

2001 Annual Update Report:

**Breeding bird monitoring in
Great Lakes National Forests:
1991-2001**

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. Eleven years of surveys have been completed in the Chippewa and Superior NF, and ten years in the Chequamegon NF.
- Breeding bird surveys in the St. Croix region of Minnesota have been conducted over the past ten years at 171 points. Surveys in southeast Minnesota have been conducted over the past seven years at 211 points.
- We were able to examine trends in abundance for 77 bird species in at least one of the five study areas. Fifty species in the Chequamegon NF, 49 species in the Chippewa NF, 41 species in the Superior NF, 39 species in the St. Croix region, and 40 species in Southeast Minnesota were tested for population trends. Thirty-five species were also tested for a regional trend (three national forests combined).
- Twenty-six species increased significantly ($P > 0.05$) in at least one study area and 32 species decreased. Two species had highly significant ($P < 0.01$) increasing trends in multiple study areas, and seven species had highly significant decreasing trends in multiple study areas. Four species had significant increasing regional trends and 11 had decreasing trends.
- The most convincing increasing trends were those of the Red-breasted Nuthatch and American Redstart regionally and in the Chippewa NF, Yellow-bellied Sapsucker and Yellow-bellied Flycatcher in the Chequamegon NF, the Chestnut-sided Warbler in the Chippewa NF, the Northern Parula in the Superior NF, and the Least Flycatcher in the St. Croix region. Eight other species had highly significant trends in southeastern Minnesota, albeit with a shorter time span than the northern sites.
- The most convincing decreasing trends are those of the Eastern Wood-Pewee, Winter Wren, Ovenbird, Scarlet Tanager, and Song Sparrow regionally, the Eastern Wood-Pewee in the Chequamegon and Superior NF, the Winter Wren in the Chequamegon NF, the Song Sparrow in the Chippewa NF, the Hermit Thrush in the Chequamegon and Chippewa NF, and the Black-and-white Warbler in the Chequamegon NF, Superior NF and St. Croix region. The Brown-headed Cowbird decreased in southeastern Minnesota during the six years of monitoring there.
- The percentage of increasing species in each study area ranged from 13% in St. Croix, MN study area to 28% in Southeast MN. The percentage of decreasing species ranged from 20% in Southeast MN to 31% in the Chippewa NF. Over half the species in each study area had a non-significant trend ($P > 0.05$).

- There are 17 instances where a species showed a significant increase in a particular study area in results from 2000, with no increase noted in 2001, and 11 instances where a species was not increasing in 2000 and is increasing in 2001. Conversely, there are five instances where a decreasing species in a particular study area from 2000 is no longer showing a significant decrease, and 25 instances where a species was not decreasing in 2000 and is decreasing in 2001.
- Ten of the 35 species that were tested for a regional trend had similar trends on Breeding Bird Survey routes. One species had an increasing regional trend and an increasing BBS trend, three species had decreasing trends on both, and six species had non-significant trends on both.
- When compared to all species tested, ground nesters were more prevalent among decreasing species (33% vs. 48%) and less prevalent among increasing species (33% vs. 19%), however the differences were not statistically significant ($P = 0.069$). Evidence from other regional studies have demonstrated greater nest predation rates on ground nests near forest edges, as well as a significant increase in the creation of forest edges in recent years. Landscape fragmentation and nest predation may be having negative effects on declining ground-nesters such as the Winter Wren, Hermit Thrush, Black-and-white Warbler, Ovenbird, and Song Sparrow.
- Averaged over all study areas, 10.6% of the points have been harvested since the beginning of monitoring, which is about 1% a year. This is comparable to the 4.8% change from mature forest to early-successional types on federally managed forest lands in northeastern Minnesota between 1990 and 1995.

INTRODUCTION

Concerns about the population 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, limited coverage in some areas can make it difficult to use BBS data to characterize population trends in smaller geographic areas (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 localized information (Green 1995, Howe et al. 1997). The relatively heavily forested landscapes of northern Minnesota and Wisconsin are considered to be population "sources" for some forest bird species and may be supplementing population "sinks" in the agricultural landscapes of the lower Midwest (Robinson et al. 1995, Temple and Flaspohler 1998),

highlighting the importance of monitoring trends in forest bird populations in the Upper Midwest.

In response to the need for regional population 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 (June 1 to July 10).

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 seven- to eleven-year time frame of the monitoring. Our intent is to summarize the most important results and to 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 and regional standards (Ralph et al. 1993, 1995, Howe et al. 1997). The monitoring program also was designed so that it would integrate with each National Forest's method of describing forest 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 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 sampling unit in the St. Croix and southeast Minnesota study areas is different than in the three national forests. Because stands 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. Stands were stratified in a similar fashion as those in the National Forests with restrictions based on access and travel time. A total of 171 and 211 stands (points) were established in St. Croix and Southeast study areas, respectively (Figure 1). All points in the St. Croix region are located on state-owned lands. In southeastern Minnesota, 85% of points are on state-owned land, 6% are on county-owned land, and 9% are on private lands.

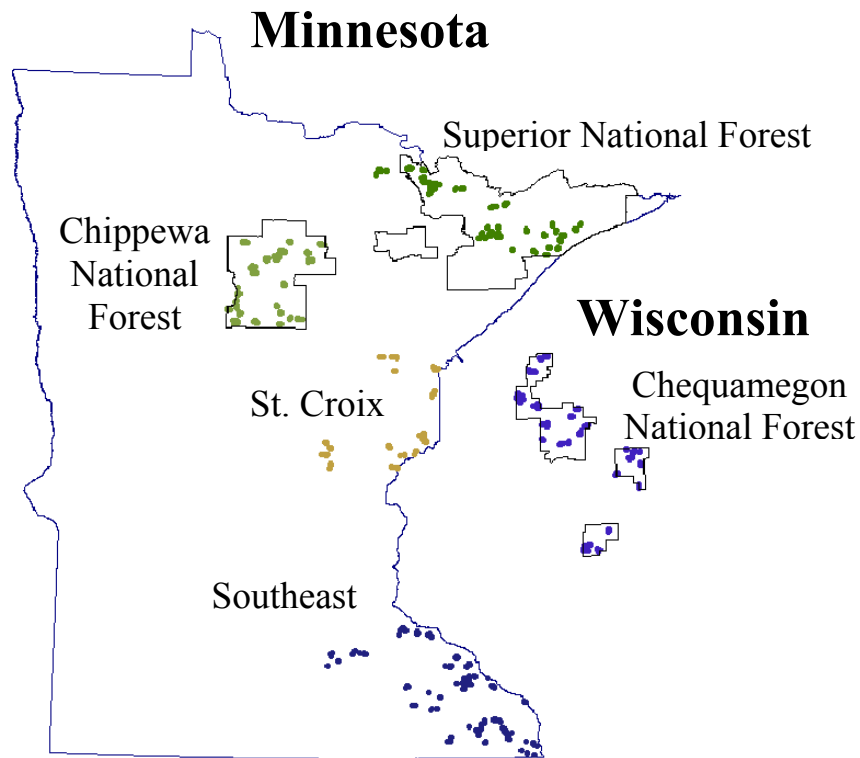


Figure 1. General locations of breeding bird point counts in five regions of Minnesota and Wisconsin.

Sampling

Ten-minute point counts were conducted at each point between June and early July (Reynolds et al. 1980). Point counts are appropriate for determining the relative abundance of most singing passerine species, but are inadequate for waterfowl, woodpeckers, 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., 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 point were recorded with estimates of their distance from that point. From 1991 to 1994, all birds heard or seen within 100 m of the point were recorded. In 1995, we changed our methods to include all birds heard or seen from the 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 were 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 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% 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). 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 criteria to ensure that our analyses provided reliable population information. Stands 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 five years in Southeast MN. Only data for species observed on a minimum of five stands per study area and in at least three years on each stand were included. 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.

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 each 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 stand were analyzed. For the St. Croix region, where the point is the sampling unit, relative abundance is the count of individuals of each species within 100 m at each point. Since points in Southeast MN have been sampled using an unlimited radius in all years, 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.

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 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). Yearly mean relative abundance is calculated by using information about the yearly mean relative abundance in neighboring years. With every new year of sampling, we can expect mean relative abundance in the most recent years to vary slightly.

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 result 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 to determine statistical significance.

