*2000 Annual Update Report:*

# Breeding bird monitoring in Great Lakes National Forests: 1991-2000

Report to: Chequamegon/Nicolet, Chippewa and Superior National Forests

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## SUMMARY

- A total of 135, 168, and 133 stands (1,268 survey points) were surveyed for breeding birds in the Chippewa, Superior, and Chequamegon National Forests, respectively. Surveys have been completed for ten years in the Chippewa and Superior, and for nine years in the Chequamegon NF.

- Breeding bird surveys in the St. Croix region of Minnesota have been conducted over the last nine years at 171 points. Surveys in southeast Minnesota have been conducted over the last six years at 211 points.

- We were able to examine trends in abundance for 72 bird species in at least one of the five study areas. Fifty species in the Chequamegon NF, 40 species in the Superior NF, 47 species in the Chippewa NF, 36 species in the St. Croix region, and 36 species in Southeast Minnesota were tested.

- Twenty-nine species showed a significant increase ($P \leq 0.05$) in at least one of the five study areas, and 23 species showed a significant decrease. The Least Flycatcher showed significant increases ($P < 0.01$) in two study areas and the American Robin increased in three study areas. The Eastern Wood-Pewee, Black-and-white Warbler, and Brown-headed Cowbird showed significant declines ($P < 0.01$) n two study areas and the Common Yellowthroat and White-throated Sparrow declined in three study areas.

- Nine (18%) of the species tested in the Chequamegon NF had increasing trends and nine (18%) had decreasing trends. In the Chippewa NF, 12 (26%) of the species tested increased significantly and 10 (21%) decreased. Seven (18%) of the species tested in the Superior NF had significant increasing trends, and seven (18%) had decreasing trends. In the St. Croix study area, six (17%) of the species tested increased significantly, and seven (19%) decreased. In the Southeast, ten (28%) species increased significantly and three (8%) decreased.

- The regional analysis of the three National Forests combined revealed five species (14%) with significant increases: Yellow-bellied Flycatcher, Least Flycatcher, Red-breasted Nuthatch, American Robin, and American Redstart. Six species (17%) had significant decreases: Eastern Wood-Pewee, Ovenbird, Canada Warbler, Scarlet Tanager, Song Sparrow, White-throated Sparrow.

- Over 70% of the decreasing species nest on the ground, which is significantly more than would be expected. Ground-nesting species that declined in multiple study areas, such as the White-throated Sparrow, Common Yellowthroat, Black-and-white Warbler, and Ovenbird, warrant closer attention in the future.

- Neither increasing nor decreasing species showed a relationship with any particular migration strategy, although no permanent residents declined significantly.

- The abundance of many species varied over the survey period but did not show significant increases or decreases. A common thread among many species was a decline in abundance between 1994 and 1996, with an increase from 1996 to 1998. The reason for this pattern is unclear, but it may be related to winter and spring weather.

## INTRODUCTION

Concerns about the status of continental forest breeding birds have been raised in recent years for a variety of reasons (Lynch and Whigham 1984, Terborgh 1989, Hagen and Johnston 1992, Finch and Stangel 1993, Martin and Finch 1995). Several species may be declining in abundance in some regions of North America, possibly due to forest fragmentation on the breeding grounds, deforestation on wintering grounds in the tropics, or other factors (Robbins et al. 1989, Robinson et al. 1995). 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, however, detection of population trends in smaller geographic areas is problematic (Peterjohn et al. 1995). Also, continental trends have the potential to mask regional population trends (Holmes and Sherry 1988), thus there is a need for regional monitoring programs that provide more specific information (Green 1995, Howe et al. 1997).

In response to the need for regional data, a long-term forest breeding bird monitoring program was established on the Chippewa and Superior National Forests in 1991, the Chequamegon National Forest and the St. Croix region of east-central Minnesota in 1992, and in Southeast Minnesota in 1995. Currently, 818 stands (1,650 points) within the five study areas are monitored during each breeding season.

The primary objective of this report is to update National Forest Service personnel on results of the forest bird monitoring program. We focus on abundance trends of individual species, as well as assemblages of species, over the six to ten year time frame of the monitoring. Our intent is to summarize the most important results and provide detailed information in appendix form for those who need more specific results. Other objectives, including bird/habitat and bird/landscape relationships, development of management recommendations for birds, and development and monitoring of the forest plan, are being met through ongoing work as part of Minnesota's Forest Bird Diversity Initiative.

## DESIGN AND METHODS

### *Experimental Design*

Experimental design and point count sampling used in our program follow national standards (Ralph et al. 1993, 1995). The monitoring program also was designed so that it would integrate with each National Forest's method of describing vegetation cover types (Hanowski and Niemi 1995). The sampling unit in our design is a forest stand that is ≥ 16 ha (40 acres), the minimum size needed for three non-overlapping point counts. Stands within each of the National Forests are stratified by forest type so that our sample of stands is representative of the area available in each Forest. Four to five stands (12 to 15 points) is the maximum amount that can be sampled by one person in a single morning. Thus, stands were selected in a restricted random manner to accommodate access and travel time between stands. A total of 135, 168, and 133 stands (1,268 survey points) were established in the Chippewa, Superior, and Chequamegon National Forests, respectively.

The difference in the design between the three National Forests and the St. Croix and Southeast Minnesota study areas is the sampling unit. Because forest patches in the St. Croix region and Southeast Minnesota are generally small (< 16 ha), only one survey point could be placed in each stand. For these study areas, a stand had to be at least 4 ha (10 acres) in size. Points were stratified in a similar fashion as stands in the National Forests with restrictions based on access and travel time. A total of 171 and 211 sampling points were established in St. Croix and Southeast study areas, respectively (Figure 1).

### *Sampling*

Ten-minute point counts were conducted at each point during June and early July (Reynolds et al. 1980). This method is appropriate for determining the relative abundance of most singing passerine species, but is inadequate for waterfowl and most raptors. In addition, because only one survey is conducted in June or early July, this method may underestimates the relative abundance of early nesting species (e.g., many permanent residents that begin breeding in April, including woodpeckers and chickadees).

