

Minnesota National Forest Breeding Bird Monitoring Program Annual Report 1995–2018

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SUMMARY

- A total of 353 forest stands were surveyed for breeding birds including 160 and 191 stands (1029 survey points) in the Chippewa and Superior National Forests (NFs), respectively in 2018.
- Trends in relative abundance were calculated for 77 bird species (1 more than in 2017), including 67 species in the Chippewa NF and 65 in the Superior NF for 24 years from 1995 to 2018.
- In Chippewa NF 75% of species with adequate trend information are estimated to be stable or increasing over the past 24 years. Overall, 15 species trends were significantly increasing (13 in 2017), 15 species trends had significantly decreasing trends (12 in 2017), and 35 species trends (38 in 2017) that were relatively stable from 1995 to 2018.
- In Superior NF 69% of species with adequate trend information are estimated to be stable or increasing over the past 24 years. Of these, 15 species trends were significantly increasing (13 in 2017), 19 species had significantly decreasing trends (13 in 2017), and 30 species (38 in 2017) had relatively stable trends from 1995 to 2018.
- Six species increased in both the Chippewa and Superior NFs: Blue Jay, Red-breasted Nuthatch, Black-and-white Warbler, Nashville Warbler, Pine Warbler, and Black-throated Green Warbler. With the exception of Nashville Warbler, these species tend to be associated with more mature forests.
- Seven species decreased in both NFs; Downy Woodpecker, Red-eyed Vireo, Winter Wren, Chipping Sparrow, Song Sparrow, Connecticut Warbler, Common Yellowthroat. However, 18 species had significantly declining regional trends when the two National Forests were combined: Common Loon, Downy Woodpecker, Olive-sided Flycatcher, Eastern Wood-Pewee, Yellow-bellied Flycatcher, Blue-headed Vireo, Red-eyed Vireo, American Crow, Winter Wren, Hermit Thrush, Chipping Sparrow, Song Sparrow, White-throated Sparrow, Connecticut Warbler, Mourning Warbler, Common Yellowthroat, Chestnut-sided Warbler, and Scarlet Tanager.
- Regional trends for guilds were mixed over the period from 1995-2018. Species associated with upland conifer, lowland conifer, mixed forest, canopy nesters, cavity nesters, and permanent resident species all significantly increased. Early successional, shrub nesting, and short-distance migrant species significantly decreased, while deciduous forest, ground nesting, and long-migrant species had no significant change.
- Connecticut Warbler has shown one of the most consistent declines of any species in the monitoring program and this year reached a new and disappointing low: for the first time in 24 years of monitoring, no Connecticut Warblers were detected in either Chippewa NF or Superior NF.
- The overall trend information indicates that most breeding bird species within these NFs for which we are capable of monitoring and detecting trends are either increasing or stable in populations, while several species such as the Connecticut Warbler, Olive-sided Flycatcher, and Winter Wren continue to have trends that remain a concern. These species are commonly found in lowland coniferous forests.

OVERVIEW

Minnesota's National Forest Breeding Bird Monitoring Program has documented trends in forest bird abundances for 24 years. These data have provided insight into the impacts of forest management on breeding birds and helped inform the development of management policies and conservation initiatives. This report summarizes forest bird monitoring data gathered from 1995 through 2018. 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 diversity of breeding bird species 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, Sekercioglu 2012; Sekercioglu 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 a 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, Eglington 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 birds into forest management planning and implementation will help ensure the health and diversity of ecosystems while 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 1) to establish a baseline inventory of local forest breeding bird assemblages, 2) to monitor population changes of forest bird species over time, and 3) to identify bird-habitat associations, particularly those relevant to forest management activities.

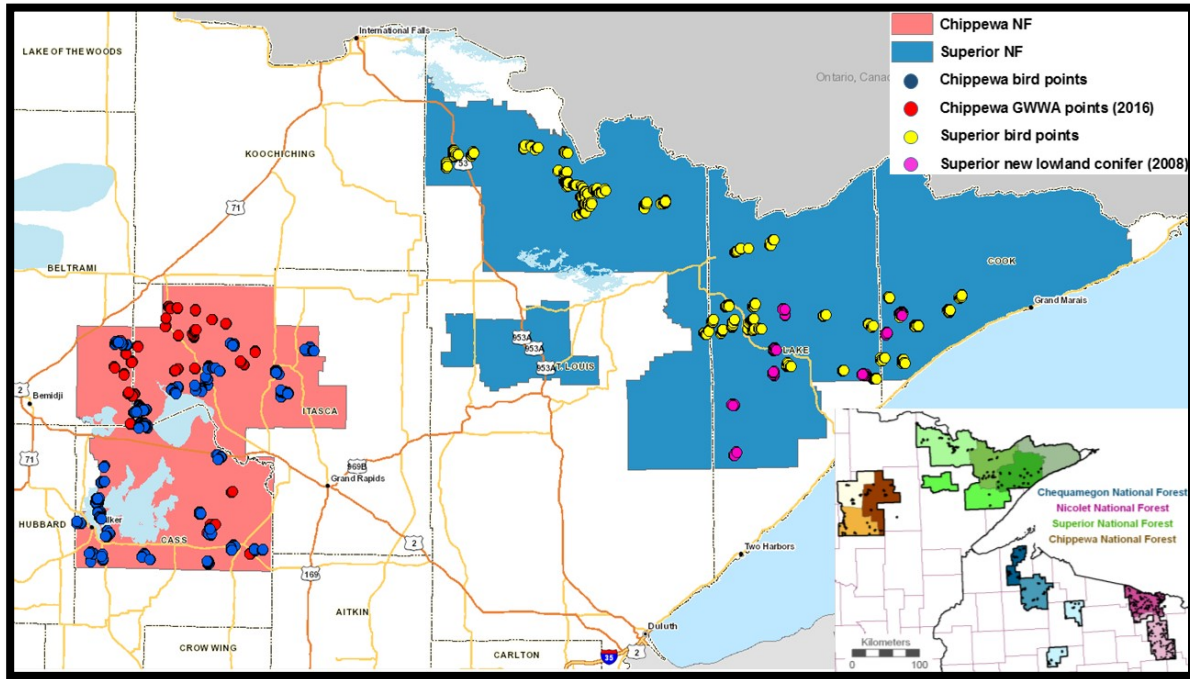


Figure 1. Locations of forest breeding bird point counts in northern Minnesota’s Chippewa and Superior National Forests. Approximately 1,000 individual points are annually sampled between the Chippewa and Superior NFs. Inset shows the regional scope of National Forests included in Niemi et al. (2016).

RESULTS

Throughout the 24 field seasons of the Minnesota National Forest Breeding Bird Monitoring Project we have detected over 359,000 individual birds of 165 species on approximately 22,000 ten-minute point counts in the Chippewa and Superior NFs (Figure 2). In 2018, we sampled 160 stands in the Chippewa NF and 191 in the Superior NF. Seventy-seven species were assessed for trends in at least one national forest, including 67 in the Chippewa NF and 65 in the Superior NF (Table 1). As monitoring has proceeded through the years, new species have met our criteria for inclusion in trend analyses on each national forest. The number of species assessed has increased steadily from 36 in 2000, when the criteria were first applied, to 77 in 2018. Regional trends were calculated for 55 species between the Chippewa and Superior NFs.

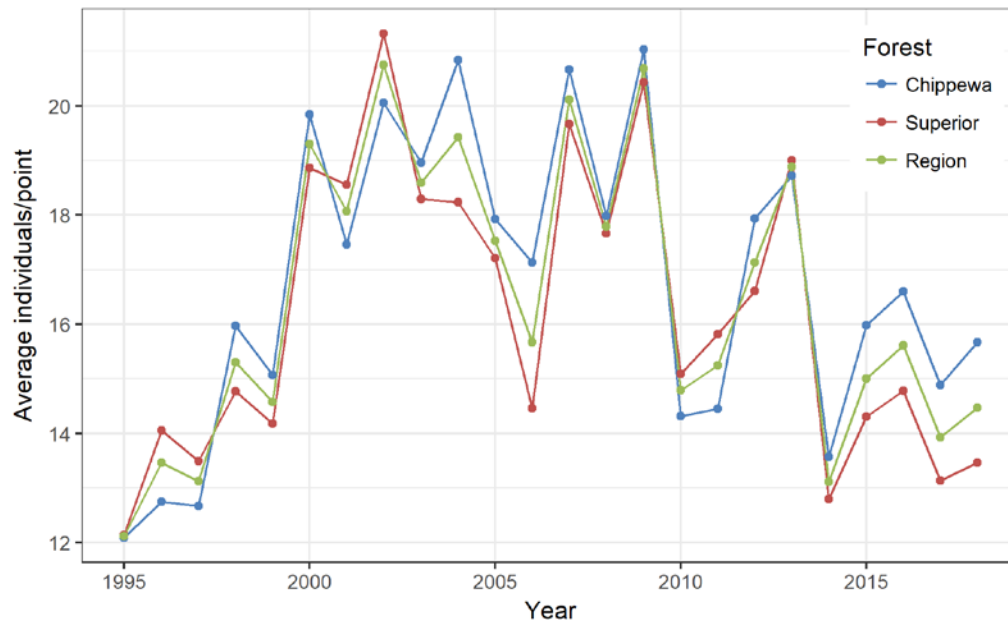


Figure 2. Average number of individual birds detected per point each year in the Chippewa and Superior NFs. The 25 stands added to the Superior NF in 2008 and the 24 stands added to the Chippewa NF in 2016 were included in the summary.

Overview of Data Summaries

We 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.

Appendix A includes trend graphs of calculated annual index for individual species within the Chippewa and Superior NFs, and regionally over the 24 year time period of the study. Appendix B is a complete statistical summary of the trend analysis including species, trend within each NF, regional trend (if possible), trend significance (P), variation explained by trend (r^2), and the number of stands (n) in which the species was detected sufficiently to include in the trend calculation. The combination of trend 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 detect several species that do not fit these criteria. 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 may provide useful insights.

Trend significance is a valuable way to look at large-scale patterns within and between NFs, however the annual index influences the significance (how different is the trend 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 with red for low indices, yellow average, and green high, the color was applied to individual species to visualize the relative changes that have occurred over time not the actual value of the index.

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 (where BBS routes are located) using standardized point-count methods. Comparing trends at multiple spatial scales provide 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 12 (BCR 12) and BBS survey-wide (North America; Table 10).

Appendix C describes 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 2018 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, 2008–2018. 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 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
Canada Warbler	0.16	0.2	0.22	0.3	0.3	0.34	0.39	0.4	0.44	0.46	0.48	0.52	0.52	0.43	0.52	0.56	0.55	0.53	0.55	0.55	0.56	0.6	0.56	0.59
Common Loon	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	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	0.4	0.3
Connecticut Warbler	1.0	1.0	0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1
Golden-winged Warbler	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6
Olive-sided Flycatcher	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.0
Purple Finch	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Veery	1.3	1.4	1.4	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	1.7	1.9	2.0	1.9	1.9	1.9	1.9	1.9	1.9
Winter Wren	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.4
Wood Thrush	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
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
Black-billed Cuckoo	0.0	0.0	0.1	0.3	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.0	-0.1
Black-throated Blue Warbler	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.4
Canada Warbler	0.52	0.53	0.57	0.58	0.6	0.6	0.61	0.64	0.65	0.68	0.67	0.68	0.66	0.66	0.64	0.63	0.62	0.63	0.61	0.6	0.61	0.6	0.55	0.57
Cape May Warbler	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	0.4	0.4	0.4	0.5	0.5	0.5	0.5
Common Loon	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	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	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Golden-winged Warbler	0.2	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.4
Olive-sided Flycatcher	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
Purple Finch	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
Veery	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Winter Wren	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	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	0.6	0.6	0.5
Wood Thrush	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.2

Figure 3. Estimated annual indices from 1995-2018 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
Coniferous forest species	2.2	2.3	2.6	2.8	2.7	2.7	2.9	2.9	3.0	3.0	3.1	3.1	3.2	3.3	3.1	3.5	3.0	3.0	2.8	2.9	2.8	2.8	2.7	2.7
Deciduous forest species	11.7	12.5	12.7	13.0	14.3	14.9	15.5	16.0	16.5	16.8	16.8	16.9	16.6	16.5	15.8	14.8	15.5	15.8	14.9	14.7	14.6	14.3	14.2	13.9
Early-successional species	3.6	4.0	4.1	4.4	4.5	4.6	4.7	4.9	5.1	5.1	5.0	5.0	4.8	4.8	4.6	4.5	4.5	4.3	4.4	4.2	4.2	4.2	4.1	4.1
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	3.0	3.0	2.9	2.9
Mixed forest species	2.2	2.3	2.5	2.6	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.2	3.2	3.2	3.5	3.1	3.1	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
Long-distance migrants	16.8	17.9	18.3	19.0	20.2	20.8	21.4	22.1	22.6	23.0	23.0	23.1	22.8	22.6	21.9	21.3	21.4	21.4	20.7	20.5	20.3	20.0	19.8	19.5
Permanent residents	1.7	1.8	2.0	2.3	2.3	2.4	2.5	2.7	2.8	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
Short-distance migrants	6.7	6.9	7.6	8.2	7.9	8.1	8.4	8.6	8.9	9.0	9.0	8.8	8.7	8.4	8.5	8.5	7.8	7.5	7.4	7.2	6.9	6.7	6.4	6.2
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
Canopy nesting species	4.7	5.1	5.4	5.8	5.7	5.8	6.0	6.2	6.3	6.4	6.4	6.4	6.3	6.4	6.1	6.5	5.9	5.9	5.7	5.7	5.6	5.5	5.4	5.4
Cavity nesting species	1.4	1.5	1.7	1.8	2.0	2.1	2.2	2.4	2.5	2.6	2.6	2.7	2.7	2.7	2.6	2.5	2.5	2.6	2.5	2.5	2.4	2.4	2.4	2.4
Ground nesting species	10.5	11.0	11.6	12.4	12.4	12.6	13.0	13.5	14.0	14.2	14.3	14.3	14.3	13.8	14.3	13.8	13.7	13.4	13.4	13.2	13.1	12.9	12.6	12.5
Shrub nesting species	8.4	9.0	9.1	9.4	10.2	10.6	10.9	11.1	11.4	11.5	11.4	11.3	11.0	10.9	10.1	9.8	9.8	9.7	9.2	8.9	8.7	8.6	8.3	8.1
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
Coniferous forest species	2.6	2.7	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.5	3.4	3.6	3.6	3.6	3.7	3.7	3.5	3.5	3.5	3.4	3.4	3.3	3.4	3.2
Deciduous forest species	10.4	10.8	11.3	11.5	12.0	12.4	12.7	12.9	13.2	13.3	13.3	13.2	12.8	12.4	12.2	11.8	11.6	11.3	11.1	10.9	10.6	10.3	9.9	9.9
Early-successional species	4.8	5.1	5.2	5.4	5.5	5.8	6.0	6.1	6.3	6.5	6.4	6.3	6.1	6.1	5.9	5.7	5.4	5.1	5.0	4.7	4.6	4.4	4.2	3.8
Lowland-conifer species	3.9	4.1	4.3	4.5	4.5	4.6	4.7	4.9	5.1	5.2	5.1	5.1	5.2	5.2	5.1	5.1	5.0	4.9	4.9	4.8	4.7	4.6	4.8	4.4
Mixed forest species	2.3	2.4	2.5	2.5	2.6	2.7	2.7	2.8	2.9	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.8	2.8	2.7	2.6	2.5	2.5	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
Long-distance migrants	17.5	18.2	18.8	19.2	19.8	20.4	20.8	21.3	21.7	22.0	21.8	21.7	21.3	20.9	20.5	20.0	19.7	19.2	19.0	18.6	18.3	17.9	17.6	17.1
Permanent residents	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.7	2.8	2.9	2.9	3.0	3.0	3.0	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4
Short-distance migrants	6.8	7.1	7.3	7.6	7.8	8.1	8.4	8.6	8.9	9.1	9.1	9.1	9.1	9.1	8.9	8.7	8.3	8.0	7.7	7.4	7.1	6.7	6.6	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
Canopy nesting species	3.8	4.0	4.1	4.3	4.3	4.5	4.6	4.7	4.9	5.1	5.0	5.2	5.2	5.3	5.3	5.3	5.1	5.1	5.0	4.9	4.8	4.8	4.7	4.5
Cavity nesting species	1.2	1.3	1.4	1.5	1.7	1.8	1.9	2.1	2.2	2.2	2.3	2.3	2.3	2.3	2.2	2.1	2.0	2.0	1.9	1.8	1.7	1.6	1.5	1.5
Ground nesting species	13.8	14.4	14.7	15.2	15.6	16.1	16.4	16.8	17.2	17.4	17.3	17.3	17.0	16.8	16.5	16.2	15.8	15.3	15.1	14.7	14.4	14.0	13.8	13.2
Shrub nesting species	7.2	7.5	7.8	8.0	8.3	8.6	8.8	9.0	9.2	9.4	9.2	9.1	8.8	8.6	8.4	8.1	7.8	7.6	7.4	7.2	7.0	6.7	6.6	6.2

Figure 4. Estimated annual indices from 1995-2018 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-seven species were tested this year for Chippewa NF, of these 15 species (22%) had significantly increasing trends (Table 2; Table 3), 15 species (22%) had significantly declining trends (Table 4), and 37 species had non-significant trend indices (see Table 5; Appendix A).

Increasing Species. Three species, Lincoln’s Sparrow, Ruby-throated Hummingbird, and Wood Thrush showed new significantly increasing trends in 2018. Cedar Waxwing was the only species that changed from significantly increasing to non-significant in 2018. Importantly, three species of conservation concern showed significantly increasing trends in Chippewa NF; Canada Warbler, Veery, and Wood Thrush.

Canada Warblers inhabit a wide range of deciduous and coniferous forests but are most common in mixed coniferous-deciduous forests that are moist and have well-developed understory shrub layers (Reitsma et al. 2010; Grinde and Niemi 2016). This species is positively associated with natural disturbances such as wind or tree-fall gaps and outbreaks of invasive insects such as the eastern spruce budworm (*Choristoneura fumiferana*; Crawford and Jennings 1989, Hagan and Grove 1999, Mitchell 1999, Faccio 2003). Chippewa NF is at the southern edge of the Canada Warbler’s breeding range, and thus they are not widespread throughout the forest (n = 24; Appendix A). Observations of the species vary annually but we expect 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 –2.05% population decline nationally and –2.57% in BCR 12 since 1966 (Sauer et al. 2017; 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 and Wood Thrush are designated as Species in Greatest Conservation Need (SGCN) by the Minnesota Department of Natural Resources (MNDNR; MNDNR 2015). Wood Thrush have experienced widespread population decline and were listed by the MNDNR as a SGCN due to habitat loss and habitat degradation. BBS population trends show a -1.91% decline at the national scale and -3.39% in BCR 12 since 1966 (Sauer et al. 2017; Table 10). Wood Thrush is associated with deciduous and mixed forests, showing a strong preference for mature mesic uplands. Chippewa NF's abundance of large, mature hardwood stands are likely important (and will increase in importance) for Wood Thrush in the state. Veery were listed as SGCN by the MNDNR because this species has shown long-term population declines (Sauer et al. 2017; Figure 3; Table 10) and six percent of the total population breeds in Minnesota, which is the highest of any U.S. state (Pfanmuller 2012). Veery breed in a variety of cover types, however forest stands with a well-developed understory of shrubs and small trees is a common feature and research also suggests this species is sensitive to fragmentation (Robbins et al. 1989; Blake 1991). Veery will likely benefit from sustainable forest management that promotes larger forest stands and well-developed understories.

Decreasing Species. Three species; Downy Woodpecker, Alder Flycatcher, and Blue-headed Vireo showed new significantly decreasing trends this year (Appendix A; Table 6). Two species have shown significantly decreasing trends for at least 7 years through 2018; Connecticut Warbler and Song Sparrow. Chipping Sparrow, Least Flycatcher, and Winter Wren have had declining trends for 5 years, American Robin had a declining trend for the past 4 years, and Eastern Wood-Pewee has had a declining trend for 3 years. Olive-sided Flycatcher, Red-eyed Vireo, Brown-headed Cowbird, Common Yellowthroat, and Scarlet Tanager have been declining for the past 2 years. Three of these species are designated as SGCN: 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. A total of 1,225 individuals of 76 species from all observations using unlimited distance counts were detected from the 25 additional Golden-winged Warbler stands (75 points) that were added in 2016. The most abundant species (mean observations/point) were Veery (1.8), Red-eyed Vireo (1.6), Common Yellowthroat (1.4), Nashville Warbler (1.3), and Ovenbird (1.1; Table 7). Thirty-eight species (50%) had 5 or fewer observations. Golden-winged Warbler was the 20th most abundant species. A total of 15 Golden-winged Warblers were detected (an average of 0.6 bird per stand). Golden-winged Warblers were detected at 19% of the points surveyed (14/75 points) and at 40% of the stands surveyed (10/25 stands; Table 7).

Superior NF Trends

Sixty-five species were tested for trends in 2018 in Superior NF, of these 15 species (23%) had significantly increasing trends (Table 2; Table 3), 19 species (29%) had significantly decreasing trends (Table 4), and 31 species had non-significant trend indices (but see Table 5).

Increasing Species. Northern Waterthrush and Ruffed Grouse showed new significantly increasing trends in 2018. Notably, two species designated as SGCN (MNDNR 2015) show significantly increasing trends in Superior NF; Cape May Warbler and Purple Finch.

Cape May Warbler was listed as a SGCN due to steep population declines throughout their range (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 -2.51% decline at the national scale but have been relatively stable (-0.15%) in BCR 12 (Sauer et al. 2017;

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, thus 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.

Purple Finch have experienced a statistically valid decline documented by the BBS that indicate a -1.23% decline at the national scale and -1.87% decline in BCR 12 since 1966 (Sauer et al. 2017; 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. Six species showed new significantly decreasing trends this year in Superior NF; Common Raven, Common Yellowthroat, Magnolia Warbler, Rose-breasted Grosbeak, Winter Wren and Veery (Appendix A; Table 6). Common Loon, Connecticut Warbler, Swainson's thrush, and Yellow-bellied Flycatcher have shown declining trends for the last 7 years. American Crow, Chipping Sparrow, Downy Woodpecker, Mourning Warbler, and Red-eyed Vireo have been declining for 5 years, Hermit Thrush has declined for the last 4 years, and Song Sparrow and Chestnut-sided Warbler have been declining for 2 years. Winter Wren was significantly declining in 2016, returned to a non-significant trend in 2017, but has returned to a significant decline in 2018.

Four of these species are designated as SGCN; Common Loon, Connecticut Warbler, Veery, 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. Veery indices have been consistently declining in Superior NF over time (Figure 3; Appendix A). This species is commonly found in regenerating stands that have a well-developed understory of shrubs and small trees (Pfanmuller et al. 2017). This suggests the decline in aspen harvests that have occurred in forests may be associated with declines in the population (Niemi et al. 2016). Conservation considerations for Connecticut Warbler and Winter Wren are summarized below in the "Regional Trends" section.

Lowland-conifer Forest Stands. We completed a separate trend analysis for lowland conifer stands in the Superior NF from 2008 to 2018 (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. Nineteen species that are associated with conifer or lowland-conifer for breeding habitat were included in the analysis. Not surprisingly, 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, Tennessee Warbler, and Yellow-bellied Flycatcher were significantly increasing while Common Raven and Winter Wren had trends that were significantly decreasing in lowland-conifer forests from 2008 to 2018 (Table 8; Appendix B).

Regional Trends- Pooled National Forests

We calculated a regional trend that combines data from both Chippewa and Superior NFs for 55 species in 2018. Fourteen species (25%) were increasing significantly (Table 2) and 18 species (33%) were decreasing significantly (Table 4).

Increasing Species. All 12 species that had increasing regional trends in 2017 were significant in 2018. Additionally, new region-wide increases were detected in American Redstart and Northern Waterthrush (Table 6).

Decreasing Species. New regional declines were identified in Blue-headed Vireo and White-throated Sparrow. Additional species that had continued regional declines included American Crow, Chestnut-sided Warbler, Chipping Sparrow, Common Loon, Common Yellowthroat, Connecticut Warbler, Downy Woodpecker, Eastern Wood-Pewee, Hermit Thrush, Mourning Warbler, Olive-sided Flycatcher, Red-eyed Vireo, Scarlet Tanager, Song Sparrow, Winter Wren, and Yellow-bellied Flycatcher. 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 one of the most consistent declines of any species in the monitoring program and this year reached a new and disappointing low: for the first time in 24 years of monitoring, no Connecticut Warblers were detected (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 shrub understory of Labrador tea and swamp laurel is also a frequent habitat characteristic (Pfanmuller et al. 2017). The restricted breeding range and specific habitat requirements coupled with a small and declining population led to multiple conservation designations by multiple agencies. 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 the stressors for the species that lead to their designation of SGCN (MNDNR 2015). Connecticut Warbler is also designated a Sensitive Species on both the Chippewa and Superior National Forests (U.S. Forest Service 2012).

Connecticut Warblers have experienced statistically valid declines at all spatial scales including -8.01% in Chippewa NF, -7.04% in Superior NF, -7.80% in regional trend estimates, and BBS trends that indicate a -2.86% decline in BCR 12 and a -1.93% decline at the national scale (Sauer et al. 2017; 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 Flycatchers have 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 its long-term population declines, have led to the classification as a Yellow Watch species by PIF to prevent further declines (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 National Forests (U.S. Forest Service 2012).

In Chippewa NF Olive-sided Flycatchers have shown a significantly valid decline of -5.15%, trends in Superior NF are not statistically significant ($P = 0.06$) but show a similar result (-2.77%), regional trend estimates indicate a statistically significant -4.51% decline, and BBS trends show a -4.77% decline in BCR

12 and a -3.10% decline at the national scale (Sauer et al. 2017; 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, because of its low numbers and remote breeding habitat, few studies have identified best management practices critical for maintaining populations. Recommendations generally focus on protecting existing sites that provide suitable habitat, retaining snags and tall trees in harvested stands, and insuring 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 (MNDP 2015). Significant decreasing population trends were detected in Chippewa NF (-2.49%), Superior NF (-0.66%), and regionally (-1.25%) in 2018. However, BBS population trends are relatively stable in BCR 12 (0.30) and nationally (0.23; Sauer et al. 2017; Figure 3; Table 10). Winter Wren uses a variety of forest cover types including a strong preference for mixed swamp conifer stands, lowland hardwood, black spruce-tamarack, and upland aspen-spruce-fir stands. Common features of occupied habitats includes 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, nest 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 (1.17%) in BCR 12 (Sauer et al. 2017; Figure 3; Table 10). We suggest referring to the results of 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.

Guild Analyses

At both the NF and regional scale nearly all migratory, nesting, and habitat association guilds showed significant increases from 1995 to 2018 (Table 9). However, species associated with early-successional forests and shrub/sub-canopy nesting species 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 (-0.57%) and regionally (-0.47%). Long-distance migrants showed significant declines (-0.03%) in Superior NF, but also displayed a significant positive trend in Chippewa NF (0.29%; Figure 4, Table 9). Permanent residents continue to show the greatest overall percentage increase over the past 24 years with an increase of 1.01% 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 2018 including Chipping Sparrow, Mourning Warbler, Chestnut-sided Warbler, and Song Sparrow. Regional decreasing trends were significant for four species that are highly associated with early-successional forests: Chestnut-sided Warbler, Mourning Warbler, Song Sparrow, and White-throated Sparrow. Trends for these species are consistent with national BBS trends (Sauer et al. 2017; Table 10). These results are likely due to the reduction in logging that has occurred in these two NFs over the past 18 years as documented in Niemi et al. (2016, p. 48–52).

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. The most important habitat features are a combination of ground vegetation, shrubs, and scattered trees. These features are often characteristic of young aspen forests, brushy clearcuts, shrubby lowlands and overgrown farmlands. In Minnesota, most birds of this species have been observed in alder-willow wetlands and young aspen forests (Niemi et al. 2016).

Range-wide Golden-winged Warbler populations have declined an average of 2.28% per year from 1966 through 2015 (Sauer et al. 2017; Table 10). This decline is most notable in the eastern populations, such as New York (5.1% decline per year), Pennsylvania (6.7% decline per year), and the Appalachian Mountains (8.4% decline per year). Loss of young forest habitat is considered a major threat in this eastern region. Guidelines for managing breeding habitat were developed by the Golden-winged Warbler Working Group (2013) and identified north-central Minnesota as a focal area for habitat management. The guidelines emphasize the importance of establishing patches of habitat that have interspersed clumps of shrubs and/or saplings, an open canopy, and adjacency to mature forest stands.

Currently, over 50% of 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 (0.05) and Superior (1.23) NFs. Importantly, trend estimates have been increasing in Chippewa NF since 2014, this is likely a result of active habitat management that has occurred in the forest during this time period (Figure 3). Continued conservation actions should focus on maintaining suitable young forest habitat and ensuring the protection of wet lowland shrub habitat.

Aerial Insectivores. Four of the five forest-associated flycatchers (Olive-sided Flycatcher, Yellow-bellied Flycatcher, Least Flycatcher, and Eastern Wood-Pewee) have been declining either regionally or in at least one NF. The fifth forest-associated flycatcher (Great Crested Flycatcher) is nearing a significant decline ($P = 0.06$) 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. 2017; 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.

CONCLUSIONS

There are several possible hypotheses as to why so many species seem to be stable or increasing in relative abundance over the past 24 years. First, and most apparent, logging activity has steadily decreased in both the Chippewa and Superior NFs over the past ten years, primarily due to factors that have contributed to reduced demand for lumber, paper, and other forest products. This has led to several

potentially important changes to the age structure of forests. Over the period 1977–2012, northeastern Minnesota saw an increase in the proportion of forest that is greater than 60 years old and a concurrent decrease in mid-successional forests of 41–60 years old (MFRC 2013). Aspen forests provide an excellent example of how this structural diversity develops; stands >60 years old have 2–3 times higher natural mortality than those that are 41–60 years old (MFRC 2013), thus providing a variety of habitat elements from snags that increase nest-cavities to tree-fall gaps that create shrubby growth utilized by many species.

Silvicultural practices have also changed over the last two decades. Although about 70% of harvesting is completed through clear-cutting, this has steadily decreased from 1991 to 2008 with selection harvesting, thinning, and patch clear-cuts being utilized more often (D’Amato et al. 2009). Over the same period, there has been a nearly two-fold increase in the number of clear-cuts that incorporate leave trees (44% in 1991 to 80% in 2008) (D’Amato et al. 2009). With logging providing the most significant disturbance in these NFs, changes in practice have a variety of effects on both local and regional populations of birds. This is especially true if modifications (e.g., leaving standing timber and snags in clear-cuts) mimic disturbance features that these species evolved to utilize. Changing age-class structure and silvicultural practices might better represent the natural fire disturbance regime that once dominated these forests (Heinselman 1973; Niemi et al. 1998, 2016) and to which most of these bird species certainly respond.

Despite increasing mature forest cover, several species that are decreasing breed primarily in mid-to-late-successional forests including the Connecticut Warbler, Hermit Thrush, Swainson’s Thrush, and Yellow-bellied Flycatcher. For each, there are potential reasons for these trends. First, these species have primarily boreal distributions and are at or near the southern edge of their breeding range in these NFs. This is where we might expect initial declines to be most evident, especially if changing climatological factors are influencing these species’ populations. For example, Langham et al. (2015) predicts large-scale shifts northward due to climate changes by the year 2080. Additionally, these species are all associated with coniferous and, especially, lowland coniferous forests, which have different logging and management pressures than upland deciduous forests. These species also share similar food types and foraging-space in dense, shrubby growth near the ground (Jones and Donovan 1996; Pitocchelli et al. 1997; Evans Mack and Yong 2000; Gross and Lowther 2001).

The overall message in this report is positive regarding breeding forest birds in the Chippewa and Superior NFs. Although there is evidence of positive trends in forest-cover across the region (5.5% in last 35 years; MFRC 2013), from a historical perspective, most of these forest-associated breeding species likely have much lower populations today than in the past due to habitat loss. For example, Minnesota has lost almost half of its forest area from 31 million acres in the mid-1800s to less than 17 million acres today. These rates of forest loss are conservative relative to other U.S. states and in over-wintering habitats of Mexico and in Central and South America. Maintaining adequate forested habitat across these species’ ranges and identifying the factors influencing their populations will be a major challenge for many generations to come.

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TABLES

Table 1. Trends for two National Forests (NF) and pooled NFs based on linear regression of loess-smoothed annual index of abundance (See Methods) (1995–2018). 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	ns	I*
American Robin	D**	ns	ns
Black-and-white Warbler	I**	I**	I**
Black-billed Cuckoo	-	ns	-
Black-capped Chickadee	ns	ns	ns
Black-throated Blue Warbler	-	ns	-
Black-throated Green Warbler	I**	I**	I**
Blackburnian Warbler	ns	ns	ns
Blue-headed Vireo	D*	ns	D*
Blue Jay	I**	I**	I**
Broad-winged Hawk	-	D*	-
Brown-headed Cowbird	D*	-	-
Brown Creeper	ns	ns	ns
Canada Jay	ns	ns	ns
Canada Warbler	I**	ns	ns
Cape May Warbler	-	I**	-
Cedar Waxwing	ns	ns	I*

Species	Chippewa NF	Superior NF	Regional
Chestnut-sided Warbler	ns	D**	D**
Chipping Sparrow	D**	D**	D**
Common Loon	ns	D**	D**
Common Raven	ns	D*	ns
Common Yellowthroat	D**	D*	D**
Connecticut Warbler	D**	D**	D**
Dark-eyed Junco (Slate-colored)	ns	-	-
Downy Woodpecker	D*	D*	D**
Eastern Towhee	ns	-	-
Eastern Wood-Pewee	D*	ns	D*
Evening Grosbeak	-	ns	-
Golden-crowned Kinglet	ns	I**	ns
Golden-winged Warbler	ns	ns	ns
Gray Catbird	ns	-	-
Great Crested Flycatcher	ns	-	-
Hairy Woodpecker	ns	ns	ns
Hermit Thrush	ns	D**	D**
Indigo Bunting	ns	-	-
Least Flycatcher	D**	ns	ns
Lincoln's Sparrow	I**	ns	ns
Magnolia Warbler	ns	D*	ns
Mourning Dove	I*	-	-
Mourning Warbler	ns	D**	D**
Nashville Warbler	I**	I**	I**
Northern Flicker (Yellow-shafted)	ns	ns	ns

Species	Chippewa NF	Superior NF	Regional
Northern Parula	ns	I**	I**
Northern Waterthrush	ns	I*	I*
Olive-sided Flycatcher	D**	ns	D**
Ovenbird	I**	ns	I**
Palm Warbler (Western)	ns	-	-
Pileated Woodpecker	I**	ns	I*
Pine Warbler	I**	I**	I**
Purple Finch	ns	I*	ns
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**	-
Ruby-throated Hummingbird	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**	-
Veery	I**	D*	ns
White-breasted Nuthatch	ns	-	-
White-throated Sparrow	ns	ns	D*
Wilson's Snipe	ns	ns	ns
Winter Wren	D**	D*	D**

Species	Chippewa NF	Superior NF	Regional
Wood Thrush	I*	ns	ns
Yellow-bellied Flycatcher	ns	D**	D*
Yellow-bellied Sapsucker	I**	ns	I*
Yellow-rumped Warbler (Myrtle)	ns	I**	I**
Yellow-throated Vireo	ns	-	-
Yellow Warbler	ns	-	-

Table 2. Species with significantly increasing trends ($P \leq 0.05$) for two national forests and region-wide (1995–2018), 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**	Black-and-white Warbler**	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**	Golden-crowned Kinglet**	Cedar Waxwing*
Mourning Dove*	Nashville Warbler**	Nashville Warbler**
Nashville Warbler**	Northern Parula**	Northern Parula**
Ovenbird**	Northern Waterthrush*	Northern Waterthrush*
Pileated Woodpecker**	Pine Warbler**	Ovenbird**
Pine Warbler**	Purple Finch*	Pileated Woodpecker*
Red-breasted Nuthatch**	Red-breasted Nuthatch**	Pine Warbler**
Ruby-throated Hummingbird*	Ruby-crowned Kinglet**	Red-breasted Nuthatch**
Veery**	Ruffed Grouse*	Yellow-bellied Sapsucker*
Wood Thrush*	Tennessee Warbler**	Yellow-rumped Warbler (Myrtle)**
Yellow-bellied Sapsucker**	Yellow-rumped Warbler (Myrtle)**	

Table 3. Summary of species with increasing trends ($P \leq 0.05$) on two national forests (1995–2018). Individual species graphs can be found in Appendix A.

Increased in one NF	Increased in both NFs
Canada Warbler	Black-and-white Warbler
Cape May Warbler	Black-throated Green Warbler
Golden-crowned Kinglet	Blue Jay
Lincoln's Sparrow	Nashville Warbler
Mourning Dove	Pine Warbler
Northern Parula	Red-breasted Nuthatch
Northern Waterthrush	
Ovenbird	
Pileated Woodpecker	
Purple Finch	
Ruby-crowned Kinglet	
Ruby-throated Hummingbird	
Ruffed Grouse	
Tennessee Warbler	
Veery	
Wood Thrush	
Yellow-bellied Sapsucker	
Yellow-rumped Warbler (Myrtle)	

Table 4. Species with significantly decreasing trends ($p < 0.05$) for two national forests (1995–2018), 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**	Broad-winged Hawk*	Blue-headed Vireo*
Blue-headed Vireo*	Chestnut-sided Warbler**	Chestnut-sided Warbler**
Brown-headed Cowbird*	Chipping Sparrow**	Chipping Sparrow**
Chipping Sparrow**	Common Loon**	Common Loon**
Common Yellowthroat**	Common Raven*	Common Yellowthroat**
Connecticut Warbler**	Common Yellowthroat*	Connecticut Warbler**
Downy Woodpecker*	Connecticut Warbler**	Downy Woodpecker**
Eastern Wood-Pewee*	Downy Woodpecker*	Eastern Wood-Pewee*
Least Flycatcher**	Hermit Thrush**	Hermit Thrush**
Olive-sided Flycatcher**	Magnolia Warbler*	Mourning Warbler**
Red-eyed Vireo*	Mourning Warbler**	Olive-sided Flycatcher**
Scarlet Tanager**	Red-eyed Vireo**	Red-eyed Vireo**
Song Sparrow**	Rose-breasted Grosbeak*	Scarlet Tanager**
Winter Wren**	Song Sparrow**	Song Sparrow**
	Swainson's Thrush**	White-throated Sparrow*
	Veery*	Winter Wren**
	Winter Wren*	Yellow-bellied Flycatcher*
	Yellow-bellied Flycatcher**	

Table 5. Species with marginally significant trends ($0.05 < P \leq 0.10$) for two national forests and region-wide (1995–2018), 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
Golden-crowned Kinglet (-)	Black-billed Cuckoo (-)	Least Flycatcher (-)
Great Crested Flycatcher (-)	Olive-sided Flycatcher (-)	Magnolia Warbler (-)
Indigo Bunting (-)	Ovenbird (-)	Red-winged Blackbird (-)
	White-throated Sparrow (-)	Swamp Sparrow (-)

Table 6. Species with changes in trend significance from 2017 to 2018. Changes were either in a positive direction, from decreasing (2017) to non-significant (2018) or non-significant to increasing, or in a negative direction, from increasing to non-significant or non-significant to decreasing. The specific National Forest 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
	American Redstart, Regional Lincoln’s Sparrow, Chippewa Northern Waterthrush, Regional Northern Waterthrush, Superior Ruby-throated Hummingbird, Chippewa Ruffed Grouse, Superior Wood Thrush, Chippewa	Cedar Waxwing, Chippewa	Alder Flycatcher, Chippewa Blue-headed Vireo, Chippewa Blue-headed Vireo, Regional Common Raven, Superior Common Yellowthroat, Superior Downy Woodpecker, Chippewa Magnolia Warbler, Superior Rose-breasted Grosbeak, Superior Veery, Superior White-throated Sparrow, Regional Winter Wren, Superior

Table 7. Summary of the 20 most common species in 2018 from 24 stands (72 points) first added to the Chippewa National Forest 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	25	0.3	27	1	56
American Crow	34	0.5	28	1.4	40
American Redstart	30	0.4	28	1.2	64
American Robin	17	0.2	17	0.7	36
Black-and-white Warbler	26	0.3	35	1	52
Black-capped Chickadee	16	0.2	17	0.6	44
Blue Jay	33	0.4	36	1.3	76
Cedar Waxwing	16	0.2	19	0.6	48
Chestnut-sided Warbler	63	0.8	48	2.5	84
Common Yellowthroat	108	1.4	77	4.3	100
Golden-winged Warbler	15	0.2	19	0.6	40
Nashville Warbler	95	1.3	61	3.8	84
Ovenbird	80	1.1	61	3.2	84
Red-eyed Vireo	117	1.6	76	4.7	96
Rose-breasted Grosbeak	25	0.3	25	1	44
Sedge Wren	22	0.3	17	0.9	28
Swamp Sparrow	56	0.7	45	2.2	64
Veery	138	1.8	83	5.5	96
White-throated Sparrow	65	0.9	49	2.6	76
Yellow-bellied Sapsucker	17	0.2	20	0.7	44

Table 8. Population trend estimates (% annual change) and associated test statistics for lowland-conifer forests in the Superior National Forest (2008–2018). 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	Superior			
	Trend (%)	<i>P</i>	<i>r</i> ²	<i>n</i>
Blackburnian Warbler	-1.40	0.50	0.11	21
Blue-headed Vireo	-6.28	0.20	0.65	14
Canada Jay	-12.61	0.20	0.92	5
Cape May Warbler	24.93	<0.01	0.95	7
Chipping Sparrow	-1.44	0.82	0.10	7
Common Raven	-14.09	<0.01	0.81	8
Dark-eyed Junco (Slate-colored)	24.04	<0.01	0.91	7
Golden-crowned Kinglet	-0.23	0.87	0.03	31
Magnolia Warbler	2.67	0.16	0.11	34
Nashville Warbler	0.43	0.57	0.04	42
Northern Parula	-3.20	0.30	0.46	17
Northern Waterthrush	-0.99	0.78	0.16	10
Red-breasted Nuthatch	-2.40	0.09	0.70	34
Ruby-crowned Kinglet	-0.95	0.60	0.05	29
Swainson's Thrush	-1.83	0.28	0.17	29
Tennessee Warbler	23.04	0.01	0.95	8
Winter Wren	-3.47	0.02	0.47	41
Yellow-bellied Flycatcher	4.44	<0.01	0.90	37
Yellow-rumped Warbler (Myrtle)	2.39	0.20	0.22	33

Table 9. Test statistics and sample sizes for guild trend analyses on two National Forests and a combined regional analysis (1995–2018). 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	0.50	0.02	0.12	124	0.87	<0.01	0.44	147	0.71	<0.01	0.28	271
Deciduous forest species	0.37	<0.01	0.07	126	-0.52	<0.01	0.15	147	-0.05	0.56	0.00	273
Early-successional species	-0.13	0.72	0.01	125	-0.95	<0.01	0.23	147	-0.61	0.01	0.14	272
Lowland-conifer species	0.35	0.12	0.18	120	0.42	<0.01	0.16	147	0.39	<0.01	0.18	267
Mixed forest species	0.77	<0.01	0.27	126	0.00	0.94	0.00	147	0.37	<0.01	0.09	273
Long-distance migrants	0.29	<0.01	0.06	126	-0.32	<0.01	0.08	147	-0.03	0.59	0.00	273
Permanent residents	1.19	<0.01	0.40	126	0.85	<0.01	0.20	147	1.01	<0.01	0.29	273
Short-distance migrants	-0.57	<0.01	0.13	126	-0.38	0.04	0.05	147	-0.47	<0.01	0.08	273
Canopy nesting species	0.11	0.47	0.01	126	0.77	<0.01	0.37	147	0.44	<0.01	0.15	273
Cavity nesting species	1.54	<0.01	0.47	126	0.41	0.09	0.03	147	1.01	<0.01	0.19	273
Ground nesting species	0.47	<0.01	0.17	126	-0.31	<0.01	0.07	147	0.00	0.99	0.00	273
Shrub nesting species	-0.54	<0.01	0.11	126	-0.82	<0.01	0.26	147	-0.67	<0.01	0.17	273

Table 10. Trend direction for 77 bird species with trend estimates in at least one National Forest. Breeding Bird Survey (BBS) trends in Bird Conservation Region 12 (BCR12) and BBS survey-wide (North America) are included for comparison. 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. National Forest trends are 1995 through 2018, while BBS trends are 1966 through 2015 (Sauer et al. 2017).

Common Name	Chippewa	Superior	Regional	BCR12	N America
Alder Flycatcher	-2.96	0.79	-0.32	0.15	-0.89
American Bittern		-1.40		-0.45	-0.52
American Crow	-0.19	-4.26	-1.18	0.64	0.07
American Goldfinch	1.72	0.83	1.43	-0.33	-0.17
American Redstart	0.86	1.00	0.95	-0.18	-0.28
American Robin	-1.88	0.34	-0.50	-0.23	0.12
Black-and-white Warbler	3.45	0.93	1.91	-0.60	-0.86
Black-billed Cuckoo		-3.80		-0.85	-1.62
Black-capped Chickadee	-0.28	-0.59	-0.41	1.79	0.61
Black-throated Blue Warbler		1.43		1.34	1.95
Black-throated Green Warbler	1.69	1.62	1.64	0.62	0.35
Blackburnian Warbler	0.72	-0.52	-0.12	0.56	0.35
Blue-headed Vireo	-1.70	-0.93	-1.33	3.57	2.86
Blue Jay	1.25	0.93	1.07	0.86	-0.66
Broad-winged Hawk		-7.52		0.48	1.02
Brown-headed Cowbird	-3.56			-5.10	-0.66
Brown Creeper	-0.60	-0.98	-0.77	3.37	0.55
Canada Jay	-0.79	-0.47	-0.58	-0.16	-0.32
Canada Warbler	3.81	0.17	0.66	-2.57	-2.05
Cape May Warbler		6.80		-0.15	-2.51
Cedar Waxwing	1.24	1.55	1.39	-0.90	0.07
Chestnut-sided Warbler	-0.29	-1.59	-1.01	-0.09	-1.15
Chipping Sparrow	-2.95	-3.54	-3.15	-0.72	-0.60
Common Loon	-0.49	-4.21	-1.55	1.17	0.66
Common Raven	-0.25	-1.48	-0.86	2.74	2.04
Common Yellowthroat	-1.36	-1.58	-1.43	-0.34	-1.01
Connecticut Warbler	-8.01	-7.04	-7.80	-2.86	-1.93
Dark-eyed Junco (Slate-colored)	5.95			-2.09	-1.38
Downy Woodpecker	-2.51	-8.38	-3.88	0.29	0.03
Eastern Towhee	-2.31			-2.20	-1.34
Eastern Wood-Pewee	-1.07	-1.58	-1.13	-1.45	-1.40
Evening Grosbeak		-5.51		-6.54	-6.36
Golden-crowned Kinglet	-2.02	1.47	0.66	0.51	-1.54
Golden-winged Warbler	0.05	1.23	0.36	-0.83	-2.28
Gray Catbird	-1.13			-1.57	-0.01
Great Crested Flycatcher	-1.82			-1.64	-0.03
Hairy Woodpecker	0.36	1.77	1.05	1.72	0.81

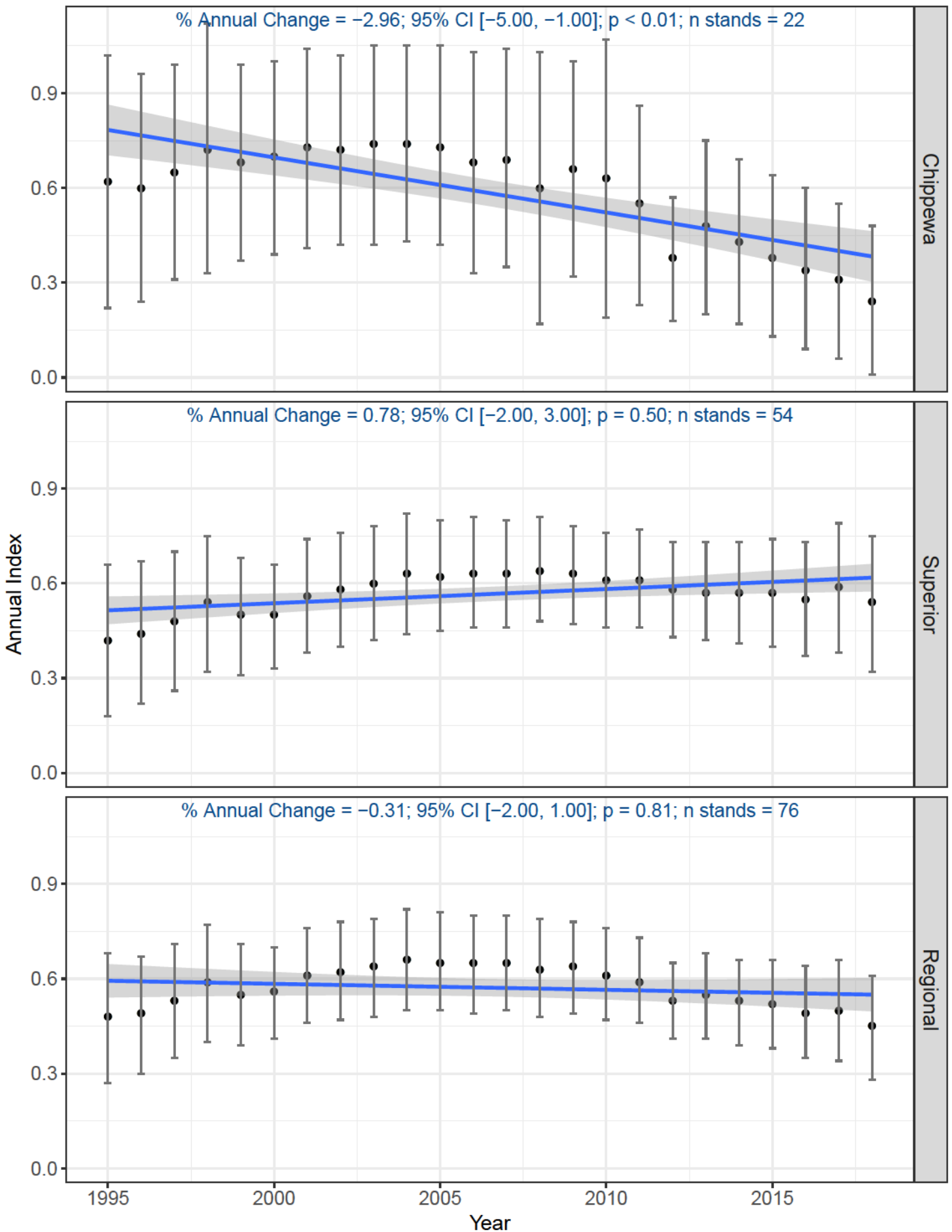
Common Name	Chippewa	Superior	Regional	BCR12	N America
Hermit Thrush	0.01	-1.70	-0.80	0.50	0.33
Indigo Bunting	-4.24			0.14	-0.73
Least Flycatcher	-1.77	0.49	-1.02	-2.20	-1.71
Lincoln's Sparrow	7.07	-3.58	4.00	-2.19	-0.36
Magnolia Warbler	-0.29	-0.83	-0.79	1.56	0.87
Mourning Dove	3.36			2.23	-0.29
Mourning Warbler	-0.07	-2.14	-1.50	-1.01	-1.18
Nashville Warbler	1.18	1.13	1.14	-0.02	0.01
Northern Flicker (Yellow-shafted)	1.25	-0.03	0.34	-0.85	-1.33
Northern Parula	1.03	1.54	1.37	4.63	1.11
Northern Waterthrush	1.81	2.36	2.06	-1.20	1.19
Olive-sided Flycatcher	-5.15	-2.77	-4.51	-4.77	-3.10
Ovenbird	1.42	-0.33	0.44	-0.11	-0.07
Palm Warbler (Western)	1.91			2.69	-1.78
Pileated Woodpecker	4.16	0.55	1.67	4.38	1.41
Pine Warbler	2.07	5.14	2.60	4.74	0.88
Purple Finch	-0.55	4.00	1.71	-1.87	-1.23
Red-breasted Nuthatch	4.34	3.03	3.63	2.73	0.72
Red-eyed Vireo	-0.40	-1.23	-0.75	0.83	0.75
Red-winged Blackbird	-1.59	-1.59	-1.57	-0.82	-0.93
Rose-breasted Grosbeak	0.25	-1.05	-0.50	-1.56	-0.86
Ruby-crowned Kinglet		7.06		-2.63	0.47
Ruby-throated Hummingbird	6.00			1.51	1.44
Ruffed Grouse		1.98		-0.17	0.29
Scarlet Tanager	-1.37	-1.20	-1.29	-1.24	-0.22
Song Sparrow	-5.54	-3.83	-4.81	-1.11	-0.76
Swainson's Thrush		-3.96		-0.93	-0.84
Swamp Sparrow	-2.00	-1.03	-1.74	1.13	0.93
Tennessee Warbler		10.20		-3.67	-1.03
Veery	1.11	-0.77	0.23	-1.48	-1.13
White-breasted Nuthatch	0.98			1.85	1.71
White-throated Sparrow	-0.33	-0.59	-0.51	-1.01	-0.93
Wilson's Snipe	3.22	-1.25	0.62	-1.53	0.25
Winter Wren	-2.49	-0.66	-1.25	0.30	0.23
Wood Thrush	3.45	-2.18	2.30	-3.39	-1.91
Yellow-bellied Flycatcher	1.27	-1.74	-0.98	0.52	2.26
Yellow-bellied Sapsucker	2.22	-0.58	0.88	2.30	1.10
Yellow-rumped Warbler (Myrtle)	0.23	1.74	1.11	0.31	-0.40
Yellow-throated Vireo	-0.70			1.71	0.98
Yellow Warbler	0.80			-1.02	-0.61

APPENDICES

Appendix A

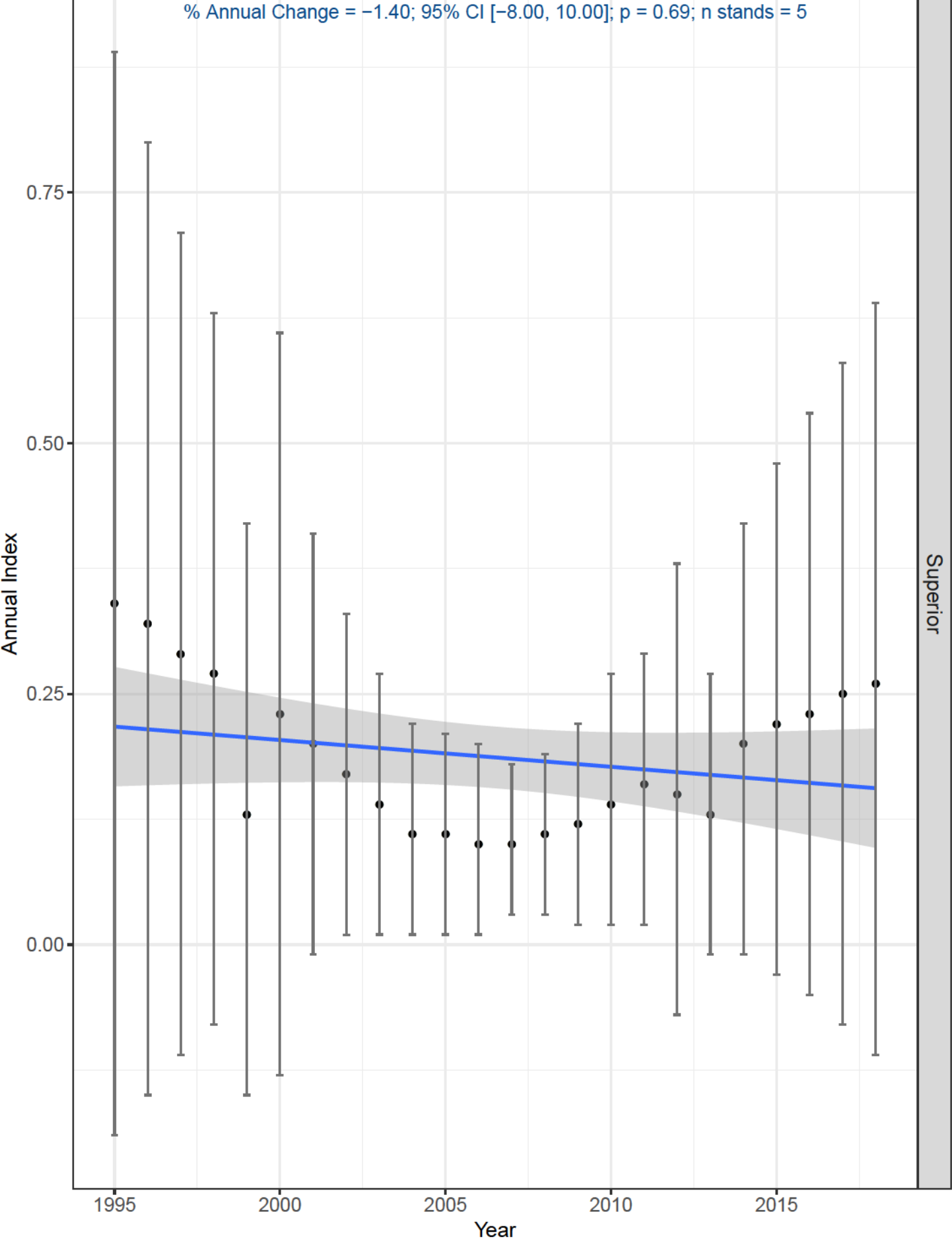
Population trend graphs of calculated annual index for individual species within the Chippewa and Superior NFs, and regionally over the 24 year time period (1995–2018) of the study.

