Regional Breeding Bird Monitoring in Western Great Lakes National Forests[1]

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Abstract

We established breeding bird monitoring programs in three National Forests in northern Minnesota (Superior and Chippewa in 1991) and northern Wisconsin (Chequamegon in 1992). A total of 134, 169, and 132 stands (1,272 survey points) have been surveyed annually in these forests through 2002. We examined trends in relative abundance for 53 species in the Chequamegon, 51 species in the Chippewa, and 41 species in the Superior. Thirty-six species were also tested for regional trends by combining data from the three forests. Twenty-four species increased significantly ($P < 0.05$) in at least one forest and 23 species decreased. Six species had significant increasing regional trends and ten had significant decreasing trends. The most convincing increasing regional trends ($P < 0.01$) were Least Flycatcher (*Empidonax minimus*) and American Redstart (*Setophaga ruticilla*). The most convincing regional decreasing trends were Eastern Wood-Pewee (*Contopus virens*), Winter Wren (*Troglodytes troglodytes*), Hermit Thrush (*Catharus guttatus*), and Song Sparrow (*Melospiza melodius*). Species with increasing trends were early- to mid-successional, deciduous forest species that nest in the shrub or subcanopy layers, whereas species with decreasing trends were mature forest species, many of which nest on the ground. Nest predation may be having negative effects on declining ground-nesters. In a comparison of 35 species, our trends and BBS trends from strata 20 and 28 were the same for 10 species. Inconsistencies in trends were likely due to differences in area included to calculate trends and sampling methods. Our monitoring data have been used extensively by the Forest Service and Minnesota and Wisconsin for a variety of activities related to bird conservation in this region. In addition, bird/habitat data have been used to develop forest management planning software applications.

Key words: breeding birds, monitoring, Great Lakes, forests, population trends.

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Introduction

In response to the need for National Forests to monitor management indicator species, we established long-term forest breeding bird monitoring programs in 1991 on the Chippewa and Superior National Forests in northern Minnesota and in 1992 on the Chequamegon National Forest in northern Wisconsin. Although large-scale population monitoring programs such as the U.S. Geological Survey's Breeding Bird Survey (BBS) provide important information on trends at a continental scale, limited coverage in specific regions like a National Forest can make it difficult to use BBS data to characterize population trends locally (Peterjohn et al. 1995). For example, there are only five BBS routes in the Superior, four routes in the Chippewa, and three routes in the Chequamegon. Our objectives for monitoring were to: (1) establish off-road and habitat specific monitoring programs in each forest, (2) create bird-habitat relationships relevant to the Forest Service cover classification system, (3) establish potential links between population trends and habitat or landscape changes, and (4) develop bird species linkages with forest models used in forest management (Hanowski and Niemi 1995).

In addition to providing population trend information for each National Forest, we leveraged their investment (about $600,000 over 12 years) with over three million dollars in state and other funding sources to accomplish the third and fourth objectives. In this paper we briefly describe our monitoring program and report on: 1) current population trends detected over the past 12 years; 2) how these trends compare to BBS trends from the same physiographic region; and 3) how these data have contributed to bird conservation efforts in this region.

Methods

Sampling Design

Sampling design and point count methods used in our program follow national and regional standards (Ralph et al. 1993, 1995; Howe et al. 1997). The monitoring program was designed to integrate with each National Forest's method of describing forest cover types (Hanowski and Niemi 1995). The sampling unit in our design is a forest stand that is ≥16 ha (40 acres), which is the minimum size needed for three non-overlapping 100 m-radius point counts. Stands within each of the Forests are stratified and proportionately sampled by forest cover type, so that our sample of stands is representative of the area available in each Forest. Four to five stands (12 to 15 points) are the maximum number that can be sampled by one person in a single morning. Thus, stands were selected in a random manner but in a way to accommodate access and travel time between stands. A total of 134, 169, and 132 stands (1,272 survey points) were established in the Chippewa, Superior, and Chequamegon National Forests, respectively (*Figure 1*).

