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Submitted by:

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SUMMARY

- A total of 353 forest stands were surveyed for breeding birds, including 160 and 190 stands (1022 survey points) in the Chippewa and Superior National Forests (NFs), respectively in 2021.
- Trends in relative abundance were calculated for 77 bird species (same as 2020), including 69 species in the Chippewa NF and 67 in the Superior NF for 27 years from 1995 to 2021. There were 31 additional species that were detected in Chippewa NF and 30 species in Superior NF that did not meet our inclusion criteria for trend analysis.
- In Chippewa NF, 52 species that met our inclusion criteria had stable or increasing trends over the past 27 years. Overall, 18 species trends were significantly increasing (15 in 2020), 34 species trends (37 in 2020) that were relatively stable, and 17 species trends had significantly decreasing trends (17 in 2020) from 1995 to 2021.
- In Superior NF, 42 species that met our inclusion criteria had stable or increasing trends over the past 27 years. Of these, 13 species trends were significantly increasing (14 in 2020), 29 species (28 in 2020) had relatively stable trends, and 25 species had significantly decreasing trends (24 in 2020), from 1995 to 2021.
- Eight species increased in both the Chippewa and Superior NFs: Black-throated Green Warbler, Blue Jay, Nashville Warbler, Northern Waterthrush, Pine Warbler, Purple Finch, Red-breasted Nuthatch, and Ruby-crowned Kinglet. With the exception of Nashville Warbler, these species tend to be associated with more mature forests.
- Eight species decreased in both NFs: Black-capped Chickadee, Chipping Sparrow, Common Yellowthroat, Connecticut Warbler, Hermit Thrush, Red-eyed Vireo, Song Sparrow, and Winter Wren. However, 22 species had significantly declining regional trends when the two NFs were combined: American Crow, American Robin, Black-capped Chickadee, Brown Creeper, Canada Jay, Chestnut-sided Warbler, Chipping Sparrow, Common Loon, Common Raven, Common Yellowthroat, Connecticut Warbler, Downy Woodpecker, Hermit Thrush, Magnolia Warbler, Mourning Warbler, Olive-sided Flycatcher, Red-eyed Vireo, Scarlet Tanager, Song Sparrow, Winter Wren, Yellow-bellied Flycatcher, Yellow-rumped Warbler.
- Regional trends for guilds were mixed over the period from 1995-2021. Species associated with upland conifer, canopy and cavity nesting, and permanent resident species all significantly increased. Shrub nesting, early-successional, and short-distance migrant species significantly decreased, while deciduous forest, lowland conifer, mixed forest, ground nesting, and long-distance migrant species had no significant change.
- Connecticut Warbler has shown one of the most consistent declines of any species in the monitoring program. In 2021, only one individual was detected in Chippewa NF.
- 815,000 acres, or roughly 60% of Minnesota's tamarack, have been impacted by eastern larch beetle (*Dendroctonus simplex*) since 2001. The changes to forest habitats are likely impacting breeding bird communities and potentially influencing trends for some bird species.
- The overall trend results indicate the majority of breeding bird species that are abundant enough to analyze have either increasing or stable trends. However, the declining trends for lowland conifer obligate breeders, aerial insectivores, species that require old growth, and short-distance migrants continue to be a concern.

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The following appendices are individually attached to this document:

Appendix A. Population trend graphs of calculated annual index for individual species within the Chippewa and Superior NFs, and regionally over the 25-year time period (1995–2021) of the study.

Appendix B. Population trend estimates (% annual change) and associated test statistics for the Chippewa NF, Superior NF, and a combined regional analysis (1995–2021). Included for each species are its trend (% annual change) within each NF, a regional trend (if possible), the significance of the trend (P), the explained variation of the trend (r^2), and the number of stands (n) in which the species was detected sufficiently to include in the trend calculation.

Appendix C. Common and scientific name, four-letter abbreviation, migration strategy, nest site, and typical habitat of each species with adequate information for trend analysis in 2021.

Appendix D. Number of observations on the Chippewa NF for species not tested for population trends in 2021. Includes flyovers and all birds regardless of distance.

Appendix E. Number of observations on the Superior NF for species not tested for population trends in 2021. Includes flyovers and all birds regardless of distance.

Appendix F. Results of trend analysis for 20 species that are associated with conifer or lowland-conifer for breeding habitat. Forty-two lowland conifer stands, including 25 stands that were added to the sampling design in 2008, that are primarily composed of black spruce, tamarack, or mixed swamp conifer were included in this analysis.

Appendix G. Study and design methods.

Appendix H. Estimated annual indices from 1995 to 2021 for breeding birds in Chippewa NF. A stretched color scheme was applied to each species with red for low indices, yellow average, and green high, to visualize relative changes in indices over time.

Appendix I. Estimated annual indices from 1995 to 2021 for breeding birds in Superior NF. A stretched color scheme was applied to each species with red for low indices, yellow average, and green high, to visualize relative changes in indices over time.

OVERVIEW

The Avian Ecology Lab at the Natural Resources Research Institute completed the 27th year of Minnesota's National Forest Breeding Bird Monitoring Program in 2021. These data have provided insight into the impacts of forest management on breeding bird populations and informed the development of management policies and conservation initiatives. This report summarizes forest bird monitoring data gathered from 1995 through 2021. Here we summarize the current status of species trends and overall trends for migration, habitat, and nesting guilds. We focus our discussion on species of conservation importance in the state to provide an ecological context and discuss management implications of the observed patterns in the region for these species.

INTRODUCTION

The breeding bird communities of the western Great Lakes region have among the richest species diversity in North America (Green 1995; Howe et al. 1997; Rich et al. 2004; Niemi et al. 2016). Maintaining avian diversity in forest ecosystems affords many benefits for forest health and productivity; diverse bird communities play a vital role in maintaining both the structure and function of ecosystems by providing numerous ecological services such as seed dispersal and pest control (Krieger 2001; Whelan et al. 2008; Philpott et al. 2009; Sekercioğlu et al. 2012; Sekercioğlu et al. 2017). Further, because birds integrate environmental variables over space and time, changes in forest bird communities provide meaningful signals of local forest health or degradation (Niemi and McDonald 2004; Gnass Giese et al. 2015).

The USDA Forest Service manages 191 million acres in 44 states, comprising the largest amount of single-ownership breeding bird habitat in the United States. The ecological setting of Superior and Chippewa National Forests (NFs) is particularly important because they are located in the transition zone between boreal forest and eastern deciduous forest. These forests are characterized by a diverse mosaic of forest communities varying from upland pine and aspen-birch to lowland conifer and open shrub bog and provide important habitat for over 150 breeding bird species (Niemi et al. 2016). However, changes in climate, disturbance regimes, and land-use practices have led to significant changes in forest composition in the region; these ongoing changes are likely to have substantial consequences on avian populations and communities (Meynard and Quinn 2008; Eglinton and Pearce-Higgins 2012; Riordan and Rundel 2014; Grinde and Niemi 2016; Niemi et al. 2016).

Adaptive forest management has the potential to mitigate impacts of climate and land use changes on bird communities by conserving and cultivating critical habitats. Moreover, actively integrating forest bird communities into forest management planning and implementation will ensure the health and diversity of ecosystems while also meeting society's needs. The development of successful adaptive management plans is contingent on understanding the long-term impacts of forest management on forest-dependent breeding bird species. The Minnesota National Forest Breeding Bird Monitoring Project was established in 1991 in the Chippewa and Superior NFs in response to the need for habitat-specific regional population data. Currently, more than 350 stands (> 1,000 points) within the two NFs are surveyed annually during the breeding season (June 1 to July 10) using standardized, 10-min point counts (Figure 1; see Appendix E for detailed designs and methods).

This monitoring program was designed to 1) establish a baseline inventory of local forest breeding bird assemblages, 2) monitor population changes of forest bird species over time, and 3) identify bird-habitat associations, particularly those relevant to forest management activities.

