2004 Annual Update Report:

Breeding bird monitoring in Great Lakes National Forests: 1991-2004

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

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SUMMARY

- A total of 132, 134, and 164 stands (1,246 survey points) were surveyed for breeding birds in the Chequamegon, Chippewa, and Superior National Forests (NF), respectively in 2004. Annual surveys have been conducted since 1991 in the Chippewa and Superior NF, and since 1992 in the Chequamegon NF.
- Trends in relative abundance were calculated for 69 bird species, including 55 species in the Chequamegon NF, 54 in the Chippewa NF, and 45 in the Superior NF. Thirty-seven species were also tested for a pooled trend by combining data from the three national forests.
- A total of 154 species/national forest trends were calculated (not including pooled trends), 59 (38%) of which were significant ($P \leq 0.05$). Seventeen species increased significantly ($P \leq 0.05$) in at least one national forest and 24 species decreased. Eight species had significant increasing pooled trends and 14 had decreasing trends.
- The percentage of increasing species on each national forest ranged from 9% in the Chequamegon NF, to 20% in the Superior NF. The percentage of decreasing species ranged from 24% in the Chequamegon NF, to 33% in the Chippewa NF.
- Of the 151 species/national forest trends calculated in 2003, 23 (15%) changed in 2004. Negative trends (n = 15) were more likely to change than positive trends (n = 8). Trends at the $0.01 > P > 0.05$ significance level (20 trends) were more likely to change than those at the $P \leq 0.01$ level (three trends)
- The short-distance migrant guild showed highly significant declines on all national forests. Long-distance migrants declined in the Chequamegon and Superior NF and increased in the Chippewa NF. Permanent residents increased on the Chippewa and Superior NF and were stable on the Chequamegon NF.
- The ground nesting guild declined on all national forests, while shrub/sub-canopy nesters increased on all national forests. The canopy and cavity nesting guilds showed stable trends, except for a decrease in canopy nesters in the Chequamegon NF and an increase in cavity nesters in the Superior NF.
- The lowland coniferous, deciduous and early-successional forest bird guilds showed widespread declines on our study areas. The upland coniferous bird guild increased on the Superior NF and pooled NFs. The mixed forest bird guild increased on the Chippewa NF and declined on the Superior NF.
- Evidence from recent regional studies have demonstrated greater nest predation rates on ground nests near forest/clearcut edges, as well as a significant increase in the creation of forest edges in recent years. Increasing amounts of forest edge and nest predation may be having negative effects on declining ground-nesters such as the Winter Wren, Veery, Hermit Thrush, Ovenbird, and White-throated Sparrow.
- Of the 1274 survey sites on the three national forests, 14.2% have been at least partially harvested since the beginning of monitoring, which is about 1% a year (Table 7). This harvest rate 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 (i.e. ~1% annual change). Thus, it appears that management activities on our sample sites are representative of the national forests as a whole, and that the trends we are documenting are probably occurring across the regional landscape.

- Many of the declining trends that we have detected have been consistent across the years and are not likely due to annual variation. One of the main goals of this monitoring program is to identify potential declines of forest bird species. This is especially true for species of conservation concern such as the Eastern Wood-Pewee, Winter Wren, Hermit Thrush, Ovenbird, and White-throated Sparrow. The declines observed over the past years for common species such as the Ovenbird and White-throated Sparrow are a continuing concern and special management consideration should be given to these species.

INTRODUCTION

The national forests of the western Great Lakes have among the richest diversity of breeding bird species in North America (Green 1995, Rich et al. 2004). An increased appreciation of this diversity, along with concerns about potential declines of some species, has led to a strong interest in monitoring forest bird populations in the region. The relatively heavily forested landscapes of northern Minnesota and Wisconsin are considered to be population "sources" for many 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.

Agencies such as the USDA Forest Service have a need for population trend data at the scale of an individual national forest, to identify when and where population changes are occurring and identify potential conservation problems. 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 at smaller geographic scales (Peterjohn et al. 1995). Continental trends also have the potential to mask regional population trends (Holmes and Sherry 1988), thus there is a need for regional monitoring programs that can provide more localized information (Green 1995, Howe et al. 1997).

In response to the need for regional population data, a long-term forest breeding bird monitoring program was established in 1991 on the Chippewa and Superior National Forests, and in 1992 on the Chequamegon National Forest and the St. Croix region of east-central Minnesota. The Forest Service is mandated to monitor certain management indicator species (Manley 1993), and our monitoring program expands beyond indicator species to include all forest songbird species that we can adequately sample. Currently, 435 stands (1,271 points) within the three national forests are surveyed once during each breeding season (June 1 to July 10). From 1995 to 2001 we surveyed an additional 211 points in southeast Minnesota, however, counts were discontinued due to a lack of funding. See Lind et al. (2001b) for 1995-2001 results from southeast Minnesota. Surveys in the St.

Croix region of east-central Minnesota were also discontinued after 2003 due to lack of funding, with 1992-2003 results available in our 2003 annual report (Lind et al. 2003).

The primary objective of this report is to update U.S. Forest Service personnel on results of the forest bird monitoring program. We focus on relative abundance trends of individual species, as well as assemblages of species, over the 13 to 14 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. This report, as well as annual update reports from 1998 to 2003, can be found on the internet at: http://www.nrri.umn.edu/mnbirds/reports.htm. Other objectives, including bird/habitat and bird/landscape relationships, development of management recommendations for birds, and development and monitoring of the forest plan, were met through Minnesota's Forest Bird Diversity Initiative (Niemi et al. 2003). Additional information on these objectives will be available as time and monetary resources become available.

DESIGN AND METHODS

Sample Design

The monitoring program was designed to provide an accurate estimate of population change for forest bird species on three national forests in northern Minnesota and Wisconsin (Figure 1). The spatial extent of each national forest is large, on the order of tens of thousands of hectares, and each area includes a mosaic of forest stand types. We distributed sampling locations across the forest mosaic in a stratified random manner. A list of forest stands was created for each study area, and stands with the same stand type according to dominant tree species and stocking density were grouped into strata. Stands were ≥ 16 ha (40 acres) and were identified from the individual national forest inventories. For each national forest, a number of stands were selected from each stratum so that the final proportion of stands of each stand type was equal to the proportion of forested land area of each stand type (Hanowski and Niemi 1995). Our sample of stands is therefore representative of the forest cover in each national forest. A total of 133, 135, and 169 stands were established in the Chequamegon, Chippewa, and Superior National Forests, respectively.

Stands were large enough to accommodate three sampling points a minimum of 220 meters apart. Changes to forest cover through natural and anthropogenic disturbance have occurred on sampling locations since the beginning of the study and may have caused concomitant changes in bird populations. Because sampling locations are permanently marked, we are able to incorporate such changes into our descriptions of bird population patterns through time.

