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Source: The Condor, 119(3) : 576-593

Published By: American Ornithological Society

URL: https://doi.org/10.1650/CONDOR-17-83.1

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THE CONDOR
Ornithological Applications

AmericanOrnithology.org

Volume 119, 2017, pp. 576–593
DOI: 10.1650/CONDOR-17-83.1

PERSPECTIVE

The first 50 years of the North American Breeding Bird Survey

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Submitted April 26, 2017; Accepted May 17, 2017; Published July 26, 2017

ABSTRACT
The vision of Chandler (Chan) S. Robbins for a continental-scale omnibus survey of breeding birds led to the development of the North American Breeding Bird Survey (BBS). Chan was uniquely suited to develop the BBS. His position as a government scientist had given him experience with designing and implementing continental-scale surveys, his research background made him an effective advocate of the need for a survey to monitor pesticide effects on birds, and his prominence in the birding community gave him connections to infrastructure—a network of qualified volunteer birders who could conduct roadside surveys with standardized point counts. Having started in the eastern United States and the Atlantic provinces of Canada in 1966, the BBS now provides population change information for ~546 species in the continental United States and Canada, and recently initiated routes in Mexico promise to greatly expand the areas and species covered by the survey. Although survey protocols have remained unchanged for 50 years, the BBS remains relevant in a changing world. Several papers that follow in this Special Section of *The Condor: Ornithological Advances* review how the BBS has been applied to conservation assessments, especially in combination with other large-scale survey data. A critical feature of the BBS program is an active research program into field and analytical methods to enhance the quality of the count data and to control for factors that influence detectability. Papers in the Special Section also present advances in BBS analyses that improve the utility of this expanding and sometimes controversial survey. In this Perspective, we introduce the Special Section by reviewing the history of the BBS, describing current analyses, and providing summary trend results for all species, highlighting 3 groups of conservation concern: grassland-breeding birds, aridland-breeding birds, and aerial insectivorous birds.

Keywords: aerial insectivore, aridland, Chandler S. Robbins, grassland, hierarchical model, North American Breeding Bird Survey

Los primeros 50 años del Conteo de Aves Reproductivas de América del Norte

RESUMEN
La visión de Chandler (Chan) S. Robbins de un conteo completo a escala continental de las aves reproductivas llevó al desarrollo del Conteo de Aves Reproducción (BBS por sus siglas en inglés). Chan estaba especialmente preparado para desarrollar el BBS. Su cargo como un científico del gobierno le había dado la experiencia de diseñar e implementar muestreos a escala continental, sus antecedentes de investigación lo convirtieron en un defensor efectivo de la necesidad de un conteo para monitorear los efectos de los pesticidas en las aves y su prominencia en la comunidad de ornitólogos le dio conexiones con una red de voluntarios observadores de aves calificados que podían realizar conteos a lo largo de las rutas en puntos de conteo estandarizados. Comenzando en el este de Estados Unidos y las Provincias Atlánticas de Canadá en 1966, el BBS brinda en la actualidad información sobre cambios poblacionales de ~546 especies de las áreas continentales de Estados Unidos y Canadá, y las rutas iniciadas recientemente en México prometen una gran expansión de las áreas y las especies cubiertas por el conteo. Aunque los protocolos de muestreo han permanecido sin cambios a lo largo de 50 años, el BBS sigue siendo relevante en un mundo cambiante. Muchos artículos que siguen en esta Sección Especial de *The Condor: Avances Ornitológicos* revisan como el BBS ha sido aplicado a evaluaciones de conservación, especialmente en combinación con otros datos de gran escala. Una necesidad imperiosa del programa BBS es un programa de investigación activo de los métodos de campo y analíticos para mejorar la calidad de los datos de conteo y el control de los factores que influencian la detectabilidad. Los artículos en la Sección Especial también presentan avances en los análisis del BBS que mejoran la utilidad de este muestreo en expansión y a veces controversial. En esta Perspectiva introducimos la Sección Especial revisando la historia del BBS, describiendo los análisis actuales y brindando resultados resumidos de tendencia para todas las especies, destacando tres grupos de interés para la

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conservación: aves reproductivas de pastizal, aves reproductivas de ambientes áridos y aves insectívoras aéreas.

Palabras clave: ambientes áridos, Chandler S. Robbins, Conteo de Aves Reproductivas de América del Norte, insectívoros aéreos, modelo jerárquico, pastizal

An Influential and Evolving Survey

The North American Breeding Bird Survey (BBS) was initiated in 1966 with a goal of monitoring change in North American breeding bird populations (Robbins et al. 1986). It now provides long-term population change data for ~424 species over most of North America, with more limited data for an additional ~122 species. BBS data inform virtually all geographic studies of North American birds; analyses show us which species are increasing and decreasing, and by how much (Sauer et al. 2017a). Its comprehensive nature and the ready availability of its results via the Internet have contributed to the perception of the BBS as a "one-stop shop" for population change data (Pardieck et al. 2016, Environment and Climate Change Canada 2017, Sauer et al. 2017a). The BBS is the premier source of bird population status and change data for conservation activities and scientific studies, as reviewed in two papers in this Special Section (Hudson et al. 2017, Rosenberg et al. 2017). Nevertheless, even after 50 years of data collection, the BBS is still a work-in-progress; the scope of the survey continues to expand while ongoing work seeks to strengthen BBS methods and analyses.

Origins of the BBS. The BBS was Chandler (Chan) S. Robbins's idea. As a biologist working for the U.S. Fish and Wildlife Service (USFWS), he had three research themes that came together to form the BBS (Robbins 2016, Sauer 2016). First, he had worked with DDT and other pesticides that affected birds, starting with field experiments at the Patuxent Wildlife Research Center in the 1940s (Linduska and Surber 1948). Rachel Carson edited Chan's reports on the consequences of DDT on birds, and he credited Carson with creating the public interest in bird populations that ultimately persuaded USFWS administrators to let him start the BBS (Chandler S. Robbins, personal communication). By the early 1960s, Chan was frequently being asked by the public about the effects of pesticides on bird populations, and he was keenly aware of the reports attributing avian mortality to pesticide exposure. Chan used Carson's (1962) *Silent Spring* as the basis of his lobbying within the USFWS for a continental-scale survey that would help us understand whether regional populations were declining and better evaluate pesticide effects on bird populations.

Second, Chan had been developing and implementing roadside surveys for American Woodcock (*Scolopax minor*), Mourning Dove (*Zenaida macroura*), and Wilson's Snipe (*Gallinago delicata*). He had been tasked with developing approaches for surveying these harvested species that would permit estimation of population change. He realized that these roadside survey methods could be easily modified to collect data on all species encountered along roads, as long as a corps of observers could be found to survey them.

Third, by the 1960s, Chan had several decades of experience working with citizen science projects, in particular the Christmas Bird Count, hawk watches, and breeding-bird censuses (Sauer and Droege 1990), and he had an extensive network of birding contacts across North America (Robbins 2016). He knew the value of networking and collaboration, and from these contacts he recruited observers for the survey and set up a network of state and provincial coordinators who could tend to the ongoing task of matching local birders to nearby routes. At the 2016 symposium at the North American Ornithological Conference celebrating the BBS's 50th anniversary, Chan related the story that the same day he received permission to start the breeding bird survey, he called Anthony (Tony) Erskine from the Canadian Wildlife Service and asked if Canada would be interested in participating. Tony took the proposal to his superiors, and he almost immediately called Chan back to say that Canada "was in." Tony, and thus Canada, was a partner from the very start of the BBS. Chan capitalized on the pesticide concerns as a rationale for the survey, drew upon his prior experience in surveys to design the program, and was able to convince his birding and other professional connections to implement the program.

Silk purses and sows' ears. Chan was apparently a firm believer in the maxim "The perfect is the enemy of the good." The BBS is (we would argue) "good," and perhaps even unique and unparalleled as a coherent, continental-scale monitoring program. However, from the start, Chan endured aggressive criticism that the BBS's design had fatal flaws. Some of his colleagues in the USFWS asked pointed questions along these lines: How can you consider developing a monitoring program with no means of estimating detection rates of birds, and along roadsides where bird populations may not represent the broader landscape? Fifty years into the program, we are still asking these questions, and critics still point to these concerns with the BBS. However, the risks that Chan took in starting the BBS appear to have been justified; even though many alternatives to point counts now exist, research has not yet produced an alternative approach to data collection that is clearly superior to point counts and feasible to implement along BBS routes. Additionally, although research on deficiencies in BBS sampling has documented the need for ongoing vigilance in BBS analyses (e.g., Griffith et al.

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2010), the research has not demonstrated fatal flaws in the BBS methods.