Point counts were conducted by trained observers (see observer training section below) from approximately 0.5 hour before to 4 hours after sunrise on days with little wind (< 15 km/hr) and little or no precipitation. All birds heard or seen from the center point were recorded with estimates of their distance from that point. From 1991 to 1994, all

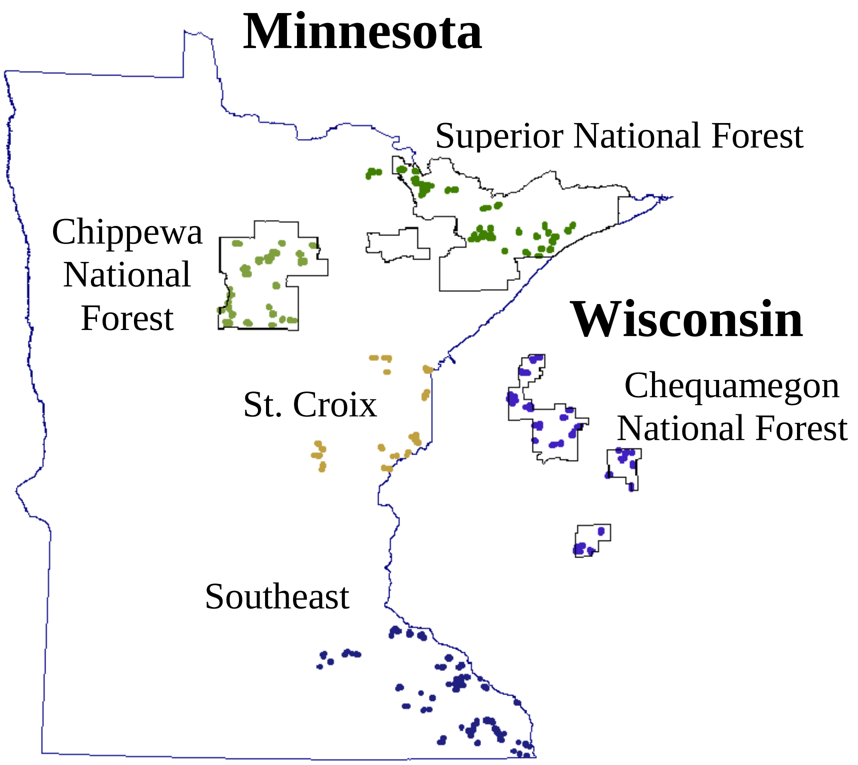


Figure 1. General locations of breeding bird point counts in five regions of Minnesota and Wisconsin.

birds heard or seen within 100 m of the point count center were recorded. In 1995, we changed our methods to include all birds heard or seen from the census point so that our results could be compared with other monitoring programs in this region (see Howe et al. 1997). The number of individuals observed for each species can 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.

We attempt to have each observer sample a similar number of stands of each forest cover type. This is done to minimize bias caused by observer differences in sampling different forest cover types. Weather data (cloud cover, temperature, and wind speed) and time of day was recorded before each count. Counts that had rain throughout the entire census or excessive winds (> 15 km/hr) were dropped from the analyses for that particular year.

***Observer training***

Prior to the field season, tapes of 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%

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).

***Analysis***

The aim of our work was to describe the status of bird populations in each of our study areas. We attempted to accomplish 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 represents a significant increase or decrease since the study began (Link and Sauer 1997). In order to describe both of these components, we built statistical models of species' relative abundance as a function of time.

*Relative abundance*

We used a set of quality criteria to ensure that our analysis provided reliable population information. Sampling units (stands or sites) were included in the analysis only if they had been sampled in at least six years for the four northern study areas, and at least four years in Southeast MN. Species were used only if they were 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 set of regional analyses.

Only the sampling units and species that met the quality criteria were used to calculate yearly relative abundance. Because the sampling unit varied between forest regions, yearly relative abundance was calculated using methods specific to each region. For the three national forests and the St. Croix region, we used birds detected within 100 m of the sampling point. This was done to avoid confounding population trends with the expected increase in species observations due to the change to an unlimited radius in 1995. Relative abundance for species from the three national forests was calculated 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 stands were analyzed. For the St. Croix region, where the point is the sampling unit, relative abundance is the count of individuals of each species at each point. Points in Southeast MN have been sampled using an unlimited radius in all years, and at each point we used the count from the unlimited radius as the measure of relative abundance.

*Population trajectory*

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). In addition, because we used a non-parametric technique, we were not limited to data that met assumptions of normality. Relative abundances (counts) often are not normally distributed.

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. An overall mean relative abundance for each species in each study area was then calculated by averaging the fitted (smoothed) relative abundance across all stands in each year. The individual fitted values were used in a bootstrap procedure to estimate a 95% 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 (Appendix A).

*Population trend*

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 trend, 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 and time using simple linear regression. In addition, we used the slope coefficient to characterize direction of the trend and the change in mean relative abundance per year. All statistical analyses were conducted in S-Plus (MathSoft, Inc. 1999). An important limitation to keep in mind with regards to the linear regression method is that variation in annual mean abundance was not accounted for, which may have resulted in an artificially large number of species with significant trends. However, we feel that this method better reflects the population change over the entire span of the study, compared to the confidence interval method, which uses only the first and last years. Confidence intervals have been included as another method of interpreting population change, however, results from this method are not discussed here (Appendix A). Non-overlap between the first and last years of monitoring indicates a significant trend ($P < 0.05$), keeping in mind that an "outlier" during the first or last year may have a strong effect on the significance of the trend.

*Breeding Bird Survey Trends*

Trends derived from this study were also compared to trends from the U.S. Geological Survey's Breeding Bird Survey (BBS). The BBS is a nation-wide volunteer-based roadside survey, and is a major source of information for trends in regional and continental bird populations (Robbins et al. 1986). Comparisons were made with BBS data from four regions: the Northern Spruce/Hardwoods, Great Lakes Transition, and

Driftless Area physiographic regions, as well as Minnesota statewide (Figure 2). Note that the three physiographic regions extend across multiple states.