S*ampling*

Point count sampling used in our program follow national and regional standards (Ralph et al. 1993, 1995, Howe et al. 1997). 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, grouse, 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. permanent residents that begin breeding in April, such as woodpeckers and chickadees).

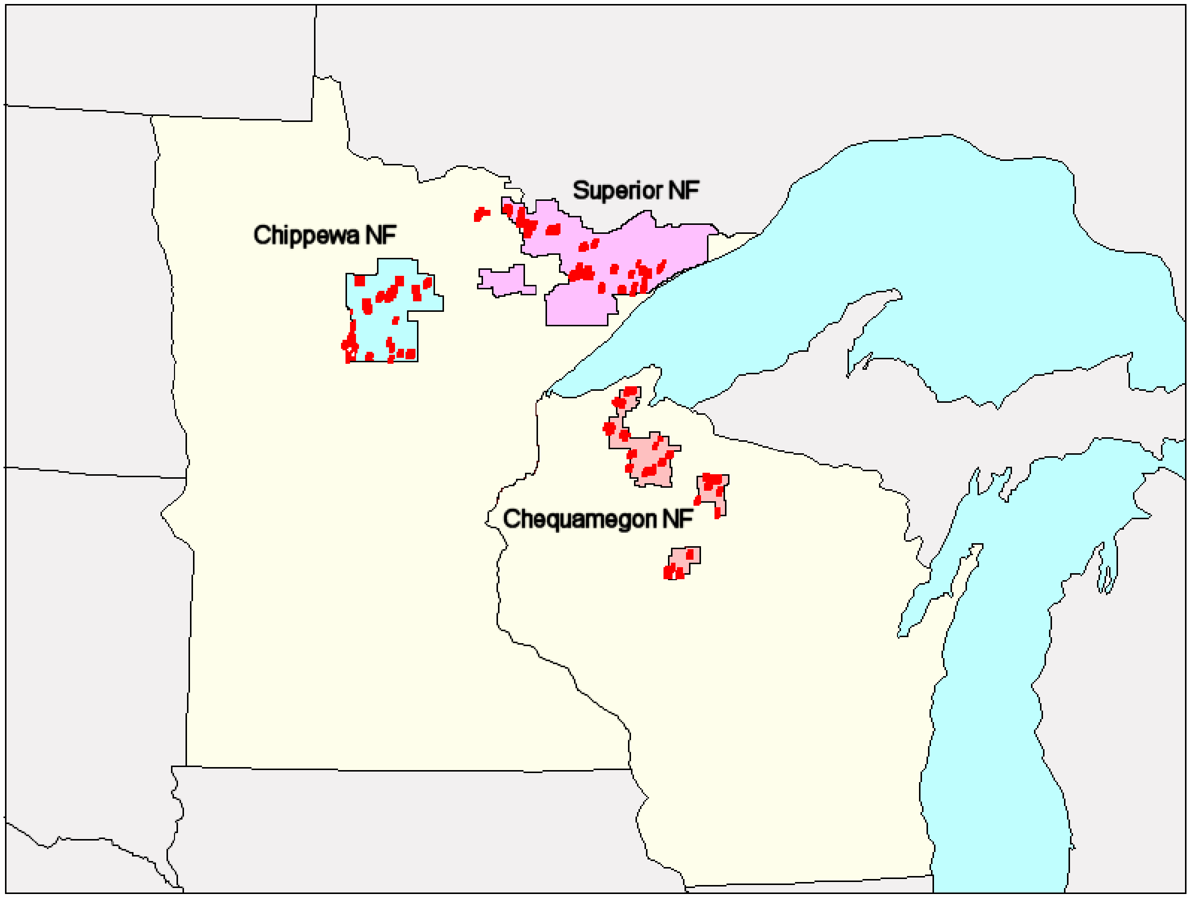

Figure 1. Locations of forest breeding bird point counts in northern Minnesota and Wisconsin (1991-2004).

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. From 1995-2004, we included all birds heard or seen from the point, regardless of distance, 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 attempted to have each observer sample a similar number of stands of each forest cover type. This was done to minimize bias due to 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.

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 pattern of population change through time can be viewed in two distinct ways: 1) as *population trajectory*, the path of a population through time, including its ups and downs, and 2) as *population trend*, the overall pattern of increase or decrease over the course of the study, presented as a positive or negative number. We built statistical models of species relative abundance as a function of time to describe these features of bird populations.

Relative abundance

For each species, yearly relative abundance was calculated using birds detected within 100 m of each point. 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 summed and analyzed.

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. Data were included for a species if it was observed on a minimum of five stands per study area and in at least three years on each stand. For species that were observed on a minimum of five stands in each of the three national forests, we pooled all stands and carried out an additional (three national forest combined) analysis. Although this pooled analysis does not include lands in non-federal ownerships, it should give an indication of population trends at a larger scale than the individual national forest.

Population trajectory

Population trajectory can be thought of simply as the size of a population across time. Because we do not record every individual bird present in our study areas, we cannot know true population size. Instead, we must rely on our sample design to give an estimate of population size in each year. Central to our analytical process is how we scaled up bird abundance recorded at the stand level to an annual index of population size for the study areas. We used a non-parametric route regression procedure similar to that described by James et al. (1996), in which observed abundances on each stand are smoothed and then combined to give a region-wide index of population size.

We used locally-weighted (LOESS) regression to smooth the time series of species relative abundance for each stand. In LOESS-regression, fitted values (points along the curve) for years are calculated by giving a small amount of weight to neighboring years, for example, a year with high raw abundance for a species would tend to bring up the fitted values for the year before and the year after. We then computed the arithmetic mean and 95% confidence intervals using the fitted values from the within-stand regressions for each species in each year. The mean fitted value represents the annual index of population size. By plotting the mean fitted values and confidence intervals in a time series, we get a graphic depiction of the population trajectory (Appendix A). With every new year of sampling, we can expect the modeled abundance of a species in a given year to vary slightly from previous years' results, due to the way fitted abundance values are calculated in the LOESS-regression.