Consequently, the BBS's design and field protocols have remained the same over 50 years of surveying. Surveyors from 1966 could run a BBS route today and feel completely comfortable, although they might be a bit inconvenienced by safety straps, alarm chimes, and odd buzzing noises, or distracted by the built-in GPS units and media centers of modern vehicles. Once escaping the vehicle, however, the survey proceeds as it did in 1966. This is remarkable, considering how much the world has changed around the BBS. Sauer et al. (2013) describe some of these changes: (1) In addition to changes in car technology, there are more cars on the roads, and their presence influences counts; (2) climate is changing, as evidenced by earlier springs and differing seasonal patterns of bird activity; (3) roadside habitats have changed, with more houses and fewer natural habitats along BBS routes; and (4) small roads that host BBS routes have become larger roads with more cars and more disturbance. The survey has also expanded, from the original survey area in the eastern United States in 1966 to the contiguous United States and southern Canada by 1968. Additional expansion has occurred almost every year of the BBS, and recent expansion has taken the survey into northern Mexico.

Along with the environment in which counts are conducted, our notions of appropriate ways of counting birds have also changed. Simple point counts such as those collected by the BBS have been shown to be subject to a variety of environmental factors that influence detection of birds (Nichols et al. 2009), and the analysis of a survey that "encounters an unknown proportion of birds in an undefined area" (Link and Sauer 1998a) has its complications. In the years following the implementation of the BBS, myriad quantitative approaches were developed for obtaining reliable estimates of bird population size or density from counts (Nichols et al. 2009). Maintenance of the simple survey design in the face of these methodological developments is not due to apathy or a lack of inspiration; the BBS programs in Canada, Mexico, and the United States have encouraged these developments by sponsoring many research programs designed to test new counting methods (e.g., Farnsworth et al. 2005) and assess consequences of roadside sampling (Sauer et al. 2013, Veech et al. 2017). Rather, it is due to the fact that no method yet suggested has the flexibility to be implemented on roadside surveys conducted by thousands of observers. There is also a scale issue, as the current analyses focus on estimation of change at the route level, rather than at the scale of individual counting locations (stops) along the route (Sauer 2016). Many of the factors that influence detectability, such as habitat, operate at the scale of individual stops, but it is only in recent years that the BBS offices have begun to curate bird and location data at the stop level. Full investigation of detection, as it relates to the BBS, must wait until reliable information exists as to where stops actually occur along BBS routes. In the absence of stop-level information provided by the BBS, researchers have used remote sensing to determine this information for individual projects, as in Niemuth et al. (2017) in this Special Section.

The BBS has maintained credibility in the face of changing environments and developed a reputation for robustness due to innovations in analyses. Development of Bayesian approaches for fitting hierarchical models have allowed us to overcome scale-specific limitations that made early analyses of BBS data cumbersome exercises in approximation (Sauer 2016). Implementation of these model-based approaches has also allowed us to address the fundamental criticisms of the BBS (e.g., Link and Sauer 1998b) by providing the means for evaluating effects of the changing world on BBS results and by controlling for environmental changes such as vehicle disturbance and phenology (as indexed by counting day). Expansion of the survey is accommodated in this model-based framework by imposing hierarchical structure among regions to enhance estimation in strata with limited data. Modeling can be extended to accommodate off-road expansions of the survey, as is reported for Alaska in this Special Section (Handel and Sauer 2017). In our view, BBS analyses require statistical controls for the effects of routes and observers; we can think of no inference based on BBS data that would provide reliable results without these controls, and hierarchical models are an essential component of the ongoing exploration of how the changing environment along BBS routes influences counts (e.g., Griffith et al. 2010).

One great benefit of hierarchical models is that they have changed our perspective on detectability modeling; advances in hierarchical modeling have led to a confluence of approaches for estimating both population change and detectability. In each, the underlying population size (at stops or routes, depending on the analysis) is viewed as a latent parameter, and modeled connections of the counts to the underlying population sizes form the basis of inference (Kéry et al. 2009). However, the goal of most BBS analyses is unbiased estimation of change over time, while most detectability analyses focus on directly estimating the local population size. For the goal of estimation of population change over time, current analysis methods control for observer differences at the scale of routes and also allow for controlling for additional features such as vehicle-related disturbance or phenology (Sauer et al. 2013), features long thought to possibly bias estimation of change over time. Identifying factors that influence detection, and determining their importance for inclusion in the BBS analysis, is our primary tool for addressing concerns about the counting process of the BBS (e.g.,

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Sauer et al. 1994); ongoing assessments include modeling the effects of experimental protocol changes (e.g., collecting time-distance information; Twedt 2015) and phenology change (Sauer et al. 2013).

One key consequence of the BBS design and analysis is that population size is not easily estimated; the model-based controls for detectability allow for estimation of population change but do not provide the information needed to scale the relative population indices produced in BBS analyses to an absolute population size. Although changes in field protocols have been suggested for the BBS to better inform population estimation (e.g., Farnsworth et al. 2005, Twedt 2015), analyses using these approaches have not yet proved effective for estimating detectability at critical scales needed for analysis as they have been applied only to estimate species-level detection rates. These species-level detectability adjustments provide no information relevant for BBS population change analyses. However, population estimates are often required for management needs such as setting population goals (Rosenberg and Blancher 2005) or estimating allowable take (Runge et al. 2009). Researchers have used additional data to scale BBS results to actual population sizes through (1) applying a series of adjustments that collectively estimate actual detection rates (Rosenberg and Blancher 2005, Runge et al. 2009), (2) using data from other surveys to scale BBS data to produce an unbiased population estimate (e.g., Zimmerman et al. 2015, 2017), or (3) modeling on-road vs. off-road populations using population and habitat data collected on and off roads (Sauer et al. 2013, Sauer 2016).

This discussion emphasizes an essential attribute of the BBS, and of any other omnibus, continental-scale survey: Wise use and interpretation of the survey involves an ongoing process of exploring how the counts relate to actual populations, in terms of both detectability and how sampling varies across space and time, and in developing appropriate models that adequately represent these relationships.

BBS Results

Hierarchical models for BBS analyses. Here, we provide a brief summary of BBS results from 50 years of surveying. Unfortunately, Mexican results do not yet provide sufficient information for analyses of population change. We provide results for 424 species from a "core" area that includes data extending back to 1966, as well as results from the period 1993–2015 for 546 species in an expanded survey area. The core area is the contiguous United States and southern portions of Canada (Sauer and Link 2011). The expanded area adds 7 additional strata (defined by Bird Conservation Regions within states and provinces): Western Alaska, Alaska Arctic Plains and Mountains, Alaska Northern Pacific Rainforest, Alaska Northwestern Interior Forest, Yukon Territory Northwestern Interior Forest, Northwest Territories Boreal Taiga Plains, and Newfoundland Boreal Softwood Shield. Prior to 1993, these 7 strata had very limited coverage. See Sauer et al. (2017b) for details of the core and expanded survey areas and strata.

The summary results we present here are based on a log-linear hierarchical model in which the log of the expected counts is a linear function of stratum (S), slope (β), year (γ), observer/route (ω), first year (η), and overdispersion (ε) effects, that is:

$$\log(\lambda_{i,j,t}) = S_i + \beta_i(t - t^*) + \omega_j + \gamma_{i,t} + \eta I(j,t) + \varepsilon_{i,j,t} \quad (1)$$

Counts are assumed to be distributed as Poisson, i, j, and t index stratum, route/observer, and year, respectively, and t^* is a fixed year (1986) that centers the regression. Descriptions of the distributions of these parameters are provided in Sauer et al. (2013); the analysis presented here differs slightly from earlier implementations, in that stratum and slope effects are hierarchical, governed by mean and variance hyperparameters that have diffuse normal and gamma distributions, respectively (Sauer et al. 2017b).

This model contains parameters related to population change (i.e. β, γ) that are indexed at the stratum scale. Summary of population change is accomplished by first estimating a time series of annual indices that are functions of stratum abundance, slope and year effects, and variance components that are added to accommodate asymmetries in the log normal distribution:

$$n_{i,t} = z_i \exp\left(S_i + \beta_i(t - t^*) + \gamma_{i,t} + 0.5\sigma^2_\omega + 0.5\sigma^2_\varepsilon\right) \quad (2)$$

where z_i is a scaling factor (proportion of routes in which the species was encountered in the region). Indices for groups of strata are area-weighted (among regions) yearly indices. Trend is defined as the ratio of annual indices (for region i) for the first year (t_a) and last year (t_b) in the period of interest, taken to the appropriate power:

$$B_i = \left\{\frac{n_{i,t_b}}{n_{i,t_a}}\right\}^{\frac{1}{t_b - t_a}} \quad (3)$$

For regions composed of several strata, trend was defined as the ratio of the regional annual indices. Trend is presented as percent change per year (i.e. $(B_i - 1)$*100%). Models were fit using Bayesian methods, via the program JAGS (http://mcmc-jags.sourceforge.net/), and inference was based on medians and credible intervals computed from the posterior distributions of parameters and derived statistics. To accommodate the differences in estimated precision in comparing species trend results, we employed the hierarchical model approach described by Sauer and