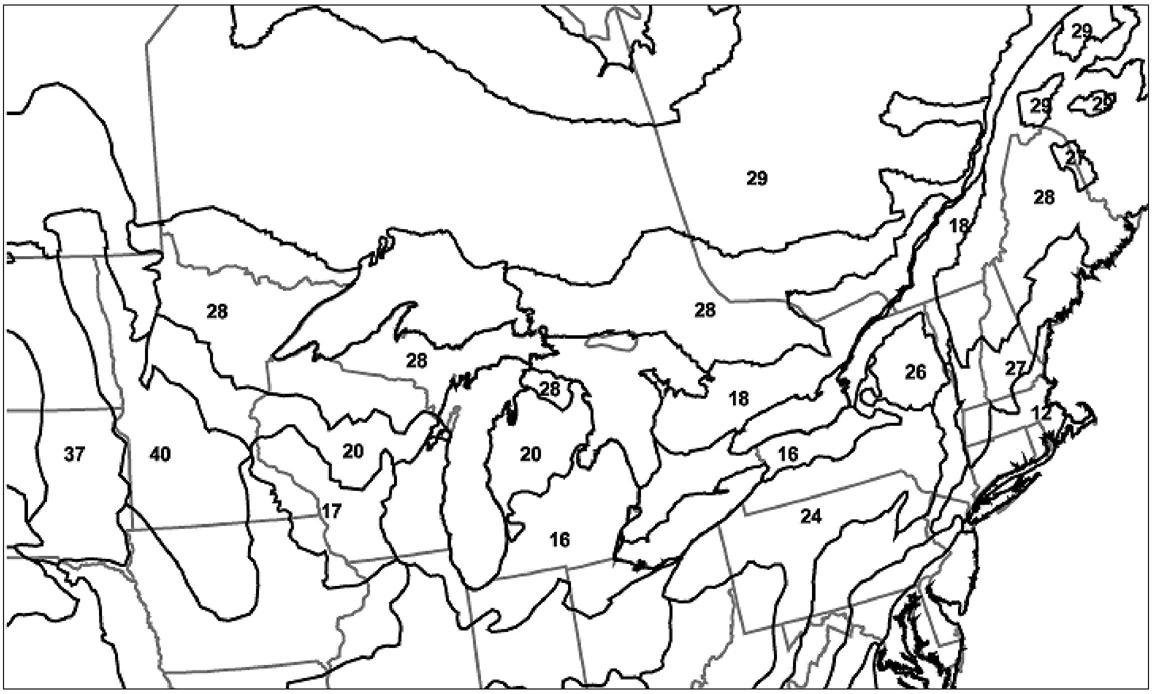


Figure 2. Map of BBS physiographic regions. 28 = Northern Spruce/Hardwoods, 20 = Great Lakes Transition, and 17 = Driftless Area. (Taken from BBS website: http://www.mp2-pwrc.usgs.gov/bbs/)

In addition to the trend analysis, we used a Fisher's Exact test to determine if population trend (increasing or decreasing) was independent of nesting or migration strategy. It is important to note that some species use different migration strategies and different nesting substrates in different portions of their ranges. For example, American Crows and White-breasted Nuthatches are short-distance migrants in rural portions of northern Minnesota, but are permanent residents in central and southern Minnesota. Many species of birds that typically nest in the subcanopy or canopy will sometimes nest in the shrub layer (e.g., Red-eyed Vireo, Black-throated Green Warbler, etc.).

## RESULTS AND DISCUSSION

We were able to examine trends for 72 species in at least one of the five study areas (Table 1). We also examined a regional trend (the three National Forests combined) for 35 species (Table 2). Individual species graphs for the study areas in which they were tested can be found in Appendix A. Test statistics and sample sizes for each species and study area can be found in Appendix B. The scientific name, migration strategy, and typical nest site of each species tested is listed in Appendix C.

Table 1. Trends for NRRI study areas and BBS trends for Minnesota and three physiographic regions. I = significantly increasing, D = significant;y decreasing. * $P \leq 0.05$, ** $P \leq 0.01$. Individual species graphs are in Appendix A and test statistics and sample sizes can be found in Appendix B.

| **Species** | **Chequam. NF** | **Chippewa NF** | **Superior NF** | **St. Croix Minn.** | **Southeast Minn.** | **BBS Minn.** | **BBS – N. Spr./Hardw.** | **BBS - G. L. Transition** | **BBS – Driftl. Area** |
|---|---|---|---|---|---|---|---|---|---|
| Ring-necked Pheasant | | | | | ns | D* | I** | ns | I* |
| Mourning Dove | | | | | ns | D** | I** | ns | ns |
| Red-bellied Woodpecker | | | | | ns | ns | ns | I* | ns |
| Yellow-bellied Sapsucker | I** | ns | ns | ns | ns | ns | I* | I* | ns |
| Downy Woodpecker | | | | | ns | ns | ns | ns | ns |
| Hairy Woodpecker | ns | ns | | | | ns | I** | D** | ns |
| Eastern Wood-Pewee | D** | D* | D** | ns | I* | ns | D** | ns | ns |
| Yellow-bellied Flycatcher | I** | ns | I* | ns | | ns | ns | | |
| Alder Flycatcher | I* | ns | ns | ns | | ns | ns | ns | ns |
| Least Flycatcher | ns | I** | ns | I** | | ns | D** | ns | ns |
| Great Crested Flycatcher | ns | D** | | ns | ns | ns | D** | ns | ns |
| Eastern Kingbird | ns | | | | | ns | I** | D** | ns |
| Yellow-throated Vireo | | I* | | I* | ns | ns | I** | ns | ns |
| Blue-headed Vireo | ns | I** | ns | | | ns | I** | ns | |
| Warbling Vireo | | | | | I* | ns | ns | ns | I* |
| Red-eyed Vireo | ns | ns | ns | I* | ns | I* | I** | I** | ns |
| Blue Jay | ns | ns | ns | ns | ns | ns | ns | ns | D** |
| American Crow | | | | | I* | I** | I** | ns | ns |
| Black-capped Chickadee | ns | ns | I* | ns | I* | ns | I* | ns | ns |
| Red-breasted Nuthatch | I* | I* | ns | ns | | ns | I** | I* | ns |
| White-breasted Nuthatch | ns | I** | | I* | I* | ns | ns | ns | D** |
| Brown Creeper | D* | ns | I* | | | ns | ns | ns | |
| House Wren | | | | | I* | ns | I* | ns | ns |
| Winter Wren | D** | ns | ns | ns | | I* | I** | ns | |
| Golden-crowned Kinglet | ns | ns | ns | ns | | ns | ns | ns | |
| Ruby-crowned Kinglet | | | ns | | | D* | ns | | |
| Blue-gray Gnatcatcher | | | | | ns | ns | | ns | ns |
| Veery | ns | ns | ns | I** | ns | ns | D** | D* | ns |
| Swainson's Thrush | | | I* | | | ns | D* | ns | |
| Hermit Thrush | D** | ns | ns | ns | | ns | I** | ns | |
| Wood Thrush | I* | | | ns | I** | ns | D** | ns | I** |
| American Robin | I** | I** | I* | ns | I** | ns | ns | ns | ns |
| Gray Catbird | | I** | | ns | ns | ns | D** | ns | ns |
| Brown Thrasher | ns | | | | | ns | D** | ns | D* |
| Cedar Waxwing | | ns | | | | ns | ns | ns | ns |
| Blue-winged Warbler | | | | | D* | ns | | ns | I** |