Population trend

Population trend can be thought of as a statement of the direction and magnitude of population change a given time period (Link and Sauer 1997). Because a significant trend implies a unidirectional change, linear methods can be used to detect trend without asserting that the population trajectory is linear (Urquhart and Kincaid 1999). To assess trend, we modeled the relationship between the annual index of population size for a study area (described in *Population Trajectory* above) and time using simple linear regression. We used the slope coefficient to characterize direction and magnitude of the trend. To facilitate comparison, slopes were converted to units of % annual change by dividing annual population indexes by the predicted value of the index at the midpoint of the survey period prior to regressing the index against time (Bart et al. 2003). We assessed the significance of the regressions using a bootstrap procedure (Manly 1990) in which trends were computed for 500 bootstrap resamples of the stands used to calculate the annual population index. For each bootstrap resample, trend was calculated using the same steps as for the original trend. For each original trend, an exact p-value was calculated as the percentile at which zero occurred in the distribution of 500 bootstrapped slopes. For example, $p = 0.01$ would be equivalent to 99% of bootstrapped slopes being greater than zero, which would give us a high degree of confidence that the true population slope was different from zero.

Guild Analyses

We examined trends for three types of guilds: migration strategy, nesting substrate, and vegetation-type preference (Appendix C). Guild analyses followed similar procedures as the individual species analyses, except that each species was assigned a guild category and all species within that category (e.g. long-distance migrants) were combined and analyzed as a group. All non-flyover individuals of all species within the 100 m radius were included, regardless of whether the species met the inclusion criteria described above for individual species. Guild categories were taken from Erlich et al. (1988) and Freemark and Collins (1992), with modifications based on personal experience and data from the region.

Note that some species use different migration strategies, nesting substrates, and vegetation types in different portions of their geographic range. Guild analyses also can be complicated by a lack of agreement on how to categorize guilds, and there will always be species that use multiple guilds. 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). Directional trends in abundant species can strongly affect all the guilds that those species are categorized in. Given these limitations, we still feel it is important to look for underlying similarities among groups of increasing and decreasing species.

Range of Natural Variability

Bird population sizes in the Chippewa and Superior National Forests have been assessed in relation to their range of natural variability (RNV; Hanowski and Danz 2003). In an effort to place the trends from these two national forests into context with their historic and current populations, we have presented the RNV values for each of the species tested in the Chippewa and Superior NF. The RNV calculations are based on estimated historic forest conditions and the habitat affinities of each species, and represent a potential benchmark for evaluating our trends. An underlying assumption of the RNV concept is that a species is considered sustainable if it is currently present on the landscape at the same levels which it occurred historically.

RESULTS AND DISCUSSION

Over the course of 14 field seasons we have detected over 257,000 individual birds of 173 species on more than 17,000 ten-minute point counts in the three national forests (Figure 2). In 2004, we sampled 132 stands in the Chequamegon NF, 134 stands in the Chippewa NF, and 164 in the Superior NF.

Sixty-nine species were tested for trends in at least one national forest, including 55 in the Chequamegon NF, 54 in the Chippewa NF, and 45 in the Superior NF (Table 1). Additionally, 37 species were tested for a “pooled” (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.

Overview of Population Trends

A total of 154 species/national forest trends were calculated (not including pooled trends), 59 (38%) of which were significant ($P \leq 0.05$). Seventeen species increased in at least one national forest, including five (Red-eyed Vireo, Black-capped Chickadee, Cedar Waxwing, Blackburnian Warbler, and American Redstart) that increased in multiple national forests (Tables 2 and 3). Twenty-four species decreased in at least one national forest, including seven (Eastern Wood-Pewee, Winter Wren, Veery, Hermit Thrush, Black-throated Green Warbler, Ovenbird, and White-throated Sparrow) that decreased in multiple national forests.

Of the 151 species/national forest trends calculated in 2003 (Lind et al. 2003), 23 (15%) changed in 2004 (Table 4). Negative trends (n = 15) were more likely to change from 2003 than positive trends (n = 8). Trends at the $0.01 > P > 0.05$ significance level (20 trends) were more likely to change than those at the $P \leq 0.01$ level (three trends).

Many of the species we monitor exhibit large annual fluctuations in abundance, a phenomenon which has been documented on several other long-term studies (Virkkala 1991, Blake et al. 1994, Weslowski and Tomialojc 1997, Holmes and Sherry 2001). Long-term monitoring studies are important for differentiating between these short-term fluctuations and actual long-term trends. In previous years' results, we often saw species with contradictory trends in different study areas (e.g. five species in 2000 results; Lind et al. 2001a). After 14 years of sampling, nearly all of our significant trends are consistent across the national forests, suggesting that many of these are more than short-term population fluctuations.

Chequamegon National Forest

Of the 55 species tested for trends in the Chequamegon NF, five species (9%) increased significantly and 13 (24%) have decreased (Figure 3). The Yellow Warbler and American Redstart have the greatest rates of annual increase (>10%). The Red-eyed Vireo is the most ubiquitous species on our surveys in the Chequamegon (Appendix B), and while it actually has one of the lower rates of increase, it is substantial given the species' distribution and abundance on the forest. No species are showing new increasing trends this year, and two formerly increasing species, the Alder Flycatcher and the Eastern Kingbird, now have non-significant trends (Table 4).

The Eastern Wood-Pewee, Winter Wren, Veery, and Hermit Thrush are well-represented on the Chequamegon NF, but have some of the greatest declines (6-11% annually; Appendix B). The Red-winged Blackbird and Evening Grosbeak have the two greatest rates of decrease, but they are tested on just five and six stands, respectively, and their trends may be more susceptible to site-specific influences than other species. Both of these species are, however, showing substantial declines in other parts of their ranges (Sauer 2004). The Yellow-rumped Warbler and Black-throated Green Warbler have new declines in 2004, and the Nashville Warbler, Black-and-white Warbler, and Song Sparrow were declining in 2003, but are no longer showing significant declines (Table 4).

Chippewa National Forest

Of the 54 species tested in the Chippewa NF, 10 species (19%) increased significantly and 18 (20%) decreased (Figure 3). The Cedar Waxwing has the highest annual rate of increase (14%), but its population trajectory (Appendix A) shows an increase since the mid-1990's with an increase in the variance about the mean. This is probably due to encountering flocks of this gregarious species during some point counts and none in others. The Black-capped Chickadee, Chestnut-sided Warbler, and American Redstart are well-represented species on the forest, with 4-6% annual increases. The Red-eyed Vireo has one of the lowest rates of increase among the significantly increasing species, but because of its wide distribution, the increase is probably occurring over a large portion of the forest. It has also had a dramatic increase since 1998 (Appendix A). The American Robin has a new increasing trend on the Chippewa NF this year, and the Blue-headed Vireo, Palm Warbler, and Indigo Bunting are no longer increasing significantly (Table 4).

The greatest rate of annual decrease in the Chippewa NF is that of the Connecticut Warbler (14%). Although it is sampled on only 14 stands, it has declined consistently since 1991 and the stands it is monitored on are spread across most of the forest. Well-represented species that are showing annual rates of decline of 5% or more include the Great Crested Flycatcher, Winter Wren, Ovenbird, Song Sparrow, White-throated Sparrow, and Brown-headed Cowbird. The Nashville Warbler is declining at 2%/year, but its trend may be especially important given its widespread distribution on the Chippewa NF. No species have new decreasing trends, and seven formerly decreasing species are no longer showing a significant decline (Table 4).