Breeding Bird Survey Trends

Regional trends (three national forests combined) derived from this study were 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 between 1990 and 2000 (1966-2000 results are also presented) from the Northern Spruce/Hardwoods (strata 28) and the Great Lakes Transition (strata 20) physiographic regions (Figure 2). It is important to note that these physiographic regions extend across multiple states. Trends from the BBS were obtained from their website (Sauer et al. 2001). The 10-year analysis is a new feature and the USGS advises that the analysis should be considered experimental and results should be viewed with caution.

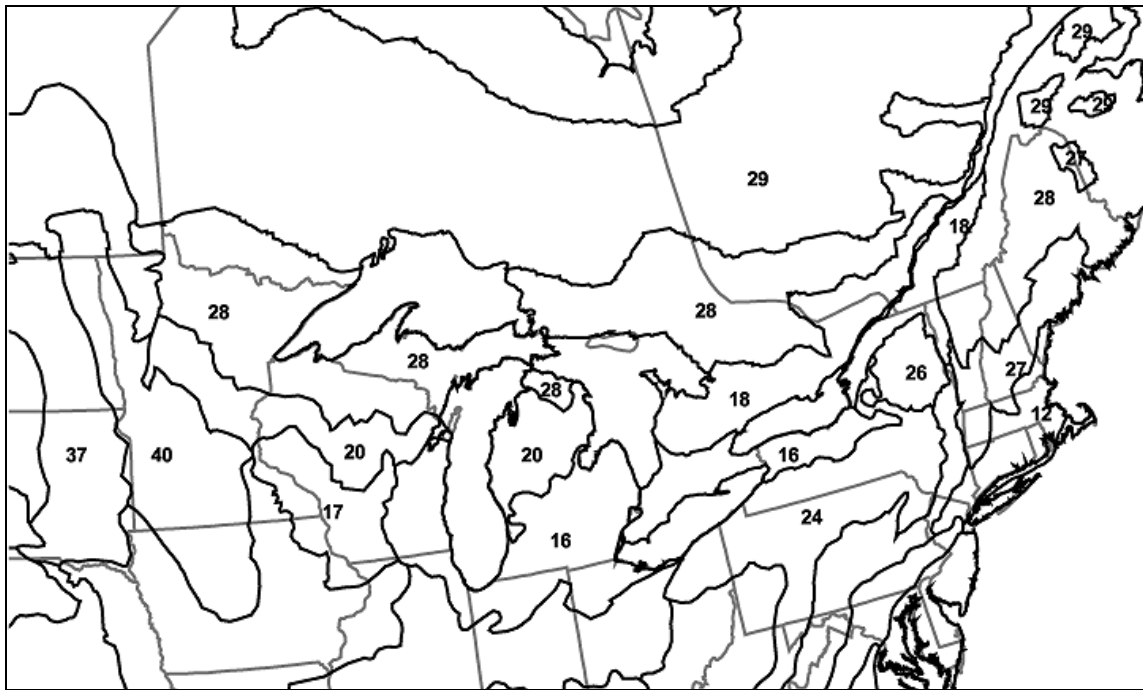


Figure 2. Map of BBS physiographic regions. 28 = Northern Spruce/Hardwoods, 20 = Great Lakes Transition. (Taken from BBS website: <http://www.mp2-pwrc.usgs.gov/bbs/>)

Guild Analyses

In addition to the trend analysis, we used a Fisher's Exact test to find if population trend (increasing or decreasing) was independent of migration strategy, nesting substrate, or vegetation-type preference. It is important to note that some species use different migration strategies, nesting substrates, and vegetation types in different portions of their ranges. Guild analyses can also be complicated by a lack of agreement on how to categorize guilds and there will always be species that use multiple guilds. Additionally, species guilds are not mutually exclusive and the species pool in a migration guild, for example, can be very similar to the species pool in a nesting guild (Sauer et al. 1996).

RESULTS

Over the course of 11 field seasons we have detected nearly 229,000 individual birds of 182 species on more than 16,500 ten-minute point counts. In 2001, we sampled 133 stands in the Chequamegon NF, 131 in the Chippewa NF, 168 in the Superior NF, 166 stands in the St. Croix region, and 211 stands in southeastern Minnesota.

Seventy-seven species were tested for trends in at least one study area, including 50 in the Chequamegon NF, 49 in the Chippewa NF, 41 in the Superior NF, 39 in the St. Croix region, and 40 in southeastern Minnesota (Table 1). Additionally, 35 species were tested for a “regional” (three national forests combined) trend. See Appendix A for graphs of individual species trajectories and Appendix B for test statistics and sample sizes used in the trend analyses.

Population Trends

Twenty-six species increased in at least one study area, including seven that increased in two study areas, and two that increased in three study areas (Tables 2 & 3). Thirty-two species decreased in at least one study area, including nine that decreased in two study areas, six that decreased in three study areas, and one that decreased in four study areas. Five species had both an increasing and decreasing trend. Two species had highly significant ($P < 0.01$) increasing trends in multiple study areas, and seven species had highly significant decreasing trends in multiple study areas (Table 4).

Four species had increasing regional trends (three national forests combined) and 11 had decreasing trends (Table 3). The Brown Creeper was the only species with a significant regional trend and no significant trend in any of the individual forests.

The percentage of increasing species in each study area ranged from 13% in St. Croix, MN study area to 28% in Southeast MN (Figure 3). The percentage of decreasing species ranged from 20% in Southeast MN to 31% in the Chippewa NF. Over half the species in each study area had a non-significant trend ($P > 0.05$).

A comparison of this year’s results with those from 2000 (Lind et al. 2001) reveals several changes in species’ trends. (Table 5) There are 17 instances where a species showed a significant increase in a particular study area in results from 2000, with no increase noted in 2001, and 11 instances where a species was not increasing in 2000 and is increasing in 2001. Conversely, there are five instances where a decreasing species in a particular study area from 2000 is no longer showing a significant decrease, and 25 instances where a species was not decreasing in 2000 and is decreasing in 2001.

Breeding Bird Survey Trends

Of the 35 species that were tested for regional trends (three national forests combined), 15 had a significant trend (four increasing, 11 decreasing). Twenty of the 35 species had a significant BBS trend between 1990 and 2000 (11 increasing, nine decreasing; Table 6). Ten of the 35 species that were tested for a regional trend had similar trends on BBS routes from stratas 20 and 28 (Table 7). One species had an increasing regional trend and an increasing BBS trend, three species had decreasing trends on both, and six species had non-significant trends on both.

Guild Analyses

The distribution of migration strategies among increasing and decreasing species was similar to that of the pool of 77 species tested (Fisher's Exact $P = 0.291$; Figure 4). A slightly greater percentage of increasing species were long-distance migrants, when compared to all species tested (61% vs. 51%). A slightly greater percentage of decreasing species were short distance migrants (44% vs. 35%), when compared to all species tested.

Ground nesters appear to be more prevalent among decreasing species when compared to all species tested (48% vs. 33%), and less prevalent among increasing species (19% vs. 33%; Figure 5), however the differences were not statistically significant ($P = 0.069$).

The distribution of vegetation-type guilds among increasing and decreasing species was similar to that of the pool of species tested ($P = 0.669$; Figure 6). A slightly greater percentage of increasing species were those associated with deciduous forest, when compared to all species tested (38% vs. 27%). Results did not change substantially in any of the guild analyses when only those species with highly significant trends ($P < 0.01$) were considered.

Management Activities on Study Areas

Averaged over all study areas, 10.6% of the points have been harvested since the beginning of monitoring, which is about 1% a year (Table 8). This is comparable to the 4.8% change from mature forest to early-successional types on federally managed forest lands in northeastern Minnesota between 1990 and 1995 (Wolter and White, in press). A small number of our monitoring points have also had prescribed burns since the start of monitoring, but this is usually done after harvest.

DISCUSSION

Population Trends

Many of the species we monitor exhibit wide annual fluctuations in abundance. This phenomenon has been documented on several other long-term studies (Virkkala 1991, Blake et al. 1994, Weslowski and Tomialojc 1997, Holmes and Sherry 2001) and is important to keep in mind when interpreting our results. Examining individual species graphs (Appendix A) is critical when evaluating the biological significance of population trends.