Table 1 (continued).

| Species | Chequam. NF | Chippewa NF | Superior NF | St. Croix Minn. | Southeast Minn. | BBS Minn. | BBS – N. Spr./Hardw. | BBS - G. L. Transition | BBS – Driftl. Area |
|---|---|---|---|---|---|---|---|---|---|
| Golden-winged Warbler | ns | ns | D** | ns | | ns | ns | ns | |
| Tennessee Warbler | | | ns | | | ns | ns | | |
| Nashville Warbler | ns | ns | ns | D** | | ns | ns | ns | |
| Northern Parula | ns | ns | ns | | | ns | ns | ns | |
| Yellow Warbler | | D** | | | ns | ns | ns | I** | I** |
| Chestnut-sided Warbler | ns | I* | ns | ns | | ns | ns | ns | I* |
| Magnolia Warbler | | ns | I* | | | ns | ns | ns | |
| Yellow-rumped Warbler | ns | ns | ns | ns | | ns | I* | ns | |
| Black-thr. Green Warbler | ns | ns | ns | ns | | ns | I** | ns | |
| Blackburnian Warbler | ns | ns | ns | ns | | ns | I** | ns | |
| Pine Warbler | ns | ns | I* | | | ns | I* | I** | |
| Black-and-white Warbler | ns | I* | D** | D** | | ns | ns | ns | |
| American Redstart | I** | I* | ns | I* | ns | ns | ns | I* | I* |
| Ovenbird | ns | D** | ns | D* | ns | ns | ns | I** | I** |
| Northern Waterthrush | ns | | ns | | | ns | D* | ns | |
| Connecticut Warbler | | D** | | | | ns | D* | | |
| Mourning Warbler | ns | D** | ns | ns | | D** | D** | ns | ns |
| Common Yellowthroat | D** | ns | D** | D** | ns | ns | D** | ns | ns |
| Canada Warbler | ns | ns | D* | | | ns | D** | ns | |
| Scarlet Tanager | ns | ns | ns | ns | ns | ns | D** | ns | I* |
| Eastern Towhee | ns | | | | I** | D* | ns | ns | ns |
| Chipping Sparrow | ns | ns | ns | | ns | ns | ns | ns | I** |
| Clay-colored Sparrow | D* | | | | | ns | ns | ns | ns |
| Field Sparrow | | | | | D* | ns | D* | D* | D** |
| Vesper Sparrow | ns | | | | | ns | ns | D** | ns |
| Song Sparrow | D* | D* | ns | ns | ns | ns | ns | ns | I** |
| Swamp Sparrow | ns | I* | | D** | | I* | I* | ns | |
| White-throated Sparrow | D** | D** | D** | D* | | ns | ns | ns | |
| Northern Cardinal | | | | | ns | I* | I** | I** | ns |
| Rose-breasted Grosbeak | ns | D** | D* | | ns | ns | D** | ns | ns |
| Indigo Bunting | | I* | | ns | I* | D** | ns | D** | ns |
| Red-winged Blackbird | D* | | | | ns | D** | D** | D* | D** |
| Brewer's Blackbird | I* | | | | | ns | ns | ns | ns |
| Brown-headed Cowbird | I* | D** | | D* | D** | ns | D** | ns | ns |
| American Goldfinch | | | | | ns | ns | ns | I* | ns |
| Evening Grosbeak | ns | | | | | ns | D* | | |

Table 2. Regional trends based on combined data from Chippewa, Superior, and Chequamegon National Forests. I = significantly increasing, D = significant;y decreasing. * $P \leq 0.05$, ** $P \leq 0.01$. Individual species graphs can be found in Appendix A.