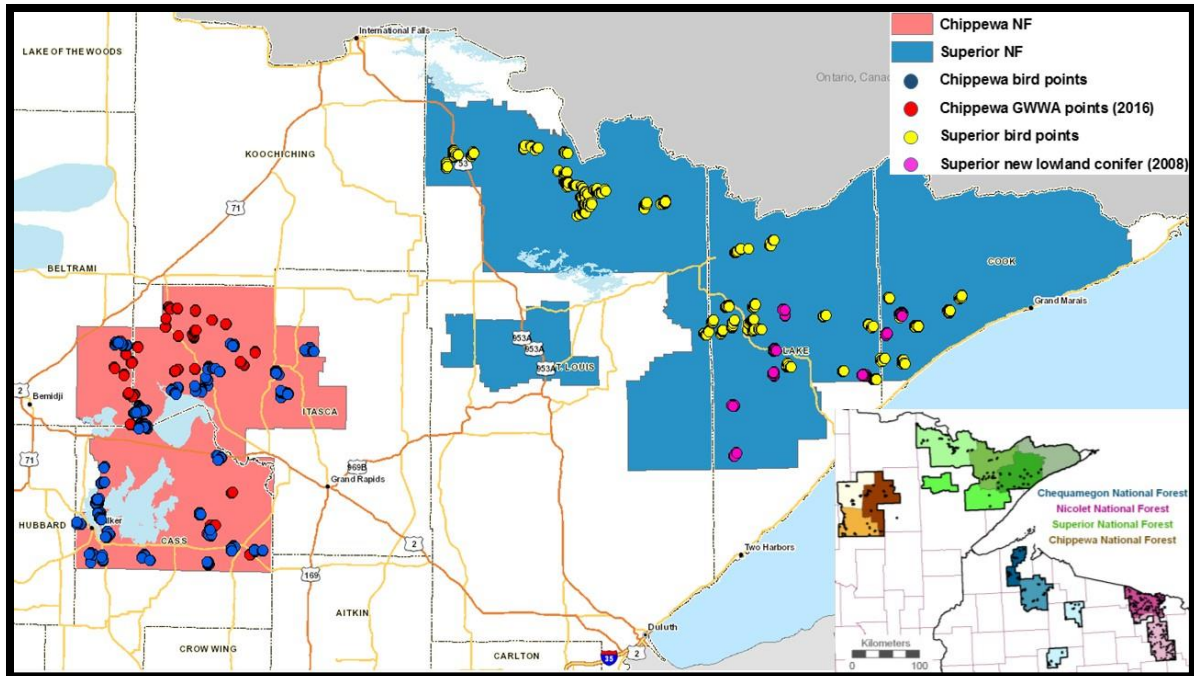


Figure 1. Locations of forest breeding bird point counts in northern Minnesota’s Chippewa and Superior NFs. Approximately 1,000 individual points are annually sampled between the Chippewa and Superior NFs. Inset shows the regional scope of NFs included in Niemi et al. (2016).

RESULTS

Observers have detected over 409,000 individual birds of 166 species on approximately 25,000 ten-minute point counts in the Chippewa and Superior NFs during the 27 field seasons of the Minnesota National Forest Breeding Bird Monitoring Project (Figure 2). In 2021, we sampled 160 stands in the Chippewa NF and 190 in the Superior NF. Seventy-seven species were assessed for trends in at least one NF, including 69 in the Chippewa NF and 67 in the Superior NF (Table 1). As monitoring continues through the years, new species meet our criteria for inclusion in trend analyses on each NF. The number of species assessed has increased steadily from 36 in 2000, when the criteria were first applied, to 77 in 2021. Regional trends that incorporate both NFs were calculated for 59 species.

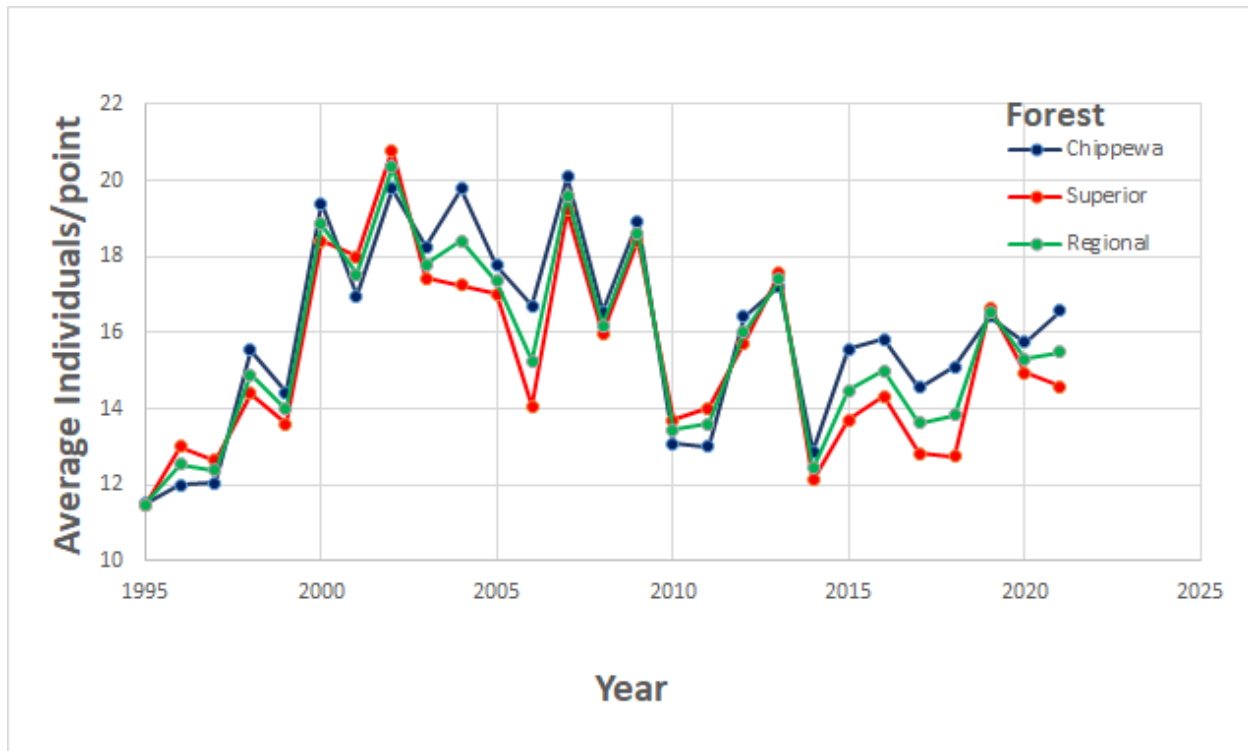


Figure 2. Average number of individual birds detected per point each year in the Chippewa and Superior NFs. The 25 stands added to the Superior NF in 2008 and the 24 stands added to the Chippewa NF in 2016 were included in the summary.

Overview of Data Summaries

We summarized current species and guild (migration, habitat, and nesting) trends. In order to provide an ecological context to our results, we focus our discussion on species of statewide conservation importance and the management implications of the observed regional patterns on these species.

Appendix A includes trend graphs of calculated annual index for individual species within each NF and regionally over the last 27 years. Appendix B is a complete statistical summary of the trend analysis including species, trend within each NF, regional trend (if applicable), trend significance (P), variation explained by trend (r^2), and the number of stands (n) in which the species trend calculation inclusion criteria. The combination of significance and explained variation indicate the strength of the trend for each species within each NF and the region. While this monitoring program was designed to survey territorial forest songbirds, we also detect and monitor several species despite not lacking this behavior. For example, trends for non-forest dwelling species (e.g., Common Loon) and species with large territories (e.g., American Crow) should be interpreted with caution. However, because we conduct surveys using consistent methodology data from such species, this information may provide useful insights.

Trend significance is a valuable way to assess large-scale patterns within and between NFs, but the annual index influences the significance (how different the trend is from zero) of the trend line from year to year. To help visualize patterns in trend index over time, we applied a heat map approach to annual indices for species and guilds in each NF (see Figure 3; Figure 4; Table 10; Appendix H; Appendix I). A stretched color scheme was applied to each species spanning from red (low) to green (high); colors

were applied to individual species in order to visualize the relative changes that have occurred over time instead of the raw index value.

The U.S. Geological Survey’s Breeding Bird Survey (BBS) provides important information on trends at large geographic scales. The Minnesota National Forest Breeding Bird Monitoring Project was specifically designed to complement the BBS by strategically and systematically sampling forest habitat types away from edges associated with roads (on which BBS routes are located) using standardized point-count methods. Comparing trends at multiple spatial scales provides ecological context for species trends observed in the NFs. For this reason, we compare NF species trends to BBS trends calculated for Bird Conservation Region in which the NFs lie (BCR 12) and BBS survey-wide (North America; Table 10).

Appendix C tabulates the common name, scientific name, four-letter code used in field records, and a summary of the three major guilds included here: migration strategy, nest site, and vegetation type primarily used by the species. Appendices D and E identify the number of individuals observed for species excluded from trend analysis from 1995 to 2021 in Chippewa and Superior NFs, respectively. Appendix F is discussed in more detail below and includes results of trend analysis for lowland-conifer forests in the Superior NF, 2008–2021. Appendix G is a comprehensive overview of the study design and methods. Appendix H and Appendix I provide the estimated annual indices with a stretched color scheme for each species analyzed in Chippewa and Superior NFs, respectively, to visualize relative changes in trend indices over time.

Chippewa National Forest																												
Common Name	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Canada Warbler	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6
Common Loon	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Connecticut Warbler	0.9	1.0	0.8	0.8	0.7	0.6	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	
Golden-winged Warbler	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	
Olive-sided Flycatcher	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	
Purple Finch	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
Veery	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.6	1.9	2.0	1.9	1.8	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8
Winter Wren	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	
Wood Thrush	0.1	0.2	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Superior National Forest																												
Common Name	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Black-billed Cuckoo	0.1	0.1	0.1	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	
Black-throated Blue Warbler	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	
Canada Warbler	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Cape May Warbler	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	
Common Loon	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	
Connecticut Warbler	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.1	
Golden-winged Warbler	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.2	
Olive-sided Flycatcher	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	
Purple Finch	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
Veery	1.4	1.4	1.4	1.3	1.3	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	
Winter Wren	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.4	
Wood Thrush	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	

Figure 3. Estimated annual indices from 1995-2021 for breeding bird species of state, national, or international conservation interest. A stretched color scheme was applied to each species with red for low indices, yellow average, and green high to visualize changes in indices over time.

