica petechia*)	2	48.5	0.23	-39.2	263.0
Chestnut-sided Warbler (*Dendroica pensylvanica*)	6	21.6	0.2	-6.5	58.3
Magnolia Warbler (*Dendroica magnolia*)	6	2.0	0.76	-10.0	15.7
Black-throated Blue Warbler (*Dendroica caerulescens*)	10	-9.8	0.53	-34.3	23.9
Myrtle Warbler (*Dendroica coronata*)	10	-1.3	0.76	-9.2	7.3
Black-throated Green Warbler (*Dendroica virens*)	12	6.5	0.15	-1.9	15.7
Blackburnian Warbler (*Dendroica fusca*)	7	0.6	0.93	-11.3	14.2
Blackpoll Warbler (*Dendroica striata*)	2	-0.1*	0.02	-2.9	2.9
Black And White Warbler (*Mniotilta varia*)	11	2.1	0.64	-6.3	11.3
American Redstart (*Setophaga ruticilla*)	10	22.2	0.068	0.7	48.2
Ovenbird (*Seiurus aurocapillus*)	15	6.7	0.16	-2.2	16.5
Northern Waterthrush (*Seiurus noveboracensis*)	4	2.8	0.87	-24.3	39.5
Mourning Warbler (*Oporornis philadelphia*)	3	-19.9	0.74	-74.4	150.6
Common Yellowthroat (*Geothlypis trichas*)	8	18.6	0.08	0.5	39.8
Canada Warbler (*Wilsonia canadensis*)	7	-13.2*	0.02	-20.5	-5.1
Scarlet Tanager (*Piranga olivacea*)	14	-0.7	0.93	-16.3	17.8
Northern Cardinal (*Cardinalis cardinalis*)	4	-16.7	0.55	-51.9	44.3
Rose-breasted Grosbeak (*Pheuticus ludovicianus*)	11	18.6*	0.02	4.4	34.7
Song Sparrow (*Melospiza melodia*)	4	-10.1	0.38	-26.9	10.7
Swamp Sparrow (*Melospiza georgiana*)	3	72.9*	0.02	47.5	102.7
White-throated Sparrow (*Zonotrichia albicolis*)	9	-0.7	0.89	-9.3	8.8
Slate-colored Junco (*Junco hyemalis*)	11	-4.9	0.30	-13.3	4.4
Red-winged Blackbird (*Agelaius phoeniceus*)	4	33.0	0.48	-34.7	171.0
Common Grackle (*Quiscalus quiscula*)	3	7.2	0.73	-24.7	52.8
Brown-headed Cowbird (*Molothrus ater*)	5	63.0*	0.008	34.0	98.2
Baltimore Oriole (*Icterus galbula*)	2	20.4	0.30	-7.8	57.2
Purple Finch (*Carpodacus purpureus*)	6	32.7	0.06	5.0	67.6
American Goldfinch (*Carduelis tristis*)	8	-13.7	0.36	-36.1	16.7
Evening Grosbeak (*Coccothraustes vespertinus*)	4	-5.4	0.58	-21.1	13.4
Neotropical Migrants in Hardwood Forests	12	1.8*	0.002	0.9	2.7
All Neotropical Migrants	17	0.1	0.95	-2.4	2.6
Resident Species in Hardwood Forests	12	-8.0	0.12	-16.6	1.6
All Resident Species	17	-7.4*	0.04	-13.6	-0.7
Short-distance Migrants in Hardwood Forests	12	-2.4	0.35	-7.2	2.6
All Short-distance Migrants	17	-3.2	0.12	-6.9	0.7

the Adirondak Mountains of New York, and across U.S. Fish and Wildlife Service (USFWS) Region-5, which includes New England, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and West Virginia (Rosenberg and Wells 1995). Migration count data from Long Point Bird Observatory in Ontario further support this downward trend for Canada Warbler with a significant annual decline of 3.7% noted between 1961 and 1988 (Hussell et. al. 1992).

It seems apparent that Canada Warbler is declining over a significant portion (at least 49%) of its breeding range, with USFWS Region-5 comprising 16% of the species' breeding range and Ontario accounting for 33% (Rosenberg and Wells 1995). While the reasons for such a widespread decline may not be immediately apparent, habitat loss on the species' wintering grounds may be a contributing factor. The principle winter habitat of the Canada Warbler is mature, submontane broad-leaved forests in the Andean foothills from Venezuela to southern Peru (Rappole et. al. 1995, Curson et. al. 1994). This region has undergone tremendous habitat change over the past 50 years. By the late 1980s little forested habitat remained that had not been significantly altered by humans (Robbins et. al. 1992). In addition to exploding human populations in Columbia, Venezuela, and Peru, the Andean foothills are highly attractive due to climatic conditions and fertile soils, making it the principle region for large-scale agricultural development. The Cerulean Warbler (*Dendroica cerulea*), which also winters in this region of the Neotropics, although within a narrower ecological zone than the Canada Warbler, has also declined significantly across much of its breeding range. These declines have, at least in part, been attributed to loss of wintering habitat (Robbins et. al. 1992). Likewise, breeding populations of Canada Warblers may be severely affected by loss of wintering habitat. The Canada Warbler, identified as a species deserving special conservation attention (Rosenberg and Wells 1995, James et. al. 1996), warrants intensive study.