| **Species** | **Trend** | **Change** | ***P*** | **$R^2$** |
|---|---|---|---|---|
| Yellow-bellied Sapsucker | ns | -0.002 | 0.793 | 0.01 |
| Eastern Wood-Pewee | D** | -0.058 | 0.000 | 0.89 |
| Yellow-bellied Flycatcher | I** | 0.042 | 0.006 | 0.64 |
| Alder Flycatcher | ns | 0.033 | 0.119 | 0.28 |
| Least Flycatcher | I** | 0.053 | 0.001 | 0.76 |
| Blue-headed Vireo | ns | 0.013 | 0.216 | 0.18 |
| Red-eyed Vireo | ns | 0.042 | 0.162 | 0.23 |
| Blue Jay | ns | 0.016 | 0.335 | 0.12 |
| Black-capped Chickadee | ns | 0.020 | 0.189 | 0.20 |
| Red-breasted Nuthatch | I** | 0.025 | 0.003 | 0.70 |
| Brown Creeper | ns | -0.009 | 0.105 | 0.29 |
| Winter Wren | ns | -0.035 | 0.064 | 0.37 |
| Golden-crowned Kinglet | ns | 0.012 | 0.369 | 0.10 |
| Veery | ns | 0.003 | 0.908 | 0.00 |
| Hermit Thrush | ns | -0.013 | 0.316 | 0.12 |
| American Robin | I** | 0.040 | 0.000 | 0.80 |
| Golden-winged Warbler | ns | -0.018 | 0.221 | 0.18 |
| Nashville Warbler | ns | -0.005 | 0.811 | 0.01 |
| Northern Parula | ns | 0.006 | 0.375 | 0.10 |
| Chestnut-sided Warbler | ns | -0.006 | 0.772 | 0.01 |
| Yellow-rumped Warbler | ns | 0.034 | 0.189 | 0.20 |
| Black-throated Green Warbler | ns | 0.014 | 0.332 | 0.12 |
| Blackburnian Warbler | ns | 0.002 | 0.923 | 0.00 |
| Pine Warbler | ns | 0.011 | 0.404 | 0.09 |
| Black-and-white Warbler | ns | -0.003 | 0.420 | 0.08 |
| American Redstart | I** | 0.058 | 0.002 | 0.73 |
| Ovenbird | D* | -0.125 | 0.010 | 0.58 |
| Mourning Warbler | ns | -0.029 | 0.136 | 0.26 |
| Common Yellowthroat | ns | -0.023 | 0.091 | 0.32 |
| Canada Warbler | D* | -0.024 | 0.040 | 0.43 |
| Scarlet Tanager | D** | -0.027 | 0.009 | 0.59 |
| Chipping Sparrow | ns | -0.002 | 0.838 | 0.01 |
| Song Sparrow | D* | -0.037 | 0.014 | 0.55 |
| White-throated Sparrow | D** | -0.115 | 0.002 | 0.71 |
| Rose-breasted Grosbeak | ns | -0.017 | 0.207 | 0.19 |

Over 65% of the species we tested (47 of 72) had significant trends in abundance. Therefore, we will focus our discussion on those species with highly significant trends ($P \leq 0.01$), and those with significant trends in multiple study areas. It is important to note that a significant trend ($P \leq 0.05$) with a small sample size may be just as important as a highly significant trend ($P \leq 0.01$) with a larger sample size. It is also important to note that a significant trend for a geographically restricted species (e.g., Blue-winged Warbler, Connecticut Warbler) in just one of our five study areas could be as meaningful as trends in multiple areas for widespread species (e.g., American Robin, Ovenbird).

During the time frame of our study, slightly more species (29) demonstrated significant increases in abundance than decreases (23) in at least one of the five study areas (Table 1). Of the 29 increasing species, ten increased in more than one study area, and of the 23 decreasing species, eight declined in more than one study area (Table 3). Five species showed significant trends in different directions in different study areas. The Eastern Wood-Pewee and Brown-headed Cowbird decreased in three study areas and increased in one, the Black-and-white Warbler decreased in two study areas and increased in one, and the Brown Creeper and Swamp Sparrow each increased in one study area and declined in another. A list of species with significant trends for each study area is presented in Table 4.

While more species had increasing trends than decreasing trends, only 11 of the 29 increasing species were highly significant ($P \leq 0.01$), while 16 of the 23 decreasing species were highly significant. Also, only two species demonstrated highly significant increases in multiple study areas, while five species showed highly significant decreases (increasing and decreasing species will be discussed below). While it is encouraging to see so many increasing species, it is important to note that the majority of the declines (70%) are highly significant, and many are occurring on multiple study areas.

Many species show a decline in abundance between 1994 and 1996, with an increase from 1996 to 1998 (Appendix A). The reason for this pattern is unclear, but it may be related to winter and spring weather. The winter of 1995-1996 was among the most severe on record and the winter of 1997-1998 was among the most mild. Some researchers have found that the abundance of migrant breeding birds may be affected through heterospecific attraction (Monkkonen et al. 1996, 1997). This hypothesis states that migrants may make decisions on whether to breed based on the abundance and distribution of local populations of resident birds with similar life-history traits. A late spring could result in fewer numbers of residents being present when migrants arrive from the south, causing some migrant birds to select different areas for breeding, and causing others to forgo breeding, especially those with marginal territories.

***Increasing Species***

Two species demonstrated highly significant increases in multiple study areas. The American Robin increased in the Chequamegon and Chippewa NF's and in Southeast MN ($P < 0.01$) and in the Superior NF ($P < 0.05$). BBS data from the region did not show any significant trends for these species. This species is a short-distance migrant that uses a variety of habitats during the breeding season, including semi-open forests and

Table 3. Summary of species with increasing or decreasing trends ($P \leq 0.05$). Individual species graphs can be found in Appendix A.

| **Increased in one study area** | **Increased in two study areas** | **Increased in three or more study areas** |
|---|---|---|
| Yellow-bellied Sapsucker | Yellow-bellied Flycatcher | White-breasted Nuthatch |
| Eastern Wood-Pewee | Least Flycatcher | American Robin |
| Alder Flycatcher | Yellow-throated Vireo | American Redstart |
| Blue-headed Vireo | Black-capped Chickadee | |
| Warbling Vireo | Red-breasted Nuthatch | |
| Red-eyed Vireo | Wood Thrush | |
| American Crow | Indigo Bunting | |
| Brown Creeper | | |
| Veery | | |
| Swainson's Thrush | | |
| Gray Catbird | | |
| Chestnut-sided Warbler | | |
| Magnolia Warbler | | |
| Pine Warbler | | |
| Black-and-white Warbler | | |
| Eastern Towhee | | |
| Swamp Sparrow | | |
| Brewer's Blackbird | | |
| Brown-headed Cowbird | | |
| **Decreased in one study area** | **Decreased in two study areas** | **Decreased in three or more study areas** |
| Great Crested Flycatcher | Black-and-white Warbler | Eastern Wood-Pewee |
| Brown Creeper | Ovenbird | Common Yellowthroat |
| Winter Wren | Song Sparrow | White-throated Sparrow |
| Hermit Thrush | Rose-breasted Grosbeak | Brown-headed Cowbird |
| Blue-winged Warbler | | |
| Golden-winged Warbler | | |
| Nashville Warbler | | |
| Yellow Warbler | | |
| Connecticut Warbler | | |
| Mourning Warbler | | |
| Canada Warbler | | |
| Clay-colored Sparrow | | |
| Field Sparrow | | |
| Swamp Sparrow | | |
| Red-winged Blackbird | | |