Chippewa National Forest																											
Habitat Guilds	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coniferous forest species	2.2	2.4	2.6	2.9	2.7	2.7	2.8	2.9	3.0	3.0	3.0	3.1	3.1	3.3	3.1	3.5	3.0	3.0	2.8	2.8	2.7	2.7	2.6	2.6	2.5	2.5	2.4
Deciduous forest species	12.4	13.1	13.1	13.2	14.4	14.9	15.3	15.7	15.9	16.4	16.6	16.6	16.5	16.5	15.8	14.9	15.6	15.9	15.1	14.9	14.9	14.8	14.8	14.5	14.5	14.4	14.3
Early-successional species	3.9	4.2	4.3	4.5	4.6	4.6	4.7	4.7	4.9	5.0	5.0	4.9	4.9	4.9	4.7	4.5	4.5	4.4	4.5	4.4	4.4	4.5	4.4	4.5	4.5	4.5	4.6
Lowland-conifer species	2.6	2.7	2.9	3.1	2.9	2.8	2.9	2.9	3.0	3.0	3.1	3.1	3.1	2.9	3.3	3.4	3.0	2.8	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	2.9
Mixed forest species	2.3	2.4	2.5	2.7	2.6	2.7	2.8	2.9	3.0	3.1	3.1	3.2	3.2	3.1	3.2	3.4	3.1	3.1	3.0	3.0	3.0	3.0	2.9	2.9	2.8	2.8	2.8
Migration Guilds	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long-distance migrants	17.6	18.6	18.8	19.3	20.3	20.7	21.1	21.6	22.0	22.5	22.8	22.7	22.7	22.6	22.0	21.4	21.5	21.6	21.1	20.9	21.0	20.9	20.8	20.7	20.7	20.6	20.6
Permanent residents	1.8	1.9	2.1	2.3	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9	2.9	2.8	2.9	2.9	2.8	2.8	2.7	2.7	2.7	2.6	2.6	2.6	2.5	2.5	2.5
Short-distance migrants	6.9	7.1	7.8	8.3	8.0	8.0	8.3	8.4	8.7	8.8	8.9	8.7	8.7	8.4	8.4	8.5	7.8	7.5	7.5	7.3	7.1	6.9	6.6	6.5	6.3	6.1	5.9
Nesting Guilds	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Canopy nesting species	4.9	5.2	5.5	5.9	5.7	5.8	6.0	6.1	6.2	6.3	6.4	6.3	6.3	6.4	6.1	6.5	5.9	5.9	5.7	5.7	5.6	5.6	5.5	5.5	5.4	5.4	5.3
Cavity nesting species	1.5	1.6	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.6	2.4	2.4	2.4	2.3	2.2	2.2	2.2	2.1	2.1
Ground nesting species	10.9	11.2	11.8	12.5	12.5	12.6	12.9	13.3	13.7	14.0	14.2	14.1	14.2	13.7	14.2	13.8	13.7	13.5	13.7	13.6	13.6	13.5	13.4	13.4	13.3	13.3	13.2
Shrub nesting species	8.9	9.4	9.4	9.6	10.2	10.5	10.7	10.8	11.0	11.2	11.3	11.1	10.9	11.0	10.2	9.9	9.8	9.7	9.4	9.2	9.1	9.0	8.8	8.7	8.6	8.5	8.4
Nest parasites	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Superior National Forest																											
Habitat Guilds	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coniferous forest species	2.7	2.8	2.8	3.0	3.0	3.0	3.1	3.2	3.3	3.5	3.4	3.5	3.6	3.6	3.6	3.5	3.6	3.5	3.4	3.4	3.4	3.4	3.5	3.3	3.3	3.2	3.1
Deciduous forest species	10.8	11.1	11.5	11.6	12.1	12.3	12.5	12.7	12.8	13.0	13.2	13.0	12.8	12.4	12.3	12.0	11.7	11.5	11.5	11.4	11.3	11.2	11.0	11.2	11.0	11.0	11.0
Early-successional species	5.1	5.2	5.3	5.4	5.6	5.8	5.9	6.0	6.1	6.4	6.3	6.2	6.1	6.1	5.9	5.7	5.5	5.2	5.2	5.0	5.0	4.9	4.8	4.6	4.5	4.4	4.3
Lowland-conifer species	4.0	4.2	4.3	4.5	4.5	4.6	4.7	4.9	5.0	5.1	5.1	5.1	5.1	5.2	5.1	5.1	5.0	5.0	4.9	4.8	4.7	4.9	4.6	4.6	4.5	4.4	
Mixed forest species	2.4	2.4	2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.9	3.0	3.0	3.0	3.0	2.9	2.8	2.8	2.8	2.7	2.7	2.6	2.6	2.5	2.4	2.4	2.4	2.3
Migration Guilds	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long-distance migrants	18.2	18.7	19.1	19.4	19.9	20.3	20.6	20.9	21.2	21.7	21.7	21.5	21.2	20.9	20.6	20.2	19.9	19.4	19.4	19.3	19.2	19.0	19.0	18.7	18.7	18.6	18.6
Permanent residents	1.9	2.0	2.1	2.2	2.4	2.4	2.5	2.6	2.8	2.9	2.9	3.0	3.0	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Short-distance migrants	6.9	7.2	7.3	7.7	7.8	8.1	8.3	8.5	8.8	9.0	9.1	9.0	9.0	9.1	8.8	8.7	8.3	8.1	7.9	7.6	7.4	7.1	7.1	6.5	6.3	6.1	5.6
Nesting Guilds	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Canopy nesting species	3.8	4.0	4.1	4.3	4.3	4.5	4.6	4.7	4.8	5.0	5.0	5.1	5.2	5.2	5.2	5.3	5.1	5.2	5.1	5.0	5.0	4.9	5.0	4.8	4.8	4.7	4.6
Cavity nesting species	1.3	1.4	1.5	1.5	1.7	1.8	1.9	2.0	2.1	2.2	2.2	2.3	2.2	2.2	2.2	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.7	1.6	1.6	1.5	1.4
Ground nesting species	14.3	14.7	14.9	15.4	15.7	16.0	16.2	16.6	16.9	17.2	17.2	17.1	16.9	16.8	16.6	16.3	15.9	15.5	15.5	15.3	15.0	14.8	14.8	14.4	14.2	14.1	13.8
Shrub nesting species	7.6	7.7	7.9	8.1	8.3	8.5	8.7	8.8	8.9	9.2	9.2	9.0	8.8	8.6	8.4	8.1	7.9	7.7	7.6	7.5	7.5	7.4	7.4	7.2	7.2	7.0	7.0

Figure 4. Estimated annual indices from 1995-2021 for breeding bird habitat, migration, and nesting guilds. A stretched color scheme was applied to each species with red for low indices, yellow average, and green high to visualize changes in indices over time.

Chippewa NF Trends

Sixty-nine species in the Chippewa NF were included in our analysis in 2021; of these, 18 species had significantly increasing trends (Table 2; Table 3), 17 species had significantly declining trends (Table 4), and 34 species had non-significant trend indices (see Table 5; Appendix A).

Increasing Species. Three species showed new significantly increasing trends in Chippewa NF this year: Northern Waterthrush, Purple Finch, and Yellow-Bellied Flycatcher (Table 6). Eleven species have shown increasing trends over the last five years: Black-and-white Warbler, Black-throated Green Warbler, Blue Jay, Canada Warbler, Nashville Warbler, Ovenbird, Pileated Woodpecker, Pine Warbler, Red-breasted Nuthatch, Veery, and Yellow-bellied Sapsucker. Ruby-throated Hummingbird and Lincoln’s Sparrow have been increasing the last three years. Most notable in this list are two species of conservation concern, Canada Warbler and Veery.

Canada Warbler inhabit a wide range of deciduous and coniferous forests but are most common in moist mixed coniferous-deciduous forests that have well-developed understory shrub layers (Reitsma et al. 2010; Grinde and Niemi 2016). Observations of the species have varied annually, but we suspect the steady increase is associated with a combination of thinning, wind, and insect disturbances that have occurred in some stands. The significantly increasing trend for Canada Warbler in Chippewa NF is important; by comparison, BBS population trend estimates for Canada Warblers indicate a -1.3% continental population decline and -1.6% in BCR 12 since 1966 (Sauer et al. 2020; Figure 3; Table 10).

Because of the long-term population declines throughout their range, Canada Warbler was designated as “threatened” in Canada in 2010 and is included on the list of species of conservation concern at the national level in the United States (Butcher et al. 2007; U.S. Fish and Wildlife Service 2008; Environment Canada 2015).

Veery are designated as a Species in Greatest Conservation Need (SGCN) by the Minnesota Department of Natural Resources (MNDNR; MNDNR 2015) because this species has shown long-term population declines (Sauer et al. 2020; Figure 3; Table 10) and six percent of the total population breeds in Minnesota, the highest of any U.S. state (Pfanmuller 2012). Veery breed in a variety of cover types, including regenerating stands, but forest stands with a well-developed understory of shrubs and small trees are common features, and research also suggests sensitivity to fragmentation (Robbins et al. 1989; Blake 1991). Similar to Canada warbler, Veery may be increasing in Chippewa NF due to a combination of thinning, wind, and insect disturbances that have occurred in some stands.