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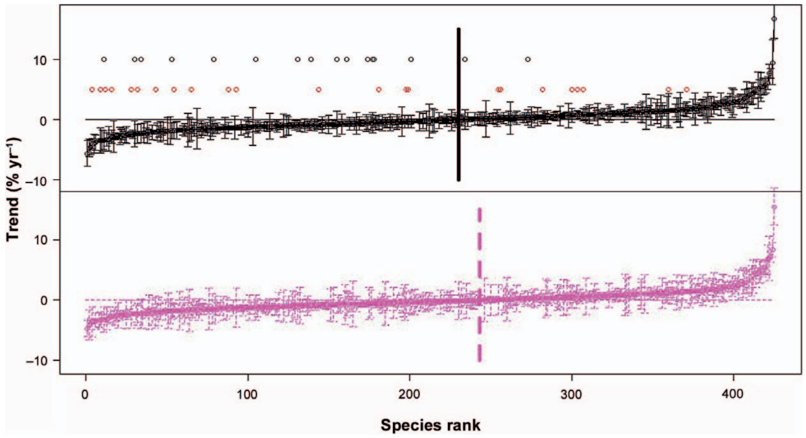

FIGURE 1. Ranked trends (1966–2015) for 424 species of North American birds, as estimated by the North American Breeding Bird Survey. The upper panel shows the results from the log-linear model with hierarchical β and *S* components, and the lower panel shows results from Sauer et al. (2017a) for the model with nonhierarchical β and *S*. Species trend data are presented in the Appendix. In each panel, the horizontal line indicates the zero trend, and species are ranked by trend magnitude on the *x*-axis. Each species trend is indicated by the median (circle) and the 95% credible interval of the posterior distribution of the trend parameter estimated using Sauer and Link's (2002) model. The vertical line indicates the rank order of the species with positive trends (i.e. species to the right of the line have positive trends as identified by the hierarchical model). Red circles indicate ranks of grassland-breeding bird species, and black circles indicate ranks of aridland-breeding bird species.

Link (2002) for ranking and displaying summary trend results. Each species' estimated trend is considered to be normally distributed, with a mean and variance that represent the trend parameter and variance for the species. These trend parameters are defined as normally distributed, with a common overall mean and variance (hierarchical parameters). Modeling the distribution of trends across all species allowed us to estimate the number of increasing species (species with trend >0) and provided a better ranking of the actual trend parameters. We also implemented a State of the Birds summary (e.g., North American Bird Conservation Initiative, U.S. Committee [NABCI] 2014) of composite trajectories for selected species groups. These summaries apply an analysis similar to that in Sauer and Link (2002) to estimate yearly composite mean change, by applying a hierarchical model to annual estimates of change from an initial base year for each subsequent year in the time series (Sauer and Link 2011). The yearly hierarchical models differ from those in Sauer and Link (2002) in that the log means were modeled, leading to a geometric mean summary of trajectories over time (Sauer and Link 2011).

We note that prior BBS analyses (e.g., Sauer et al. 2017a) did not include hierarchical structure in β and *S* (i.e. these parameters were assumed to be independently distributed as normal random variables with mean 0 and variance 1×10^{-6}). The present analysis also included strata with smaller sample sizes than were used in prior analyses (≥3 routes; Sauer et al. 2017b). We thus computed trends for the 424 species in the core area from 1966 to 2015 using Sauer et al.'s (2017a) model, and we provide occasional comparisons with results to reassure readers of continuity with prior analyses. In recent years, BBS data have been used to document consistent declines in several groups of birds, particularly in grassland-obligate and aridland-obligate breeding bird species (NABCI 2014) and in aerial insectivore species (Nebel et al. 2010, Smith et al. 2015). Because these groups are experiencing the largest declines of any group of species in North America, we highlight their trends in our summary analyses and use Sauer and Link's (2002) method to estimate the proportion of those species with positive trends for the periods 1966–2015 and 1993–2015. We also computed composite population change graphs (i.e. State of the Birds summaries) for these groups.

Fifty-year trends. Over the long term (1966–2015), significantly more species are declining than increasing in the core area. Of the 424 species we analyzed, 195 (95% credible interval: 186, 205) species, or 46% (43.8, 48.2), had positive trends as estimated using Sauer and Link's (2002) hierarchical model (Figure 1 and Appendix; for scientific names of species, see Appendix). Extreme declines occurred in Black Swift (–7.5% yr^{-1}; –9.1, –4.3), Bank Swallow (–4.9% yr^{-1}; –6.0, –3.9), Evening Grosbeak (–5.0% yr^{-1}; –6.4, –3.9), Chestnut-collared Longspur (–4.1% yr^{-1}; –5.1, –3.3), and Blackpoll Warbler (–4.3% yr^{-1}; –8.2, –1.7). However, other species are experiencing extreme population increases. Top increasers include Eurasian Collared-Dove (32.2% yr^{-1}; 27.6, 35.4), Cave Swallow (22.5% yr^{-1}; 18.1, 26.7), Wild Turkey (8.0% yr^{-1}; 7.1, 8.8), Couch's Kingbird (9.0% yr^{-1}; 8.0, 11.4), and Swallow-tailed Kite (6.5% yr^{-1}; 5.1, 7.3). Extreme increasing and declining

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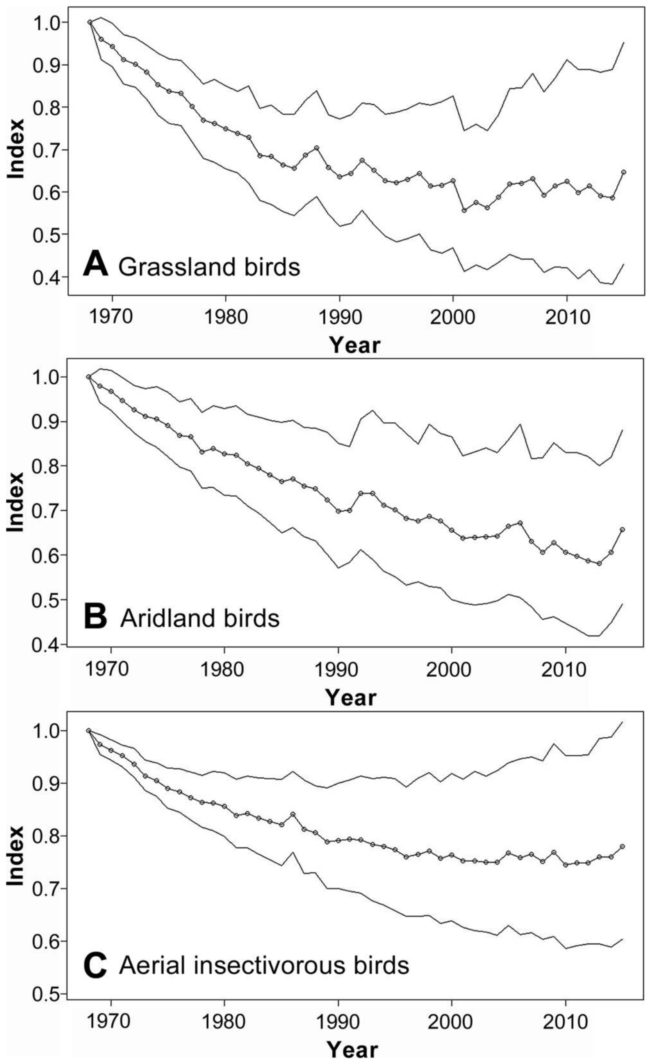

FIGURE 2. State of the Birds composite summaries of population change for 3 groups of management interest: (**A**) grassland-breeding birds, (**B**) aridland-breeding birds, and (**C**) aerial insectivorous species, as defined by Nebel et al. (2010). Index is total proportional change (median and 95% credible interval of the posterior distribution) from the 1968 base year.

species are listed in the rank order estimated by Sauer and Link's (2002) hierarchical model. The analysis using nonhierarchical β and *S* indicated 182 (171, 194) species, or 43% (40.2, 45.6) species with positive trends (Figure 1; Sauer et al. 2017a).

One of the most obvious generalizations to be made from BBS data is that "big-picture" views of bird populations are not particularly informative. To make sense of a collection of population change estimates from an omnibus survey such as the BBS, we must either consider the individual characteristics of the species (e.g., the extreme increases shown by the invasive Eurasian Collared-Dove) or look for patterns of change among species sharing common habitat or other life-history attributes. Sauer et al. (2013) provide some discussion of species and group patterns of population change. Here, we update the status assessment of our 3 groups of management interest. Of the 24 grassland bird species, 8 (5, 10) species, or 32% (20, 40), were increasing. Of the 22 aridland bird species, 7 (5, 10) species, or 31.8% (22.7, 45.4), were increasing. Of the 31 aerial insectivores, 8 (6, 10) species, or 25.8% (19.3, 32.3), were increasing. State of the Bird summaries for the 3 species groups (Figure 2) show similar patterns in the context of time series of composite change for the groups. The model with hierarchical β and *S* indicates slightly more positive trajectories than the model with nonhierarchical β and *S*, with very similar patterns of year-to-year change.