Alder Flycatcher

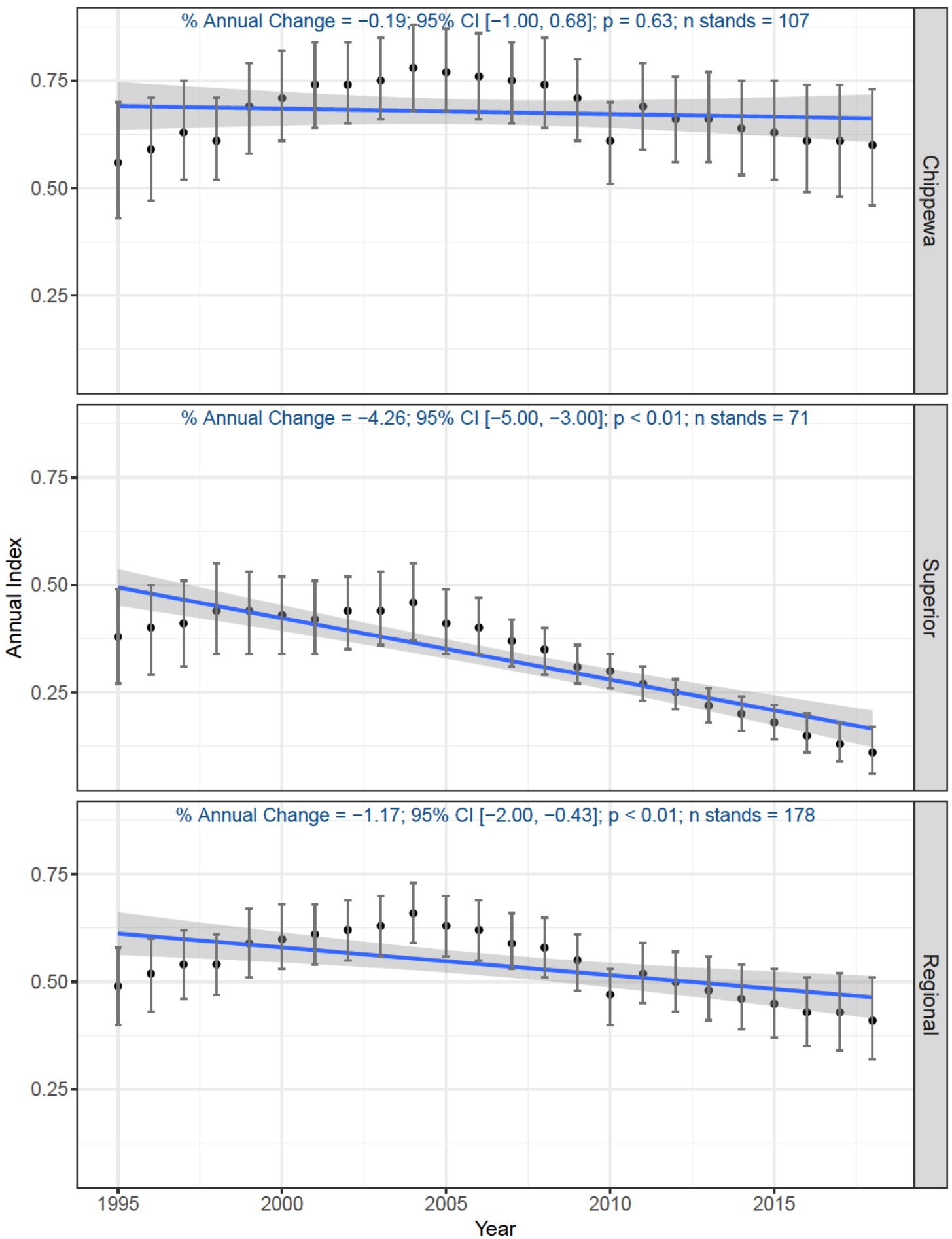


American Bittern

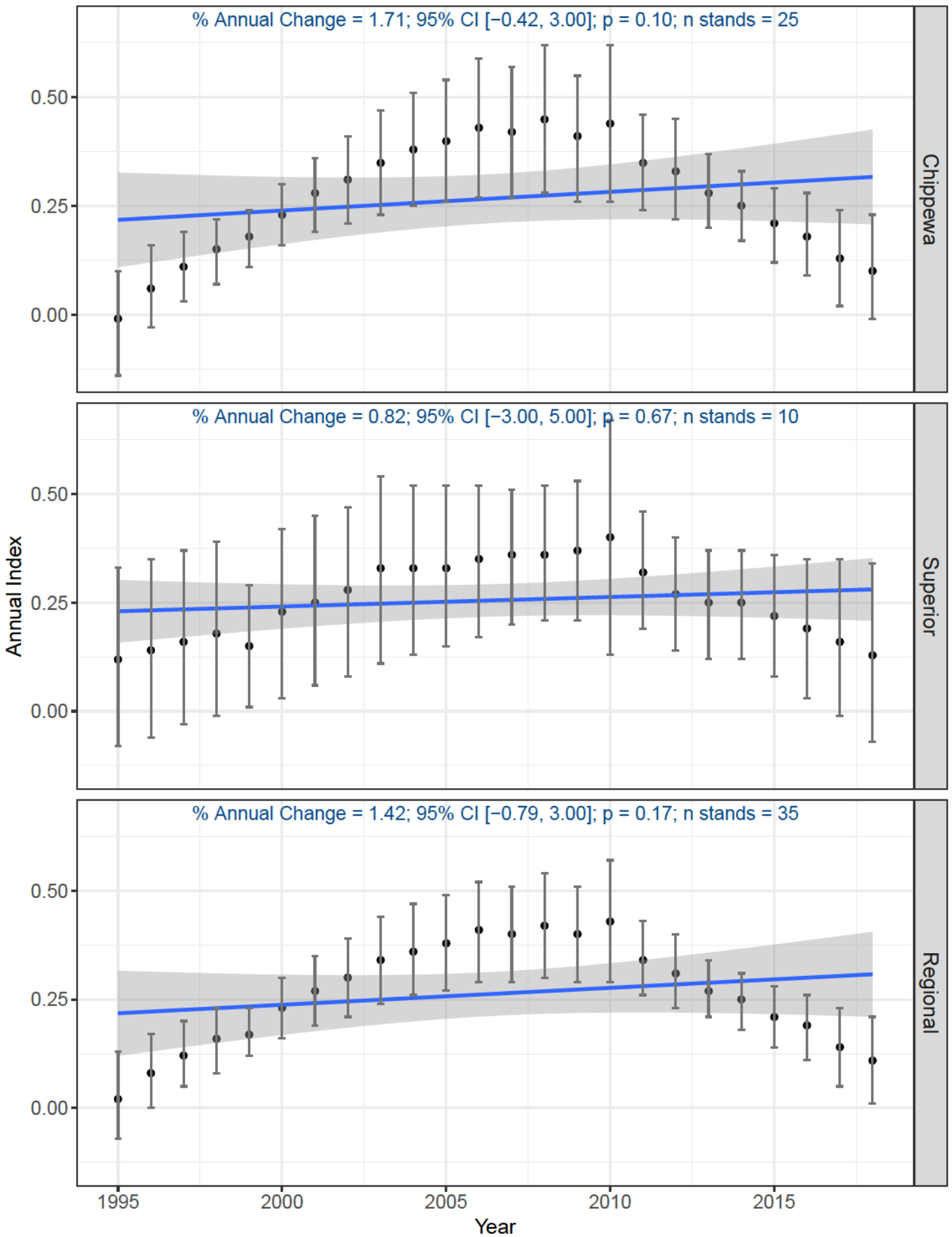
% Annual Change = -1.40; 95% CI [-8.00, 10.00]; p = 0.69; n stands = 5



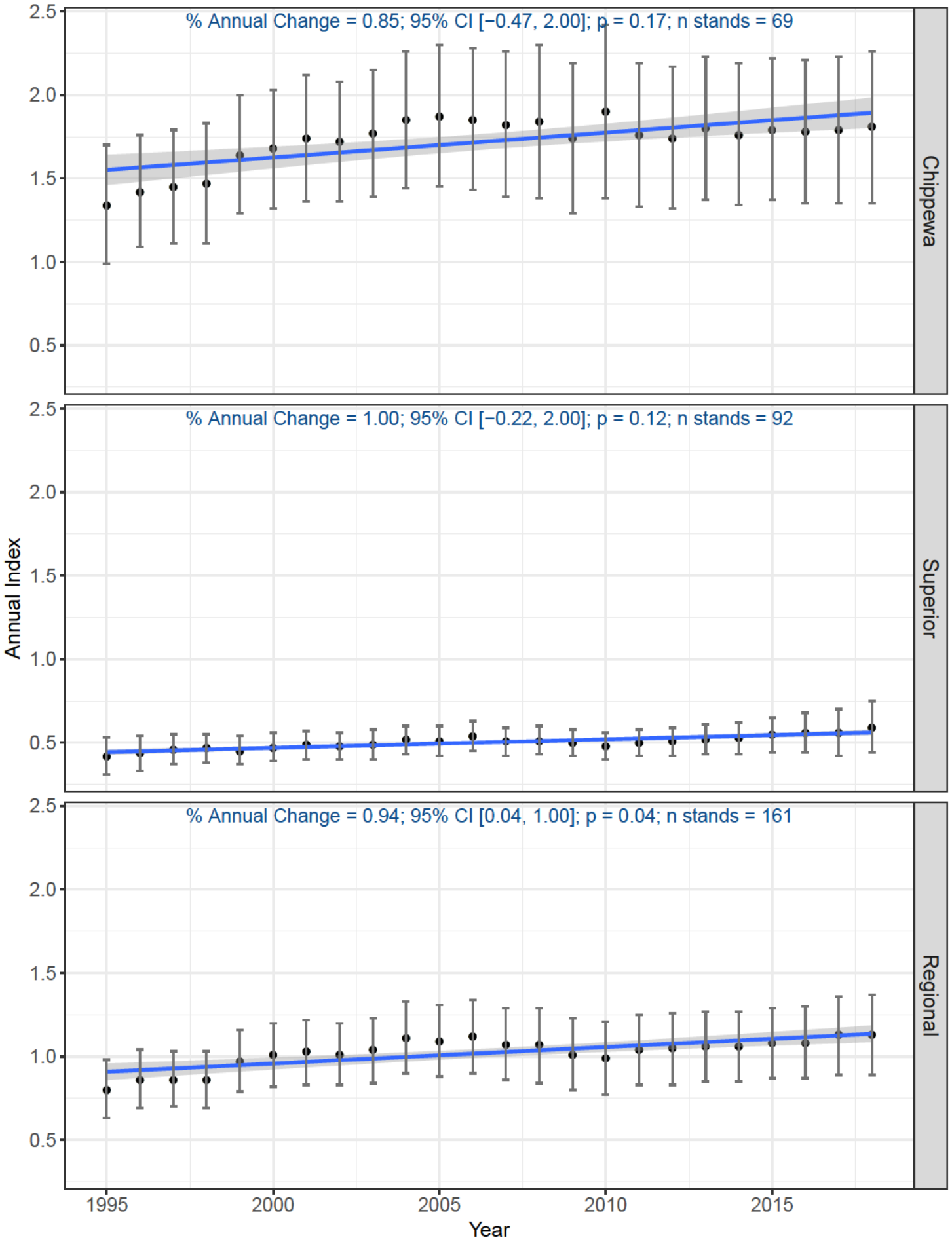
American Crow



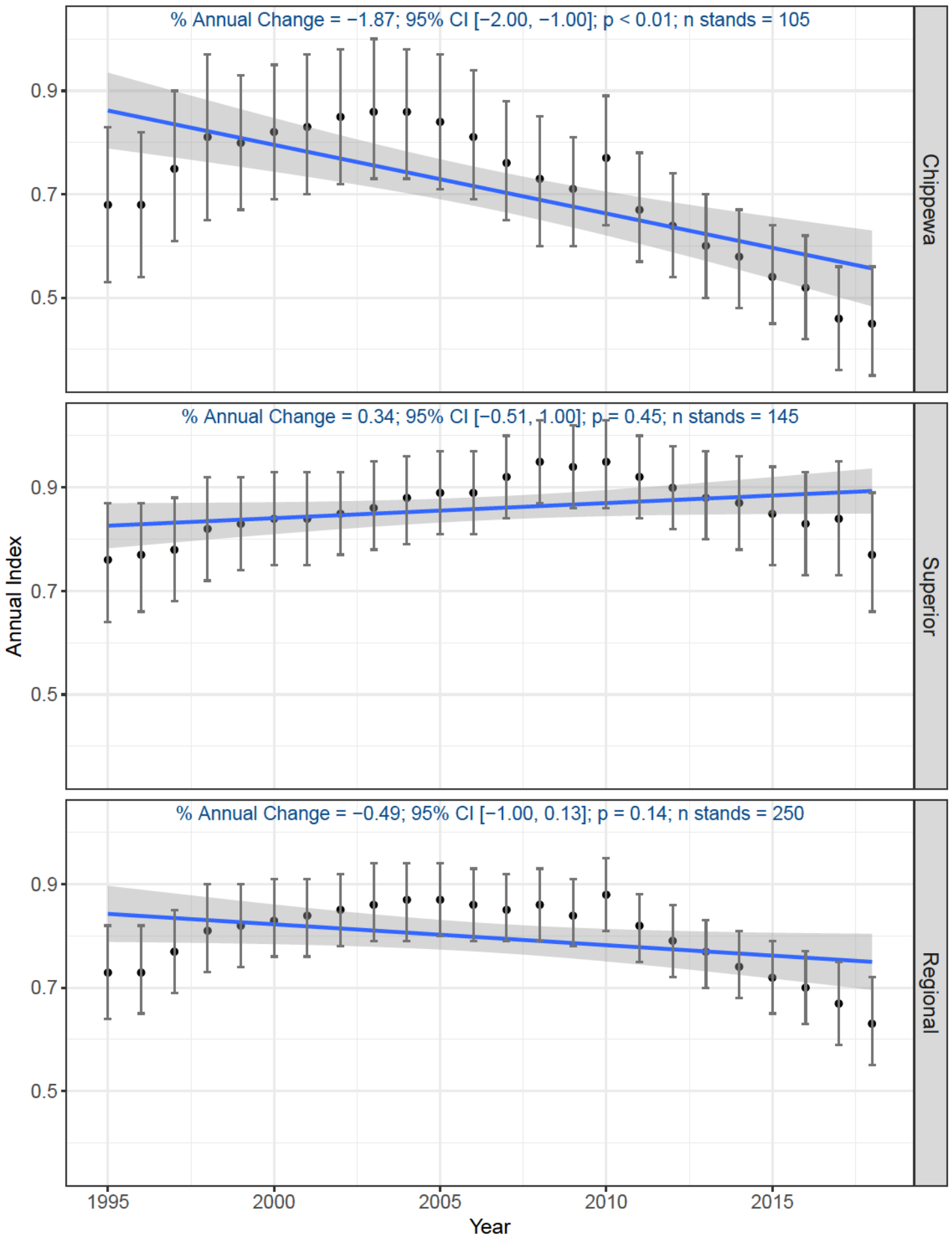
American Goldfinch



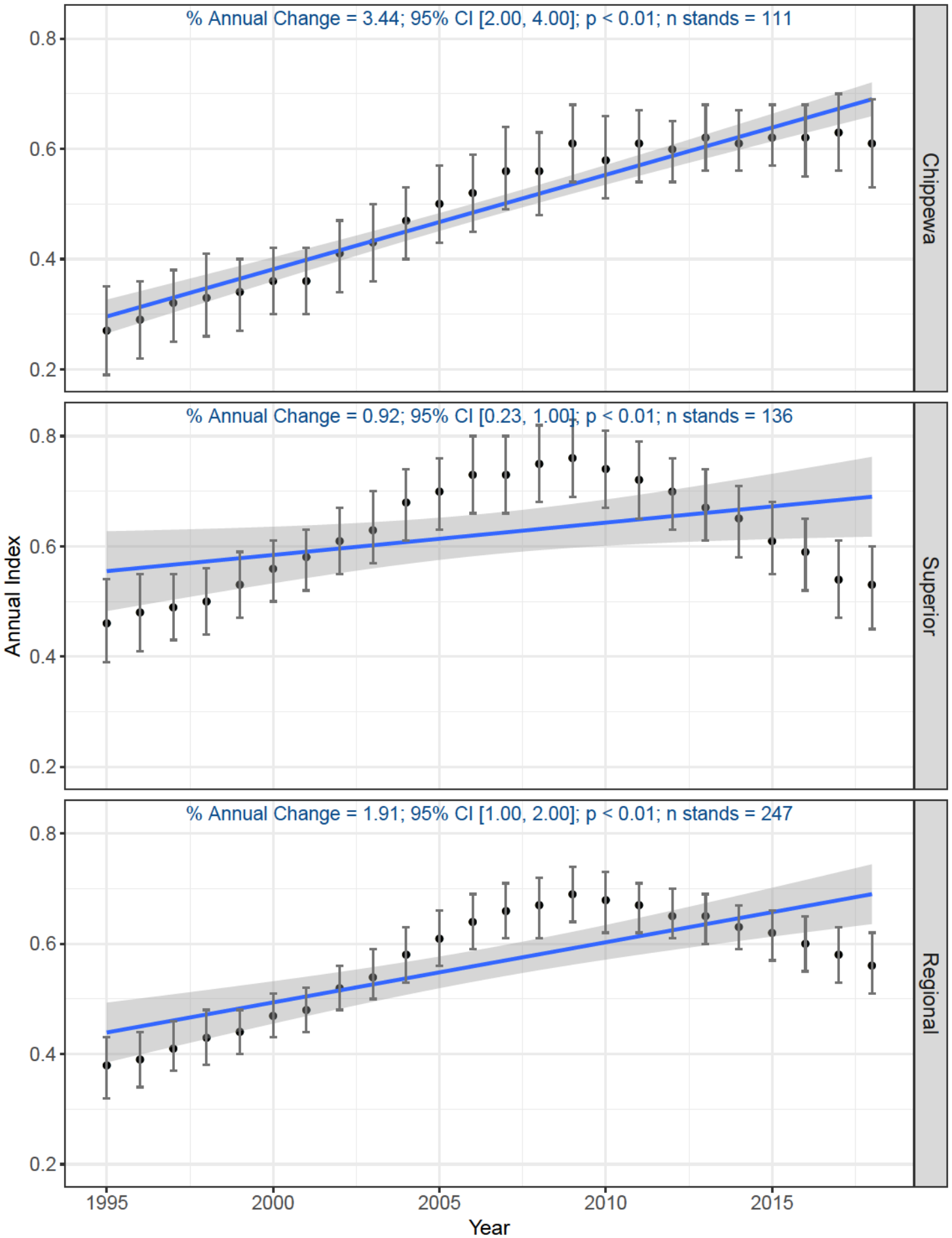
American Redstart



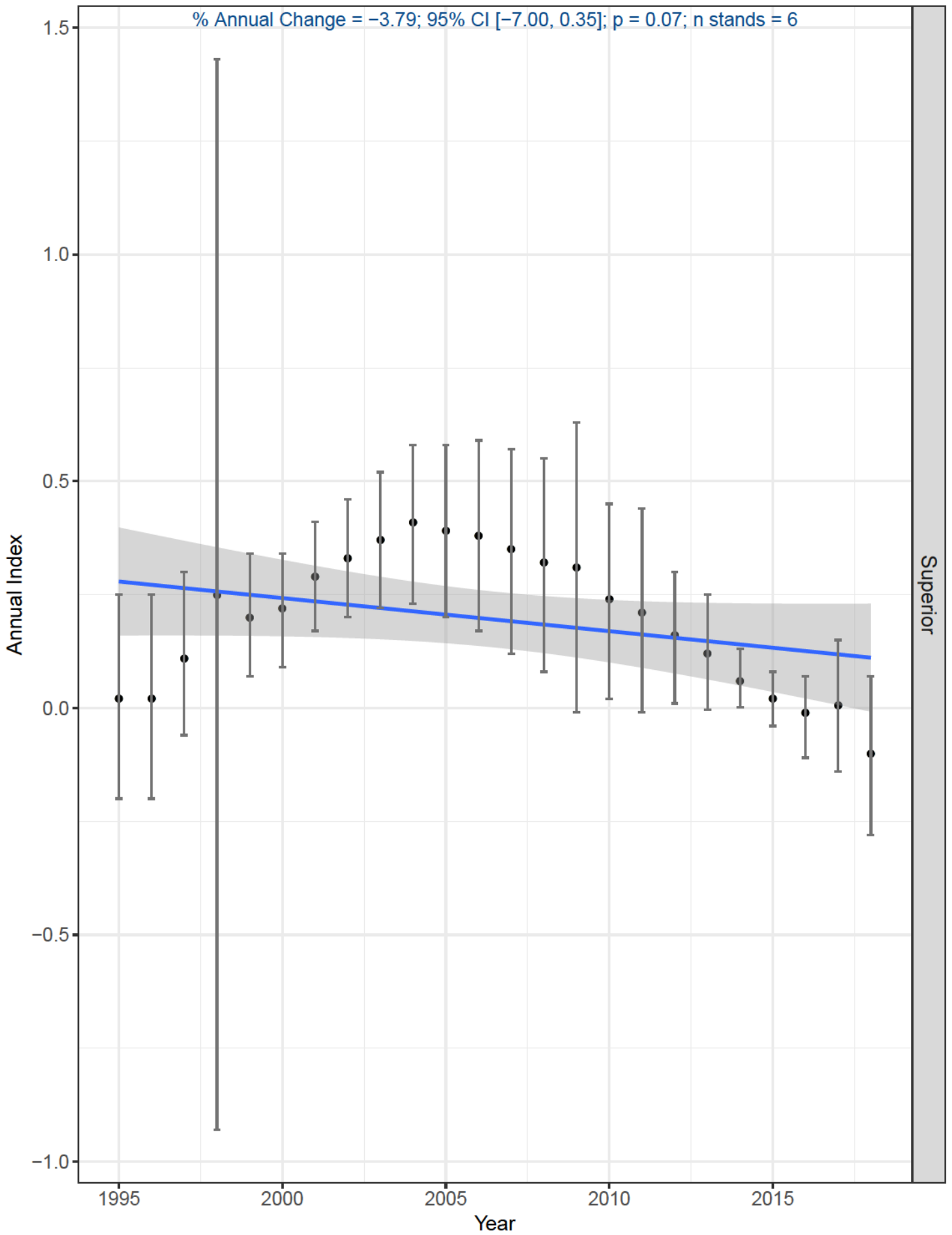
American Robin



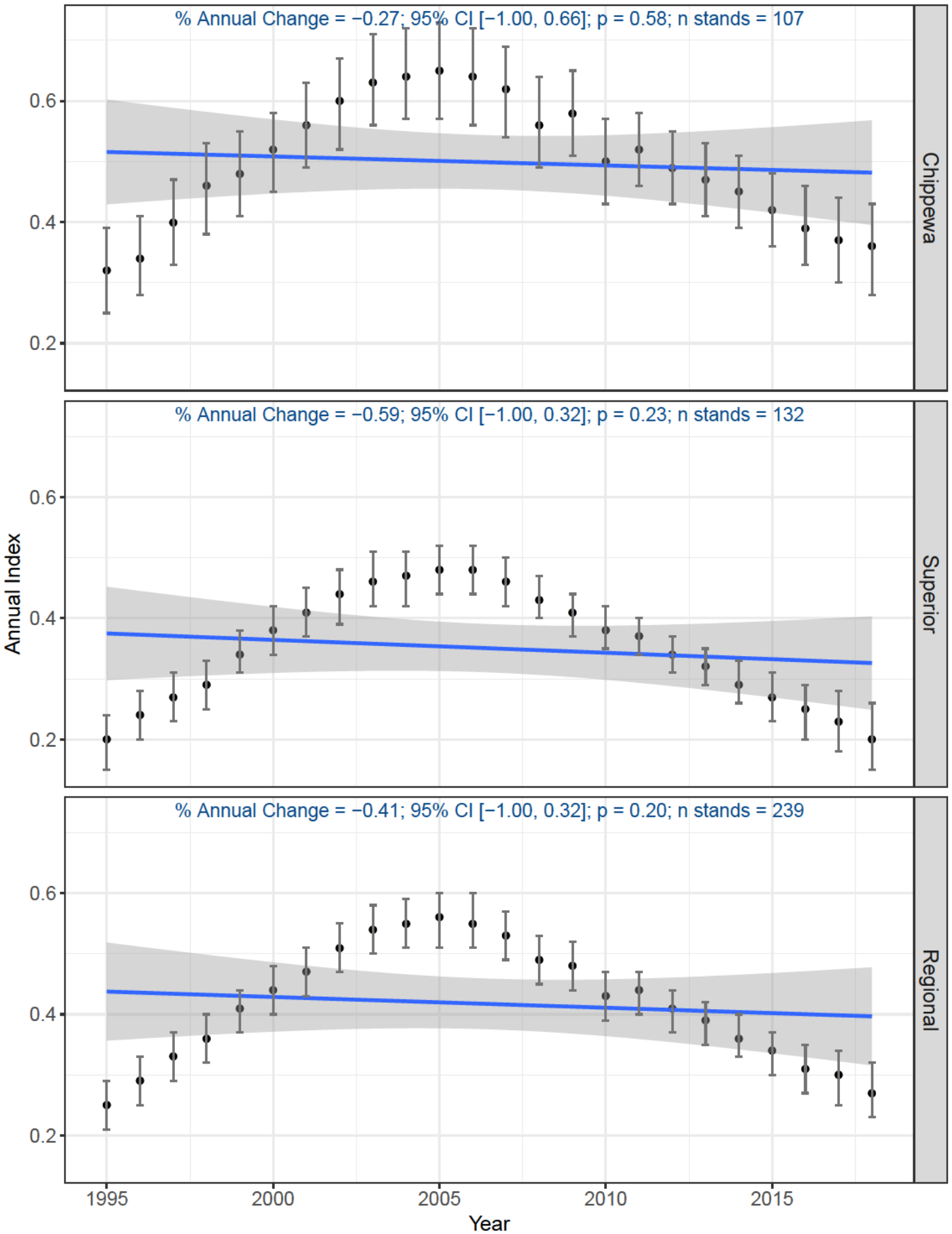
Black-and-white Warbler



Black-billed Cuckoo

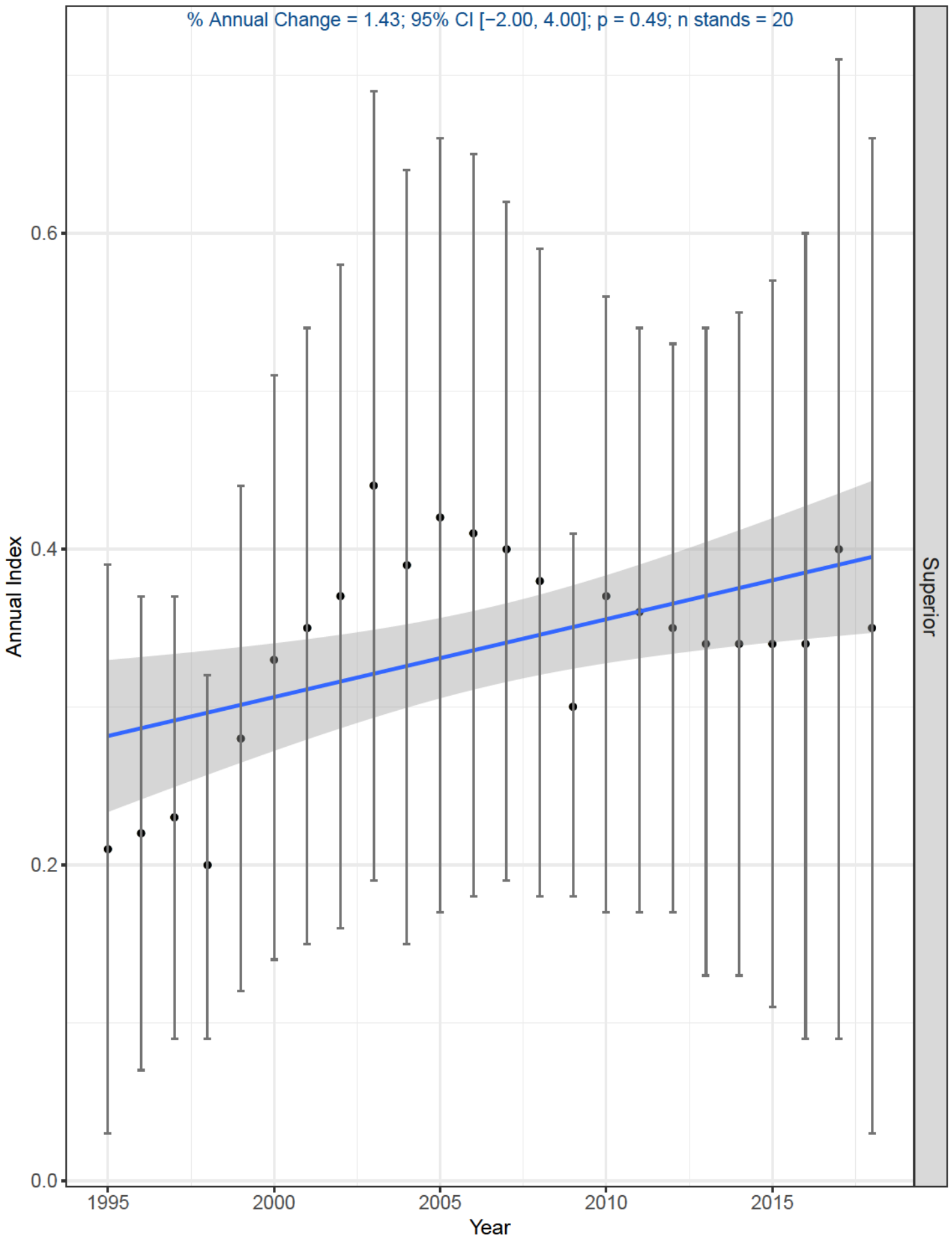


Black-capped Chickadee

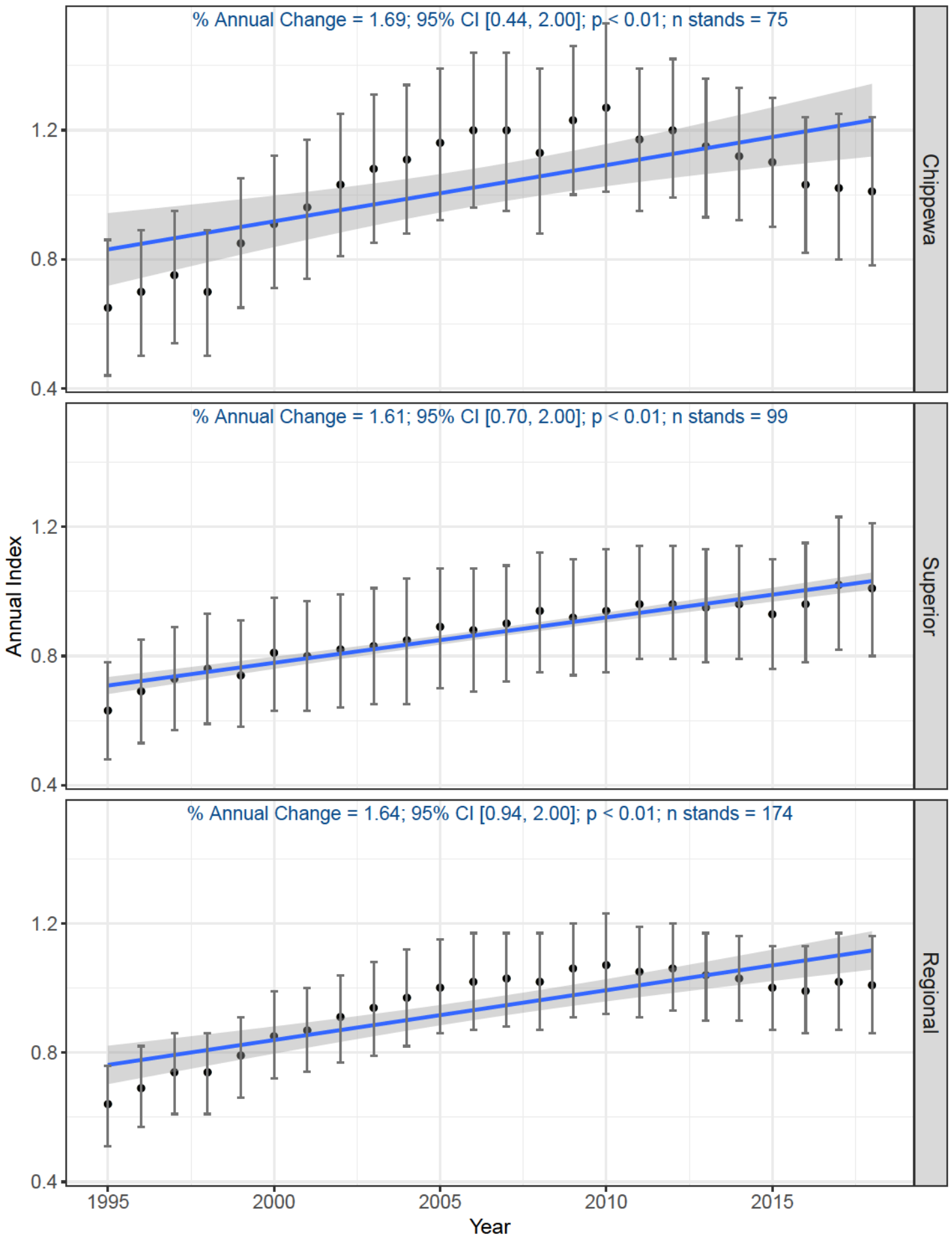


Black-throated Blue Warbler

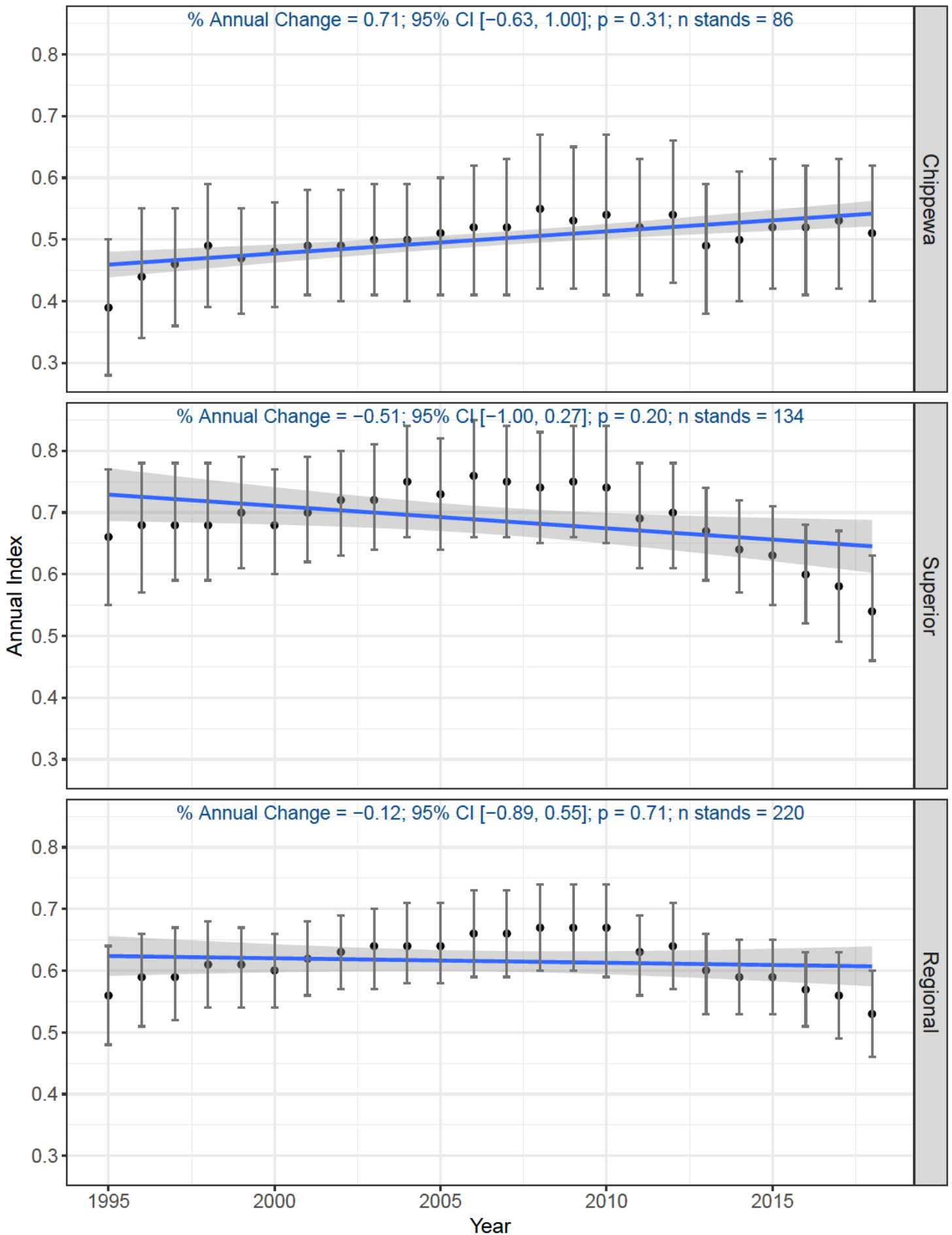
% Annual Change = 1.43; 95% CI [-2.00, 4.00]; p = 0.49; n stands = 20



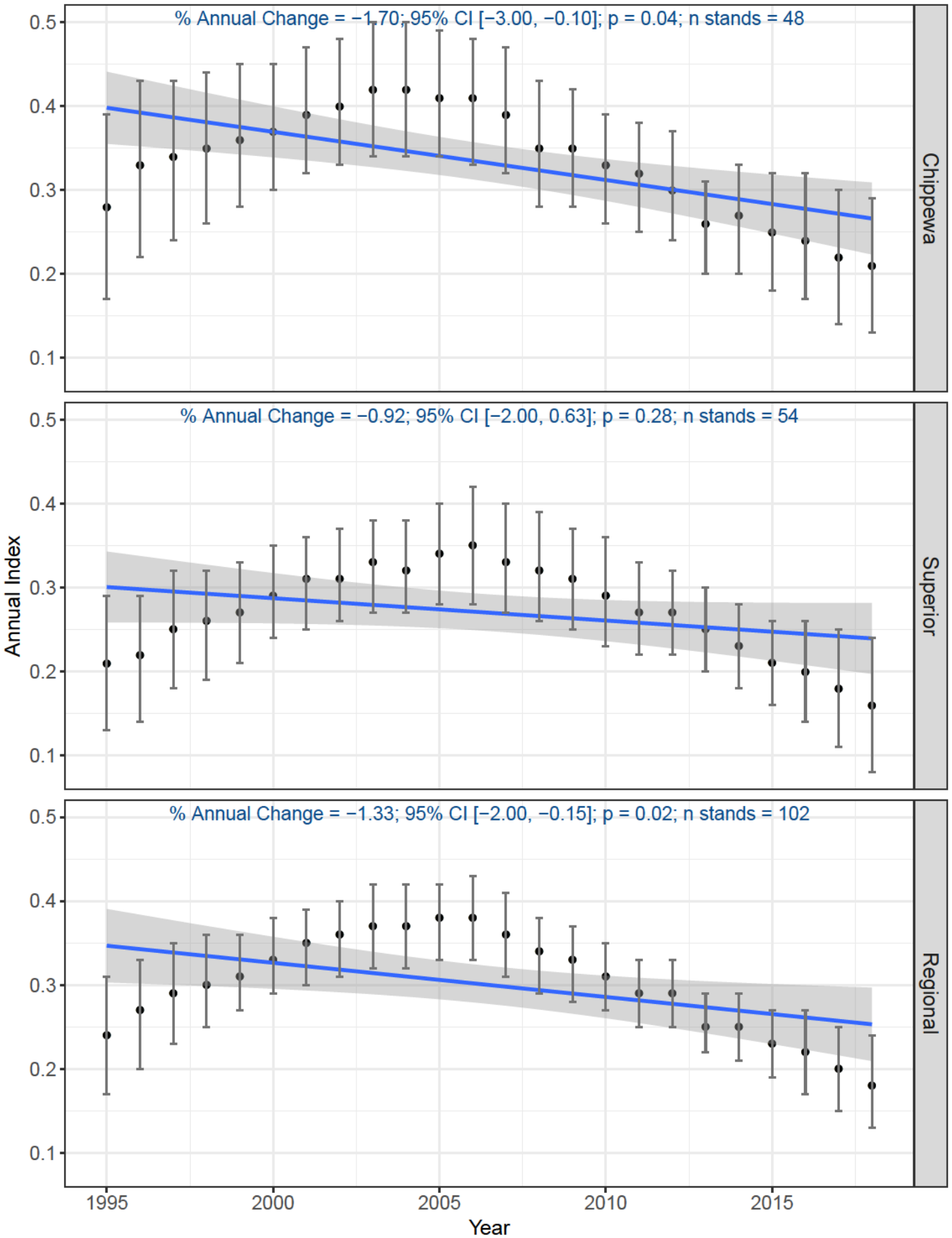
Black-throated Green Warbler



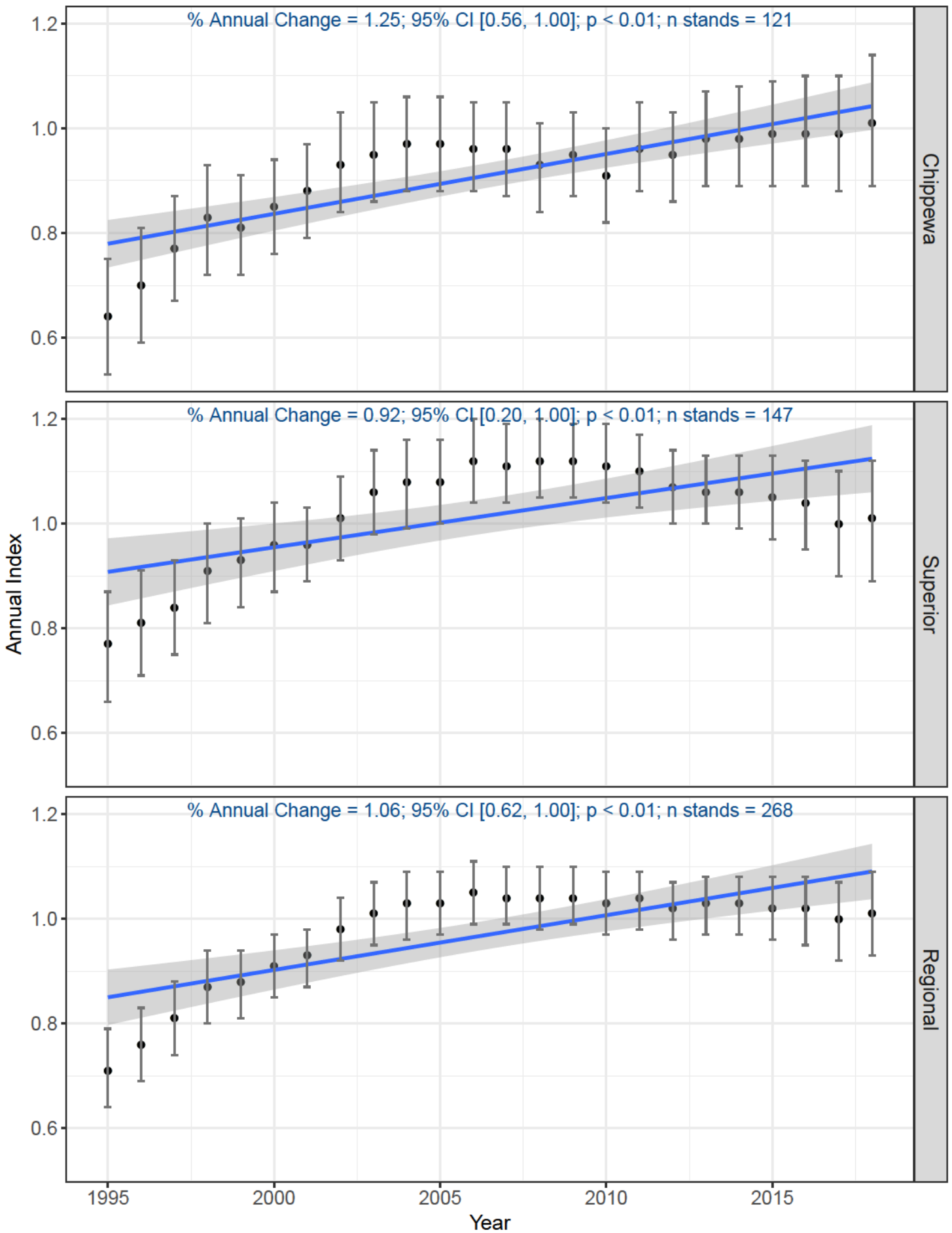
Blackburnian Warbler



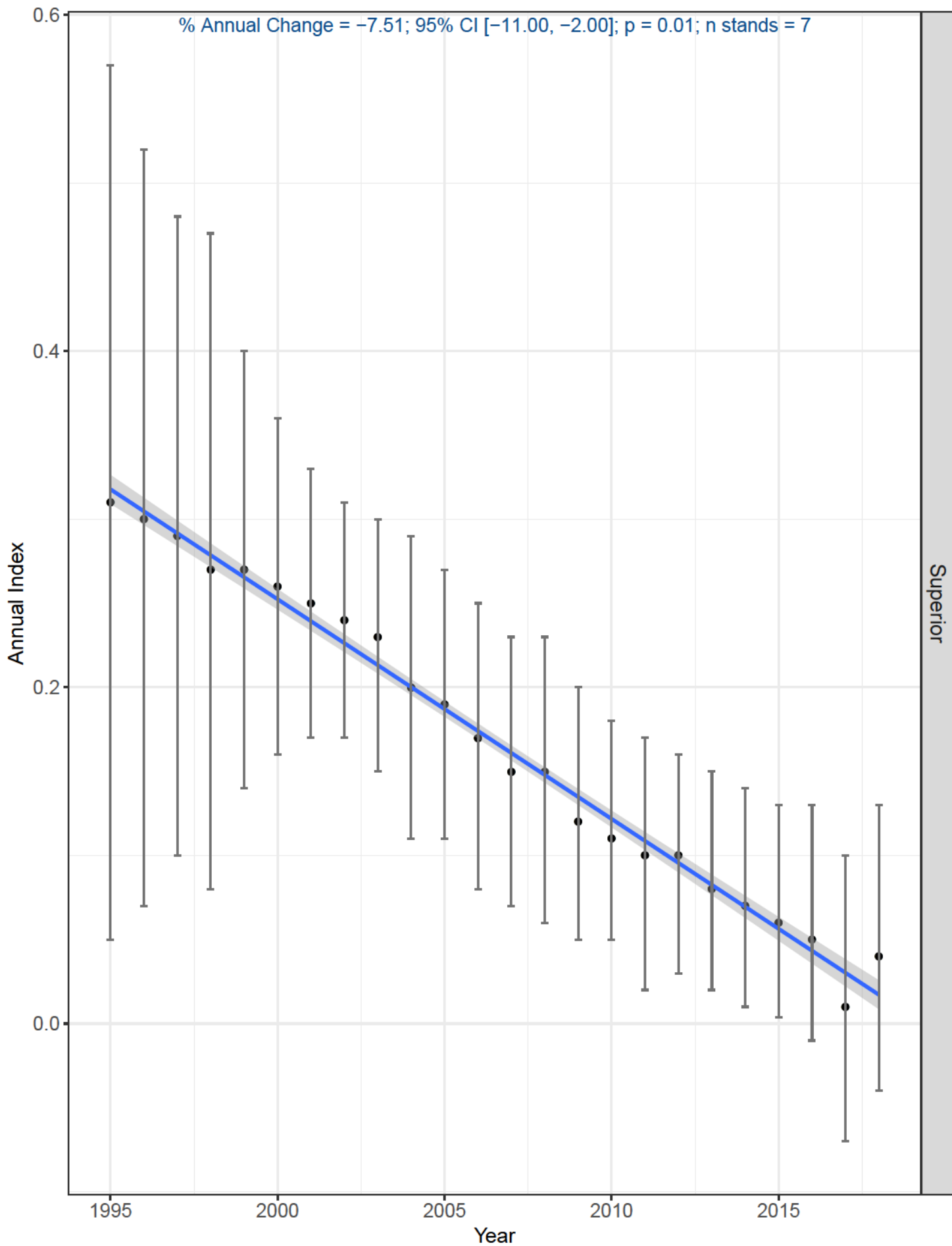
Blue-headed Vireo



Blue Jay

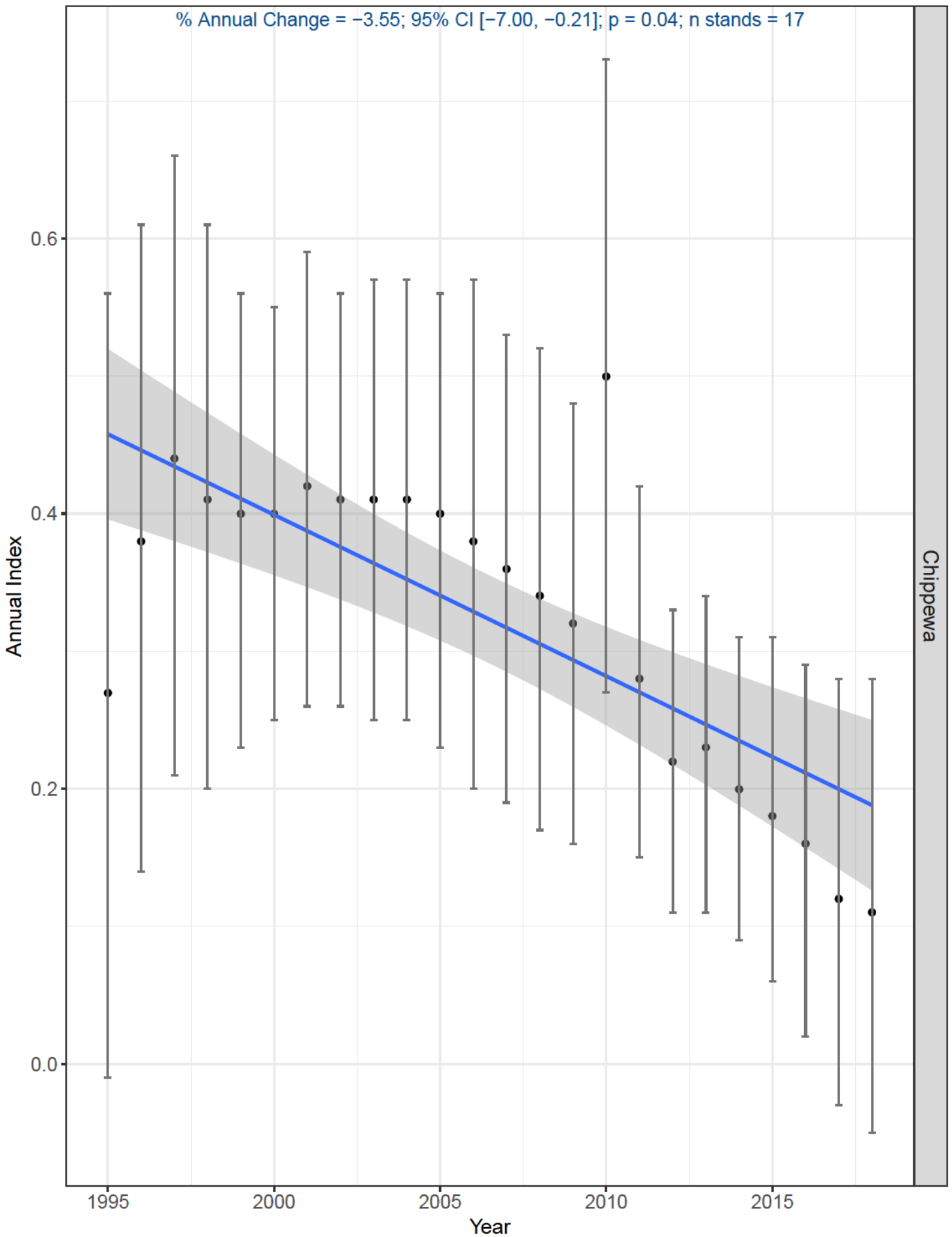


Broad-winged Hawk

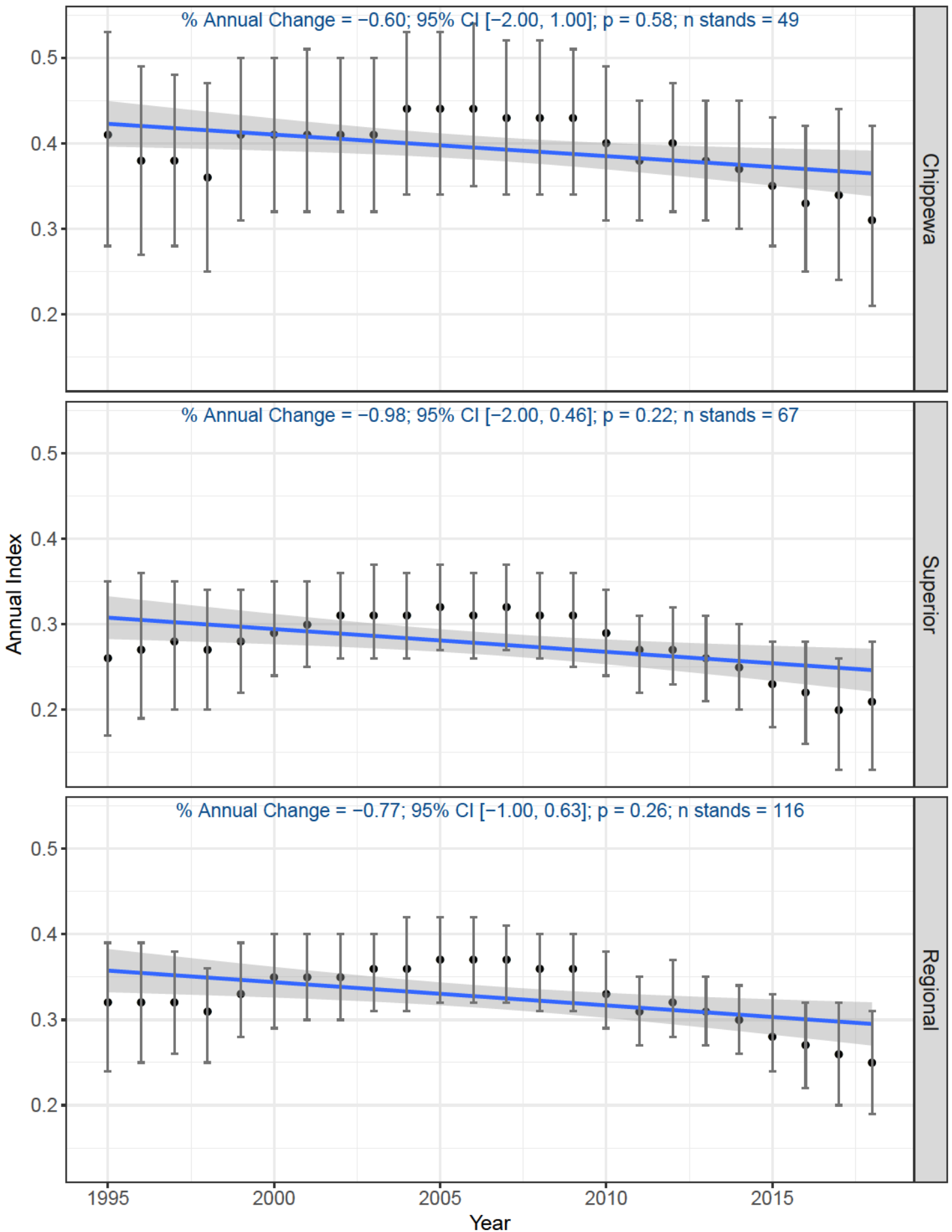


Brown-headed Cowbird

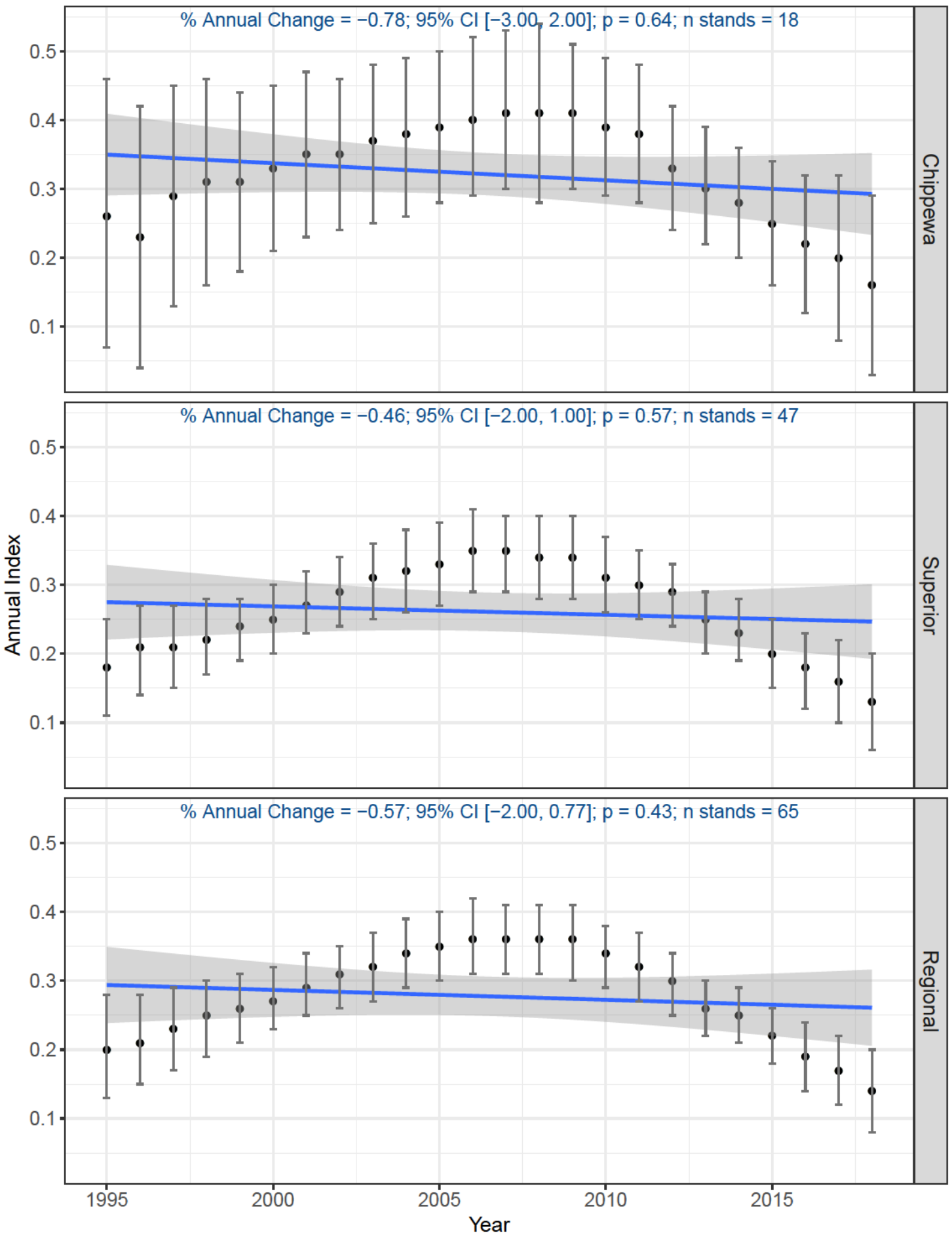
% Annual Change = -3.55; 95% CI [-7.00, -0.21]; p = 0.04; n stands = 17