Decreasing Species. Hermit Thrush and Yellow-rumped Warbler both showed new significantly decreasing trends in Chippewa NF (Appendix A; Table 6). Two species have shown significantly decreasing trends for at least the last ten years: Connecticut Warbler and Song Sparrow. Chipping Sparrow, Least Flycatcher, and Winter Wren have had declining trends for eight years, and American Robin has shown a declining trend for the past seven years. Brown-headed Cowbird, Common Yellowthroat, Olive-sided Flycatcher, Red-eyed Vireo, and Scarlet Tanager have been declining for the past five years. Three of these species are designated as a SGCN by MNDNR: Connecticut Warbler, Olive-sided Flycatcher, and Winter Wren (Figure 3; MNDNR 2015). Conservation considerations for these species are summarized below in the “Regional Trends” section.

Non-forest (Golden-winged Warbler) Stands. In 2016, 25 stands were added to the NFB surveys to focus on non-forested habitat types that are important for many early-successional bird species. In 2021, a total of 914 individuals of 56 species were detected in these stands. The most abundant species (mean observations/stand) were Veery (7.1), Ovenbird (5.6), Common Yellowthroat (5.1), Red-eyed Vireo (4.3), and Nashville Warbler (4.2; Table 7). A total of 42 Golden-winged Warblers were recorded; an average of 1.7 per stand and were detected at 19 of the 25 stands surveyed (Table 7). The average number of Golden-winged Warblers detected at these stands is 31 but the number has fluctuated annually, with a minimum of 15 observed in 2018 to a maximum of 52 individuals observed in 2019.

Superior NF Trends

Sixty-seven species in the Superior NF were included in our analysis; of these, 13 species had significantly increasing trends (Table 2; Table 3), 25 species had significantly decreasing trends (Table 4), and 29 species had non-significant trends (see Table 5; Appendix A).

Increasing Species. There were no new significantly increasing species trends this year in Superior NF; however, Northern Parula changed from significantly increasing to non-significant (Table 6). Seven species have shown increasing trends over the last five years: Black-throated Green Warbler, Blue Jay, Nashville Warbler, Pine Warbler, Red-breasted Nuthatch, Ruby-crowned Kinglet, and Tennessee Warbler. Other increases include Purple Finch over the last four years, Ruffed Grouse and Northern Waterthrush three years, and American Redstart two years. Two of these species are designated as SGCN (MNDNR 2015): Cape May Warbler and Purple Finch.

Cape May Warbler was listed as an SGCN due to steep, range-wide population declines (MNDNR 2015). This species also faces several threats including high mortality during migration, habitat loss, and narrow thermal preferences (MNDNR 2015; Pfanmuller et al. 2017). BBS population trends showed a

significant increase in Minnesota (2.36%) and a non-significant trend in the BCR 12 (0.99%) and continental scale (0.94%; Sauer et al. 2020; Figure 3; Table 10). Cape May Warblers are most abundant in a variety of medium- to old-aged coniferous habitats with spruce and balsam fir. They are considered spruce budworm specialists, and populations fluctuate widely with spruce budworm outbreaks; recent increases in this species are likely due to local spruce budworm outbreaks that have been occurring in and around Superior NF since 2010 (Sturtevant et al. 2013). Maintaining healthy coniferous forests across the landscape and increasing conifer components in existing forest stands, especially in the northern portions of the state, will be beneficial to the long-term conservation of this species.

BBS population trends indicate Purple Finch has experienced a statistically valid decline of 0.73% at the continental scale and -1.07% in BCR 12 since 1966 (Sauer et al. 2020; Table 10). This species uses a variety of habitat types including bogs, upland coniferous forests, pine forests, pine-oak barrens, lowland coniferous forests, and northern mixed forest types (Niemi et al. 2016). The reasons for the population declines in Minnesota are unknown, but changes in climate and high collision risks have been proposed. In Ontario, Cadman et al. (2007) suggested that the recent Purple Finch declines were linked to low spruce budworm populations. If this is the case, it may be a reason why the species is increasing in Superior NF.

Decreasing Species. Only White-throated Sparrow showed a new significantly decreasing trend this year in Superior NF (Appendix A; Table 6). Common Loon, Connecticut Warbler, Swainson's Thrush, and Yellow-bellied Flycatcher have shown declining trends for the last nine years. American Crow, Chipping Sparrow, Downy Woodpecker, Mourning Warbler, and Red-eyed Vireo have been declining for seven years, Hermit Thrush has declined for the last six years, and Song Sparrow and Chestnut-sided Warbler have been declining for four years. Winter Wren was significantly declining in 2016, returned to a non-significant trend in 2017, but has returned to a significant decline since 2018. Black-billed Cuckoo, Black-capped Chickadee, and Lincoln's Sparrow showed new declining trends in 2019 that have continued through 2021.

Five of these declining species are designated as SGCN: Black-billed Cuckoo, Common Loon, Connecticut Warbler, Evening Grosbeak, and Winter Wren (MNDNR 2015). Common Loons are not well surveyed by point counts, so trend indices for Superior NF should be interpreted with caution. Conservation considerations for Connecticut Warbler and Winter Wren are summarized below in the "Regional Trends" section.

Black-billed Cuckoo has experienced a statistically valid decline of 2.07% at the continental scale and -1.34% in BCR 12 since 1966 (Sauer et al. 2020; Table 10). Causes of the population declines are unclear, but food supply, pesticide use, and habitat changes have been implicated. Over 10% of the breeding population is found in Minnesota, thus the state has an important role in the overall conservation of the species (Pfanmuller 2012).

Evening Grosbeak populations have declined 2.52% at the continental scale and -5.02% in BCR 12 since 1966 (Sauer et al. 2020; Table 10). Reasons for this population decline are not well known, but multiple causes such as large-scale forestry that has reduced the age structure of forests, diseases, and a reduced number of insect infestations (e.g., spruce budworm; Pfanmuller 2012) have been suggested.

Lowland-conifer Forest Stands. We completed a separate trend analysis for lowland conifer stands in the Superior NF from 2008 to 2021 (Table 8; Appendix F). Forty-two stands primarily composed of black spruce, tamarack, or mixed swamp conifer are sampled annually in the Superior NF and were included in this analysis. Mixed swamp conifer is dominated by northern white cedar, balsam fir, and black spruce, though occasionally mixed with tamarack, paper birch, and black ash. Twenty-five of the 42 stands were

added to the sampling design in 2008 and are primarily productive black spruce forests. Twenty species that are associated with conifer or lowland-conifer for breeding habitat were included in the analysis. Unsurprisingly, the results of the lowland conifer analyses differed from the forest-scale trends due to the shortened time-series and restricted forest types. However, we feel that focusing on conifer-associated species in these stands can provide valuable insights for management over time (Table 8; Appendix B). Results indicate that Cape May Warbler, Dark-eyed Junco, Northern Waterthrush, Tennessee Warbler, and Yellow-bellied Flycatcher were significantly increasing while Common Raven, Connecticut Warbler, and Winter Wren had trends that were significantly decreasing in lowland-conifer forests from 2008 to 2021 (Table 8; Appendix B).

Regional Trends - Pooled National Forests

We calculated regional trends that combine data from both Chippewa and Superior NFs for 59 species in 2021. Overall, 13 species were increasing significantly (Table 2), 22 species were decreasing significantly, and 24 had non-significant trends (Table 4).

Increasing Species. New region-wide increases were not detected for any species, but Northern Parula and Yellow-bellied Sapsucker trends both shifted from significant increases to non-significant in 2021 (Table 6). Eight species have shown regionally increasing trends over the last five years: Blue Jay, Black-and-white Warbler, Black-throated Green Warbler, Cedar Waxwing, Nashville Warbler, Ovenbird, Pine Warbler, and Red-breasted Nuthatch. Northern Waterthrush and American Redstart have increased in each of the last four years, and Purple Finch the last three years.

Decreasing Species. The only species to show new regional declines this year was Yellow-rumped Warbler (Table 6). Sixteen species have shown declining trends over the last five years: American Crow, American Robin, Chestnut-sided Warbler, Chipping Sparrow, Common Loon, Common Yellowthroat, Connecticut Warbler, Downy Woodpecker, Hermit Thrush, Mourning Warbler, Olive-sided Flycatcher, Red-eyed Vireo, Scarlet Tanager, Song Sparrow, Winter Wren, and Yellow-bellied Flycatcher. Black-capped Chickadee and Magnolia Warbler the last three years. Of these, four species are identified as SGCN by the MNDNR: Common Loon, Connecticut Warbler, Olive-sided Flycatcher, and Winter Wren (MNDNR 2015).

Connecticut Warbler has shown the most consistent decline of any species in this monitoring program. The 2018 field season was the first time there were no Connecticut Warbler detections in either NF; there were two detections in 2020 (Figure 3). Connecticut Warbler is one of the rarest and most narrowly distributed wood-warblers in the northern coniferous forest. In Minnesota, the species is most common in mature, lowland coniferous forests comprised of widely scattered black spruce and tamarack trees. An understory of sphagnum moss and low shrubs such as Labrador tea, leatherleaf, and swamp laurel is also a common habitat characteristic (Pfanmuller et al. 2017). Because of the restricted breeding range, specific habitat requirements, and a small and declining population, Connecticut Warbler has received multiple conservation designations. It is listed as a Yellow Watch List species, a designation reserved for species that “require constant care and long-term assessment” by Partners in Flight (PIF; Rosenberg et al. 2016). MNDNR identified population declines, habitat loss, and habitat fragmentation as species stressors that prompted their designation as a SGCN (MNDNR 2015). Connecticut Warbler is also designated a Sensitive Species on both the Chippewa and Superior NFs (U.S. Forest Service 2012).