Recent changes in the expanded survey area (1993–2015). Over the short term (1993–2015), bird species tend to have more positive population trajectories. Of the 546 species included in the expanded area analysis, 306 (294, 318) species, or 56% (53.8, 58.2), had positive trends (Figure 3 and Appendix). Core area results based on the 424 species for which long-term trends were computed had similar proportions of increasers to the larger species collection, with 54% (51.8, 56.5) of species increasing. The declining species groups, although still declining, show more positive trends compared to long-term results in composite analyses. Of the 24 grassland bird species, 10 (8, 12) species, or 41% (32, 48), were increasing. Of the 22 aridland bird species, 10 (7, 12) species, or 45.4% (31.8, 54.6), were increasing. And of the 31 aerial insectivorous species, 11 (8, 13) species, or 35.4% (25.8, 41.9), were increasing. This pattern of less-severe declines after 1993 contrasts with the group trajectories for aerial insectivores estimated in Smith et al. (2015), which generally showed that more recent trends were more severe than earlier trends.

Changing Bird Populations, Changing Analyses

The 50 years of BBS population change results provide the fundamental information base for bird conservation in North America (Hudson et al. 2017, Rosenberg et al. 2017). Identification of species-level patterns of population change and identifying commonalities in trends among species that share breeding habitats or migration status have proved to be effective approaches for defining groups of species meriting conservation action (NABCI 2014). As evidenced by recent population increases, period-specific patterns of change are also of conservation interest and provide important insights into population change associated with temporal variation in weather and other environmental features (Huang et al. 2016). In addition to describing patterns of population change, modern BBS analyses offer new opportunities for testing hypotheses regarding factors that influence population change. With

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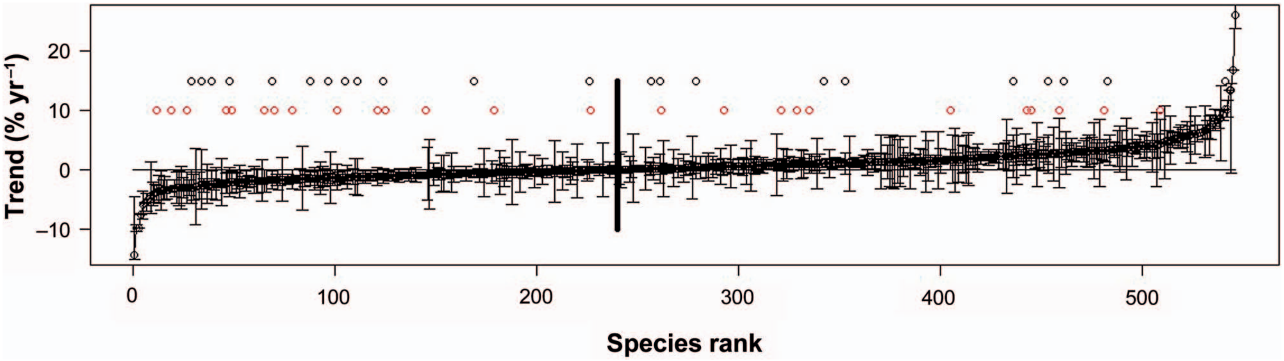

FIGURE 3. Ranked trends (1993–2015) for 546 species of North American birds, as estimated from the North American Breeding Bird Survey. Shown are the results from the log-linear model with hierarchical β and *S* components for the expanded survey area. Species trend data are presented in the Appendix. The horizontal line indicates the zero trend, and species are ranked by trend magnitude on the *x*-axis. Each species trend is indicated by the median (circle) and the 95% credible interval of the posterior distribution of the trend parameter estimated using Sauer and Link's (2002) model. The vertical line indicates the rank order of the species with positive trends (i.e. species to the right of the line have positive trends as identified by the hierarchical model). Red circles indicate ranks of grassland-breeding bird species, and black circles indicate ranks of aridland-breeding bird species.

data available at scales ranging from an individual stop to Bird Conservation Regions and even larger geographic scales, the BBS can be used to model spatial as well as temporal associations of bird abundance and change (Niemuth et al. 2017). Hierarchical models also permit aggregation of information among species and can be configured as full life-cycle models that integrate BBS data with banding and other information (Hudson et al. 2017). Model-based BBS analysis thus provides a framework both for controlling for structural limitations such as detectability and for development of models that allow us to predict environmental influences on bird populations. Integrated population models such as that employed for Wood Ducks in this Special Section (Zimmerman et al. 2017) illustrate how hierarchical models allow us to combine BBS results with other datasets to enhance the use of BBS data in population management.

Although the hierarchical models we use for BBS analyses offer many possibilities for analysis, it is difficult to avoid getting bogged down in details of the many models that could be applied to the BBS (Link and Sauer 2016). Even among the national agencies that administer the surveys, we choose slightly different model structures and spatial structuring for summary analyses (e.g., Environment and Climate Change Canada 2017, Sauer et al. 2017a). One of the perennial to-do-list items for administration of the BBS is to tighten collaboration between the national BBS offices, as well as among other groups doing BBS analyses, to ensure authoritative presentation of results. At the moment, achieving this goal is complicated by two issues: (1) uncertainty about details of model structure (Link and Sauer 2016, Link et al. 2017) and (2) expansion of the survey into new regions. Both of these are topics of active research (e.g., Link and Sauer 2016, Sauer et al. 2017b). Link et al. (2017) used cross-validation methods to compare 4 alternative models for 20 species from BBS data. Given the complexity of the modeling, the lack of temporal and spatial balance in the data due to the expansion of the survey over time (Sauer et al. 2013), and the regions of analysis, our perceptions of the best analysis are certain to be evolving. Although the timely incorporation of improved analyses can be helpful in terms of providing the best available information to users, we strongly advocate peer review of new methods and comparative analyses that ensure credibility and consistency in results over time (e.g., Smith et al. 2014, Sauer et al. 2017b).

ACKNOWLEDGMENTS

The real heroes of the BBS program are the volunteer observers, who get up early, travel long distances, provide their expertise to monitor North American bird populations, and follow through with data entry and verification. We thank them, and we also thank BBS staff from 3 countries who shuffle the papers and crunch the numbers, providing the crucial link from project to product. Finally, we thank Chan Robbins, Tony Erskine, and the other founders of the BBS, who had the fortitude to establish and maintain the BBS in the early years when its value was not always evident to administrators. This Perspective and other papers in this Special Section had their impetus in a symposium on the BBS at the North American Ornithological Conference in Washington, D.C., in 2016. J. Hatfield provided useful comments on the manuscript. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. or Canadian Government.

Author contributions: J.R.S., K.L.P., D.J.Z., A.C.S., M.-A.R.H., V.R., and H.B. organized the symposium. J.R.S., W.A.L., and

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D.K.N. conducted analyses. J.R.S. wrote the original draft and all authors participated in editing the manuscript.

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APPENDIX. Population trends for 546 species of North American breeding birds during the periods 1966–2015 and 1993–2015, as documented by the North American Breeding Bird Survey, with lower (2.5%) and upper (97.5%) limits of 95% credible intervals. *N* is the total number of routes used in the analysis for each species.