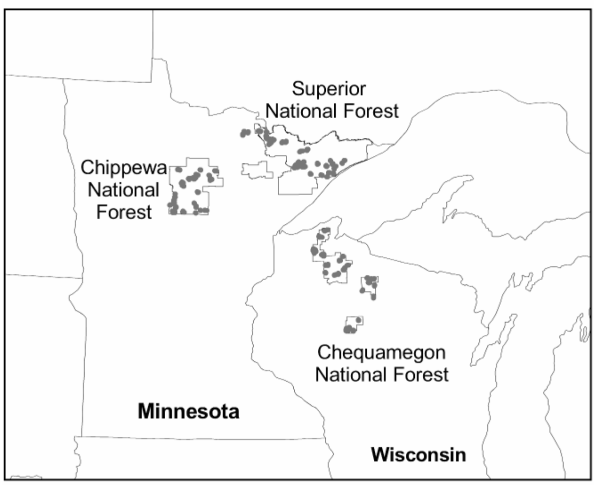

Figure 1— General locations of breeding bird points in the Chippewa, Superior and Chequamegon National Forests.

Bird Sampling

Ten-minute point counts were conducted at each point between June and early July (Reynolds et al. 1980). Point counts are appropriate for characterizing relative abundance of most singing passerine species, but are inadequate for waterfowl, grouse, and most raptors. In addition, because our surveys are conducted during the summer months, we may underestimate the relative abundance of early nesting species (e.g., permanent residents such as woodpeckers and chickadees).

Point counts were conducted by experienced and trained observers from approximately 0.5 hour before, to four hours after, sunrise on days with little wind (< 15 km/hr) and little or no precipitation. All birds heard or seen from the point were recorded with estimates of their distance from that point. We used number of birds observed within 100 m of the point count center in data analyses, primarily based on results from training observers over the past 20 years. In training sessions, we have found that it is difficult to standardize distance estimates among observers for 150 plus bird species that we encounter in our surveys. We have found that it is much easier and more realistic to train observers to consistently identify birds within and outside the 100 m radius circle. In addition, because our main objective is to calculate population trends with our point count data, and data are collected identically from year to year, counts within the 100 m radius circle are suited for this objective.

The number of individuals observed for each species can also be summed for 3-, 5-, and 10-minute periods so that regional comparisons are possible with data gathered using 3- or 5-minute point counts. To minimize bias due to observer differences in sampling different forest cover types, each observer sampled a similar number of stands of each forest cover type. Weather data (cloud cover, temperature, and wind speed) and time of day were recorded before each count.

Prior to the field season, tapes of 120+ bird songs were provided as a learning tool, and all observers were required to pass an identification test of 75 bird songs made by Cornell University's Laboratory of Ornithology. A standard for number of correct responses was established by giving the test to observers who were trained in identifying birds by sound, and who had four to five years of field experience. This was done to identify songs on the tape that were not good representations of songs heard in northern Minnesota and Wisconsin. Based on results of trained observers, the standard for passing was set at 85 percent correct responses. Songs on the tape were grouped by habitat (e.g. upland deciduous, lowland coniferous) to simulate field cues that would aid in song identification.

Observer field training was conducted during the last week of May in the Superior National Forest. Observers conducted simultaneous practice counts at several points used in the monitoring program. Data were compiled for each observer, and species lists and numbers of individuals recorded on the count by each observer were compared to that of experienced observers. Deviations from the average or species missed were noted on the field sheets and returned. In addition to field training and testing, all observers were required to have a hearing test to ensure that their hearing was within normal ranges, as established by audiologists, for all frequencies (125 to 8000 hertz).