Black-capped Chickadee and Solitary Vireo, which declined significantly according to FBMP data, experienced non-significant declines during the same period on Vermont's 23 BBS routes (Table 3). Black-capped Chickadee also showed a non-significant decline on the Ontario FBMP. However, long-term BBS data from the northern New England region (NNE) showed significant positive trends for both Black-capped Chickadee (2.2% per year) and Solitary Vireo (4.6% per year), and short-term data showed non-significant increases for Solitary Vireo on both NNE BBS and Ontario FBMP. These results suggest that the declines in these 2 species from Vermont FBMP and BBS data may reflect short-term population fluctuations and lack real biological significance over the long-term. They may also reflect sampling biases between the FBMP (off-road, stable habitats) and the BBS (roadside habitats in various successional stages).

Further comparison of these data sets reveals that 68% of the Vermont FBMP trends matched those reported on the Vermont BBS during the same time period, suggesting that these two monitoring programs are adequately tracking bird populations (Table 3). Alternately, some of the non-significant FBMP trends that don't agree with the BBS may be explained by the effects of forest fragmentation. Species such as Pileated Woodpecker and Wood Thrush, whose populations increased according to Vermont FBMP data, declined in the more fragmented, road-side habitats sampled by the BBS. Both of these species have been shown to be very sensitive to forest fragmentation, and the nesting success of the Wood Thrush, in particular, is greatly reduced in smaller forested tracts (Robinson 1997).

Population Trends by Wintering Range

Separating the species into wintering groups revealed that Neotropical migrants (N=31 species) sampled in hardwood forests showed a statistically significant increase of nearly 2% per year, but showed virtually no trend when all forested sites were combined (Table 2). In contrast, short-distance migrants (N=23 species) showed small non-significant declines in both hardwood forests and over all sites combined. Year-round residents (N=13 species) declined significantly over all study sites at a rate of 7.4% per year and showed a non-significant decline in samples of hardwood forests only.

The increase of Neotropical migrants in hardwood forests suggests that long-distance migrants experienced successful productivity in the large tracts of mature, unmanaged hardwoods sampled by the FBMP. Sherry and Holmes (1992) showed that the productivity of migrants in New England's large contiguous forests is highly correlated with population changes, and is usually driven by factors such as weather or major insect outbreaks (Holmes et. al. 1986). In Maine, Hagan et. al. (1996) demonstrated that the densities of some Neotropical migrants increased shortly after a forest was fragmented due to displaced individuals moving into available habitat. Along with these higher densities however, the productivity of at least one species, the Ovenbird, was lower in the fragments than in nonfragmented forests. We do not believe the increase observed for Neotropical migrants during the FBMP was due to recent fragmentation effects. With the exception of one FBMP site, Concord Woods, which became a habitat "island" during the study period due to heavy logging around its perimeter, no gross habitat changes were noted in or around other FBMP sites.

Populations of short-distance migrants appeared to be stable during the period, however, the majority of these species occupy early-successional or second-growth habitats and are not well represented in the FBMP data set.

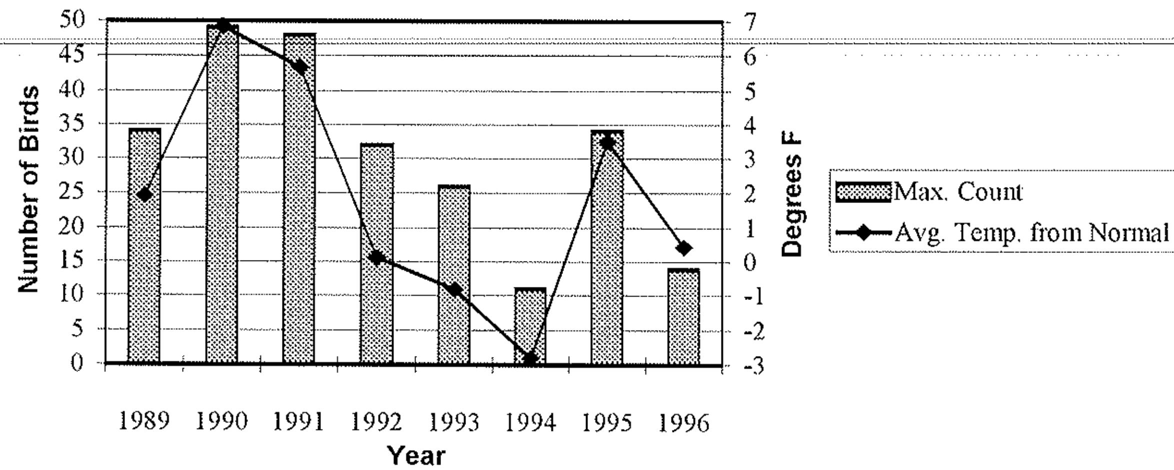
Table 3. Long- and short-term population trends for selected woodland species in Vermont, the northern New England Region (NNE), and Ontario from FBMP and BBS data; * trend is statistically significant at $P < 0.05$; species are listed in taxonomic order.