			1966–2015			1993–2015		
Common name	Scientific name	*N*	Trend (% change yr^{-1})	2.5%	97.5%	Trend (% change yr^{-1})	2.5%	97.5%
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*	147	5.736	2.543	8.591	3.454	−0.425	7.106
Fulvous Whistling-Duck	*Dendrocygna bicolor*	45	2.222	−0.888	5.195	4.905	1.399	8.713
Greater White-fronted Goose	*Anser albifrons*	19	–	–	–	16.902	16.902	16.902
Canada Goose	*Branta canadensis*	3,002	9.941	8.733	11.06	10.827	9.39	12.289
Mute Swan	*Cygnus olor*	84	3.178	−0.111	6.23	3.49	−0.847	7.824
Trumpeter Swan	*Cygnus buccinator*	125	–	–	–	7.571	7.532	7.859
Tundra Swan	*Cygnus columbianus*	26	–	–	–	0.494	−7.228	1.75
Wood Duck	*Aix sponsa*	2,252	1.832	1.483	2.196	2.055	1.556	2.555
Gadwall	*Anas strepera*	755	2.842	2.032	3.658	4.017	2.771	5.388
American Wigeon	*Anas americana*	662	−1.529	−2.588	−0.439	0.434	−1.271	2.347
American Black Duck	*Anas rubripes*	551	−1.008	−2.14	0.204	0.139	−1.656	2.297
Mallard	*Anas platyrhynchos*	3,483	0.539	−0.07	1.108	1.218	0.453	2.099
Mottled Duck	*Anas fulvigula*	113	−2.886	−4.464	−1.429	−1.873	−3.74	−0.257
Blue-winged Teal	*Anas discors*	1,267	0.885	−0.234	1.889	2.726	0.921	4.495
Cinnamon Teal	*Anas cyanoptera*	481	−2.074	−3.085	−1.143	−1.371	−2.687	0.019
Northern Shoveler	*Anas clypeata*	718	2.062	0.677	3.312	3.525	1.584	5.46
Northern Pintail	*Anas acuta*	800	−2.179	−4.013	−0.662	−0.318	−2.761	2.24
Green-winged Teal	*Anas crecca*	907	0.14	−0.889	1.113	1.039	−0.507	2.832
Canvasback	*Aythya valisineria*	299	0.929	−1.527	3.1	4.577	1.265	8.343
Redhead	*Aythya americana*	449	1.586	−0.027	3.042	3.735	0.838	6.592
Ring-necked Duck	*Aythya collaris*	525	3.397	2.073	4.579	3.879	2.456	5.413
Greater Scaup	*Aythya marila*	50	–	–	–	−0.108	−3.244	5.673
Lesser Scaup	*Aythya affinis*	552	−1.52	−3.592	−0.067	−0.872	−6.723	1.643
Common Eider	*Somateria mollissima*	29	–	–	–	−5.564	−8.803	19.477
Harlequin Duck	*Histrionicus histrionicus*	58	–	–	–	−3.491	−10.372	2.086
Surf Scoter	*Melanitta perspicillata*	27	–	–	–	−3.164	−4.289	−1.776
White-winged Scoter	*Melanitta fusca*	41	–	–	–	1.763	−4.345	3.616
Black Scoter	*Melanitta americana*	13	–	–	–	6.462	2.947	13.228
Long-tailed Duck	*Clangula hyemalis*	14	–	–	–	−3.346	−6.609	−3.332
Bufflehead	*Bucephala albeola*	293	3.122	1.987	4.194	3.285	1.779	4.412
Common Goldeneye	*Bucephala clangula*	396	0.883	−0.358	2.062	1.321	−0.086	2.829
Barrow's Goldeneye	*Bucephala islandica*	133	−1.165	−3.068	0.126	−0.931	−3.091	0.841
Hooded Merganser	*Lophodytes cucullatus*	437	4.787	3.911	5.959	5.26	4.06	6.502
Common Merganser	*Mergus merganser*	964	−0.21	−1.646	0.829	0.759	−0.273	1.848
Red-breasted Merganser	*Mergus serrator*	121	−3.556	−7.998	−0.202	−3.042	−7.14	1.042
Ruddy Duck	*Oxyura jamaicensis*	465	1.258	−0.525	2.7	2.991	0.225	5.596
Plain Chachalaca	*Ortalis vetula*	4	–	–	–	14.178	13.453	14.727
Mountain Quail	*Oreortyx pictus*	183	−0.53	−1.836	0.647	−1.591	−3.145	−0.049
Scaled Quail	*Callipepla squamata*	205	−0.595	−1.74	0.473	2.83	1.125	4.56
California Quail	*Callipepla californica*	445	0.744	0.134	1.326	0.503	−0.352	1.402
Gambel's Quail	*Callipepla gambelii*	153	−0.035	−1.345	1.211	−0.519	−1.961	0.911
Northern Bobwhite	*Colinus virginianus*	2,001	−3.493	−3.779	−3.246	−3.038	−3.402	−2.659
Montezuma Quail	*Cyrtonyx montezumae*	10	–	–	–	−3.14	−3.319	−3.137
Chukar	*Alectoris chukar*	171	1.447	−0.269	3.28	3.688	1.053	7.084
Gray Partridge	*Perdix perdix*	452	−1.615	−2.804	−0.552	−1.561	−3.082	0.059
Ring-necked Pheasant	*Phasianus colchicus*	1,869	−0.656	−1.105	−0.215	0.028	−0.626	0.724
Ruffed Grouse	*Bonasa umbellus*	1,301	0.222	−0.713	1.072	0.593	−1.199	2.084
Greater Sage-Grouse	*Centrocercus urophasianus*	158	−3.189	−5.738	−0.833	−1.823	−5.409	1.857
Spruce Grouse	*Falcipennis canadensis*	65	–	–	–	3.932	2.856	4.565
Willow Ptarmigan	*Lagopus lagopus*	37	–	–	–	3.361	−2.904	10.73
Rock Ptarmigan	*Lagopus muta*	9	–	–	–	5.624	5.623	5.624
Dusky Grouse	*Dendragapus obscurus*	80	2.095	−0.3	4.188	2.464	0.658	4.938
Sooty Grouse	*Dendragapus fuliginosus*	143	−1.531	−2.882	−0.075	0.317	−1.522	2.474
Sharp-tailed Grouse	*Tympanuchus phasianellus*	331	0.811	−0.405	2.032	1.817	0.161	3.661
Greater Prairie-Chicken	*Tympanuchus cupido*	94	2.781	−1.528	6.185	7.515	1.727	13.28
Lesser Prairie-Chicken	*Tympanuchus pallidicinctus*	12	–	–	–	15.302	−2.571	23.745
Wild Turkey	*Meleagris gallopavo*	2,230	8.025	7.096	8.777	9.391	8.563	10.216
Red-throated Loon	*Gavia stellata*	52	–	–	–	2.041	1.978	2.306
Pacific Loon	*Gavia pacifica*	56	–	–	–	−1.181	−1.258	−1.17
Common Loon	*Gavia immer*	1,001	0.963	0.306	1.586	1.214	0.259	2.09

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APPENDIX. Continued.

			1966–2015			1993–2015		
Common name	Scientific name	*N*	Trend (% change yr^{-1})	2.5%	97.5%	Trend (% change yr^{-1})	2.5%	97.5%
Least Grebe	*Tachybaptus dominicus*	14	–	–	–	−7.244	−12.849	6.157
Pied-billed Grebe	*Podilymbus podiceps*	1,109	1.164	0.155	2.057	3.131	1.637	4.799
Horned Grebe	*Podiceps auritus*	213	−0.233	−1.846	1.466	1.539	−0.798	4.118
Red-necked Grebe	*Podiceps grisegena*	243	0.548	−1.192	1.636	0.717	−0.806	2.23
Eared Grebe	*Podiceps nigricollis*	322	1.116	−0.829	3.092	3.159	0.336	6.387
Western Grebe	*Aechmophorus occidentalis*	236	−0.062	−2.261	1.579	1.983	−0.451	4.204
Wood Stork	*Mycteria americana*	163	2.306	−0.424	6.195	5.136	0.924	14.203
Magnificent Frigatebird	*Fregata magnificens*	9	–	–	–	−1.114	−3.091	3.014
Northern Gannet	*Morus bassanus*	9	–	–	–	15.974	12.116	19.234
Brandt's Cormorant	*Phalacrocorax penicillatus*	9	–	–	–	0.217	0.217	0.217
Neotropic Cormorant	*Phalacrocorax brasilianus*	46	–	–	–	7.229	4.991	7.915
Double-crested Cormorant	*Phalacrocorax auritus*	1,193	4.31	2.826	5.332	5.746	3.842	7.446
Pelagic Cormorant	*Phalacrocorax pelagicus*	24	−2.514	−6.31	1.372	−3.048	−7.462	1.806
Anhinga	*Anhinga anhinga*	238	1.414	0.458	2.516	2.652	1.293	4.506
American White Pelican	*Pelecanus erythrorhynchos*	405	5.986	4.159	7.52	8.121	5.983	10.519
Brown Pelican	*Pelecanus occidentalis*	56	3.003	−0.31	6.349	2.56	−3.192	7.571
American Bittern	*Botaurus lentiginosus*	1,136	−0.465	−1.417	0.378	1.049	−0.099	2.387
Least Bittern	*Ixobrychus exilis*	126	0.496	−1.352	2.184	0.954	−1.727	3.54
Great Blue Heron	*Ardea herodias*	3,581	0.517	0.284	0.742	0.827	0.511	1.16
Great Egret	*Ardea alba*	1,033	2.076	1.16	2.887	3.02	1.849	4.311
Snowy Egret	*Egretta thula*	491	1.615	0.15	3.117	2.438	0.295	4.783
Little Blue Heron	*Egretta caerulea*	669	−1.634	−2.332	−0.908	−1.228	−2.198	−0.063
Tricolored Heron	*Egretta tricolor*	194	−0.25	−1.804	0.866	0.245	−1.73	1.712
Reddish Egret	*Egretta rufescens*	26	–	–	–	3.292	1.998	4.672
Cattle Egret	*Bubulcus ibis*	854	−1.269	−2.148	−0.327	−1.425	−2.697	−0.064
Green Heron	*Butorides virescens*	2,287	−1.753	−1.976	−1.542	−1.749	−2.096	−1.402
Black-crowned Night-Heron	*Nycticorax nycticorax*	765	−0.379	−1.315	0.493	0.479	−0.906	1.95
Yellow-crowned Night-Heron	*Nyctanassa violacea*	390	−0.64	−1.81	0.359	−0.014	−1.37	1.372
White Ibis	*Eudocimus albus*	321	3.862	1.688	6.42	5.392	0.593	10.353
Glossy Ibis	*Plegadis falcinellus*	83	4.287	1.462	7.331	8.161	3.477	13.8
White-faced Ibis	*Plegadis chihi*	185	2.499	−1.276	6.759	6.895	0.913	15.887
Roseate Spoonbill	*Platalea ajaja*	77	5.289	4.467	8.401	6.726	4.491	10.201
Black Vulture	*Coragyps atratus*	1,022	4.931	4.278	5.536	5.453	4.573	6.312
Turkey Vulture	*Cathartes aura*	3,418	2.438	2.144	2.741	3.004	2.699	3.293
Osprey	*Pandion haliaetus*	1,053	2.622	2.079	3.17	3.921	3.414	4.528
Swallow-tailed Kite	*Elanoides forficatus*	130	6.509	5.114	7.29	6.671	4.889	7.5
White-tailed Kite	*Elanus leucurus*	121	−1.401	−2.754	−0.14	−1.451	−3.696	0.397
Mississippi Kite	*Ictinia mississippiensis*	469	0.996	−0.014	1.827	2.549	1.645	3.5
Bald Eagle	*Haliaeetus leucocephalus*	1,008	5.39	4.369	6.247	4.093	3.012	5.054
Northern Harrier	*Circus cyaneus*	1,976	−1.006	−1.377	−0.633	−0.95	−1.478	−0.453
Sharp-shinned Hawk	*Accipiter striatus*	1,376	1.371	0.989	1.784	1.575	0.954	2.173
Cooper's Hawk	*Accipiter cooperii*	2,122	2.977	2.58	3.301	3.466	3.004	3.869
Northern Goshawk	*Accipiter gentilis*	459	0.292	−0.537	1.143	0.812	−0.531	2.272
Harris's Hawk	*Parabuteo unicinctus*	74	−1.759	−3.254	−0.39	−2.236	−4.475	−0.26
White-tailed Hawk	*Geranoaetus albicaudatus*	26	–	–	–	3.138	1.93	4.962
Gray Hawk	*Buteo plagiatus*	6	–	–	–	8.492	8.262	8.538
Red-shouldered Hawk	*Buteo lineatus*	1,657	2.711	2.395	3.027	3.03	2.59	3.463
Broad-winged Hawk	*Buteo platypterus*	1,520	0.79	0.422	1.105	1.012	0.55	1.461
Short-tailed Hawk	*Buteo brachyurus*	9	–	–	–	9.119	7.748	10.016
Swainson's Hawk	*Buteo swainsoni*	1,158	0.77	0.485	1.103	0.942	0.54	1.355
Zone-tailed Hawk	*Buteo albonotatus*	22	–	–	–	3.751	3.695	3.953
Red-tailed Hawk	*Buteo jamaicensis*	4,237	1.514	1.329	1.697	1.374	1.128	1.616
Rough-legged Hawk	*Buteo lagopus*	25	–	–	–	0.397	−3.49	1.383
Ferruginous Hawk	*Buteo regalis*	502	0.837	0.18	1.509	0.897	0.112	1.673
Golden Eagle	*Aquila chrysaetos*	709	0.007	−0.453	0.467	0.136	−0.413	0.683
Yellow Rail	*Coturnicops noveboracensis*	58	–	–	–	2.187	−4.384	9.633
Black Rail	*Laterallus jamaicensis*	3	–	–	–	6.018	5.968	6.02
Clapper Rail	*Rallus crepitans*	69	−0.218	−1.624	1.908	0.477	−0.906	2.822
King Rail	*Rallus elegans*	69	−4.185	−6.453	−1.859	−5.112	−8.94	−1.514
Virginia Rail	*Rallus limicola*	379	1.791	0.799	2.798	3.071	1.534	4.75
Sora	*Porzana carolina*	1,049	0.519	−0.684	1.543	1.433	0.131	2.672
Purple Gallinule	*Porphyrio martinicus*	51	−1.548	−4.292	0.788	−0.577	−4.021	3.492