Table 1— *Trends for five study areas and regional analysis (three National Forests (NF) combined) based on LOESS-regression. I = significantly increasing, D = significantly decreasing, * P ≤ 0.05, ** P ≤ 0.01.*

Species	Scientific name	Chequamegon NF	Chippewa NF	Superior NF	Regional
Yellow-bellied Sapsucker	*Sphyrapicus varius*	ns	D**	ns	ns
Downy Woodpecker	*Picoides pubescens*		ns		
Hairy Woodpecker	*Picoides villosus*	ns	ns		
Olive-sided Flycatcher	*Contopus borealis*		ns		
Eastern Wood-Pewee	*Contopus virens*	D**	D**	D**	D**
Yellow-bellied Flycatcher	*Empidonax flaviventris*	I*	ns	I**	I**
Alder Flycatcher	*Empidonax alnorum*	ns	ns	ns	I*
Least Flycatcher	*Empidonax minimus*	ns	I**	ns	I**
Great Crested Flycatcher	*Myiarchus crinitus*	ns	D*		
Eastern Kingbird	*Tyrannus tyrannus*	I*			
Yellow-throated Vireo	*Vireo flavifrons*		ns		
Blue-headed Vireo	*Vireo solitarius*	ns	I**	ns	ns
Red-eyed Vireo	*Vireo olivaceus*	I**	ns	I*	I*
Blue Jay	*Cyanocitta cristata*	ns	ns	ns	ns
Black-capped Chickadee	*Poecile atricapillus*	ns	I**	I**	ns
Red-breasted Nuthatch	*Sitta canadensis*	ns	I*	ns	ns
White-breasted Nuthatch	*Sitta carolinensis*	ns	ns		
Brown Creeper	*Certhia americana*	ns	ns	ns	D**
House Wren	*Troglodytes aedon*	ns			
Winter Wren	*Troglodytes troglodytes*	D**	D**	D**	D**
Golden-crowned Kinglet	*Regulus satrapa*	ns	ns	ns	ns
Ruby-crowned Kinglet	*Regulus calendula*			D**	
Veery	*Catharus fuscescens*	D*	ns	D*	D*
Swainson's Thrush	*Catharus ustulatus*			I*	
Hermit Thrush	*Catharus guttatus*	D**	D**	ns	D**
Wood Thrush	*Hylocichla mustelina*	I**			
American Robin	*Turdus migratorius*	ns	ns	ns	ns
Gray Catbird	*Dumetella carolinensis*		I**		
Brown Thrasher	*Toxostoma rufum*	ns			
Cedar Waxwing	*Bombycilla cedrorum*		I**		
Golden-winged Warbler	*Vermivora chrysoptera*	ns	ns	ns	ns
Tennessee Warbler	*Vermivora peregrina*			ns	
Nashville Warbler	*Vermivora ruficapilla*	D**	ns	ns	ns
Northern Parula	*Parula americana*	ns	ns	I**	I**
Yellow Warbler	*Dendroica petechia*		D**		
Chestnut-sided Warbler	*Dendroica pensylvanica*	I**	I**	ns	ns
Magnolia Warbler	*Dendroica magnolia*		ns	I**	
Yellow-rumped Warbler	*Dendroica coronata*	ns	ns	ns	ns
Black-throated Green Warbler	*Dendroica virens*	ns	ns	D**	ns
Blackburnian Warbler	*Dendroica fusca*	I**	ns	ns	ns
Pine Warbler	*Dendroica pinus*	ns	ns	I**	ns
Palm Warbler	*Dendroica palmarum*		ns		
Black-and-white Warbler	*Mniotilta varia*	D**	I**	ns	ns
American Redstart	*Setophaga ruticilla*	I**	I**	ns	I**

Table 1. (continued)