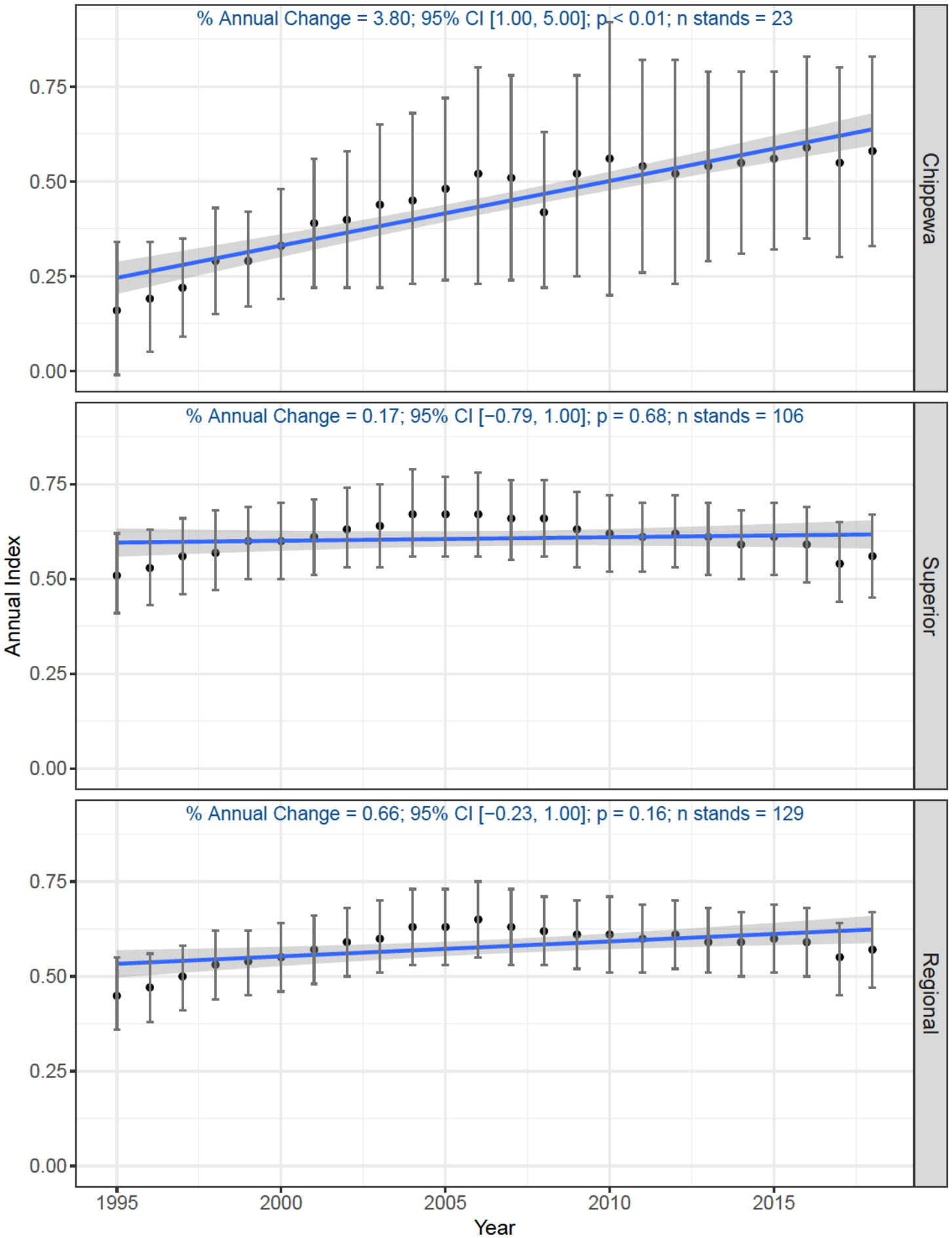
Brown Creeper



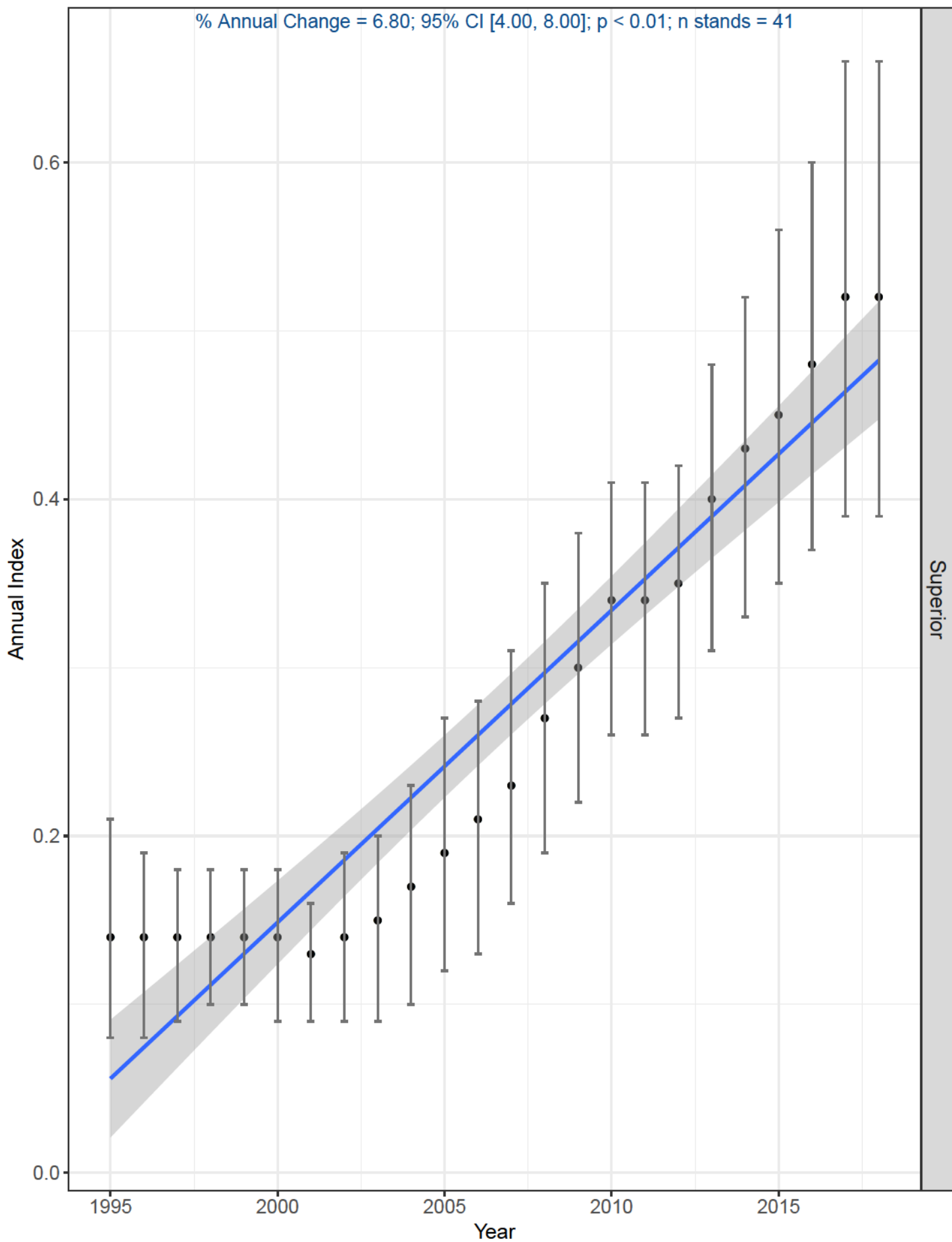
Canada Jay



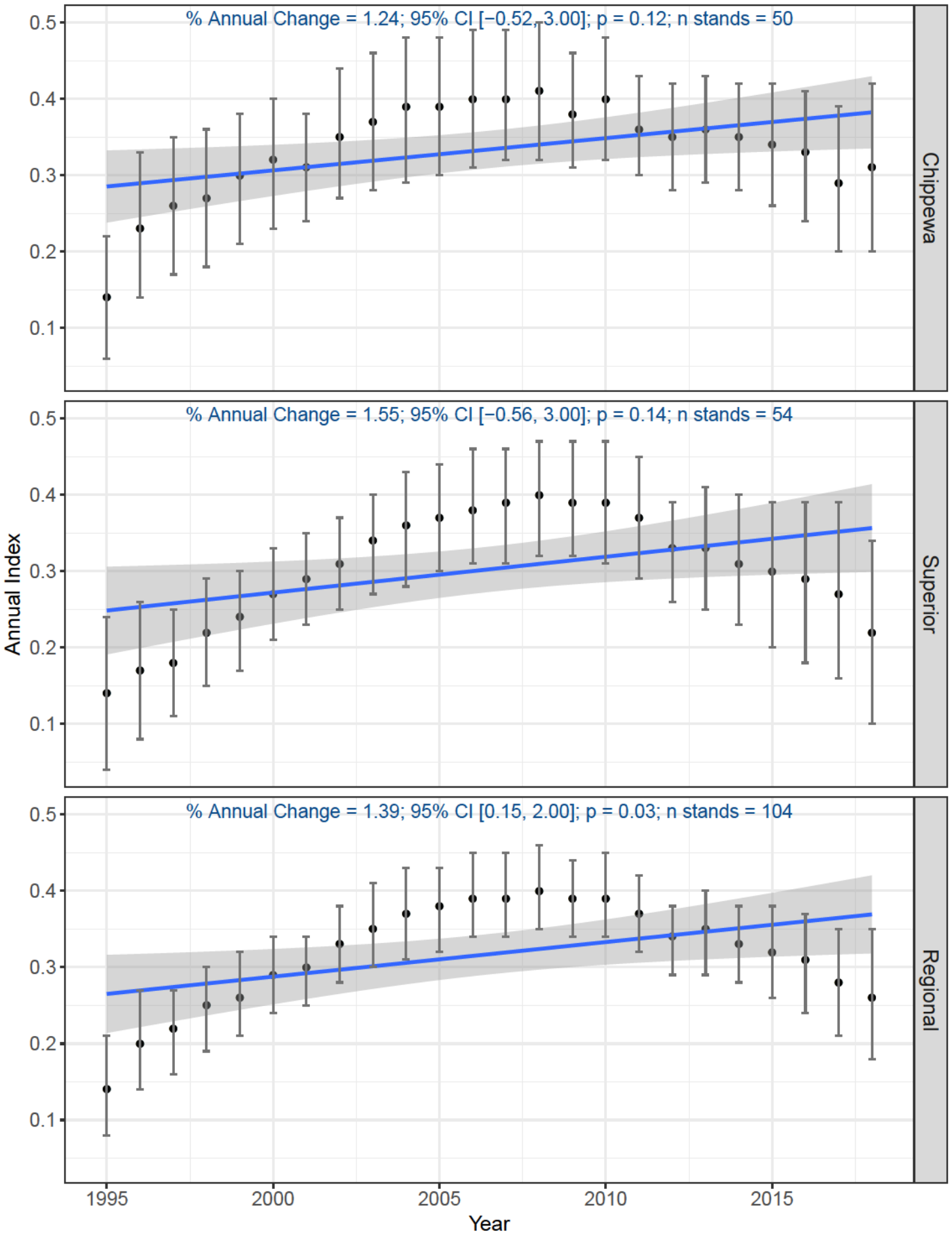
Canada Warbler



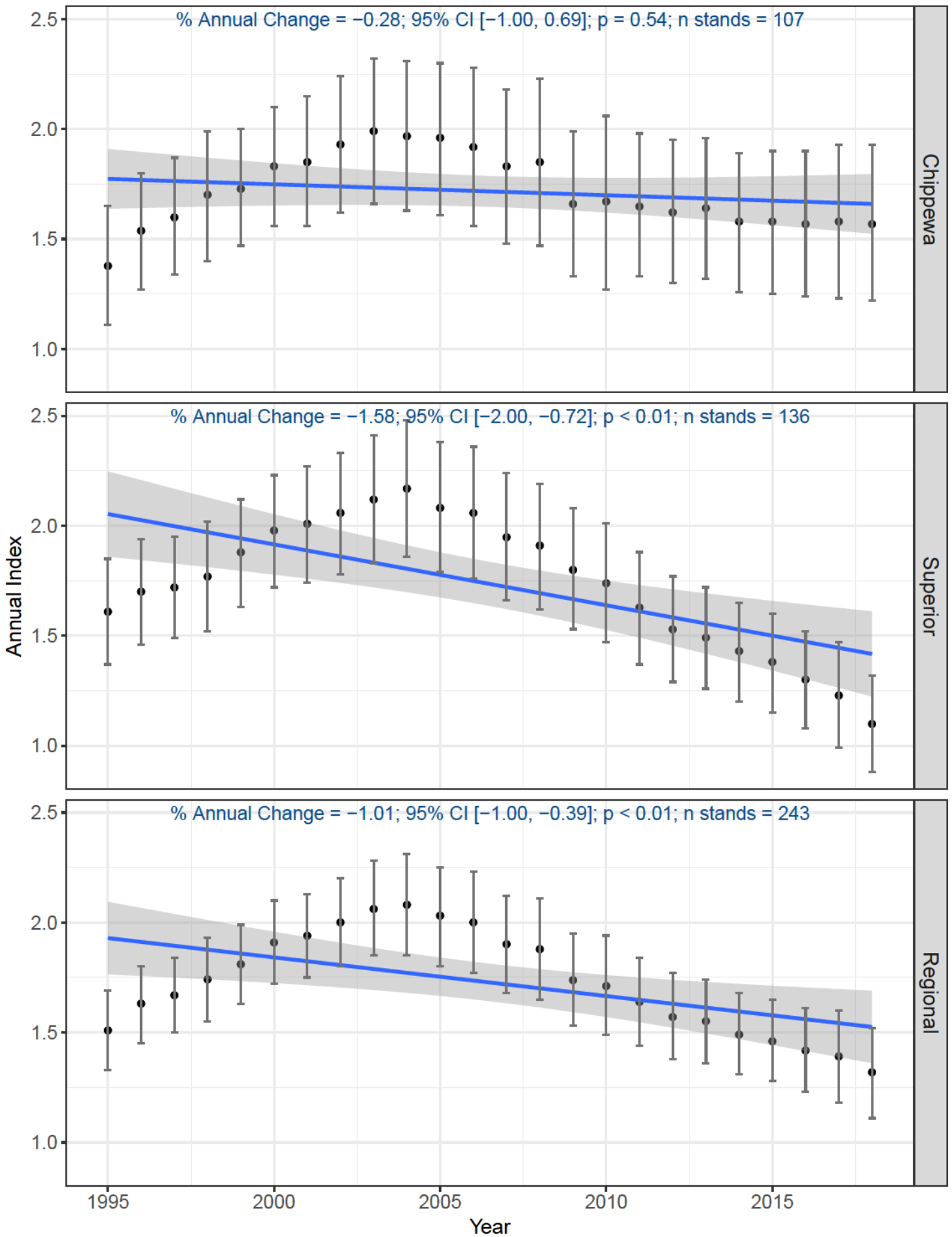
Cape May Warbler



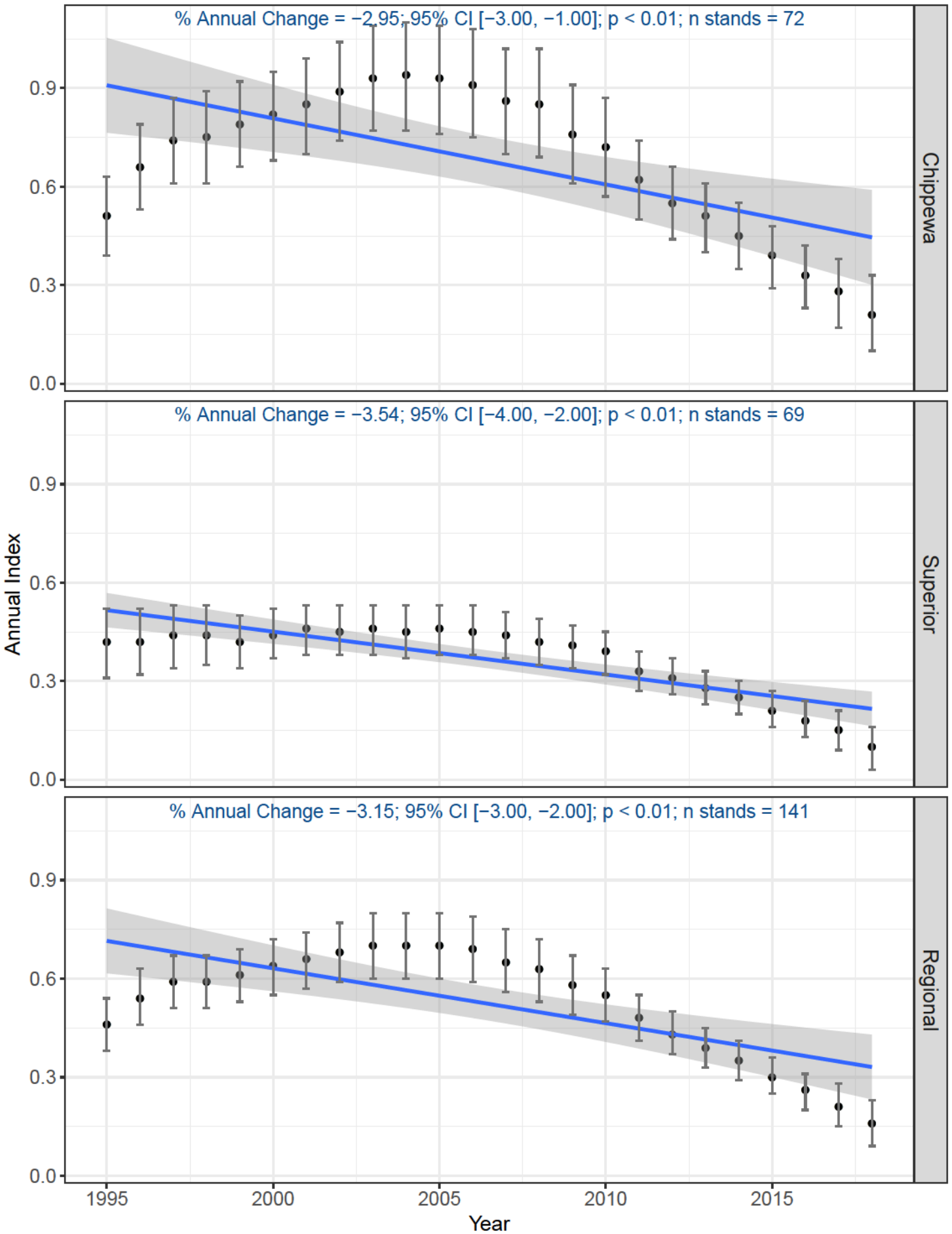
Cedar Waxwing



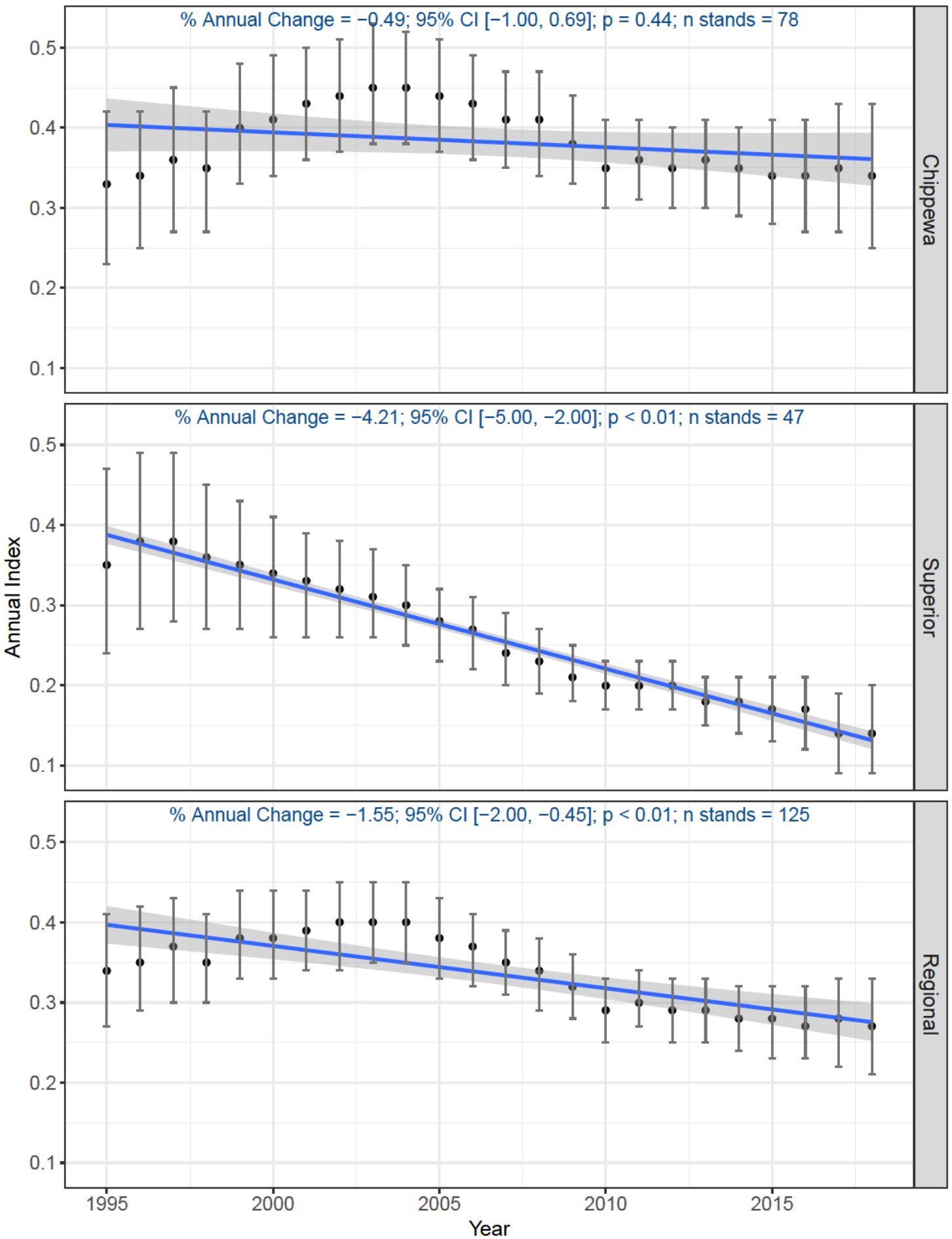
Chestnut-sided Warbler



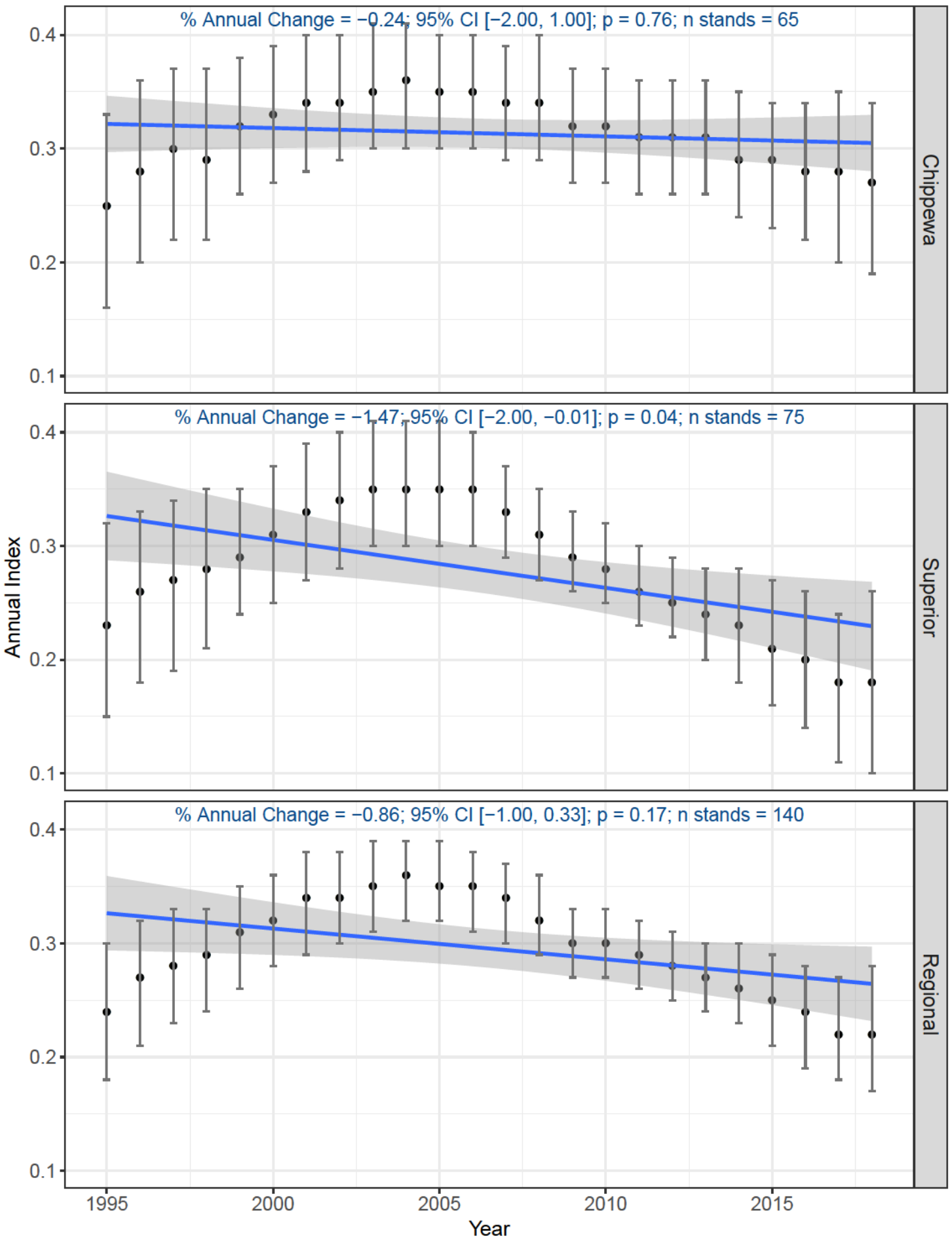
Chipping Sparrow



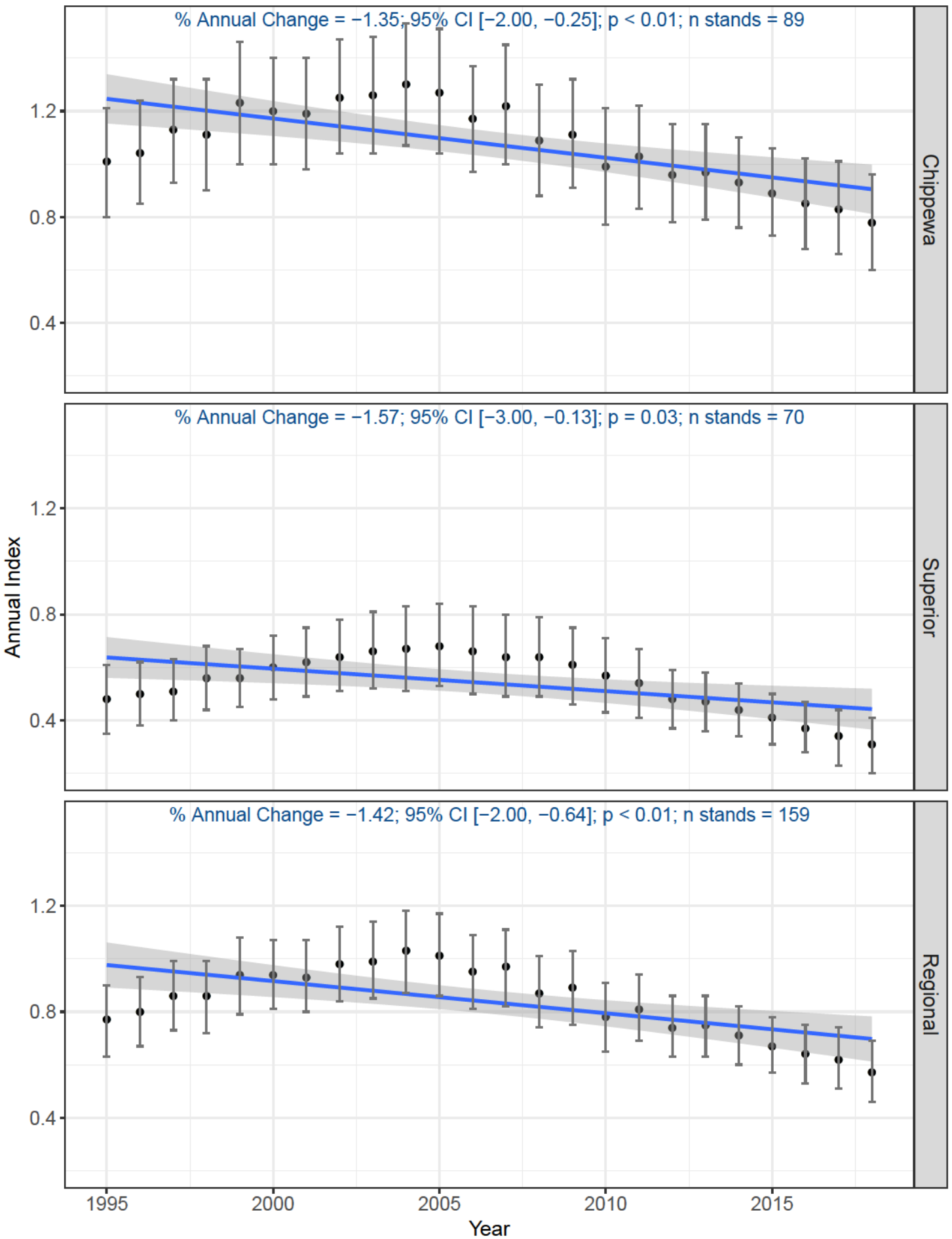
Common Loon



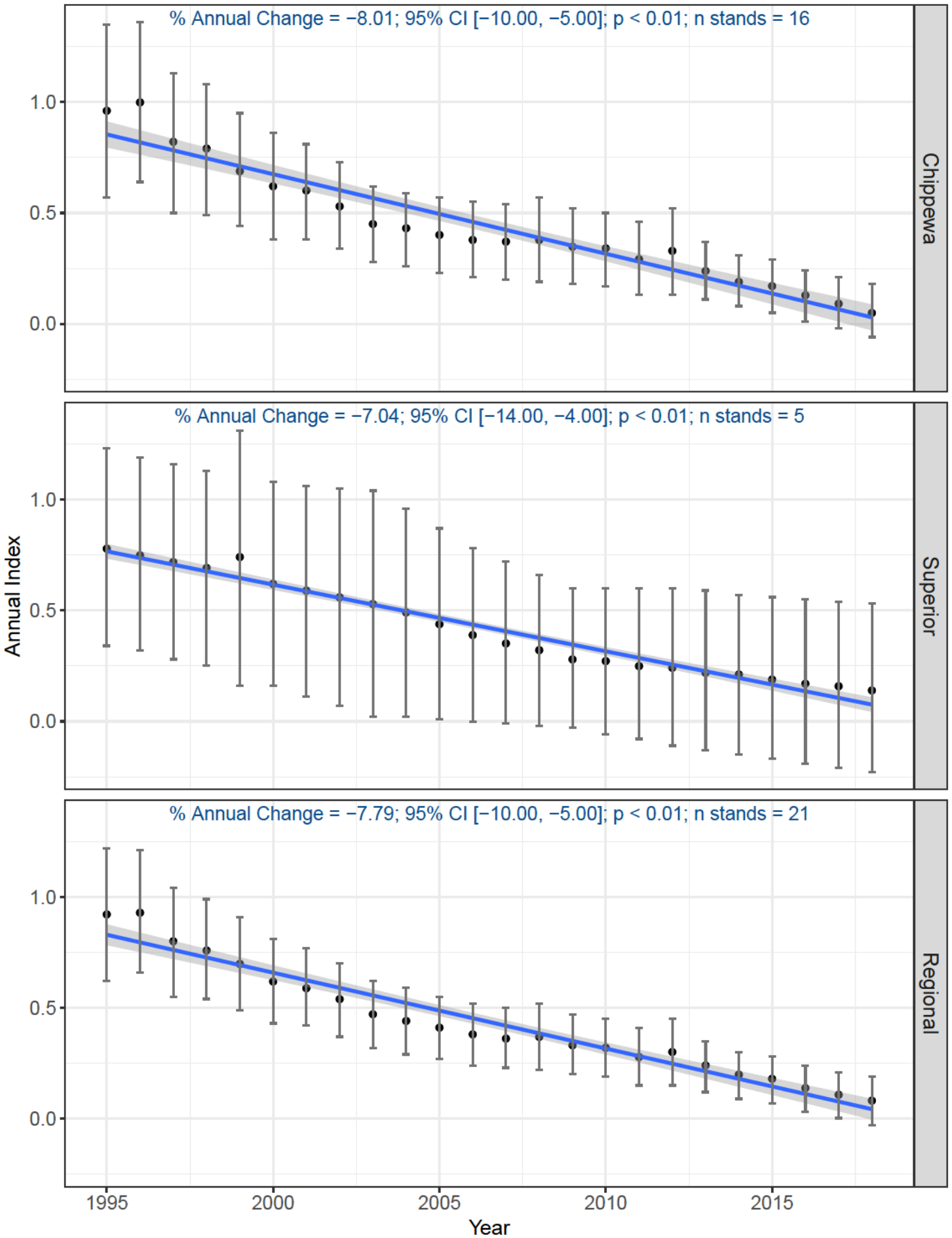
Common Raven



Common Yellowthroat

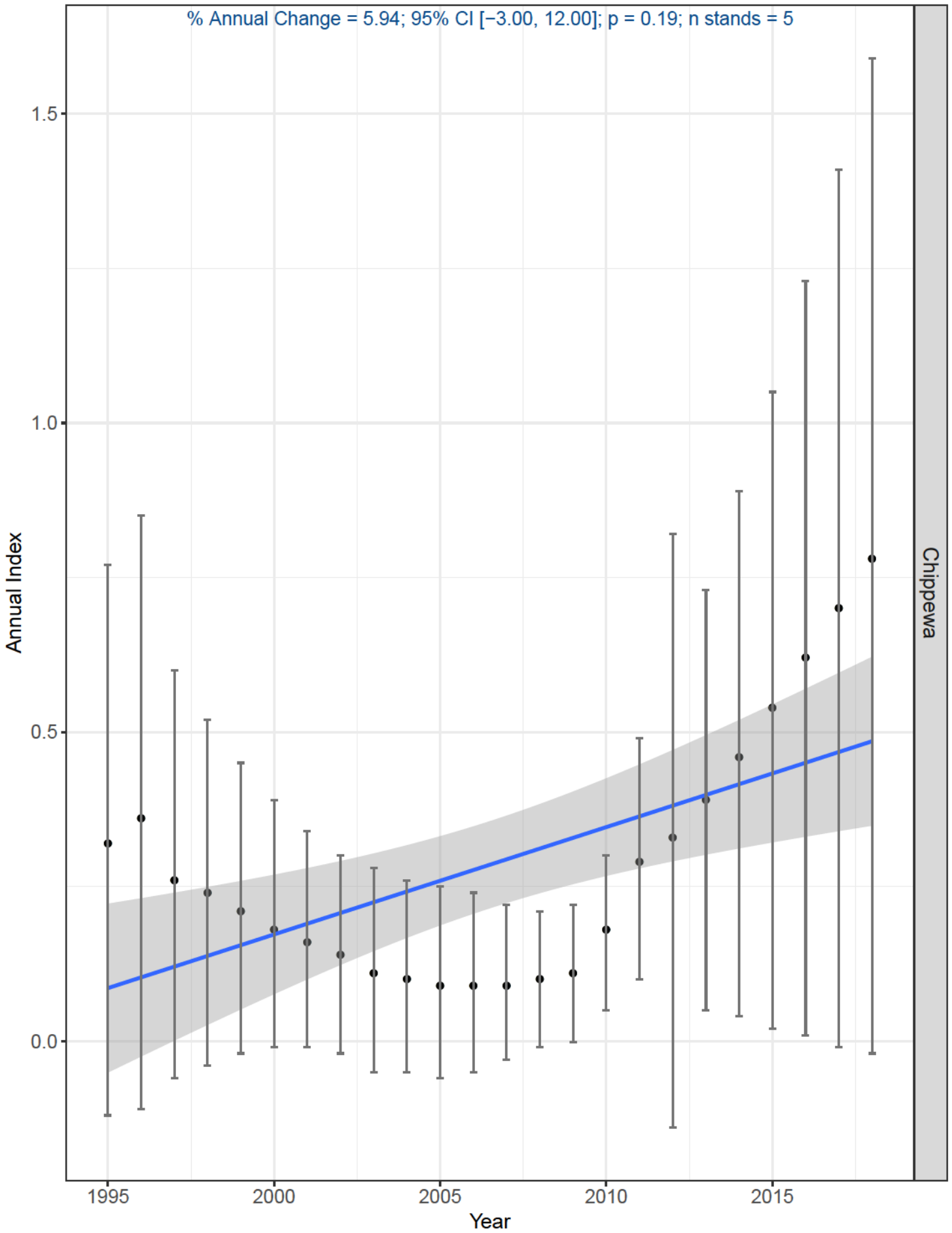


Connecticut Warbler

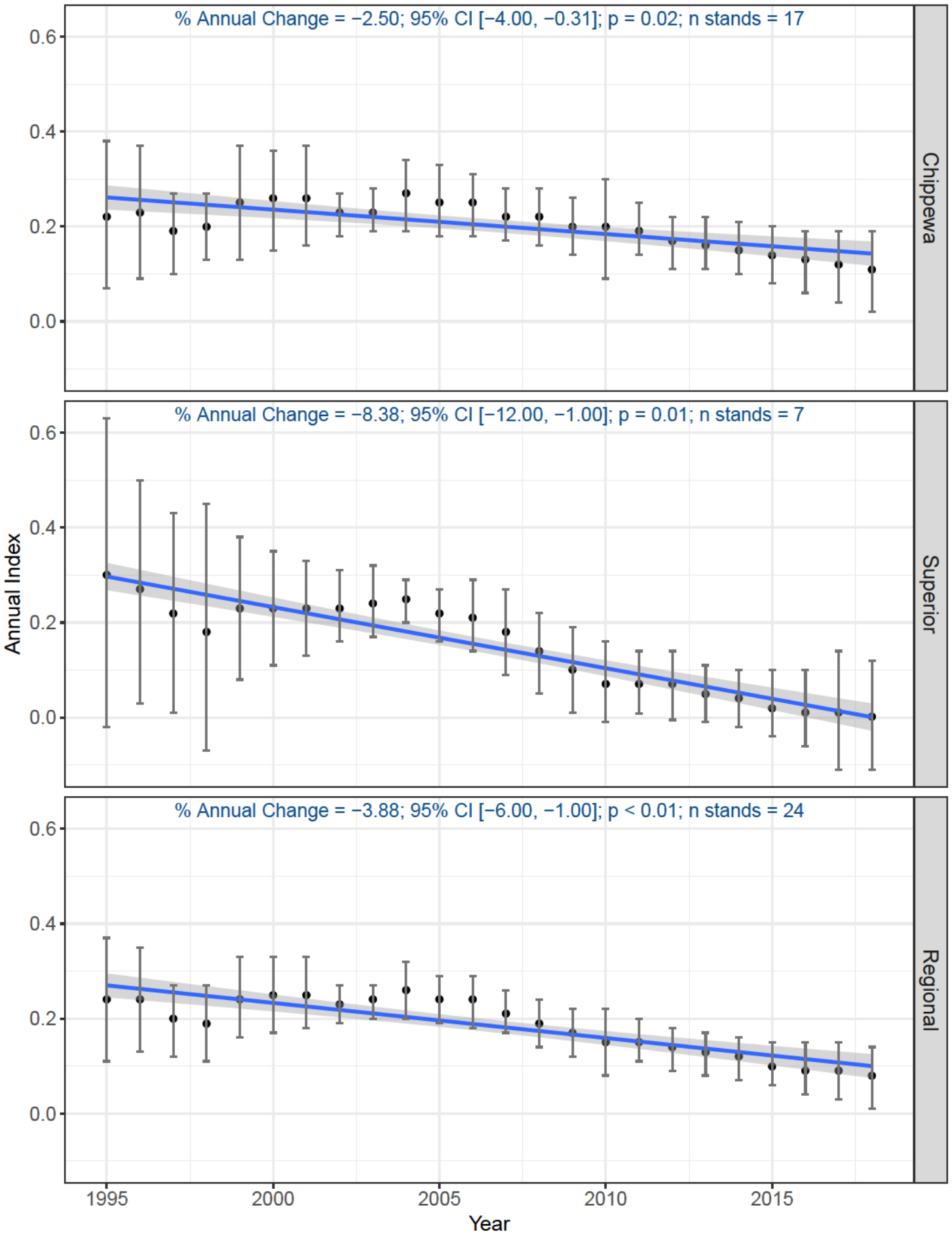


Dark-eyed Junco (Slate-colored)

% Annual Change = 5.94; 95% CI [-3.00, 12.00]; p = 0.19; n stands = 5

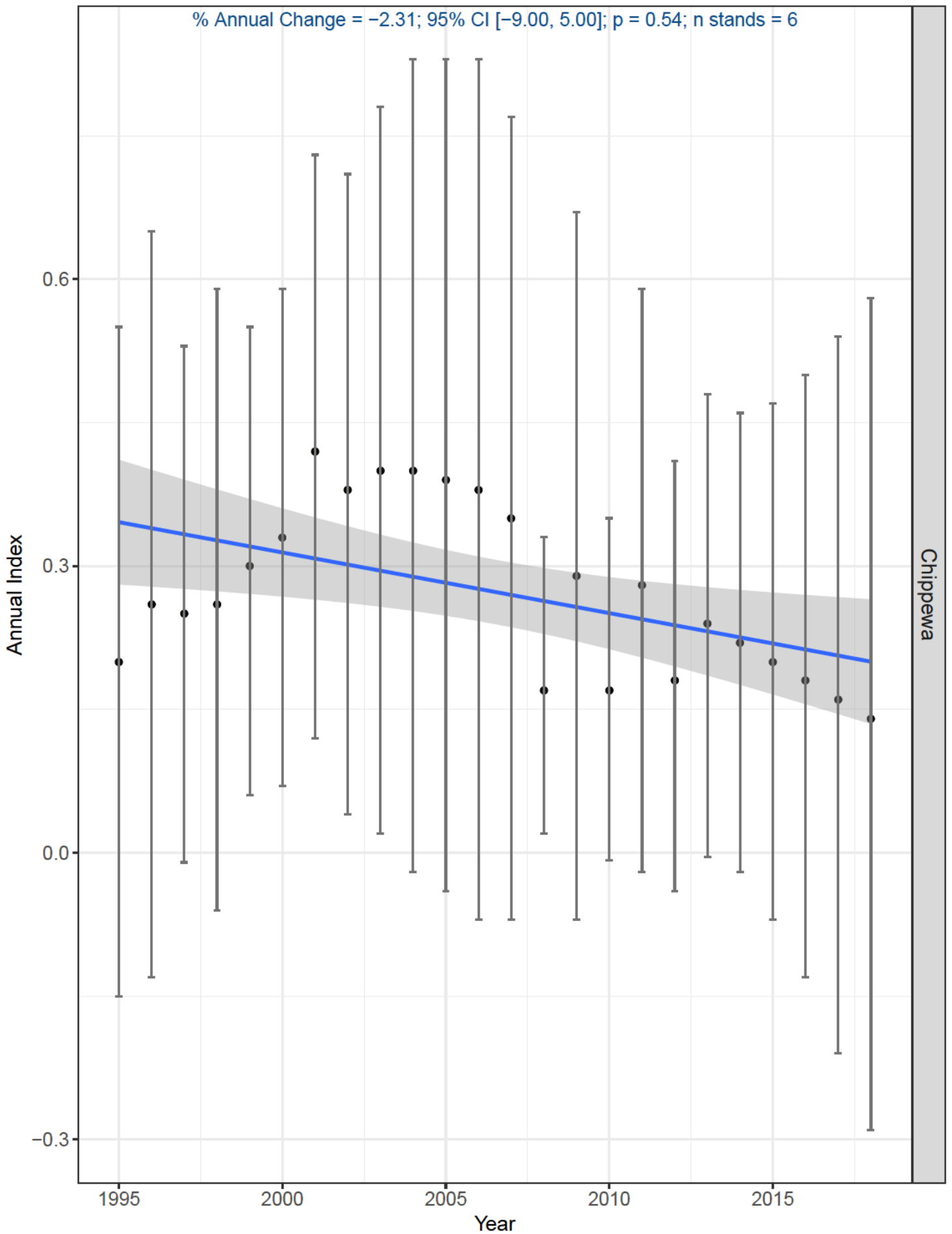


Downy Woodpecker

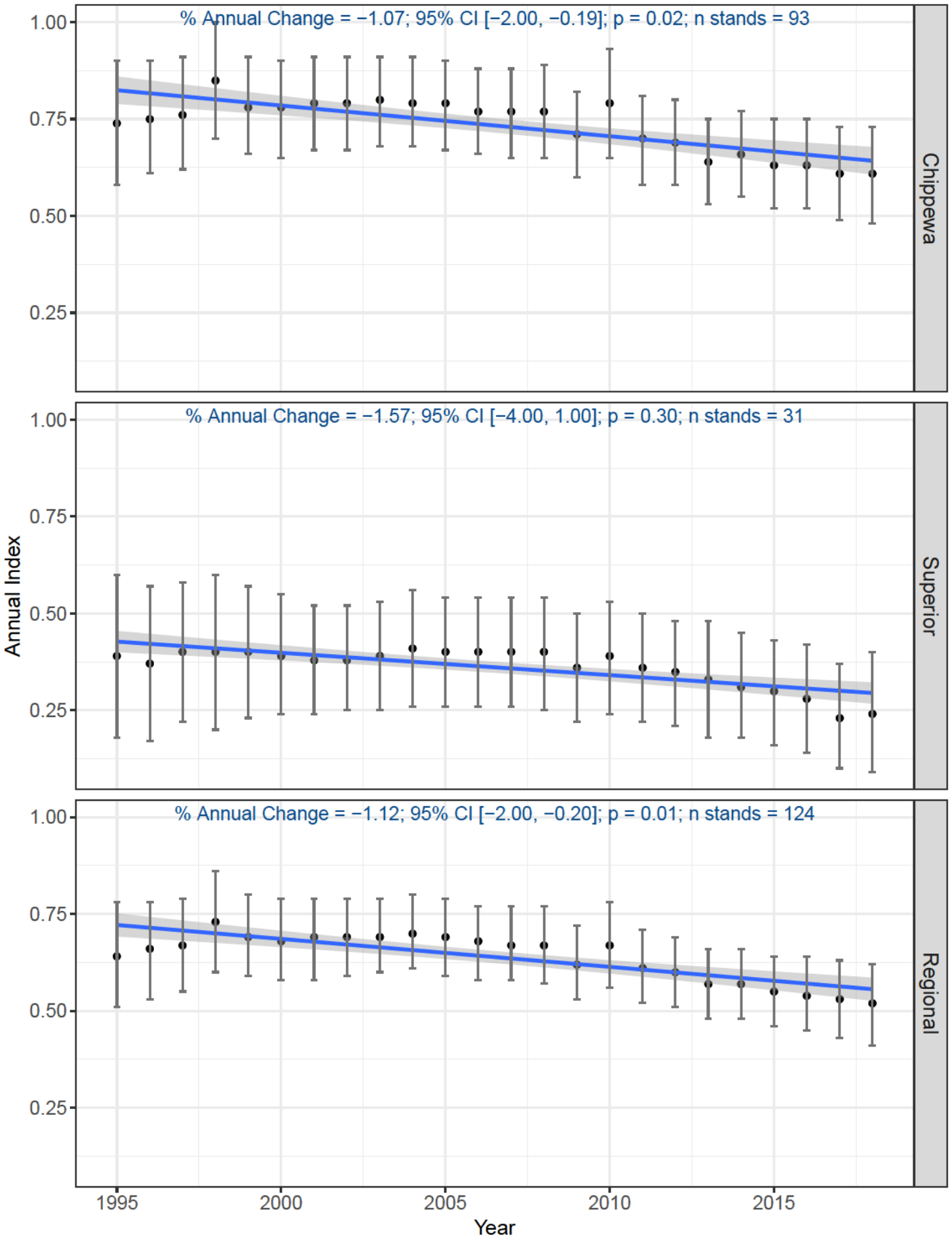


Eastern Towhee

% Annual Change = -2.31; 95% CI [-9.00, 5.00]; p = 0.54; n stands = 6

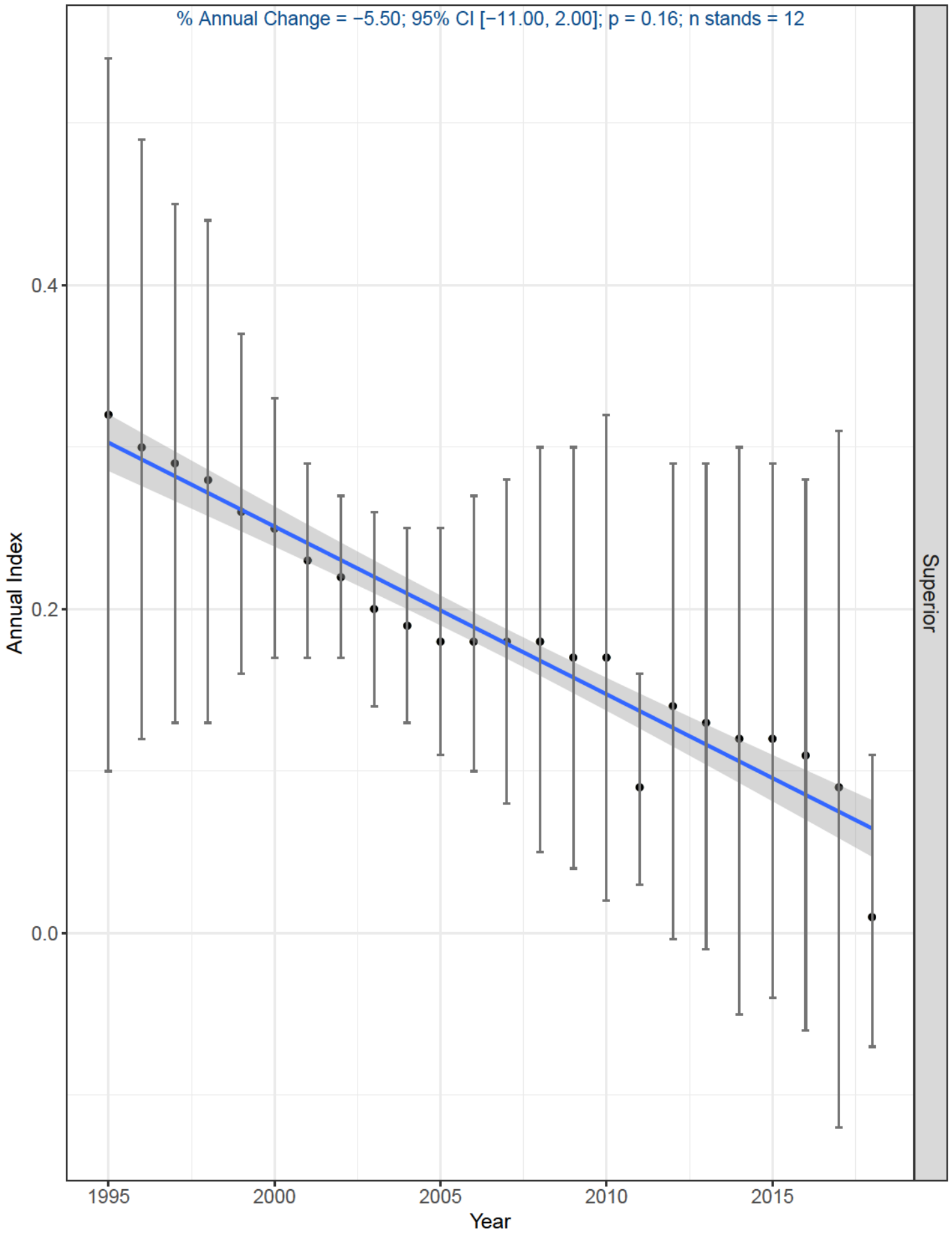


Eastern Wood-Pewee

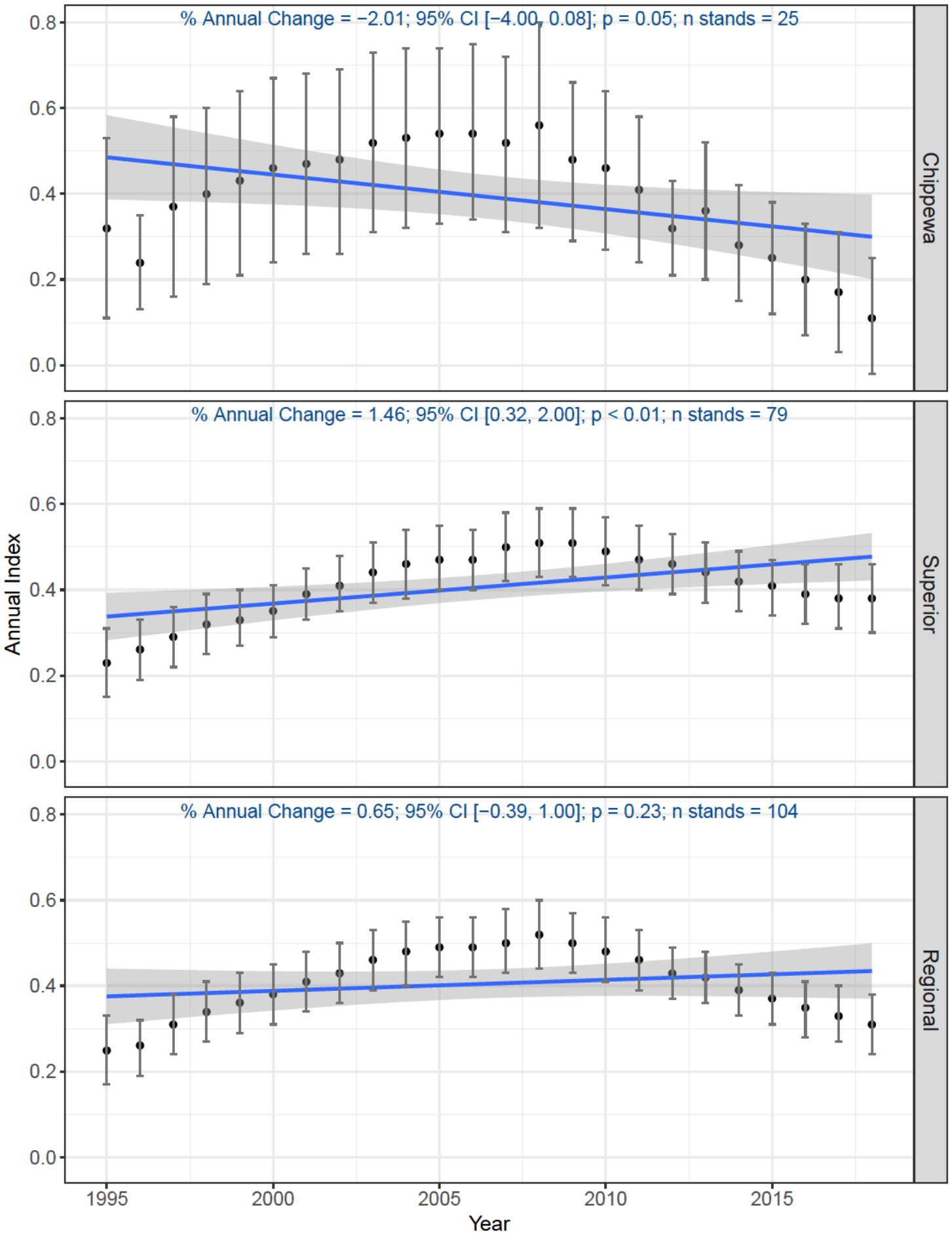


Evening Grosbeak

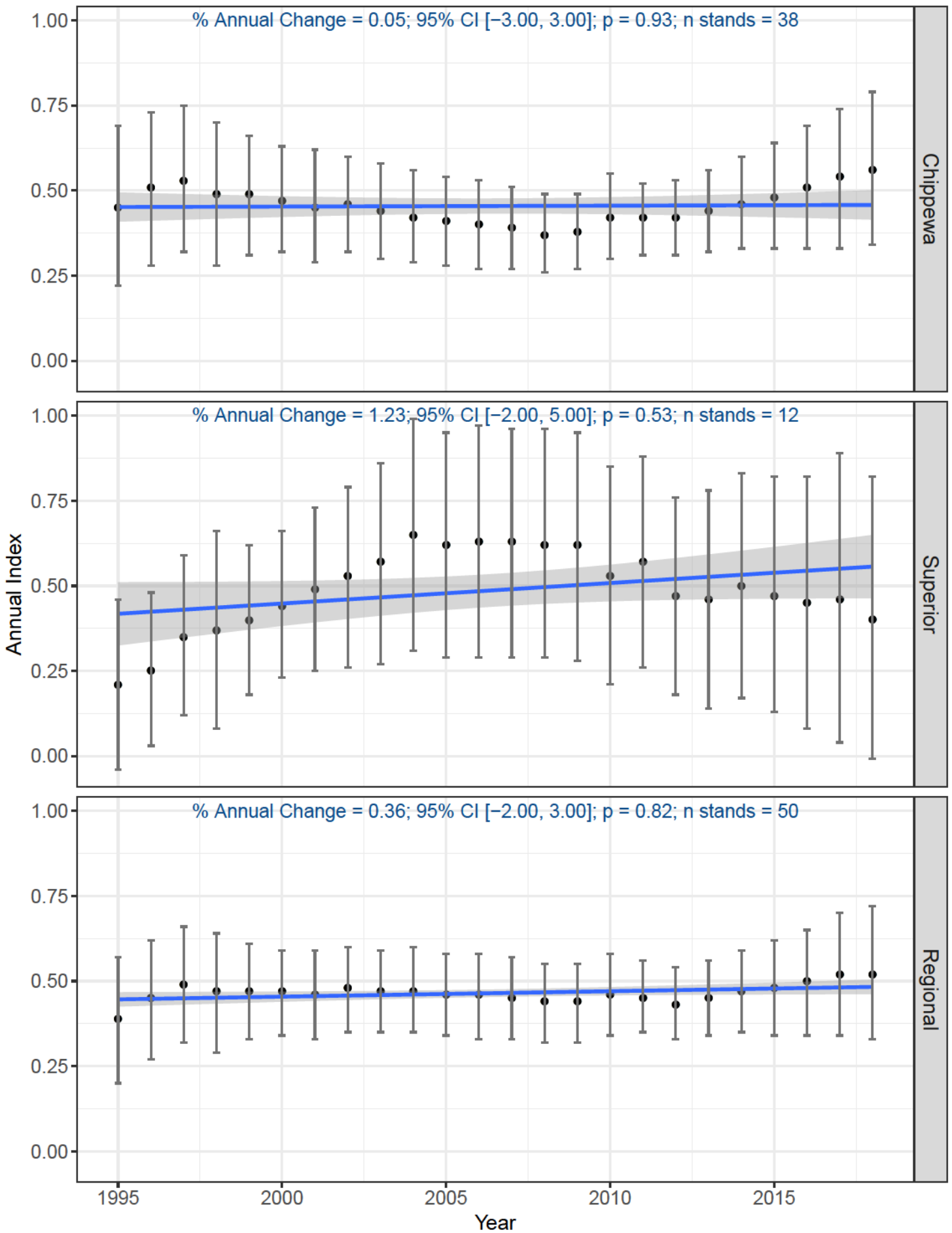
% Annual Change = -5.50; 95% CI [-11.00, 2.00]; p = 0.16; n stands = 12



Golden-crowned Kinglet

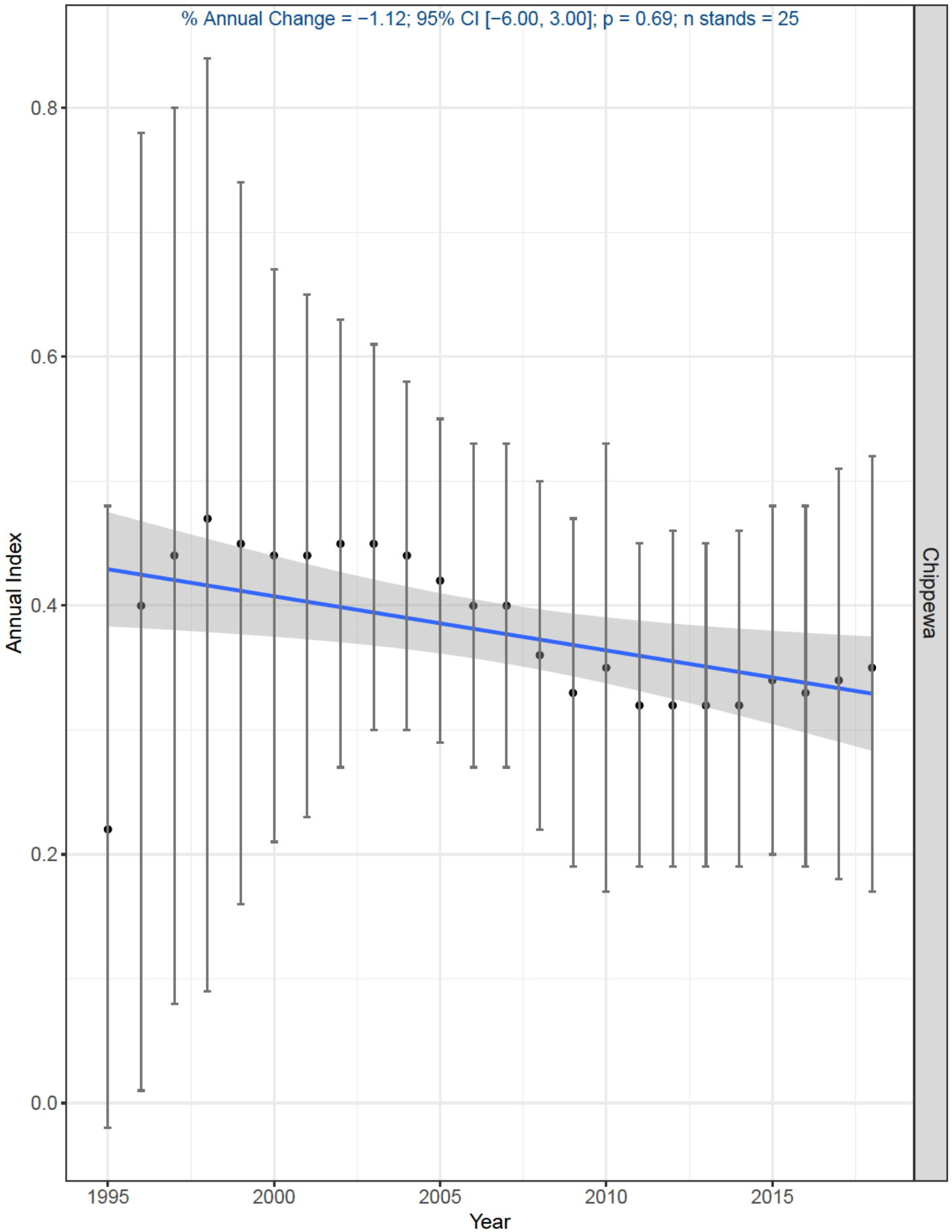


Golden-winged Warbler

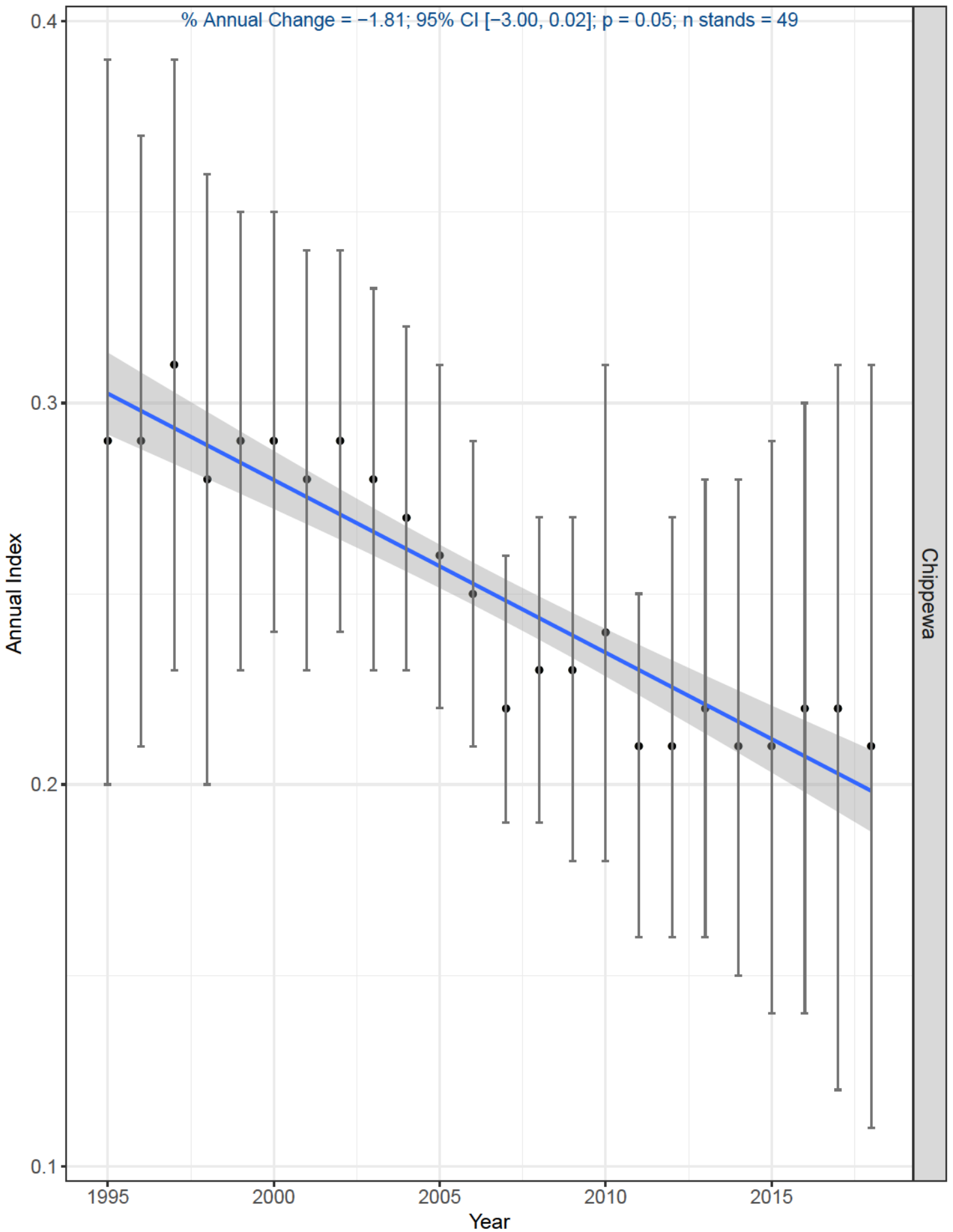


Gray Catbird

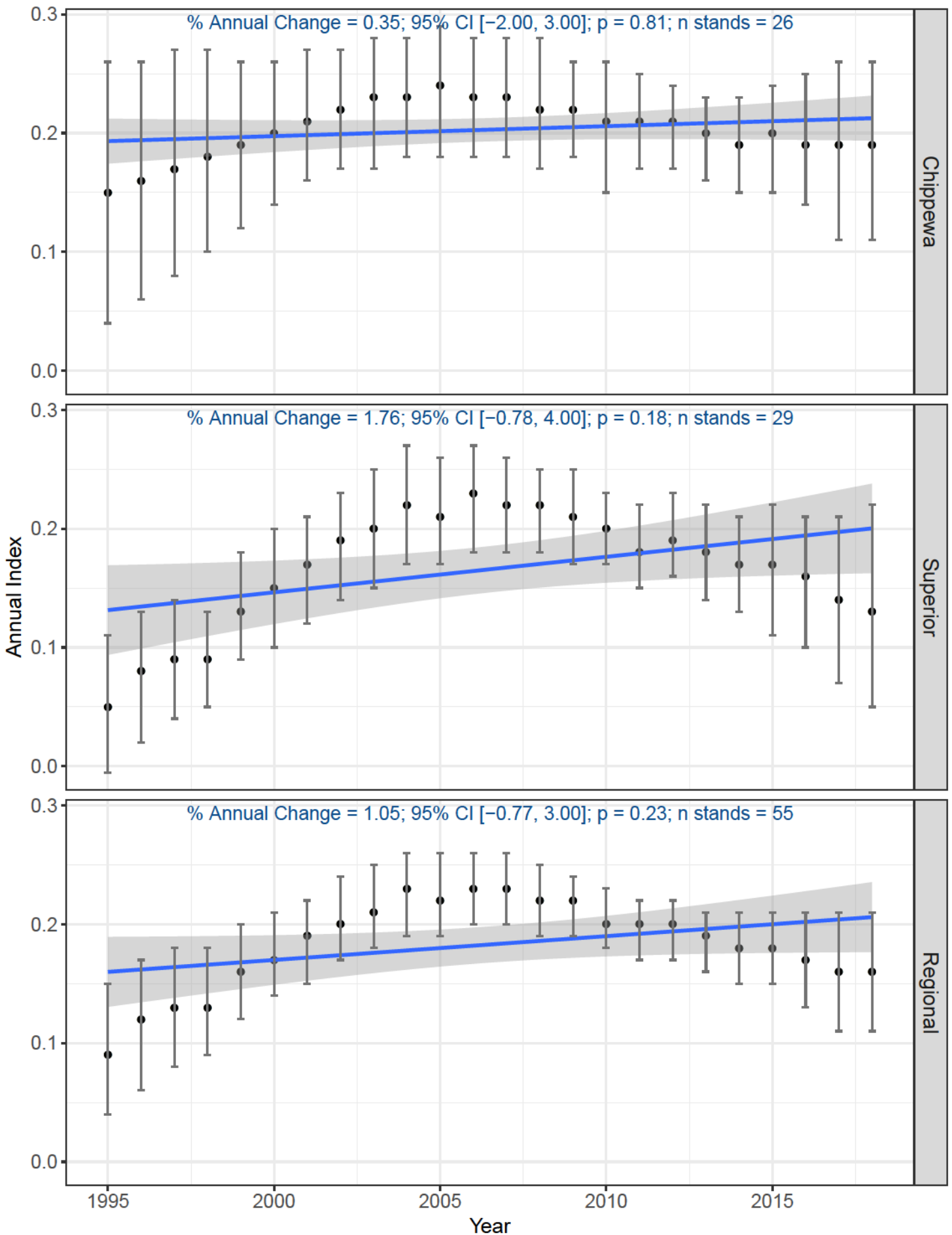
% Annual Change = -1.12; 95% CI [-6.00, 3.00]; p = 0.69; n stands = 25