Six species are moving toward their historic population levels (RNV) on the Chippewa NF. Four species are below their RNV but have increasing trends (Black-and-white Warbler, American Robin, Cedar Waxwing and Black-capped Chickadee), and two species are above their RNV but declining (Song Sparrow and Brown-headed Cowbird; Table 6). Conversely, 8 species are moving away from their historic population levels. The Gray Catbird is above its RNV and has an increasing trend, and six species are below their RNV and decreasing (especially White-throated Sparrow, Nashville Warbler, Winter Wren and Hermit Thrush). Of the 11 species within their RNV, five are increasing and two are decreasing.

Superior National Forest

Of the 45 species tested in the Superior NF, nine species (20%) are increasing and 11 (24%) are decreasing (Figure 3). The Black-capped Chickadee has the highest rate of annual increase (12%) of any species in the Superior NF, with most of its increase occurring since 1997. The Swamp Sparrow, Black-throated Blue Warbler, and Cedar Waxwing have the next highest rates of increase (10-11% annually) on the nine stands they are each tested on. The American Redstart, Northern Parula, and Magnolia Warbler are widespread species that are increasing at about 4% annually. The Swamp Sparrow's increasing trend is new this year, and the Pine Warbler was increasing in 2003 but now has a stable trend (Table 4).

The Tennessee Warbler has the greatest rate of decrease (17% annually) on the Superior NF, however, it was just abundant enough to be tested for trends during its peak in the mid-1990's, and has had only 14 detections since 1999. Scarlet Tanager and Ruby-crowned Kinglet are both declining at 9% annually on the nine stands they are each monitored on. The Eastern Wood-Pewee, Winter Wren, Rose-breasted Grosbeak, Veery and White-throated Sparrow are declining at 4-12% annually, and are widely distributed on the forest. No species have new significant declines this year, and the Mourning Warbler, Common Yellowthroat, and Chipping Sparrow were declining in 2003 but now have stable trends (Table 4.)

Six species are moving toward their historic population levels (RNV) on the Superior NF. Six species are below their RNV but have increasing trends (including Northern Parula, Black-capped Chickadee and American Redstart), and no species are above their RNV (Table 6). Seven species are below their RNV and decreasing (including Northern Waterthrush, Black-throated Green Warbler and Winter Wren). Of the 14 species within their RNV, two are increasing and four are decreasing.

Pooled National Forests

Of the 37 species tested for a pooled national forests trend, eight species (22%) increased significantly and 14 (36%) decreased (Figure 3). The American Redstart and Black-capped Chickadee increased at 5% annually. The Chestnut-sided Warbler and Red-eyed Vireo have had lower rates of increase (2% annually), but both are well represented on all of the national forests. All four of these species have had consistently increasing trends since the early to mid-1990's (Appendix A). The Blue Jay and Blackburnian Warbler each had new increases this year, and the Least Flycatcher is no longer showing a significant increase (Table 4).

The Winter Wren had the greatest annual rate of decrease (8%), which along with the Eastern Wood-Pewee, Hermit Thrush, Song Sparrow and Common Yellowthroat, has had a consistent downward trajectory since the early 1990's (Appendix A). The White-throated Sparrow has declined 5% annually, but its trajectory has remained essentially level since 1997. The Veery was relatively stable until 2000 when it began a steep decline. The Black-throated Green Warbler has a new decline this year and the Yellow-bellied Sapsucker is no longer declining (Table 4).

Management Activities on Study Areas

Of the 1274 survey sites on the three national forests, 14.2% have been at least partially harvested since the beginning of monitoring, which is about 1% a year (Table 7). A small number of our monitoring points have also had prescribed burns since the start of monitoring, but this is usually done after harvest. This harvest rate 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 (i.e. ~1% annual change; Wolter and White 2002). Thus, it appears that management activities on our sample sites are representative of the national forests as a whole, and that the trends we are documenting are probably occurring across the regional landscape.

Guild Analyses

Short-distance migrants (species that winter mainly north of Mexico) showed highly significant declines ($P \leq 0.01$) in each national forest (Table 5). The most abundant short-distance migrants in our analyses include White-throated Sparrow, American Robin, Hermit Thrush, and Yellow-rumped Warbler. Long-distance migrants (species that winter mainly south of the U.S./Mexico border) showed mixed results across our study areas, with declines in the Chequamegon and Superior NF's and an increase in the Chippewa NF. Abundant long-distance migrants included Ovenbird, Red-eyed Vireo, Nashville Warbler, and Chestnut-sided Warbler. Permanent residents increased on all study areas except the Chequamegon NF, where they were stable. Black-capped Chickadee, Blue Jay, and Red-breasted and White-breasted nuthatches are the most abundant permanet residents.

Ground nesting birds showed highly significant declines in all study areas, while shrub/sub-canopy nesters increased in all study areas (Table 5). Abundant ground-nesters include Ovenbird, Nashville Warbler, Veery, and White-throated Sparrow. The most common shrub and subcanopy-nesting species include Red-eyed Vireo, Chestnut-sided Warbler, and American Redstart. Canopy and cavity nesters showed stable trends, except for a decrease in canopy nesters in the Chequamegon NF and an increase in cavity nesters in the Superior NF.

The lowland coniferous, deciduous and early-successional forest bird guilds showed widespread declines on our study areas. The upland coniferous bird guild increased on the Superior NF and pooled NFs. The mixed forest bird guild increased on the Chippewa NF and declined on the Superior NF.

Conclusions

Most of the seven species with widespread increasing trends are either forest habitat generalists (Red-eyed Vireo, Black-capped Chickadee and Blue Jay) or early successional species (Cedar Waxwing, Chestnut-sided Warbler and American Redstart). Many of these increasing species are currently at or above their estimated RNV values. Recent increases in the amount of edge and early-successional habitat on the regional landscape (Wolter and White 2002) may be benefiting these species. The Black-capped Chickadee is a year-round resident that may also be responding to increased food availability from bird feeding activities, especially considering their increasing numbers on Minnesota Christmas Bird Counts in the past decade (National Audubon Society 2004). The Blackburnian Warbler is a mature coniferous/mixed forest species that has also shown widespread increases. Population fluctuations in this species are often attributed to changes in spruce budworm (*Choristonuera fumiferana*) abundance. There was an outbreak in early 1990's with a decline since 1998 (Blackford 2001), that seems to correspond to the Blackburnian Warbler's trajectory (Appendix A). However, this is difficult to corroborate with other spruce budworm specialists (e.g. Tennessee, Bay-breasted and Cape May warblers) which are on the southern fringe of their ranges in our study areas.