Species	Scientific name	Chequamegon NF	Chippewa NF	Superior NF	Regional
Ovenbird	*Seiurus aurocapillus*	D*	D**	ns	D*
Northern Waterthrush	*Seiurus noveboracensis*	I*		ns	
Connecticut Warbler	*Oporornis agilis*		D**		
Mourning Warbler	*Oporornis philadelphia*	ns	D**	ns	ns
Common Yellowthroat	*Geothlypis trichas*	D**	D*	D**	D**
Canada Warbler	*Wilsonia canadensis*	ns	ns	ns	ns
Scarlet Tanager	*Piranga olivacea*	ns	D**	ns	D**
Eastern Towhee	*Pipilo erythrophthalmus*	I*			
Chipping Sparrow	*Spizella passerina*	ns	ns	D**	ns
Clay-colored Sparrow	*Spizella pallida*	ns			
Vesper Sparrow	*Pooecetes gramineus*	I*			
Song Sparrow	*Melospiza melodia*	D**	D**	ns	D**
Swamp Sparrow	*Melospiza georgiana*	ns	ns	I**	ns
White-throated Sparrow	*Zonotrichia albicollis*	ns	D**	D*	D**
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	ns	ns	D**	ns
Indigo Bunting	*Passerina cyanea*	ns	I**		
Red-winged Blackbird	*Agelaius phoeniceus*	D**			
Brewer's Blackbird	*Euphagus cyanocephalus*	ns			
Brown-headed Cowbird	*Molothrus ater*	ns	D**		
Purple Finch	*Carpodacus purpureus*		ns		
American Goldfinch	*Carduelis tristis*	ns			
Evening Grosbeak	*Coccothraustes vespertinus*	D*			

Data Analysis

The aim of our work was to describe the status of bird populations in each National Forest. We accomplished this using a two-fold approach: 1) by describing the trajectory of the population path of each species through time, and 2) by evaluating whether the trend of the population path represented a significant increase or decrease since the study began (Link and Sauer 1997). To describe both of these components, we built statistical models of species relative abundance as a function of time.

For each species, yearly relative abundance was calculated using birds detected within 100 m of each point by summing the number of individuals of each species across two points per stand. In order to avoid double-counting of individuals, data from the two farthest separated points within a stand were analyzed. Stands were included in the analysis only if they had been sampled in at least six years. Data were included for a species if it was observed on a minimum of five stands per study area and in at least three years on each stand. For species that were observed on a minimum of five stands in each of the three National Forests, we pooled all stands and carried out an additional regional analysis (three National Forests combined). Although this regional analysis does not include lands in non-federal ownership, it should give an indication of population trends at a larger scale than the individual National Forest.

We used a non-parametric route regression procedure similar to that described by James et al. (1996) to characterize population trajectories. This method allowed us to use relative abundance from the sampling unit to describe populations across entire study regions, without assuming a specific pattern of population change (e.g., a linear population trajectory). For each sampling unit, a non-linear estimate of trajectory was calculated for each species by using locally-weighted regression (LOESS) to model species abundance as a smooth function of year. In LOESS-regression, fitted values (points along the curve) for years are calculated by giving a small amount of weight to neighboring years. For example, a year with high raw abundance for a species would tend to bring up the fitted values for the year before and the year after. Overall mean relative abundance for each species in each study area was then calculated by averaging the smoothed (fitted) relative abundance across all stands in each year. The individual fitted values were used in a bootstrap procedure to estimate a 95 percent confidence interval around each year's mean. By plotting the mean fitted values and confidence intervals in a time series, we get a graphic depiction of the population trajectory (see web site www.nrri.umn.edu/mnbirds/).

When we characterized population trajectories, we did not assume that the paths were linear. Changes in relative abundance over a specific time interval (population trends), however, can be viewed as linear, or directional changes (Urquhart and Kincaid 1999). Therefore, we used linear methods to detect trends, without ever asserting that the population trajectory was linear. To assess whether populations have increased or decreased, we modeled the relationship between mean fitted values (i.e. relative abundance) and time using simple linear regression. We used the slope coefficient to characterize magnitude and direction of the trend and change in mean relative abundance per year. Trends were considered significant at the $P < 0.05$ level. All statistical analyses were conducted in S-Plus (MathSoft, Inc. 1999).

We used BBS trends from 1990-2000 in the combined strata 20 and 28 (Sauer et al. 2001) and compared these trends to our trends over the same time period. We used trends created by the BBS web site (Sauer et al. 2001). These two strata include all the area where our points are located but extend beyond Minnesota and Wisconsin primarily to the east (Sauer et al. 2001). Note that trends reported in *table 1* are from 1991 or 1992 through 2002. The comparison of our trends with BBS are from the time period up to 2000 and may not be the same as those reported in *table 1* (see Lind et al. 2000).