	TRENDS					
SPECIES	**VT FBMP 1989-96**	**BBS VT 1989-95**	**BBS VT 1966-96**	**BBS NNE 1989-95**	**BBS NNE 1966-95**	**ONT FBMP 1988-94**
Yellow-bellied Sapsucker	11.6	16.2*	1.0	8.6	2.5	3.4
Downy Woodpecker	-18.1	-1.3	-4.9	1.0	0.7	-2.8
Hairy Woodpecker	-15.2	2.0	-4.6*	-2.1	-1.0	6.2*
Pileated Woodpecker	2.9	-3.5	4.8*	16.8	7.9*	-1.2
Eastern Wood Pewee	-2.2	-4.2	-6.0*	-4.8*	-2.9	-3.1
Blue Jay	7.1	1.1	1.4*	2.8*	0.3	-1.5
Black-capped Chickadee	-15.8*	-2.3	-2.0	-1.7	2.2*	-2.1
White-breasted Nuthatch	-9.7	-11.6	-1.3	-0.8	3.2*	-2.4
Brown Creeper	-4.9	-3.0	-6.7	-3.9	-3.4	-3.4
Winter Wren	-7.4	-0.3	-0.4	-7.9*	0.2	5.4*
Veery	-9.7	-2.3	0.2	-2.9*	-0.9*	-9.1*
Hermit Thrush	1.0	3.2	-3.8	4.2	1.3	2.6
Wood Thrush	0.2	-1.1	-1.0	-2.3	-1.2	1.6
Solitary Vireo	-21.7*	-2.5	2.3	1.9	4.6*	9.1
Red-eyed Vireo	-5.8	-2.1	1.7*	-1.0	-0.8	-1.0
Black-throated Blue Warbler	-9.8	-5.3	-0.6	2.8	-0.2	6.4*
Black-throated Green Warbler	6.5	2.4	-6.5	5.7*	-0.6	7.6*
American Redstart	22.2	-8.0*	-2.2	0.04	-1.5	1.9
Ovenbird	6.7	-0.1	0.1	2.1*	0.9	-6.1*
Canada Warbler	-13.2*	-4.4	-3.4*	-2.3	-1.3	1.5
Scarlet Tanager	-0.7	1.3	1.4	-0.3	-1.1	-0.3
Rose-breasted Grosbeak	18.6*	-2.5	2.5	1.3	1.7	-3.3

Winter Weather Effects on Residents

Since northern New England's severe winter weather may limit breeding populations of year-round residents, we compared their relative abundance on FBMP sites to Vermont's average winter temperatures, using National Climatic Data Center weather data that were collected in Montpelier, Vermont. For many species, breeding populations generally followed the average winter temperature change from year to year; however, the Brown Creeper showed a statistically significant correlation between weather and relative abundance (Fig. 2). Brown Creepers do not frequent seed and suet feeders as consistently as other winter resident species, and they have been shown to be susceptible to severe winter weather in other studies (Graber and Graber 1979); it is thus likely that harsh winters result in high mortality, limiting breeding populations. The strong correlation between Brown Creeper breeding populations and winter temperatures further validates the effectiveness of the FBMP in accurately tracking changes in bird populations.

Figure 2. Comparison of maximum counts of Brown Creeper at FBMP sites and average winter temperatures for Vermont in degrees F from normal ($P = 0.002$).



Species Richness

In addition to examining population trends, we determined the species richness and total number of individuals counted at each FBMP site (Table 4). This information provides a site-specific species diversity and relative abundance profile, which can be grouped by habitat type, and will be useful baseline information by which to assess any future changes in bird populations at these sites. A total of 115 species were detected on the 17 FBMP sites monitored between 1989-1996. Not surprisingly, the 2 sites with the lowest species richness and relative abundance, Camel's Hump (22 species) and Mt. Mansfield (23 species), are located in subalpine spruce-fir habitat, while the site of highest species diversity and abundance, Sandbar (63 species), consists of a floodplain forest located on the shores of Lake Champlain.

While instructive, diversity indices may be misleading if high diversity is assumed to be important from a conservation perspective (Hagan et. al. 1997). Sites with a high species diversity are not necessarily higher quality habitats or more important for sustaining viable populations of forest birds than sites with low diversity, but may simply be the result of geographic location, ecotone effects, and/or habitat features such as structure and diversity. For example, Sandbar's high species diversity was due in part to its location on Lake Champlain and the abundance of wetland bird species (e.g. gulls, waterfowl, herons, etc.) that were frequently detected on point counts. At Bald Mt., a hemlock-dominated mixed forest, the high diversity may reflect the fact that both softwood and hardwood species utilized the site, though it may not have been their preferred habitat.