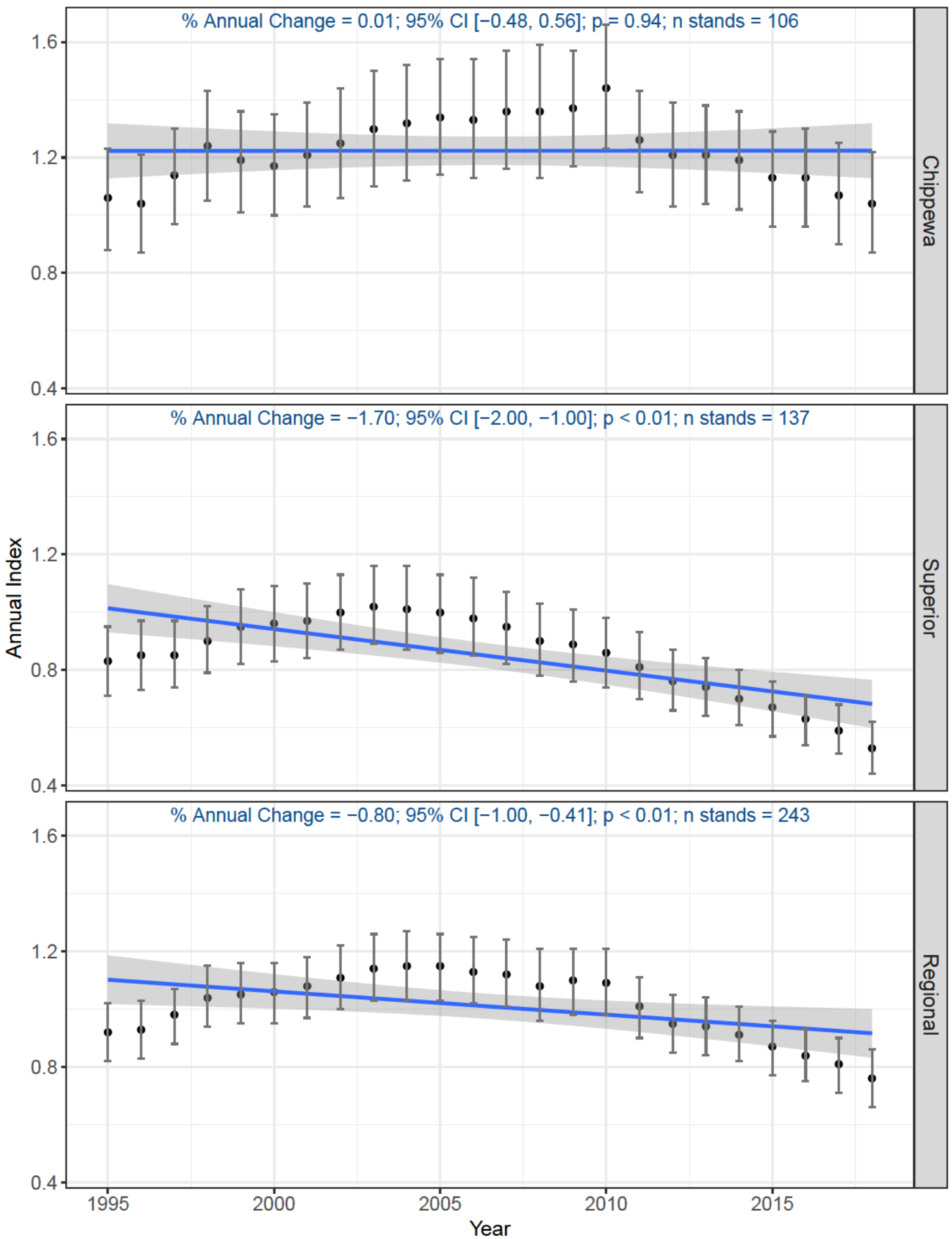
Great Crested Flycatcher



Hairy Woodpecker

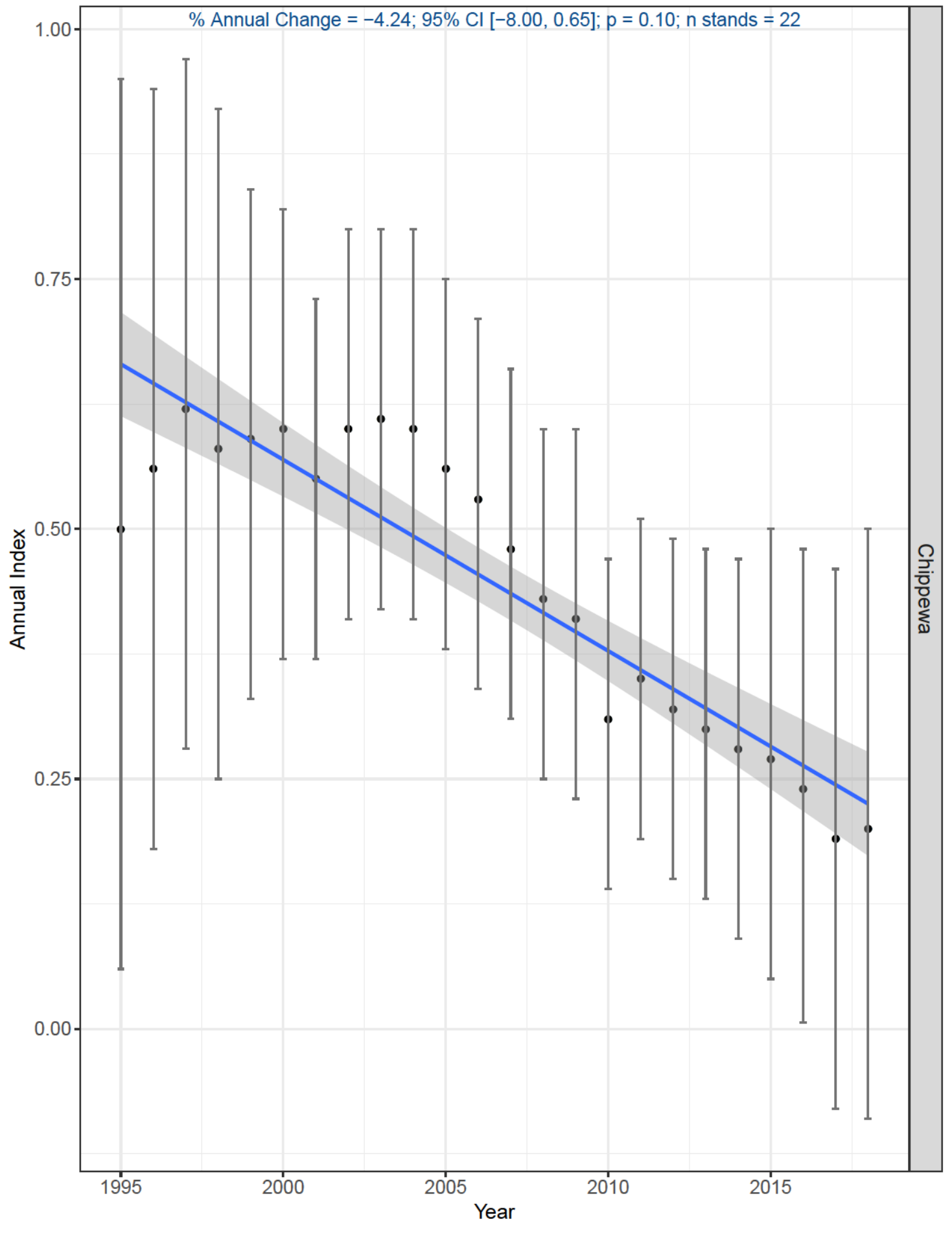


Hermit Thrush

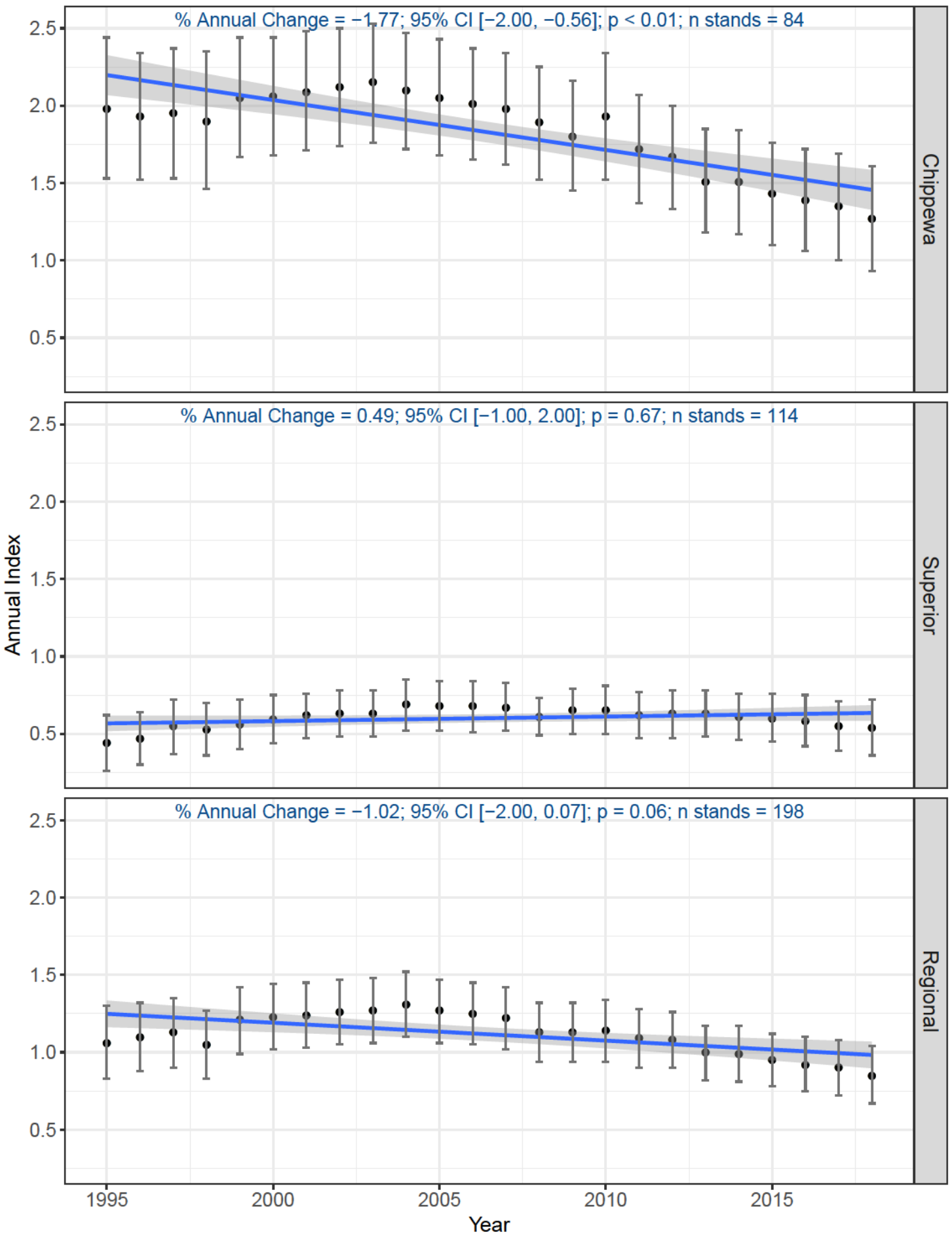


Indigo Bunting

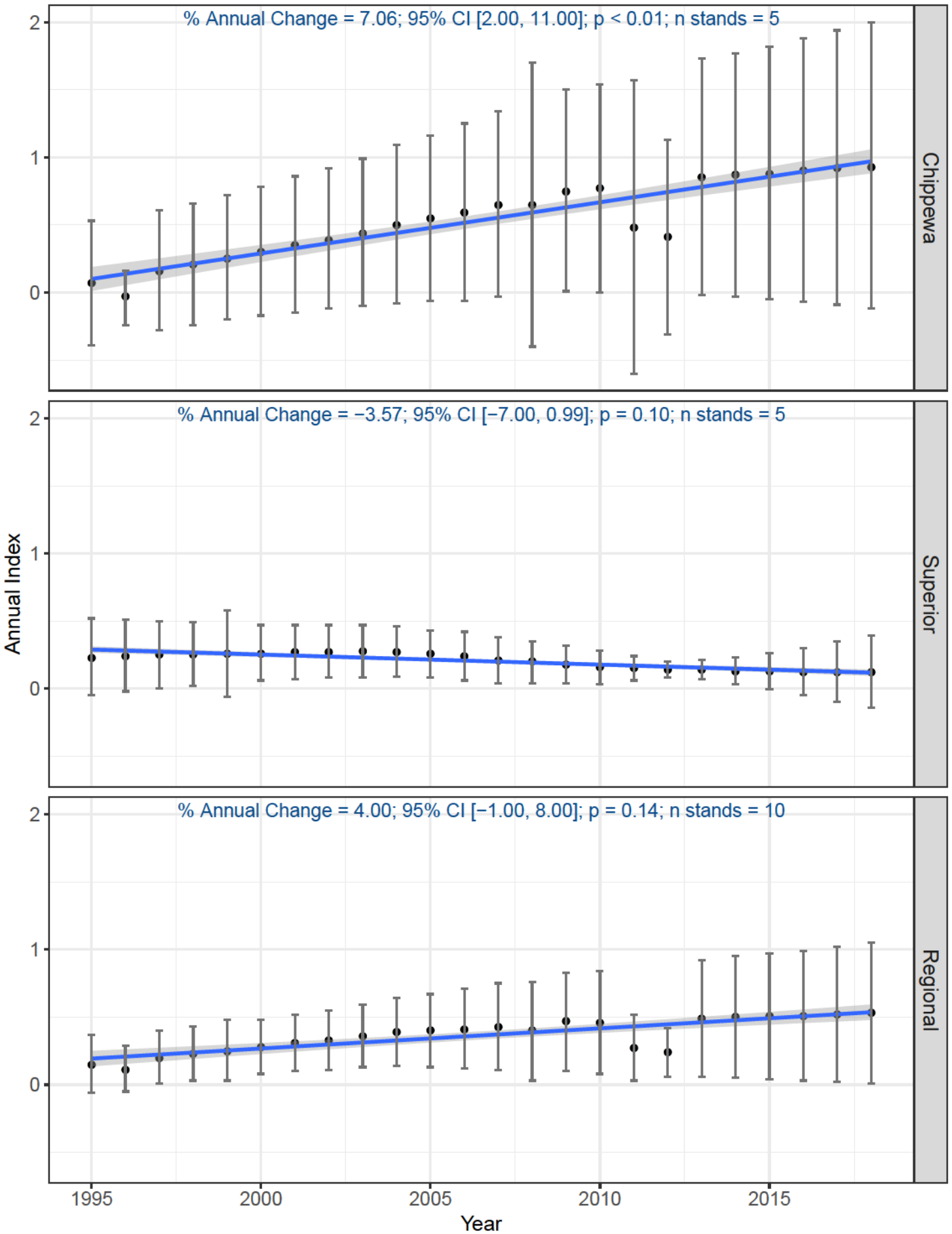
% Annual Change = -4.24; 95% CI [-8.00, 0.65]; p = 0.10; n stands = 22



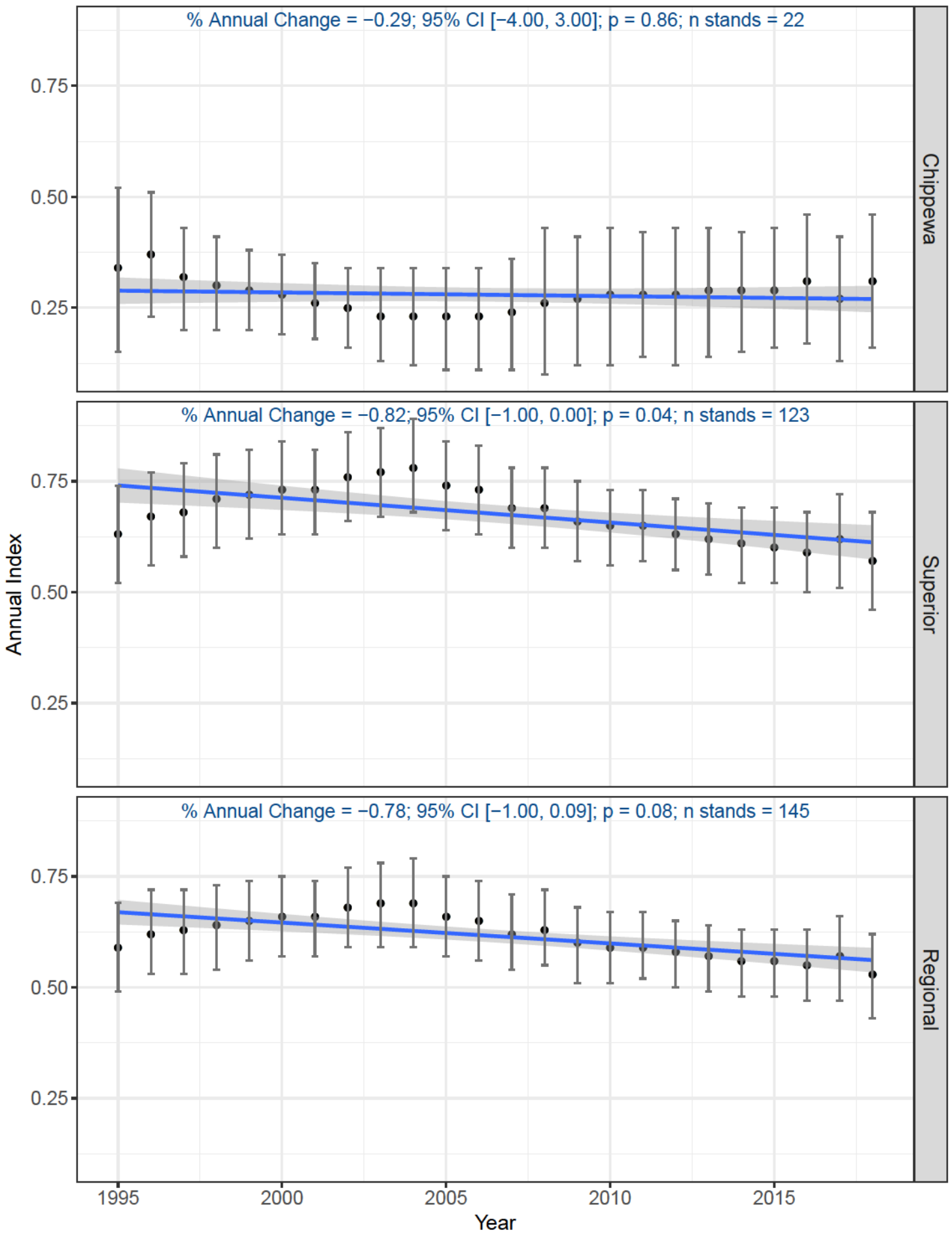
Least Flycatcher



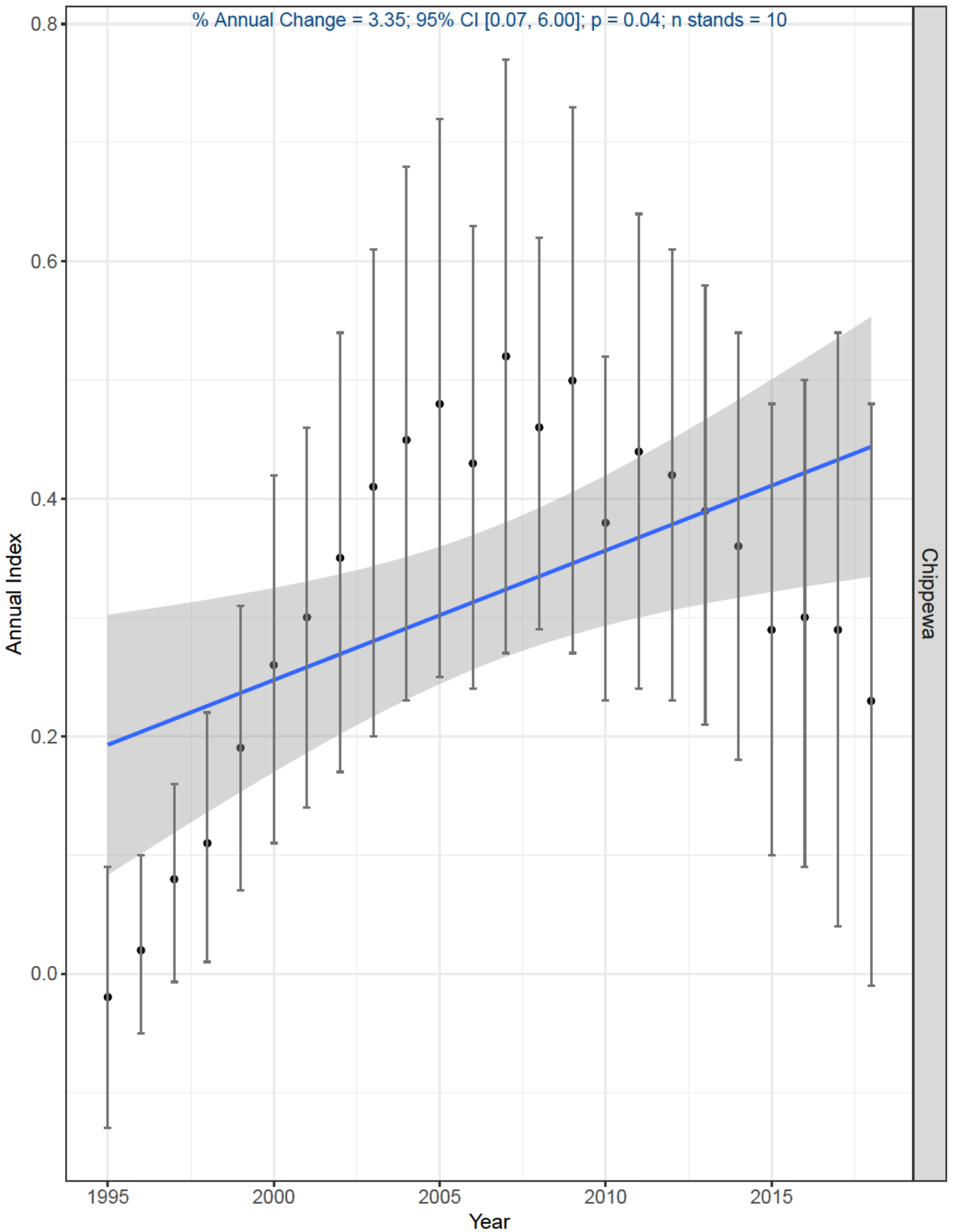
Lincoln's Sparrow



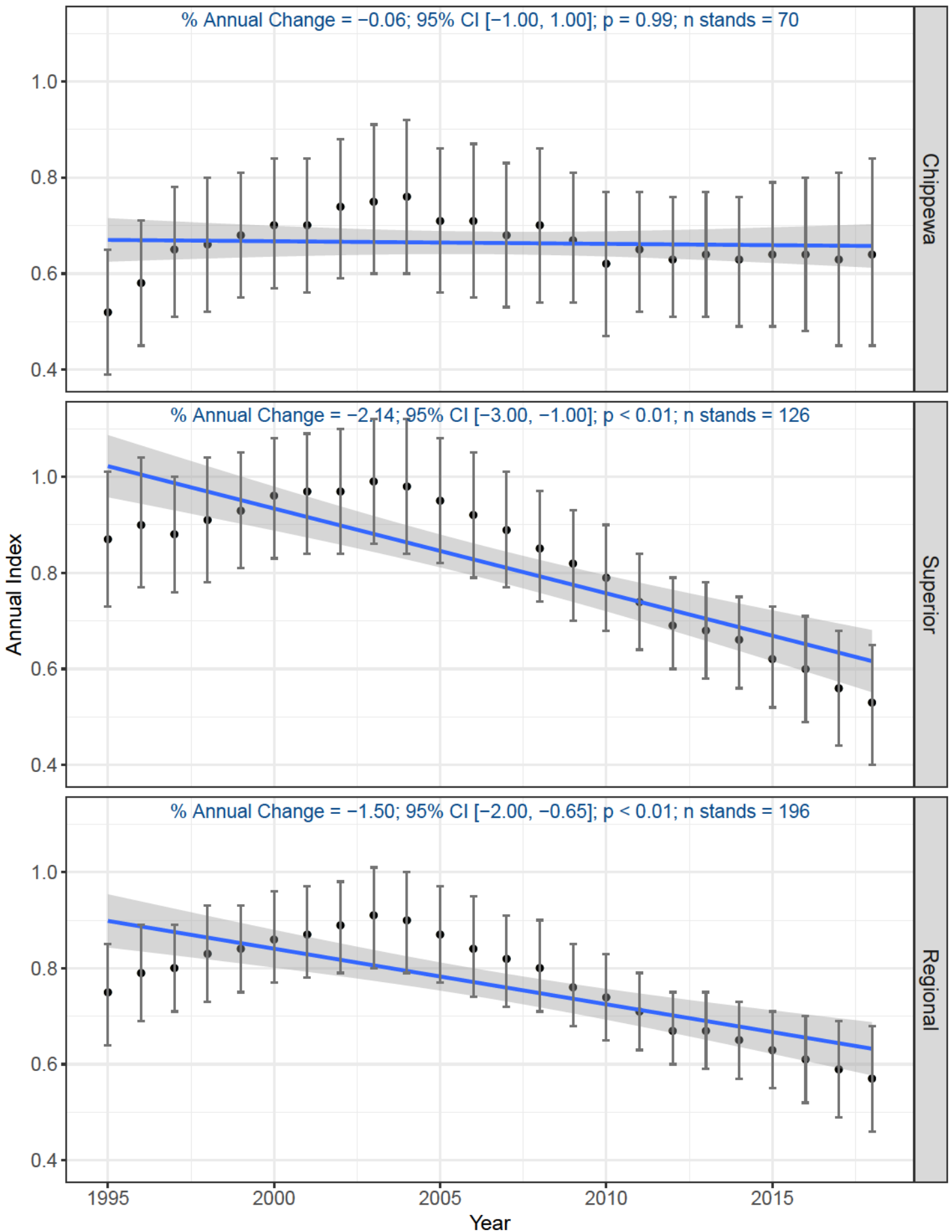
Magnolia Warbler



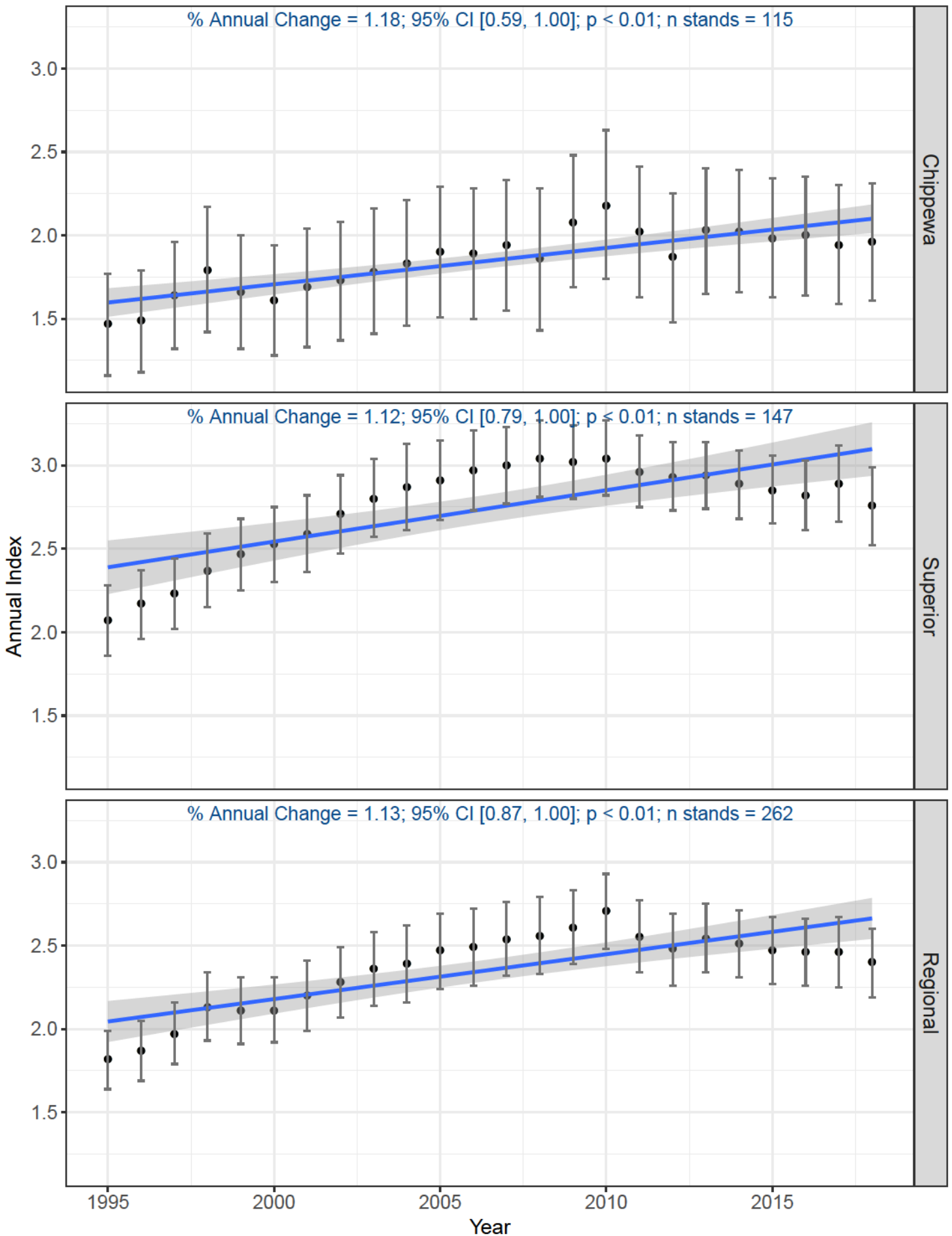
Mourning Dove



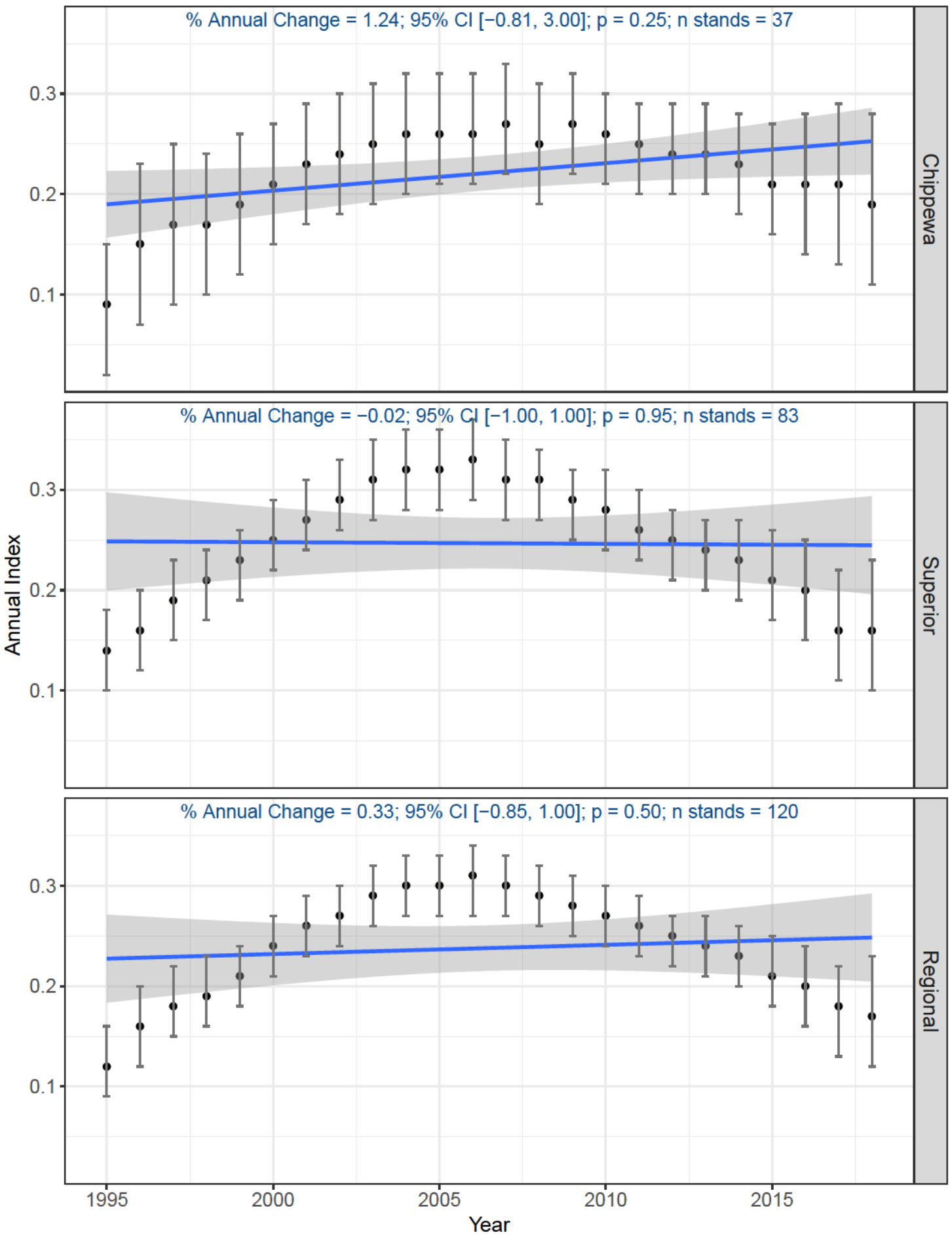
Mourning Warbler



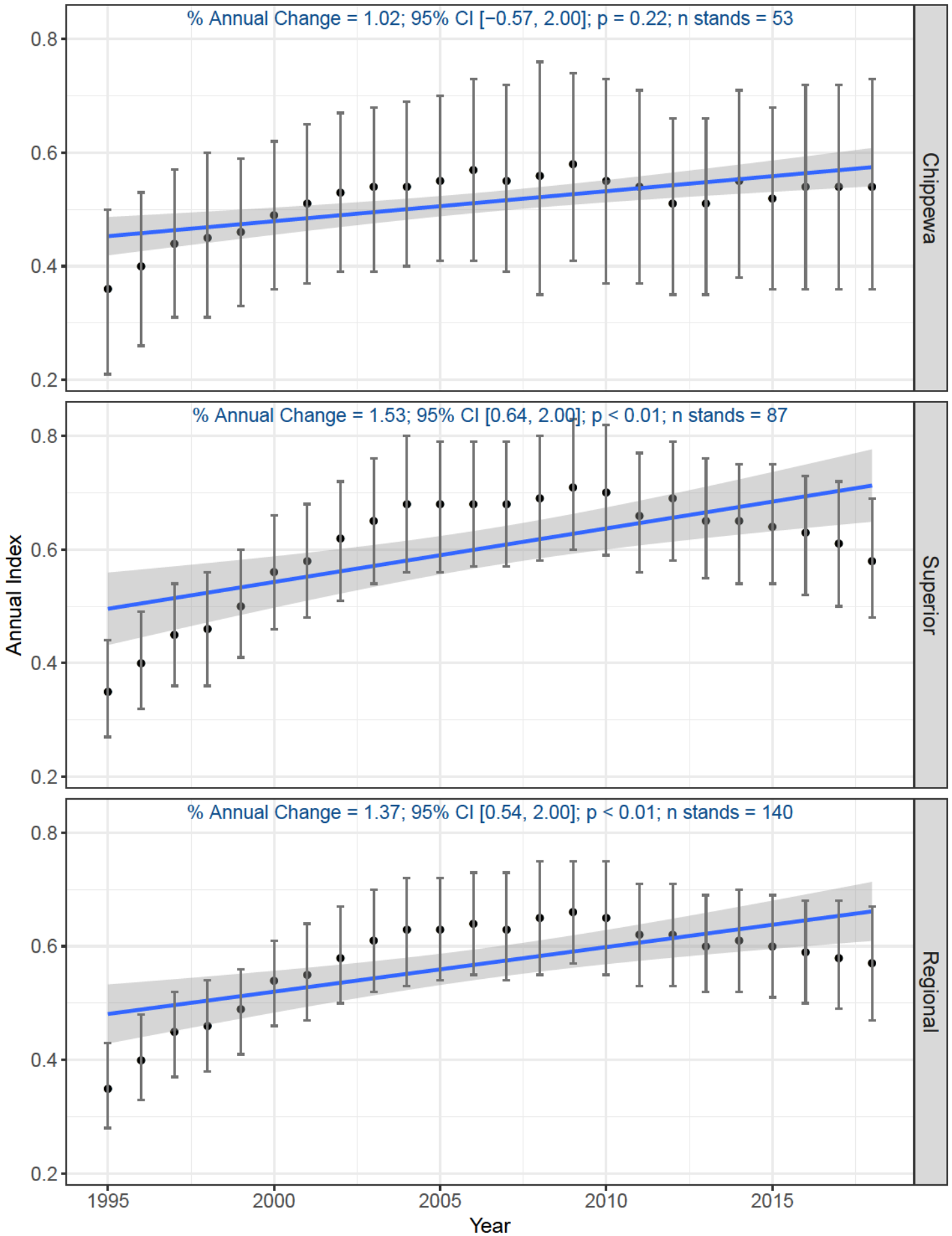
Nashville Warbler



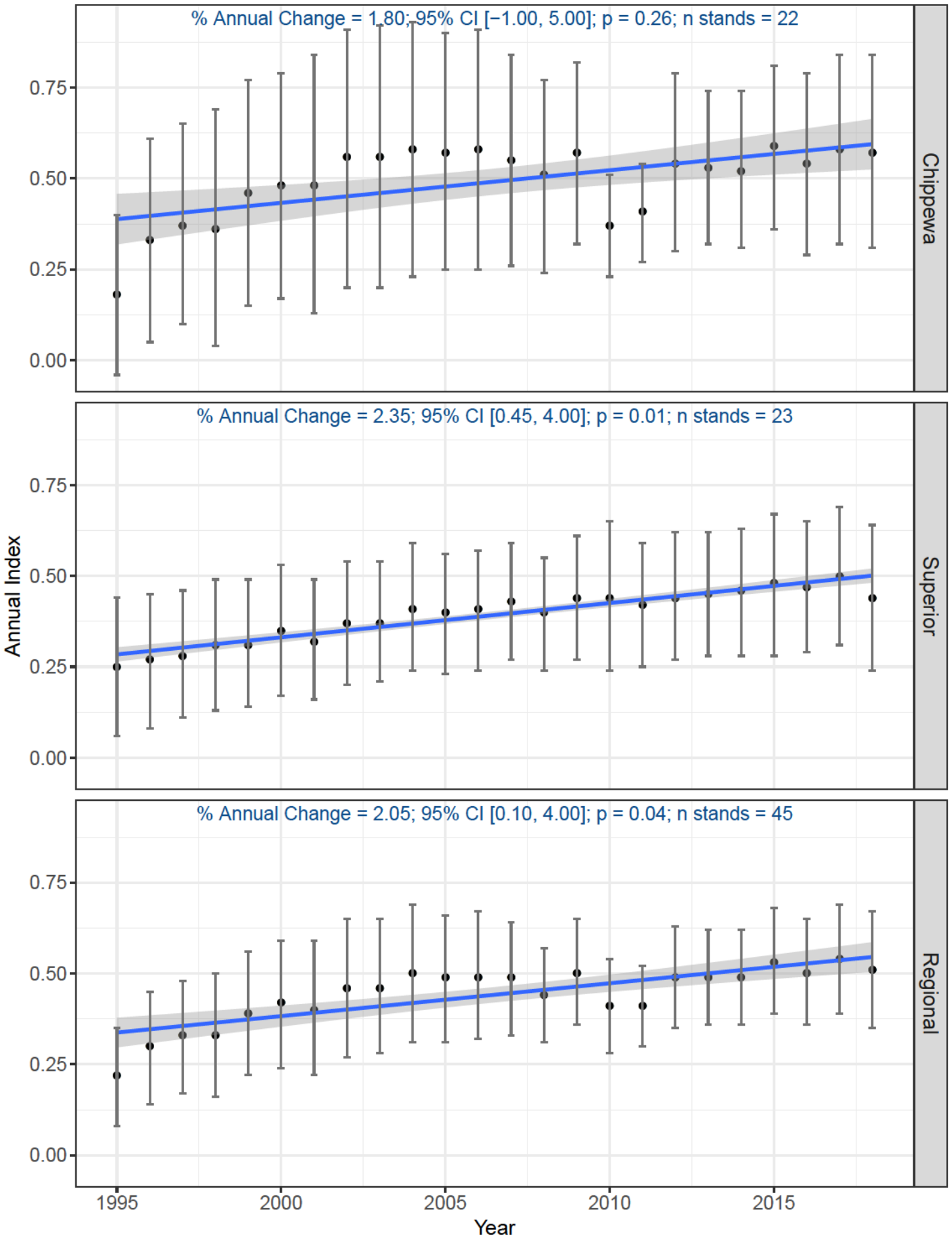
Northern Flicker (Yellow-shafted)



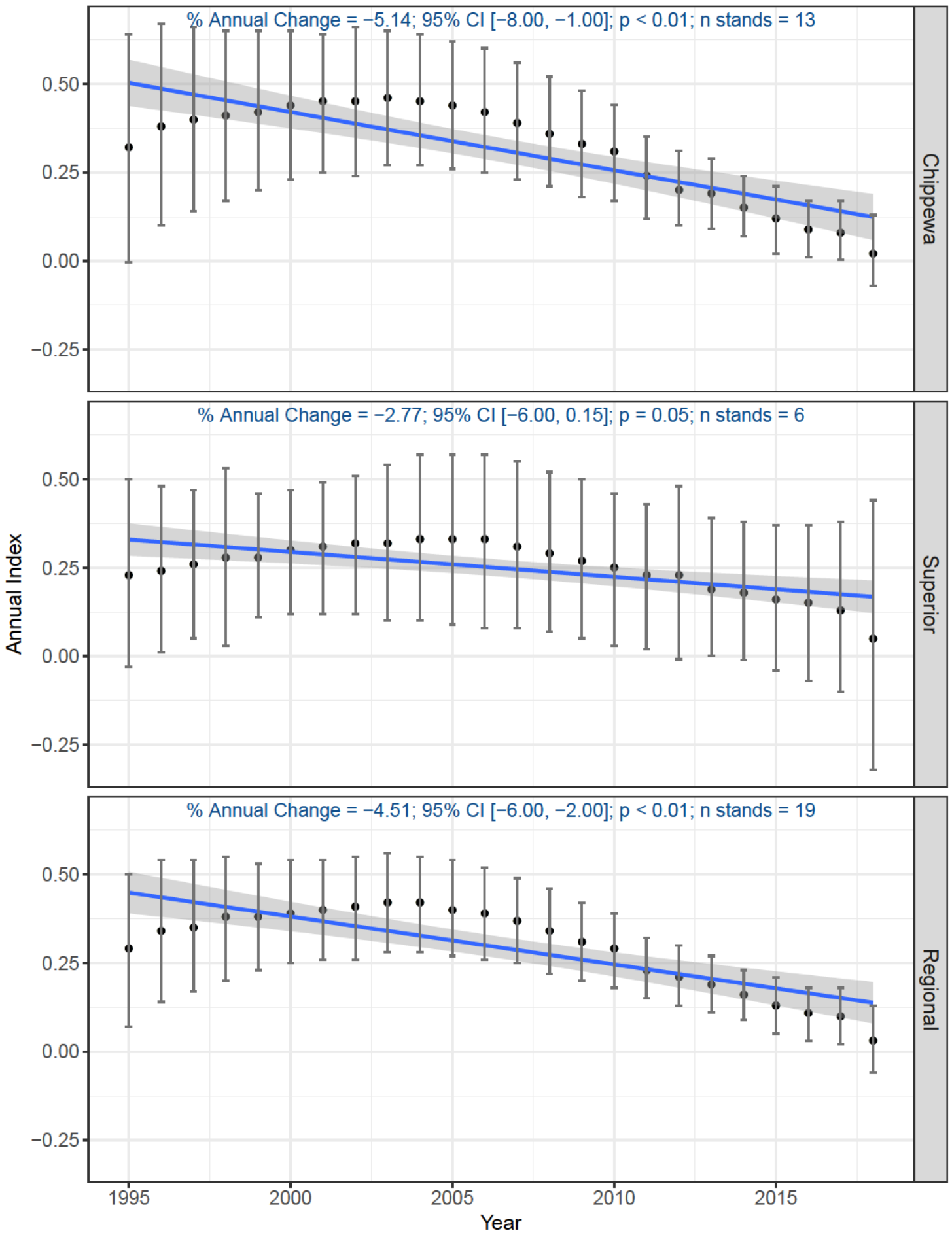
Northern Parula



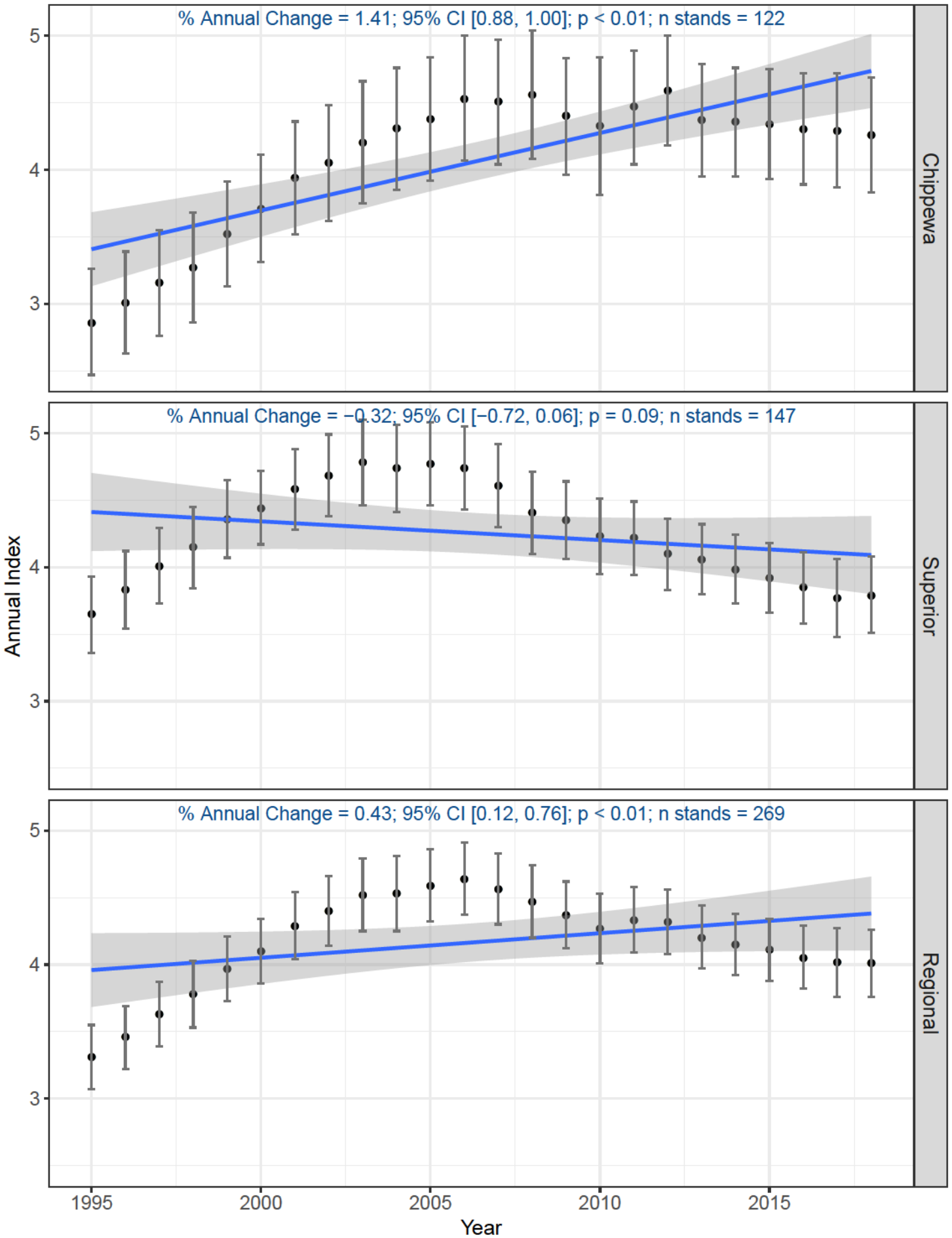
Northern Waterthrush



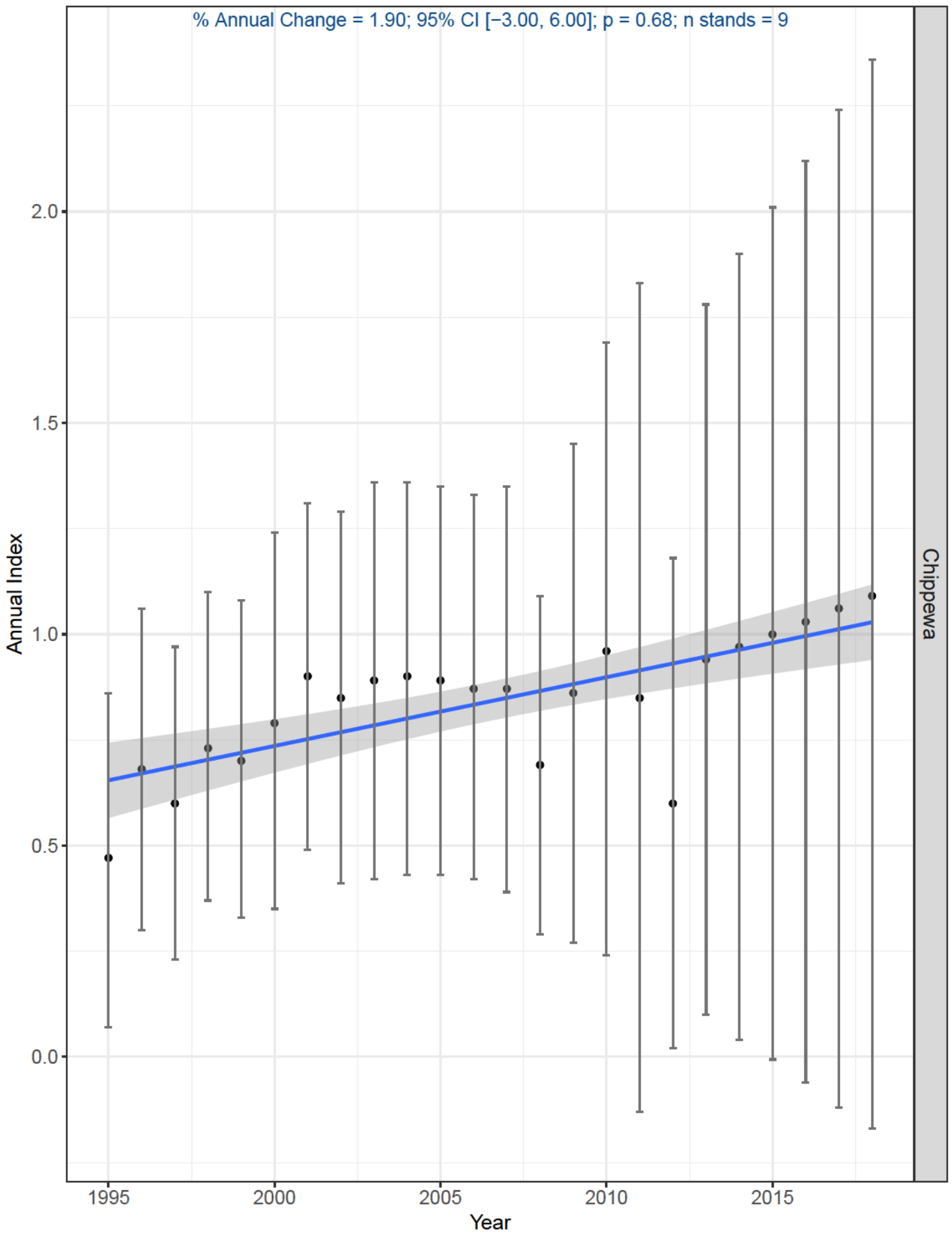
Olive-sided Flycatcher



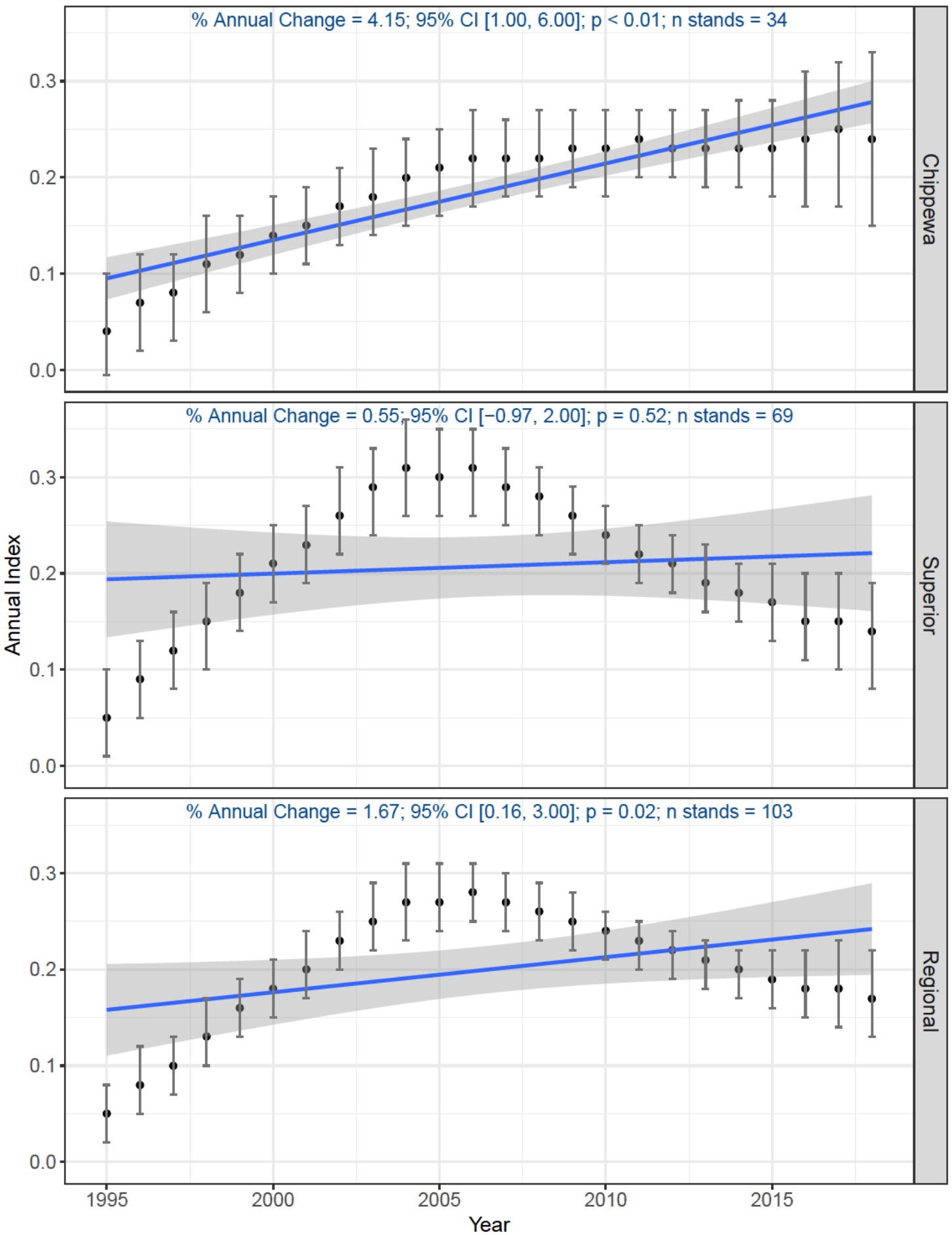
Ovenbird



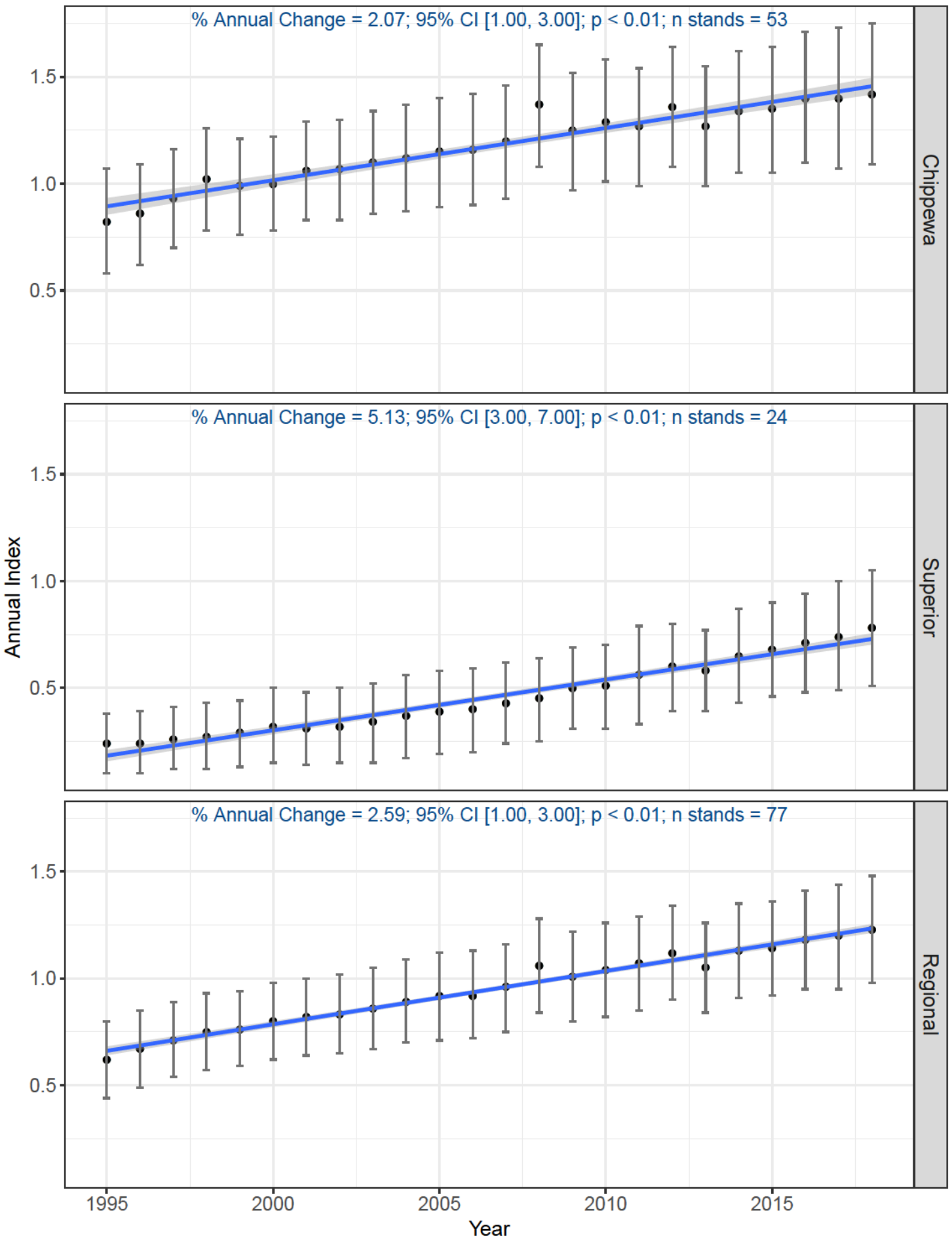
Palm Warbler (Western)