Nearly 70% of the species we tested had a statistically significant trend ($P < 0.05$) in at least one study area, while about half of the species had a highly significant trend ($P < 0.01$). Of the 58 "new" trends in Table 5, less than a third were highly significant. Because highly significant trends are less likely to change from year to year, we will mostly limit our discussion to species with trends at the $P < 0.01$ significance level.

Slightly more species showed highly significant decreases (22 species) than increases (18 species). Trends varied across the five study areas and we will address trends in each area separately.

Chequamegon NF

Increasing Species

Four species show highly significant increases in the Chequamegon NF. The Yellow-bellied Sapsucker has increased steadily since 1992 with a slight drop in recent years, and the Yellow-bellied Flycatcher increased until 1997, when it began to level off in abundance. The Wood Thrush has shown a gradual increase since 1992, with relatively wide variation in abundance. Small sample size may be an issue with this species, as only 11 stands are included in the analysis (mostly from the southern portion of the forest). The American Redstart is another species that has increased, although only nine stands are included in the analysis (again, mostly from southern sites). The Alder Flycatcher, Red-eyed Vireo, and Chestnut-sided Warbler also increased, though at a lower level of statistical significance ($0.01 < P < 0.05$). Note, however, that the Red-eyed Vireo's mean abundance is considerably higher now than it was in 1992. The American Robin was increasing significantly ($P < 0.01$) based on results to the year 2000, but has declined recently resulting in a non-significant trend in 2001.

The Chequamegon NF's increasing species have a variety of life history traits. The two most convincing increases, the Yellow-bellied Sapsucker and the Yellow-bellied Flycatcher, both use mature forests, but the former uses deciduous uplands and the latter uses coniferous lowlands. The Wood Thrush and Red-eyed Vireo are also found in mid-successional to mature deciduous uplands. The Yellow-bellied Sapsucker is the only increasing species that is not a long-distance migrant.

Decreasing Species

Nine species have highly significant decreases in the Chequamegon NF. The Eastern Wood-Pewee and Hermit Thrush have both decreased since 1994, with considerable declines in mean abundance since then. The Winter Wren has shown a drastic decline, with its abundance now half of what it was in 1992. The Nashville Warbler has shown a decline since 1992, although most of this decline occurred between 2000 and 2001. This species did not show a significant decrease based on results to the year 2000. The Black-and-white Warbler has shown a similar "new" decline, with a similar drop in abundance in recent years. The Common Yellowthroat has shown a steady decline, with most of it occurring since 1997, and the Song Sparrow has declined steadily since 1992. The White-throated Sparrow has declined since 1993, but has remained relatively stable since 1996. The Red-winged Blackbird has decreased since 1992, but has shown wide variation in abundance and small sample sizes (5 of 133 stands analyzed). The Ovenbird, Scarlet Tanager, Swamp Sparrow, and Evening Grosbeak also declined in the Chequamegon NF, though at a lower level of statistical significance ($0.01 < P < 0.05$). However, the Ovenbird's abundance is now considerably lower than it was in the early 1990's.

The four most convincing decreasing species, the Eastern Wood-Pewee, Winter Wren, Hermit Thrush, and Black-and-white Warbler all use coniferous forests to a varying degree, as does the Nashville Warbler, Ovenbird, and White-throated Sparrow. The Common Yellowthroat, Song Sparrow, White-throated Sparrow, and Red-winged Blackbird all use early-successional or open areas. Seven of the nine decreasing species ($P < 0.01$) are ground nesters.

Wisconsin DNR Threatened Species

The Red-shouldered Hawk has been detected on seven point counts since 1994; six in the Medford district and one in the Washburn district near Drummond. An Osprey (*Pandion haliaetus*) was recorded once as a flyover east of Park Falls in 2001.

Chippewa NF

Increasing Species

Five species increased at the $P < 0.01$ significance level in the Chippewa NF. The Red-breasted Nuthatch has gradually increased since 1991. The Gray Catbird has also increased since 1991, although wide variation in abundance among the small sample of stands included in the analysis (five stands; mainly in the Cass Lake and Walker districts) may be an issue with this species. Likewise, the Cedar Waxwing has also increased, but was abundant enough to be tested on only nine stands. The Chestnut-sided Warbler has gradually increased since 1994, and the American Redstart has increased, especially since 1996. Both species are well represented on our surveys. The Least Flycatcher, Black-capped Chickadee, and White-breasted Nuthatch have increased, though at a lower level of statistical significance ($0.01 < P < 0.05$). The Blue-headed Vireo and American Robin were increasing significantly ($P < 0.01$) based on results to the year 2000, but the Blue-headed Vireo has leveled off in recent years and the American Robin has decreased markedly since 1999.

Four of the five species with highly significant increases are early-successional shrub nesters, including two of the most convincing increases, the Chestnut-sided Warbler and the American Redstart. The Red-breasted Nuthatch is a cavity nester found mainly in upland coniferous forests.

Decreasing Species

Nine species had highly significant ($P < 0.01$) decreases in the Chippewa NF. The Yellow-bellied Sapsucker has declined since 1991, although the decline has been less pronounced since 1996. This species did not show a significant decline based on results to the year 2000. The Great Crested Flycatcher has decreased, but its abundance has also remained relatively stable since 1996. The Hermit Thrush is another declining species that did not show a significant decline based on results to the year 2000. It had a peak in 1994, with less of a peak in 1998, and is now at considerably lower abundance levels than in 1991. The Ovenbird has shown a drastic decline since 1991, but has remained relatively stable since 1996 and is still the second most abundant species detected on our surveys in the Chippewa NF. The Connecticut Warbler has also shown a drastic decline since 1991, however, wide variations in annual abundance and small sample size (13 stands; mainly in the Walker and Deer River districts) may be issues with this species. The Mourning Warbler, the other *Oporornis* warbler in northern Minnesota, has declined since 1991, but has actually changed very little from 1995 levels. The Song Sparrow has steadily declined since 1993. The White-throated Sparrow has shown a drastic decline since 1991, but has remained relatively stable since 1995. The Brown-headed Cowbird has declined since 1991, but has remained relatively stable since 1996. Declines in this brood parasite may benefit many of the species vulnerable to brood parasitism. The Eastern Wood-Pewee, Winter Wren, Golden-crowned Kinglet, Yellow Warbler, Blackburnian Warbler, and Scarlet Tanager also declined, though at a lower level of

statistical significance ($0.01 < P < 0.05$). However, the Winter Wren, Golden-crowned Kinglet, and Blackburnian Warbler's abundance levels are considerably lower than they were in the early 1990's. The Rose-breasted Grosbeak is the only declining species based on results to the year 2000 that is no longer declining in the Chippewa NF.

The declining species have a wide variety of life history traits, with few unifying themes. Six of the nine species with highly significant declines are ground nesters, including the most convincing declines, the Hermit Thrush and Song Sparrow. No permanent residents decreased, and other than the Yellow Warbler, no shrub nesters decreased.

Minnesota DNR Species of Concern

The Red-shouldered Hawk has been detected twice on our Chippewa NF points, once in 1996 south of Walker and once in 2001 southeast of Blackduck. The Bald Eagle (*Haliaeetus leucocephalus*) has been seen on a flyover on many points, especially near Lake Winnibigoshish and Leech Lake.

Superior NF

Increasing Species

Two species have highly significant ($P < 0.01$) increases in the Superior NF. The Pine Warbler and the Swamp Sparrow have gradually increased since 1995, are each abundant enough to test for trends on only 6 of 168 stands, and have high variation in numbers. The Black-capped Chickadee, Red-breasted Nuthatch, Northern Parula, and Magnolia Warbler also increased, though at a lower level of statistical significance ($0.01 < P < 0.05$). The abundance of the Northern Parula is considerably greater than it was in the mid-1990's.

Other than the Swamp Sparrow, all of the increasing species use coniferous forests types, ranging from pure or nearly pure pine stands for the Pine Warbler and Red-breasted Nuthatch, to mixed coniferous/deciduous forests for the Black-capped Chickadee. The most convincing increase is probably the Northern Parula's, which uses mature spruce and tamarack stands.