Table 4. Species richness and relative abundance by FBMP site. Sites are ranked by species richness.

Site #	Site Name	Number of Species	Number of Individuals	Avg. Number Indiv./Year
1	Sandbar	63	1,889	236
5	Bald Mt.	58	1,519	190
13	Bear Swamp	57	1,497	214
12	Moose Bog	53	1,353	169
9	Roy Mt.	52	1,282	160
4	Shaw Mt.	52	1,734	217
6	Sugar Hollow	48	1,209	151
3	Cornwall Swamp	43	1,348	169
17	Merck Forest	41	817	163
7	The Cape	41	1,292	162
10	Concord Woods	38	1,328	166
11	May Pond	38	891	149
8	Dorset Bat Cave	37	1,210	173
2	Pease Mt.	32	1,011	126
14	Underhill	32	734	122
15	Mt Mansfield	23	693	116
16	Camel's Hump	22	492	82
	All Sites Combined	115	20,299	2,806

Species Occurrence

We examined occurrence data for 30 selected woodland species and the Brown-headed Cowbird, a brood parasite and forest edge/agricultural species (Table 5). The 2 most abundant species were Ovenbird and Red-eyed Vireo. A total of 1,872 Ovenbirds and 1,620 Red-eyed Vireos were recorded, with average counts of 23 and 20 individuals, respectively, per site visit (note that average counts were calculated only from visits during which the species was reported). On point count stations, these 2 species were also the most widespread, with Ovenbird occurring on 68.1% of all stations and Red-eyed Vireo reported at 67% of station visits. These results are consistent with data from the Vermont Breeding Bird Atlas Project (Laughlin and Kibbe 1985), in which Red-eyed Vireo was detected in 100% of the priority blocks in the state and Ovenbird in 98% of priority blocks.

Among FBMP sites, Ovenbird and Hermit Thrush were the most widespread species, each occurring on 84.6% of all site visits, while Red-eyed Vireo was reported on 74% of site visits. While Hermit Thrush was more widely distributed than Red-eyed Vireo, indicating its tolerance for a greater variety of habitat types, Hermit Thrush populations were less dense, averaging 12 individuals per site visit compared to 20 for Red-eyed Vireo (Table 5). The Atlas of Breeding Birds of Vermont reported Hermit Thrush densities of 5-18 pairs per 40.5 hectares, compared to 44 pairs per 40.5 hectares for Red-eyed Vireos. The greater density of Red-eyed Vireos probably reflects its smaller breeding territories, which average 0.5 hectares in size (range 0.3 - 0.7 ha) (Williamson 1971, Rice 1978), while Hermit Thrush breeding territories average 0.722 hectares (range 0.06 - 3.34 ha) (Martin 1960).

Occurrence data provide a landscape level perspective of population densities and relative abundance of birds breeding in Vermont's forested habitats. Once the FBMP database is overlaid with landscape attributes from a Geographic Information System (GIS) database, and compared to detailed habitat information currently being collected at each site, a better understanding should emerge of how different forest features such as canopy closure, percent ground cover, and vegetation type and structure, affect bird populations.

Table 5. Overall species occurrences for 30 selected species from FBMP data, 1989-1996. Averages are calculated based on positive values only. The total number of site visits was 123, and the total number of station visits was 615. Species are listed in taxonomic order.

		Site			Station		
Species	**Total Count**	**Average Count**	**Maximum Count**	**Percentage of sites**	**Average Count**	**Maximum Count**	**Percentage of Stations**
Yellow-bellied Sapsucker	259	5	19	43.1	2	8	21.8
Downy Woodpecker	199	3	10	47.2	2	5	20.2
Hairy Woodpecker	120	1	7	43.9	1	4	13.8
Pileated Woodpecker	119	2	8	40.7	2	4	12.4
Eastern Wood Peewee	792	14	26	61.0	3	8	44.1
Great Crested Flycatcher	397	7	26	43.1	3	8	25.7
Blue Jay	364	4	11	79.7	1	6	40.0
Black-capped Chickadee	417	6	16	65.9	2	8	34.3
White-breasted Nuthatch	192	4	10	45.5	2	4	18.9
Brown Creeper	248	4	14	48.0	2	5	19.8
Winter Wren	779	11	20	67.5	3	6	45.5
Veery	706	9	28	73.2	3	8	42.3
Hermit Thrush	899	12	34	84.6	3	9	53.5
Wood Thrush	506	9	25	46.3	3	8	31.4
American Robin	402	5	12	69.9	2	9	32.5
Solitary Vireo	260	4	20	42.3	2	6	18.4
Red-eyed Vireo	1,620	20	32	74.0	4	11	67.0
Blk-throated Blue Warbler	796	15	30	50.4	4	8	36.1
Myrtle Warbler	597	9	28	54.5	3	10	34.6
Blk-throated Green Warbler	578	9	19	56.1	3	8	33.5
Blackburnian Warbler	304	8	18	35.8	2	8	20.0
Black and White Warbler	268	4	12	48.8	2	4	20.7
American Redstart	429	7	21	49.6	3	8	25.5
Ovenbird	1,872	23	38	84.6	4	10	68.1
Canada Warbler	242	5	14	37.4	2	6	16.4
Scarlet Tanager	584	8	18	60.2	2	8	39.8
Rose-breasted Grosbeak	540	8	22	60.2	3	6	34.5
White-throated Sparrow	664	12	28	45.5	3	8	32.7
Slate-colored Junco	408	6	14	54.5	2	7	28.1
Brown-headed Cowbird	128	3	9	28.5	2	4	12.9