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APPENDIX. Continued.

			1966–2015			1993–2015		
Common name	Scientific name	*N*	Trend (% change yr^{-1})	2.5%	97.5%	Trend (% change yr^{-1})	2.5%	97.5%
Common Gallinule	*Gallinula galeata*	235	−1.637	−2.955	−0.216	−1.662	−3.594	0.412
American Coot	*Fulica americana*	1,040	0.766	−1.087	2.296	4.627	1.948	7.307
Limpkin	*Aramus guarauna*	39	–	–	–	1.376	−3.26	8.346
Sandhill Crane	*Grus canadensis*	834	5.118	4.471	5.736	5.514	4.196	6.574
Black-necked Stilt	*Himantopus mexicanus*	290	2.122	0.424	3.762	3.465	1.366	5.58
American Avocet	*Recurvirostra americana*	489	0.301	−1.053	1.384	1.293	−0.308	2.854
American Oystercatcher	*Haematopus palliatus*	7	–	–	–	−2.143	−3.115	−0.858
Black Oystercatcher	*Haematopus bachmani*	15	–	–	–	−2.545	−13.049	5.672
American Golden-Plover	*Pluvialis dominica*	12	–	–	–	−1.552	−7.589	3.23
Pacific Golden-Plover	*Pluvialis fulva*	10	–	–	–	0.295	−0.117	0.295
Snowy Plover	*Charadrius nivosus*	4	–	–	–	1.641	−5.081	8.368
Wilson's Plover	*Charadrius wilsonia*	13	–	–	–	4.609	−3.558	9.582
Semipalmated Plover	*Charadrius semipalmatus*	50	–	–	–	−2.677	−5.667	0.395
Killdeer	*Charadrius vociferus*	4221	−1.053	−1.228	−0.886	−0.376	−0.592	−0.158
Mountain Plover	*Charadrius montanus*	79	−2.04	−4.45	−0.556	−1.557	−4.239	0.315
Spotted Sandpiper	*Actitis macularius*	1,970	−1.342	−1.707	−0.982	−0.733	−1.391	−0.003
Solitary Sandpiper	*Tringa solitaria*	190	0.086	−0.336	2.198	1.495	0.773	4.788
Wandering Tattler	*Tringa incana*	10	–	–	–	−0.6	−11.949	8.919
Greater Yellowlegs	*Tringa melanoleuca*	168	2.237	−0.224	4.49	2.077	0.38	3.824
Willet	*Tringa semipalmata*	528	−0.489	−1.033	0.065	−0.156	−0.901	0.602
Lesser Yellowlegs	*Tringa flavipes*	254	−2.205	−4.594	0.204	−1.695	−3.635	0.378
Upland Sandpiper	*Bartramia longicauda*	1,024	0.389	−0.102	0.83	0.956	0.33	1.626
Whimbrel	*Numenius phaeopus*	19	–	–	–	3.631	3.077	3.709
Long-billed Curlew	*Numenius americanus*	474	0.235	−0.506	0.933	0.491	−1.219	1.52
Bar-tailed Godwit	*Limosa lapponica*	4	–	–	–	−9.375	−26.553	0.38
Marbled Godwit	*Limosa fedoa*	368	−0.218	−0.639	0.166	0.422	−0.164	0.834
Ruddy Turnstone	*Arenaria interpres*	5	–	–	–	−14.657	−15.149	−13.871
Least Sandpiper	*Calidris minutilla*	30	–	–	–	−3.759	−6.66	0.839
Western Sandpiper	*Calidris mauri*	11	–	–	–	−2.425	−13.703	−0.995
Short-billed Dowitcher	*Limnodromus griseus*	12	–	–	–	−0.746	−9.151	4.041
Wilson's Snipe	*Gallinago delicata*	1,964	0.251	−0.215	0.657	0.907	−0.26	1.847
American Woodcock	*Scolopax minor*	592	−1.441	−2.045	−0.822	−1.019	−1.99	−0.018
Wilson's Phalarope	*Phalaropus tricolor*	596	−0.334	−1.435	0.682	1.021	−0.631	2.761
Red-necked Phalarope	*Phalaropus lobatus*	24	–	–	–	−2.144	−2.556	0.632
Parasitic Jaeger	*Stercorarius parasiticus*	9	–	–	–	0.159	0.138	0.16
Long-tailed Jaeger	*Stercorarius longicaudus*	19	–	–	–	−4.095	−8.886	0.744
Black Guillemot	*Cepphus grylle*	10	–	–	–	3.116	3.048	4.555
Pigeon Guillemot	*Cepphus columba*	22	–	–	–	1.815	−1.809	8.608
Marbled Murrelet	*Brachyramphus marmoratus*	47	–	–	–	2.904	0.94	5.366
Rhinoceros Auklet	*Cerorhinca monocerata*	8	–	–	–	7.678	−2.324	16.452
Black-legged Kittiwake	*Rissa tridactyla*	14	–	–	–	9.292	3.825	19.555
Bonaparte's Gull	*Chroicocephalus philadelphia*	134	–	–	–	−1.616	−2.051	−1.194
Laughing Gull	*Leucophaeus atricilla*	198	2.438	0.547	4.515	2.726	0.087	5.678
Franklin's Gull	*Leucophaeus pipixcan*	373	−2.244	−4.791	−0.062	−0.183	−3.54	3.501
Mew Gull	*Larus canus*	139	–	–	–	−4.604	−6.902	−2.758
Ring-billed Gull	*Larus delawarensis*	1,274	1.67	0.574	2.772	2.083	0.15	3.875
Western Gull	*Larus occidentalis*	27	−2.653	−6.087	3.02	−1.181	−4.603	8.159
California Gull	*Larus californicus*	408	−0.945	−2.356	0.538	1.334	−1.092	3.719
Herring Gull	*Larus argentatus*	717	−3.353	−5.559	−2.093	−2.427	−4.379	−0.649
Glaucous-winged Gull	*Larus glaucescens*	104	−1.165	−3.636	1.122	−4.138	−6.814	−0.352
Glaucous Gull	*Larus hyperboreus*	17	–	–	–	13.395	13.395	13.395
Great Black-backed Gull	*Larus marinus*	148	0.295	−7.545	1.216	2.544	−4.969	4.888
Aleutian Tern	*Onychoprion aleuticus*	6	–	–	–	−15.105	−15.277	−2.354
Least Tern	*Sternula antillarum*	135	−2.719	−5.63	0.067	−1.204	−4.481	2.548
Gull-billed Tern	*Gelochelidon nilotica*	36	2.117	0.146	4.724	3.874	1.954	7.392
Caspian Tern	*Hydroprogne caspia*	212	1.009	−0.872	2.466	1.661	−0.757	3.853
Black Tern	*Chlidonias niger*	538	−1.389	−3.416	0.229	2.009	−0.428	4.883
Common Tern	*Sterna hirundo*	253	−1.858	−3.786	0.314	−0.585	−2.896	3.16
Arctic Tern	*Sterna paradisaea*	81	–	–	–	−3.064	−5.777	0.008
Forster's Tern	*Sterna forsteri*	285	−0.93	−2.636	0.615	0.223	−2.498	2.554
Royal Tern	*Thalasseus maximus*	57	0.476	−2.338	4.43	2.063	−2.269	10.591
Sandwich Tern	*Thalasseus sandvicensis*	7	–	–	–	7.932	6.816	10.746