Species with widespread declines on our study sites are mainly found in mature forest habitats, with the possible exception of Veery and White-throated Sparrow. While White-throated Sparrow abundance is often higher in clearcuts than in mature forests, reproductive rates have been shown to be up to three times greater in older forests (75-100 years) than in younger forests. The Eastern Wood-Pewee, Winter Wren, Veery, and White-throated Sparrow have each shown significant declines on our surveys as well as USGS Breeding Bird Survey routes over much of their range (Sauer 2004). Increases in edge and early-successional habitats may be having negative effects on these species, although there are examples of increases in mature forest species on individual national forests (e.g., White-breasted Nuthatch Black-throated Blue Warbler, Northern Waterthrush).

The declines in ground nesters and increases in shrub nesters in our study seem to occur irrespective of migration strategy and habitat. It is possible that declines in ground-nesting populations are being influenced by recent changes in the landscapes of the Upper Midwest. Although the landscape surrounding the three national forests is primarily forested, average forest stand sizes and ages have changed in recent years. Wolter and White (2002) demonstrated a substantial decrease in patch size and interior forest area and a significant increase in edge density in early successional forest types in northeastern Minnesota between 1990 and 1995. Studies have shown that nesting success is reduced in landscapes with reduced patch sizes and high amounts of edge habitat, probably due to an increase in generalist nest predators (Robinson et al. 1995, Donovan et al. 1997). In the forested landscapes of the upper Midwest, recent studies have found higher predation rates on ground nests near forest/clearcut edges than in interior areas (Fenske-Crawford and

Niemi 1997, Manolis et al. 2000, Flaspohler et al. 2001). Data from the Minnesota 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.

Many of the declining trends that we have detected have been consistent across the years and are not likely due to annual variation. Many of the declining trends that we have detected have been consistent across the years and are not likely due to annual variation. One of the main goals of this monitoring program is to identify potential declines of forest bird species. This is especially true for species of conservation concern such as the Eastern Wood-Pewee, Winter Wren, Hermit Thrush, Ovenbird, and White-throated Sparrow. The declines observed over the past years for common species such as the Ovenbird and White-throated Sparrow are a continuing concern and special management consideration should be given to these species. Several species are currently well below their estimated RNV values and they may not remain common if their declining trends continue.

Many of the declining species breed in mature forests, and many are ground-nesters. Some of these population declines may be linked to recent reductions in forest patch size and stand age on the landscape, especially in light of regional studies showing high nest predation on ground-nests near forest edges. Although the factors responsible for population declines are not definitively known, the prominence of declining ground-nesting species suggests that it would be prudent to curb further reductions in average forest patch sizes and age on the landscape. Several of these declining species have high PIF conservation values (e.g. Veery, Mourning Warbler, Eastern Wood-Pewee), and the extensive forests of northern Minnesota and Wisconsin represent excellent opportunities to provide “source” populations for many species.

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Table 1. Trends for three national forests and combined trend (1991-2004), 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	Chequamegon NF	Chippewa NF	Superior NF	Combined Trend
Yellow-bellied Sapsucker	ns	ns	ns	ns
Downy Woodpecker		ns		
Hairy Woodpecker	ns	ns		
Northern Flicker			ns	
Olive-sided Flycatcher		ns		
Eastern Wood-Pewee	D**	D**	D**	D**
Yellow-bellied Flycatcher	ns	ns	ns	I*
Alder Flycatcher	ns	ns	ns	ns
Least Flycatcher	ns	I*	ns	ns
Great Crested Flycatcher	ns	D*		
Eastern Kingbird	ns			
Yellow-throated Vireo	ns	ns		
Blue-headed Vireo	ns	ns	ns	ns
Red-eyed Vireo	I**	I**	I**	I**
Gray Jay		ns	ns	
Blue Jay	ns	ns	ns	I**
Black-capped Chickadee	ns	I**	I**	I**
Red-breasted Nuthatch	ns	ns	ns	ns
White-breasted Nuthatch	ns	I**		
Brown Creeper	D**	ns	ns	D*
House Wren	ns			
Winter Wren	D**	D**	D**	D**
Golden-crowned Kinglet	D*	ns	ns	ns
Ruby-crowned Kinglet			D**	
Veery	D**	ns	D**	D**
Swainson's Thrush			ns	
Hermit Thrush	D**	D**	ns	D**
Wood Thrush	ns			
American Robin	ns	I*	ns	ns
Gray Catbird		I**		
Brown Thrasher	ns			
Cedar Waxwing		I**	I**	
Golden-winged Warbler	ns	ns	ns	ns
Tennessee Warbler			D**	
Nashville Warbler	ns	D**	ns	D**
Northern Parula	ns	ns	I**	I*
Yellow Warbler	I**	D**		
Chestnut-sided Warbler	ns	I**	ns	I**
Magnolia Warbler		ns	I**	
Black-throated Blue Warbler			I**	

Table 1 (continued)

Species	Chequamegon NF	Chippewa NF	Superior NF	Combined Trend
Yellow-rumped Warbler	D*	ns	ns	ns
Black-throated Green Warbler	D*	ns	D**	D*
Blackburnian Warbler	I**	ns	I**	I*
Pine Warbler	ns	ns	ns	ns
Palm Warbler		ns		
Black-and-white Warbler	ns	I*	ns	ns
American Redstart	I**	I**	I**	I**
Ovenbird	D**	D**	D**	D**
Northern Waterthrush	I**	ns	D**	ns
Connecticut Warbler		D**		
Mourning Warbler	ns	ns	ns	D**
Common Yellowthroat	D*	ns	ns	D**
Canada Warbler	ns	ns	ns	ns
Scarlet Tanager	ns	ns	D*	D**
Eastern Towhee	ns			
Chipping Sparrow	ns	ns	ns	ns
Clay-colored Sparrow	ns			
Vesper Sparrow	ns			
Song Sparrow	ns	D**	ns	D*
Swamp Sparrow	ns	ns	I*	ns
White-throated Sparrow	D*	D**	D**	D**
Rose-breasted Grosbeak	ns	ns	D**	D*
Indigo Bunting	ns	ns		
Red-winged Blackbird	D**	ns		
Brewer's Blackbird	ns			
Brown-headed Cowbird	ns	D*		
Purple Finch		ns		
American Goldfinch	ns			
Evening Grosbeak	D**			

Table 2. Species trends ($P \leq 0.05$) by study area (1991-2004), based on simple linear regression. ** $P \leq 0.01$. Species graphs can be found in Appendix A.