Brown-headed Cowbirds

The FBMP was designed to monitor forest interior species and to avoid sampling those species, such as Brown-headed Cowbird, associated with the habitat edges created by forest fragmentation. To evaluate our site selection protocol and to determine whether the FBMP effectively samples interior forests and avoids edge species, as well as to determine the extent to which Brown-headed Cowbirds penetrate into interior FBMP forest sites, we examined occurrence data for this species (Table 5).

Brown-headed Cowbird was recorded on 28.5% of all FBMP site visits, and on 12.9% of all visits to FBMP point count stations, with a total of 128 individual occurrences. While these numbers were higher than anticipated for this species, most cowbirds (95.3%) were found at FBMP sites located in the Champlain Lowlands, a physiographic region of the state that is largely agricultural (Fig. 1, Table 6). This corroborates the results of Coker and Capen (1995), who found that cowbirds in Vermont were most likely to occur in forested habitats if they were near large cleared areas (>9.8 hectares) with high concentrations of livestock. Conversely, Coker and Capen (1995) found that small forest openings (< 4 hectares) located at least 7 km from livestock areas were unlikely to attract cowbirds. Airola (1986) demonstrated that distance from a cowbird feeding area was an indicator of the rate of cowbird parasitism; sites that were closer to feeding areas had higher parasitism rates. We suspect that FBMP sites in the Champlain Lowlands may experience relatively high rates of parasitism by Brown-headed Cowbirds, while study sites in the other physiographic regions probably have much lower rates. If so, the fragmented forests of the Champlain Lowlands may act as population sinks, with high rates of brood parasitism and nest predation resulting in extremely low reproductive rates for many migratory species (Brittingham and Temple 1983). At the same time, the large interior forests of nearby areas may support source populations which produce enough surplus birds to sustain the losses of the sinks.

It thus appears that our site selection criteria adequately avoid edge effects for study sites within largely forested regions; however, study sites within the more fragmented landscape of the Champlain Valley may not meet our study design. While we believe that it is important to continue monitoring the Champlain Valley sites, we plan to establish additional study sites within more contiguous forested landscapes. This will enable us to compare data from fragmented and unfragmented sites in future trend analyses, without sacrificing sample sizes and the power of the data to detect trends. How different forest attributes, such as fragmentation, patch size, and distance to agricultural areas, affect bird populations will be more clearly understood when our data are integrated with landscape features from GIS databases.

Table 6. Annual Brown-headed Cowbird occurrences by FBMP site and physiographic region, 1989-1996.

	PHYSIOGRAPHIC	YEAR								
SITE NAME	REGION	1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
Bald Mt.	Champlain Lowlands	3	3	6	5	2	2	2	2	25
Pease Mt.	Champlain Lowlands	0	0	0	3	4	4	4	4	19
Cornwall Swamp	Champlain Lowlands	3	1	1	0	0	4	5	3	17
Sandbar	Champlain Lowlands	5	3	3	0	3	6	0	6	26
Shaw Mt.	Champlain Lowlands	3	9	9	9	5	0	0	0	35
Bear Swamp	North Central	0	0	0	0	2	0	0	0	2
Roy Mt.	East Central	1	0	0	0	0	0	0	0	1
Dorset Bat Cave	Taconics	0	0	1	0	0	0	0	0	1
Merck Forest	Taconics	0	0	0	0	0	1	0	0	1
Sugar Hollow	Taconics	0	1	0	0	0	0	0	0	1
	TOTAL COUNT	15	17	20	17	16	17	11	15	128

Power Analysis

Statistical power analysis has recently gained prominence in applied ecological research (Cohen 1988, Steidl et al. 1997), being advocated to improve research designs and to facilitate interpreting results (Gerrodette 1987). For long-term monitoring projects, statistical power can be defined as the probability that a trend will be detected when the trend is occurring, despite any "noise" in the data. For any monitoring program, it is imperative to assess statistical power in order to determine basic sampling criteria such as the number of sites to be surveyed and the frequency of counts.