Table 4. Statistically significant increasing and decreasing species ($P \leq 0.05$) by study area. ** $P \leq 0.01$. Individual species graphs can be found in Appendix A.

**Increasing Species**

| Chequamegon NF | Chippewa NF | Superior NF | St Croix | Southeast MN |
|---|---|---|---|---|
| ** Yell.-bellied Sapsucker | ** Least Flycatcher | Yell.-bellied Flycatcher | ** Least Flycatcher | Eastern Wood-Pewee |
| ** Yell.-bellied Flycatcher | Yellow-throated Vireo | Blk-capped Chickadee | Yellow-throated Vireo | Warbling Vireo |
| Alder Flycatcher | ** Blue-headed Vireo | Brown Creeper | Red-eyed Vireo | American Crow |
| Red-breasted Nuthatch | Red-breasted Nuthatch | Swainson's Thrush | White-br. Nuthatch | Blk-capped Chickadee |
| Wood Thrush | ** White-br. Nuthatch | American Robin | ** Veery | White-br. Nuthatch |
| ** American Robin | ** American Robin | Magnolia Warbler | American Redstart | House Wren |
| ** American Redstart | ** Gray Catbird | Pine Warbler | | ** Wood Thrush |
| Brewer's Blackbird | Chestnut-sided Warbler | | | ** American Robin |
| Brown-headed Cowbird | Blk-and-white Warbler | | | ** Eastern Towhee |
| | American Redstart | | | Indigo Bunting |
| | Swamp Sparrow | | | |
| | Indigo Bunting | | | |

**Decreasing Species**

| Chequamegon NF | Chippewa NF | Superior NF | St Croix | Southeast MN |
|---|---|---|---|---|
| ** Eastern Wood-Pewee | Eastern Wood-Pewee | ** Eastern Wood-Pewee | ** Nashville Warbler | Blue-winged Warbler |
| Brown Creeper | ** Grt. Crested Flycatcher | ** Golden-winged Warbler | ** Blk-and-white Warbler | Field Sparrow |
| ** Winter Wren | ** Yellow Warbler | ** Blk-and-white Warbler | Ovenbird | ** Brown-headed Cowbird |
| ** Hermit Thrush | ** Ovenbird | ** Common Yellowthroat | ** Common Yellowthroat | |
| ** Common Yellowthroat | ** Connecticut Warbler | Canada Warbler | ** Swamp Sparrow | |
| Clay-colored Sparrow | ** Mourning Warbler | ** White-thr. Sparrow | White-thr. Sparrow | |
| Song Sparrow | Song Sparrow | Rose-br. Grosbeak | Brown-headed Cowbird | |
| ** White-throated Sparrow | ** White-throated Sparrow | | | |
| Red-winged Blackbird | ** Rose-br. Grosbeak | | | |
| | ** Brown-headed Cowbird | | | |

suburban areas, and typically nests in shrubs and small trees. The Least Flycatcher increased in the Chippewa NF and St. Croix study areas ($P < 0.01$). Interestingly, this species has decreased significantly ($P < 0.01$) along BBS routes in the Northern Spruce/Hardwoods (NSH) region, which includes both of these study areas. The Least Flycatcher is a long-distance migrant that is typically associated with mature deciduous forest during the breeding season, nesting in the subcanopy layer.

Four species demonstrated a highly significant increase ($P \leq 0.01$) in one study area, and at least one significant increase ($P \leq 0.05$) in another. The Yellow-bellied Flycatcher increased in the Chequamegon NF ($P < 0.01$) and the Superior NF ($P < 0.05$), although it has declined gradually in the Superior since 1997. It showed no significant trends in BBS data from the region. This long-distance migrant has a high affinity for mature lowland coniferous forests during the breeding season and nests on the ground. This species, along with the Eastern Towhee and Veery, is the only ground-nesting species to show a significant increase at the $P < 0.01$ level.

The White-breasted Nuthatch increased in the Chippewa NF ($P < 0.01$) as well as the St. Croix and Southeast MN study areas ($P < 0.05$). The only trend detected in regional BBS data was a highly significant decline in the Driftless Area. This permanent resident is usually found breeding in mature deciduous forests and is a primary cavity nester. It is often found at suburban and rural bird feeders during the non-breeding season.

The Wood Thrush increased in Southeast MN ($P < 0.01$) and in the Chequamegon NF ($P < 0.05$). BBS data also show a highly significant increase in the Driftless Area, although data from the NSH region indicates a highly significant decline. The Wood Thrush is a long-distance migrant that commonly breeds in the subcanopy of mesic deciduous forests, as well as mixed forests and suburban areas.

The American Redstart increased in the Chequamegon NF ($P < 0.01$) as well as the Chippewa NF and St. Croix study areas ($P < 0.05$). The species also increased ($P < 0.05$) along BBS routes in the Great Lakes Transition (GLT) and Driftless Area. American Redstarts are long-distance migrants that breed in shrubby, early-successional deciduous and mixed forests, as well as the understory of older deciduous forests.