Connecticut Warblers have experienced statistically valid declines at all spatial scales: -8.44% in Chippewa NF, -7.77% in Superior NF, and -8.30% regionally. BBS trends indicate a 1.79% decline in BCR

12 but a non-significant trend -0.77% decline at the continental scale (Sauer et al. 2020; Figure 3; Table 10). The reasons for these steep declines are unknown, and detailed studies to assess demographic information as well as full life-cycle analyses are needed. Niemi et al. (2016) also highlighted the need to protect and conserve large tracts of black spruce-tamarack forests and emphasized the importance of selecting stands found adjacent to upland coniferous stands, which also provide suitable habitat for this species.

Olive-sided Flycatcher has shown a relatively consistent decline in both forests since 2008 (Figure 3). Habitat loss and degradation on both breeding and non-breeding grounds, coupled with long-term population declines, have led to its classification as a Yellow Watch species by PIF (Rosenberg et al. 2016). In Minnesota, the species was designated a SGCN due to the long-term declines in population (MNDNR 2015) and is also on the regional forester's Sensitive Species List for both the Chippewa and Superior NFs (U.S. Forest Service 2012). Olive-sided Flycatchers have shown a significant decline of -4.82% in Chippewa NF, -0.60% in Superior NF, and -3.63% regionally. BBS trends indicate a 3.05% decline in BCR 12 and a -2.08% decline at the continental scale (Sauer et al. 2020; Figure 3; Table 10). This species is most common in northern bogs and coniferous forests with natural or anthropogenic forest openings and edges (Pfanmuller et al. 2017). Although habitat loss and degradation have been cited as potential stressors, few studies have identified best management practices critical for maintaining populations due to its low density and remote breeding habitat. Recommendations generally focus on protecting existing sites that provide suitable habitat, retaining snags and tall trees in harvested stands, and ensuring the availability of forest openings in appropriate habitats at the landscape scale (Kreitinger and Paulios 2013).

Winter Wren has shown a consistent decline since 2006 in Chippewa NF and since 2011 in Superior NF (Figure 3). Habitat loss is generally identified as the cause of the decline and led to its designation as a SGCN (MNDNR 2015). Significant decreasing population trends were detected in Chippewa NF (-2.55%), Superior NF (-0.99%), and regionally (-1.50%) in 2020. However, BBS population trends are relatively stable in BCR 12 (0.69%) and continentally (0.23%; Sauer et al. 2020; Figure 3; Table 10). Winter Wren uses a variety of forest cover types including mixed swamp conifer, lowland hardwood, black spruce-tamarack, and upland aspen-spruce-fir stands. Common features of occupied habitats include the presence of water and a dense understory littered with coarse woody debris including dead logs, slash piles, and upturned roots at the base of fallen trees (Pfanmuller et al. 2017). These structures provide foraging opportunities, nesting sites, and singing perches for Winter Wrens. Forest management plans that aim to conserve mature forest stands across the landscape and promote management practices that ensure the retention of snags and downed and decaying wood help provide additional suitable habitat for Winter Wren.

As stated above, we caution the reliability of the trends for Common Loon and note that BBS trends indicate Common Loon populations are increasing (0.52%) in BCR 12 (Sauer et al. 2020; Figure 3; Table 10). We refer readers to the Minnesota Loon Monitoring Program, a 20 year, volunteer-based monitoring program designed to monitor loon populations in the state for more detailed information specific to this species. The Minnesota Loon Monitoring Program reports that while overall loon populations in the northern and central portion of the state have remained relatively stable, those in the Cook/Lake index area (i.e., Superior NF) have shown a marginally significant decline since 1994 (Larson 2019).

Guild Analyses

At both the NF and regional scale, the majority of migratory, nesting, and habitat association guilds showed significant increases from 1995 to 2021 (Table 9). However, species associated with shrub/sub-canopy nesting showed significantly decreasing trends that were consistent in both NFs and regionally. A continued noteworthy pattern is the trends among the migratory guilds. Short-distance migrants showed significant declines in Chippewa NF (-0.87%), Superior NF (-0.70%), and regionally (-0.78%). Short-distance migrants are arriving on the breeding grounds earlier as spring phenology advances (Zuckerberg et al. 2015). If birds are initiating territorial behavior earlier each year, our rigid survey window could be failing to detect individuals in a manner that would appear as a declining trend. Increasingly volatile weather during the spring season may be causing true declines in short-distance migrants, especially as species arrive to the breeding grounds earlier.

Long-distance migrants showed significant declines (-0.21%) in Superior NF but also displayed a significant positive trend in Chippewa NF (0.25%; Figure 4, Table 9). Permanent residents continue to show the greatest overall percentage increase over the past 27 years with an increase of 0.81% per year regionally (Table 9).

Early-successional Habitat Guild. Trend estimates for early-successional species were highest from 2000 to 2010 in Chippewa NF and Superior NF but have been steadily decreasing since that time (Figure 4). Several species associated with open areas and early-successional habitats showed statistically significant declines in 2021 including Chipping Sparrow, Mourning Warbler, Chestnut-sided Warbler, and Song Sparrow. Regionally decreasing trends were significant for three species that are highly associated with early-successional forests: Chestnut-sided Warbler, Mourning Warbler, and Song Sparrow. All the aforementioned species are declining in BCR 12 with the exception of the Chestnut-sided Warbler, and overall trends for these species are consistent with continental BBS trends (Sauer et al. 2020; Table 10). These results are likely due to the reduction in logging that has occurred in the two NFs over the past 18 years as documented in Niemi et al. (2016, p. 48–52). However, with the increased focus on the creation of early-successional habitat on state and county land throughout the state, we are not overly concerned with this decline on the NFs. We do not recommend additional cutting aimed at early-successional habitat creation for birds.

Golden-winged Warbler is a species of high conservation concern in Minnesota and has received considerable attention from federal, regional, and local agencies. This species is designated a Red Watch List species by PIF and a SGCN by the MNDNR (MNDNR 2015; Rosenberg et al. 2016). Golden-winged Warbler uses shrub wetlands and young successional habitats with dense ground cover and scattered trees. In Minnesota, most birds of this species have been observed in alder-willow wetlands and young aspen forests (Niemi et al. 2016). While Golden-winged Warbler population trends continue to decrease across BCR12 and at the continental scale, population trends in Minnesota have remained stable, likely due to multi-agency efforts to create habitat across the state (Golden-winged Warbler Working Group 2019).

Currently, over 50% of all Golden-winged Warblers breed in Minnesota and habitat management of Minnesota forests is critical for the long-term survival of the species. Golden-winged Warbler populations in Minnesota's NFs have remained fairly stable over time and trend estimates showed a non-significant trend in both Chippewa (1.61) and Superior (-0.44) NFs (Appendix B; Table 10). Importantly, trend estimates have been increasing in Chippewa NF since 2014, likely the result of active habitat management that has occurred in the forest during this time period (Figure 3). Currently, we are conducting a study to determine management actions that maximize productivity of Golden-winged Warblers focusing on the post-fledging period.

Aerial Insectivores. There are five forest-associated flycatcher species observed in the NFs that we are able to run trend analysis for: Eastern Wood-Pewee, Great Crested Flycatcher, Least Flycatcher, Olive-sided Flycatcher, and Yellow-bellied Flycatcher. Three of these species (Olive-sided Flycatcher, Yellow-bellied Flycatcher, and Least Flycatcher) have consistently shown either regional or single NF declines. Eastern Wood-Pewee previously had a significant decline in Chippewa NF and regionally in 2020, but the trend became non-significant this year. Great Crested Flycatcher has a non-significant decline ($P = 0.98$) in the Chippewa NF, the only NF of the two where it is found in suitable abundance for trend analysis. Olive-sided Flycatcher, Least Flycatcher, and Eastern Wood-Pewee are experiencing widespread, significant declines in eastern North America (Pfanmuller et al. 2017; Sauer et al. 2020; Table 10). Yellow-bellied Flycatcher is declining in the northeastern U.S., in Superior NF, and regionally when both NFs are combined. In contrast, Great Crested Flycatcher has maintained a relatively stable population over the past 40 plus years, although there are many areas where their populations are declining. Great Crested Flycatcher is a species that readily uses fragmented forests as long as suitable nest cavities remain (Pfanmuller et al. 2017). The decline in flycatchers may be related to similar issues and declines in aerial insectivores such as swallows and swifts reported by Nebel et al. (2010). Recent research in Europe suggests that the flying insect populations have declined by more than 75% over the duration of a 27-year study. If loss of insect diversity and abundance is also occurring in North America, cascading effects on food webs are likely (Hallman et al. 2017). However, these issues are complex because each bird species has a unique life history and we are unsure how resources or the timing in the availability of resources are changing due to climate and other forest disturbances, but these issues deserve further study (Spiller and Dettmers 2019). In response to our growing concern over the status of aerial insectivore populations, we submitted a research proposal to assess the connections between land-use, food availability and quality, and productivity of aerial insectivores and hope to provide management recommendations to address some of these issues. Identifying connections between forest structure and insect availability is an important next step in the development of conservation and management plans for aerial insectivores.