We conducted a power analysis of FBMP data for 4 species over 4 different time periods (Table 7). To calculate the power of our data, we used the *Monitor* 6.2 software program (Gibbs 1995),

Table 7. Results of statistical power analysis to detect trends for 4 species over 4 time periods, using FBMP data from 1989-1996. N = number of sites used to calculate power; bold brackets denote power estimates >0.80.

Black-throated Blue Warbler (N=11)

	PERCENT POPULATION CHANGE																				
YEARS	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
10	.984	.982	.978	.904	.892	.824	.656	.454	.214	.112	.028	.130	.350	.670	.900	.990	1.00	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	.998	.988	.984	.952	.862	.584	.222	.030	.284	.848	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.986	.866	.450	.052	.620	.992	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.994	.694	.050	.860	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Ovenbird (N=15)

	PERCENT POPULATION CHANGE																				
YEARS	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
10	1.00	1.00	.994	.994	.974	.908	.788	.606	.372	.130	.046	.126	.464	.840	.968	1.00	1.00	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	1.00	1.00	1.00	.996	.968	.762	.290	.034	.354	.926	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.980	.620	.050	.762	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.998	.850	.052	.958	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Canada Warbler (N=9)

	PERCENT POPULATION CHANGE																				
YEARS	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
10	.992	.974	.948	.886	.844	.738	.578	.460	.220	.092	.046	.092	.326	.626	.850	.978	.998	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	1.00	.998	.980	.944	.818	.582	.218	.046	.280	.772	.988	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.839	.452	.065	.484	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.970	.646	.048	.846	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Hermit Thrush (N=15)

	PERCENT POPULATION CHANGE																				
YEARS	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
10	.992	.980	.958	.928	.858	.778	.634	.442	.234	.110	.066	.100	.324	.642	.896	.982	.998	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	.998	.998	.988	.954	.858	.606	.236	.062	.286	.840	.994	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.990	.888	.410	.048	.520	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.998	.984	.698	.042	.830	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

specifically designed to estimate the statistical power of population monitoring programs to detect trends. The probability that FBMP data would detect a 0-10% population increase or decrease was calculated for 4 Neotropical migrants over 10, 15, 20, and 25 years. Using Black-throated Blue Warbler as an example, after 10 years of data collection, we would only have a 35% probability of detecting a 2% increase for this species should it occur, but we would have a 99% probability of detecting a 5% increase (Table 7).

However, after 15 years of monitoring, our power to detect a 2% increase jumps to 84.8%. In all cases, increasing trends are more readily detected than decreasing trends and small population changes are more difficult to detect than large changes.

The FBMP's power to accurately detect fairly small population changes (2% increases and 3% declines) is adequate for species that are well represented in our data set, especially after 15 years of monitoring. The power analysis suggests that the population trends we detected in Black-capped Chickadee, Solitary Vireo, Canada Warbler, and Rose-breasted Grosbeak, had a high probability of occurring. Considering that 1997 represented the 9th year of data collection, and that additional FBMP sites have been added over the last few years to increase our sample sizes (with plans to establish more sites in upcoming years), future power to detect changes in forest bird populations will increase.

Summary of Results

By accurately monitoring breeding populations for many species of forest-dwelling songbirds in Vermont, we believe that the FBMP is well positioned to contribute to meaningful conservation strategies. An analysis of an 8-year data set has provided preliminary information on population trends and has generated indices of relative abundance, and species diversity and distribution, on both local (site-specific) and landscape levels. These baseline data will be valuable when comparing the results from future analyses, and in assessing future changes in bird populations. Data from the FBMP showed a significant decline in breeding populations of Canada Warbler over the 8-year period, corroborating similar trends from the BBS and Long Point Bird Observatory's migration monitoring program. We believe that Canada Warbler is a species warranting special conservation attention, and one worthy of intensive demographic research on both its breeding and wintering grounds. Our analysis showed a strong correlation between harsh winter temperatures and breeding populations of Brown Creeper, suggesting that severe winters may limit Brown Creepers. Moreover, this correlation suggests that the FBMP accurately detects changes in breeding populations, even if a species' overall trend is not statistically significant.

Using the number of Brown-headed Cowbird occurrences at each study site as a measure of the project's success in avoiding forest edge effects, we established that, out of 17 study sites, the 5 sites located in a highly agricultural region may not meet our study design, while 12 sites within largely forested landscapes effectively avoid edge effects. Future linkage of FBMP data with a GIS database incorporating landscape features (e.g., degree of fragmentation, patch size, surrounding land use patterns, etc.) will enable identification of spatial relationships between geographical features and bird population data. Further, our evaluation of habitat features at each study site will enable us to correlate forest stand composition and structure with bird population data in future analyses.

A power analysis conducted for 4 species using the 8-year data set revealed that the FBMP adequately sampled those species found on more than half of our 17 study sites and the power to detect small population changes will increase dramatically after 15 years of monitoring. These results also indicated that the population trends we detected in Black-capped Chickadee, Solitary Vireo, Canada Warbler and Rose-breasted Grosbeak, probably occurred during the time period analyzed.