Increasing Species

Chequamegon NF	Chippewa NF	Superior NF	Pooled national forests
** Red-eyed Vireo	Least Flycatcher	** Red-eyed Vireo	Yellow-bellied Flycatcher
** Yellow Warbler	** Red-eyed Vireo	** Black-capped Chickadee	** Red-eyed Vireo
** Blackburnian Warbler	** Black-capped Chickadee	** Cedar Waxwing	** Blue Jay
** American Redstart	** White-breasted Nuthatch	** Northern Parula	** Black-capped Chickadee
** Northern Waterthrush	American Robin	** Magnolia Warbler	Northern Parula
	** Gray Catbird	** Black-throated Blue Warbler	** Chestnut-sided Warbler
	** Cedar Waxwing	** Blackburnian Warbler	Blackburnian Warbler
	** Chestnut-sided Warbler	** American Redstart	** American Redstart
	Black-and-white Warbler	Swamp Sparrow	
	** American Redstart		

Decreasing Species

Chequamegon NF	Chippewa NF	Superior NF	Pooled national forests
** Eastern Wood-Pewee	** Eastern Wood-Pewee	** Eastern Wood-Pewee	** Eastern Wood-Pewee
** Brown Creeper	Great Crested Flycatcher	** Winter Wren	Brown Creeper
** Winter Wren	** Winter Wren	** Ruby-crowned Kinglet	** Winter Wren
Golden-crowned Kinglet	** Hermit Thrush	** Veery	** Veery
** Veery	** Nashville Warbler	** Tennessee Warbler	** Hermit Thrush
** Hermit Thrush	** Yellow Warbler	** Black-throated Green Warbler	** Nashville Warbler
Yellow-rumped Warbler	** Ovenbird	** Ovenbird	Black-throated Green Warbler
Black-throated Green Warbler	** Connecticut Warbler	** Northern Waterthrush	** Ovenbird
** Ovenbird	** Song Sparrow	Scarlet Tanager	** Mourning Warbler
Common Yellowthroat	** White-throated Sparrow	** White-throated Sparrow	** Common Yellowthroat
White-throated Sparrow	Brown-headed Cowbird	** Rose-breasted Grosbeak	** Scarlet Tanager
** Red-winged Blackbird			Song Sparrow
** Evening Grosbeak			** White-throated Sparrow
			Rose-breasted Grosbeak

Table 3. Summary of species with increasing or decreasing trends ($P \leq 0.05$) 1991-2004. Individual species graphs can be found in Appendix A.

Increased in one national forest	**Increased in two national forests**	**Increased in three national forests**
Least Flycatcher	Black-capped Chickadee	Red-eyed Vireo
White-breasted Nuthatch	Cedar Waxwing	American Redstart
American Robin	Blackburnian Warbler	
Gray Catbird		
Northern Parula		
Yellow Warbler		
Chestnut-sided Warbler		
Magnolia Warbler		
Black-throated Blue Warbler		
Black-and-white Warbler		
Northern Waterthrush		
Swamp Sparrow		
Decreased in one national forest	**Decreased in two national forests**	**Decreased in three national forests**
Great Crested Flycatcher	Veery	Eastern Wood-Pewee
Brown Creeper	Hermit Thrush	Winter Wren
Golden-crowned Kinglet	Black-throated Green Warbler	Ovenbird
Ruby-crowned Kinglet		White-throated Sparrow
Tennessee Warbler		
Nashville Warbler		
Yellow Warbler		
Yellow-rumped Warbler		
Northern Waterthrush		
Connecticut Warbler		
Common Yellowthroat		
Scarlet Tanager		
Song Sparrow		
Rose-breasted Grosbeak		
Red-winged Blackbird		
Brown-headed Cowbird		
Evening Grosbeak		

Table 4. Summary of changes in trends between 2003 and 2004 analyses.

Species with new significant trends ($P \leq 0.05$) in 2004

Increasing		*Decreasing*	
Species	Study area	Species	Study area
American Robin	Chippewa NF	Yellow-rumped Warbler	Chequamegon NF
Swamp Sparrow	Superior NF	Black-thr. Green Warbler	Chequamegon NF
Blue Jay	Pooled NF's	Black-thr. Green Warbler	Pooled NF's
Blackburnian Warbler	Pooled NF's		

Species no longer showing significant trends ($P > 0.05$) in 2004

Was increasing in 2003		*Was decreasing in 2003*	
Species	Study area	Species	Study area
Alder Flycatcher	Chequamegon NF	Nashville Warbler	Chequamegon NF
Eastern Kingbird	Chequamegon NF	Black-and-white Warbler	Chequamegon NF
Blue-headed Vireo	Chippewa NF	Song Sparrow	Chequamegon NF
Palm Warbler	Chippewa NF	Yellow-bellied Sapsucker	Chippewa NF
Indigo Bunting	Chippewa NF	Hairy Woodpecker	Chippewa NF
Pine Warbler	Superior NF	Brown Creeper	Chippewa NF
Least Flycatcher	Pooled NF's	Veery	Chippewa NF
		Blackburnian Warbler	Chippewa NF
		Common Yellowthroat	Chippewa NF
		Scarlet Tanager	Chippewa NF
		Mourning Warbler	Superior NF
		Common Yellowthroat	Superior NF
		Chipping Sparrow	Superior NF
		Yellow-bellied Sapsucker	Pooled NF's

Table 5. Test statistics and sample sizes for guild trend analyses (1991-2004). All species combined within each guild category and analyzed as a group, regardless of whether a species meets criteria for individual species analyses. Change = percent annual change. N = number of stands analyzed. See Appendix A for trend graphs.