Five species demonstrated a highly significant increase ($P \leq 0.01$) increase in one study area. The Yellow-bellied Sapsucker increased in the Chequamegon NF, the Blue-headed Vireo and Gray Catbird increased in the Chippewa NF, the Veery increased in the St. Croix, and the Eastern Towhee increased in Southeast MN. According to BBS data, the Yellow-bellied Sapsucker also increased in the NSH and GLT regions ($P < 0.05$) and the Blue-headed Vireo increased in the NSH ($P < 0.01$). However, the Gray Catbird decreased in the NSH ($P < 0.01$), the Veery decreased in the NSH ($P < 0.01$) and the GLT ($P < 0.05$), and the Eastern Towhee decreased statewide in Minnesota ($P < 0.05$).

Eighteen other species increased at the $P \leq 0.05$ significance level in one or two study areas (Table 4). However, four of these species declined in one or more study areas. As with all species tested, increasing or decreasing, it is important to examine the trend graphs (Appendix A) when trying to evaluate the biological importance of these trends.

***Decreasing Species***

Five species demonstrated significant declines at $P \leq 0.01$ in multiple study areas. The White-throated Sparrow declined in each of the three National Forests ($P < 0.01$) as well as in the St. Croix ($P < 0.05$). No significant trends were detected in the regional BBS data. This species is a short-distance migrant that nests on the ground in a variety of habitats including mesic shrubby areas, forest edges, and early-successional forests. The Common Yellowthroat also declined ($P < 0.01$) in three study areas; the Chequamegon and Superior NF's and the St. Croix. BBS data also indicate a highly significant decline in the NSH region. The Common Yellowthroat is a ground-nesting short-distance migrant that breeds primarily in wet non-forested areas such as marshes, alder swamps, and recent clearcuts. The Eastern Wood-Pewee declined in the Chequamegon and Superior NF's ($P < 0.01$) and the Chippewa NF ($P < 0.05$). A highly significant decreasing trend was also detected in the BBS data for the NSH region. This species is a long-distance migrant that nests in the canopy of mature deciduous and coniferous forests. The Brown-headed Cowbird declined in the Chippewa NF and Southeast MN ($P < 0.01$) and the St. Croix study area ($P < 0.05$). A highly significant decline was also detected in the BBS data for the NSH region. This species is an obligate brood parasite that is frequently found in fragmented landscapes and is often associated with agricultural feedlots used for foraging. The Black-and-white Warbler declined ($P < 0.01$) in the Superior NF and the St. Croix. No significant BBS trends were detected in the region. This species is a long-distance migrant that nest on the ground in coniferous and deciduous forests in a range of successional stages. The Black-and-white Warbler, along with the Eastern Wood-Pewee and Brown-headed Cowbird, also increased in one study area, albeit at the $P \leq 0.05$ significance level.

Two species demonstrated a highly significant decline ($P < 0.01$) in one study area and a significant decline ($P < 0.05$) in another. The Ovenbird declined in the Chippewa NF ($P < 0.01$) and in the St. Croix ($P < 0.05$). Highly significant increases were detected in the BBS data from the GLT and Driftless Area. This species is a long-distance migrant that nests on the ground in a variety of forests with open to semi-open understories. The Rose-breasted Grosbeak declined in the Chippewa NF ($P < 0.01$) and Superior NF ($P < 0.05$) and a highly significant decline was detected in the BBS data from the NSH region. This species is a long-distance migrant that nests in shrubs and small trees in early to mid-successional deciduous and mixed forests.

Nine species demonstrated a significant decline at $P \leq 0.01$ in one study area. The Winter Wren and Hermit Thrush declined in the Chequamegon NF, the Great Crested Flycatcher, Yellow Warbler, Connecticut Warbler, and Mourning Warbler declined in the Chippewa NF, the Golden-winged Warbler declined in the Superior NF, and the Nashville Warbler and Swamp Sparrow declined in the St. Croix (the Swamp Sparrow also increased ($P < 0.05$) in the Chippewa NF). BBS data indicate that the Great Crested Flycatcher, Connecticut Warbler, and Mourning Warbler also increased in the NSH region. The Winter Wren, Hermit Thrush, and Swamp Sparrow actually increased in the NSH region and the remaining species showed no statistically significant BBS trends.

Six species decreased at the $P \leq 0.05$ significance level in one study area (Table 4). The Brown Creeper also increased ($P < 0.05$) in the Superior NF.

A decline in the Brown-headed Cowbird population may be beneficial to many forest birds vulnerable to brood parasitism. Although Brown-headed Cowbird parasitism continues to be a problem in many areas (Robinson et al. 1995), and the species is still abundant in parts of the region (Green 1995), the declines in our study are encouraging.

***Trends Among Study Areas***
The proportions of increasing and decreasing species were similar across the five study areas, except in the Southeast. Nine (18%) of the species tested in the Chequamegon NF had increasing trends and nine (18%) had decreasing trends. In the Chippewa NF, 12 (26%) of the species tested increased significantly and 10 (21%) decreased. Seven (18%) of the species tested in the Superior NF had significant increasing trends, and seven (18%) had decreasing trends. In the St. Croix study area, six (17%) of the species tested increased significantly, and seven (19%) decreased. However, in the Southeast, ten (28%) species increased significantly and only three (8%) decreased. While most study areas had similar proportions of increasing and decreasing species, all study areas have more highly significant ($P \leq 0.01$) decreases than increases. The Superior NF had no highly significant increasing species.

The regional analysis (three National Forests combined) also revealed fairly even proportions of increasing and decreasing species. While each of the five increasing species were significant at $P \leq 0.01$, only three of the six decreasing species were. Only one of the 11 species with a significant regional trend, the Scarlet Tanager, did not have a corresponding trend in one of the National Forests. Although its trend was highly significant, it has shown a gradual increase regionally every year since 1997. Five of the eleven regional trends were reflected in BBS data from the NSH or GLT regions. The Red-breasted Nuthatch and American Redstart both had increasing BBS trends, and the Eastern Wood-Pewee, Canada Warbler, and Scarlet Tanager had decreasing trends. Two of our regional trends were opposite of BBS trends. The Least Flycatcher increased in our regional analysis, but decreased on BBS routes in the NSH region, and the Ovenbird decreased in our analysis, but increased in the GLT region (which only encompasses the southern portion of the Chequamegon NF). The remaining four species showed no significant trends in BBS data from the region.