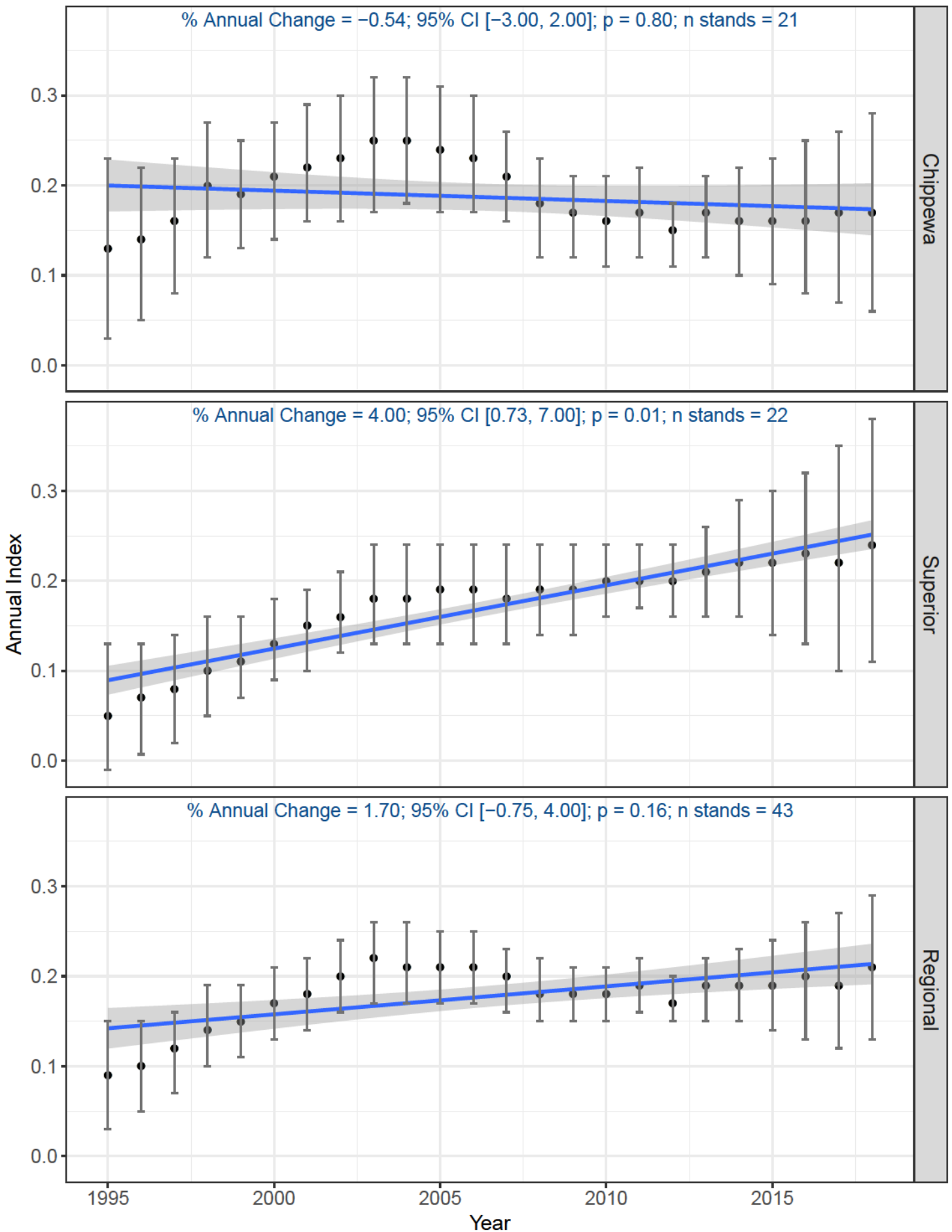
Pileated Woodpecker



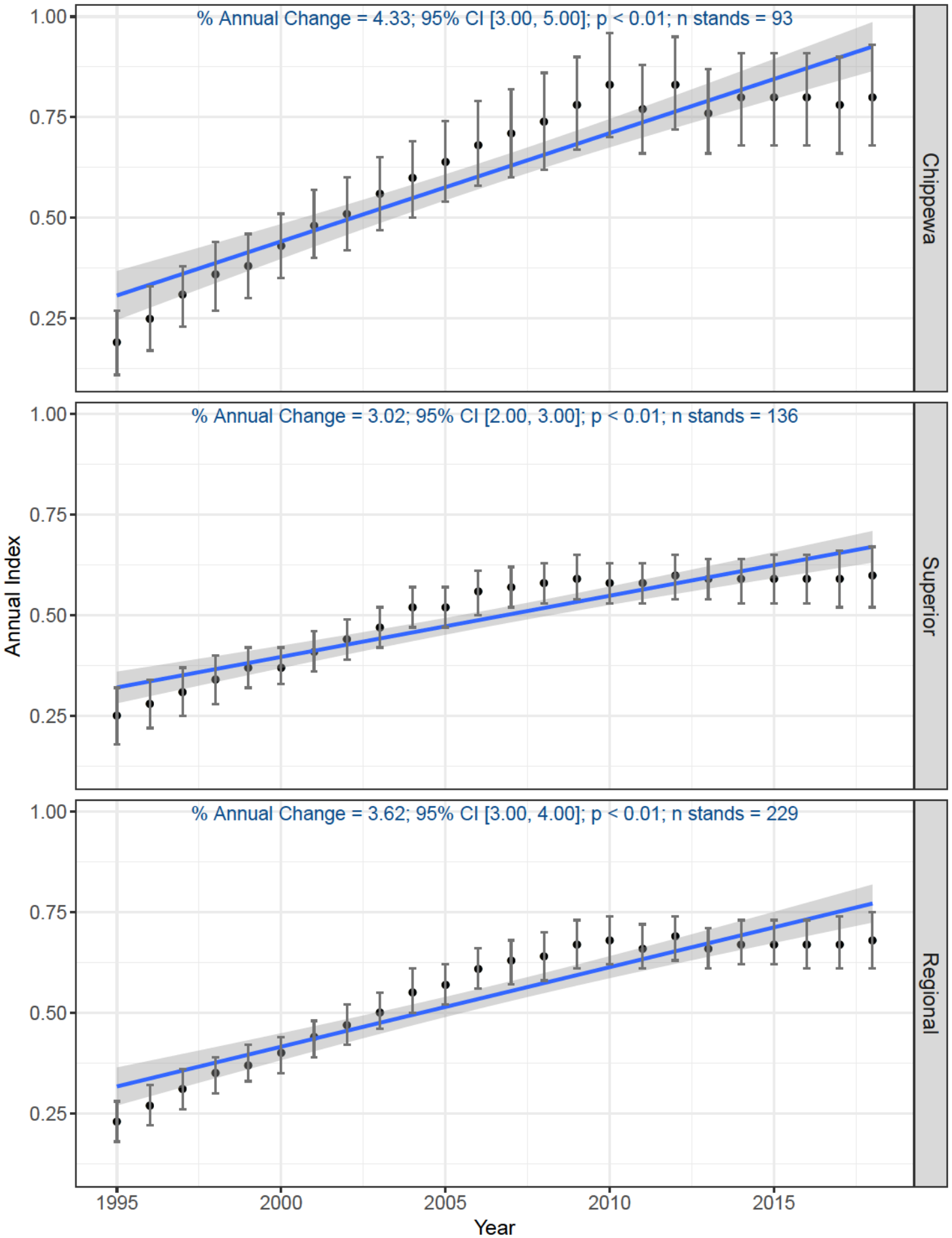
Pine Warbler



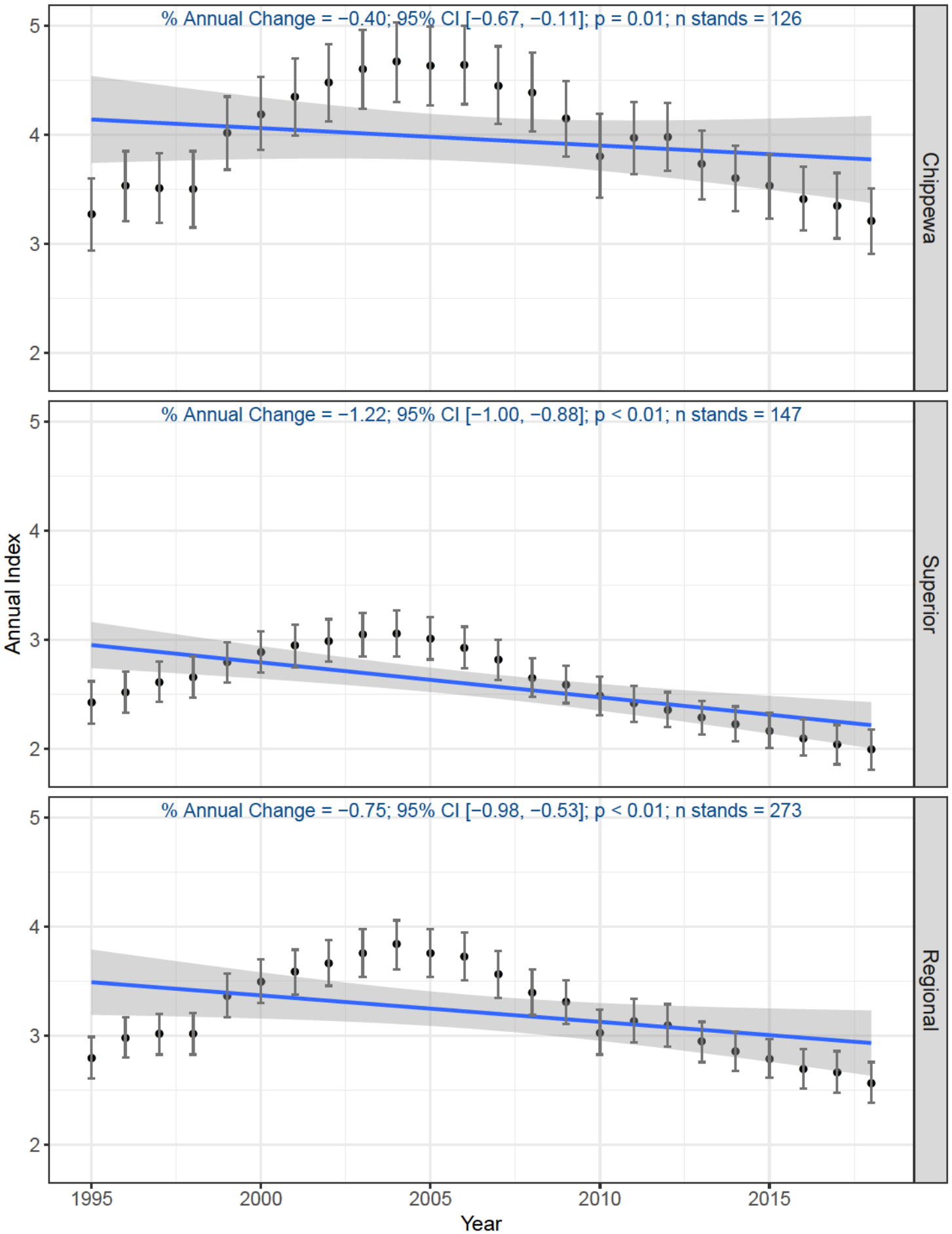
Purple Finch



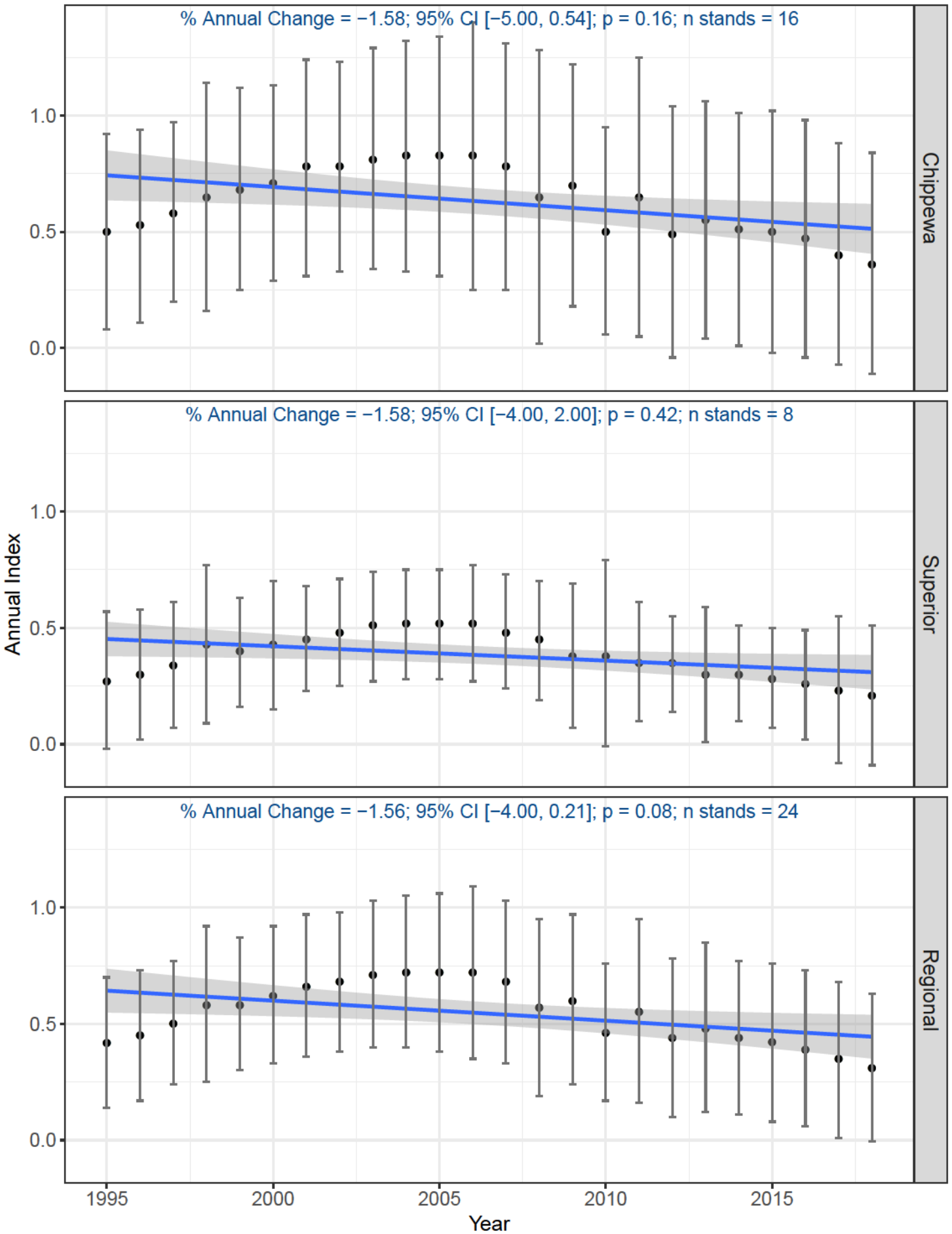
Red-breasted Nuthatch



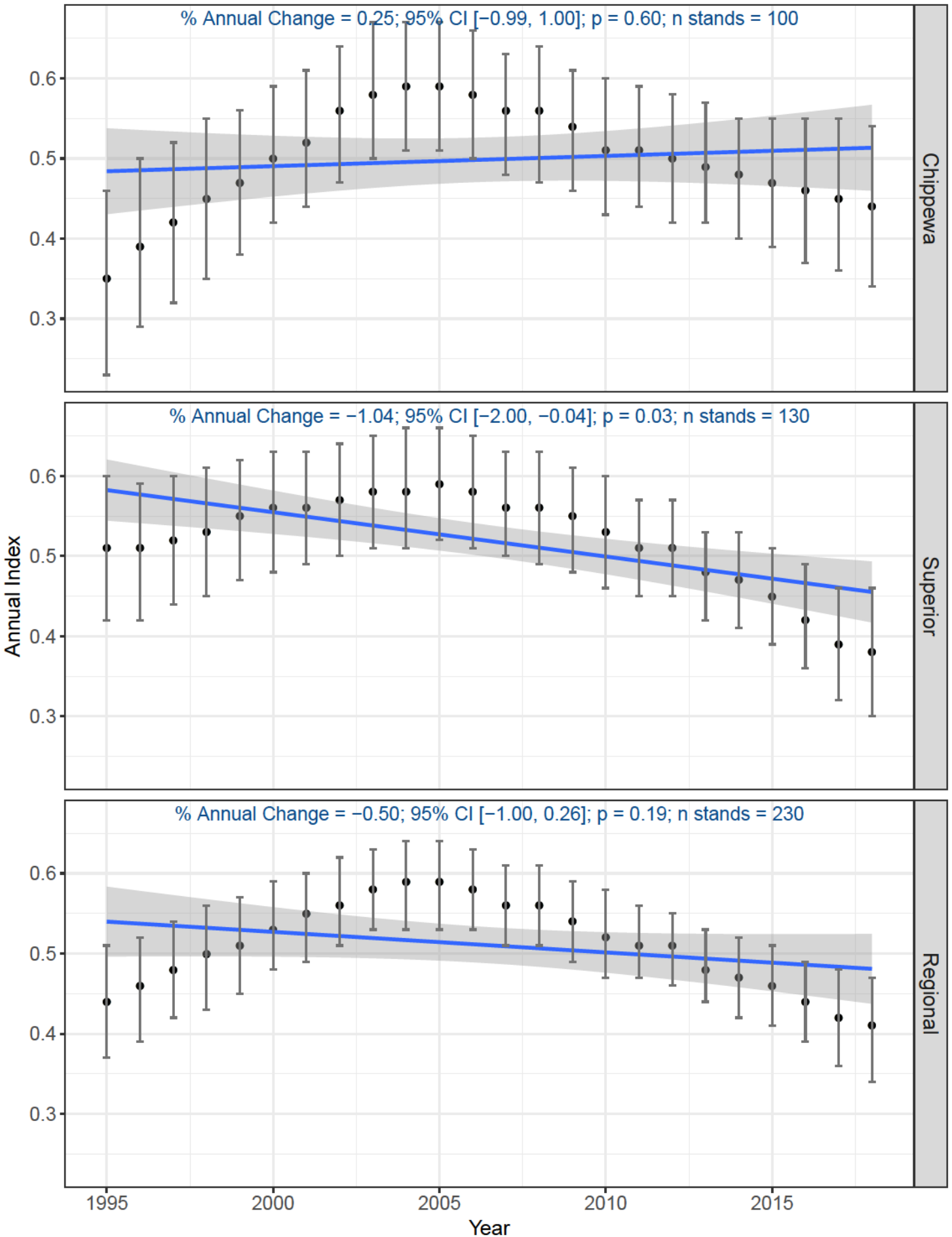
Red-eyed Vireo



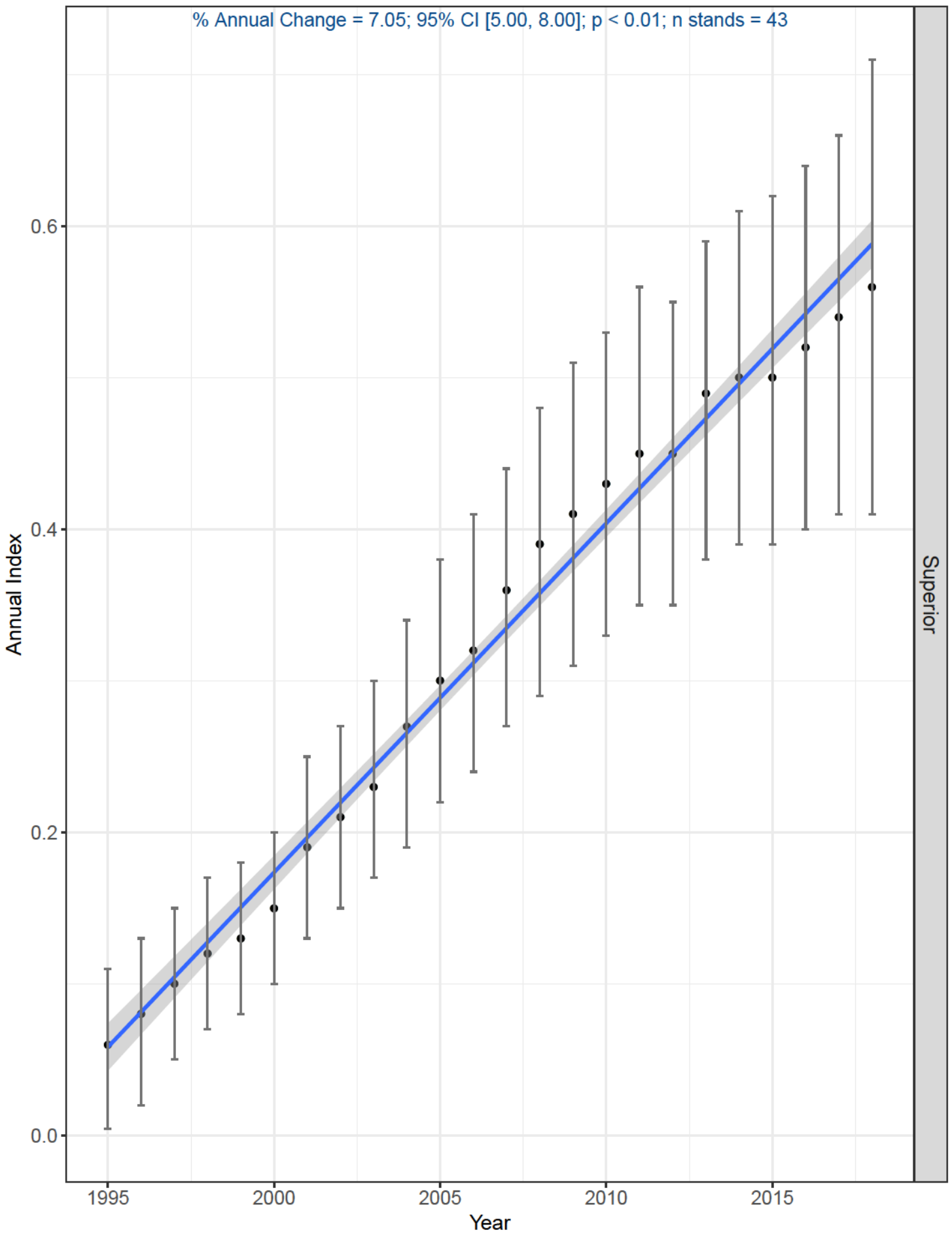
Red-winged Blackbird



Rose-breasted Grosbeak

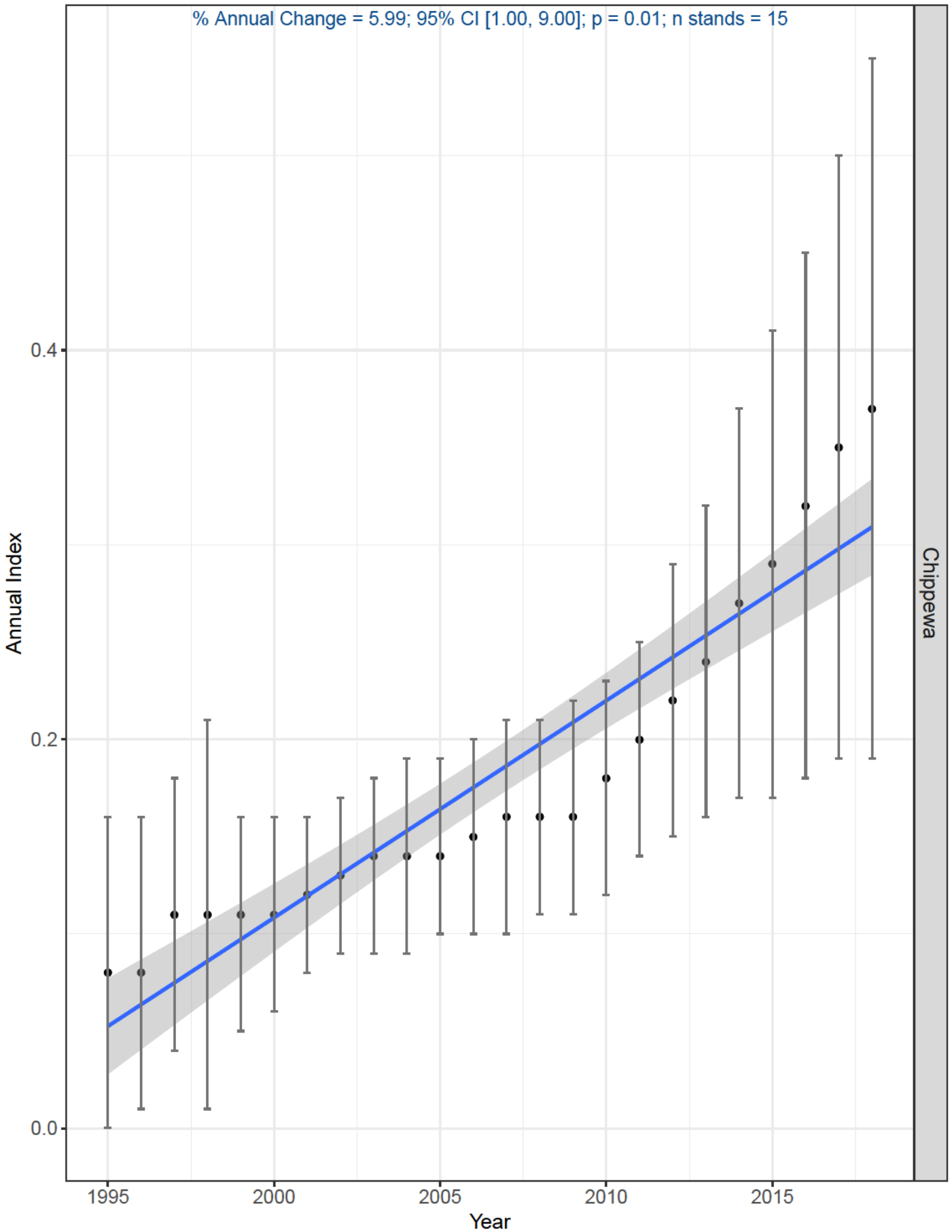


Ruby-crowned Kinglet



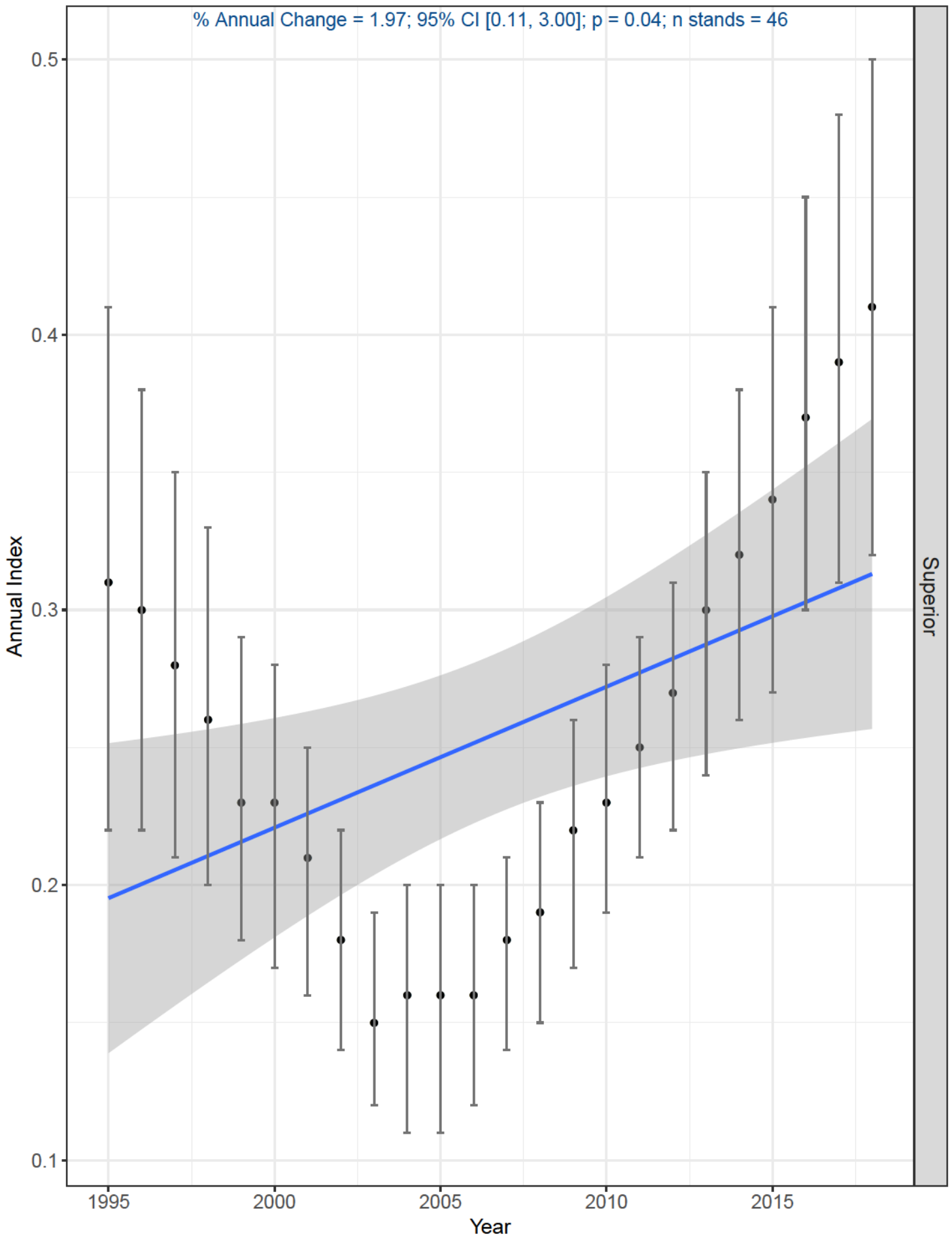
Ruby-throated Hummingbird

% Annual Change = 5.99; 95% CI [1.00, 9.00]; p = 0.01; n stands = 15

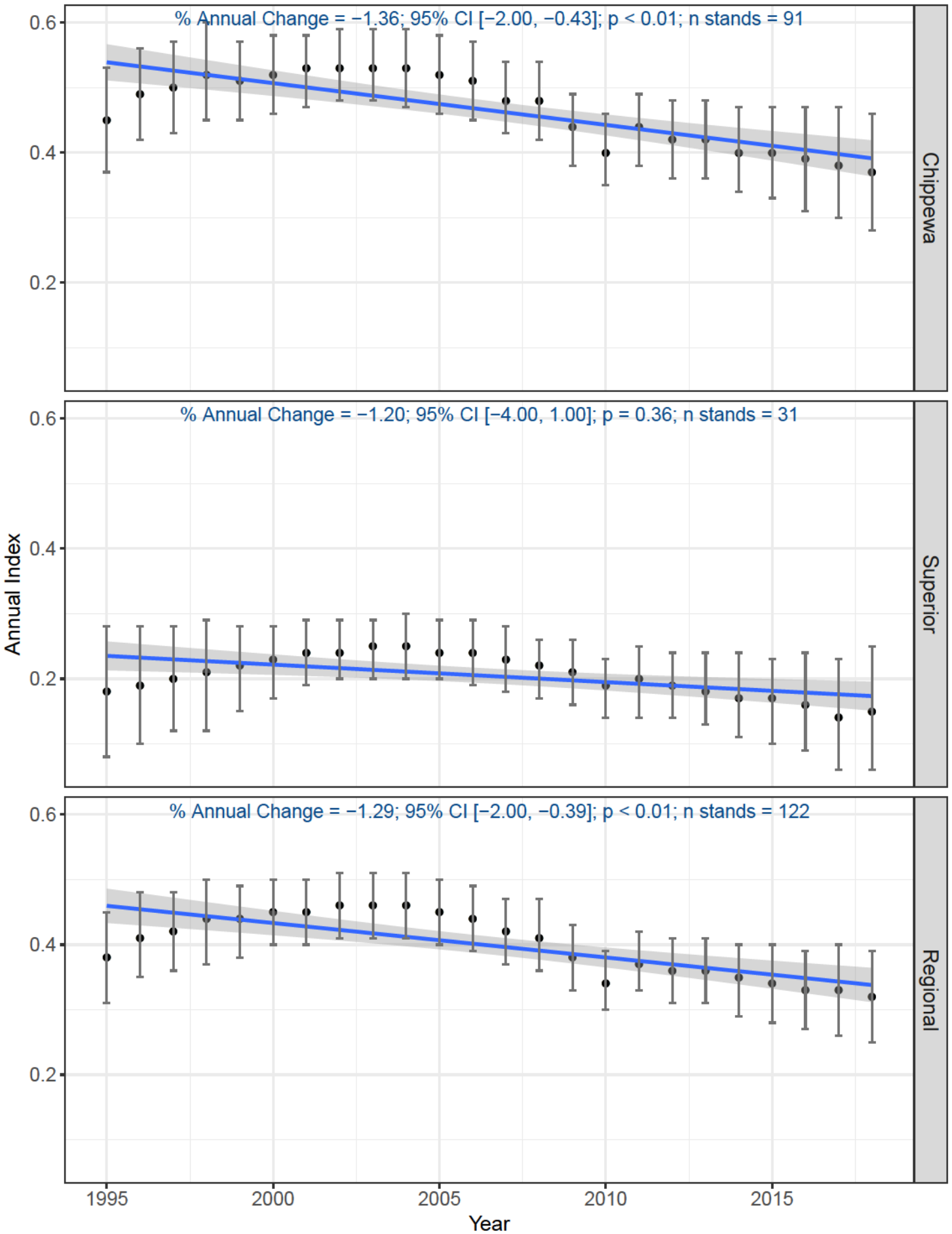


Ruffed Grouse

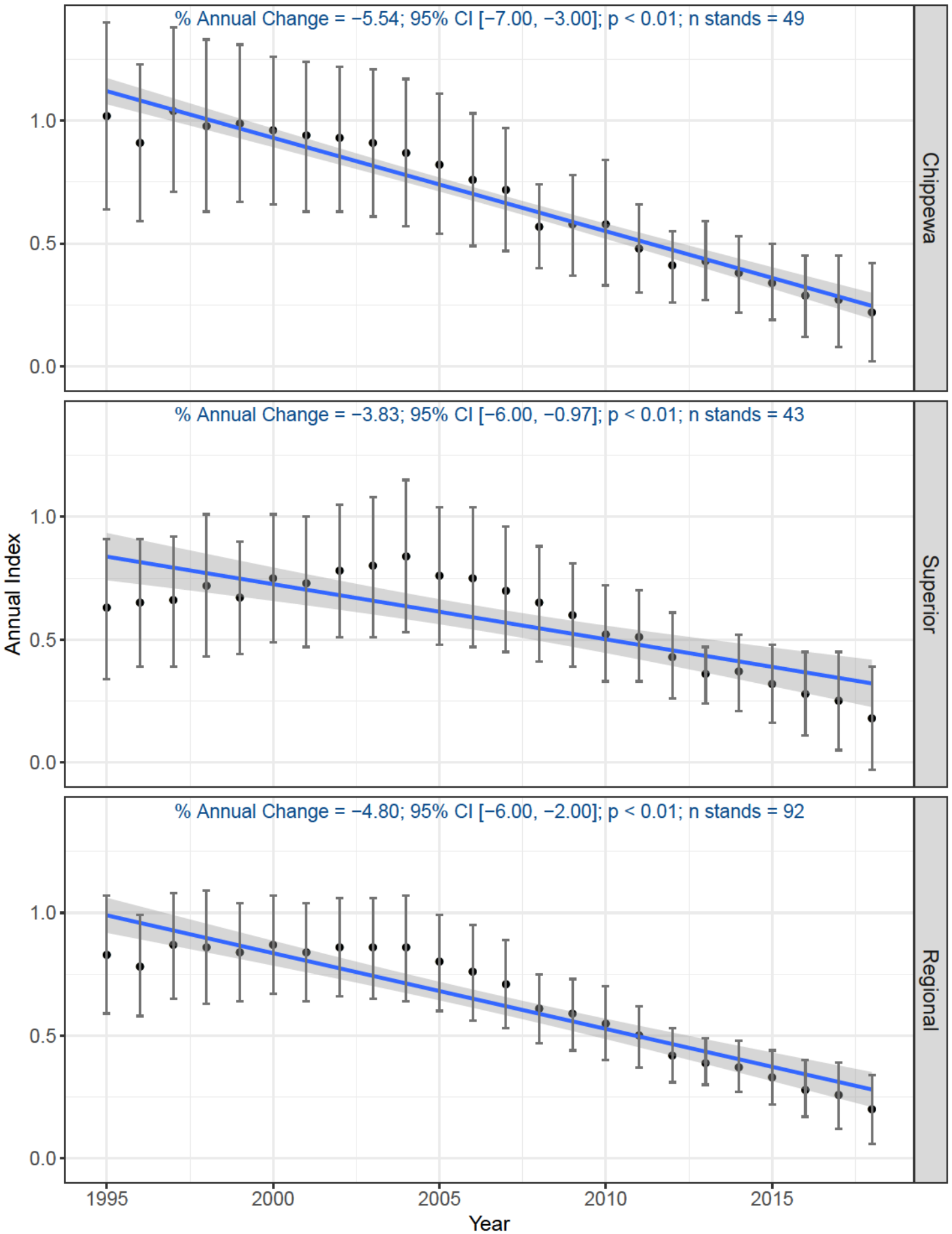
% Annual Change = 1.97; 95% CI [0.11, 3.00]; p = 0.04; n stands = 46



Scarlet Tanager

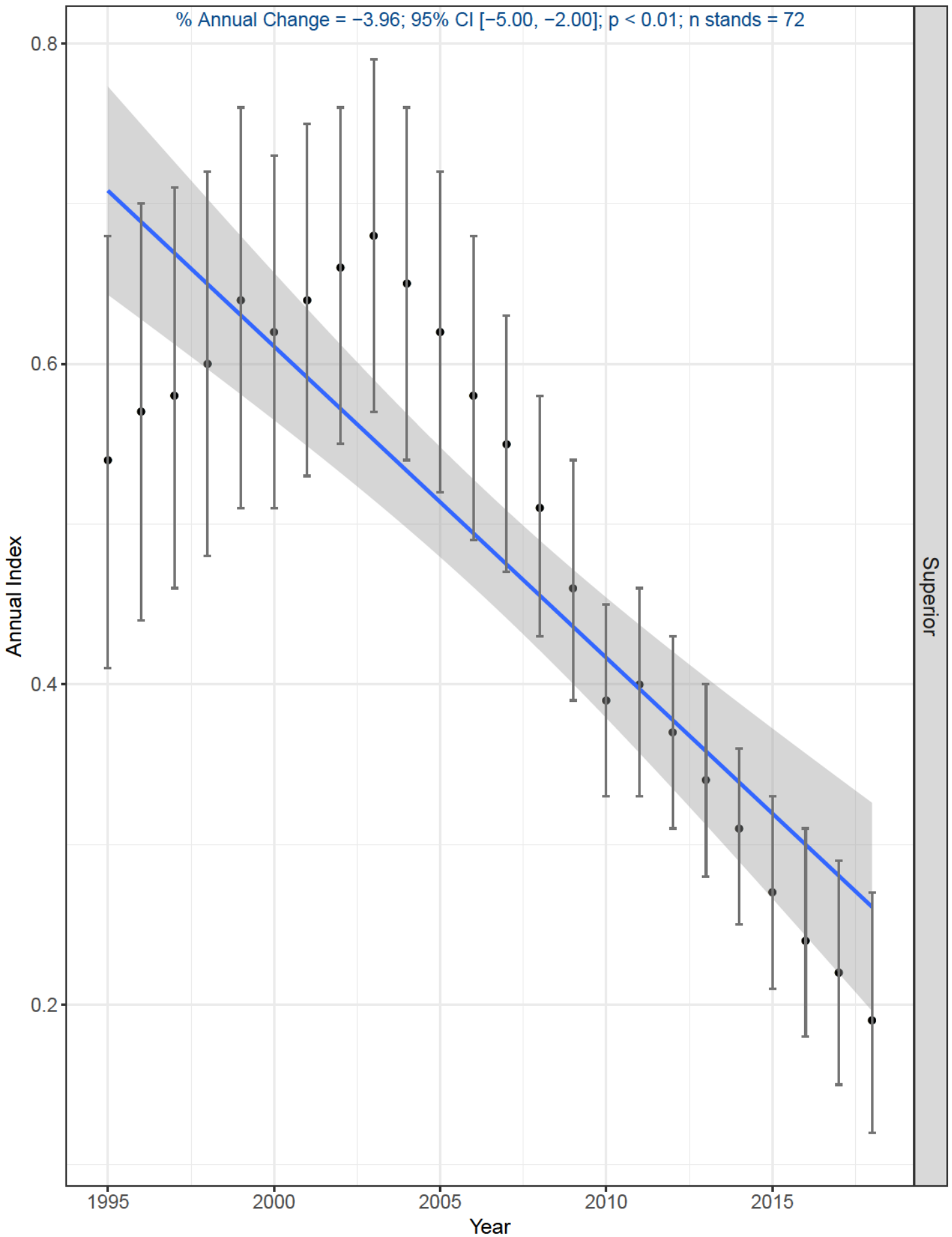


Song Sparrow

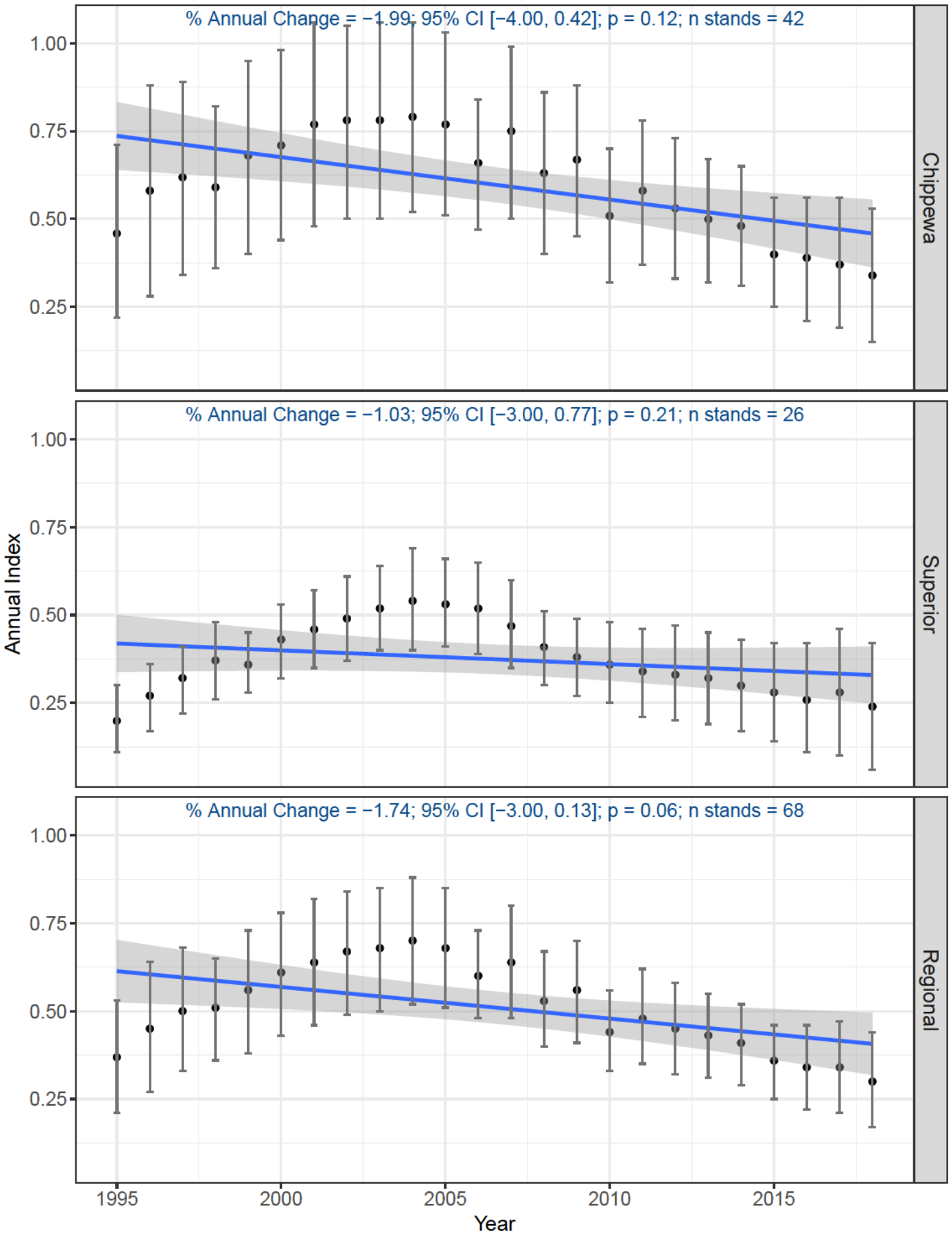


Swainson's Thrush

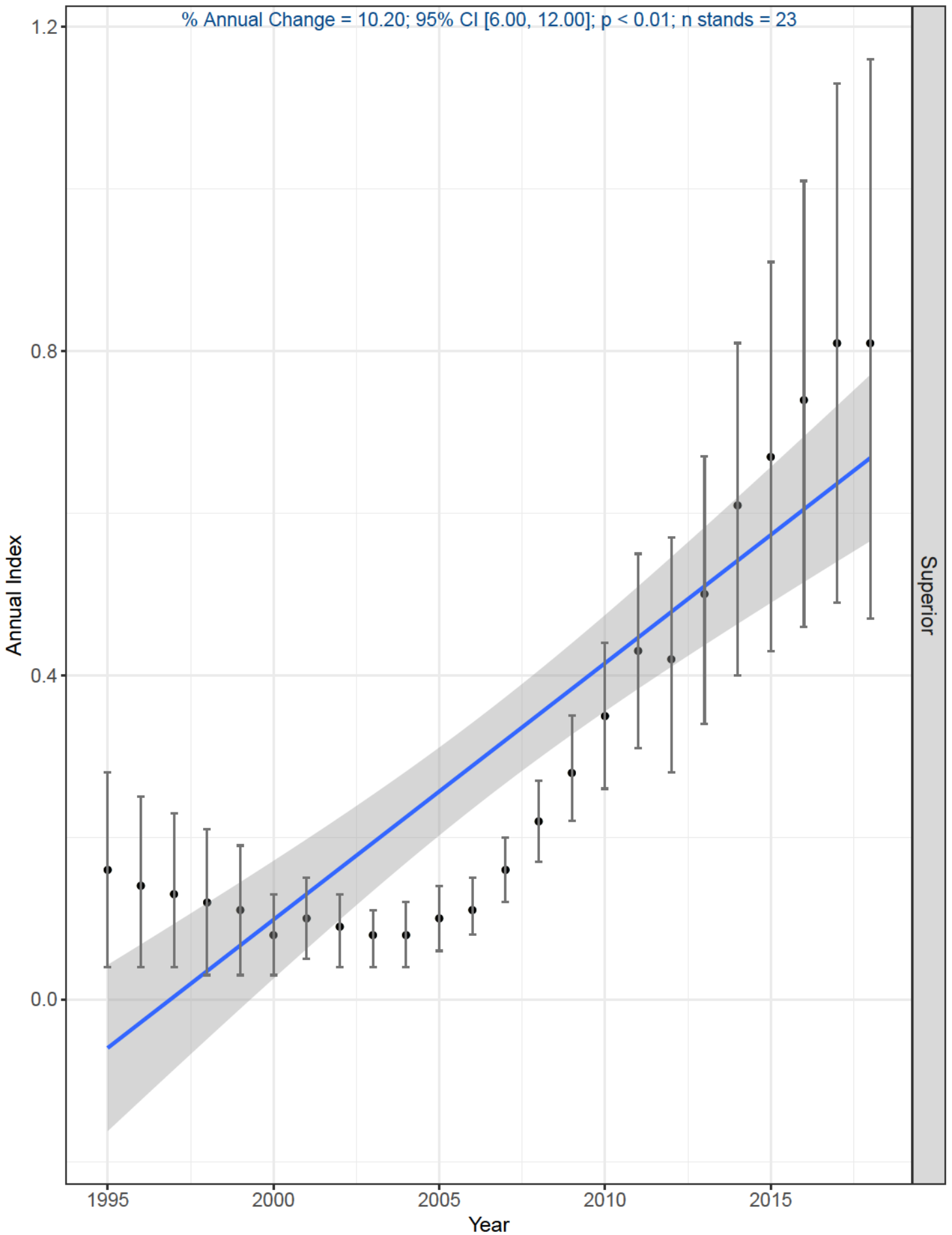
% Annual Change = -3.96; 95% CI [-5.00, -2.00]; p < 0.01; n stands = 72



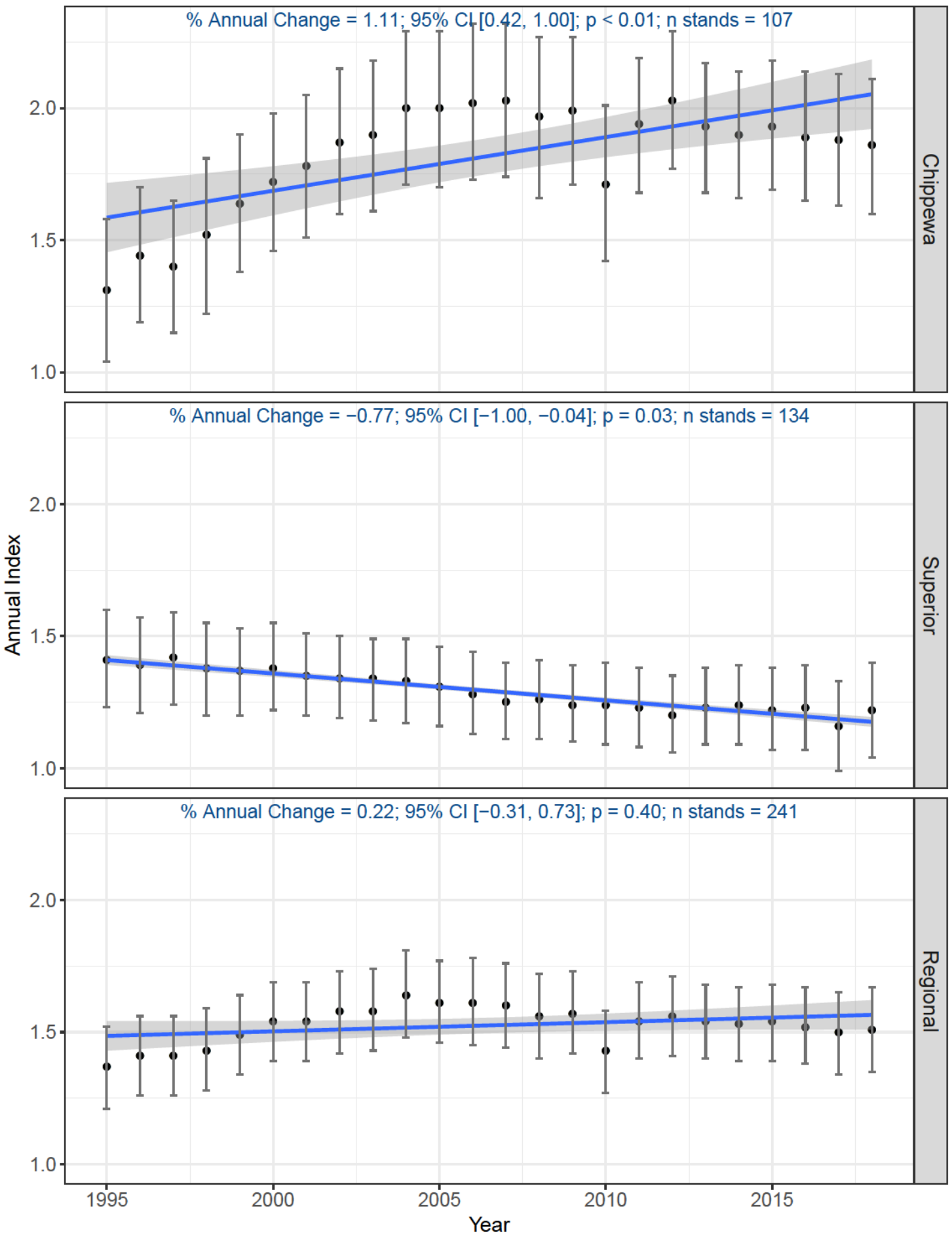
Swamp Sparrow



Tennessee Warbler

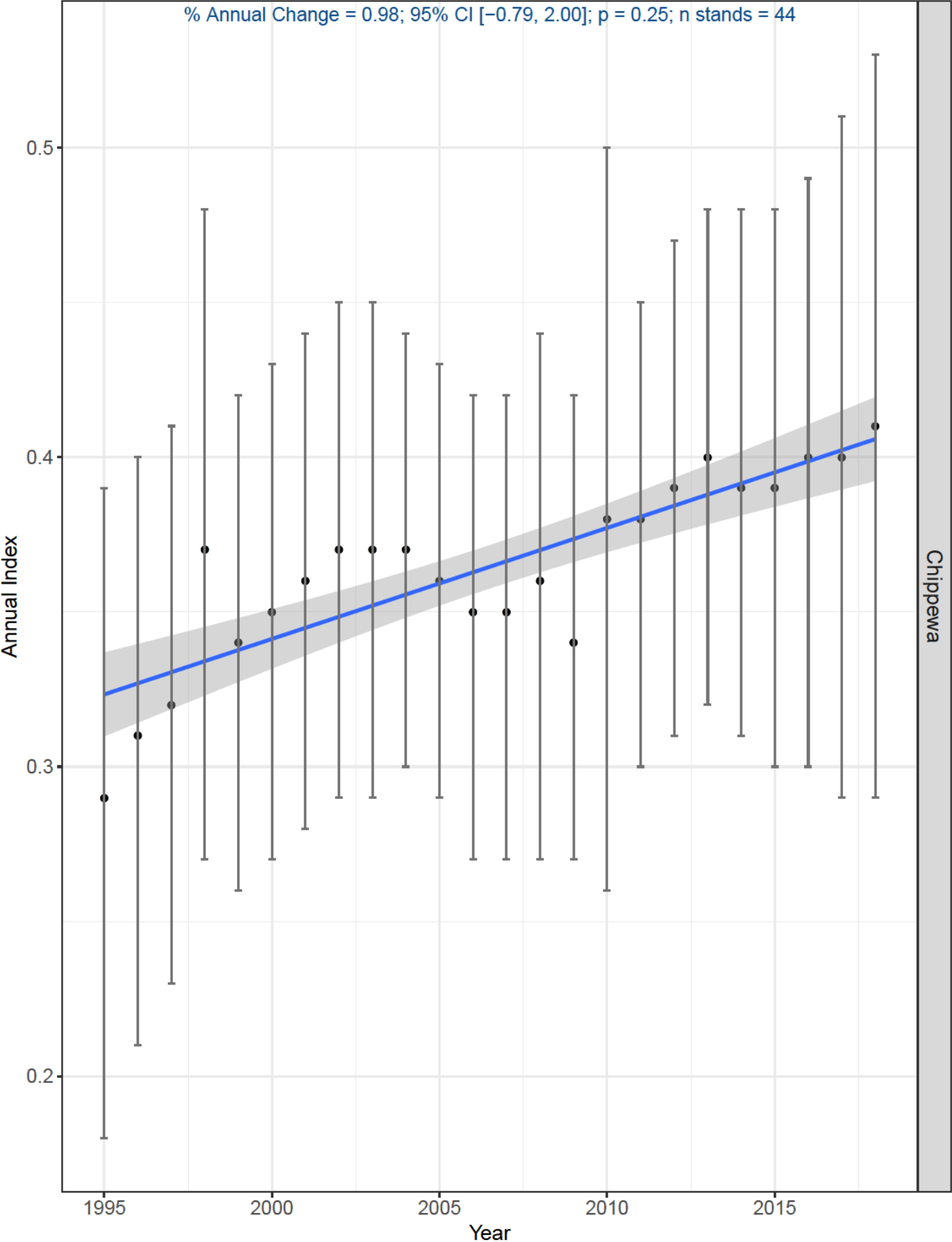


Veery

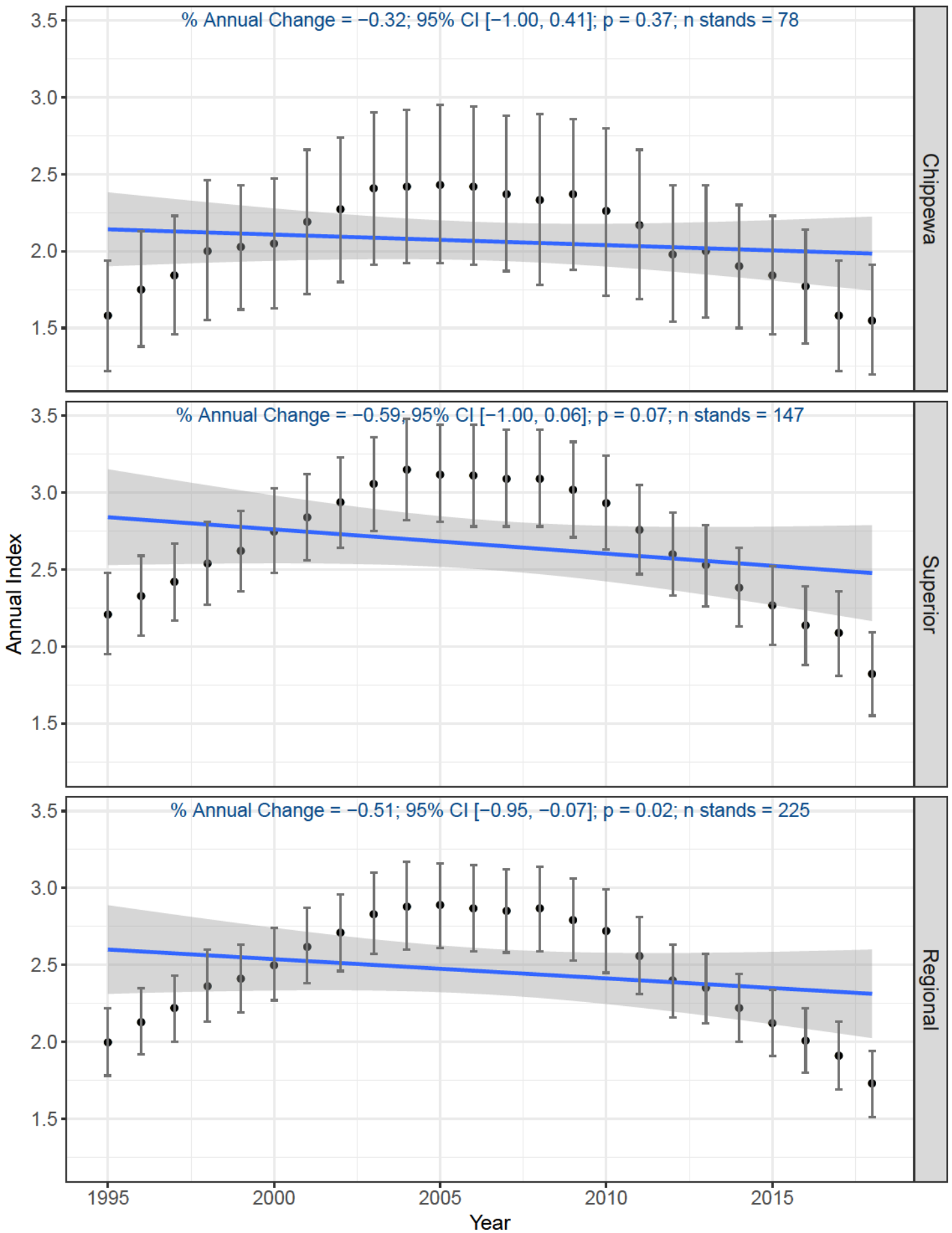


White-breasted Nuthatch

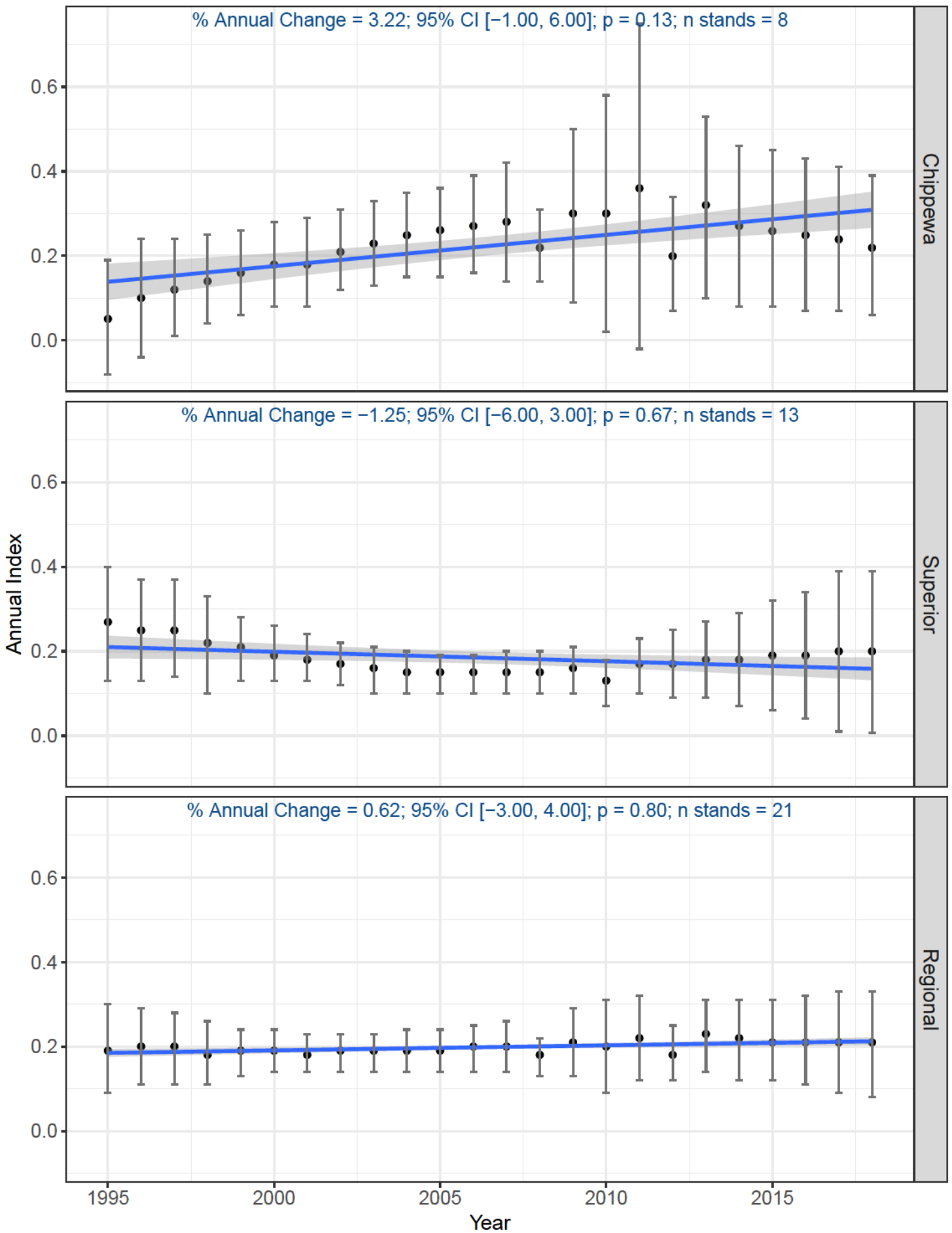
% Annual Change = 0.98; 95% CI [-0.79, 2.00]; p = 0.25; n stands = 44