Decreasing Species

Six species decreased at the $P < 0.01$ significance level in the Superior NF. The Eastern Wood-Pewee declined steadily since 1991, with abundance levels considerably lower now than in 1991. The Ruby-crowned Kinglet has declined, but was tested for trends on only six stands, and annual variation is high. This species was not decreasing based on results to the year 2000. The Golden-winged Warbler has also declined, but only seven stands are included in the analysis and six of these are from two adjacent compartments north of Orr in the LaCroix district. The Black-and-white Warbler is a well represented species and has consistently declined since 1991. The Common Yellowthroat has declined since 1993. The Canada Warbler has gradually declined since 1992, although abundance levels have changed very little. The Winter Wren, Black-throated Green Warbler, Chipping Sparrow, White-throated Sparrow, and Rose-breasted Grosbeak have also declined, though at a lower level of statistical significance ($0.01 < P < 0.05$). The White-throated Sparrow has actually shown a consistent increase since 1996.

The two most convincing decreases, the Eastern Wood-Pewee and the Black-and-white Warbler, have few shared life history traits, other than both being long-distance migrants.

The Eastern Wood-Pewee nests in the canopy of primarily mature upland deciduous forests and the Black-and-white Warbler nests on the ground in lowland mid- to late-successional mixed forests.

Minnesota DNR Species of Concern

No endangered, threatened, or species of concern have been detected on our surveys in the Superior NF.

St. Croix Region

Increasing Species

Three species have highly significant ($P < 0.01$) increases in the St. Croix region. The Least Flycatcher has shown a drastic increase since 1992, with a drop in recent years. The Veery has increased gradually, but has also shown a drop in recent years and its abundance level is now close to 1992's. The Canada Warbler has increased, however, wide variation and small sample sizes (5 of 166 stands included in the analysis) are issues for this species. The American Redstart and Cedar Waxwing have also increased, though at a lower level of statistical significance ($0.01 < P < 0.05$).

Most of the increasing species use deciduous or mixed forests, including the most convincing increase, the Least Flycatcher's. The Cedar Waxwing is the only species that is not a long-distance migrant.

Decreasing Species

Two species have shown highly significant ($P < 0.01$) decreases in the St. Croix region. The Black-and-white Warbler has gradually decreased since 1992 with a slight rebound in recent years and the Common Yellowthroat has shown a gradual decline. The Eastern Wood-Pewee, Great Crested Flycatcher, Golden-crowned Kinglet, Nashville Warbler, Ovenbird, Mourning Warbler, and Brown-headed Cowbird have also decreased, though at a lower level of statistical significance ($0.01 < P < 0.05$). However, the Eastern Wood-Pewee has shown a steep decline since 1998 and the abundance levels of the Ovenbird and Brown-headed Cowbird are considerably lower now than they were in 1992. The Swamp Sparrow was declining ($P < 0.01$) based on results to the year 2000, but has increased in recent years, resulting in a non-significant trend.

There appear to be few shared life history traits among the declining species and few of the declines appear particularly strong. The most convincing declining species, the Black-and-white Warbler, is a long-distance migrant that nests on the ground in mid-successional to mature mixed forests.

Minnesota DNR Species of Concern

The Loggerhead Shrike is a threatened species in Minnesota and one was detected on a point count in Carlton County in 1997. A Red-shouldered Hawk was detected once in 1997 in the St. Croix State Forest east of Sandstone. A pair of Trumpeter Swans (*Cygnus buccinator*) flew overhead during a point count near Kettle Lake in Carlton County in 2001.

Southeast MN

Increasing Species

Eight species have highly significant ($P < 0.01$) increases in southeast Minnesota. The Eastern Wood-Pewee has gradually increased since 1995, but without a substantial increase in mean abundance. The American Crow has shown a dramatic increase since 1997, almost doubling in abundance. The Black-capped Chickadee, White-breasted Nuthatch, House Wren, and Wood Thrush have all shown a consistent increases. The American Robin has increased since 1995, but has shown a slight decrease since 1999. The Indigo Bunting has gradually increased since 1996. The Warbling Vireo, Red-eyed Vireo, and Ovenbird also increased, though at a lower level of statistical significance ($0.01 < P < 0.05$). However, the Red-eyed Vireo's abundance has increased substantially since 1995. The Eastern Towhee was increasing ($P < 0.01$) based on results to the year 2000, but now has a non-significant trend.

All of the highly significant increasing species are well represented in our surveys and their trends appear convincing (except for possibly the Eastern Wood-Pewee), although the time span is shorter (6 years) as compared to the other study areas. All of these species use deciduous forest, which is the main forest type we sample in southeast Minnesota (coniferous forests are scarce in this region). No other life history traits appear particularly prevalent among the increasing species.

Decreasing Species

Five species have highly significant decreases in southeast Minnesota, although small sample size may be an issue with all but one of the species. The Hairy Woodpecker and Blue-winged Warbler decreased since 1996, but were abundant enough to be analyzed on only five and eight stands, respectively. The Chipping Sparrow has gradually declined since 1995, but only 12 stands are included in the analysis. The Field Sparrow has declined since 1996, but was abundant enough to be analyzed on only 13 stands. The Brown-headed Cowbird is well represented (96 of 211 stands) that has shown a drastic decline since 1995, but has leveled off since 1999. The Blue-gray Gnatcatcher, Red-winged Blackbird, and American Goldfinch have also declined, though at a lower level of statistical significance ($0.01 < P < 0.05$).

Other than the Hairy Woodpecker and Chipping Sparrow, the decreasing species are mainly found in early-successional forests or open areas. The most convincing decreasing species, the Brown-headed Cowbird, is dependant on open agricultural areas and feedlots for feeding. As mentioned before, declines in this brood parasite may benefit many of the species vulnerable to brood parasitism.

Minnesota DNR Species of Concern

Many Species of Concern have been detected on our southeast Minnesota points and most of these species are at the periphery of their range. The Red-shouldered Hawk has been detected on 10 sites across three southeastern counties. It has been found south of Red Wing in Goodhue County, at Nerstrand State Park and near Sakatah Lake State Park in Rice County, and southwest of Wabasha in Wabasha County. The Acadian Flycatcher has been detected at several points across the seven southeastern counties, with most occurring in and around Beaver Creek Valley State Park in Houston County, southeast of Rochester in Olmstead County, and at various locations across Rice County. The

Cerulean Warbler has also been detected at scattered locations across southeast Minnesota, with most occurring northwest of Caledonia in Houston County, west of Rochester in Olmstead County, and west of Red Wing in Goodhue County. The Louisiana Waterthrush has been detected three times, twice at Beaver Creek Valley State Park in Houston County and once at Whitewater State Park in Winona County. A Hooded Warbler was detected once in 1996 east of Rochester.

Regional Trends (3 NF's combined)

Increasing Species

Two species showed a highly significant trend in the regional analysis. The Red-breasted Nuthatch has gradually increased since 1991, although its abundance level has not changed substantially since 1994. The American Redstart has shown an increase, especially since 1996. The Yellow-bellied Flycatcher and Northern Parula have also increased, though at a lower level of statistical significance ($0.01 < P < 0.05$). All of the species with significant regional trends had a corresponding trend on at least one of the national forests.

No life history traits appear particularly prevalent among the increasing species. They range from the American Redstart, an early successional deciduous forest long-distance migrant, to the Red-breasted Nuthatch, a mature coniferous forest permanent resident. The Yellow-bellied Flycatcher and Northern Parula also use mature conifers, the former using lowlands and the latter using primarily uplands. The increases of the Red-breasted Nuthatch and American Redstart appear to be the most convincing.

Decreasing Species

Six species had highly significant ($P < 0.01$) declines in the regional analysis. The Eastern Wood-Pewee has steady decline with a substantial drop in abundance since 1991. The Winter Wren has decreased regionally since 1991, with rebounds around 1993 and 1998. This species has shown steep declines in recent years in all four northern study areas. The Ovenbird has decreased since 1991 with a steep drop in 1996 and a rebound until 1998. The Scarlet Tanager and Song Sparrow have each shown a gradual regional decline since 1991. The White-throated Sparrow has declined since 1991, but has actually shown a slight increase since 1996. The Brown Creeper, Hermit Thrush, Black-and-white Warbler, Common Yellowthroat, and Canada Warbler have also decreased regionally, though at a lower level of statistical significance ($0.01 < P < 0.05$). The Brown Creeper is the only species with a significant regional trend and no corresponding trend in any of the national forests.

All of the highly significant regional decreases appear convincing, but few life history traits appear particularly prevalent among the decreasing species. Eight of the 11 decreasing species are ground nesters (four of the six highly significant declines).