Future Goals And Objectives

Future plans for the Forest Bird Monitoring Program include the continuation and expansion of our long-term census in forested habitats of Vermont. The broader goals of the project are to maintain this important baseline of data, to examine the influence of forest fragmentation on migrant songbirds breeding in Vermont, and to implement an effective educational effort that will promote long-term forest management practices that are compatible with viable songbird populations. Data collection will continue to focus on annual censusing of breeding birds in the major forest habitat types of northern New England, with an emphasis on northern hardwoods, lowland spruce-fir, and subalpine spruce-fir. Since 1995, 10 additional FBMP study sites have been established in Vermont, 2 in northern hardwood forests and 8 in subalpine spruce-fir. Several subalpine FBMP sites have also been established in New York, New Hampshire, and Maine.

Specifically, the 5-year objectives of this project include:

1) establishment of 12 additional study sites (6 in lowland spruce-fir, 6 in northern hardwood) to increase the statistical power of the data;
2) recruitment of volunteer birders to census these new monitoring sites;
3) completion of vegetation sampling at each monitoring site, and correlation of habitat data with bird population data analyses;
4) identification and archiving of available GIS data for all monitoring sites to examine the influence of landscape patterns on bird distributions and population trends;
5) collaboration with the CWS and the Ontario FBMP to establish the most effective means of data analysis and to compare data sets;
6) implementation of intensive studies on selected species of concern (e.g. Canada Warbler);
7) initiation of research on demographics and reproductive success at selected FBMP sites that may enable more meaningful interpretation of FBMP data;
8) establishment of partnerships with state and federal forestry professionals in Vermont and development of effective educational materials and programs which promote sustainable forestry on both local and landscape scales;
9) continued production of a bi-annual FBMP Newsletter to increase communication with volunteers, natural resource professionals, and regional scientists, and to generate additional awareness of the program.

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Literature Cited

Anonymous. 1995. Ontario Forest Bird Monitoring Program Newsletter Vol. 5(1), Canadian Wildlife Service, Guelph, Ontario.

Airola, D. A. 1986. Brown-headed Cowbird parasitism and habitat disturbance in the Sierra Nevada. J. Wildl. Manage. 50: 571-575.

Blondel, Jacques, C. Ferry, and B. Frochot. 1981. Point counts with unlimited distance. In: Ralph, C. John; Scott, J. Michael, editors. Estimating numbers of terrestrial birds. Studies in Avian Biology 6: 414-420.

Brittingham, M. C., and S. A. Temple. 1983. Have cowbirds caused forest songbirds to decline? BioScience 33: 31-35.

Cohen, J. 1988. Statistical power analysis for the behavioral sciences. Academic Press, New York, NY. 474pp.

Coker, D. R., and D. E. Capen. 1995. Landscape-level habitat use by Brown-headed Cowbirds in Vermont. J. Wildl. Manage. 59: 631-637.

Collins, B. T., and J. S. Wendt. 1990. The breeding bird survey in Canada 1966-1983: Analysis of trends in breeding populations. Tech. Rep. Series 75. Ottawa, Ontario: Canadian Wildlife Service, Environment Canada.

Curson, J., D. Quinn, and D. Beadle. 1994. Warblers of the Americas: An Identification Guide. Houghton Mifflin Co., Boston, Massachusetts, 252pp.

Donovan, T. M., F. R. Thompson, III, J. Faaborg, and J. R. Probost. 1995. Reproductive success of migratory birds in habitat sources and sinks. Conservation Biology 9: 1380-1395.

Droege, S. 1990. The North American Breeding Bird Survey. Pages 1-4 in Survey designs and statistical methods for the estimation of avian population trends. U.S. Fish and Wildlife Service, Biological Reports 90(1).

Gerrodette, T. 1987. A power analysis for detecting trends. Ecology 68: 1364-1372.

Gibbs, J. P. 1995. Monitor users manual. Version 6.2.

Graber, J. W., and R. R. Graber. 1979. Severe winter weather and bird populations in southern Illinois. Wilson Bull. 91: 88-103.

Hagan, J. M. III, and D. W. Johnston, eds. 1992. Ecology and Conservation of Neotropical migrant landbirds. Smithsonian Institution Press, Washington, D.C.

Hagan, J. M. III, M. W. Vander Haegen, and P. S. McKinley. 1996. The early development of forest fragmentation effects on birds. Conservation Biology 10: 188-202.

Hagan, J. M. III, P. S. McKinley, A. L. Meehan, and S. L. Grove. 1997. Diversity and abundance of landbirds in a northeastern industrial forest. J. Wildl. Manage. 61: 718-735.

Holmes, R. T., T. W. Sherry, and F. W. Sturges. 1986. Bird community dynamics in a temperate deciduous forest: long-term trends at Hubbard Brook. Ecological Monographs 50: 201-220.