Guild Category		Chequamegon NF				Chippewa NF				Superior NF				Pooled National Forests			
		change	*P*	R^2	N	change	*P*	R^2	N	change	*P*	R^2	N	change	*P*	R^2	N
Migration	Short-distance	**-2.617**	**0.000**	**0.900**	**129**	**-1.849**	**0.000**	**0.779**	**126**	**-2.385**	**0.000**	**0.844**	**147**	**-2.251**	**0.000**	**0.954**	**402**
	Long-distance	**-0.755**	**0.004**	**0.883**	**129**	0.248	0.260	0.030	126	**-0.758**	**0.000**	**0.543**	**147**	**-0.569**	**0.000**	**0.272**	**402**
	Permanent Resident	0.013	0.980	0.000	120	**2.189**	**0.008**	**0.680**	**124**	**3.005**	**0.000**	**0.927**	**142**	**1.924**	**0.000**	**0.828**	**386**
Nesting	Ground	**-3.036**	**0.000**	**0.980**	**129**	**-3.017**	**0.000**	**0.850**	**126**	**-2.429**	**0.000**	**0.844**	**147**	**-2.951**	**0.000**	**0.879**	**402**
	Shrub/Sub-canopy	**1.255**	**0.012**	**0.651**	**129**	**3.295**	**0.000**	**0.853**	**126**	**0.773**	**0.016**	**0.511**	**147**	**1.741**	**0.000**	**0.778**	**402**
	Canopy	**-0.909**	**0.044**	**0.632**	**124**	-0.608	0.220	0.235	126	-0.260	0.444	0.248	147	**-0.506**	**0.028**	**0.786**	**397**
	Cavity	-0.752	0.288	0.757	123	0.856	0.244	0.227	125	**3.001**	**0.000**	**0.897**	**144**	**1.154**	**0.000**	**0.755**	**392**
Vegetation Preference	Coniferous forest	-0.301	0.740	0.025	105	0.706	0.196	0.371	107	**1.579**	**0.004**	**0.753**	**145**	**0.753**	**0.020**	**0.458**	**357**
	Lowland coniferous	**-2.018**	**0.000**	**0.797**	**102**	**-2.339**	**0.000**	**0.891**	**96**	-0.356	0.348	0.366	147	**-1.475**	**0.000**	**0.880**	**345**
	Deciduous forest	**-1.074**	**0.000**	**0.847**	**127**	-0.271	0.412	0.018	126	**-0.866**	**0.016**	**0.482**	**147**	**-0.674**	**0.000**	**0.376**	**400**
	Early-succession	0.953	0.456	0.597	98	**2.285**	**0.004**	**0.658**	**117**	**-1.783**	**0.036**	**0.368**	**145**	-0.355	0.540	0.022	360
	Mixed forest	**-3.454**	**0.000**	**0.980**	**120**	-0.824	0.188	0.296	122	**-2.473**	**0.000**	**0.918**	**147**	**-2.062**	**0.000**	**0.845**	**389**

Table 6. Comparison of species trends (1991-2004) and % of the range of natural variability (RNV) for 2003 populations on the Chippewa and Superior National Forests (from Hanowski and Danz 2003). 100% of RNV indicates that a species was considered to be within its historic range of natural variability. I = significantly increasing, D = significantly decreasing. * $P \leq 0.05$, ** $P \leq 0.01$.

Species	Chippewa NF trend	% of RNV	Superior NF trend	% of RNV
Yellow-bellied Sapsucker	ns	100%	ns	100%
Downy Woodpecker	ns	122%		
Hairy Woodpecker	ns	71%		
Olive-sided Flycatcher	ns	53%		
Eastern Wood-Pewee	D**	100%	D**	100%
Yellow-bellied Flycatcher	ns	60%	ns	100%
Least Flycatcher	I*	100%	ns	100%
Great Crested Flycatcher	D*	100%		
Yellow-throated Vireo	ns	110%		
Blue-headed Vireo	ns	39%	ns	66%
Red-eyed Vireo	I**	100%	I**	97%
Gray Jay	ns	69%	ns	69%
Blue Jay	ns	72%	ns	69%
Black-capped Chickadee	I**	95%	I**	70%
Red-breasted Nuthatch	ns	56%	ns	70%
White-breasted Nuthatch	I**	100%		
Brown Creeper	ns	91%	ns	77%
Winter Wren	D**	60%	D**	87%
Golden-crowned Kinglet	ns	80%	ns	82%
Ruby-crowned Kinglet			D**	100%
Veery	ns	100%	D**	100%
Swainson's Thrush			ns	100%
Hermit Thrush	D**	70%	ns	68%
American Robin	I*	62%	ns	99%
Gray Catbird	I**	244%		
Cedar Waxwing	I**	88%	I**	87%
Golden-winged Warbler	ns	112%	ns	
Tennessee Warbler			D**	100%
Nashville Warbler	D**	52%	ns	83%
Northern Parula	ns	44%	I**	65%
Chestnut-sided Warbler	I**	100%	ns	100%
Magnolia Warbler	ns	38%	I**	100%
Black-throated Blue Warbler			I**	100%
Yellow-rumped Warbler	ns	46%	ns	63%
Black-throated Green Warbler	ns	76%	D**	80%

Table 6 (continued)

Species	Chippewa NF trend	% of RNV	Superior NF trend	% of RNV
Blackburnian Warbler	ns	70%	I**	88%
Pine Warbler	ns	56%	ns	72%
Palm Warbler	ns	28%		
Black-and-white Warbler	I*	59%	ns	100%
American Redstart	I**	100%	I**	78%
Ovenbird	D**	88%	D**	99%
Northern Waterthrush	ns		D**	51%
Connecticut Warbler	D**	97%		
Mourning Warbler	ns	100%	ns	100%
Canada Warbler	ns	47%	ns	100%
Scarlet Tanager	ns	105%	D*	58%
Chipping Sparrow	ns	88%	ns	82%
Song Sparrow	D**	110%	ns	86%
White-throated Sparrow	D**	42%	D**	89%
Rose-breasted Grosbeak	ns	100%	D**	97%
Indigo Bunting	ns	160%		
Brown-headed Cowbird	D*	120%		
Purple Finch	ns	62%		

Table 7. Number of harvested points in each study area since the beginning of monitoring.

Study Area	Total # of sites	# clearcut	# partially or selectively cut*	% harvested
Chequamegon NF	390	15	30	11.5%
Chippewa NF	393	21	42	16.2%
Superior NF	491	42	31	14.9%