Breeding Bird Survey Trends

The results from the Breeding Bird Survey are sometimes thought of as a “benchmark” for comparison with results from regional studies. In the case of our off-road counts, it is unclear whether a direct comparison with BBS results is warranted (see below), nonetheless we have included the comparison. Less than a third of the species (ten of 35)

tested for regional trends (three national forests combined) had an equivalent BBS trend in stratas 20 and 28 combined. The Northern Parula increased and the Eastern Wood-Pewee, Ovenbird, and Song Sparrow decreased on our surveys and the BBS. Six other species had a non-significant trend on both surveys.

The relative lack of conformity between the two surveys is not surprising, given the differences between our study design and that of the BBS. While the results from the BBS are widely used and there are many benefits to the survey's design, there are some possible biases to consider. Roadside surveys such as the BBS are likely to be situated in more developed landscapes than are off-road counts such as ours. Forest change may be different along roads than in off-road areas. The validity of BBS trends partially rests on the assumption that changes in habitats along roads are representative of the landscape as a whole (Price et al. 1995), which may or may not be the case (see Hutto et al. 1995). Long-term changes in traffic patterns could even be having an effect on BBS trends in some areas. An obvious difference between our surveys and the BBS is that BBS routes sample many non-forested areas that we do not sample, such as open wetlands and agricultural fields. We feel that when addressing population trends in forest birds, an off-road regional monitoring program such as ours should be thought of as a "benchmark" for comparisons with BBS results, rather than vice versa.

Guild Analyses

Short-distance migrants were slightly more prevalent among the decreasing species than among the increasing species, however, none of the proportions of migration strategies were significantly different from those of the species tested. Likewise, deciduous forest species were slightly more prevalent among the increasing species, but none of the proportions of vegetation-type guilds were significantly different from those of the species tested.

Eight of eleven (73%) regionally decreasing species are ground-nesters, and nearly half (48%) of all decreasing species are ground-nesters, as compared to the 33% of the species tested that are ground-nesters. While this was not statistically significant ($P < 0.069$), ground nesters appear to be prevalent among decreasing species in most study areas. There are a number of potential causes for this observed pattern, including increased nest predation or decreased food supply over time.

Although the landscapes surrounding our four northern study areas are primarily forested, there are indications that the landscape is becoming more fragmented in recent years. Wolter and White (in press) 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, studies have found higher predation rates on ground nests near forest edges than in interior areas (Fenske-Crawford and Niemi 1997, Manolis et al. 2000, Flaspohler et al. 2001). Data from the Minnesota DNR 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).

In most cases, each group of species with significant trends in a given study area has a wide variety of traits, and except for the declining ground-nesters, no real unifying theme. This is not surprising given the wide diversity of species we sample, the heterogeneity of the landscape, and the myriad factors that can potentially affect bird populations. Other researchers have highlighted the pitfalls of trying to generalize possible factors among groups of species (Holmes and Sherry 2001).

Conclusions

Regionally, the Red-breasted Nuthatch and American Redstart have both shown highly significant increasing trends as well as a convincing trend in the Chippewa NF. Other species with relatively strong increasing trends on individual study areas include the Yellow-bellied Sapsucker and Yellow-bellied Flycatcher in the Chequamegon NF, the Chestnut-sided Warbler in the Chippewa NF, the Northern Parula in the Superior NF, and the Least Flycatcher in the St. Croix region. Eight other species had highly significant trends in southeastern Minnesota, albeit with a shorter time span than the northern sites.

The most convincing regional declines are those of the Eastern Wood-Pewee, Winter Wren, Ovenbird, Scarlet Tanager, and Song Sparrow. The Eastern Wood-Pewee also had highly significant declines in the Chequamegon NF and the Superior NF, the Winter Wren had a highly significant decline in the Chequamegon NF, and the Song Sparrow in the Chippewa NF. The Hermit Thrush declined in the Chequamegon NF and in the Chippewa NF, and the Black-and-white Warbler has shown substantial declines in the Chequamegon NF, Superior NF and St. Croix region. The Brown-headed Cowbird decreased in southeastern Minnesota during the six years of monitoring there.

We have focused on highly significant trends, particularly those occurring in multiple study areas. It is important to keep in mind that a moderately significant trend, or even a non-significant one, could be a “first warning” of a more pronounced trend, especially if we are at the edge of a species’ distribution or if the species uses vegetation-types that we do not sample.

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Table 1. Trends for five study areas and regional analysis (three national forests combined) based on linear regression. I = significantly increasing, D = significantly decreasing. * $P \leq 0.05$, ** $P \leq 0.01$. See Appendix A for species graphs and Appendix B for test statistics and sample sizes.

Species	Chequam. NF	Chippewa NF	Superior NF	St. Croix Minn.	Southeast Minn.	Regional
Ring-necked Pheasant					ns	
Mourning Dove					ns	
Red-bellied Woodpecker					ns	
Yellow-bellied Sapsucker	I**	D**	ns	ns	ns	
Downy Woodpecker					ns	
Hairy Woodpecker	ns	ns			D**	
Pileated Woodpecker					ns	
Olive-sided Flycatcher		ns				
Eastern Wood-Pewee	D**	D*	D**	D*	I**	D**
Yellow-bellied Flycatcher	I**	ns	ns	ns		I*
Acadian Flycatcher					ns	
Alder Flycatcher	I*	ns	ns	ns		ns
Least Flycatcher	ns	I*	ns	I**		ns
Great Crested Flycatcher	ns	D**		D*	ns	
Eastern Kingbird	ns					
Yellow-throated Vireo		ns		ns	ns	
Blue-headed Vireo	ns	ns	ns			ns
Warbling Vireo					I*	
Red-eyed Vireo	I*	ns	ns	ns	I*	ns
Blue Jay	ns	ns	ns	ns	ns	ns
American Crow					I**	
Black-capped Chickadee	ns	I*	I*	ns	I**	ns
Red-breasted Nuthatch	ns	I**	I*	ns		I**
White-breasted Nuthatch	ns	I*		ns	I**	
Brown Creeper	ns	ns	ns			D*
House Wren					I**	
Winter Wren	D**	D*	D*	ns		D**
Golden-crowned Kinglet	ns	D*	ns	D*		ns
Ruby-crowned Kinglet			D**			
Blue-gray Gnatcatcher					D*	
Veery	ns	ns	ns	I**	ns	ns
Swainson's Thrush			ns			
Hermit Thrush	D**	D**	ns	ns		D*
Wood Thrush	I**			ns	I**	
American Robin	ns	ns	ns	ns	I**	ns
Gray Catbird		I**		ns	ns	
Brown Thrasher		ns				

Table 1 (continued)

Species	Chequam. NF	Chippewa NF	Superior NF	St. Croix Minn.	Southeast Minn.	Regional
Cedar Waxwing		I**		I*		
Blue-winged Warbler					D**	
Golden-winged Warbler	ns	ns	D**	ns		ns
Tennessee Warbler			ns			
Nashville Warbler	D**	ns	ns	D*		ns
Northern Parula	ns	ns	I*			I*
Yellow Warbler		D*			ns	
Chestnut-sided Warbler	I*	I**	ns	ns		ns
Magnolia Warbler		ns	I*			
Yellow-rumped Warbler	ns	ns	ns	ns		ns
Black-throated Green Warbler	ns	ns	D*	ns		ns
Blackburnian Warbler	ns	D*	ns	ns		ns
Pine Warbler	ns	ns	I**			ns
Palm Warbler		ns				
Black-and-white Warbler	D**	ns	D**	D**		D*
American Redstart	I**	I**	ns	I*	ns	I**
Ovenbird	D*	D**	ns	D*	I*	D**
Northern Waterthrush	ns		ns			
Connecticut Warbler		D**				
Mourning Warbler	ns	D**	ns	D*		ns
Common Yellowthroat	D**	ns	D**	D**	ns	D*
Canada Warbler	ns	ns	D**	I**		D*
Scarlet Tanager	D*	D*	ns	ns	ns	D**
Eastern Towhee	ns				ns	
Chipping Sparrow	ns	ns	D*		D**	ns
Clay-colored Sparrow	ns					
Field Sparrow					D**	
Vesper Sparrow	ns					
Song Sparrow	D**	D**	ns	ns	ns	D**
Swamp Sparrow	D*	ns	I**	ns		ns
White-throated Sparrow	D**	D**	D*	ns		D**
Northern Cardinal					ns	
Rose-breasted Grosbeak	ns	ns	D*	ns	ns	ns
Indigo Bunting	ns	ns		ns	I**	
Red-winged Blackbird	D**				D*	
Brewer's Blackbird	ns					
Brown-headed Cowbird	ns	D**		D*	D**	
Baltimore Oriole					ns	
American Goldfinch					D*	
Evening Grosbeak	D*					

Table 2. Increasing and decreasing species ($P \leq 0.05$) by study area, based on simple linear regression. ** $P \leq 0.01$. Individual species graphs can be found in Appendix A.