CONCLUSIONS

The majority (63-75%) of bird species surveyed on the NFs show either stable or increasing trends. However, due to the loss of forest that has occurred over the past century, most forest-associated breeding species likely have much lower populations today than in the past. Minnesota has lost almost half of its forested area: from an estimated 31 million acres in the mid-1800s, the state's forests cover less than 17 million acres today. The fact that there are fewer forested acres on the landscape heightens the importance of the NFs as breeding bird habitat: the Chippewa and Superior NFs play an essential role in the creation and maintenance of sustainable forest bird populations in Minnesota and the region.

While the majority of species are showing stable trends, the consistent declines in species and species guilds are cause for growing concern. Lowland conifer specialists such as Canada Jay, Olive-sided Flycatcher, Yellow-bellied Flycatcher, and Connecticut Warbler are significantly declining across the NFs. We strongly recommend limiting black spruce harvest whenever and wherever possible, especially in non-productive sites where economic margins are slim. Maintaining as much black spruce on the landscape as possible will be the only way to mitigate the declines in these species while on the breeding grounds.

Aerial insectivores such as Olive-sided, Least, and Yellow-bellied Flycatchers continue to decline across the NFs. It is likely that aerial insectivores are suffering from a decrease in insect populations, and these effects likely compound from breeding, migration, and non-breeding seasons. While some of these effects are beyond the scope of the NFs, we recommend any actions on the forests that enhance the

complexity and heterogeneity of forest stands, an action that will likely benefit insect and corresponding bird populations. All aerial insectivores face compounding threats; for example, Olive-sided Flycatcher and Yellow-bellied Flycatcher are also lowland conifer specialists as discussed above. Declines in species that fit into two or more declining guilds should receive additional consideration with regard to forest management planning and impacts.

While Minnesota's forests are currently, on average, getting older, few stands are ecologically old. As a result, species that require old growth forests continue to decline. Species such as Brown Creeper and Winter Wren rely on stands in which trees grow to maturity, die, and fall over (e.g., decadent aspen stands) for breeding and foraging. Many woodpecker species require large-diameter trees for cavity nests which are subsequently used by species such as Wood Duck, Northern Saw-whet Owl, and Great Crested Flycatcher. Scarlet Tanager, Yellow-throated Vireo, and Wood Thrush populations rely on old deciduous forests, and their populations continue to decline as well. We recommend any management that allows forest stands to remain on the landscape well beyond typical rotation age and, ideally, through senescence and natural regeneration.

Recent and future changes to the forested regions of Minnesota will have significant impacts on forest bird populations. The dramatic increase in tamarack killed by eastern larch beetle (665,000 acres; ~50% in the last 19 years; MNDNR 2019) is undoubtedly affecting breeding birds, but the extent and nature of these effects is largely unknown. It is unclear what bird species use tamarack during and after stand infestation, and the long-term consequences of the outbreak are also unknown. Unfortunately, few tamarack stands are sampled in the current monitoring program.

The Chippewa and Superior NFs continue to play a critical role in the health of bird populations in Minnesota and the Upper Midwest. Because national forests are managed for sustainable multiple uses as opposed to economic return, the trends reported here likely represent a "best case scenario" for mature and lowland conifer bird species across public ownership. There are ample opportunities to use forest management to conserve and improve breeding bird habitats to ensure the long-term conservation of Minnesota's biodiversity. We believe that many bird populations are reaching critical tipping points that, if passed, will necessitate considerable conservation action. Researchers at the Natural Resources Research Institute are committed to conserving healthy populations of Minnesota's birds and are eager to work together to find creative solutions to provide management recommendations and guidance to any interested parties.

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TABLES

Table 1. Trends for two NFs and pooled NFs based on linear regression of loess-smoothed annual index of abundance (See Methods) (1995-2021). I = significantly increasing, D = significantly decreasing. * $P < 0.05$, ** $P < 0.01$. See Appendix A for species graphs and Appendix B for test statistics and sample sizes.

Species	Chippewa NF	Superior NF	Regional
Alder Flycatcher	D**	ns	ns
American Bittern	-	ns	-
American Crow	ns	D**	D**
American Goldfinch	ns	ns	ns
American Redstart	ns	I*	I*
American Robin	D**	ns	D**
Black-and-white Warbler	I**	ns	I**
Black-billed Cuckoo	-	D**	-
Black-capped Chickadee	D**	D**	D**
Black-throated Blue Warbler	-	ns	-
Black-throated Green Warbler	I**	I**	I**
Blackburnian Warbler	ns	ns	ns
Blue-headed Vireo	D*	ns	ns
Blue Jay	I**	I**	I**
Broad-winged Hawk	ns	D*	ns
Brown-headed Cowbird	D**	-	-
Brown Creeper	ns	D**	D**
Canada Jay	ns	D**	D**
Canada Warbler	I**	ns	ns
Cape May Warbler	-	I**	-
Cedar Waxwing	ns	I**	I**
Chestnut-sided Warbler	ns	D**	D**
Chipping Sparrow	D**	D**	D**
Common Loon	ns	D**	D**
Common Raven	ns	D**	D*
Common Yellowthroat	D*	D**	D**
Connecticut Warbler	D**	D**	D**
Dark-eyed Junco (Slate-colored)	ns	ns	ns
Downy Woodpecker	ns	D**	D*
Eastern Towhee	ns	-	-
Eastern Wood-Pewee	ns	ns	ns

Species	Chippewa NF	Superior NF	Regional
Evening Grosbeak	-	D*	-
Golden-crowned Kinglet	ns	ns	ns
Golden-winged Warbler	ns	ns	ns
Gray Catbird	ns	-	-
Great Crested Flycatcher	ns	-	-
Hairy Woodpecker	ns	ns	ns
Hermit Thrush	D**	D**	D**
Indigo Bunting	D**	-	-
Least Flycatcher	D**	ns	ns
Lincoln's Sparrow	I**	D**	ns
Magnolia Warbler	ns	D**	D**
Mourning Dove	I*	-	-
Mourning Warbler	ns	D**	D**
Nashville Warbler	I**	I**	I**
Northern Flicker (Yellow-shafted)	ns	ns	ns
Northern Parula	ns	ns	ns
Northern Waterthrush	I*	I**	I**
Olive-sided Flycatcher	D**	ns	D**
Ovenbird	I**	ns	I**
Palm Warbler (Western)	ns	-	-
Pileated Woodpecker	I**	ns	ns
Pine Warbler	I**	I**	I**
Purple Finch	I*	I*	I**
Red-breasted Nuthatch	I**	I**	I**
Red-eyed Vireo	D**	D**	D**
Red-winged Blackbird	ns	ns	ns
Rose-breasted Grosbeak	ns	D*	ns
Ruby-crowned Kinglet	I**	I**	I**
Ruby-throated Hummingbird	I**	ns	I**
Ruffed Grouse	-	I**	-
Scarlet Tanager	D**	ns	D**
Song Sparrow	D**	D**	D**
Swainson's Thrush	-	D**	-
Swamp Sparrow	ns	ns	ns
Tennessee Warbler	-	I**	-

Species	Chippewa NF	Superior NF	Regional
Veery	I**	ns	ns
White-breasted Nuthatch	ns	-	-
White-throated Sparrow	ns	D*	ns
Wilson's Snipe	ns	ns	ns
Winter Wren	D**	D**	D**
Wood Thrush	ns	ns	ns
Yellow-bellied Flycatcher	I*	D**	D*
Yellow-bellied Sapsucker	I**	ns	ns
Yellow-rumped Warbler (Myrtle)	D*	ns	D**
Yellow-throated Vireo	ns	-	-
Yellow Warbler	ns	-	-

Table 2. Species with significantly increasing trends ($P \leq 0.05$) for two NFs and region-wide (1995-2021), based on regression of loess-smoothed annual index of abundance. ** $P \leq 0.01$. Species graphs can be found in Appendix A.

Chippewa NF	Superior NF	Regional
Black-and-white Warbler**	American Redstart*	American Redstart*
Black-throated Green Warbler**	Black-throated Green Warbler**	Black-and-white Warbler**
Blue Jay**	Blue Jay**	Black-throated Green Warbler**
Canada Warbler**	Cape May Warbler**	Blue Jay**
Lincoln's Sparrow**	Cedar Waxwing**	Cedar Waxwing**
Mourning Dove*	Nashville Warbler**	Nashville Warbler**
Nashville Warbler**	Northern Waterthrush**	Northern Waterthrush**
Northern Waterthrush*	Pine Warbler**	Ovenbird**
Ovenbird**	Purple Finch*	Pine Warbler**
Pileated Woodpecker**	Red-breasted Nuthatch**	Purple Finch**
Pine Warbler**	Ruby-crowned Kinglet**	Red-breasted Nuthatch**
Purple Finch*	Ruffed Grouse**	Ruby-crowned Kinglet**
Red-breasted Nuthatch**	Tennessee Warbler**	Ruby-throated Hummingbird**
Ruby-crowned Kinglet**		
Ruby-throated Hummingbird**		
Veery**		
Yellow-bellied Flycatcher*		
Yellow-bellied Sapsucker**		

Table 3. Summary of species with increasing trends ($P \leq 0.05$) on two NFs (1995-2021). Individual species graphs can be found in Appendix A.