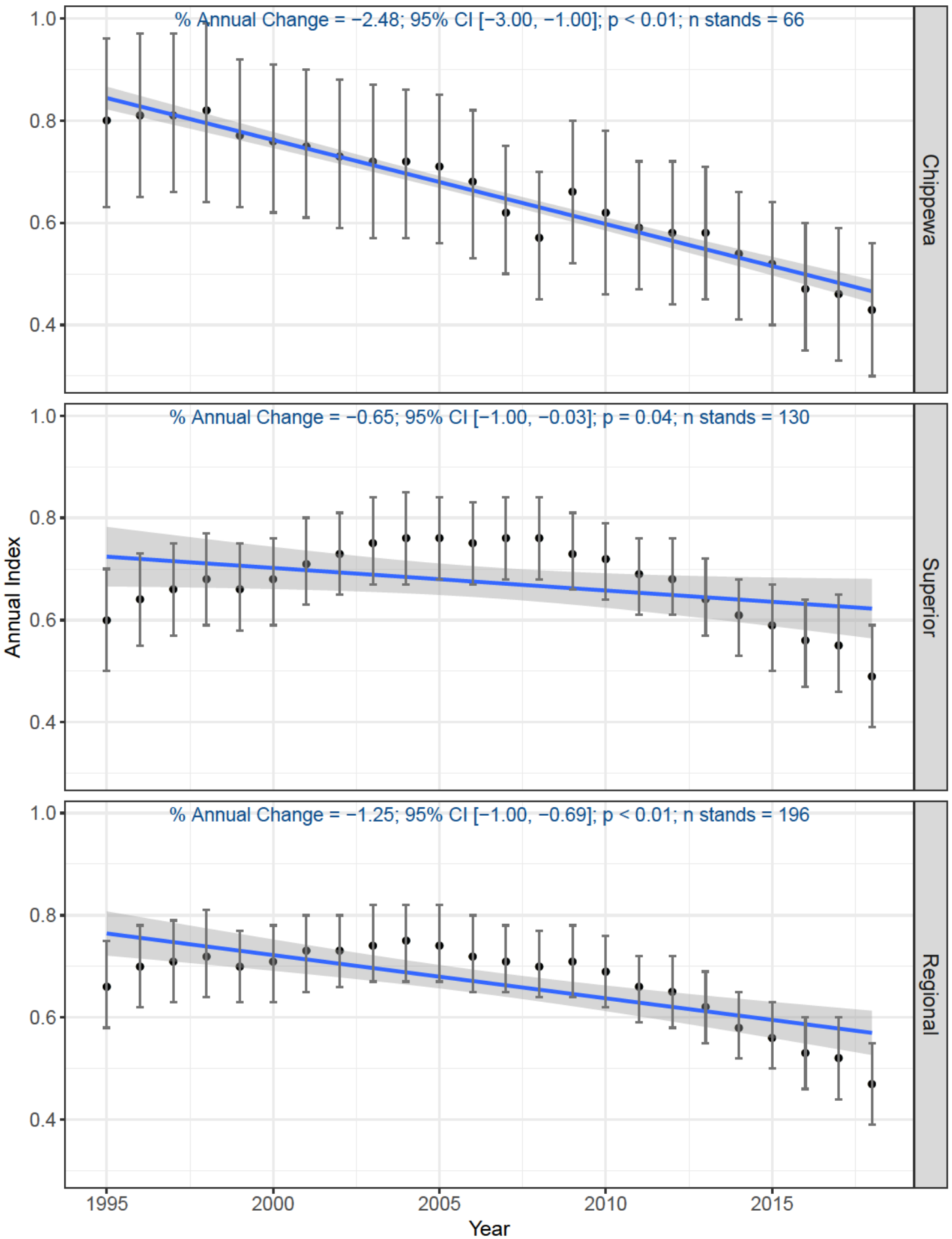
White-throated Sparrow



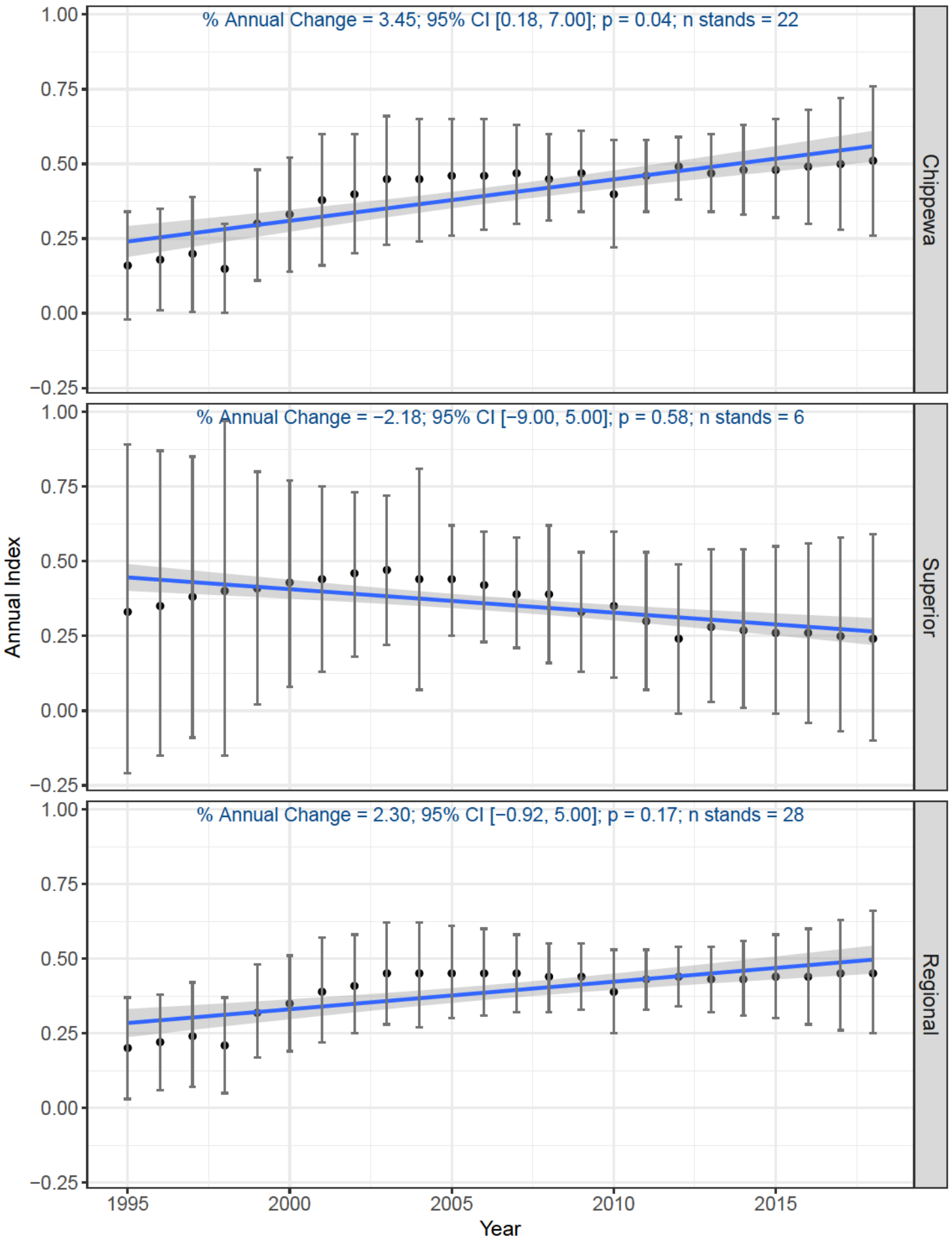
Wilson's Snipe



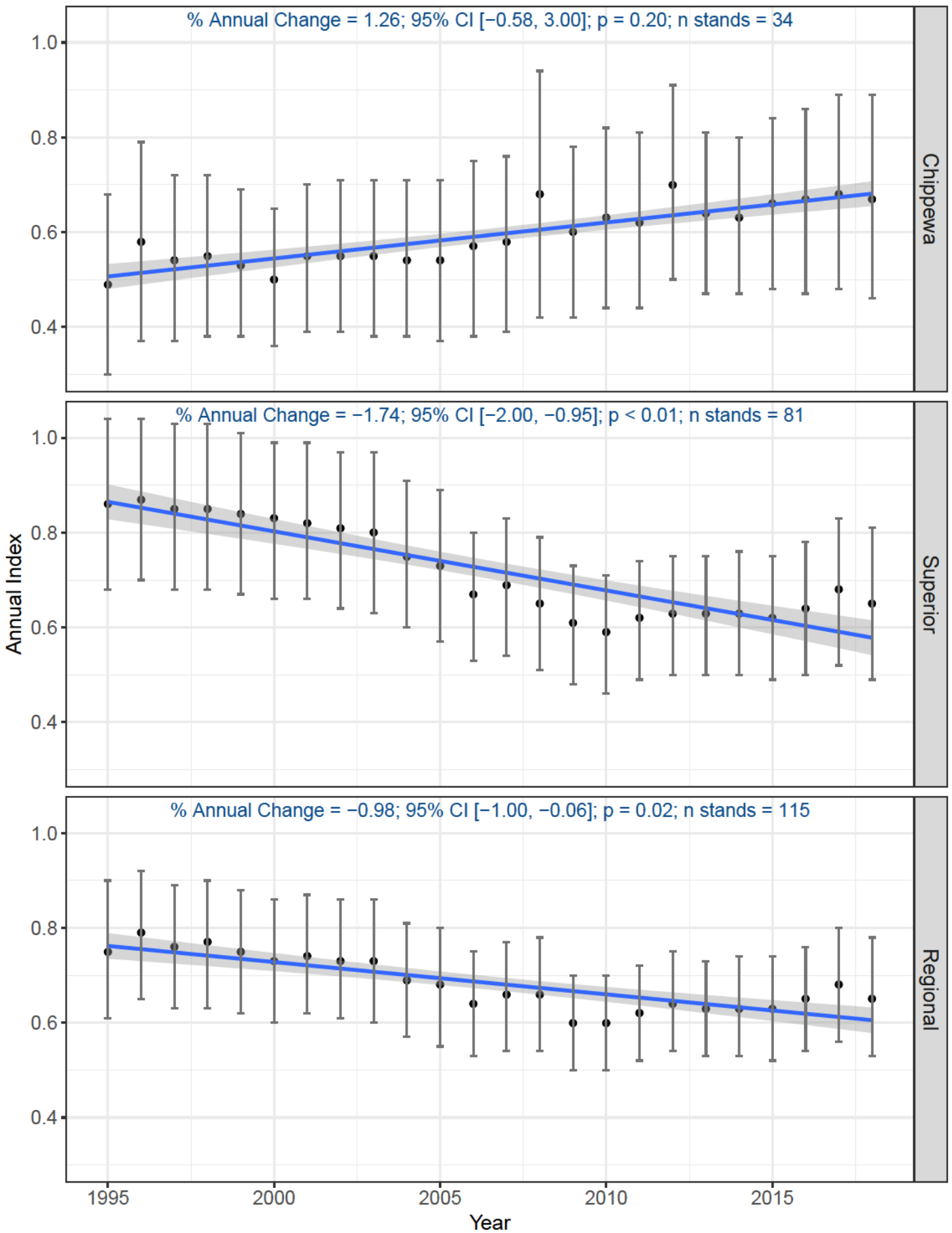
Winter Wren



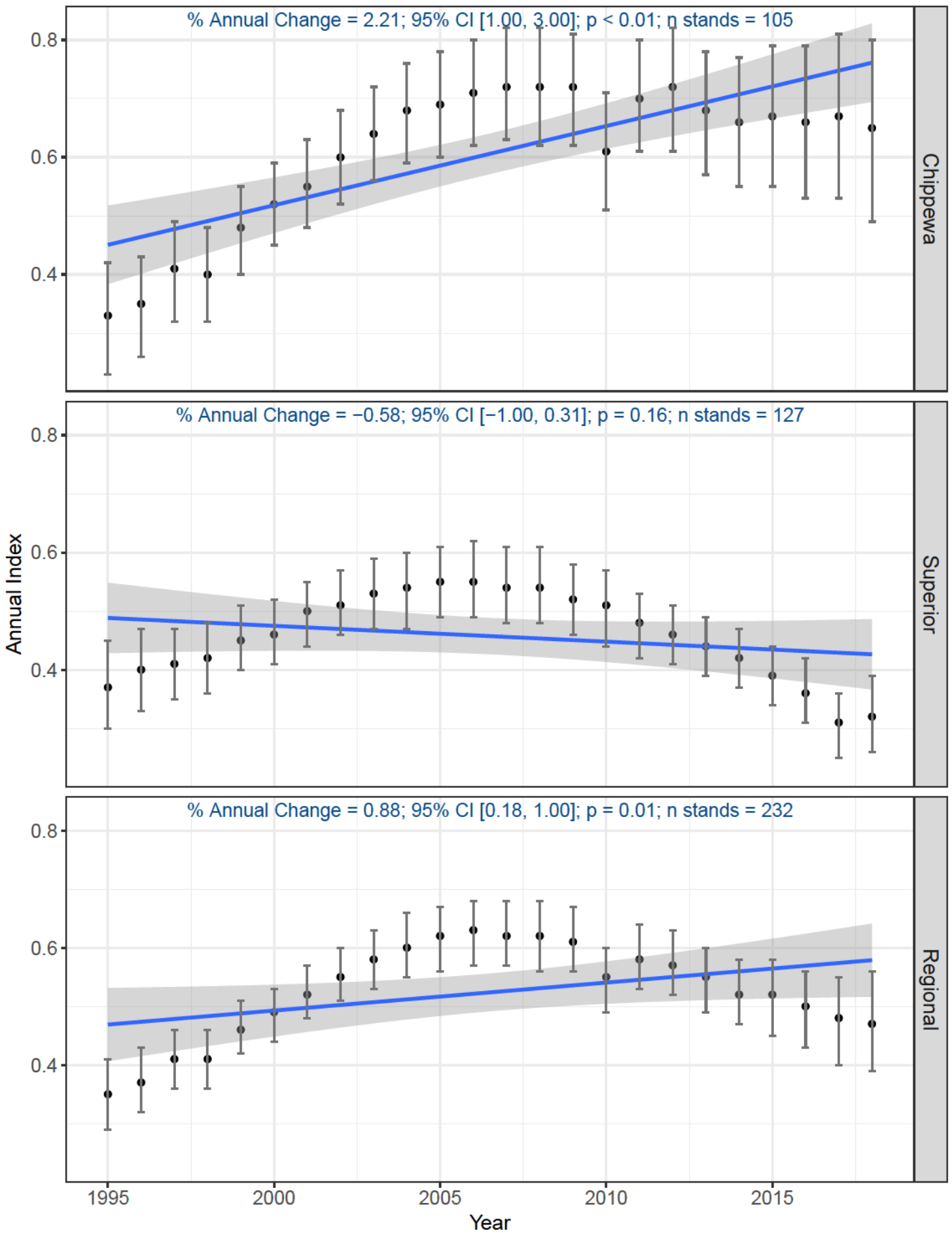
Wood Thrush



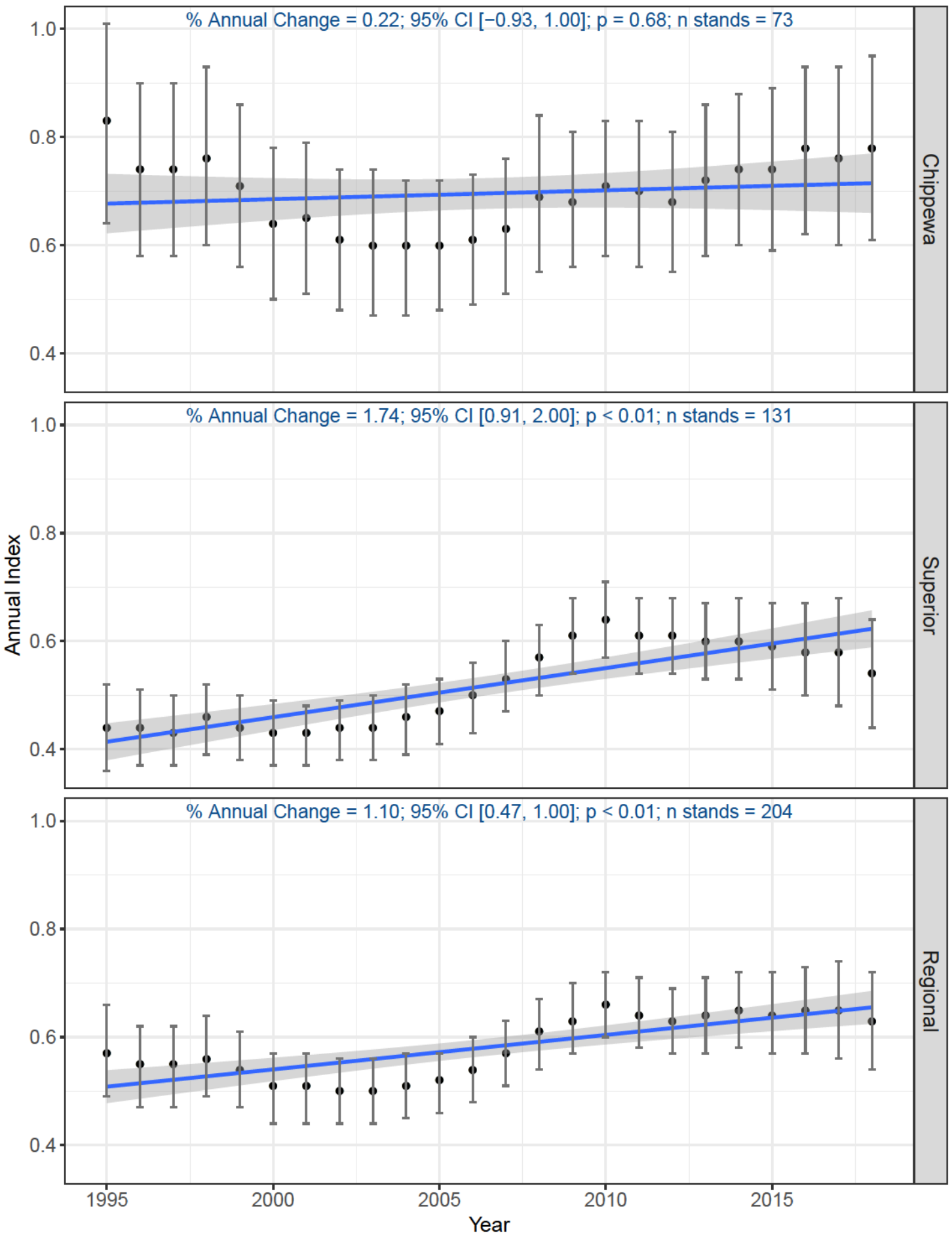
Yellow-bellied Flycatcher



Yellow-bellied Sapsucker

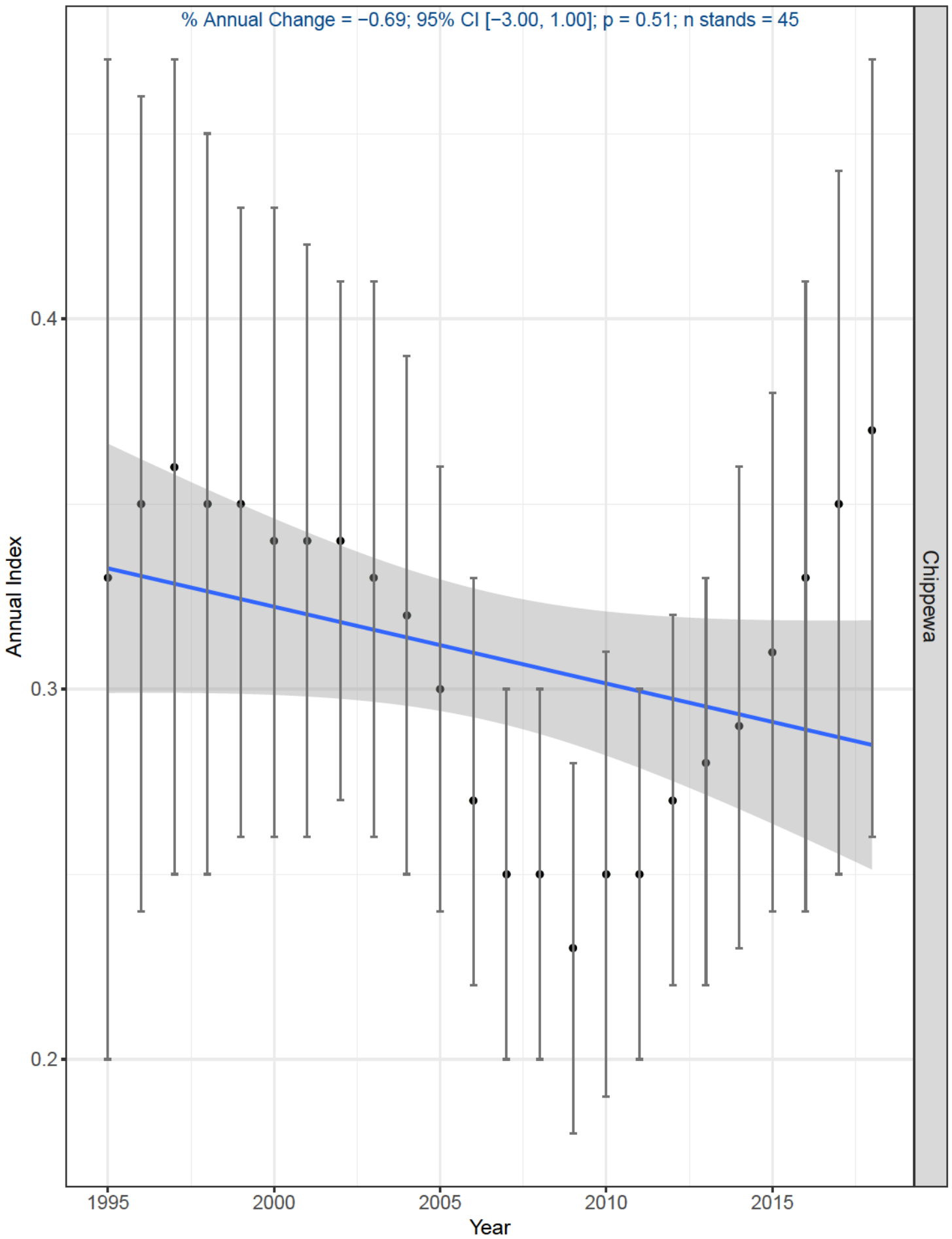


Yellow-rumped Warbler (Myrtle)



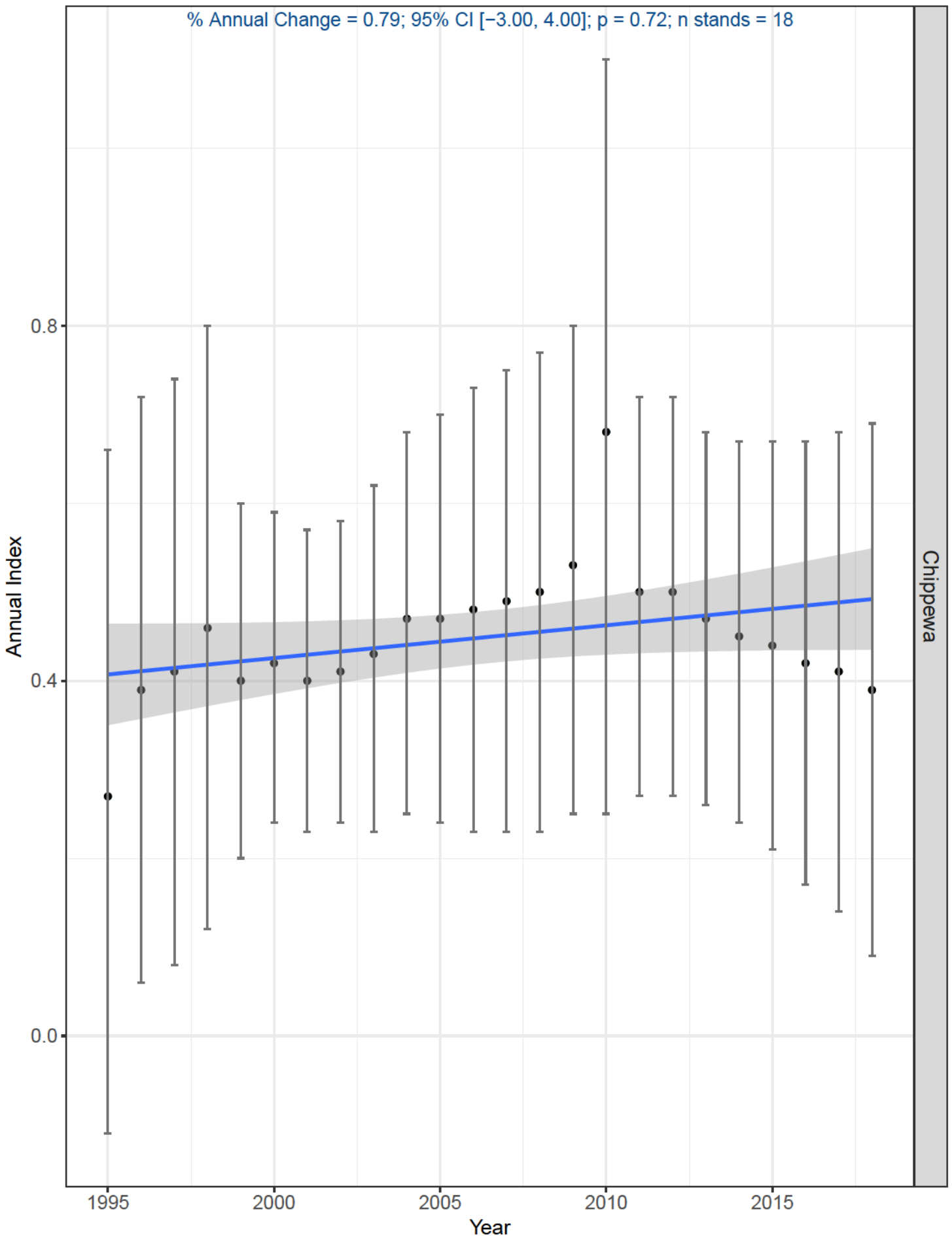
Yellow-throated Vireo

% Annual Change = -0.69; 95% CI [-3.00, 1.00]; p = 0.51; n stands = 45

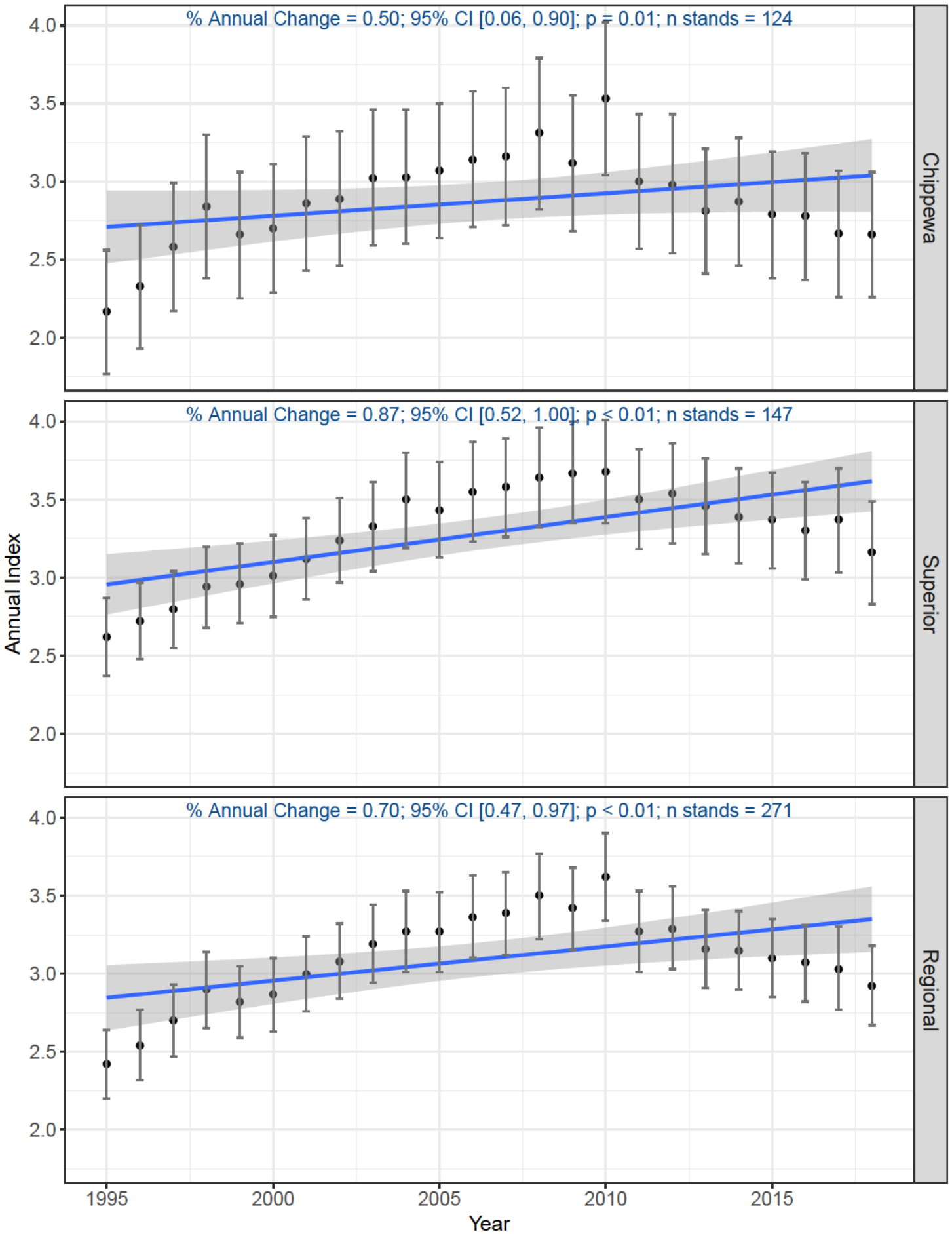


Yellow Warbler

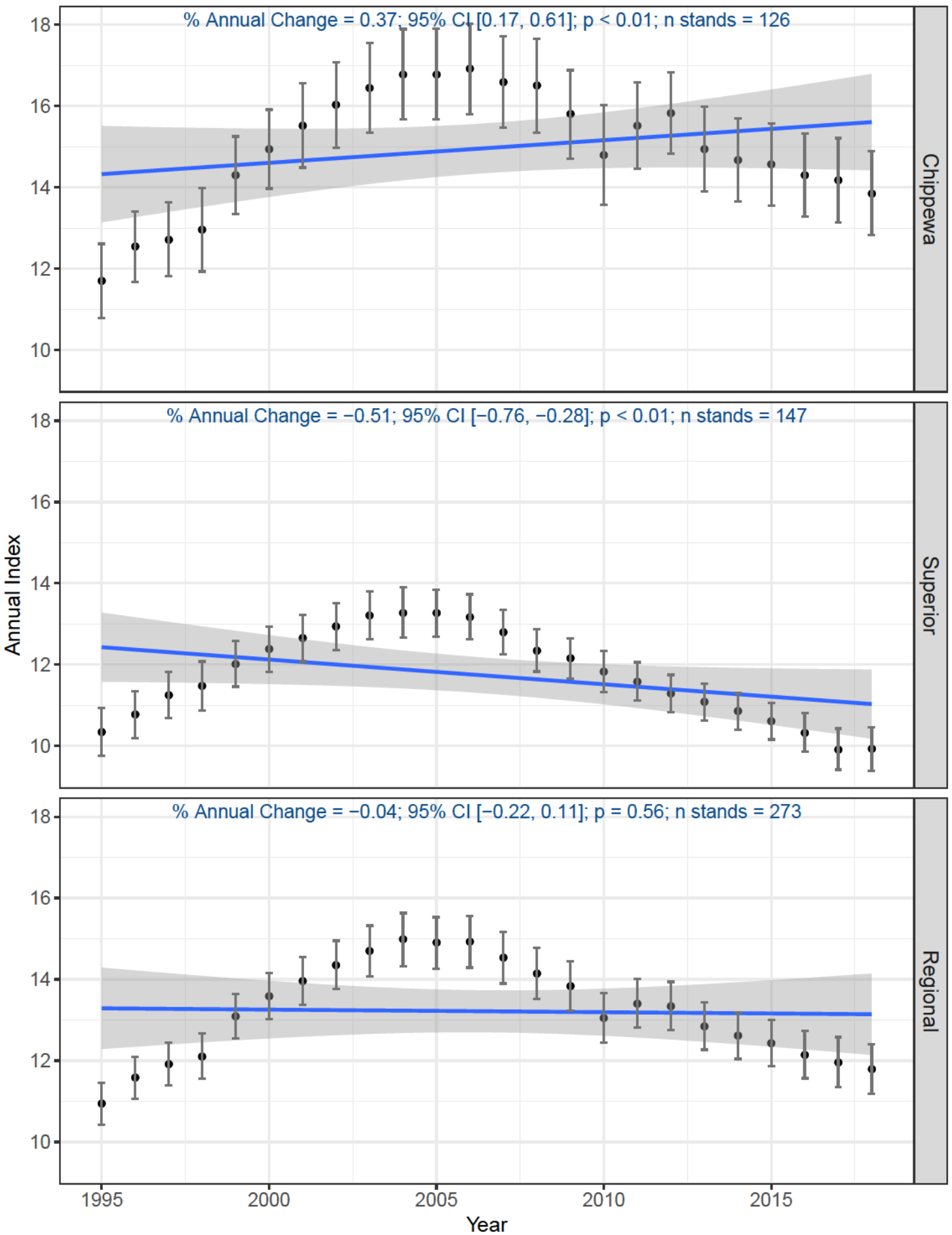
% Annual Change = 0.79; 95% CI [-3.00, 4.00]; p = 0.72; n stands = 18



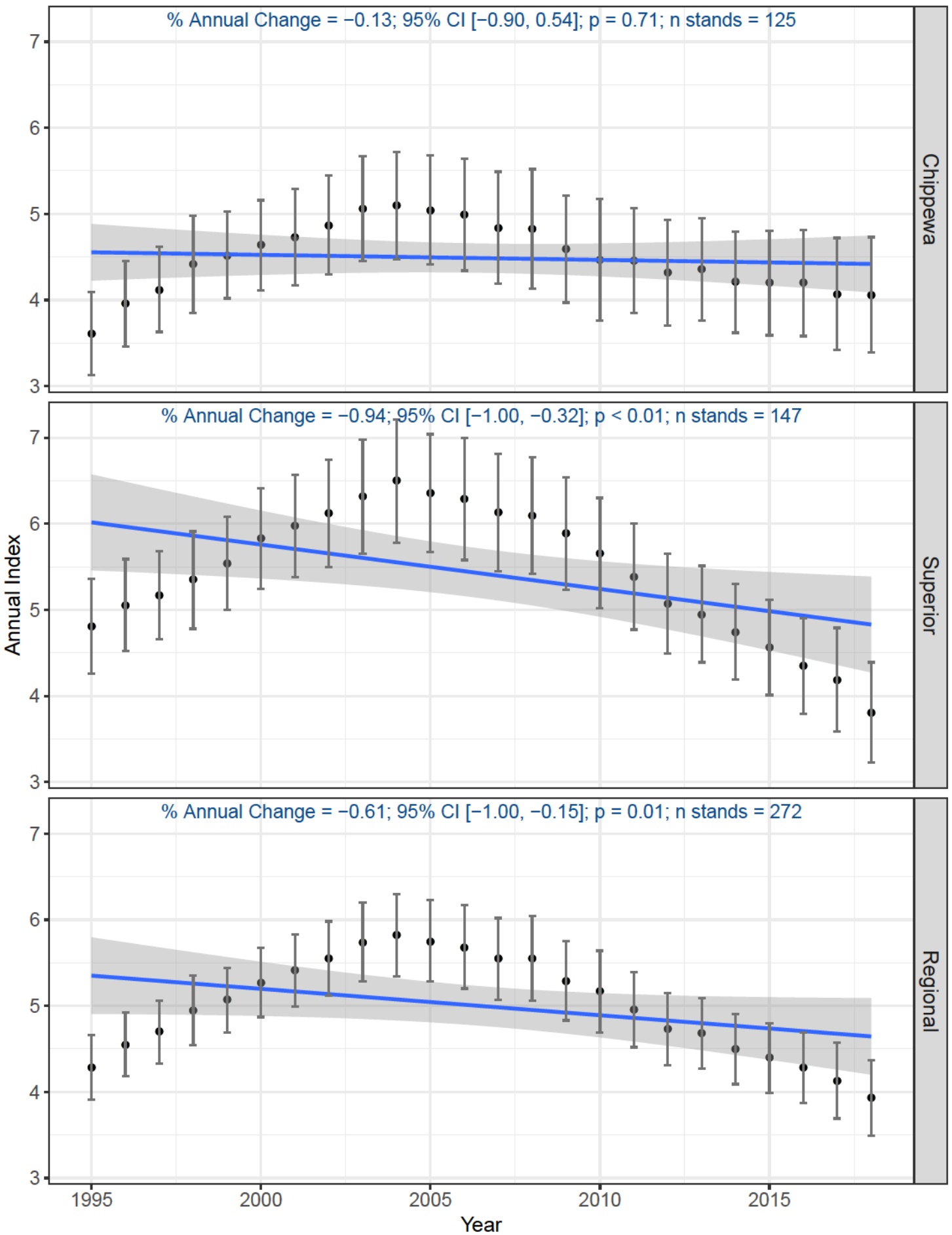
Coniferous forest species



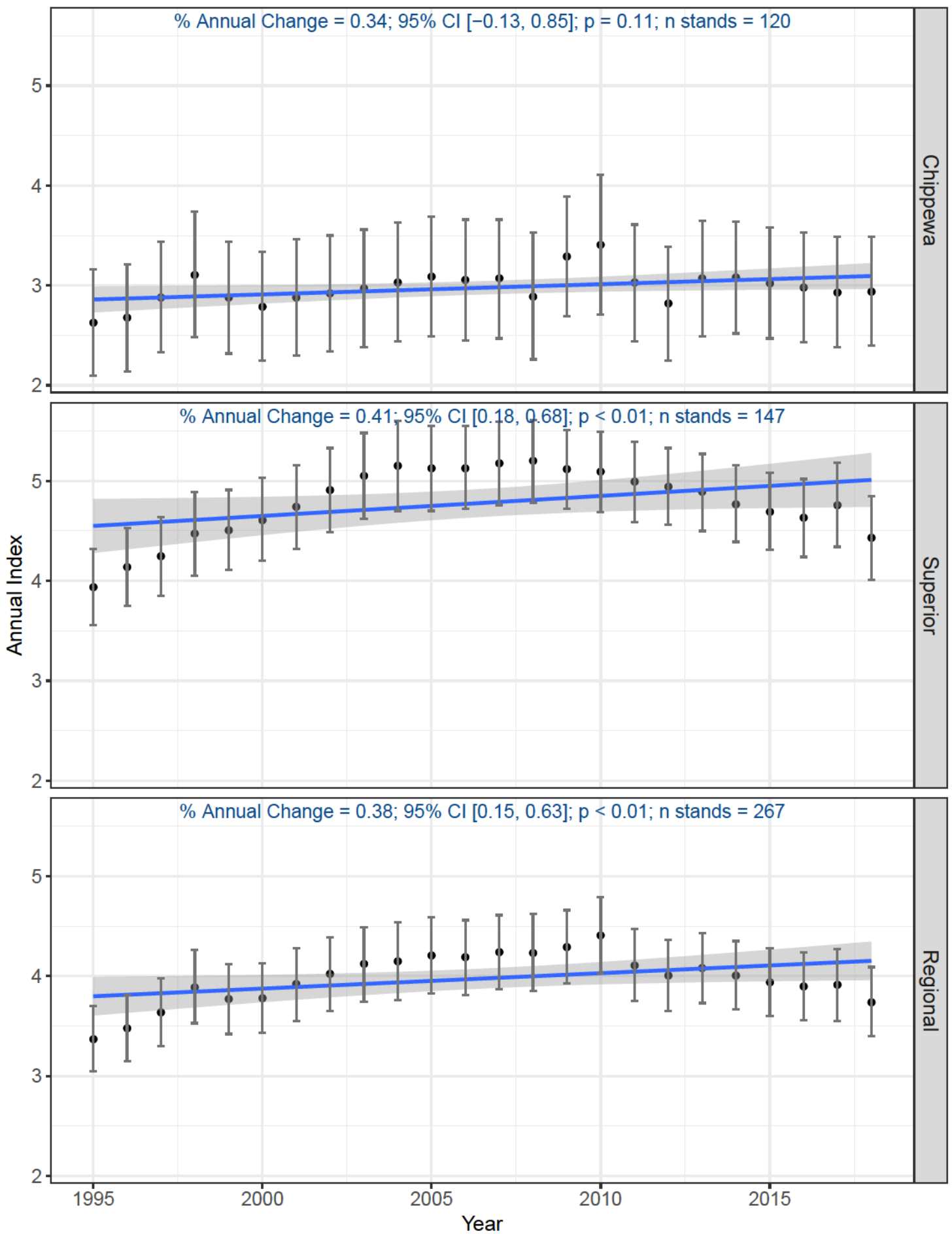
Deciduous forest species



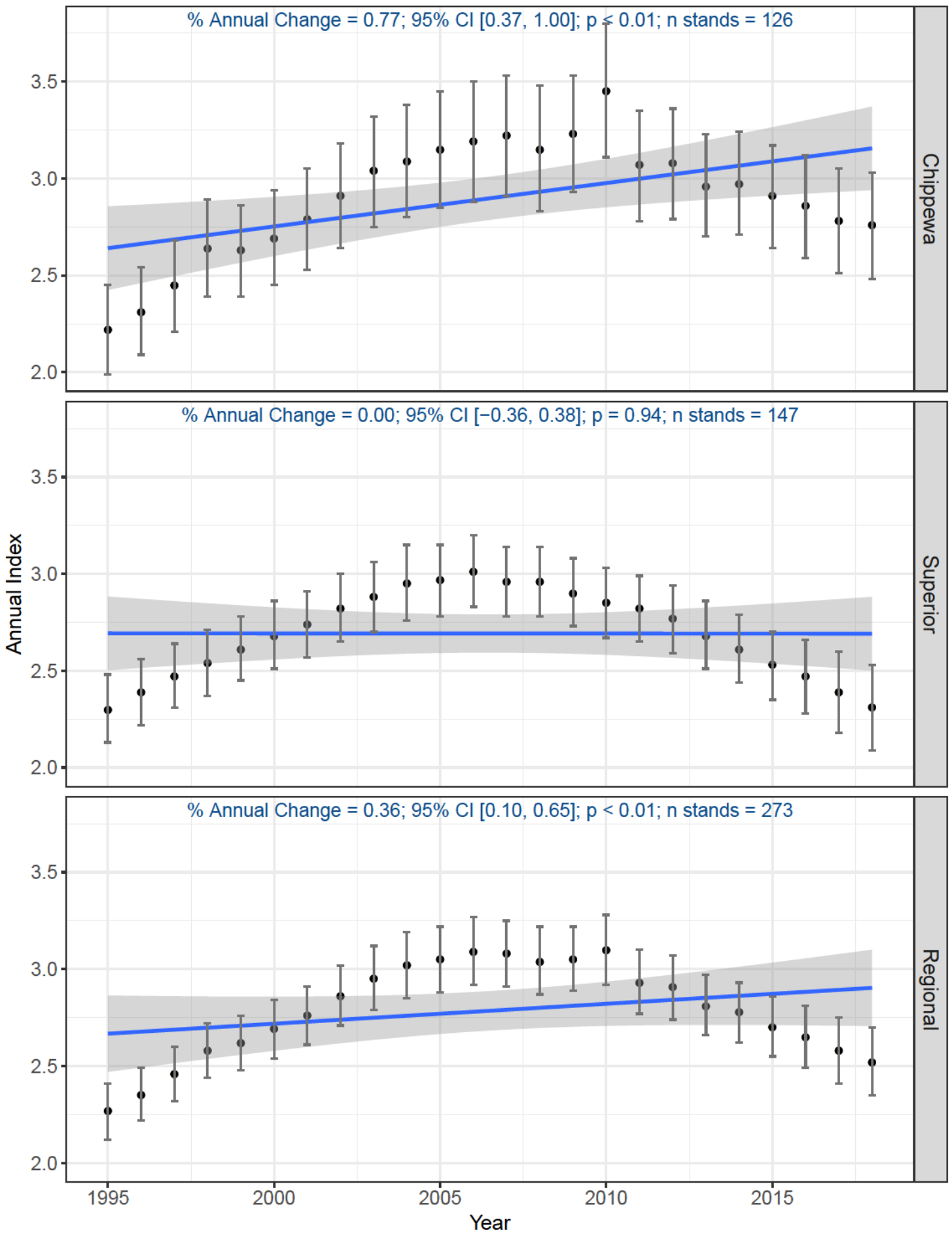
Early-successional species



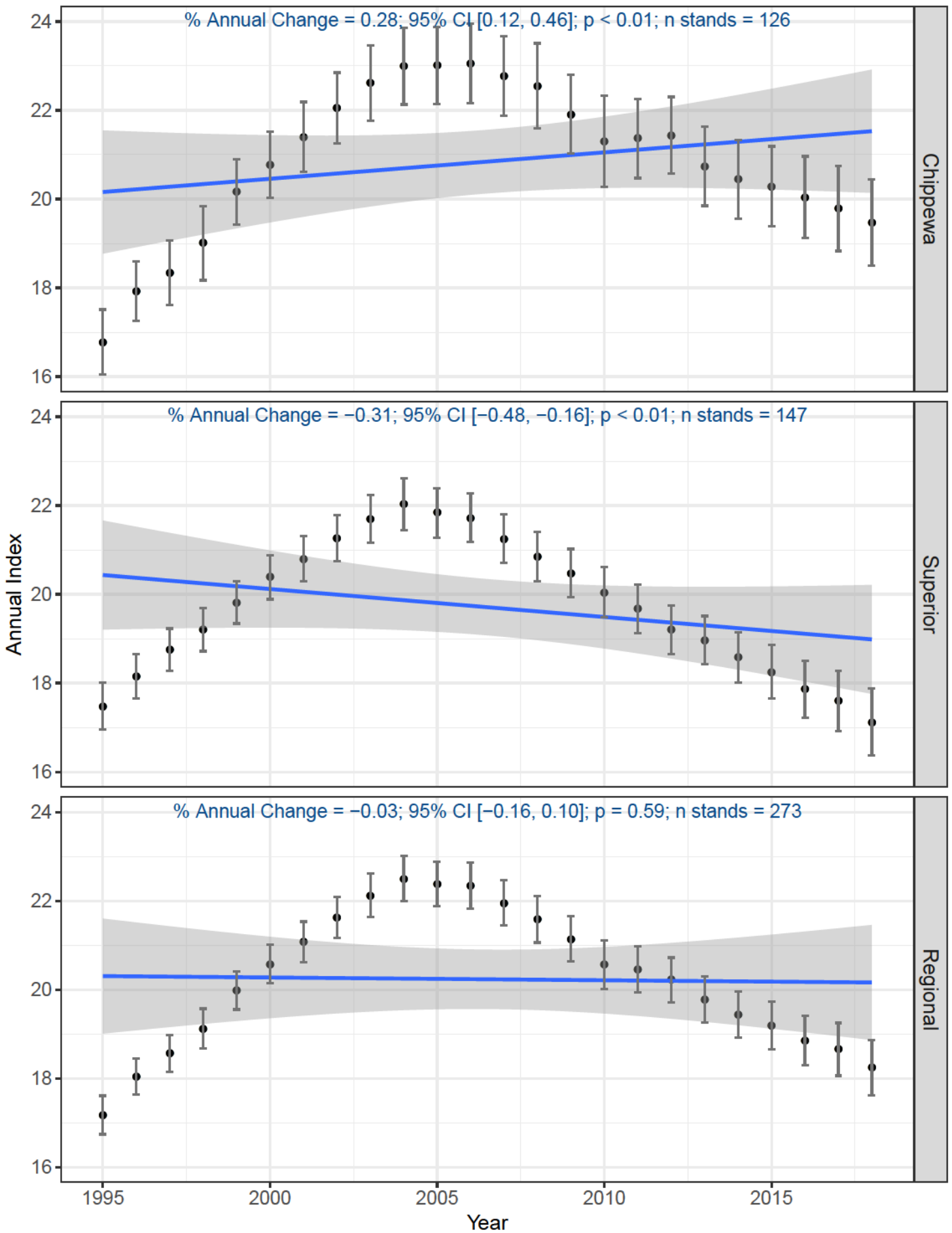
Lowland-conifer species



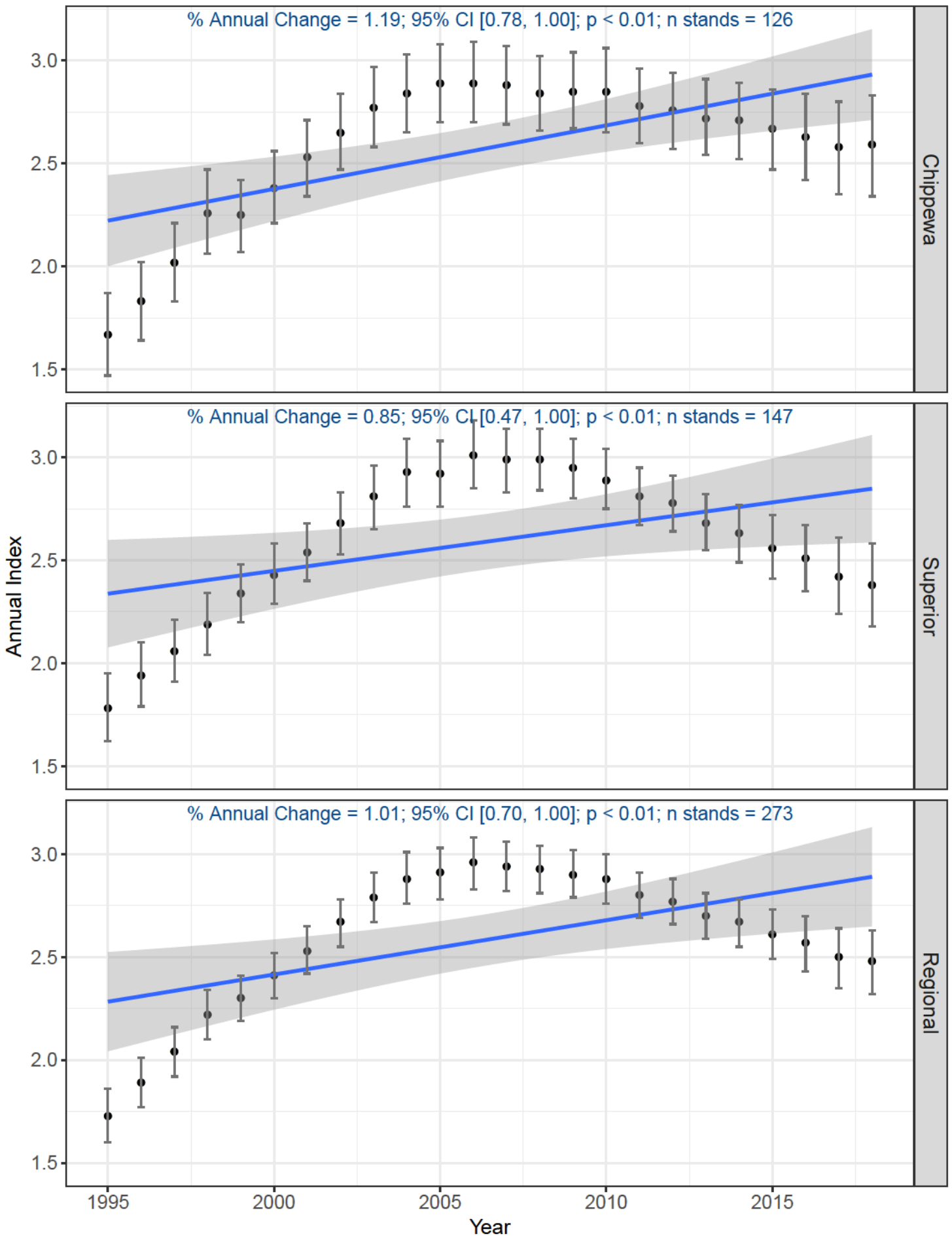
Mixed forest species



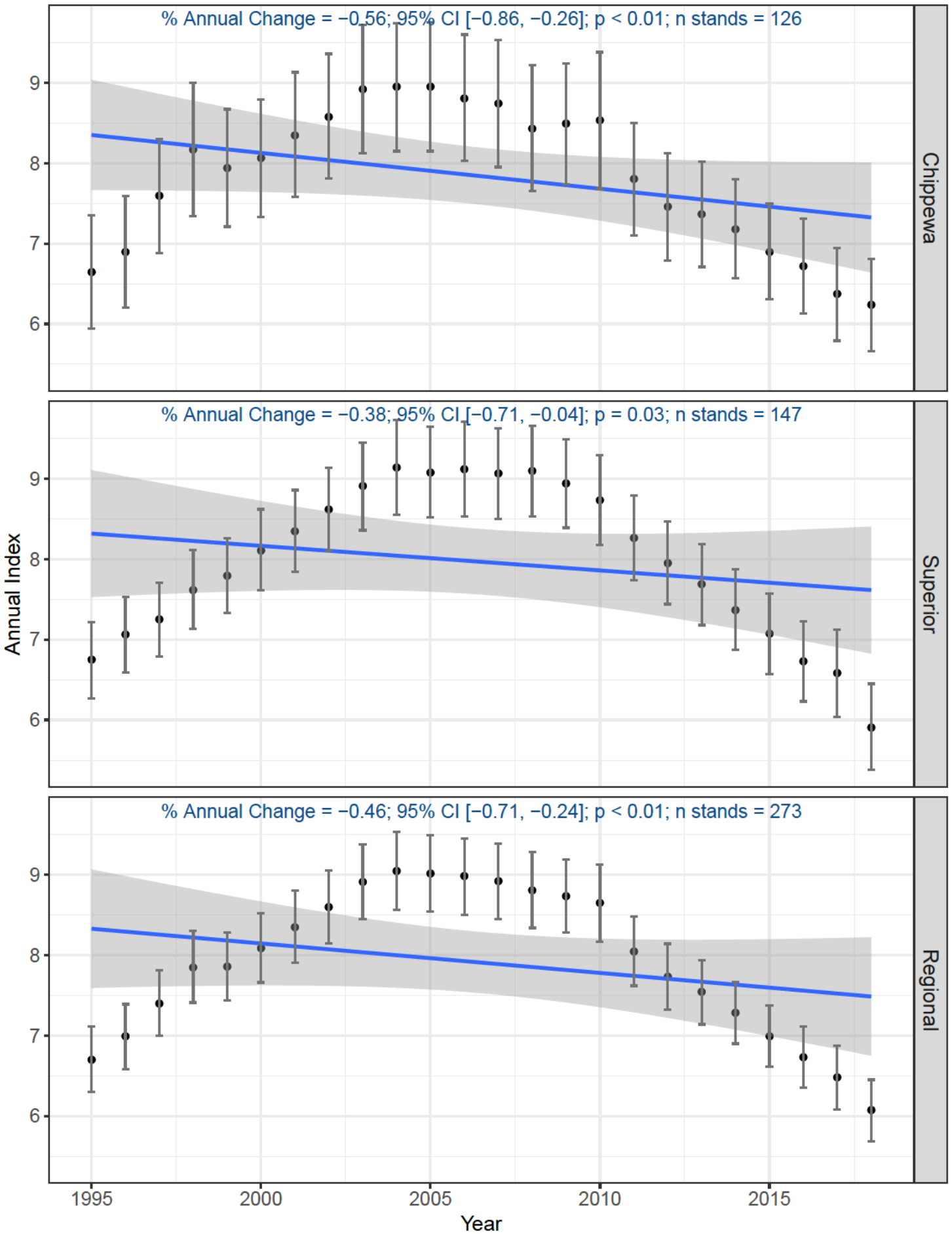
Long-distance migrants



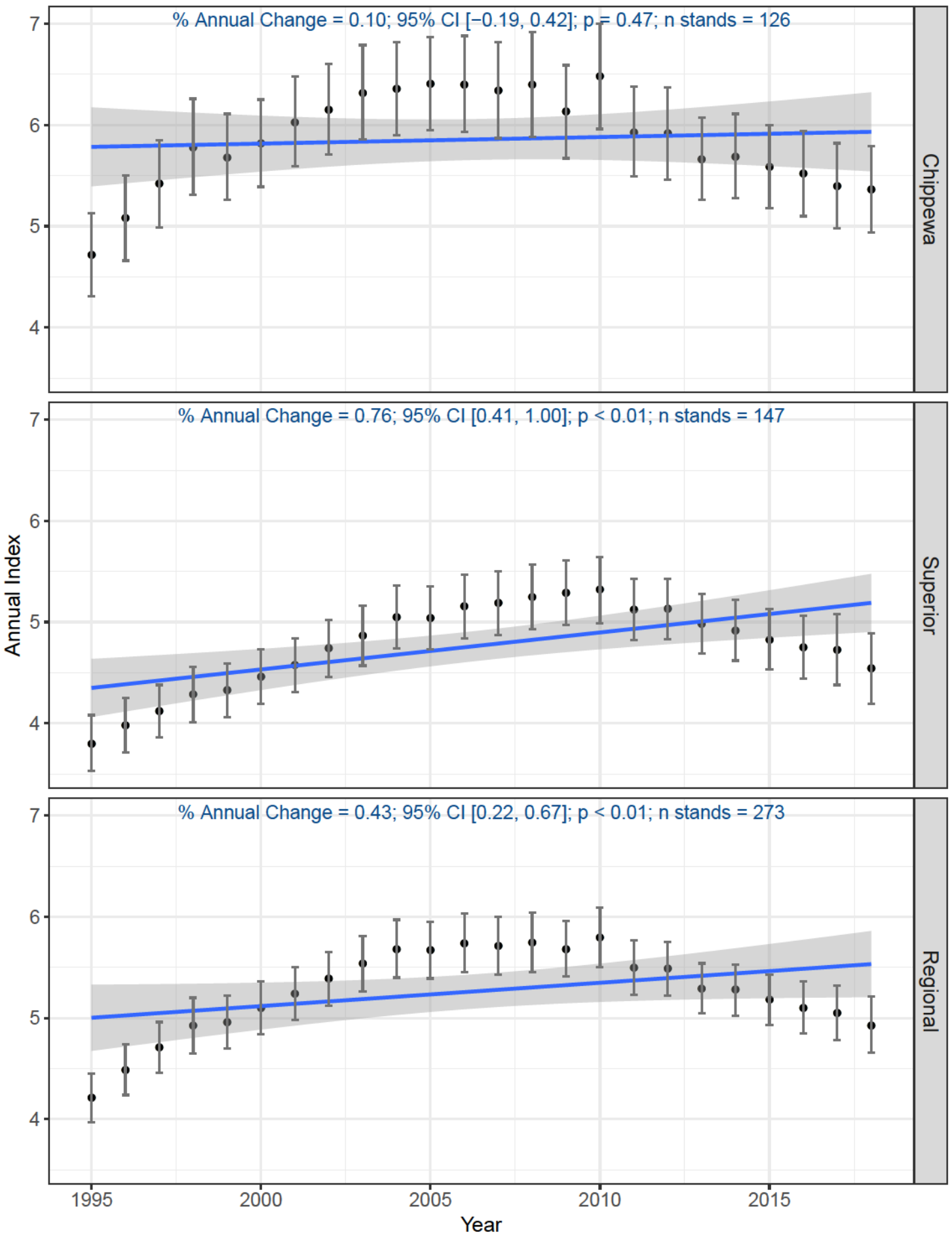
Permanent residents



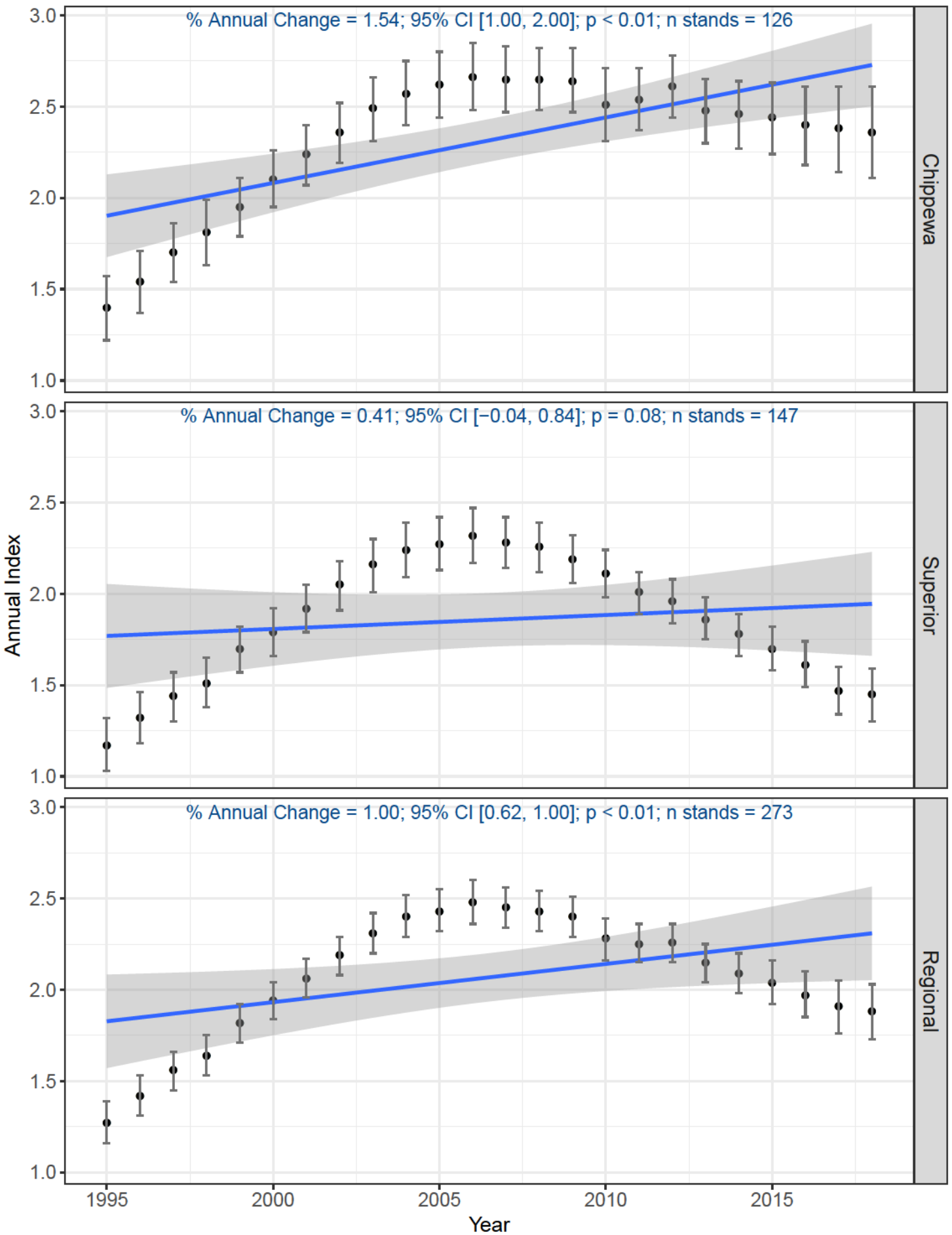
Short-distance migrants



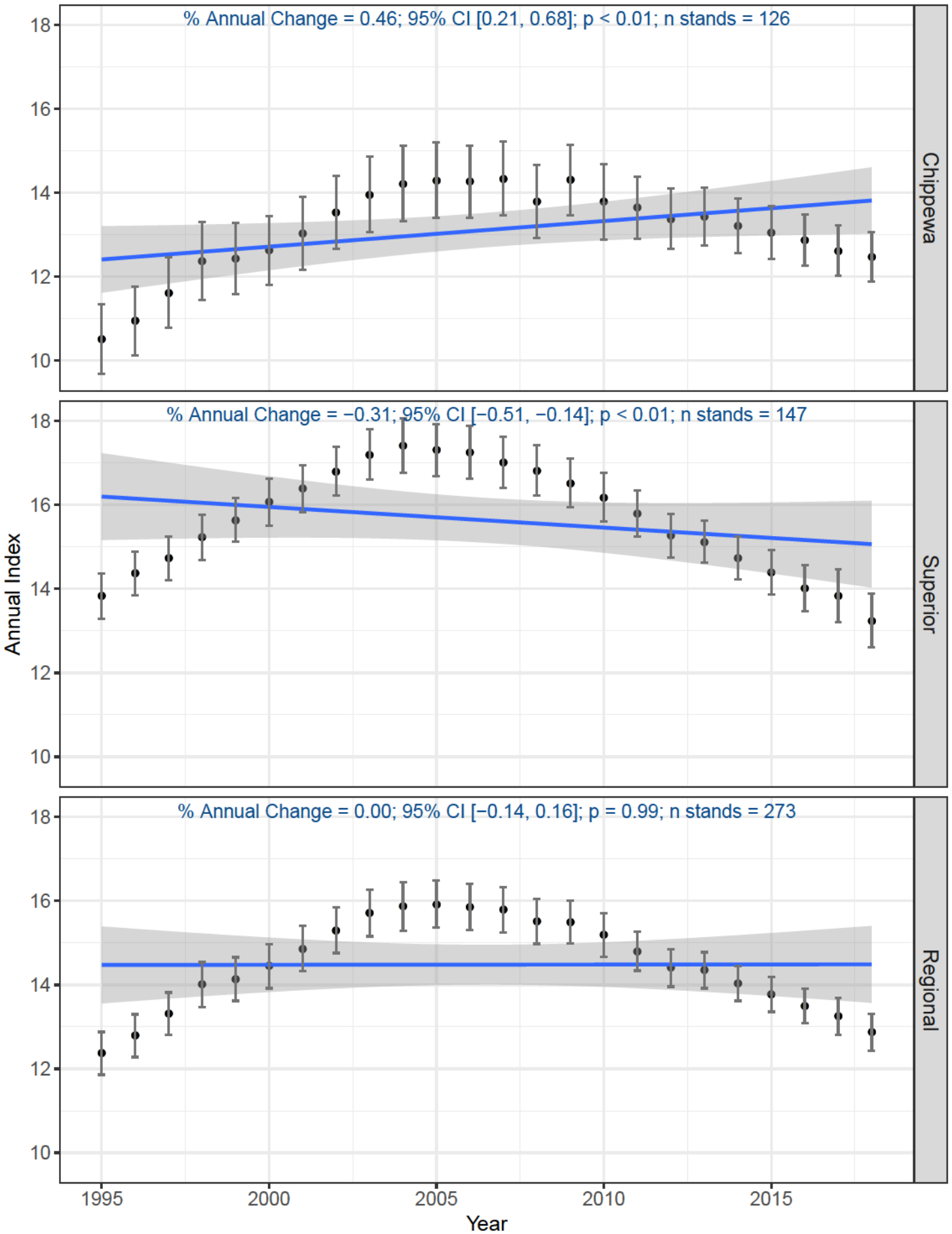
Canopy nesting species



Cavity nesting species

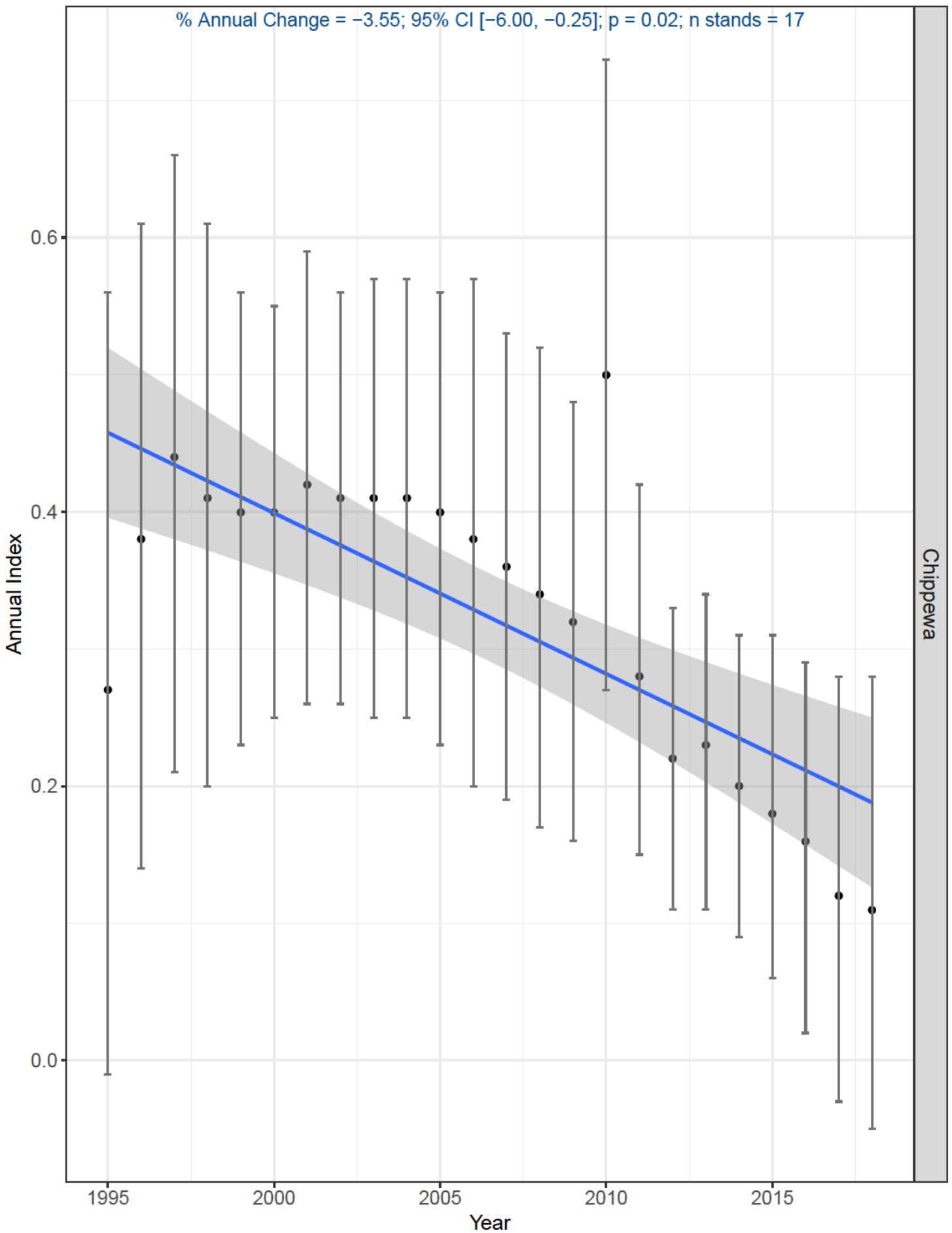


Ground nesting species

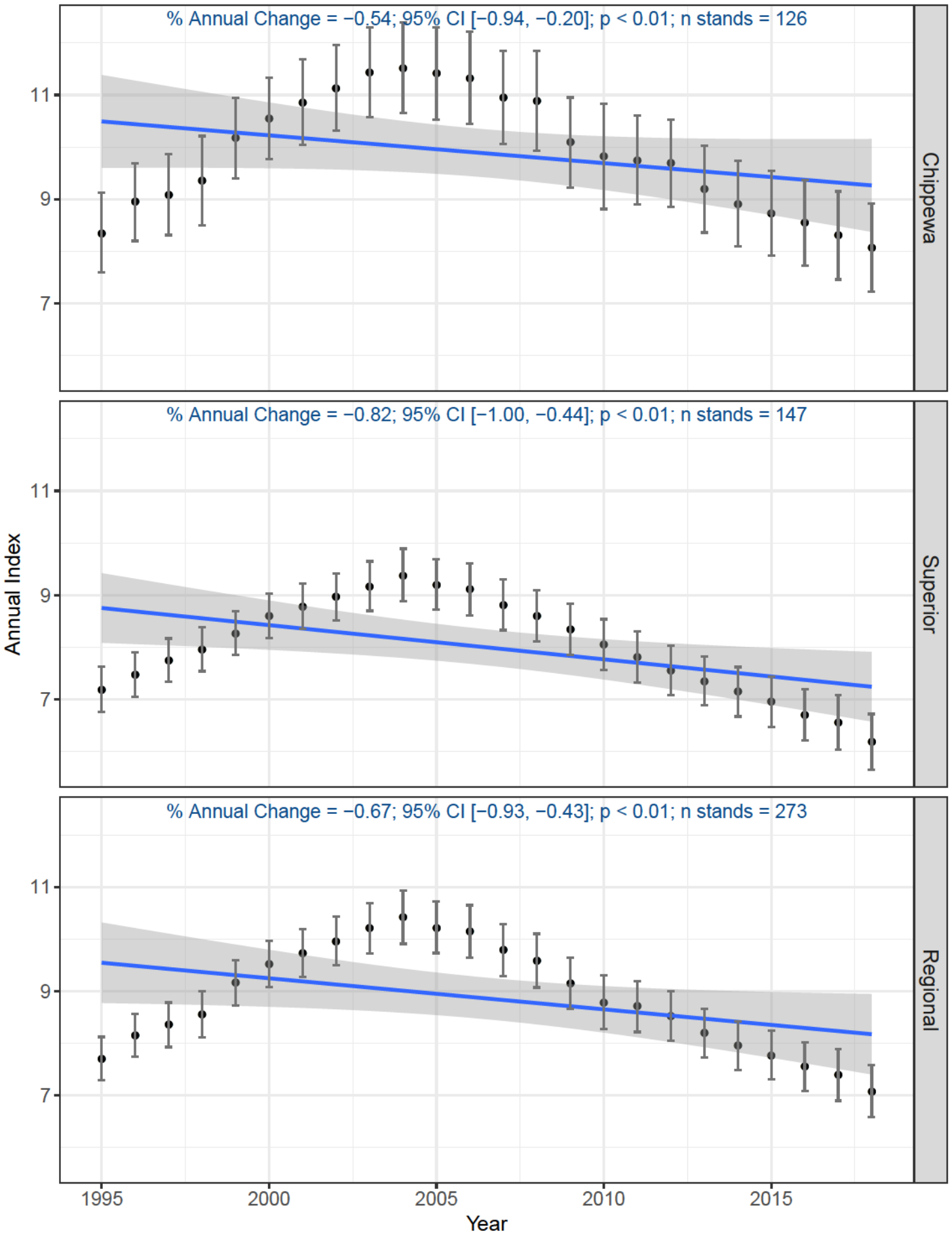


Nest parasites

% Annual Change = -3.55; 95% CI [-6.00, -0.25]; p = 0.02; n stands = 17



Shrub nesting species



Appendix B

Population trend estimates (% annual change) and associated test statistics for the Chippewa National Forest, Superior National Forest, and a combined regional analysis (1995–2018). 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.