Increasing Species		
<u>Chequamegon NF</u>	<u>Chippewa NF</u>	<u>Superior NF</u>
** Yellow-bellied Sapsucker	Least Flycatcher	Black-capped Chickadee
** Yellow-bellied Flycatcher	Black-capped Chickadee	Red-breasted Nuthatch
Alder Flycatcher	** Red-breasted Nuthatch	Northern Parula
Red-eyed Vireo	White-breasted Nuthatch	Magnolia Warbler
** Wood Thrush	** Gray Catbird	** Pine Warbler
Chestnut-sided Warbler	** Cedar Waxwing	** Swamp Sparrow
** American Redstart	** Chestnut-sided Warbler	
	** American Redstart	
<u>St Croix, MN</u>	<u>Southeast MN</u>	<u>Regional</u>
** Least Flycatcher	** Eastern Wood-Pewee	Yellow-bellied Flycatcher
** Veery	Warbling Vireo	** Red-breasted Nuthatch
Cedar Waxwing	Red-eyed Vireo	Northern Parula
American Redstart	** American Crow	** American Redstart
** Canada Warbler	** Black-capped Chickadee	
	** White-breasted Nuthatch	
	** House Wren	
	** Wood Thrush	
	** American Robin	
	Ovenbird	
	** Indigo Bunting	
Decreasing Species		
<u>Chequamegon NF</u>	<u>Chippewa NF</u>	<u>Superior NF</u>
** Eastern Wood-Pewee	** Yellow-bellied Sapsucker	** Eastern Wood-Pewee
** Winter Wren	Eastern Wood-Pewee	Winter Wren
** Hermit Thrush	** Great Crested Flycatcher	** Ruby-crowned Kinglet
** Nashville Warbler	Winter Wren	** Golden-winged Warbler
** Black-and-white Warbler	Golden-crowned Kinglet	Black-throated Green Warbler
Ovenbird	** Hermit Thrush	** Black-and-white Warbler
** Common Yellowthroat	Yellow Warbler	** Common Yellowthroat
Scarlet Tanager	Blackburnian Warbler	** Canada Warbler
** Song Sparrow	** Ovenbird	Chipping Sparrow
Swamp Sparrow	** Connecticut Warbler	White-throated Sparrow
** White-throated Sparrow	** Mourning Warbler	Rose-breasted Grosbeak
** Red-winged Blackbird	Scarlet Tanager	
Evening Grosbeak	** Song Sparrow	
	** White-throated Sparrow	
	** Brown-headed Cowbird	
<u>St Croix, MN</u>	<u>Southeast MN</u>	<u>Regional</u>
Eastern Wood-Pewee	** Hairy Woodpecker	** Eastern Wood-Pewee
Great Crested Flycatcher	Blue-gray Gnatcatcher	Brown Creeper
Golden-crowned Kinglet	** Blue-winged Warbler	** Winter Wren
Nashville Warbler	** Chipping Sparrow	Hermit Thrush
** Black-and-white Warbler	** Field Sparrow	Black-and-white Warbler
Ovenbird	Red-winged Blackbird	** Ovenbird
Mourning Warbler	** Brown-headed Cowbird	Common Yellowthroat
** Common Yellowthroat	American Goldfinch	Canada Warbler
Brown-headed Cowbird		** Scarlet Tanager
		** Song Sparrow
		** White-throated Sparrow

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	Least Flycatcher	Black-capped Chickadee
Eastern Wood-Pewee	Red-eyed Vireo	American Redstart
Yellow-bellied Flycatcher	Red-breasted Nuthatch	
Alder Flycatcher	White-breasted Nuthatch	
Warbling Vireo	Wood Thrush	
American Crow	Cedar Waxwing	
House Wren	Chestnut-sided Warbler	
Veery		
American Robin		
Gray Catbird		
Northern Parula		
Magnolia Warbler		
Pine Warbler		
Ovenbird		
Canada Warbler		
Swamp Sparrow		
Indigo Bunting		
Decreased in one study area	Decreased in two study areas	Decreased in three or more study areas
Yellow-bellied Sapsucker	Great Crested Flycatcher	Eastern Wood-Pewee
Hairy Woodpecker	Golden-crowned Kinglet	Winter Wren
Ruby-crowned Kinglet	Hermit Thrush	Black-and-white Warbler
Blue-gray Gnatcatcher	Nashville Warbler	Ovenbird
Blue-winged Warbler	Mourning Warbler	Common Yellowthroat
Golden-winged Warbler	Scarlet Tanager	White-throated Sparrow
Yellow Warbler	Chipping Sparrow	Brown-headed Cowbird
Black-throated Green Warbler	Song Sparrow	
Blackburnian Warbler	Red-winged Blackbird	
Connecticut Warbler		
Canada Warbler		
Field Sparrow		
Swamp Sparrow		
Rose-breasted Grosbeak		
American Goldfinch		
Evening Grosbeak		

Table 4. Species with highly significant trends ($P < 0.01$) in multiple study areas.

<u>Increasing</u>			<u>Decreasing</u>	
Species	# of study areas		Species	# of study areas
Wood Thrush	2		Eastern Wood-Pewee	2
American Redstart	2		Hermit Thrush	2
			Black-and-white Warbler	3
			Common Yellowthroat	3
			Song Sparrow	2
			White-throated Sparrow	2
			Brown-headed Cowbird	2

Table 5. Summary of changes in trends from 2000 analyses (does not include regional trends). Numbers in parentheses indicate species with changes in multiple study areas.

Species with new significant trends ($P < 0.05$) in 2001

Increasing	Decreasing
Red-eyed Vireo (2)	Yellow-bellied Sapsucker
Black-capped Chickadee	Hairy Woodpecker
Red-breasted Nuthatch	Eastern Wood-Pewee
Cedar Waxwing (2)	Great Crested Flycatcher
Northern Parula	Winter Wren (2)
Chestnut-sided Warbler	Golden-crowned Kinglet (2)
Ovenbird	Ruby-crowned Kinglet
Canada Warbler	Blue-gray Gnatcatcher
Swamp Sparrow	Hermit Thrush
	Nashville Warbler
	Black-throated Green Warbler
	Blackburnian Warbler
	Black-and-white Warbler
	Ovenbird
	Mourning Warbler
	Scarlet Tanager (2)
	Chipping Sparrow (2)
	Swamp Sparrow
	Red-winged Blackbird
	American Goldfinch
	Evening Grosbeak

Species with new non-significant trends ($P > 0.05$) in 2001

Was increasing in 2000	Was decreasing in 2000
Yellow-bellied Flycatcher	Brown Creeper
Yellow-throated Vireo	Clay-colored Sparrow
Blue-headed Vireo	Swamp Sparrow
Red-eyed Vireo	White-throated Sparrow
Red-breasted Nuthatch	Rose-breasted Grosbeak
White-breasted Nuthatch	
Brown Creeper	
Swainson's Thrush	
American Robin (3)	
Black-and-white Warbler	
Eastern Towhee	
Swamp Sparrow	
Indigo Bunting	
Brewer's Blackbird	
Brown-headed Cowbird	

Table 6. Trends for two time periods from Breeding Bird Survey routes in the Northern Spruce/Hardwoods (strata 28) and the Great Lakes Transition (strata 20) physiographic strata combined. Only species tested for regional trends on NRRI study areas included.