Hussell, D.J.T., M.H. Mather, and P.H. Sinclair. 1992. Trends in numbers of tropical- and temperate-wintering migrant landbirds in migration at Long Point, Ontario, 1961-1988. In: Hagan, J. M. III, and D. W. Johnston, editors. Ecology and Conservation of Neotropical migrant landbirds. Smithsonian Institution Press, Washington, D.C., pp. 101-114.

James, F.C., C.E. McCulloch, and D.A. Wiedenfeld. 1996. New approaches to the analysis of population trends in land birds. Ecology 77: 13-25.

Kendall, W. L., B. G. Peterjohn, and J. R. Sauer. 1996. First-time observer effects in the North American Breeding Bird Survey. The Auk 113: 823-829.

Laughlin, S.B., and D.P. Kibbe, eds. 1985. The atlas of breeding birds of Vermont. Univ. Press of New England, Hanover, NH.

Marquis, R. J. and C. J. Whelan. 1994. Insectivorous birds increase growth of white oak through consumption of leaf-chewing insects. Ecology 75: 2007-2014.

Martin, N.D. 1960. An analysis of bird populations in relation to forest succession in Algonquin Provincial Park, Ontario. Ecology 41: 126-240.

Paton, P. W. 1994. The effect of edge on avian nest success: how strong is the evidence? Conservation Biology 8: 17-26.

Rappole, J.H., E.S. Morton, T.E. Lovejoy III, and J.L. Ruos. 1995. Nearctic Avian Migrants in the Neotropics. Smithsonian Institution, Washington D.C., 324pp.

Rice, J. 1978. Ecological relationships between two interspecifically territorial vireos. Ecology 59: 526-528.

Robbins, C.S., D. Bystrak, and P.H. Geissler. 1986. The Breeding Bird Survey: its first fifteen years, 1965-1979. U.S. Fish and Wildlife Service Resource Publication 157, Washington D.C.

Robbins, C.S., J.W. Fitzpatrick, and P.B. Hamel. 1992. A warbler in trouble: *Dendroica cerulea*. In: Hagan, J. M. III, and D. W. Johnston, editors. Ecology and Conservation of Neotropical migrant landbirds. Smithsonian Institution Press, Washington, D.C., pp. 549-562.

Robinson, S. K., J. A. Grybowski, S. I. Rothstein, M. C. Brittingham, L. J. Petit, and F. R. Thompson III. 1993. Management implications of cowbird parasitism for Neotropical migrant songbirds. In: D. M. Finch and P. W. Stangel, editors. Status and management of Neotropical migratory birds. General technical report RM-229, pp. 93-102. U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Robinson, S. K., F. R. Thompson, III, T. M. Donovan, D. Whithead, and J. Faaborg. 1995. Regional forest fragmentation and the nesting success of migratory birds. Science 267: 1987-1990.

Robinson, S. K. 1997. The case of the missing songbirds. Consequences 3(1).

Rosenberg, K.V. and J.V. Wells. 1995. Importance of Geographic Areas to Neotropical Migrant Birds in the Northeast. U.S. Fish and Wildlife Service Report, Region-5, Hadley, MA.

Sauer, J. R., B. G. Peterjohn, and W. Link. 1994. Observer differences in the North American Breeding Bird Survey. The Auk 111: 50-62.

Sauer, J. R., B. G. Peterjohn, S. Schwartz, and J.E. Hines. 1996. The North American Breeding Bird Home Page. Version 95.1. Patuxent Wildlife Research Center, Laurel, MD.

Sherry, T. W., and R. T. Holmes. 1992. Population fluctuation in a long-distance Neotropical migrant: demographic evidence for the importance of breeding season events in the American Redstart. In: Hagan, J. M. III, and D. W. Johnston, editors. Ecology and Conservation of Neotropical migrant landbirds. Smithsonian Institution Press, Washington, D.C., pp. 431-442.

Steidl, R. J., J. P. Hayes, and E. Schauber. 1997. Statistical power analysis in wildlife research. J. Wildl. Manage. 61: 270-279.

Temple, S. A. and J. A. Wiens. 1989. Bird Populations and environmental changes: can birds be bio-indicators? American Birds 43: 260-270.

Terborgh, J. 1989. Where have all the birds gone? Princeton University Press, Princeton, NJ.

Welsh, D. A. 1995. An overview of the Forest Bird Monitoring Program in Ontario, Canada. In: C. J. Ralph, J. R. Sauer, and S. Droege, technical editors. Monitoring bird populations by point counts. General technical report PSW-GTR-149, pp. 93-97. Pacific Southwest Research Station, Forest Service, U.S. Dept. of Agriculture, Albany, California.

Wilcove, D. S. 1985. Nest predation in forest tracts and the decline of migratory songbirds. Ecology 66: 1211-1314.

Williamson, P. 1971. Feeding Ecology of the Red-eyed Vireo and associated foliage-gleaning birds. Ecological Monographs 41: 129-152.