Results

Sixty-six species were tested for trends in at least one forest, including 53 in the Chequamegon, 51 in the Chippewa, and 41 in the Superior (*table 1*). Additionally, 36 species were tested for a "regional" (three National Forests combined) trend.

Of the 53 species tested for trends in the Chequamegon, 10 species (19 percent) increased significantly and 11 (21 percent) decreased (*table 1*). The most convincing increases ($P < 0.01$) were those of the Red-eyed Vireo (*Vireo olivaceus*) and American Redstart (*Setophaga ruticilla*). The most convincing declines were those of the Eastern Wood-Pewee (*Contopus virens*), Winter Wren (*Troglodytes troglodytes*), Hermit Thrush (*Catharus guttatus*), and Common Yellowthroat (*Geothlypis trichas*).

Of the 51 species tested in the Chippewa National Forest, ten species (20 percent) increased significantly and 14 (27 percent) decreased (*table 1*). The largest increases were those of the Least Flycatcher (*Empidonax minimus*), Cedar Waxwing (*Bombycilla cedrorum*), Chestnut-sided Warbler (*Dendroica pensylvanica*), and American Redstart. The Eastern Wood-Pewee, Winter Wren, Hermit Thrush, Ovenbird (*Seiurus aurocapillus*), Connecticut Warbler (*Oporornis agilis*) Mourning Warbler (*Oporornis philadelphia*), Song Sparrow (*Melospiza melodia*), and Brown-headed Cowbird (*Molothrus ater*) each had decreasing trends.

Of the 41 species tested in the Superior National Forest, eight species (20 percent) increased, and nine (22 percent) decreased (*table 1*). The most significant increases were those of the Black-capped Chickadee (*Poecile atricapillus*) and Magnolia Warbler (*Dendroica magnolia*). The most convincing decreasing trends were those of the Eastern Wood-Pewee and Winter Wren.

Of the 36 species tested for a regional trend, six species (17 percent) increased significantly and ten (28 percent) decreased (*table 1*). The most significant increases were those of the Least Flycatcher and American Redstart. The most convincing declines were those of the Eastern Wood-Pewee, Winter Wren, Hermit Thrush, and Song Sparrow.

In a comparison of 35 species, our regional trends and BBS agreed on trends for ten species (*table 2*). Overall, our regional trend data detected 11 decreases, four increases and 20 non-significant trends. In contrast, BBS trends found nine decreases, 11 increases and 15 non-significant trends. Opposite trends were found for Winter Wren and Hermit Thrush and for 23 species, either our trend or BBS were non-significant while the other trend was either increasing or decreasing.

Discussion

Most of the species we monitor exhibit large annual fluctuations in abundance, a phenomenon that has been documented on several other long-term studies (Virkkala 1991, Blake et al. 1994, Wesolowski and Tomialojc 1997, Holmes and Sherry 2001). Long-term monitoring studies are important for differentiating between these short-term fluctuations and actual long-term trends. The majority of species tested had non-significant trends. Species such as the Least Flycatcher, Red-eyed Vireo, American Redstart, and Chestnut-sided Warbler have increased in multiple study areas since the early 1990's and may be benefiting from current and past management practices, including the creation of early- to mid-successional deciduous forest types. All of these species nest above the ground and

Table 2— *Comparison of Natural Resources Research Institute (NRRI) regional trends (1991-2000) with Breeding Bird Survey (BBS) trends from the northern spruce/hardwoods (strata 28) and the Great Lakes transition (strata 20) physiographic strata combined.*