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

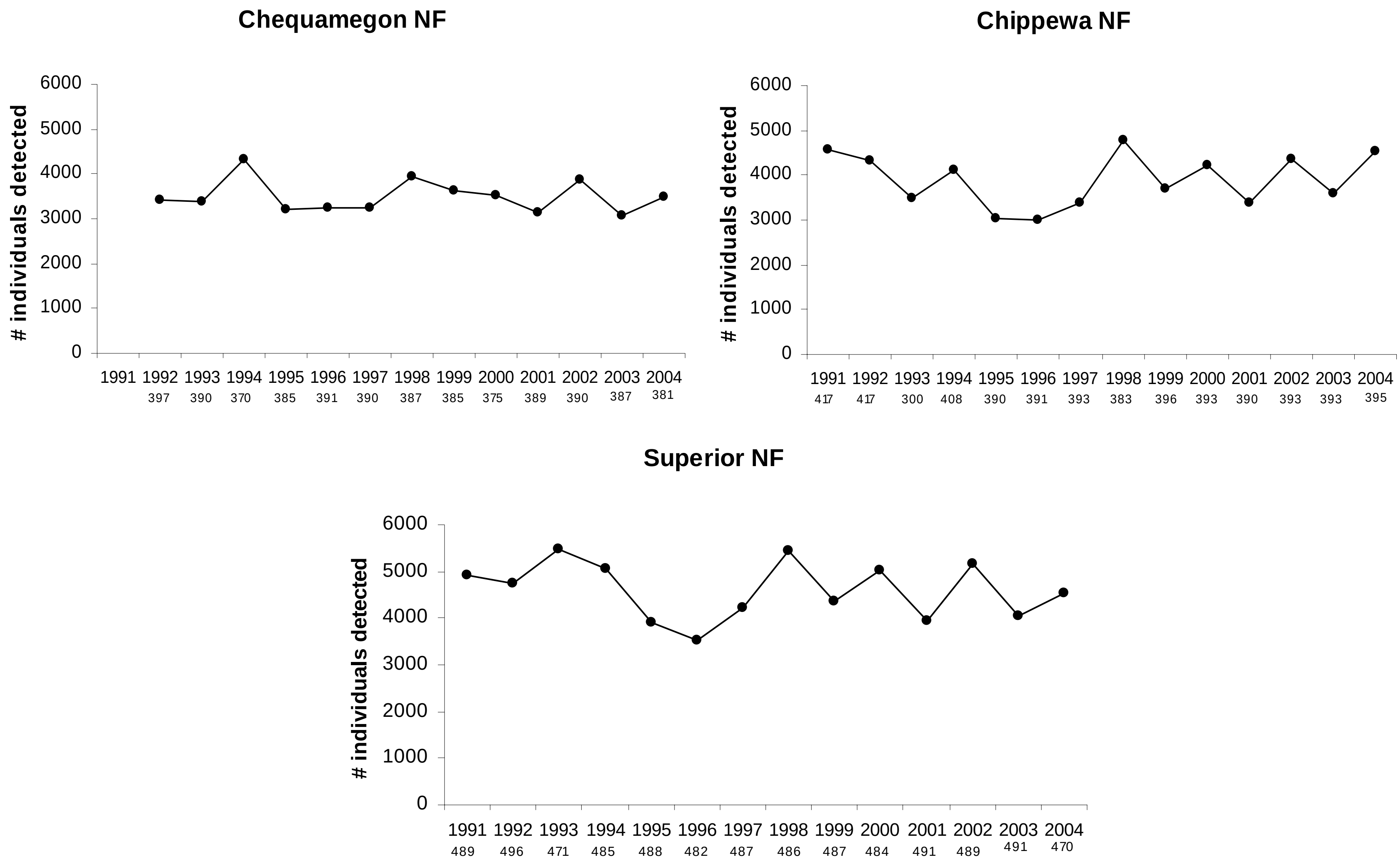

Figure 2. Total number of individuals detected annually in each national forest (1991-2004), based on raw data before applying analysis criteria (e.g. includes flyovers, etc.). The number of sites sampled is presented below each year.

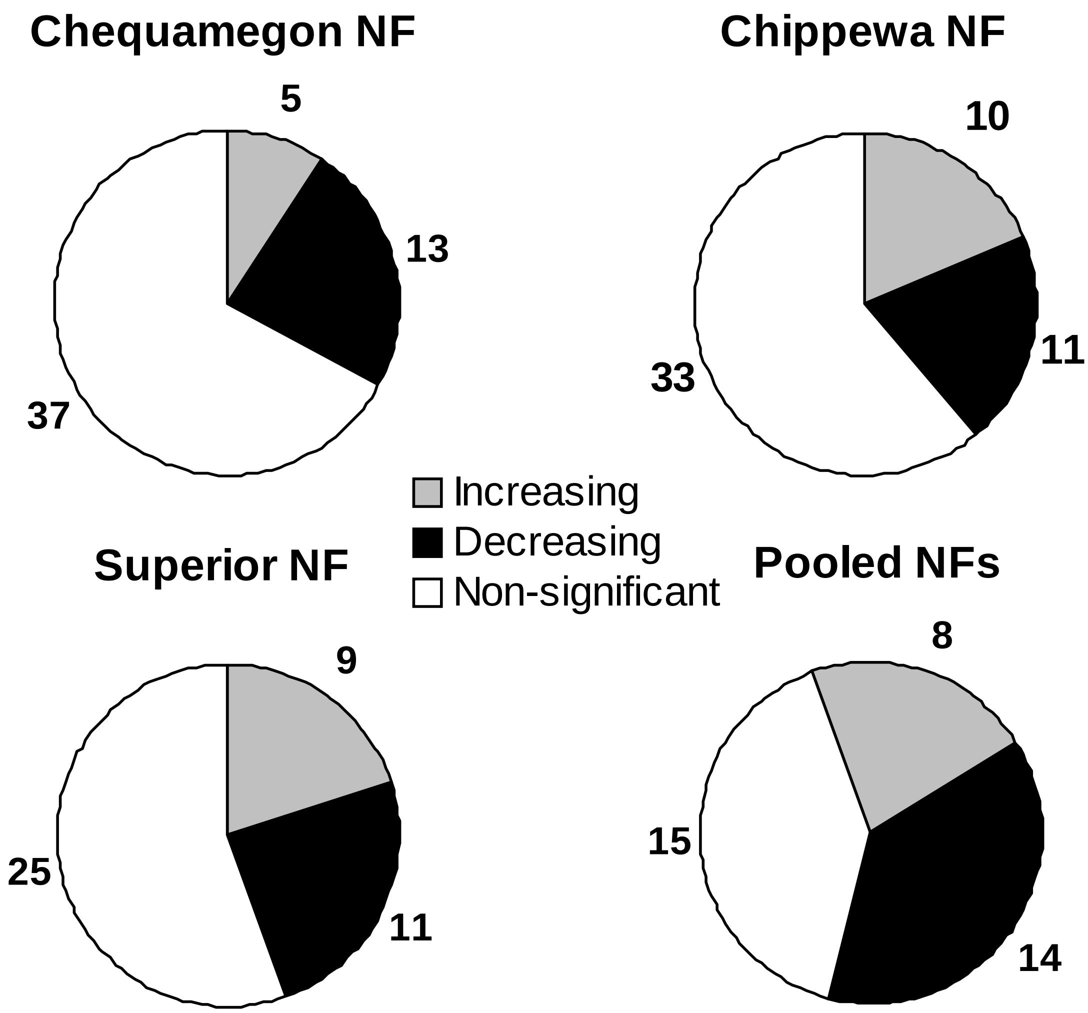

Figure 3. Summary of significant trends ($P \leq 0.05$) by national forest (1991-2004). Pooled trends include three national forests combined. See Table 1 for list of species trends by national forest.

Appendix A

Trends in relative abundance by study area for all species and guilds tested (1991-2004)

Please see the *Analysis* section in the body of the report for details about how the plots were constructed.