Increased in one NF	Increased in both NFs
American Redstart	Black-throated Green Warbler
Black-and-white Warbler	Blue Jay
Canada Warbler	Nashville Warbler
Cape May Warbler	Northern Waterthrush
Cedar Waxwing	Pine Warbler
Lincoln's Sparrow	Purple Finch
Mourning Dove	Red-breasted Nuthatch
Ovenbird	Ruby-crowned Kinglet
Pileated Woodpecker	
Ruby-throated Hummingbird	
Ruffed Grouse	
Tennessee Warbler	
Veery	
Yellow-bellied Flycatcher	
Yellow-bellied Sapsucker	

Table 4. Species with significantly decreasing trends ($p < 0.05$) for two NFs (1995-2021), based on regression of loess-smoothed annual index of abundance. ** $P < 0.01$. Species graphs can be found in Appendix A.

Chippewa NF	Superior NF	Regional
Alder Flycatcher**	American Crow**	American Crow**
American Robin**	Black-billed Cuckoo**	American Robin**
Black-capped Chickadee**	Black-capped Chickadee**	Black-capped Chickadee**
Blue-headed Vireo*	Broad-winged Hawk*	Brown Creeper**
Brown-headed Cowbird**	Brown Creeper**	Canada Jay**
Chipping Sparrow**	Canada Jay**	Chestnut-sided Warbler**
Common Yellowthroat*	Chestnut-sided Warbler**	Chipping Sparrow**
Connecticut Warbler**	Chipping Sparrow**	Common Loon**
Hermit Thrush**	Common Loon**	Common Raven*
Indigo Bunting**	Common Raven**	Common Yellowthroat**
Least Flycatcher**	Common Yellowthroat**	Connecticut Warbler**
Olive-sided Flycatcher**	Connecticut Warbler**	Downy Woodpecker*
Red-eyed Vireo**	Downy Woodpecker**	Hermit Thrush**
Scarlet Tanager**	Evening Grosbeak*	Magnolia Warbler**
Song Sparrow**	Hermit Thrush**	Mourning Warbler**
Winter Wren**	Lincoln's Sparrow**	Olive-sided Flycatcher**
Yellow-rumped Warbler (Myrtle)*	Magnolia Warbler**	Red-eyed Vireo**
	Mourning Warbler**	Scarlet Tanager**
	Red-eyed Vireo**	Song Sparrow**
	Rose-breasted Grosbeak*	Winter Wren**
	Song Sparrow**	Yellow-bellied Flycatcher*
	Swainson's Thrush**	Yellow-rumped Warbler (Myrtle)**
	White-throated Sparrow*	
	Winter Wren**	
	Yellow-bellied Flycatcher**	

Table 5. Species with marginally significant trends ($0.05 < P \leq 0.10$) for two NFs and region-wide (1995-2021), based on regression of loess-smoothed annual index of abundance. Direction of trend indicated by either positive (+) or negative-sign (-). Species graphs can be found in Appendix A.

Chippewa NF	Superior NF	Regional
Common Loon (-)	Black-and-white Warbler (+)	Eastern Wood-Pewee (-)
Eastern Wood-Pewee (-)	Dark-eyed Junco (Slate-colored) (+)	Least Flycatcher (-)
Golden-crowned Kinglet (-)	Golden-crowned Kinglet (+)	Pileated Woodpecker (+)
Wood Thrush (+)	Swamp Sparrow (-)	Swamp Sparrow (-)
	Yellow-rumped Warbler (Myrtle) (-)	Veery (+)
		White-throated Sparrow (-)
		Wood Thrush (+)

Table 6. Species with changes in trend significance from 2020 to 2021. Changes were either in a positive direction, from decreasing (2020) to non-significant (2021) or non-significant to increasing, or in a negative direction, from increasing to non-significant or non-significant to decreasing. The specific NF where the change occurred is indicated. Species graphs can be found in Appendix A.

Decreasing to non-significant	Non-significant to increasing	Increasing to non-significant	Non-significant to decreasing
Eastern Wood-Pewee, Chippewa	Northern Waterthrush, Chippewa	Northern Parula, Regional	Hermit Thrush, Chippewa
Eastern Wood-Pewee, Regional	Purple Finch, Chippewa	Northern Parula, Superior	White-throated Sparrow, Superior
Golden-crowned Kinglet, Chippewa	Yellow-bellied Flycatcher, Chippewa	Yellow-bellied Sapsucker, Regional	Yellow-rumped Warbler (Myrtle), Chippewa Yellow-rumped Warbler (Myrtle), Regional

Table 7. Summary of the 20 most common species in 2021 from 25 stands (75 points) first added to the Chippewa NF in 2016. Included in the summary are total individuals observed, mean abundance (observations/point, stand), and percent occupied (points, stands). Points sampled are intended to target Golden-winged Warblers or non-forested habitats. Sites chosen represent a broad range of environmental conditions from open, wet shrubby habitats to dryer, forested upland habitats.

Species	Total Individuals	Point		Stand	
		Mean Abundance	% Occupied	Mean Abundance	% Occupied
Alder Flycatcher	49	0.7	43	2.0	76
American Crow	37	0.5	40	1.5	68
American Redstart	30	0.4	27	1.2	52
American Robin	16	0.2	20	0.6	52
Black-and-white Warbler	55	0.7	60	2.2	92
Black-capped Chickadee	19	0.3	20	0.8	52
Blue Jay	67	0.9	60	2.7	88
Chestnut-sided Warbler	83	1.1	57	3.3	96
Common Yellowthroat	127	1.7	79	5.1	100
Golden-winged Warbler	42	0.6	44	1.7	76
Nashville Warbler	104	1.4	67	4.2	88
Ovenbird	140	1.9	87	5.6	96
Red-eyed Vireo	108	1.4	84	4.3	100
Red-winged Blackbird	17	0.2	12	0.7	24
Rose-breasted Grosbeak	33	0.4	40	1.3	76
Sedge Wren	26	0.3	19	1.0	44
Swamp Sparrow	63	0.8	44	2.5	72
Veery	177	2.4	92	7.1	100
White-throated Sparrow	74	1.0	61	3.0	92
Yellow Warbler	17	0.2	17	0.7	32

Table 8. Population trend estimates (% annual change) and associated test statistics for lowland-conifer forests in the Superior NF (2008-2021). Only species in "conifer" and "lowland-conifer" habitat guilds were analyzed. Included for each species are its trend within the Superior NF, the significance of the trend (P), the explained variation of the trend (r^2), and the number of stands (n) in which the species was detected sufficiently to include in the trend calculation.

Species	Trend (%)	P	r^2	n
Blackburnian Warbler	1.06	0.66	0.18	26
Blue-headed Vireo	-0.73	0.72	0.05	20
Canada Jay	-10.20	0.09	0.97	8
Cape May Warbler	17.26	<0.01	1.00	13
Chipping Sparrow	-2.13	0.49	0.60	7
Common Raven	-7.93	<0.01	0.83	9
Connecticut Warbler	-14.66	<0.01	0.93	5
Dark-eyed Junco (Slate-colored)	10.78	0.05	0.83	8
Golden-crowned Kinglet	-1.56	0.34	0.80	34
Magnolia Warbler	0.47	0.70	0.01	37
Nashville Warbler	0.00	0.98	0.00	42
Northern Parula	-3.44	0.18	0.80	19
Northern Waterthrush	6.63	<0.01	0.71	13
Red-breasted Nuthatch	0.79	0.53	0.06	40
Ruby-crowned Kinglet	1.73	0.33	0.30	30
Swainson's Thrush	1.80	0.19	0.57	33
Tennessee Warbler	19.30	<0.01	0.96	16
Winter Wren	-2.74	<0.01	0.61	41
Yellow-bellied Flycatcher	3.07	<0.01	0.80	38
Yellow-rumped Warbler (Myrtle)	-1.10	0.40	0.07	35

Table 9. Test statistics and sample sizes for guild trend analyses on two NFs and a combined regional analysis (1995-2021). All species combined within each guild category and analyzed as a group, regardless of whether a species meets criteria for individual species analyses. Trend = percent annual change in population trend. n = number of stands with detections. See Appendix A for trend graphs.