Species	Chippewa				Superior				Regional			
	Trend	<i>P</i>	<i>r</i> ²	<i>n</i>	Trend	<i>P</i>	<i>r</i> ²	<i>n</i>	Trend	<i>P</i>	<i>r</i> ²	<i>n</i>
Alder Flycatcher	-2.96	0.01	0.62	22	0.78	0.50	0.26	54	-0.31	0.81	0.03	76
American Bittern	-	-	-	-	-1.40	0.69	0.06	5	-	-	-	-
American Crow	-0.19	0.63	0.01	107	-4.26	0.00	0.80	71	-1.17	0.00	0.37	178
American Goldfinch	1.71	0.10	0.05	25	0.82	0.67	0.03	10	1.42	0.17	0.05	35
American Redstart	0.85	0.17	0.48	69	1.00	0.12	0.77	92	0.94	0.04	0.57	161
American Robin	-1.87	0.00	0.54	105	0.34	0.45	0.14	145	-0.49	0.14	0.16	250
Black-and-white Warbler	3.44	0.00	0.91	111	0.92	0.01	0.18	136	1.91	0.00	0.59	247
Black-billed Cuckoo	-	-	-	-	-3.79	0.07	0.12	6	-	-	-	-
Blackburnian Warbler	0.71	0.31	0.52	86	-0.51	0.20	0.20	134	-0.12	0.71	0.01	220
Black-capped Chickadee	-0.27	0.58	0.01	107	-0.59	0.23	0.02	132	-0.41	0.20	0.01	239
Black-throated Blue Warbler	-	-	-	-	1.43	0.49	0.26	20	-	-	-	-
Black-throated Green Warbler	1.69	0.00	0.46	75	1.61	0.00	0.91	99	1.64	0.00	0.70	174
Blue Jay	1.25	0.00	0.69	121	0.92	0.01	0.43	147	1.06	0.00	0.57	268
Blue-headed Vireo	-1.70	0.04	0.38	48	-0.92	0.28	0.10	54	-1.33	0.02	0.24	102
Broad-winged Hawk	-	-	-	-	-7.51	0.01	0.98	7	-	-	-	-
Brown Creeper	-0.60	0.58	0.23	49	-0.98	0.22	0.30	67	-0.77	0.26	0.27	116
Brown-headed Cowbird	-3.55	0.04	0.54	17	-	-	-	-	-	-	-	-
Canada Jay	-0.78	0.64	0.06	18	-0.46	0.57	0.01	47	-0.57	0.43	0.02	65
Canada Warbler	3.80	0.00	0.85	23	0.17	0.68	0.02	106	0.66	0.16	0.28	129

Species	Chippewa				Superior				Regional			
	Trend	<i>P</i>	<i>r</i> ²	<i>n</i>	Trend	<i>P</i>	<i>r</i> ²	<i>n</i>	Trend	<i>P</i>	<i>r</i> ²	<i>n</i>
Mourning Warbler	-0.06	0.99	0.00	70	-2.14	0.00	0.72	126	-1.50	0.00	0.60	196
Nashville Warbler	1.18	0.00	0.69	115	1.12	0.00	0.56	147	1.13	0.00	0.62	262
Northern Flicker (Yellow-shafted)	1.24	0.25	0.20	37	-0.02	0.95	0.00	83	0.33	0.50	0.01	120
Northern Parula	1.02	0.22	0.46	53	1.53	0.00	0.43	87	1.37	0.00	0.45	140
Northern Waterthrush	1.80	0.26	0.36	22	2.35	0.01	0.88	23	2.05	0.04	0.63	45
Olive-sided Flycatcher	-5.14	0.00	0.68	13	-2.77	0.05	0.45	6	-4.51	0.00	0.64	19
Ovenbird	1.41	0.00	0.60	122	-0.32	0.09	0.07	147	0.43	0.01	0.13	269
Palm Warbler (Western)	1.90	0.68	0.53	9	-	-	-	-	-	-	-	-
Pileated Woodpecker	4.15	0.00	0.82	34	0.55	0.52	0.01	69	1.67	0.02	0.15	103
Pine Warbler	2.07	0.00	0.93	53	5.13	0.00	0.96	24	2.59	0.00	0.98	77
Purple Finch	-0.54	0.80	0.04	21	4.00	0.01	0.86	22	1.70	0.16	0.40	43
Red-breasted Nuthatch	4.33	0.00	0.87	93	3.02	0.00	0.84	136	3.62	0.00	0.86	229
Red-eyed Vireo	-0.40	0.01	0.05	126	-1.22	0.00	0.44	147	-0.75	0.00	0.18	273
Red-winged Blackbird	-1.58	0.16	0.23	16	-1.58	0.42	0.19	8	-1.56	0.08	0.22	24
Rose-breasted Grosbeak	0.25	0.60	0.02	100	-1.04	0.03	0.41	130	-0.50	0.19	0.10	230
Ruby-crowned Kinglet	-	-	-	-	7.05	0.00	0.98	43	-	-	-	-
Ruby-throated Hummingbird	5.99	0.01	0.87	15	-	-	-	-	-	-	-	-
Ruffed Grouse	-	-	-	-	1.97	0.04	0.22	46	-	-	-	-
Scarlet Tanager	-1.36	0.00	0.66	91	-1.20	0.36	0.31	31	-1.29	0.00	0.57	122
Song Sparrow	-5.54	0.00	0.94	49	-3.83	0.01	0.65	43	-4.80	0.00	0.87	92
Swainson's Thrush	-	-	-	-	-3.96	0.00	0.76	72	-	-	-	-
Swamp Sparrow	-1.99	0.12	0.35	42	-1.03	0.21	0.07	26	-1.74	0.06	0.26	68
Tennessee Warbler	-	-	-	-	10.20	0.00	0.77	23	-	-	-	-
Veery	1.11	0.00	0.45	107	-0.77	0.03	0.91	134	0.22	0.40	0.11	241

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 2018.

Common Name	Scientific Name	Abbr.	Migration Strategy	Nest Site	Vegetation Type
Alder Flycatcher	<i>Empidonax alnorum</i>	ALFL	Long-distance	Subcanopy or Shrub	Shrub swamp
American Bittern	<i>Botaurus lentiginosus</i>	AMBI	Short-distance	Ground	Shrub swamp
American Crow	<i>Corvus brachyrhynchos</i>	AMCR	Short-distance	Canopy	Deciduous forest
American Goldfinch	<i>Spinus tristis</i>	AMGO	Short-distance	Subcanopy or Shrub	Fields and meadows
American Redstart	<i>Setophaga ruticilla</i>	AMRE	Long-distance	Subcanopy or Shrub	Early successional
American Robin	<i>Turdus migratorius</i>	AMRO	Short-distance	Subcanopy or Shrub	Fields and meadows
Black-and-white Warbler	<i>Mniotilta varia</i>	BAWW	Long-distance	Ground	Mixed forest
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	BBCU	Long-distance	Subcanopy or Shrub	Deciduous forest
Blackburnian Warbler	<i>Setophaga fusca</i>	BLBW	Long-distance	Canopy	Coniferous forest
Black-capped Chickadee	<i>Poecile atricapillus</i>	BCCH	Permanent Resident	Cavity	Deciduous forest
Black-throated Blue Warbler	<i>Setophaga caerulescens</i>	BTBW	Long-distance	Subcanopy or Shrub	Deciduous forest
Black-throated Green Warbler	<i>Setophaga virens</i>	BTNW	Long-distance	Subcanopy or Shrub	Mixed forest
Blue Jay	<i>Cyanocitta cristata</i>	BLJA	Permanent Resident	Canopy	Deciduous forest
Blue-headed Vireo	<i>Vireo solitarius</i>	BHVI	Short-distance	Subcanopy or Shrub	Coniferous forest
Broad-winged Hawk	<i>Buteo platypterus</i>	BWHA	Long-distance	Canopy	Mixed forest
Brown Creeper	<i>Certhia americana</i>	BRCR	Short-distance	Cavity	Deciduous forest
Brown-headed Cowbird	<i>Molothrus ater</i>	BHCO	Short-distance	Brood Parasite	Fields and meadows
Canada Jay	<i>Perisoreus canadensis</i>	GRAJ	Permanent Resident	Subcanopy or Shrub	Lowland coniferous forest
Canada Warbler	<i>Cardellina canadensis</i>	CAWA	Long-distance	Ground	Mixed forest
Cape May Warbler	<i>Setophaga tigrina</i>	CMWA	Long-distance	Canopy	Coniferous forest
Cedar Waxwing	<i>Bombycilla cedrorum</i>	CEDW	Short-distance	Subcanopy or Shrub	Ponds, lakes, rivers, streams
Chestnut-sided Warbler	<i>Setophaga pensylvanica</i>	CSWA	Long-distance	Subcanopy or Shrub	Early successional

Common Name	Scientific Name	Abbr.	Migration Strategy	Nest Site	Vegetation Type
Chipping Sparrow	<i>Spizella passerina</i>	CHSP	Short-distance	Canopy	Coniferous forest
Common Loon	<i>Gavia immer</i>	COLO	Short-distance	Ground	Ponds, lakes, rivers, streams
Common Raven	<i>Corvus corax</i>	CORA	Permanent Resident	Canopy	Coniferous forest
Common Yellowthroat	<i>Geothlypis trichas</i>	COYE	Long-distance	Ground	Shrub swamp
Connecticut Warbler	<i>Oporornis agilis</i>	CONW	Long-distance	Ground	Lowland coniferous forest
Dark-eyed Junco (Slate-colored)	<i>Junco heymalis hyemalis</i>	SCJU	Short-distance	Ground	Lowland coniferous forest
Downy Woodpecker	<i>Dryobates pubescens</i>	DOWO	Permanent Resident	Cavity	Deciduous forest
Eastern Towhee	<i>Pipilo erythrophthalmus</i>	EATO	Short-distance	Ground	Early successional
Eastern Wood-Pewee	<i>Contopus virens</i>	EAWP	Long-distance	Canopy	Mixed forest
Evening Grosbeak	<i>Coccothraustes vespertinus</i>	EVGR	Permanent Resident	Canopy	Mixed forest
Golden-crowned Kinglet	<i>Regulus satrapa</i>	GCKI	Short-distance	Canopy	Coniferous forest
Golden-winged Warbler	<i>Vermivora chrysoptera</i>	GWWA	Long-distance	Ground	Early successional
Gray Catbird	<i>Dumetella carolinensis</i>	GRCA	Long-distance	Subcanopy or Shrub	Early successional
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	GCFL	Long-distance	Cavity	Deciduous forest
Hairy Woodpecker	<i>Dryobates villosus</i>	HAWO	Permanent Resident	Cavity	Deciduous forest
Hermit Thrush	<i>Catharus guttatus</i>	HETH	Short-distance	Ground	Mixed forest
Indigo Bunting	<i>Passerina cyanea</i>	INBU	Long-distance	Subcanopy or Shrub	Fields and meadows
Least Flycatcher	<i>Empidonax minimus</i>	LEFL	Long-distance	Subcanopy or Shrub	Deciduous forest
Lincoln's Sparrow	<i>Melospiza lincolni</i>	LISP	Long-distance	Ground	Lowland coniferous forest
Magnolia Warbler	<i>Setophaga magnolia</i>	MAWA	Long-distance	Subcanopy or Shrub	Coniferous forest
Mourning Dove	<i>Zenaidura macroura</i>	MODO	Short-distance	Canopy	Fields and meadows
Mourning Warbler	<i>Geothlypis philadelphia</i>	MOWA	Long-distance	Ground	Early successional
Nashville Warbler	<i>Oreothlypis ruficapilla</i>	NAWA	Long-distance	Ground	Lowland coniferous forest
Northern Flicker (Yellow-shafted)	<i>Colaptes auratus auratus</i>	YSFL	Short-distance	Cavity	Fields and meadows
Northern Parula	<i>Setophaga americana</i>	NOPA	Long-distance	Canopy	Lowland coniferous forest

Common Name	Scientific Name	Abbr.	Migration Strategy	Nest Site	Vegetation Type
Northern Waterthrush	<i>Parkesia noveboracensis</i>	NOWA	Long-distance	Ground	Lowland coniferous forest
Olive-sided Flycatcher	<i>Contopus cooperi</i>	OSFL	Long-distance	Canopy	Early successional
Ovenbird	<i>Seiurus aurocapilla</i>	OVEN	Long-distance	Ground	Deciduous forest
Palm Warbler (Western)	<i>Setophaga palmarum palmarum</i>	WPWA	Long-distance	Ground	Lowland coniferous forest
Pileated Woodpecker	<i>Dryocopus pileatus</i>	PIWO	Permanent Resident	Cavity	Deciduous forest
Pine Warbler	<i>Setophaga pinus</i>	PIWA	Short-distance	Canopy	Coniferous forest
Purple Finch	<i>Haemorhous purpureus</i>	PUFI	Short-distance	Canopy	Mixed forest
Red-breasted Nuthatch	<i>Sitta canadensis</i>	RBNU	Permanent Resident	Cavity	Coniferous forest
Red-eyed Vireo	<i>Vireo olivaceus</i>	REVI	Long-distance	Subcanopy or Shrub	Deciduous forest
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	RWBL	Short-distance	Subcanopy or Shrub	Open wetlands
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>	RBGR	Long-distance	Subcanopy or Shrub	Deciduous forest
Ruby-crowned Kinglet	<i>Regulus calendula</i>	RCKI	Short-distance	Canopy	Coniferous forest
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	RTHU	Long-distance	Canopy	Ponds, lakes, rivers, streams
Ruffed Grouse	<i>Bonasa umbellus</i>	RUGR	Permanent Resident	Ground	Deciduous forest
Scarlet Tanager	<i>Piranga olivacea</i>	SCTA	Long-distance	Canopy	Deciduous forest
Song Sparrow	<i>Melospiza melodia</i>	SOSP	Short-distance	Ground	Fields and meadows
Swainson's Thrush	<i>Catharus ustulatus</i>	SWTH	Long-distance	Subcanopy or Shrub	Lowland coniferous forest
Swamp Sparrow	<i>Melospiza georgiana</i>	SWSP	Short-distance	Ground	Shrub swamp
Tennessee Warbler	<i>Oreothlypis peregrina</i>	TEWA	Long-distance	Ground	Lowland coniferous forest
Veery	<i>Catharus fuscescens</i>	VEER	Long-distance	Ground	Deciduous forest
White-breasted Nuthatch	<i>Sitta carolinensis</i>	WBNU	Permanent Resident	Cavity	Deciduous forest
White-throated Sparrow	<i>Zonotrichia albicollis</i>	WTSP	Short-distance	Ground	Early successional
Wilson's Snipe	<i>Gallinago delicata</i>	COSN	Short-distance	Ground	Open wetlands
Winter Wren	<i>Troglodytes hiemalis</i>	WIWR	Short-distance	Ground	Lowland coniferous forest
Wood Thrush	<i>Hylocichla mustelina</i>	WOTH	Long-distance	Subcanopy or Shrub	Deciduous forest

Common Name	Scientific Name	Abbr.	Migration Strategy	Nest Site	Vegetation Type
Yellow Warbler	<i>Setophaga petechia</i>	YWAR	Long-distance	Subcanopy or Shrub	Shrub swamp
Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>	YBFL	Long-distance	Ground	Lowland coniferous forest
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	YBSA	Short-distance	Cavity	Deciduous forest
Yellow-rumped Warbler (Myrtle)	<i>Setophaga coronata coronata</i>	MYWA	Short-distance	Canopy	Coniferous forest
Yellow-throated Vireo	<i>Vireo flavifrons</i>	YTVI	Long-distance	Canopy	Deciduous forest

Appendix D

Number of observations on the Chippewa National Forest for species not tested for population trends in 2018. Includes flyovers and all birds regardless of distance.

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
American Bittern					1														1		1			1
American Kestrel								1			1							1						
American White Pelican					1				2				3	7									1	1
American Woodcock									2		2			2				1	1					1
Bald Eagle		1			1	1	1	1			1	1	2		2			1			2	1	3	
Baltimore Oriole	5	5	1	2	2	5	1	2	11	1	1	3	2				1	3			1	1	3	1
Bank Swallow														2										
Barn Swallow						2		1													1	4		
Barred Owl				3	1	2		2	4	3	1	5	2	1		1	2	3	3	2		1	8	2
Bay-breasted Warbler														3		1	1			4	2			
Belted Kingfisher		3	3	1	1		4	5	3	2	1	3	4			2			1		2	3	3	3
Black-backed Woodpecker	1			1	3	2	2	4	1	2				13		1				3	2		1	1
Black-billed Cuckoo	3	1	2		9	2	2	7	2	1		21	11	3			2		5	1	1	6	2	15
Black-throated Blue Warbler	2		2	1	3						1	1												1
Blackpoll Warbler			1											1										
Blue-winged Warbler																				2	3	2		

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Boreal Chickadee	1						1	4	4	4	5										1		1	
Brewer's Blackbird				3		3	6	4																
Broad-winged Hawk	4	5	2	6	1	4	6	7	8	10	5	5	8	6	3	2	2	5	9	8	7	11	6	10
Brown Thrasher						1	1				2			2	7		1				1			
Canada Goose					2		3		4			2	2	2	1	1		1	55	2	1	3	6	10
Cape May Warbler	2				4		1	1	2			1	1	4	7			2	6		2		5	3
Chimney Swift				1		2	2	3					2	3	1	2	1				1	1	2	3
Clay-colored Sparrow			2	2			10	10	8	5	6		7		6		4				3			
Cliff Swallow						12																		
Common Grackle	1	1		2	9	14	2	2	5		3	6	7	2	1	1	3	2		10	8	10	4	1
Common Merganser						1			9				1				2							
Common Nighthawk	1				5	3			2			1					1		3				1	
Cooper's Hawk					1		1	2		1			1									1		3
Eastern Bluebird				2	1	4	3	9	5		2		1					2	2			3		1
Eastern Kingbird	4		3	4	3		3	3	2	6	11	6	5	2	3	3	1		1	2	5	5	3	1
Eastern Phoebe	1	2	3	2	2	5		2	5	3	5	4	2	3	6	2	3	2	2		1	1		
Eastern Whip-poor-will					2								2				1		1					
Evening Grosbeak		3	3	14	20	34	1	14	6	9	9	8	2								2	1	2	14

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Field Sparrow														1										
Great Blue Heron	2				4	4	4		6	5	4	4	1		3		3	2		2	1	3	1	6
Great Gray Owl						1					1												3	
Great Horned Owl						1		2							1				1					
Green-winged Teal					5								1											
Green Heron								2	1			2									1	1	3	2
Herring Gull						2						1						1		2				
Hooded Merganser								1					2											
House Wren	1			1	6	2	4	1	6	3	2	2	8	1	1				9	1	4			
Killdeer	1		1			1		2	1					1			3				1			
Lesser Scaup																	1							
Long-eared Owl												3												
Mallard		1			9	7	1	1	1		1	8	1	1	1						1	1	3	2
Marsh Wren														1	1				1			3		
Merlin				1					1								1	1						1
Northern Goshawk												2				2							1	
Northern Harrier					1																		1	
Osprey	1				1	1	1		1												1			

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Solitary Sandpiper					1																			
Sora					1	2	1	2							1		1							
Spruce Grouse																					1			
Swainson's Thrush	7	1	2	17	5	4	2	4	13			1		1	1	7	4	1	7	1	2			1
Tennessee Warbler					2	2							1	8			2				9		1	3
Tree Swallow		1			1	9	2	1		3	1	3	6						2	3	2	6	6	
Trumpeter Swan																	4		1		7	4	3	11
Turkey Vulture		1				1		1		1	1		1						2		4	1		
Vesper Sparrow	1									1			8		1					1				
Virginia Rail												1												
Warbling Vireo		2	3	1							3	2	1			1	1	4	4					
White-winged Crossbill	1	23		1		50								2	81	8					2	3		
Wild Turkey														1		2					1			
Willow Flycatcher	2	1		1																		1		
Wilson's Warbler															4						2	1		1
Wood Duck					1	1	14	1	4			1							1	4	2	1	1	3
Yellow-billed Cuckoo	8		1	22			2					1		1		3					1			

Appendix E

Number of observations on the Superior National Forest for species not tested for population trends in 2018. Includes flyovers and all birds regardless of distance.

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
American Black Duck									2	2														
American Kestrel		1			1		1	1	1															
American Three-toed Woodpecker																	1							
American White Pelican			4																					
American Woodcock			1							2				2	1			2			3	1		
Bald Eagle						1		1					1					2	1	1		1		
Baltimore Oriole		4	4	2	2	1	1	4	3			1		2				1						
Bank Swallow								1																
Barn Swallow								1																
Barred Owl	1		5		5				1	1	1		4		3	1	1	2	1	1	1			2
Bay-breasted Warbler	8	10			4									2				1	2	14	18	1		
Belted Kingfisher	2	5	1	2	2	4		3	5	1	1	2	2	2	10	4	8	6		2	4	3		3
Black-backed Woodpecker					1	4	5	3	5	3	2	2	8	2			1	4		6	2	3	4	11
Blackpoll Warbler	1													2										
Blue-winged Teal																			1					

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bobolink														1										
Boreal Chickadee		1			1		2	3	6	8	5		7	8	6	4	1	8	11	5	9	10	9	3
Boreal Owl													1											
Brewer's Blackbird			1				1																	
Brown-headed Cowbird	3	3	1		7	1	1	4	4	1				1		1							1	
Brown Thrasher	1	3	2	1							1							1						
Canada Goose			1	1	2			26	7	2	2		2	3	6		5	27	98	16	3	10	3	45
Chimney Swift											3		2	1	1	2		1						3
Clay-colored Sparrow			1	1				5	2	1	1	1								1				
Common Goldeneye								3	1		1						1							
Common Grackle		3		2			6	8	4	1	1	7	1	1	2	3	4	6	1	1	5	1	3	3
Common Merganser						3		5	1	4		1	1	1					4	1				
Common Nighthawk		1			3	1				1		1										1		
Cooper's Hawk												1												
Dark-eyed Junco (Slate-colored)	9	5	2	3	2	1	9	1	5	2	1	3	8	4	11		3	21	11	16	15	29	16	16
Eastern Bluebird								1		2		1											3	8
Eastern Kingbird	4	1		2	1			7	1	1	1						3	3					2	
Eastern Phoebe	1	2			2	2	3	1	1	1	1	2	2	8	3	6		2	1	1			1	

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Eastern Whip-poor-will		1							1							1		1						
Gray Catbird		3	1	1		6	1	2		1		2		3	1	2	4	3	1	2	1			
Great Blue Heron										1		2	3	1	3			1		3				1
Great Crested Flycatcher	10	8	13	4	2	13	4	3	10	4	2	3	7	24	3	20	4	6	1	7			1	3
Great Gray Owl											1													
Great Horned Owl					1					2												2	1	
Green-winged Teal								11										1						
Green Heron						1																		
Herring Gull					6			2				2										1		
Hooded Merganser																		3						
House Wren	4	2	1	1	3		1	1		2			1	2				2			1		1	2
Indigo Bunting			4	4	7	1	4	10	12	6	10	3	10	5	1			1	4		2			
Killdeer		4	1	3				2		1							6	2						
Lesser Scaup															1									
Long-eared Owl																					1			
Mallard		1	1	2	1	4	8	7	3		2		1	3			2	8	3			3	2	
Marsh Wren										1														
Merlin						1	2					1						1			1	2	1	

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Ruby-throated Hummingbird	1	2	4	4	2	8	4	8	7	4	10	6	10	5	20	9	14	11	9	5	13	11	3	4
Sandhill Crane				2											1		2		1			1	1	9
Savannah Sparrow											1			2	1				1					
Sedge Wren	4	2				3	1	2		9	2	3	3	8	2				1			2		1
Sharp-shinned Hawk						1				1			3	1				1						3
Solitary Sandpiper							1																	
Sora								1										1				1		
Spruce Grouse						1			1	2				1		1	2		1			1	2	1
Tree Swallow					2	1				2						1		1				1	2	
Trumpeter Swan																		2			4	4	2	14
Turkey Vulture	1			2			1			3	1		4	1			2	1	1	1		2		1
Vesper Sparrow	2	6									1		1											
Virginia Rail															1				1					
Warbling Vireo																								1
White-breasted Nuthatch	1	6	3	1		5	1	3	13	3	4	3		8	14	11	2	21	5	2		8		6
White-winged Crossbill		1		2		10	3	4	14	3	1		5	173	5			1	19			3	1	1
Wild Turkey																							1	
Wilson's Warbler	1		1											1	5				1	2	1			

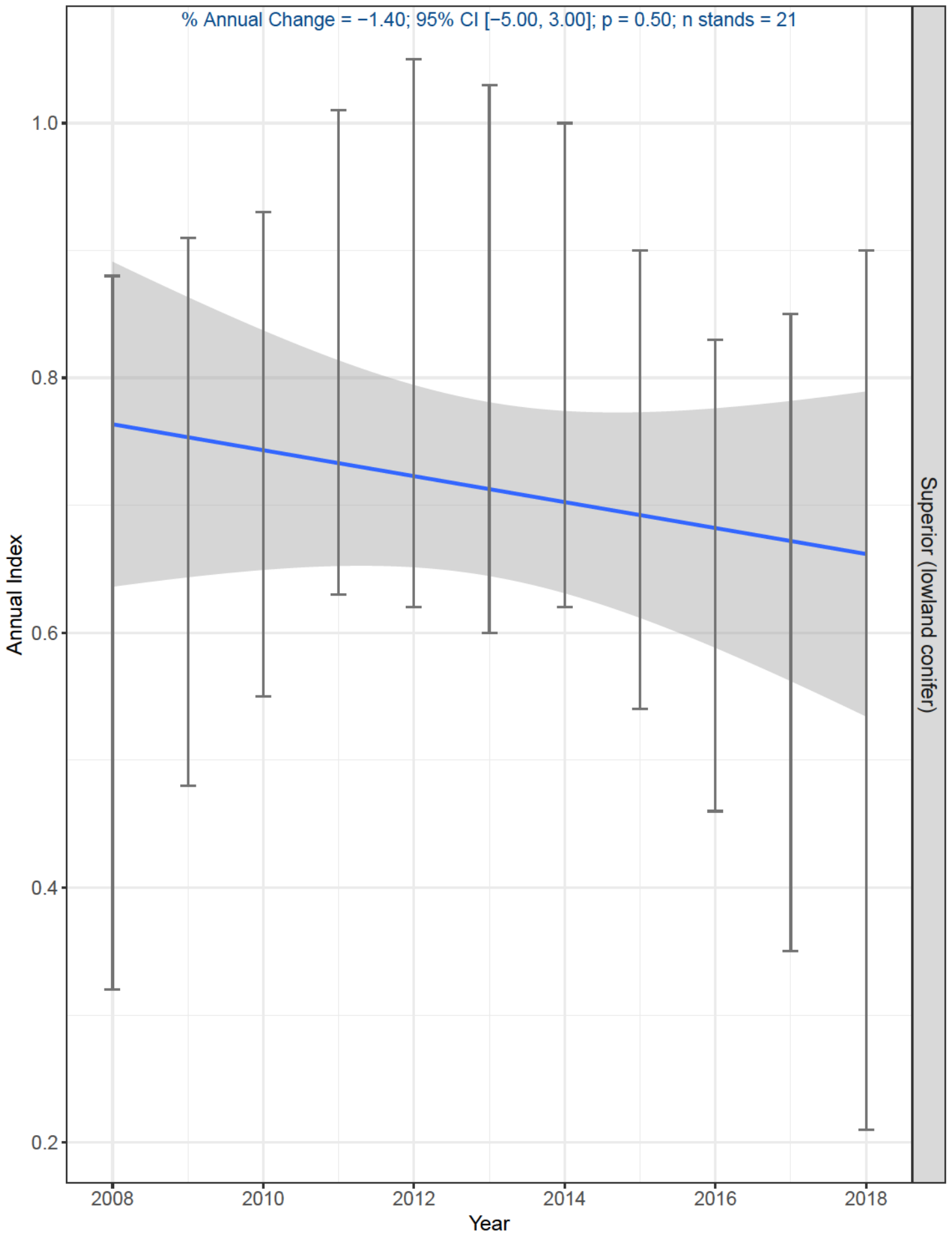
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Wood Duck						1	1								1		2	4						
Yellow-billed Cuckoo	2		1	3	1											1						1	2	
Yellow-throated Vireo	2	5				4	1		3			1		2							3		1	2
Yellow Warbler	6	1		1			1	2	3		1	1		5	5	3	2	20	10	4	5			1

Appendix F

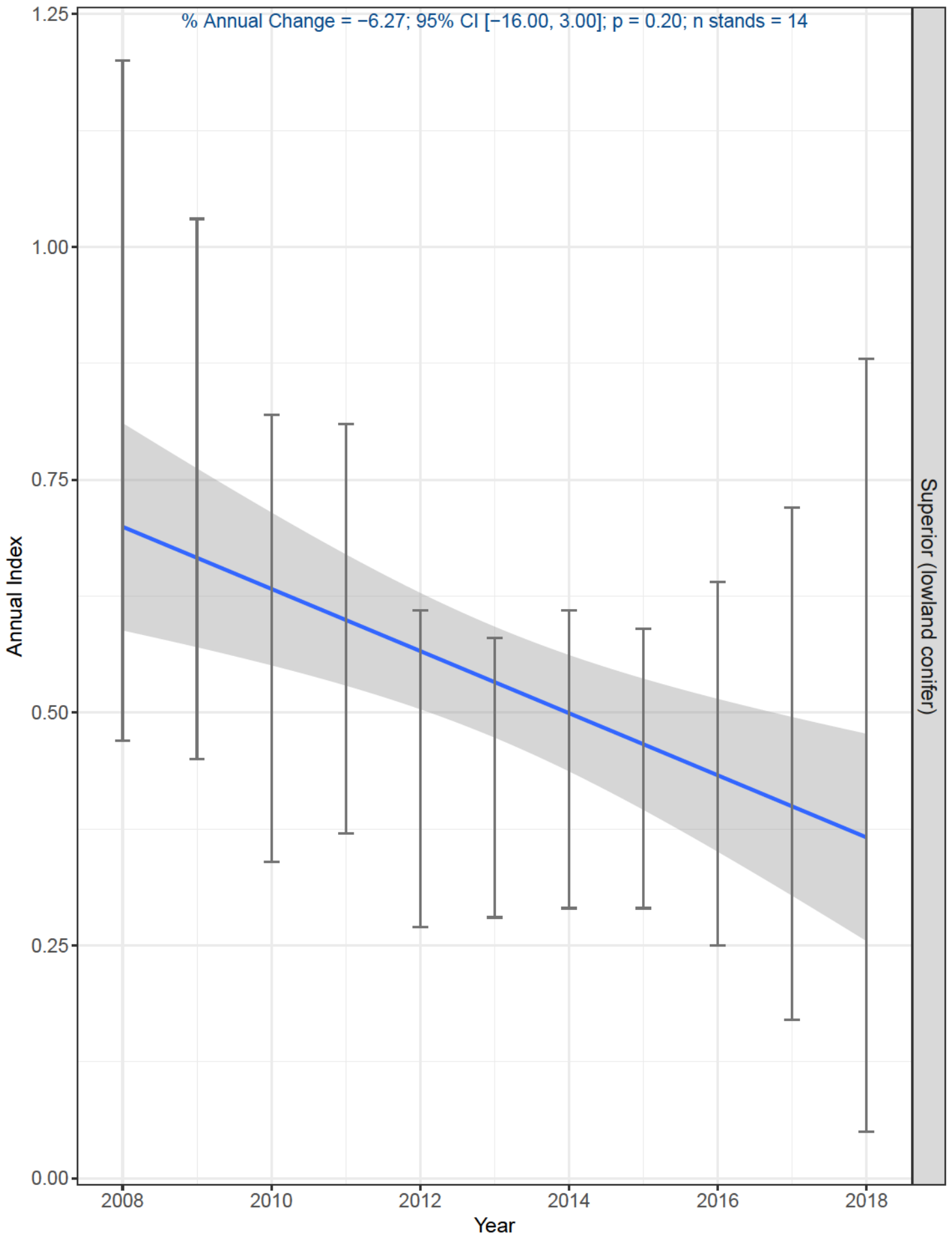
Results of trend analysis for 19 species that are associated with conifer or lowland-conifer for breeding habitat. Forty-two lowland conifer stands, including 25 stands that were added to the sampling design in 2008, that are primarily composed of black spruce, tamarack, or mixed swamp conifer were included in this analysis.

Blackburnian Warbler

% Annual Change = -1.40; 95% CI [-5.00, 3.00]; p = 0.50; n stands = 21

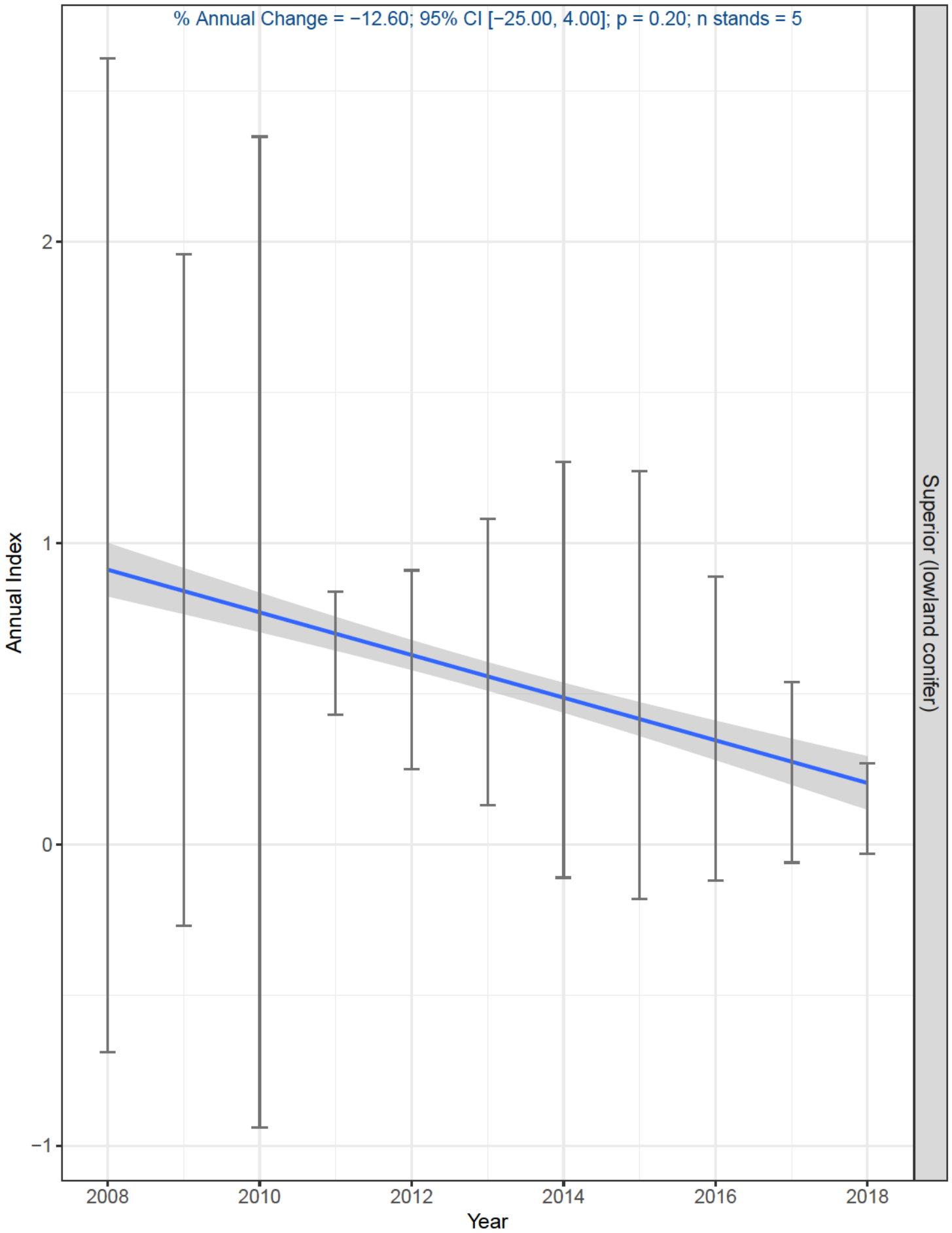


Blue-headed Vireo

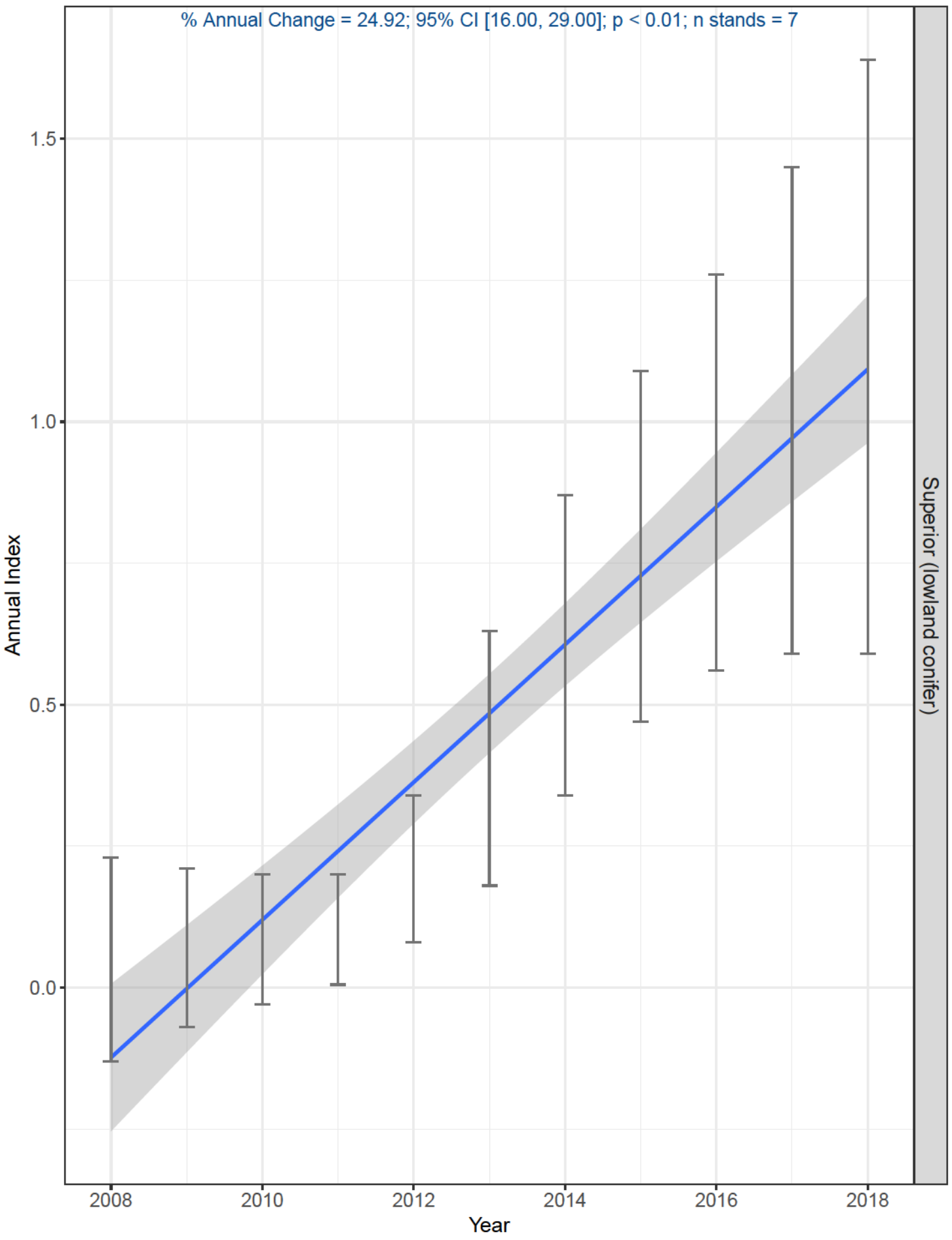


Canada Jay

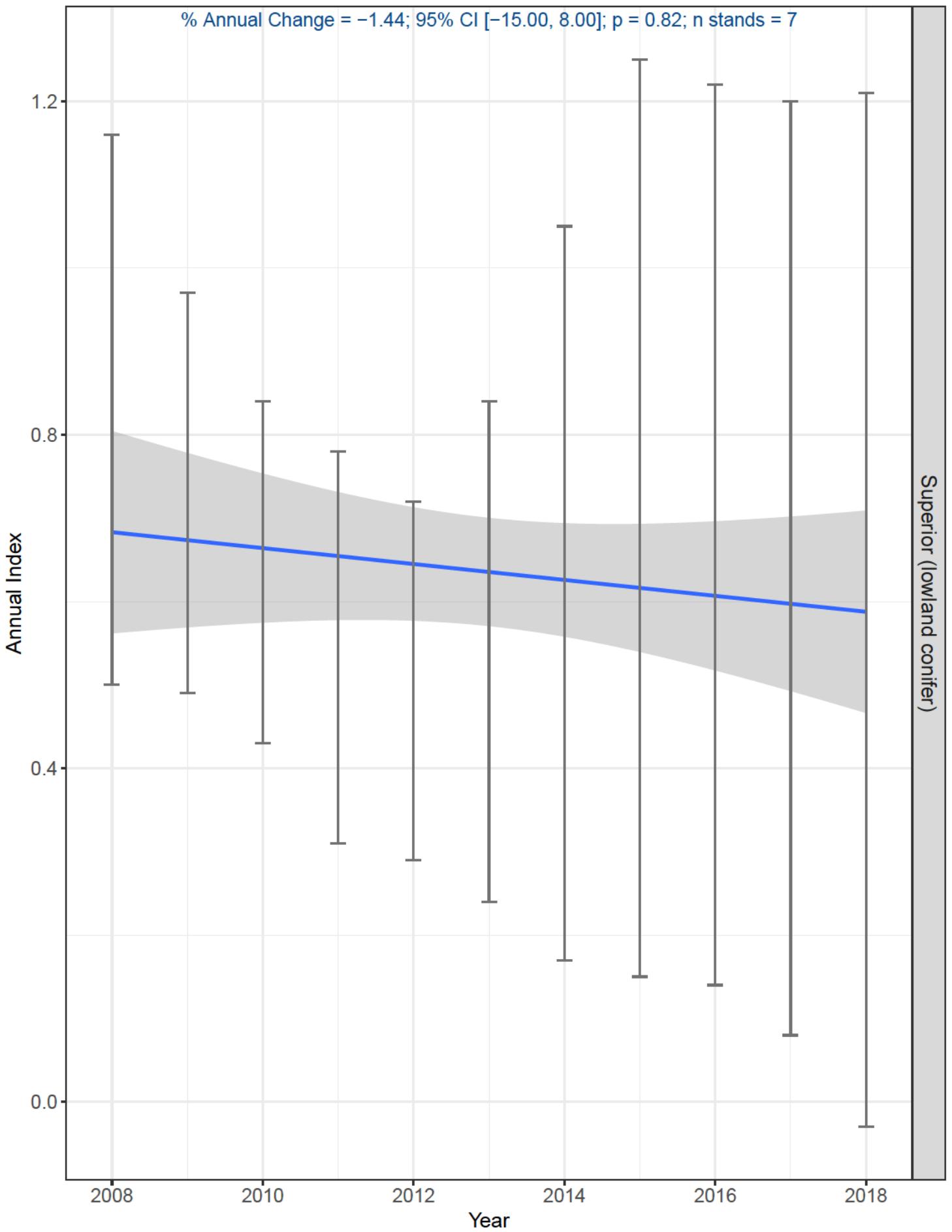
% Annual Change = -12.60; 95% CI [-25.00, 4.00]; p = 0.20; n stands = 5



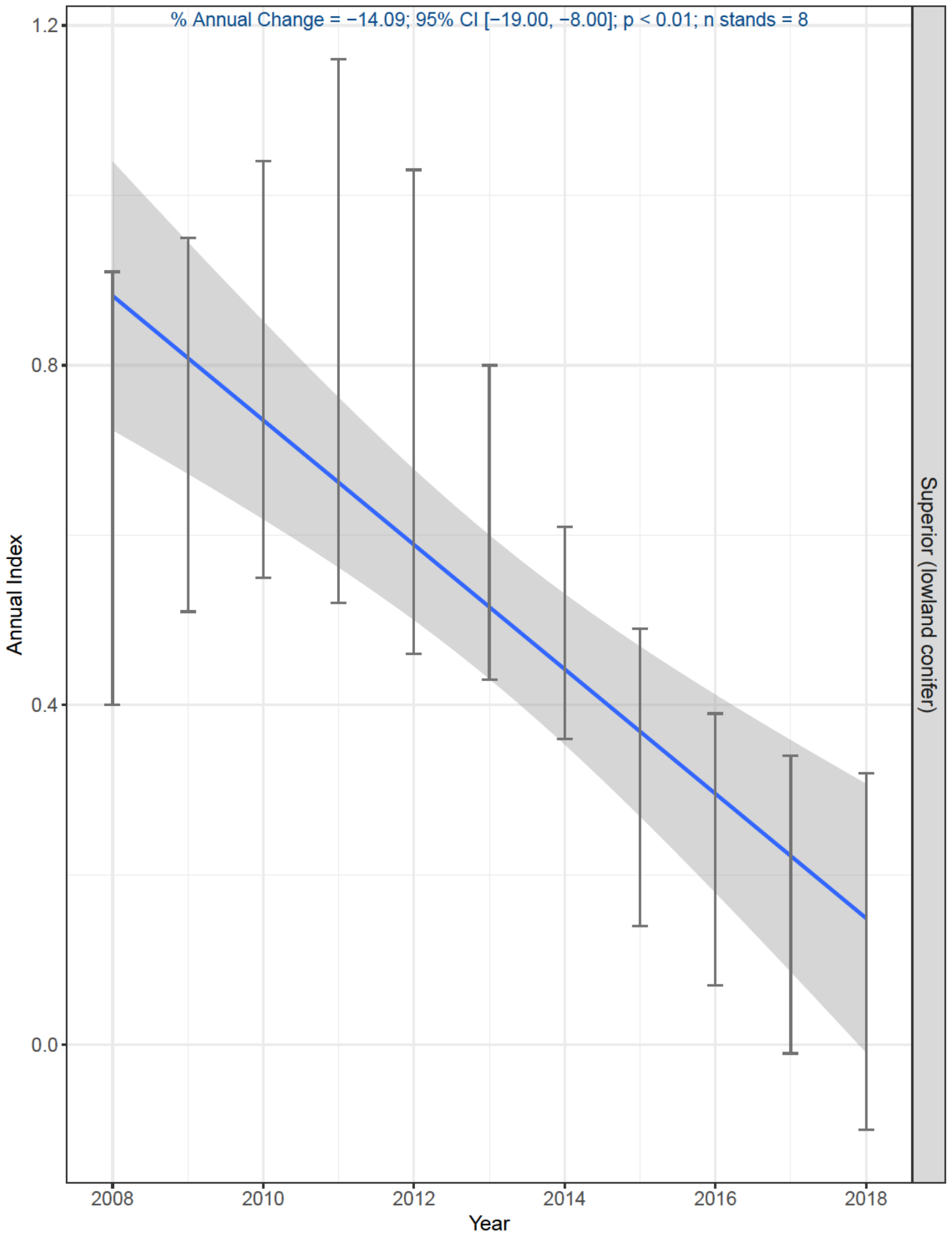
Cape May Warbler



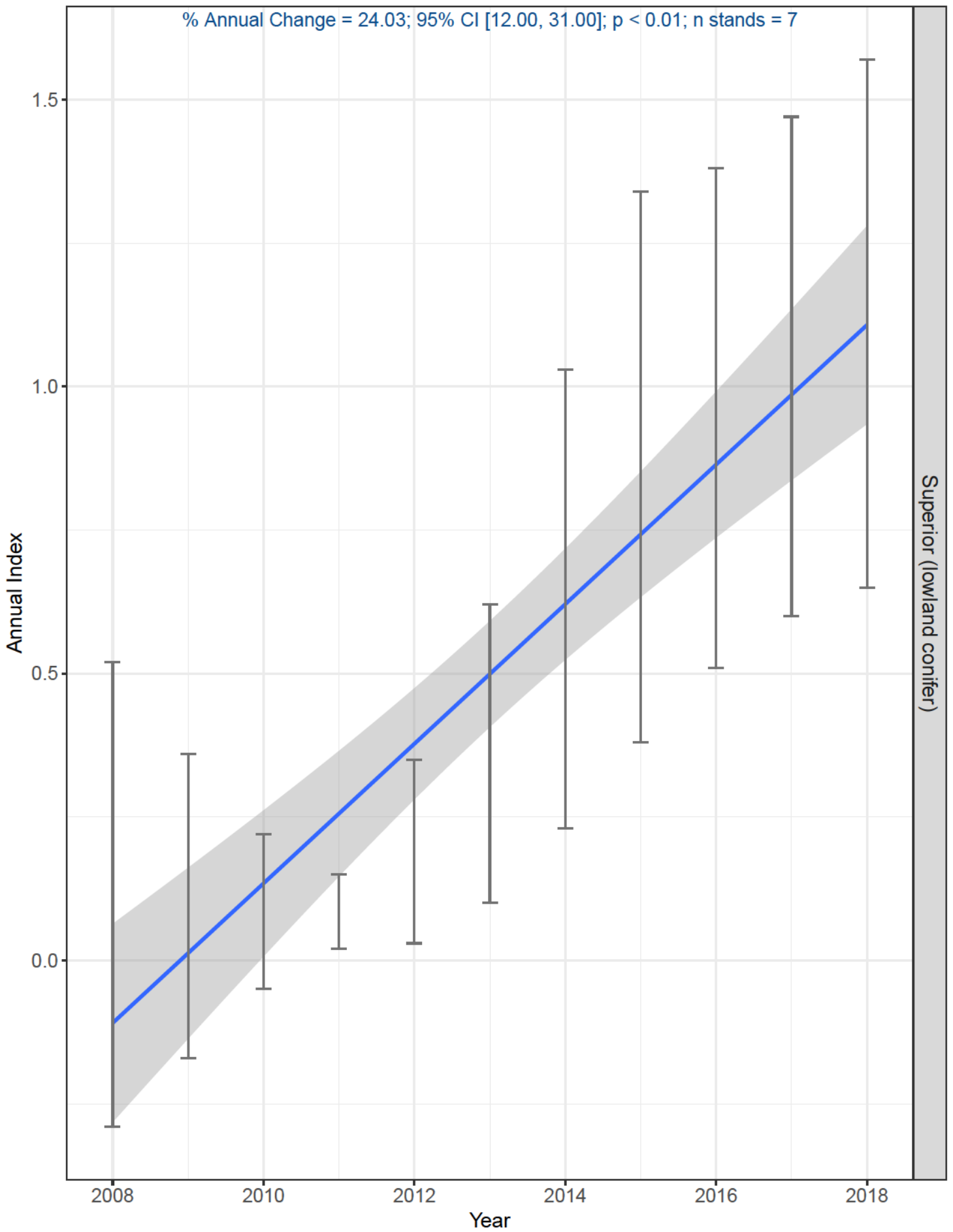
Chipping Sparrow



Common Raven

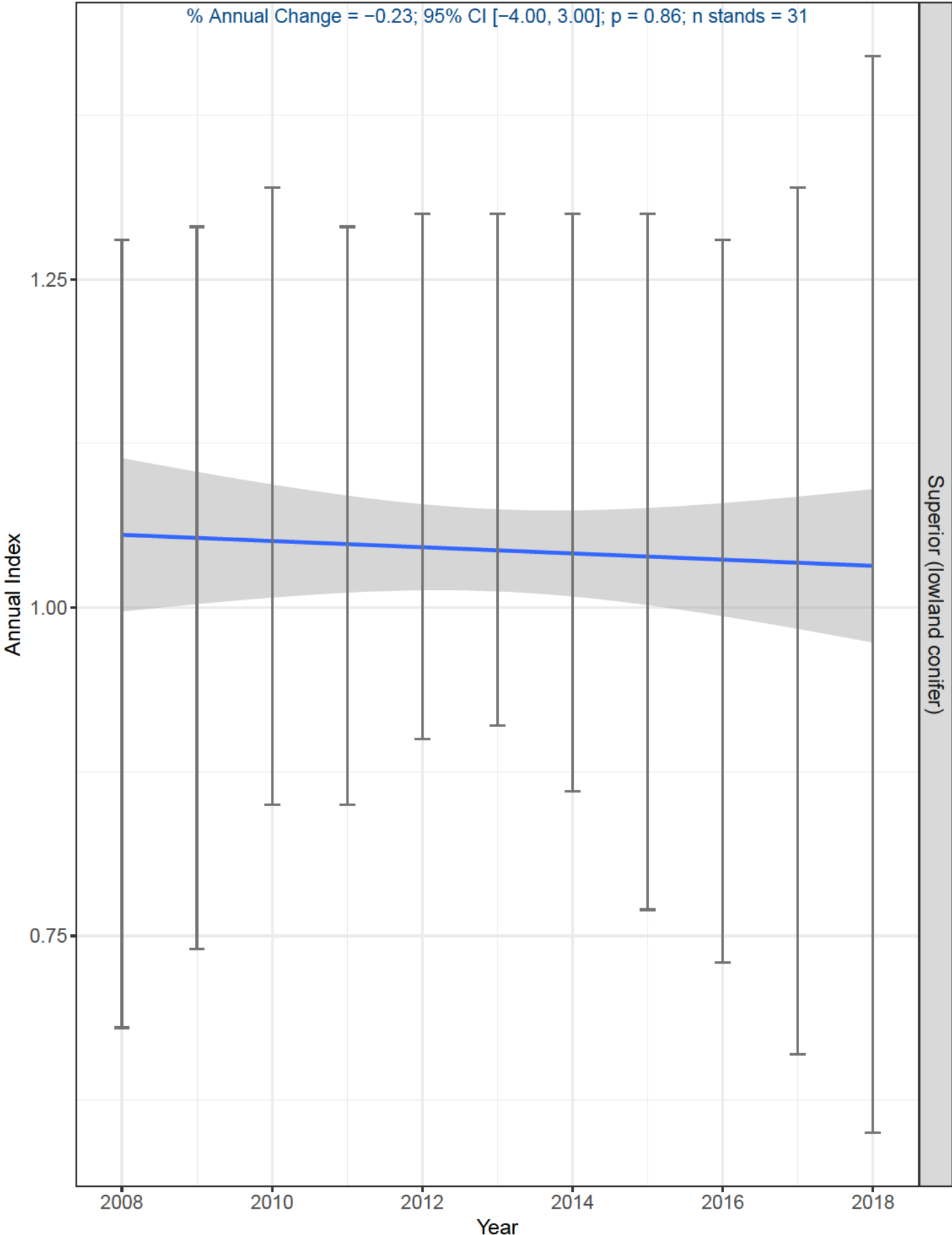


Dark-eyed Junco (Slate-colored)