Species	<u>1966 to 2000</u>			<u>1990 to 2000</u>		
	Trend	<i>P</i>	# of routes	Trend	<i>P</i>	# of routes
Eastern Wood-Pewee	-2.83	0.001	317	-2.9	0.000	259
Yellow-bellied Flycatcher	1.23	0.315	145	1.63	0.307	98
Alder Flycatcher	5.01	0.162	63	9.46	0.006	39
Least Flycatcher	-2.22	0.000	352	-2.2	0.007	317
Blue-headed Vireo	5.55	0.000	262	5.41	0.000	224
Red-eyed Vireo	1.73	0.000	358	2.57	0.000	330
Blue Jay	0.23	0.377	357	2.53	0.000	327
Black-capped Chickadee	2.36	0.000	354	2.7	0.000	330
Red-breasted Nuthatch	2.87	0.000	300	-2.1	0.067	267
Brown Creeper	2.91	0.380	95	7.22	0.064	75
Winter Wren	4.71	0.000	299	2.38	0.002	264
Golden-crowned Kinglet	3.07	0.056	191	0.22	0.865	163
Veery	-1.87	0.000	345	-2	0.001	308
Hermit Thrush	1.97	0.000	323	2.24	0.006	295
American Robin	0.13	0.378	358	0.49	0.151	330
Golden-winged Warbler	-0.47	0.635	109	-4.7	0.000	87
Nashville Warbler	0.76	0.034	324	0.42	0.455	287
Northern Parula	2.1	0.004	216	2.75	0.010	179
Chestnut-sided Warbler	-0.33	0.413	346	-1.8	0.000	306
Yellow-rumped Warbler	2.17	0.000	309	2.58	0.000	277
Black-throated Green Warbler	-0.03	0.976	295	2.81	0.001	261
Blackburnian Warbler	1.37	0.068	269	0.31	0.786	216
Pine Warbler	5.15	0.000	128	4.58	0.053	110
Black-and-white Warbler	0.55	0.232	332	-1	0.166	300
American Redstart	-1.16	0.196	345	-0.7	0.443	309
Ovenbird	0.09	0.655	356	-1.3	0.002	323
Mourning Warbler	-0.44	0.283	298	-2.3	0.006	255
Common Yellowthroat	-0.28	0.444	359	-0.3	0.518	331
Canada Warbler	-2.25	0.056	243	-2.9	0.093	177
Scarlet Tanager	0.13	0.770	254	-1.2	0.194	203
Chipping Sparrow	-0.32	0.272	348	-0.7	0.158	314
Song Sparrow	-0.97	0.000	358	-1.6	0.000	330
Swamp Sparrow	1.19	0.035	301	2.32	0.021	248
White-throated Sparrow	-1.14	0.001	333	0.71	0.071	294
Rose-breasted Grosbeak	-1.86	0.012	290	-1.7	0.000	333

Table 7. Comparison of NRRI regional trends with Breeding Bird Survey trends from the Northern Spruce/Hardwoods (strata 28) and the Great Lakes Transition (strata 20) physiographic strata combined. See Appendix C for abbreviations.

		NRRI Trends			
		Increase	Decrease		N.S.
BBS Trends	Increase	NOPA	WIWR HETH		ALFL BCCH BHVI MYWA REVI BTNW BLJA SWSP
	Decrease		EAWP OVEN SOSP		LEFL MOWA VEER RBGR GWWA CSWA
	N.S.	YBFL RBNU AMRE	BRCR BAWW COYE	CAWA SCTA WTSP	GCKI BLBW AMRO PIWA NAWA CHSP

Table 8. Number of harvested points in each study area since the beginning of monitoring

Study Area	Total # of sites	# clearcut	# partially or selectively cut*
Chequamegon NF	389	6	27
Chippewa NF	390	22	36
Superior NF	491	41	25
St. Croix, MN	166	4	9
Southeast MN	211	1	4

* Sites in the partially cut category can include anywhere from 10-90% of the 100 m radius count circle harvested.

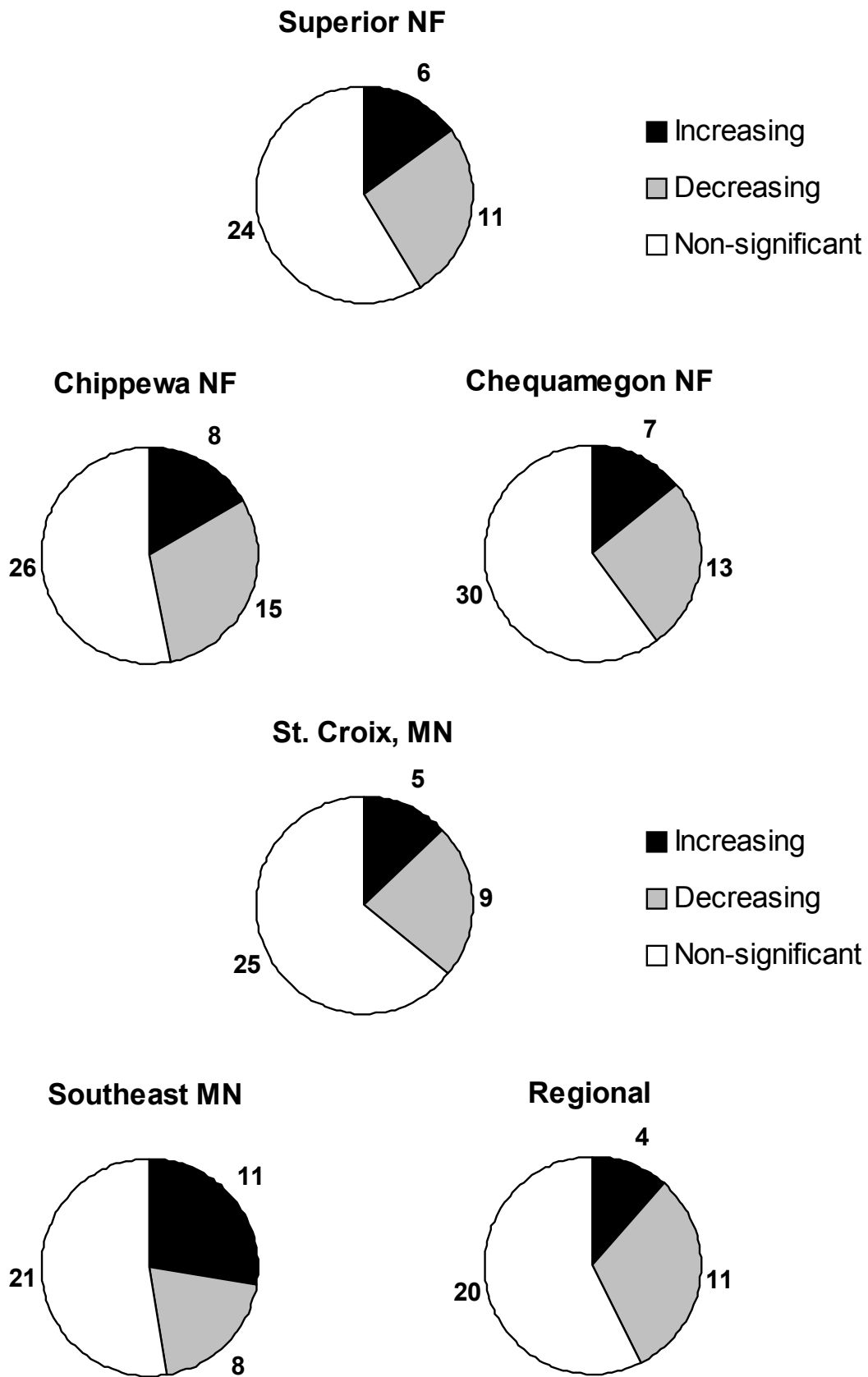


Figure 3. Summary of significant trends ($P < 0.05$) by study area. Regional trends include three national forests combined. See Table 1 for list of species trends by study area.