Guild Category	Chippewa NF				Superior NF				Regional			
	Trend (%)	P	r ²	n	Trend (%)	P	r ²	n	Trend (%)	P	r ²	n
Coniferous forest species	-0.07	0.77	0.00	124	0.59	<0.01	0.30	147	0.31	0.02	0.08	271
Deciduous forest species	0.22	0.02	0.05	126	-0.32	<0.01	0.17	147	-0.03	0.61	0.00	273
Early-successional species	0.05	0.92	0.00	125	-0.85	<0.01	0.36	147	-0.48	0.02	0.21	272
Lowland-conifer species	0.28	0.18	0.18	120	0.21	0.09	0.06	147	0.22	0.06	0.09	267
Mixed forest species	0.55	<0.01	0.23	126	-0.21	0.19	0.04	147	0.16	0.19	0.03	273
Long-distance migrants	0.25	<0.01	0.10	126	-0.21	<0.01	0.10	147	0.01	0.85	0.00	273
Permanent residents	0.74	<0.01	0.27	126	0.87	<0.01	0.36	147	0.81	<0.01	0.32	273
Short-distance migrants	-0.87	<0.01	0.36	126	-0.70	<0.01	0.19	147	-0.78	<0.01	0.26	273
Canopy nesting species	-0.11	0.40	0.02	126	0.60	<0.01	0.33	147	0.25	0.02	0.08	273
Cavity nesting species	0.72	<0.01	0.17	126	0.04	0.86	0.00	147	0.40	<0.01	0.05	273
Ground nesting species	0.45	<0.01	0.31	126	-0.33	<0.01	0.15	147	-0.01	0.82	0.00	273
Shrub nesting species	-0.62	<0.01	0.27	126	-0.64	<0.01	0.36	147	-0.62	<0.01	0.31	273
Nest parasites	-4.42	<0.01	0.73	19	-	-	-	-	-	-	-	-

Table 10. Trend direction for 77 bird species in Chippewa and Superior NFs and corresponding Breeding Bird Survey (BBS) trends in Bird Conservation Region 12 (BCR12) and survey-wide (North America). Color-coding indicates direction if the trend 95% CI did not include zero: red is a negative trend, green is a positive trend. Yellow indicates that the 95% CI included zero. NF trends are 1995 through 2021, while BBS trends are 1966 through 2019 (Sauer et al. 2020). Note BBS trends for American Redstart and Downy Woodpecker were not available.

Common Name	Chippewa	Superior	Regional	BCR12	N America
Alder Flycatcher	-2.77	0.34	-0.56	0.07	-0.54
American Bittern	NA	-1.64	NA	-0.25	-0.74
American Crow	-0.52	-3.79	-1.30	-0.03	-0.23
American Goldfinch	0.34	2.08	0.86	-0.97	-0.60
American Redstart	0.82	1.29	1.00		
American Robin	-1.85	-0.28	-0.88	-0.28	0.13
Black-and-white Warbler	3.75	0.52	1.86	-0.11	-0.28
Black-billed Cuckoo	NA	-4.07	NA	-1.34	-2.07
Black-capped Chickadee	-1.18	-1.39	-1.26	1.48	0.49
Black-throated Blue Warbler	NA	2.32	NA	1.26	1.24
Black-throated Green Warbler	1.23	1.59	1.41	0.04	0.00
Blackburnian Warbler	0.78	-0.06	0.20	0.26	0.17
Blue-headed Vireo	-1.43	-0.32	-0.88	2.97	2.02
Blue Jay	1.43	1.15	1.26	0.42	-0.59
Broad-winged Hawk	2.73	-4.73	-1.72	0.49	0.60
Brown-headed Cowbird	-4.42	NA	NA	-4.19	-0.51
Brown Creeper	-1.36	-2.08	-1.69	2.18	0.37
Canada Jay	-1.51	-2.25	-2.00	-0.16	-0.27
Canada Warbler	3.60	0.22	0.71	-1.58	-1.33
Cape May Warbler	NA	5.66	NA	0.99	0.94
Cedar Waxwing	0.79	2.84	1.89	-1.27	-0.14
Chestnut-sided Warbler	-0.15	-1.37	-0.83	0.04	-0.80
Chipping Sparrow	-3.61	-4.19	-3.79	-0.73	-0.63
Common Loon	-0.98	-4.38	-1.93	0.52	0.29
Common Raven	-0.40	-1.54	-0.97	2.42	1.99
Common Yellowthroat	-1.28	-2.39	-1.56	-0.28	-0.56
Connecticut Warbler	-8.63	-8.01	-8.52	-1.79	-0.77
Dark-eyed Junco (Slate-colored)	4.44	3.15	3.93	-1.52	-0.70
Downy Woodpecker	-1.97	-7.95	-3.28		
Eastern Towhee	-0.29	NA	NA	-1.81	-1.40
Eastern Wood-Pewee	-0.88	-0.63	-0.82	-0.69	-1.07
Evening Grosbeak	NA	-5.01	NA	-5.02	-2.52
Golden-crowned Kinglet	-1.75	0.87	0.24	1.59	-0.71
Golden-winged Warbler	1.61	-0.44	1.17	-0.71	-1.85
Gray Catbird	-1.80	NA	NA	-1.05	0.02
Great Crested Flycatcher	-0.03	NA	NA	-1.39	-0.01

Common Name	Chippewa	Superior	Regional	BCR12	N America
Hairy Woodpecker	1.29	1.05	1.21	1.32	0.66
Hermit Thrush	-0.78	-2.48	-1.57	0.45	-0.01
Indigo Bunting	-5.17	NA	NA	-0.14	-0.62
Least Flycatcher	-1.66	0.82	-0.80	-1.66	-1.04
Lincoln's Sparrow	5.74	-4.19	3.20	-1.13	0.22
Magnolia Warbler	-0.23	-1.26	-1.18	1.00	0.80
Mourning Dove	2.22	NA	NA	2.19	-0.42
Mourning Warbler	-0.19	-2.15	-1.54	-0.56	-1.60
Nashville Warbler	1.01	0.93	0.94	0.12	-0.20
Northern Flicker (Yellow-shafted)	-0.32	-0.63	-0.54	-0.78	-1.21
Northern Parula	0.46	0.65	0.59	3.88	1.16
Northern Waterthrush	2.68	4.44	3.56	-0.39	1.05
Olive-sided Flycatcher	-5.26	-0.21	-3.79	-3.05	-2.08
Ovenbird	1.32	-0.22	0.46	0.01	0.28
Palm Warbler (Western)	2.35	NA	NA	1.10	0.65
Pileated Woodpecker	2.80	0.14	0.94	3.88	1.28
Pine Warbler	1.53	4.63	2.13	3.43	1.29
Purple Finch	2.28	2.99	2.59	-1.07	-0.73
Red-breasted Nuthatch	3.01	2.86	2.92	2.55	0.81
Red-eyed Vireo	-0.61	-0.93	-0.74	0.82	0.59
Red-winged Blackbird	-1.36	-1.47	-1.37	-0.36	-0.62
Rose-breasted Grosbeak	-0.08	-0.91	-0.57	-0.54	-0.24
Ruby-crowned Kinglet	7.57	6.48	6.59	-0.84	0.70
Ruby-throated Hummingbird	4.90	1.79	4.34	0.97	0.95
Ruffed Grouse	NA	3.19	NA	0.12	0.61
Scarlet Tanager	-1.44	-1.03	-1.34	-0.95	-0.13
Song Sparrow	-5.42	-4.44	-5.00	-0.88	-0.59
Swainson's Thrush	NA	-3.33	NA	-0.71	-0.46
Swamp Sparrow	-1.49	-1.62	-1.51	1.14	0.86
Tennessee Warbler	NA	8.25	NA	-0.98	-0.60
Veery	0.92	-0.14	0.42	-0.91	-0.61
White-breasted Nuthatch	-0.28	NA	NA	1.63	1.15
White-throated Sparrow	-0.10	-0.58	-0.44	-0.75	-0.74
Wilson's Snipe	1.74	-2.25	-0.40	-0.17	0.71
Winter Wren	-2.65	-1.19	-1.67	0.69	0.25
Wood Thrush	2.85	0.07	2.27	-1.69	-1.30
Yellow-bellied Flycatcher	1.76	-1.78	-0.84	1.22	2.02
Yellow-bellied Sapsucker	1.24	-0.54	0.38	1.67	0.88
Yellow-rumped Warbler (Myrtle)	-1.14	-0.63	-0.84	0.24	0.21
Yellow-throated Vireo	0.08	NA	NA	1.58	0.90
Yellow Warbler	-0.45	NA	NA	-0.38	-0.40

APPENDICES

The following appendices are individually attached to this document:

Appendix J. Population trend graphs of calculated annual index for individual species within the Chippewa and Superior NFs, and regionally over the 25-year time period (1995–2021) of the study.

Appendix K. Population trend estimates (% annual change) and associated test statistics for the Chippewa NF, Superior NF, and a combined regional analysis (1995–2021). Included for each species are its trend (% annual change) within each NF, a regional trend (if possible), the significance of the trend (P), the explained variation of the trend (r^2), and the number of stands (n) in which the species was detected sufficiently to include in the trend calculation.

Appendix L. Common and scientific name, four-letter abbreviation, migration strategy, nest site, and typical habitat of each species with adequate information for trend analysis in 2021.

Appendix M. Number of observations on the Chippewa NF for species not tested for population trends in 2021. Includes flyovers and all birds regardless of distance.

Appendix N. Number of observations on the Superior NF for species not tested for population trends in 2021. Includes flyovers and all birds regardless of distance.

Appendix O. Results of trend analysis for 20 species that are associated with conifer or lowland-conifer for breeding habitat. Forty-two lowland conifer stands, including 25 stands that were added to the sampling design in 2008, that are primarily composed of black spruce, tamarack, or mixed swamp conifer were included in this analysis.

Appendix P. Study and design methods.

Appendix Q. Estimated annual indices from 1995 to 2021 for breeding birds in Chippewa NF. A stretched color scheme was applied to each species with red for low indices, yellow average, and green high, to visualize relative changes in indices over time.

Appendix R. Estimated annual indices from 1995 to 2021 for breeding birds in Superior NF. A stretched color scheme was applied to each species with red for low indices, yellow average, and green high, to visualize relative changes in indices over time.