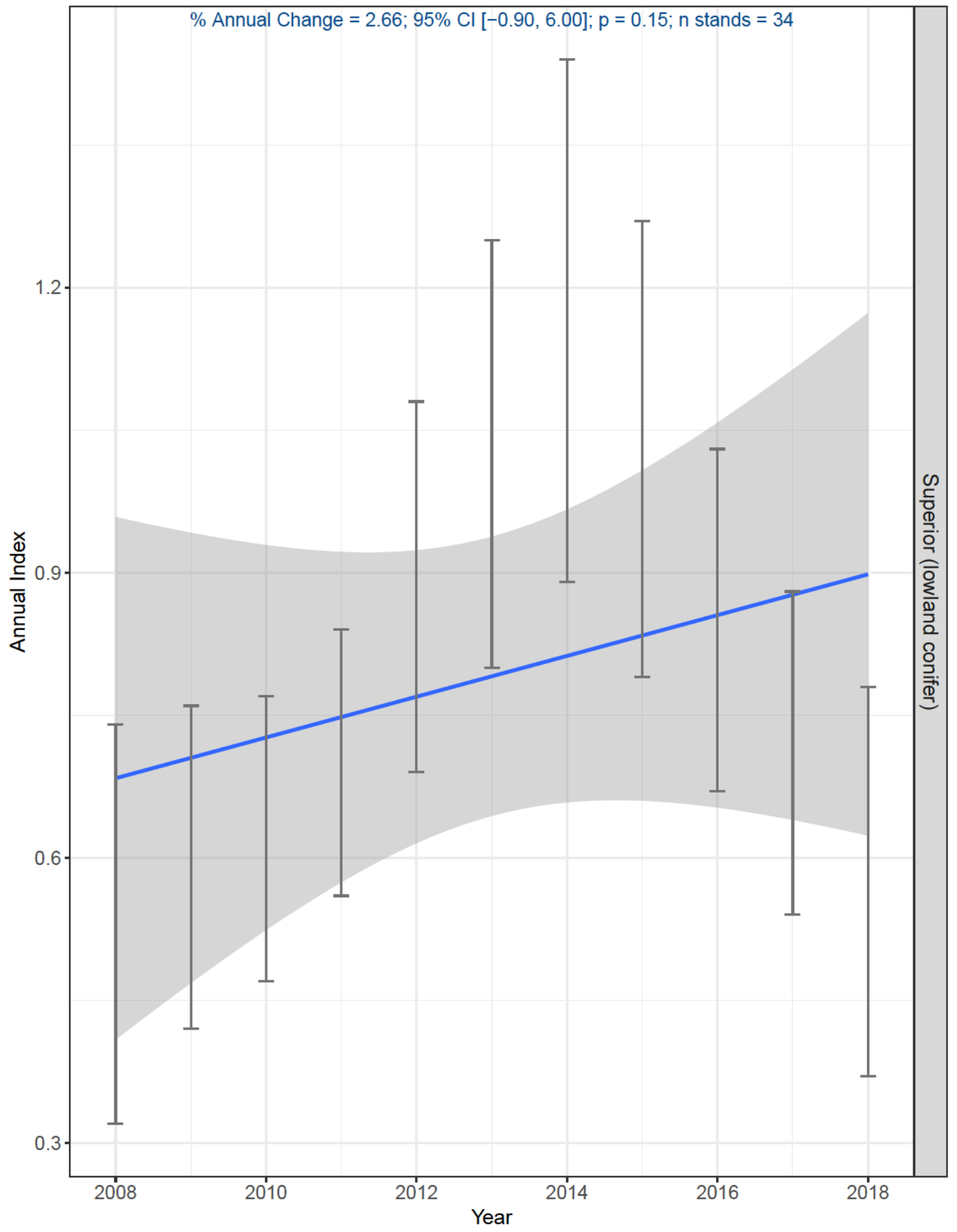


Golden-crowned Kinglet

% Annual Change = -0.23; 95% CI [-4.00, 3.00]; p = 0.86; n stands = 31

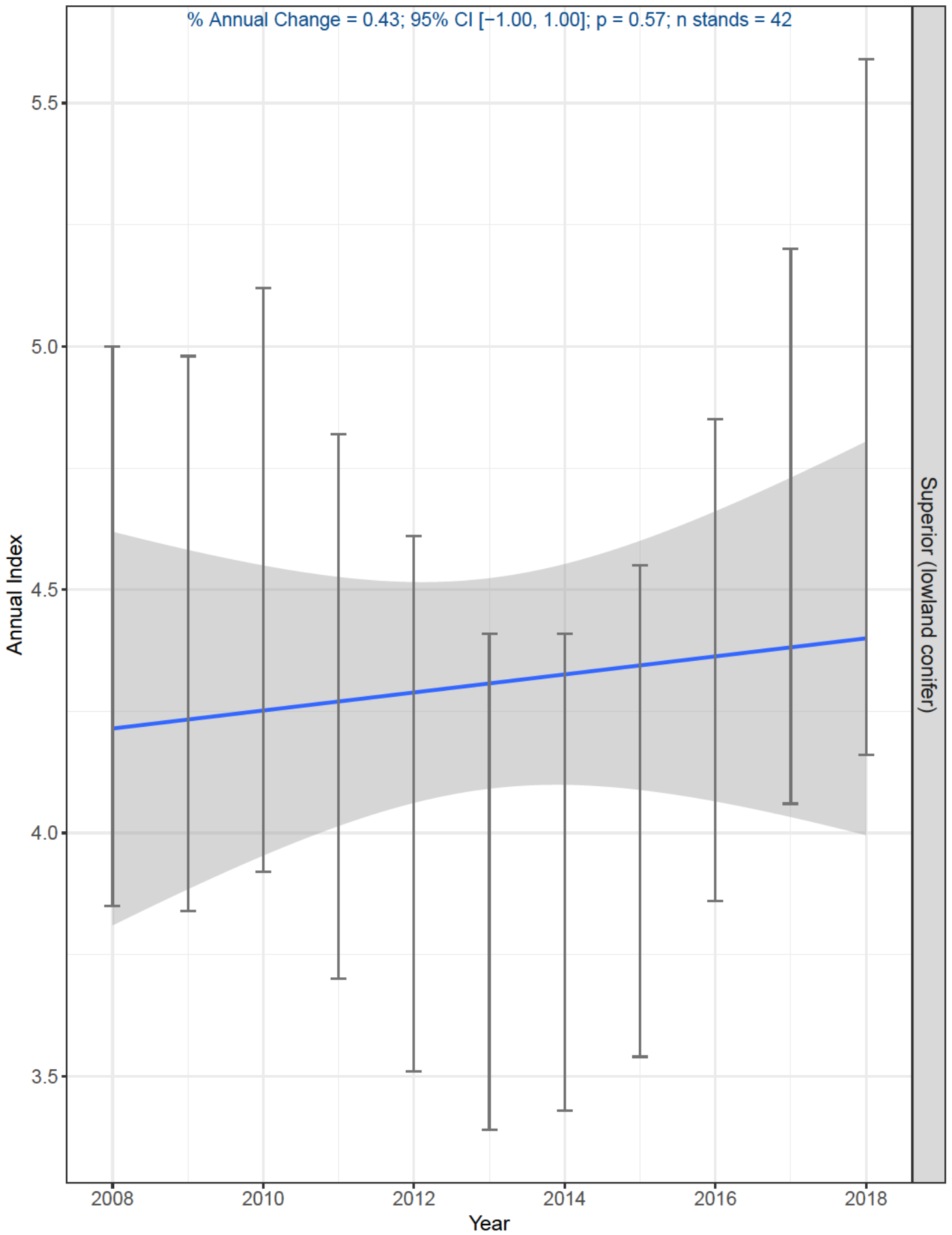


Magnolia Warbler



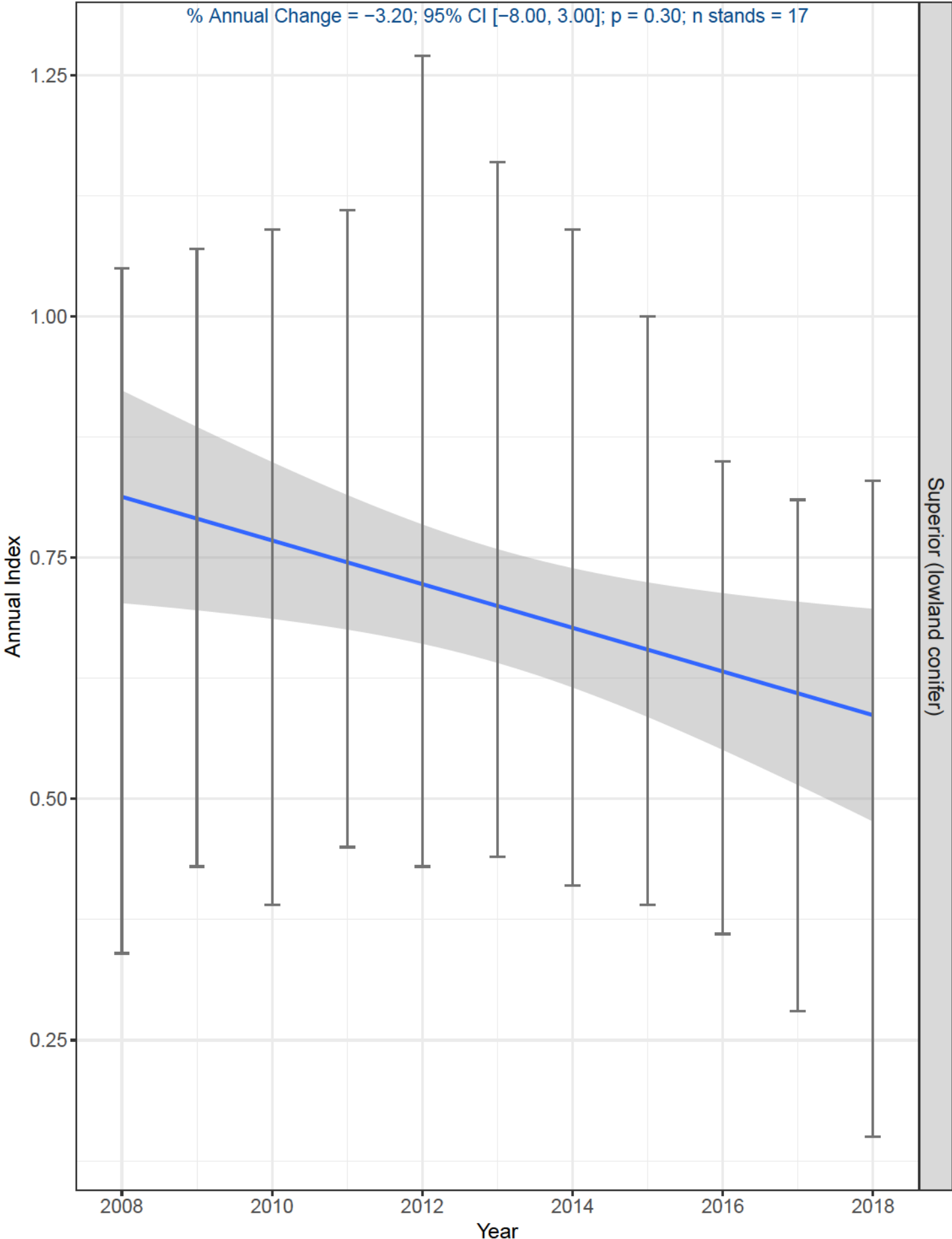
Nashville Warbler

% Annual Change = 0.43; 95% CI [-1.00, 1.00]; p = 0.57; n stands = 42



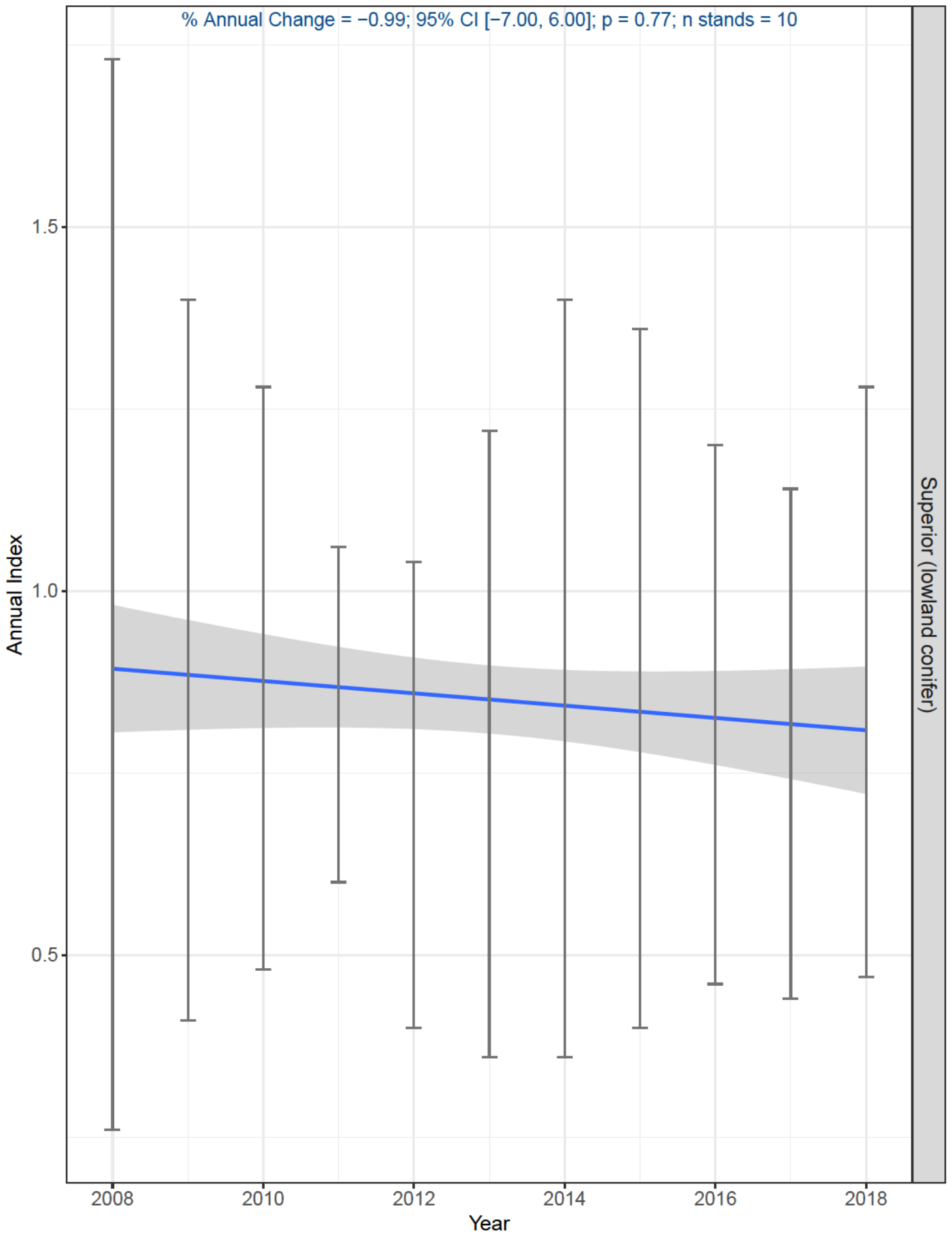
Northern Parula

% Annual Change = -3.20; 95% CI [-8.00, 3.00]; p = 0.30; n stands = 17



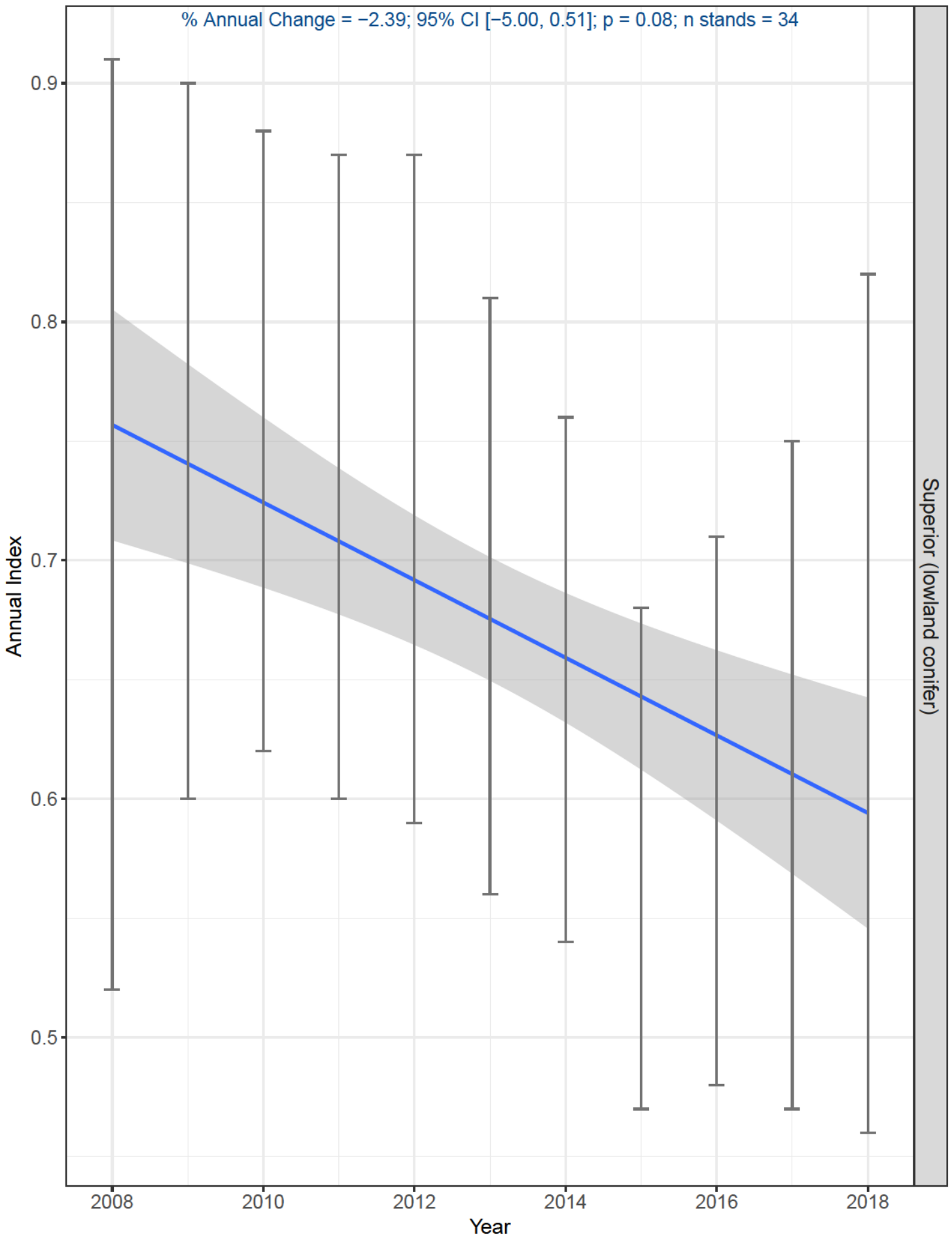
Northern Waterthrush

% Annual Change = -0.99; 95% CI [-7.00, 6.00]; p = 0.77; n stands = 10



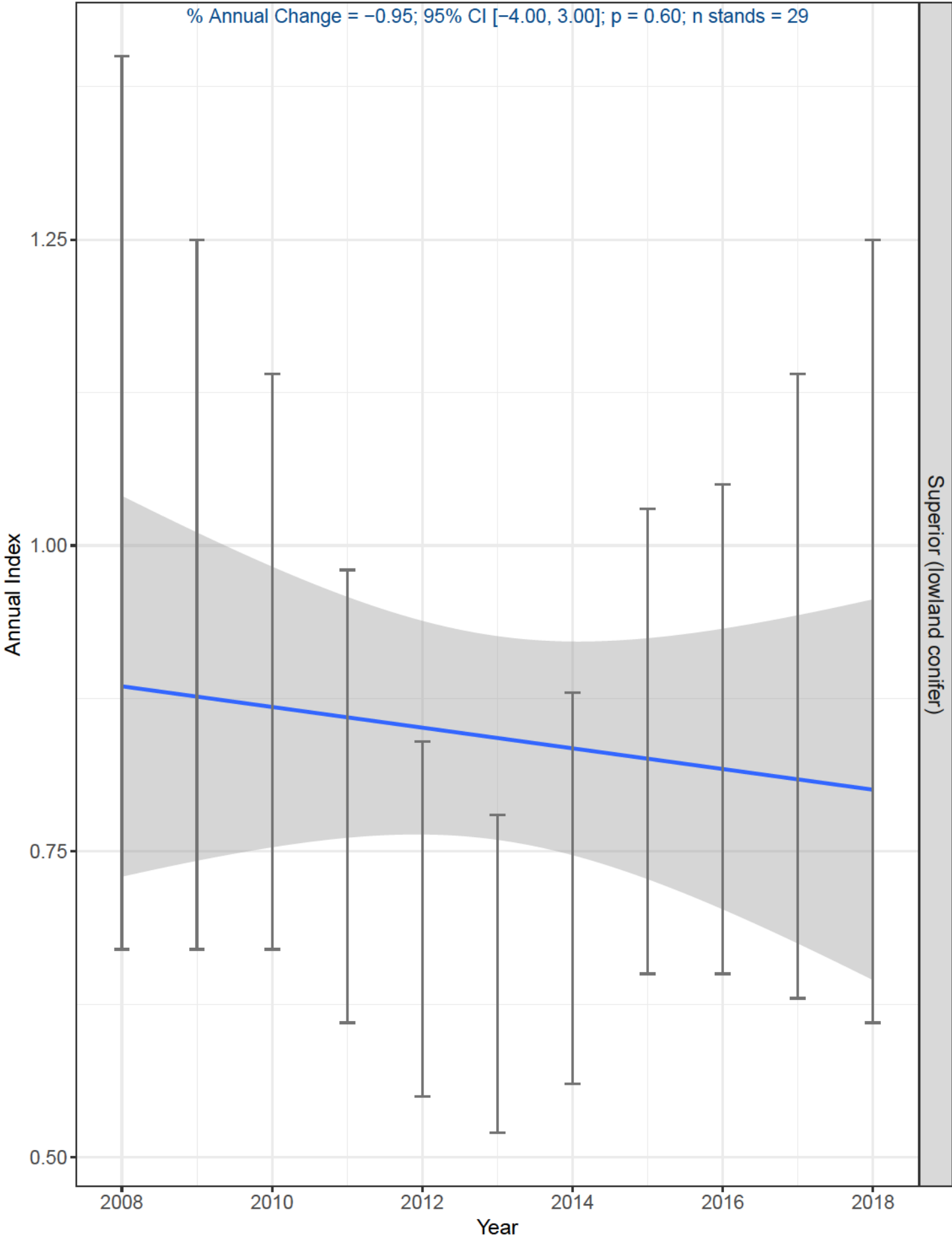
Red-breasted Nuthatch

% Annual Change = -2.39; 95% CI [-5.00, 0.51]; p = 0.08; n stands = 34



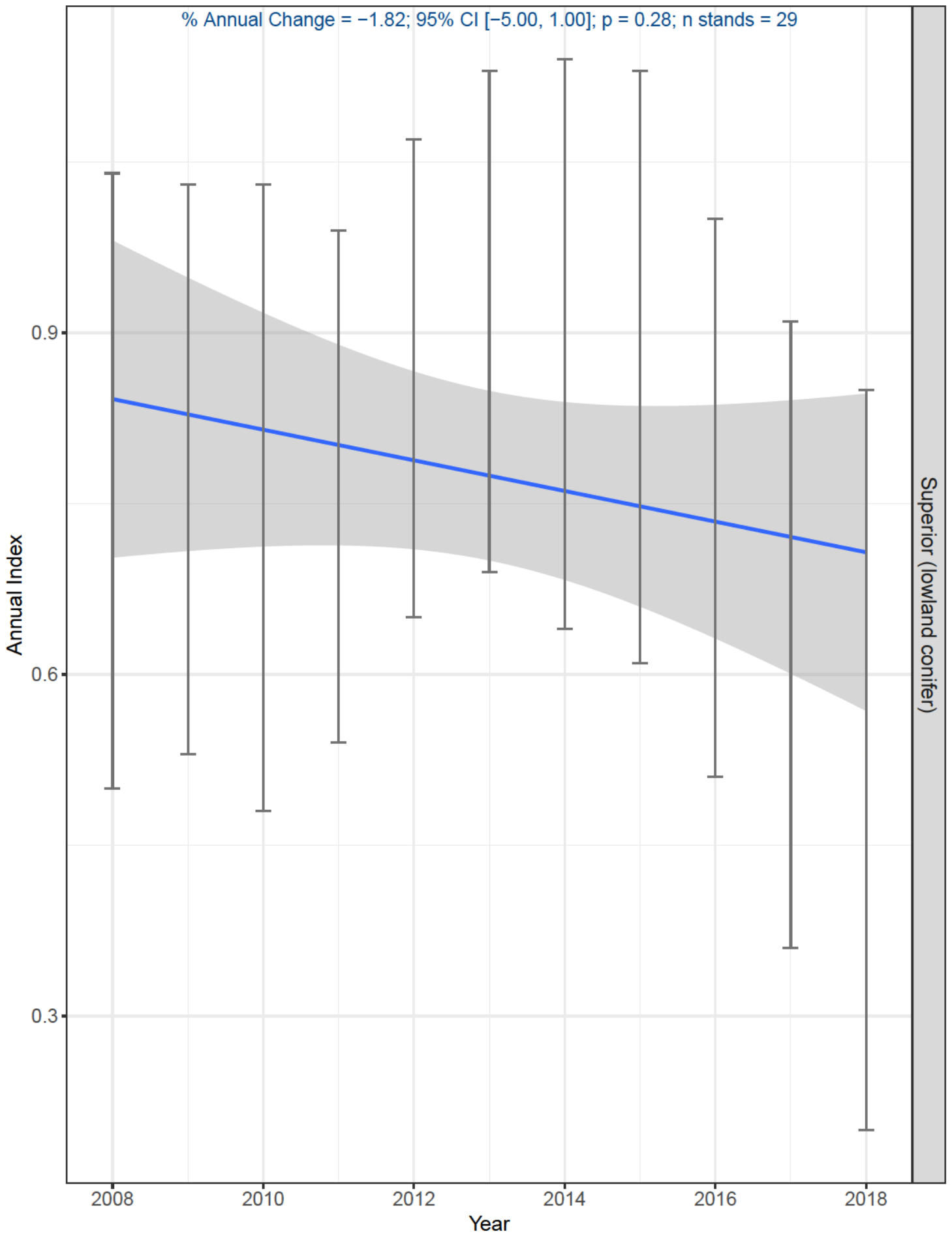
Ruby-crowned Kinglet

% Annual Change = -0.95; 95% CI [-4.00, 3.00]; p = 0.60; n stands = 29



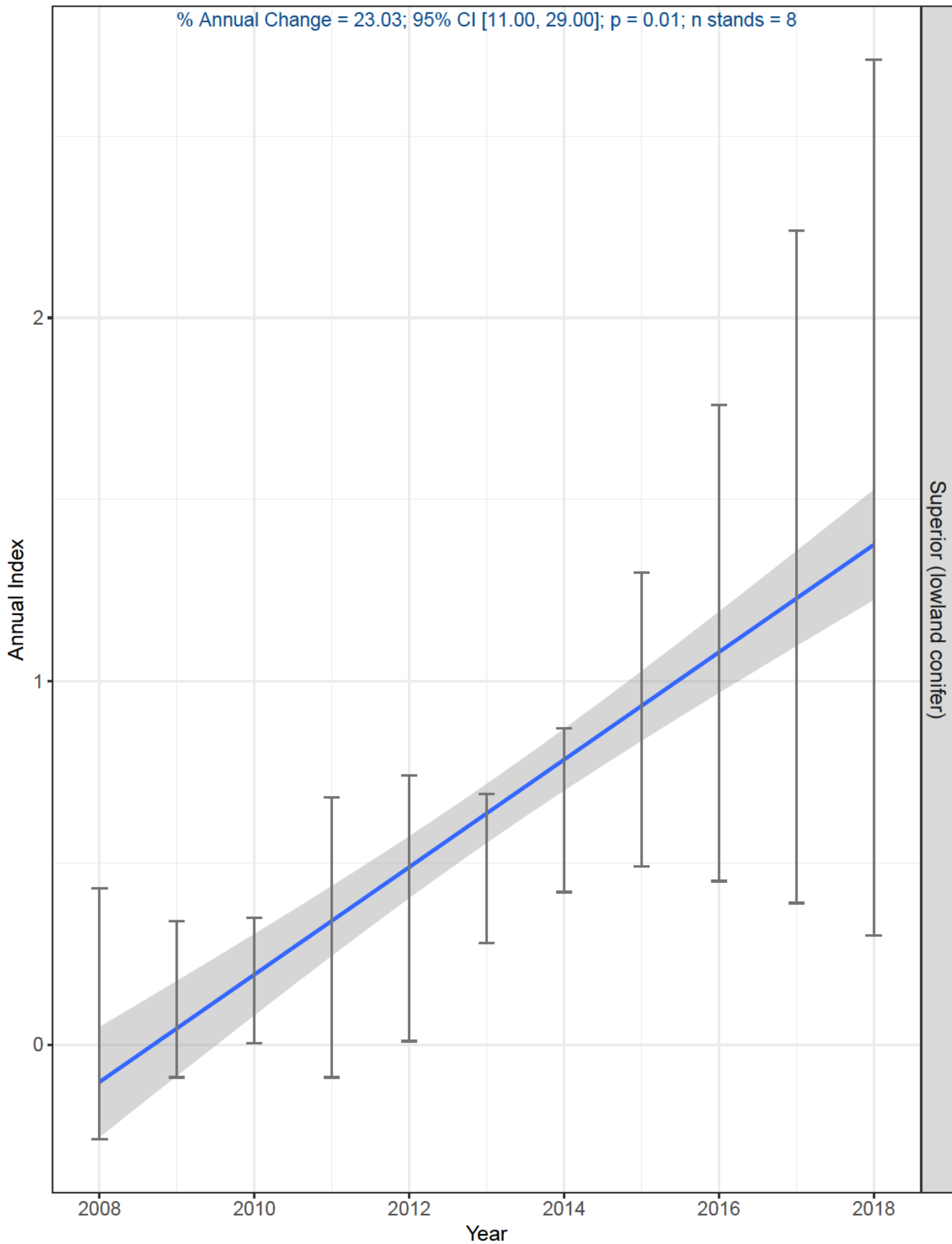
Swainson's Thrush

% Annual Change = -1.82; 95% CI [-5.00, 1.00]; p = 0.28; n stands = 29



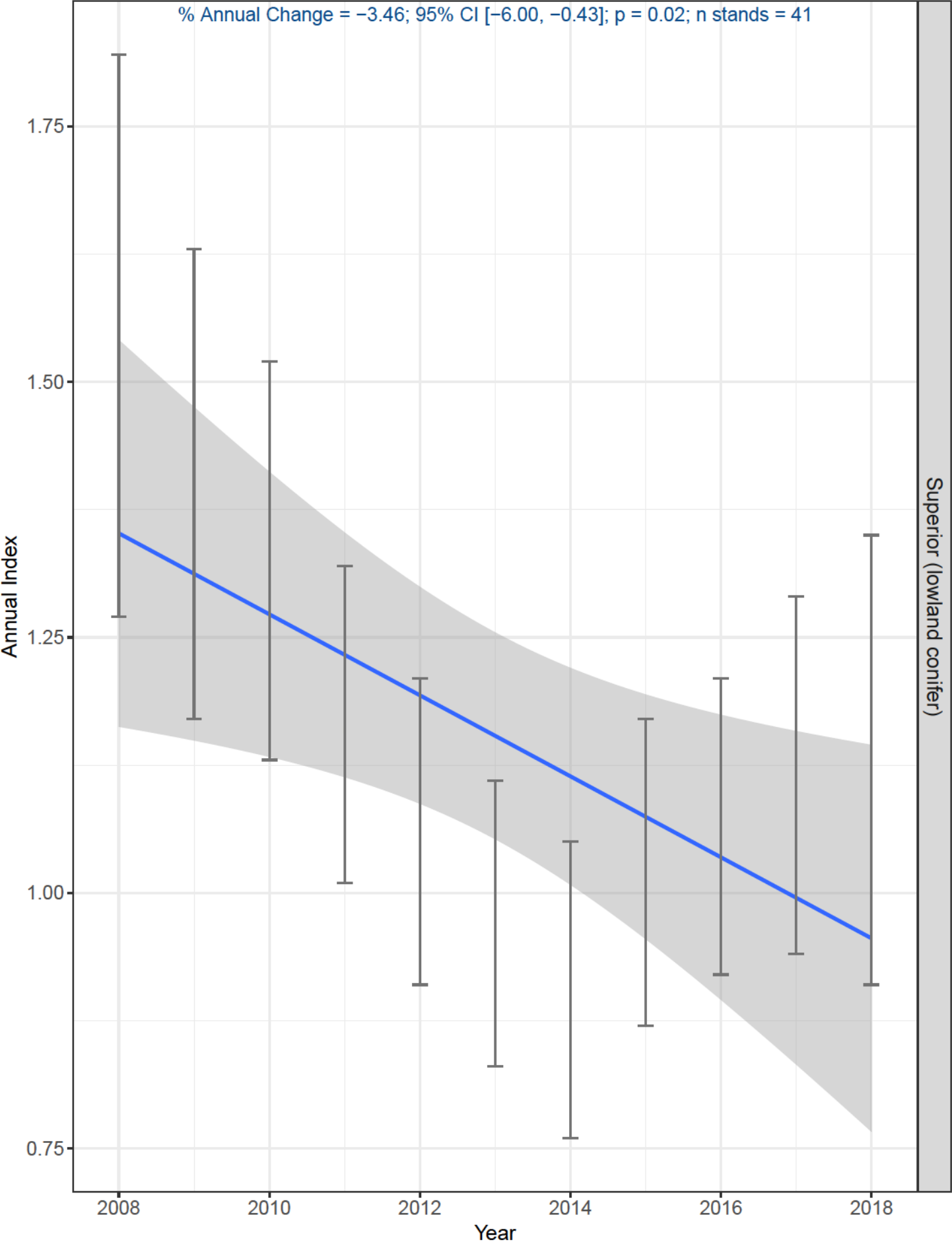
Tennessee Warbler

% Annual Change = 23.03; 95% CI [11.00, 29.00]; p = 0.01; n stands = 8

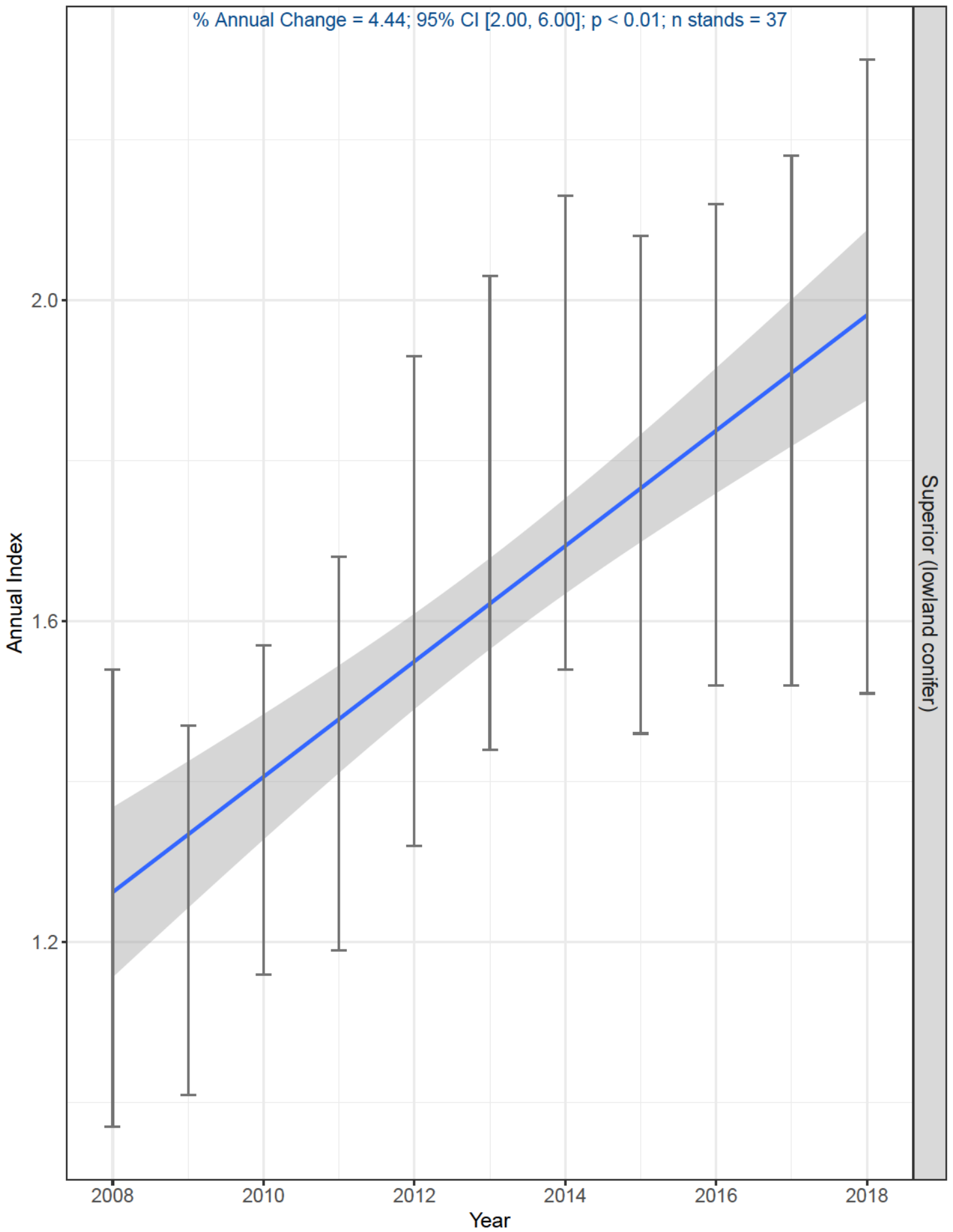


Winter Wren

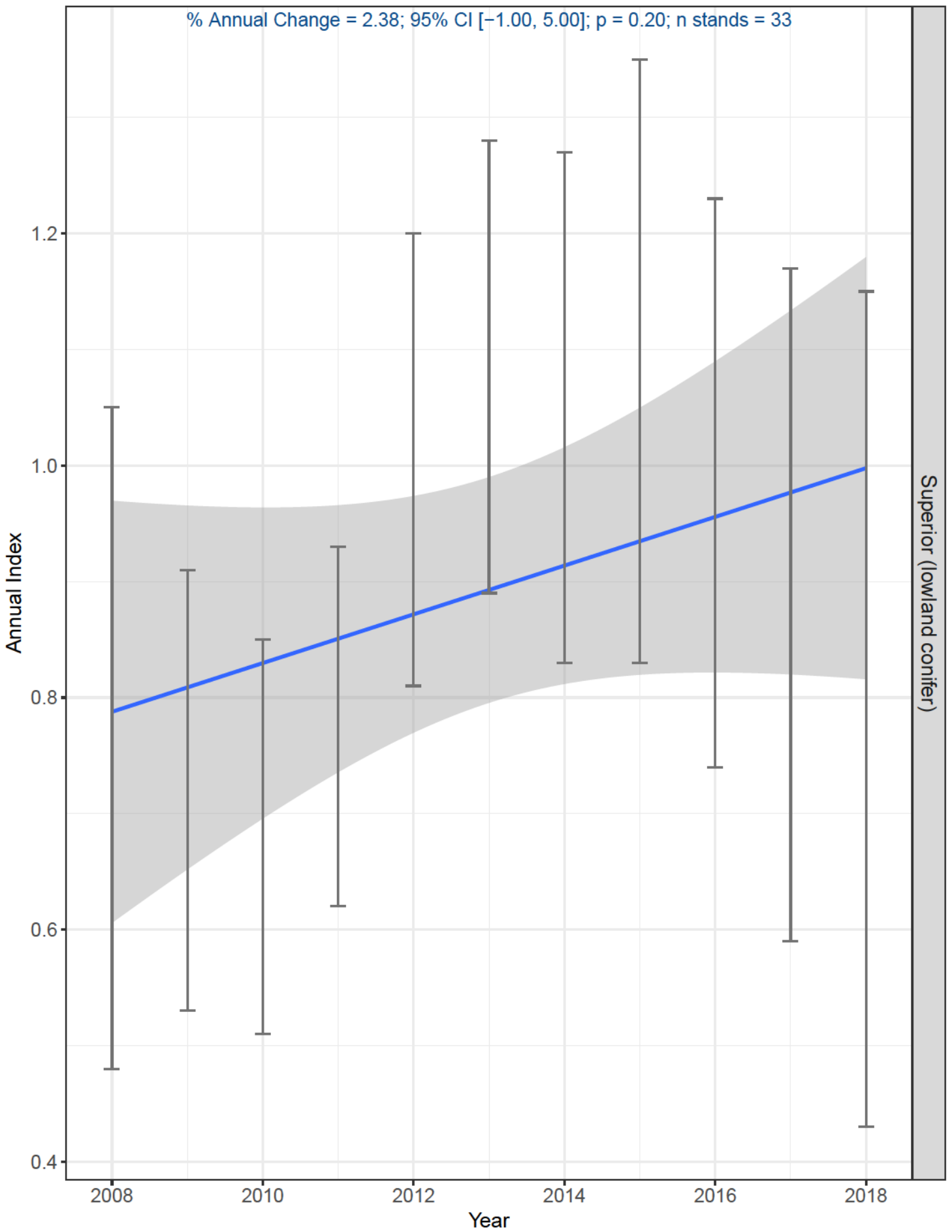
% Annual Change = -3.46; 95% CI [-6.00, -0.43]; p = 0.02; n stands = 41



Yellow-bellied Flycatcher



Yellow-rumped Warbler (Myrtle)



Appendix G

STUDY DESIGN AND METHODS

Sample Design

At the onset of the monitoring program, sampling locations were distributed across the forest mosaic in a proportionally stratified random manner. For each NF, stands ≥ 16 ha were grouped from their respective compartment inventories into strata defined by dominant tree species (i.e., forest cover type) and stocking density. Because the Superior NF is large, we randomly selected three of the six districts to sample (Tofte, Kawishiwi, and LaCroix). We also excluded the Boundary Waters Canoe Area Wilderness because there is no timber management and it is logistically difficult to access. For each NF, stands were randomly selected from each stratum so the final proportion of stands was equal to the proportion of forested land area of each cover type and stocking density for each of the NFs (Hanowski and Niemi 1995a). A total of 135 and 169 stands were originally selected in the Chippewa and Superior NFs, respectively (Figure 1). A total of 13 habitat types were sampled in the Chippewa NF and 12 in the Superior NF (Niemi et al. 2016, p. 11). Due to potential interest in logging lowland-conifer forests, 25 stands primarily composed of productive black spruce forest were added to the Superior NF in 2008. Twenty-seven non-forested (open, early-successional, shrubby wetland) stands (81 points) were added to the monitoring program in Chippewa NF in 2016 to more adequately monitor populations of Golden-winged Warblers. The overall design of the monitoring project has been peer-reviewed as part of two national breeding bird monitoring meetings (Hanowski and Niemi 1995a; Hanowski et al. 2002, 2005) and in several peer-reviewed publications (e.g., Niemi et al. 2004; Etterson et al. 2009; Lapin et al. 2013; Grinde and Niemi 2016; Grinde et al. 2017).

Breeding Bird Counts

Three permanent point count sites were established within each stand in 1991, point count sites were initially located a minimum of 220 m apart and at least 100 m from the edge of the forest stand (Hanowski et al. 1990, 1995a; Blake et al. 1992). Ten-minute point counts are conducted at each site between early to mid-June in the Superior NF, and late June to early July in the Chippewa NF (Etterson et al., 2009; Niemi et al., 2016). Point counts are conducted by trained observers (see observer training below) from approximately 0.5 h before to 4 h after sunrise on days with little wind ($< 15 \text{ km hr}^{-1}$) and little or no precipitation. All birds heard or seen from the site were recorded, and distance was estimated as 0–25 m, 25–50 m, 50–100 m, or > 100 m (Howe et al., 1997, Niemi et al., 2016). Weather data (cloud cover, temperature, and wind speed) and time of day were recorded before each count.

Observer Training

Testing and training of counters is an important component of the monitoring program. Prior to the field season, recordings of 120+ bird species were provided to all potential counters. Counters are tested on their ability to identify 86 of these species by song. Songs on the recording were grouped by habitat (e.g., upland deciduous, lowland coniferous) to simulate field cues that would aid in song identification. A standard for number of correct responses was established by giving the test to observers who had four to five years of field experience. Based on their results, the standard for passing was set at 85% correct responses. All point counters employed to collect data for this project have reached this benchmark. In late May of each monitoring year, observer field training was conducted over a four day period to ensure accuracy and consistency in data collection. In addition to field training and testing, all observers were

required to have a hearing test to ensure their hearing was within the normal range, as established by audiologists, for frequencies 125 to 8,000 hertz.

Analysis

Population/abundance estimates

Bird population estimates are defined here as the annual mean number of observations of a species in a 10-min point count for each NF and for the NFs combined (i.e., regional trends). Stand-level abundance estimates for species trend analyses in the Chippewa and Superior NFs were calculated by summing the numbers of individuals across the two furthest points per stand. The middle point in each stand was excluded because an unlimited radius count from the center of the middle point sometimes overlapped areas counted on the other points. In addition, Hanowski and Niemi's (1995a) analysis of these data determined that two points per stand were nearly equivalent in power to detect change as the use of three points per stand. The mid-point of the stand has been recorded regardless because 1) it may be used as a test point for habitat prediction modeling, 2) little time is saved by skipping the point, 3) occupancy models require a minimum of three replications in a stand (MacKenzie et al. 2006; Grinde and Niemi 2016), and 4) data collected annually from the point still can be used to estimate population change. The following criteria were used to ensure trend analyses provide reliable population information: 1) Stands have been sampled for at least six years, 2) Data were included for trend analyses if a species was observed at a minimum of five stands per NF and during at least three years at each stand, 3) Species that were observed at five or fewer stands in each of the NFs, the data were pooled into a "regional" analysis.

Population trajectories

A population trajectory is defined as the relative change in size of a population across years. Because we do not detect every individual bird present in our study areas, we cannot know true population size. Instead, we must assume that our sample design gives a representative index of population size for each year. We used locally weighted (LOESS) regression to smooth the time series of species relative abundance for each stand (James et al. 1996). 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 and the respective confidence intervals represent the uncertainty in the estimated index. The time series of the fitted mean population index and confidence intervals graphically define a species' population trajectory.

Population trend

A population trend defines the direction and magnitude of population change over a given time period (Link and Sauer 1997). Non-linear trends notwithstanding, we view a significant trend as a unidirectional change, therefore linear methods can be used to detect a trend without asserting that the population trajectory is linear (Urquhart and Kincaid 1999). Population trends were assessed using simple linear regression applied to an annual index of population size for a study area (described above) and time. We used the slope coefficient to characterize direction and magnitude of the trend. To facilitate comparison, slopes were converted to units of percent annual change by dividing annual population indexes by the predicted value of the index at the midpoint of the entire survey period (1995 to 2018) prior to regressing the index with time (Bart et al. 2003). We assessed the significance of the regressions using a bootstrap procedure (Manly 1991) 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. We are currently exploring the feasibility of using a hierarchical modeling approach for these data that is similar to methods used for trend detection in the BBS (Sauer and Link 2011; Link et al. 2017)

Guild analyses

Each species was categorized within three different guild types: migration, nesting, and habitat preference (Appendix C). Information for categorizing species was obtained primarily from Ehrlich et al. (1988), Freemark and Collins (1992). Given that some species use different migration strategies, nesting substrates, and vegetation types in different portions of their geographic range, we further modified guild assignments based on personal experience with forest birds in the region. All individuals of a species that were assigned to each guild were included in the same analysis described above for individual species.

Species guilds are not mutually exclusive, so the species pool in a migration guild, for example, can include many of the same species that were assigned to a nesting guild (Sauer et al. 1996). Directional trends in abundant species (e.g., Ovenbird or Red-eyed Vireo) can strongly influence the trend of the guilds in which it is a member. Given these limitations, we believe it is important to examine common patterns of change among species within a guild. If all or many species within a guild show similar trends in relative abundance, then a more thorough examination of potential stressors affecting this portion of their life histories may reveal causes of observed trends. For instance, a severe drought in the late 1980s was correlated with a decline in the population levels of many breeding bird species found in the habitat guild of aspen forests of northern Wisconsin (Blake et al. 1992).

Appendix H

Estimated annual indices from 1995 to 2018 for breeding birds in Chippewa NF. A stretched color scheme was applied to each species with red for low indices, yellow average, and green to visualize relative changes in indices over time.

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
Alder Flycatcher	0.62	0.61	0.65	0.73	0.69	0.70	0.73	0.73	0.74	0.74	0.74	0.68	0.70	0.61	0.66	0.64	0.55	0.38	0.48	0.44	0.39	0.35	0.31	0.25
American Crow	0.57	0.60	0.64	0.62	0.69	0.72	0.74	0.75	0.76	0.78	0.78	0.76	0.75	0.75	0.71	0.61	0.69	0.67	0.67	0.65	0.64	0.62	0.62	0.60
American Goldfinch	-0.02	0.06	0.11	0.15	0.18	0.23	0.28	0.31	0.35	0.38	0.41	0.44	0.42	0.45	0.41	0.45	0.36	0.34	0.29	0.25	0.21	0.19	0.14	0.11
American Redstart	1.35	1.43	1.45	1.47	1.65	1.68	1.75	1.72	1.77	1.86	1.88	1.86	1.83	1.84	1.75	1.91	1.77	1.75	1.80	1.77	1.80	1.78	1.80	1.81
American Robin	0.69	0.69	0.76	0.82	0.81	0.82	0.84	0.85	0.87	0.86	0.84	0.82	0.77	0.73	0.71	0.77	0.68	0.64	0.61	0.58	0.55	0.52	0.46	0.46
Black-and-white Warbler	0.27	0.29	0.32	0.34	0.34	0.37	0.37	0.41	0.44	0.47	0.50	0.53	0.57	0.56	0.62	0.59	0.61	0.60	0.62	0.62	0.63	0.62	0.63	0.61
Black-capped Chickadee	0.32	0.35	0.41	0.46	0.49	0.52	0.56	0.60	0.64	0.65	0.65	0.65	0.62	0.57	0.58	0.50	0.52	0.50	0.48	0.45	0.43	0.40	0.38	0.36
Black-throated Green Warbler	0.66	0.70	0.75	0.70	0.85	0.92	0.96	1.03	1.08	1.12	1.16	1.21	1.20	1.14	1.23	1.27	1.17	1.21	1.15	1.13	1.10	1.04	1.03	1.01
Blackburnian Warbler	0.39	0.45	0.46	0.50	0.47	0.48	0.50	0.50	0.50	0.50	0.51	0.52	0.53	0.55	0.54	0.54	0.53	0.55	0.49	0.51	0.53	0.52	0.53	0.52
Blue-headed Vireo	0.29	0.33	0.34	0.35	0.37	0.38	0.40	0.41	0.42	0.43	0.42	0.41	0.40	0.36	0.36	0.33	0.32	0.31	0.26	0.27	0.25	0.25	0.22	0.22
Blue Jay	0.64	0.70	0.77	0.83	0.82	0.86	0.89	0.94	0.96	0.97	0.98	0.97	0.96	0.93	0.96	0.91	0.97	0.95	0.99	0.99	1.00	1.00	0.99	1.02
Brown-headed Cowbird	0.28	0.38	0.44	0.41	0.40	0.41	0.43	0.41	0.42	0.41	0.40	0.39	0.37	0.35	0.32	0.51	0.29	0.22	0.23	0.21	0.19	0.16	0.12	0.12
Brown Creeper	0.41	0.39	0.38	0.36	0.41	0.42	0.42	0.41	0.42	0.44	0.44	0.45	0.44	0.44	0.43	0.40	0.38	0.40	0.38	0.38	0.36	0.34	0.35	0.32
Gray Jay	0.27	0.24	0.29	0.31	0.32	0.33	0.36	0.36	0.37	0.38	0.39	0.41	0.42	0.41	0.41	0.39	0.38	0.33	0.31	0.29	0.26	0.23	0.20	0.16
Canada Warbler	0.16	0.20	0.22	0.30	0.30	0.34	0.39	0.40	0.44	0.46	0.48	0.52	0.52	0.43	0.52	0.56	0.55	0.53	0.55	0.55	0.56	0.60	0.56	0.59
Cedar Waxwing	0.15	0.24	0.26	0.28	0.30	0.32	0.31	0.36	0.38	0.39	0.40	0.41	0.41	0.41	0.39	0.41	0.37	0.35	0.37	0.35	0.34	0.33	0.30	0.31
Chestnut-sided Warbler	1.38	1.54	1.61	1.70	1.74	1.83	1.86	1.94	2.00	1.98	1.96	1.92	1.84	1.85	1.66	1.67	1.66	1.63	1.64	1.58	1.58	1.57	1.58	1.58
Chipping Sparrow	0.51	0.67	0.74	0.76	0.79	0.82	0.85	0.90	0.93	0.94	0.93	0.92	0.87	0.86	0.76	0.73	0.62	0.55	0.51	0.46	0.39	0.33	0.28	0.22
Common Loon	0.33	0.34	0.37	0.35	0.41	0.42	0.43	0.45	0.46	0.46	0.45	0.43	0.42	0.41	0.39	0.36	0.37	0.35	0.36	0.35	0.35	0.35	0.35	0.34
Common Raven	0.25	0.29	0.30	0.30	0.33	0.33	0.35	0.35	0.36	0.36	0.36	0.35	0.35	0.35	0.32	0.33	0.32	0.31	0.31	0.30	0.29	0.29	0.28	0.27
Common Yellowthroat	1.01	1.05	1.13	1.11	1.23	1.20	1.19	1.26	1.27	1.30	1.28	1.18	1.23	1.09	1.12	0.99	1.03	0.97	0.98	0.94	0.90	0.86	0.84	0.78
Connecticut Warbler	0.96	1.00	0.82	0.79	0.70	0.63	0.60	0.54	0.46	0.43	0.41	0.39	0.37	0.39	0.35	0.34	0.30	0.33	0.25	0.20	0.18	0.13	0.09	0.06
Dark-eyed Junco (Slate-colored)	0.32	0.37	0.27	0.24	0.22	0.19	0.17	0.14	0.12	0.11	0.09	0.09	0.10	0.10	0.11	0.18	0.30	0.34	0.39	0.47	0.54	0.62	0.70	0.79
Downy Woodpecker	0.23	0.24	0.19	0.20	0.25	0.26	0.27	0.23	0.24	0.27	0.26	0.25	0.23	0.22	0.21	0.20	0.20	0.17	0.17	0.16	0.14	0.13	0.12	0.11
Eastern Towhee	0.20	0.26	0.26	0.27	0.31	0.33	0.43	0.38	0.40	0.41	0.39	0.38	0.35	0.18	0.30	0.17	0.28	0.18	0.24	0.22	0.20	0.18	0.16	0.15
Eastern Wood-Pewee	0.75	0.76	0.77	0.85	0.79	0.78	0.79	0.80	0.80	0.80	0.79	0.78	0.77	0.77	0.72	0.80	0.70	0.70	0.65	0.66	0.64	0.64	0.62	0.61
Golden-crowned Kinglet	0.33	0.25	0.38	0.40	0.43	0.46	0.48	0.48	0.52	0.53	0.54	0.55	0.52	0.56	0.48	0.46	0.41	0.32	0.36	0.29	0.25	0.21	0.17	0.12
Golden-winged Warbler	0.46	0.51	0.54	0.49	0.49	0.48	0.46	0.47	0.45	0.43	0.42	0.41	0.40	0.38	0.38	0.43	0.42	0.42	0.45	0.47	0.49	0.51	0.54	0.57
Gray Catbird	0.23	0.40	0.45	0.47	0.45	0.44	0.44	0.45	0.46	0.45	0.43	0.41	0.40	0.36	0.33	0.36	0.32	0.33	0.32	0.33	0.35	0.34	0.35	0.35
Great Crested Flycatcher	0.30	0.30	0.31	0.28	0.30	0.30	0.29	0.29	0.29	0.28	0.27	0.26	0.23	0.23	0.23	0.25	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.21
Hairy Woodpecker	0.15	0.16	0.18	0.19	0.20	0.21	0.22	0.23	0.23	0.24	0.24	0.24	0.23	0.23	0.23	0.21	0.22	0.21	0.20	0.20	0.20	0.20	0.19	0.19
Hermit Thrush	1.06	1.04	1.14	1.25	1.19	1.18	1.22	1.25	1.31	1.33	1.35	1.34	1.37	1.36	1.37	1.45	1.26	1.22	1.21	1.20	1.13	1.13	1.08	1.05
Indigo Bunting	0.51	0.56	0.63	0.59	0.59	0.60	0.55	0.61	0.61	0.61	0.57	0.53	0.49	0.43	0.42	0.31	0.36	0.32	0.31	0.29	0.28	0.25	0.19	0.21
Least Flycatcher	1.99	1.94	1.95	1.91	2.06	2.06	2.10	2.13	2.15	2.10	2.06	2.01	1.98	1.89	1.81	1.93	1.72	1.67	1.52	1.51	1.43	1.39	1.35	1.28
Lincoln's Sparrow	0.07	-0.04	0.16	0.21	0.26	0.30	0.35	0.40	0.44	0.50	0.55	0.59	0.65	0.65	0.76	0.78	0.49	0.41	0.85	0.87	0.89	0.91	0.92	0.94
Magnolia Warbler	0.34	0.38	0.32	0.31	0.30	0.28	0.27	0.25	0.24	0.23	0.23	0.23	0.24	0.27	0.27	0.28	0.29	0.28	0.29	0.29	0.30	0.32	0.28	0.32
Mourning Dove	-0.02	0.02	0.08	0.12	0.20	0.27	0.31	0.36	0.41	0.46	0.49	0.44	0.52	0.46	0.50	0.38	0.45	0.42	0.40	0.37	0.30	0.30	0.29	0.23
Mourning Warbler	0.52	0.59	0.65	0.67	0.68	0.71	0.70	0.74	0.76	0.76	0.72	0.71	0.69	0.71	0.68	0.63	0.65	0.64	0.65	0.63	0.64	0.65	0.64	0.65
Nashville Warbler	1.47	1.49	1.64	1.80	1.67	1.61	1.69	1.73	1.79	1.84	1.90	1.89	1.89	1.95	1.86	2.09	2.19	2.03	1.87	2.03	2.03	1.99	2.00	1.95
Northern Flicker (Yellow-shafted)	0.09	0.16	0.17	0.18	0.19	0.21	0.23	0.24	0.26	0.26	0.27	0.27	0.28	0.26	0.27	0.26	0.25	0.25	0.25	0.24	0.22	0.22	0.21	0.20
Northern Parula	0.36	0.40	0.44	0.46	0.46	0.50	0.51	0.54	0.54	0.55	0.56	0.57	0.56	0.56	0.58	0.56	0.54	0.51	0.51	0.55	0.53	0.54	0.55	0.55
Northern Waterthrush	0.18	0.34	0.38	0.37	0.47	0.48	0.49	0.56	0.57	0.58	0.58	0.59	0.56	0.51	0.57	0.37	0.41	0.55	0.54	0.53	0.59	0.54	0.58	0.58
Olive-sided Flycatcher	0.32	0.39	0.40	0.42	0.43	0.44	0.45	0.46	0.47	0.46	0.44	0.43	0.40	0.37	0.34	0.31	0.24	0.21	0.20	0.16	0.12	0.09	0.09	0.03
Ovenbird	2.87	3.01	3.16	3.27	3.52	3.71	3.95	4.06	4.21	4.31	4.39	4.54	4.51	4.56	4.40	4.33	4.47	4.60	4.38	4.36	4.34	4.31	4.30	4.26
Palm Warbler (Western)	0.47	0.69	0.60	0.74	0.71	0.80	0.90	0.85	0.90	0.90	0.89	0.88	0.87	0.69	0.87	0.97	0.85	0.60	0.94	0.97	1.00	1.03	1.06	1.09
Pileated Woodpecker	0.05	0.08	0.08	0.11	0.12	0.14	0.16	0.17	0.19	0.20	0.21	0.22	0.22	0.23	0.24	0.23	0.24	0.24	0.23	0.24	0.24	0.24	0.25	0.25
Pine Warbler	0.83	0.86	0.94	1.03	0.99	1.00	1.06	1.07	1.10	1.13	1.15	1.17	1.20	1.37	1.25	1.30	1.27	1.36	1.27	1.34	1.35	1.41	1.41	1.43
Purple Finch	0.13	0.14	0.16	0.20	0.19	0.21	0.23	0.24	0.25	0.25	0.24	0.24	0.21	0.18	0.17	0.17	0.17	0.15	0.17	0.16	0.17	0.17	0.17	0.18
Red-breasted Nuthatch	0.19	0.26	0.31	0.36	0.39	0.43	0.49	0.52	0.57	0.60	0.64	0.69	0.72	0.75	0.79	0.84	0.78	0.84	0.77	0.80	0.80	0.80	0.78	0.81
Red-eyed Vireo	3.28	3.54	3.52	3.51	4.02	4.20	4.35	4.48	4.60	4.67	4.64	4.64	4.46	4.39	4.15	3.81	3.98	3.99	3.73	3.61	3.53	3.42	3.35	3.21
Red-winged Blackbird	0.51	0.53	0.59	0.65	0.69	0.71	0.78	0.78	0.82	0.83	0.83	0.83	0.79	0.66	0.71	0.51	0.66	0.50	0.56	0.52	0.50	0.47	0.40	0.37
Rose-breasted Grosbeak	0.35	0.40	0.43	0.45	0.47	0.51	0.53	0.56	0.59	0.59	0.59	0.58	0.56	0.56	0.54	0.52	0.52	0.50	0.50	0.48	0.47	0.47	0.46	0.45

Appendix I

Estimated annual indices from 1995–2018 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.

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
Alder Flycatcher	0.42	0.45	0.48	0.54	0.50	0.50	0.57	0.59	0.61	0.63	0.63	0.64	0.64	0.65	0.63	0.61	0.62	0.59	0.58	0.57	0.58	0.56	0.59	0.54
American Bittern	0.35	0.32	0.30	0.27	0.13	0.24	0.20	0.17	0.15	0.12	0.11	0.11	0.11	0.12	0.13	0.15	0.16	0.16	0.13	0.20	0.22	0.24	0.25	0.27
American Crow	0.39	0.40	0.41	0.45	0.44	0.43	0.43	0.44	0.45	0.47	0.42	0.41	0.37	0.35	0.32	0.31	0.28	0.25	0.22	0.20	0.18	0.16	0.14	0.12
American Goldfinch	0.12	0.15	0.17	0.19	0.15	0.23	0.26	0.28	0.33	0.33	0.34	0.35	0.36	0.37	0.38	0.40	0.33	0.28	0.25	0.25	0.23	0.20	0.17	0.13
American Redstart	0.43	0.44	0.47	0.47	0.46	0.48	0.49	0.49	0.49	0.52	0.52	0.54	0.51	0.52	0.50	0.48	0.50	0.51	0.53	0.53	0.55	0.56	0.56	0.60
American Robin	0.76	0.77	0.79	0.82	0.83	0.85	0.84	0.85	0.87	0.88	0.90	0.90	0.92	0.95	0.95	0.95	0.92	0.90	0.89	0.87	0.85	0.83	0.85	0.78
Black-and-white Warbler	0.47	0.48	0.50	0.51	0.53	0.56	0.58	0.61	0.64	0.68	0.70	0.74	0.74	0.75	0.76	0.75	0.72	0.70	0.68	0.65	0.62	0.59	0.55	0.53
Black-billed Cuckoo	0.02	0.02	0.12	0.25	0.21	0.22	0.29	0.33	0.38	0.41	0.40	0.38	0.35	0.32	0.31	0.24	0.22	0.16	0.12	0.07	0.02	-0.02	0.01	-0.10
Black-capped Chickadee	0.20	0.24	0.28	0.30	0.35	0.38	0.41	0.44	0.47	0.47	0.49	0.48	0.46	0.44	0.41	0.39	0.37	0.35	0.32	0.30	0.27	0.25	0.23	0.21
Black-throated Blue Warbler	0.21	0.23	0.24	0.21	0.28	0.33	0.35	0.38	0.44	0.40	0.42	0.42	0.41	0.39	0.30	0.37	0.36	0.35	0.34	0.35	0.35	0.35	0.41	0.35
Black-throated Green Warbler	0.64	0.69	0.73	0.77	0.75	0.81	0.81	0.82	0.83	0.85	0.89	0.88	0.90	0.94	0.93	0.94	0.97	0.97	0.96	0.97	0.94	0.97	1.03	1.01
Blackburnian Warbler	0.66	0.68	0.69	0.69	0.70	0.69	0.71	0.72	0.73	0.75	0.74	0.76	0.76	0.74	0.76	0.75	0.70	0.70	0.67	0.65	0.64	0.61	0.59	0.55
Blue-headed Vireo	0.21	0.22	0.26	0.26	0.28	0.30	0.31	0.32	0.33	0.33	0.34	0.35	0.34	0.33	0.31	0.30	0.28	0.28	0.26	0.24	0.22	0.20	0.19	0.16
Blue Jay	0.77	0.82	0.85	0.91	0.93	0.96	0.96	1.02	1.06	1.08	1.08	1.12	1.12	1.13	1.12	1.12	1.10	1.08	1.07	1.07	1.05	1.04	1.01	1.01
Broad-winged Hawk	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.24	0.23	0.21	0.19	0.17	0.16	0.15	0.13	0.12	0.10	0.10	0.09	0.08	0.07	0.06	0.01	0.04
Brown Creeper	0.26	0.28	0.28	0.28	0.29	0.30	0.30	0.31	0.32	0.31	0.33	0.31	0.32	0.31	0.31	0.30	0.27	0.28	0.27	0.25	0.24	0.23	0.20	0.21
Gray Jay	0.18	0.21	0.22	0.23	0.24	0.26	0.28	0.29	0.31	0.32	0.34	0.35	0.35	0.35	0.34	0.32	0.31	0.29	0.29	0.25	0.24	0.21	0.18	0.13
Canada Warbler	0.52	0.53	0.57	0.58	0.60	0.60	0.61	0.64	0.65	0.68	0.67	0.68	0.66	0.66	0.64	0.63	0.62	0.63	0.61	0.60	0.61	0.60	0.55	0.57
Cape May Warbler	0.15	0.14	0.14	0.15	0.15	0.14	0.13	0.15	0.15	0.17	0.20	0.21	0.24	0.27	0.30	0.34	0.34	0.35	0.40	0.43	0.46	0.49	0.53	0.53
Cedar Waxwing	0.15	0.18	0.18	0.22	0.24	0.27	0.29	0.32	0.34	0.36	0.37	0.39	0.39	0.40	0.40	0.39	0.37	0.33	0.34	0.32	0.30	0.29	0.28	0.23
Chestnut-sided Warbler	1.61	1.70	1.73	1.77	1.88	1.98	2.01	2.06	2.13	2.18	2.09	2.07	1.95	1.91	1.81	1.75	1.63	1.54	1.49	1.43	1.38	1.30	1.23	1.10
Chipping Sparrow	0.42	0.43	0.44	0.44	0.42	0.45	0.46	0.46	0.46	0.46	0.46	0.46	0.44	0.42	0.41	0.39	0.33	0.32	0.28	0.25	0.22	0.19	0.15	0.10
Common Loon	0.36	0.38	0.39	0.37	0.35	0.34	0.33	0.33	0.32	0.30	0.28	0.27	0.25	0.24	0.22	0.21	0.20	0.20	0.19	0.18	0.18	0.17	0.14	0.15
Common Raven	0.24	0.26	0.27	0.28	0.30	0.32	0.34	0.35	0.36	0.36	0.36	0.35	0.33	0.31	0.30	0.29	0.27	0.26	0.25	0.24	0.22	0.20	0.18	0.19
Common Yellowthroat	0.49	0.51	0.52	0.56	0.57	0.61	0.62	0.65	0.67	0.67	0.69	0.67	0.65	0.65	0.61	0.58	0.55	0.49	0.48	0.44	0.41	0.38	0.34	0.31
Connecticut Warbler	0.79	0.76	0.73	0.69	0.74	0.63	0.59	0.57	0.54	0.49	0.44	0.39	0.36	0.32	0.29	0.27	0.26	0.25	0.23	0.21	0.20	0.18	0.16	0.15
Downy Woodpecker	0.30	0.27	0.22	0.19	0.23	0.23	0.24	0.24	0.25	0.25	0.22	0.22	0.18	0.14	0.11	0.08	0.08	0.07	0.05	0.04	0.03	0.02	0.01	0.00
Eastern Wood-Pewee	0.39	0.37	0.40	0.41	0.41	0.40	0.39	0.39	0.39	0.42	0.40	0.41	0.41	0.40	0.36	0.39	0.36	0.35	0.34	0.32	0.30	0.28	0.24	0.25
Evening Grosbeak	0.32	0.31	0.29	0.29	0.27	0.25	0.24	0.22	0.21	0.20	0.19	0.19	0.18	0.18	0.17	0.17	0.10	0.15	0.14	0.13	0.12	0.11	0.10	0.02
Golden-crowned Kinglet	0.23	0.26	0.30	0.33	0.34	0.36	0.40	0.42	0.44	0.47	0.48	0.48	0.51	0.52	0.51	0.50	0.48	0.46	0.44	0.43	0.41	0.39	0.39	0.38
Golden-winged Warbler	0.21	0.26	0.36	0.38	0.41	0.45	0.49	0.53	0.57	0.65	0.62	0.64	0.63	0.63	0.62	0.54	0.58	0.47	0.46	0.50	0.48	0.46	0.47	0.41
Hairy Woodpecker	0.05	0.08	0.09	0.09	0.14	0.16	0.17	0.19	0.21	0.23	0.22	0.23	0.23	0.22	0.22	0.21	0.19	0.20	0.19	0.17	0.17	0.16	0.15	0.14
Hermit Thrush	0.84	0.86	0.86	0.91	0.96	0.97	0.98	1.00	1.03	1.02	1.00	0.99	0.95	0.91	0.89	0.87	0.82	0.77	0.75	0.71	0.67	0.63	0.60	0.54
Least Flycatcher	0.45	0.48	0.55	0.54	0.56	0.60	0.62	0.64	0.63	0.69	0.69	0.68	0.68	0.61	0.65	0.66	0.62	0.63	0.64	0.62	0.61	0.59	0.55	0.54
Lincoln's Sparrow	0.24	0.24	0.25	0.26	0.26	0.27	0.27	0.28	0.28	0.28	0.26	0.24	0.22	0.20	0.18	0.16	0.15	0.15	0.14	0.14	0.13	0.13	0.13	0.13
Magnolia Warbler	0.64	0.67	0.69	0.71	0.73	0.74	0.73	0.76	0.78	0.79	0.75	0.74	0.70	0.70	0.66	0.65	0.66	0.64	0.62	0.61	0.61	0.60	0.62	0.57
Mourning Warbler	0.87	0.91	0.88	0.92	0.94	0.96	0.97	0.98	0.99	0.98	0.96	0.93	0.89	0.86	0.82	0.79	0.75	0.70	0.69	0.66	0.63	0.60	0.56	0.53
Nashville Warbler	2.08	2.17	2.23	2.37	2.47	2.53	2.59	2.71	2.81	2.87	2.91	2.98	3.00	3.04	3.03	3.05	2.97	2.94	2.95	2.89	2.86	2.82	2.90	2.76
Northern Flicker (Yellow-shafted)	0.15	0.17	0.19	0.21	0.23	0.26	0.28	0.30	0.32	0.33	0.32	0.33	0.32	0.31	0.29	0.29	0.27	0.25	0.24	0.23	0.22	0.21	0.17	0.17
Northern Parula	0.36	0.41	0.45	0.46	0.51	0.57	0.59	0.62	0.65	0.69	0.68	0.69	0.69	0.70	0.72	0.71	0.67	0.69	0.66	0.65	0.65	0.63	0.61	0.59
Northern Waterthrush	0.25	0.27	0.29	0.31	0.32	0.35	0.33	0.38	0.38	0.42	0.40	0.41	0.44	0.44	0.44	0.45	0.42	0.45	0.46	0.46	0.48	0.47	0.50	0.45
Olive-sided Flycatcher	0.23	0.25	0.26	0.29	0.29	0.30	0.31	0.32	0.33	0.34	0.33	0.33	0.32	0.30	0.28	0.25	0.23	0.24	0.20	0.18	0.16	0.15	0.14	0.06
Ovenbird	3.65	3.84	4.02	4.15	4.37	4.45	4.59	4.69	4.78	4.74	4.78	4.75	4.61	4.41	4.36	4.24	4.22	4.10	4.07	3.99	3.93	3.85	3.77	3.80
Pileated Woodpecker	0.06	0.10	0.12	0.15	0.19	0.21	0.24	0.27	0.29	0.31	0.31	0.31	0.30	0.28	0.26	0.25	0.23	0.21	0.20	0.19	0.18	0.16	0.15	0.14
Pine Warbler	0.24	0.25	0.27	0.28	0.29	0.33	0.32	0.33	0.34	0.37	0.39	0.40	0.44	0.45	0.51	0.51	0.56	0.60	0.59	0.66	0.69	0.71	0.75	0.78
Purple Finch	0.06	0.07	0.08	0.11	0.12	0.14	0.15	0.17	0.19	0.19	0.19	0.19	0.19	0.19	0.20	0.20	0.21	0.20	0.21	0.23	0.22	0.23	0.23	0.25
Red-breasted Nuthatch	0.26	0.28	0.32	0.35	0.37	0.38	0.41	0.45	0.47	0.53	0.52	0.56	0.57	0.59	0.60	0.59	0.59	0.60	0.60	0.59	0.59	0.59	0.60	0.60
Red-eyed Vireo	2.43	2.52	2.62	2.66	2.80	2.89	2.95	3.00	3.05	3.06	3.02	2.93	2.82	2.66	2.60	2.49	2.42	2.37	2.29	2.23	2.17	2.11	2.05	2.00
Red-winged Blackbird	0.27	0.31	0.34	0.44	0.40	0.43	0.46	0.48	0.51	0.52	0.52	0.52	0.49	0.45	0.39	0.39	0.36	0.35	0.31	0.31	0.29	0.26	0.24	0.21
Rose-breasted Grosbeak	0.51	0.51	0.53	0.54	0.55	0.56	0.57	0.57	0.58	0.59	0.59	0.59	0.57	0.57	0.55	0.54	0.52	0.52	0.48	0.47	0.45	0.43	0.39	0.38
Ruby-crowned Kinglet	0.06	0.08	0.10	0.13	0.14	0.16	0.20	0.21	0.24	0.27	0.30	0.33	0.36	0.39	0.41	0.43	0.46	0.46	0.49	0.51	0.51	0.53	0.54	0.57
Ruffed Grouse	0.32	0.30	0.28	0.27	0.24	0.23	0.21	0.18	0.16	0.16	0.16	0.17	0.18	0.20	0.22	0.24	0.26	0.27	0.30	0.33	0.34	0.38	0.40	0.41