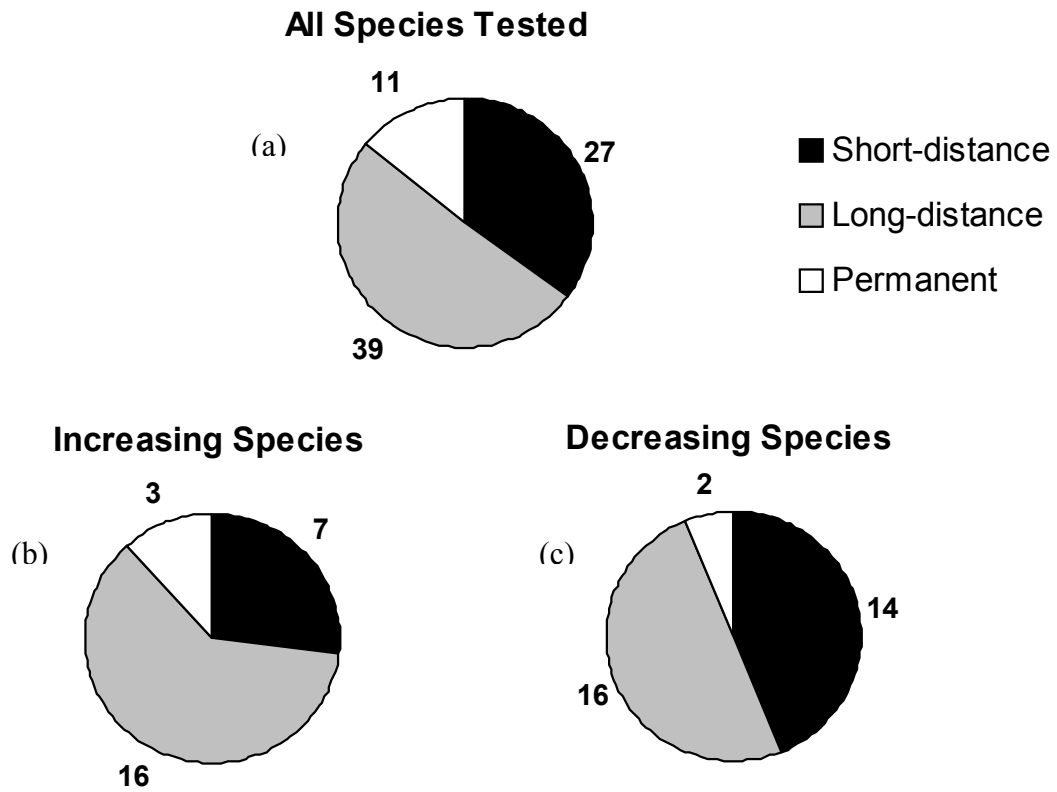


Figure 4. Distribution of species among migration guilds for all species (a), and those that increased (b) or decreased (c).

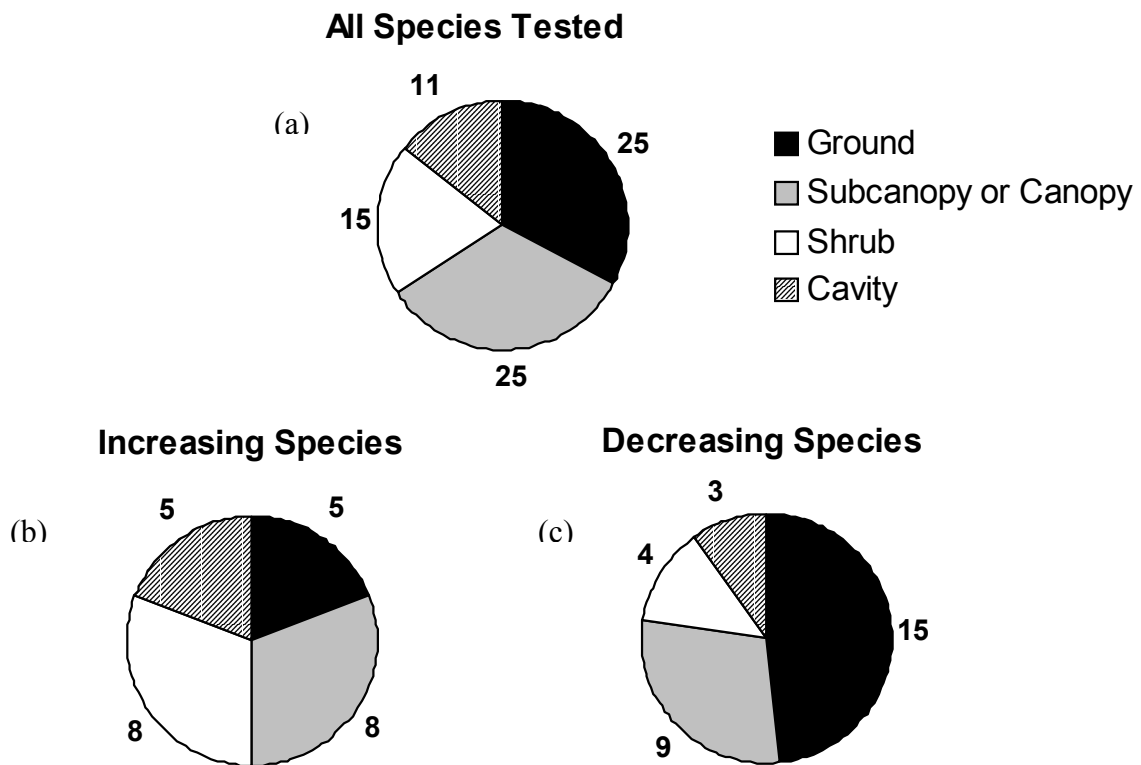


Figure 5. Distribution of species among nesting guilds for all species (a), and those that increased (b) or decreased (c).

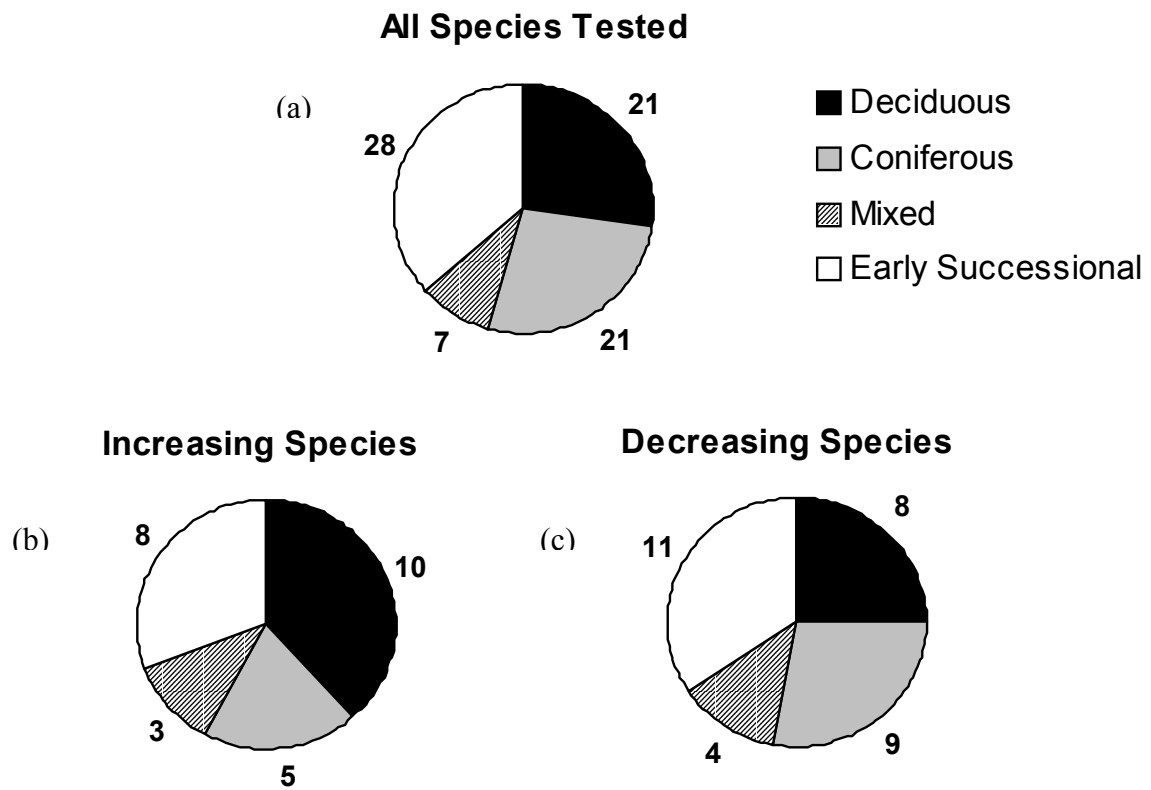


Figure 6. Distribution of species among vegetation-type guilds for all species (a), and those that increased (b) or decreased (c).