	NRRI Trends		
BBS Trends	**Increase**	**Decrease**	**Not significant**
Increase	Northern Parula	Winter Wren Hermit Thrush	Alder Flycatcher Blue-headed Vireo Red-eyed Vireo Blue Jay Black-capped Chickadee Yellow-rumped Warbler Black-throated Green Warbler Swamp Sparrow
Decrease		Eastern Wood-Pewee Ovenbird Song Sparrow	Least Flycatcher Veery Golden-winged Warbler Mourning Warbler Rose-breasted Grosbeak Chestnut-sided Warbler
Not significant	Yellow-bellied Flycatcher Red-breasted Nuthatch American Redstart	Brown Creeper Black-and-white Warbler Common Yellowthroat Canada Warbler Scarlet Tanager White-throated Sparrow	Golden-crowned Kinglet American Robin Nashville Warbler Blackburnian Warbler Pine Warbler Chipping Sparrow

are habitat generalists in this region. Some of the increasing species have relatively high conservation value (e.g. Least Flycatcher, Chestnut-sided Warbler), according to the Partners in Flight (PIF) prioritization scheme (Carter et al. 2000). This status is partly due to their declines based on BBS surveys (Least Flycatcher and Chestnut-sided Warbler).

There are, however, a number of species whose declining population trends warrant concern. Species such as the Eastern Wood-Pewee, Winter Wren, Hermit Thrush, and Connecticut Warbler have shown consistent declines and may need special management consideration. Many of the declining species breed in mature forests, and many are ground-nesters. Some of these population declines may be linked to recent changes in the landscape, especially in light of regional studies showing high nest predation on ground-nests near forest edges. Several of these declining species also have high PIF conservation values (e.g. Eastern Wood-Pewee, Connecticut Warbler), and the extensive forests of northern Minnesota and Wisconsin may represent an opportunity to provide source populations for many species.

The landscapes surrounding our study areas are primarily forested, but there are indications that the landscape has shown signs of increased fragmentation in recent years. Wolter and White (2002) used satellite data from northeastern Minnesota between 1990 and 1995 and demonstrated a substantial decrease in patch size and interior forest area and a significant increase in edge density in early successional forest types. Some studies have shown that nesting success is reduced in fragmented landscapes, probably due to an increase in generalist nest predators (Robinson et al. 1995, Donovan et al. 1997). In the forested landscapes of the upper Midwest, recent studies have found higher predation rates on ground nests near forest/clearcut edges than in interior areas (Fenske-Crawford and Niemi 1997, Manolis et al. 2000, Flaspohler et al. 2001). Data from the Minnesota Department of Natural Resources winter track survey (Berg 2001) between 1991 and 2000 indicate a peak in track indices in 1995 for potential ground nest predators such as fisher (*Martes pennati*) and pine marten (*Martes martes*), which loosely follows the declines between 1994 and 1996 in many of the species we monitor. Nonetheless, the effects of nest predation on population trends in this study are unknown. It is also possible that more than one factor may be causing the observed pattern, or that ground nesting may be a surrogate for some unknown factor(s).

It is not surprising that our trends and BBS trends agree for only a third of the species compared. Differences in methods (on versus off-road) and sizes of regions used to characterize trends probably contribute to these discrepancies. The BBS stratum covers a much larger area and extends to the east coast. This result reinforces the need for regional monitoring programs that more clearly identify species of conservation concern for smaller geographic areas such as a National Forest or State.

Our habitat specific monitoring program has provided valuable information to the National Forests, and several other State (Minnesota Department of Natural Resources, Forest Resources Council) and Federal (Environmental Protection Agency) agencies. We have made this information easily available to Forest Service personnel that are involved with forest management activities via a web site where information can be queried and downloaded. Several types of queries can be conducted on our web site that provide information on species distributions (maps), life history information (species accounts), and habitat specific relative abundance information. These data have also been used to evaluate the proposed Chippewa and Superior National Forest plan revisions. For example, we linked our bird data to forest cover data that were modeled for seven alternatives that have been proposed for managing the Forests for the next 15 years. We evaluated the relative impacts that the different alternatives would have on breeding birds and recommended which alternative would best address breeding bird conservation in these Forests.

Our habitat specific monitoring program also has provided data for forest planning software applications (see www.nrri.umn.edu/SUSTAIN and www.nrri.umn.edu/mnbirds/), for regional species specific conservation assessments (Hanowski 2002), for an extensive environmental impact statement (Jaako Pöyry Consulting 1993), and for regional bird conservation planning (http://www.uwgb.edu/birds/great lakes/).

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