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APPENDIX. Continued.

			1966–2015			1993–2015		
Common name	Scientific name	*N*	Trend (% change yr^{-1})	2.5%	97.5%	Trend (% change yr^{-1})	2.5%	97.5%
Black Skimmer	*Rynchops niger*	59	−2.626	−4.693	0.478	−1.932	−3.867	2.048
Rock Pigeon	*Columba livia*	3,425	−1.131	−1.425	−0.867	−0.396	−0.832	−0.038
White-crowned Pigeon	*Patagioenas leucocephala*	9	–	–	–	3.41	1.443	5.374
Band-tailed Pigeon	*Patagioenas fasciata*	329	−1.708	−3.001	−0.573	−0.735	−2.047	0.644
Eurasian Collared-Dove	*Streptopelia decaocto*	1,469	32.275	27.639	35.466	30.067	27.669	32.416
Spotted Dove	*Streptopelia chinensis*	13	–	–	–	−6.243	−7.433	−1.162
Inca Dove	*Columbina inca*	221	1.806	0.765	2.847	1.299	−0.28	2.744
Common Ground-Dove	*Columbina passerina*	335	−0.809	−1.495	−0.117	−0.425	−1.426	0.543
White-tipped Dove	*Leptotila verreauxi*	19	–	–	–	7.808	5.523	11.985
White-winged Dove	*Zenaida asiatica*	331	1.307	−0.131	2.427	2.146	0.686	3.291
Mourning Dove	*Zenaida macroura*	4,372	−0.275	−0.393	−0.16	0.072	−0.067	0.214
Yellow-billed Cuckoo	*Coccyzus americanus*	2,357	−1.445	−1.683	−1.218	−1.056	−1.375	−0.735
Mangrove Cuckoo	*Coccyzus minor*	9	–	–	–	1.905	−7.377	4.86
Black-billed Cuckoo	*Coccyzus erythropthalmus*	1,699	−1.646	−2.652	−0.765	1.39	0.017	3.013
Greater Roadrunner	*Geococcyx californianus*	488	0.925	0.259	1.56	1.471	0.389	2.541
Smooth-billed Ani	*Crotophaga ani*	10	–	–	–	−9.846	−9.846	−9.846
Groove-billed Ani	*Crotophaga sulcirostris*	25	−0.519	−2.859	2.889	−1.068	−6.35	2.91
Barn Owl	*Tyto alba*	147	2.326	0.755	3.767	3.602	1.58	5.597
Western Screech-Owl	*Megascops kennicottii*	99	−0.529	−1.831	0.841	0.069	−1.202	1.773
Eastern Screech-Owl	*Megascops asio*	613	−0.877	−1.619	−0.152	−0.375	−1.479	0.781
Great Horned Owl	*Bubo virginianus*	2,653	−0.462	−0.83	−0.126	−0.303	−0.803	0.219
Northern Hawk Owl	*Surnia ulula*	44	–	–	–	4.036	−0.332	8.373
Northern Pygmy-Owl	*Glaucidium gnoma*	241	0.896	−0.139	1.944	1.248	0.022	2.601
Elf Owl	*Micrathene whitneyi*	14	–	–	–	3.207	−2.611	5.487
Burrowing Owl	*Athene cunicularia*	592	−0.933	−1.725	−0.178	0.152	−1.025	1.394
Spotted Owl	*Strix occidentalis*	16	–	–	–	−1.186	−4.98	2.28
Barred Owl	*Strix varia*	1,560	1.703	1.358	2.053	2.031	1.544	2.58
Great Gray Owl	*Strix nebulosa*	74	–	–	–	2.246	0.524	5.384
Long-eared Owl	*Asio otus*	44	–	–	–	0.1	−3.794	3.238
Short-eared Owl	*Asio flammeus*	474	−0.772	−2.929	1.081	1.477	−1.701	4.751
Boreal Owl	*Aegolius funereus*	12	–	–	–	−9.995	−10.046	−9.105
Northern Saw-whet Owl	*Aegolius acadicus*	68	–	–	–	1.781	−2.376	6.822
Lesser Nighthawk	*Chordeiles acutipennis*	202	0.235	−1.051	0.98	0.277	−1.226	1.121
Common Nighthawk	*Chordeiles minor*	2,583	−1.915	−2.25	−1.587	−1.266	−1.669	−0.813
Common Pauraque	*Nyctidromus albicollis*	27	–	–	–	2.824	2.31	3.344
Common Poorwill	*Phalaenoptilus nuttallii*	349	0.002	−1.086	0.99	0.616	−0.666	1.956
Chuck-will's-widow	*Antrostomus carolinensis*	766	−2.258	−2.556	−1.984	−2.002	−2.329	−1.652
Eastern Whip-poor-will	*Antrostomus vociferus*	809	−2.777	−3.189	−2.255	−2.353	−3.051	−1.629
Black Swift	*Cypseloides niger*	114	−7.525	−9.124	−4.339	−7.093	−8.805	−3.784
Chimney Swift	*Chaetura pelagica*	2,546	−2.474	−2.622	−2.326	−2.503	−2.713	−2.296
Vaux's Swift	*Chaetura vauxi*	282	−1.883	−2.861	−0.675	−1.463	−2.57	−0.153
White-throated Swift	*Aeronautes saxatalis*	392	−0.637	−2.48	0.383	−0.216	−1.556	1.479
Magnificent Hummingbird	*Eugenes fulgens*	4	–	–	–	0.282	0.282	0.282
Blue-throated Hummingbird	*Lampornis clemenciae*	4	–	–	–	−2.223	−3.024	0.712
Ruby-throated Hummingbird	*Archilochus colubris*	2,364	1.499	1.279	1.711	1.618	1.306	1.937
Black-chinned Hummingbird	*Archilochus alexandri*	440	1.154	0.638	1.639	1.411	0.795	2.002
Anna's Hummingbird	*Calypte anna*	237	2.41	1.768	2.879	2.7	1.788	3.345
Costa's Hummingbird	*Calypte costae*	98	−0.996	−3.339	1.282	−3.908	−7.148	−0.899
Broad-tailed Hummingbird	*Selasphorus platycercus*	289	−1.488	−2.071	−0.933	−1.524	−2.202	−0.861
Rufous Hummingbird	*Selasphorus rufus*	385	−2.008	−2.511	−1.42	−1.608	−2.173	−0.875
Allen's Hummingbird	*Selasphorus sasin*	57	−4.23	−5.623	−3.023	−4.238	−5.594	−2.781
Calliope Hummingbird	*Selasphorus calliope*	216	−0.022	−0.908	0.875	0.558	−0.611	1.911
Broad-billed Hummingbird	*Cynanthus latirostris*	7	–	–	–	4.622	4.593	4.641
Buff-bellied Hummingbird	*Amazilia yucatanensis*	9	–	–	–	2.981	−5.138	12.751
Elegant Trogon	*Trogon elegans*	4	–	–	–	6.27	6.269	6.322
Belted Kingfisher	*Megaceryle alcyon*	3,173	−1.363	−1.66	−1.081	−1.245	−1.679	−0.793
Green Kingfisher	*Chloroceryle americana*	6	–	–	–	1.518	−7.441	13.902
Lewis's Woodpecker	*Melanerpes lewis*	196	−2.254	−3.686	−1.227	−1.6	−2.928	−0.336
Red-headed Woodpecker	*Melanerpes erythrocephalus*	1,847	−2.298	−2.619	−1.983	−1.472	−1.886	−1.046
Acorn Woodpecker	*Melanerpes formicivorus*	205	0.631	−0.236	1.306	1.077	0.322	1.877
Gila Woodpecker	*Melanerpes uropygialis*	46	−0.352	−1.744	0.476	−0.378	−1.887	0.601

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APPENDIX. Continued.