***Life History Comparisons***
We looked at two life-story traits, migration strategy and nesting substrate, as a step towards understanding potential reasons for observed population trends. Long-distance migrant birds are often thought to be more specific in their habitat use, and possibly more vulnerable to habitat changes, than short-distance and permanent residents (Lynch and Whigham 1984, O'Connor 1992). In this study, the Fisher's Exact test on the independence of population trend (increasing or decreasing) and migration strategy was not significant ($P = 0.2566$). However, no permanent resident declined (Figure 2).

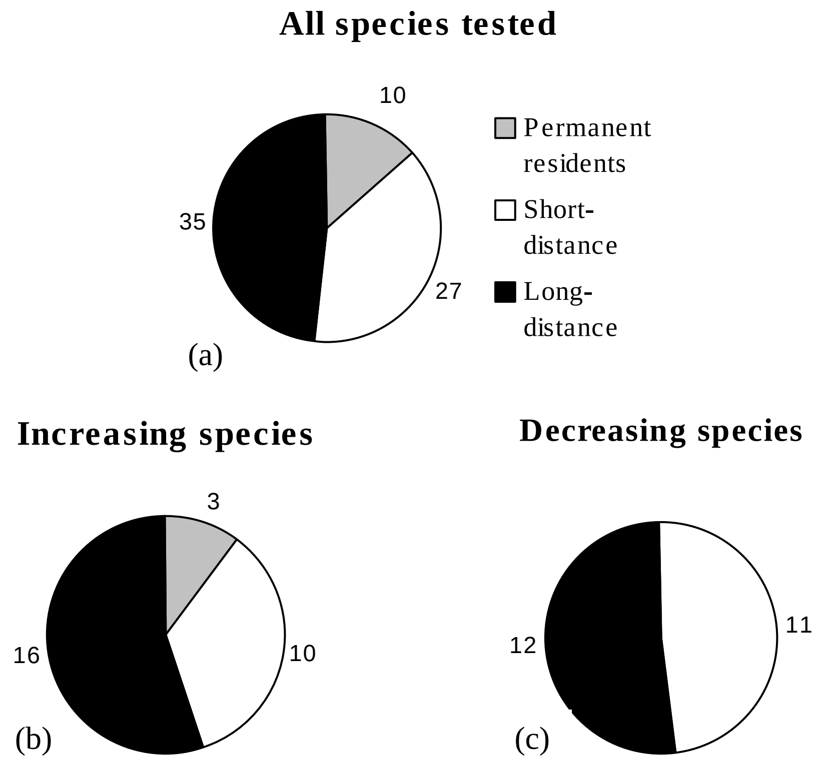


Figure 2. Distribution of species among migration guilds for all species (a), and those that increased (b) or decreased (c).

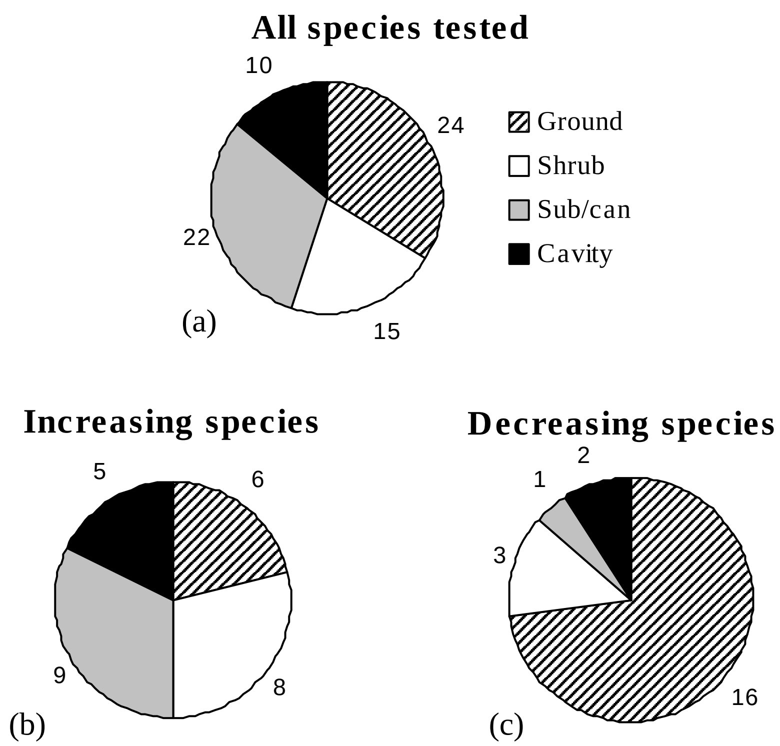


Figure 3. Distribution of species among nesting guilds for all species (a), and those that increased (b) or decreased (c).

Nesting substrate has been correlated with nest success rates, which could potentially affect the number of young recruited into a population (Martin 1992). The test on the independence of population trend (increasing or decreasing) and nesting substrate was significant (Fisher's Exact *P* = 0.0022). The comparison of ground nesters to all other nesting strategies is also significant (*P* = 0.0005). By far the greatest proportion of declining species (over 70%) were those that nest on the ground (Figure 3). Likewise, only one subcanopy or canopy nester showed a significant decline, which is much fewer than expected. Note, however, that six ground-nesting species increased significantly.

Some studies have shown that generalist nest predators, particularly in fragmented landscapes, can significantly reduce nesting success (Robinson et al. 1995, Donovan et al. 1997). In the forested landscapes of the Upper Midwest, some studies have found higher nest predation rates near forest edges (Fenske-Crawford and Niemi 1997, Flaspohler 1999), while others have not (Hanski et al. 1996). Data from the Minnesota DNR winter track survey (Berg 1999) between 1991 and 1998 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 species. Nonetheless, the effects of nest predation on population trends in this study are unknown.

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