			1966–2015			1993–2015		
Common name	Scientific name	*N*	Trend (% change yr^{-1})	2.5%	97.5%	Trend (% change yr^{-1})	2.5%	97.5%
Golden-fronted Woodpecker	*Melanerpes aurifrons*	106	−0.843	−1.444	−0.185	−0.614	−1.371	0.285
Red-bellied Woodpecker	*Melanerpes carolinus*	2,072	1.03	0.897	1.157	1.184	1.011	1.36
Williamson's Sapsucker	*Sphyrapicus thyroideus*	177	0.125	−1.04	1.37	0.662	−0.556	2.043
Yellow-bellied Sapsucker	*Sphyrapicus varius*	1,147	1.374	0.736	1.918	2.265	1.342	3.097
Red-naped Sapsucker	*Sphyrapicus nuchalis*	382	1.258	0.501	2.008	0.963	−0.197	2.096
Red-breasted Sapsucker	*Sphyrapicus ruber*	305	1.169	0.174	2.138	2.559	0.994	4.344
Ladder-backed Woodpecker	*Picoides scalaris*	322	0.151	−0.316	0.623	0.371	−0.138	0.895
Nuttall's Woodpecker	*Picoides nuttallii*	127	0.986	0.201	1.723	1.384	0.39	2.452
Downy Woodpecker	*Picoides pubescens*	3,533	0.087	−0.057	0.228	0.241	0.021	0.456
Hairy Woodpecker	*Picoides villosus*	3,439	0.906	0.653	1.181	1.089	0.76	1.434
Arizona Woodpecker	*Picoides arizonae*	5	–	–	–	2.256	2.256	2.256
Red-cockaded Woodpecker	*Picoides borealis*	56	−4.197	−5.183	−1.464	−3.2	−4.267	0.41
White-headed Woodpecker	*Picoides albolarvatus*	113	1.23	0.172	2.163	1.326	−0.035	2.587
American Three-toed Woodpecker	*Picoides dorsalis*	213	3.674	2.207	5.192	4.508	2.18	6.653
Black-backed Woodpecker	*Picoides arcticus*	308	2.054	0.538	3.439	2.557	0.018	4.809
Northern Flicker	*Colaptes auratus auratus*	4,276	−1.362	−1.522	−1.208	−1.092	−1.383	−0.785
Gilded Flicker	*Colaptes chrysoides*	37	−2.012	−2.836	−0.309	−1.875	−2.819	0.101
Pileated Woodpecker	*Dryocopus pileatus*	2,709	1.516	1.291	1.732	1.805	1.508	2.089
Crested Caracara	*Caracara cheriway*	116	6.264	4.893	7.645	5.304	3.307	7.136
American Kestrel	*Falco sparverius*	3,599	−1.14	−1.399	−0.902	−0.874	−1.225	−0.527
Merlin	*Falco columbarius*	680	3.63	2.71	4.506	3.629	2.464	4.687
Gyrfalcon	*Falco rusticolus*	6	–	–	–	−0.147	−1.008	0.042
Peregrine Falcon	*Falco peregrinus*	142	5.296	4.317	7.286	6.157	4.855	9.122
Prairie Falcon	*Falco mexicanus*	570	1.175	0.48	1.867	1.536	0.613	2.531
Monk Parakeet	*Myiopsitta monachus*	10	–	–	–	16.525	8.84	23.298
Northern Beardless-Tyrannulet	*Camptostoma imberbe*	6	–	–	–	1.242	1.24	1.244
Olive-sided Flycatcher	*Contopus cooperi*	1,421	−3.041	−3.557	−2.596	−2.535	−3.193	−1.862
Greater Pewee	*Contopus pertinax*	8	–	–	–	5.798	3.914	6.372
Western Wood-Pewee	*Contopus sordidulus*	1,371	−1.463	−2.186	−0.974	−1.086	−1.604	−0.552
Eastern Wood-Pewee	*Contopus virens*	2,521	−1.418	−1.544	−1.301	−1.147	−1.313	−0.982
Yellow-bellied Flycatcher	*Empidonax flaviventris*	547	2.41	0.928	3.516	4.188	2.354	5.897
Acadian Flycatcher	*Empidonax virescens*	1,303	−0.227	−0.457	−0.016	0.137	−0.171	0.442
Willow Flycatcher	*Empidonax traillii*	2,722	−0.852	−1.312	−0.389	−1.198	−1.873	−0.554
Least Flycatcher	*Empidonax minimus*	1,918	−1.702	−2.045	−1.372	−1.802	−2.253	−1.325
Hammond's Flycatcher	*Empidonax hammondii*	546	0.828	0.241	1.432	1.24	0.402	2.355
Gray Flycatcher	*Empidonax wrightii*	266	2.276	1.819	2.946	2.643	2.078	3.47
Dusky Flycatcher	*Empidonax oberholseri*	597	−0.467	−1.384	0.31	−0.376	−1.349	0.578
Pacific-slope Flycatcher	*Empidonax difficilis*	693	−0.4	−0.945	0.136	−0.004	−0.645	0.668
Black Phoebe	*Sayornis nigricans*	261	2.467	1.683	3.208	2.618	1.637	3.611
Eastern Phoebe	*Sayornis phoebe*	2,569	0.341	−0.097	0.643	0.102	−0.168	0.357
Say's Phoebe	*Sayornis saya*	1,074	1.174	0.722	1.576	1.47	0.948	2.003
Vermilion Flycatcher	*Pyrocephalus rubinus*	117	0.098	−0.719	1.421	0.473	−0.438	1.98
Dusky-capped Flycatcher	*Myiarchus tuberculifer*	12	–	–	–	0.492	−0.127	1.033
Ash-throated Flycatcher	*Myiarchus cinerascens*	720	1.103	0.742	1.489	1.225	0.787	1.699
Great Crested Flycatcher	*Myiarchus crinitus*	2,649	0.001	−0.13	0.131	0.187	−0.001	0.376
Brown-crested Flycatcher	*Myiarchus tyrannulus*	96	3.455	2.36	4.554	3.617	2.171	4.9
Great Kiskadee	*Pitangus sulphuratus*	31	–	–	–	4.535	3.949	7.914
Sulphur-bellied Flycatcher	*Myiodynastes luteiventris*	4	–	–	–	10.052	1.008	10.581
Couch's Kingbird	*Tyrannus couchii*	44	8.972	8.043	11.375	9.186	8.107	11.814
Cassin's Kingbird	*Tyrannus vociferans*	267	0.352	−0.584	1.25	0.988	−0.099	1.969
Thick-billed Kingbird	*Tyrannus crassirostris*	3	–	–	–	−5.649	−5.67	−5.648
Western Kingbird	*Tyrannus verticalis*	1,653	0.1	−0.238	0.419	0.109	−0.29	0.519
Eastern Kingbird	*Tyrannus tyrannus*	3,446	−1.279	−1.433	−1.135	−1.493	−1.727	−1.259
Gray Kingbird	*Tyrannus dominicensis*	30	–	–	–	−0.086	−1.988	3.493
Scissor-tailed Flycatcher	*Tyrannus forficatus*	453	−0.747	−1.036	−0.455	−0.665	−1.129	−0.203
Loggerhead Shrike	*Lanius ludovicianus*	2,062	−2.764	−3.055	−2.483	−2.36	−2.788	−1.91
Northern Shrike	*Lanius excubitor*	25	–	–	–	−1.666	−1.687	−1.644
White-eyed Vireo	*Vireo griseus*	1,493	0.623	0.423	0.818	0.926	0.653	1.195
Bell's Vireo	*Vireo bellii*	536	0.728	0.038	1.383	1.547	0.692	2.478
Black-capped Vireo	*Vireo atricapilla*	10	–	–	–	2.889	2.889	2.889
Gray Vireo	*Vireo vicinior*	96	3.199	1	5.069	4.307	2.091	6.407

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APPENDIX. Continued.

			1966–2015			1993–2015		
Common name	Scientific name	*N*	Trend (% change yr^{-1})	2.5%	97.5%	Trend (% change yr^{-1})	2.5%	97.5%
Yellow-throated Vireo	*Vireo flavifrons*	1,840	1.034	0.833	1.258	1.343	1.078	1.636
Plumbeous Vireo	*Vireo plumbeus*	274	−2.361	−4.173	−0.486	0.538	−0.211	2.052
Cassin's Vireo	*Vireo cassinii*	471	1.094	0.544	1.645	1.363	0.564	2.149
Blue-headed Vireo	*Vireo solitarius*	1,192	3.09	2.37	3.708	2.768	1.21	3.84
Hutton's Vireo	*Vireo huttoni*	234	1.344	0.574	2.161	1.93	0.837	3.058
Warbling Vireo	*Vireo gilvus*	2,868	0.909	0.655	1.157	1.084	0.75	1.432
Philadelphia Vireo	*Vireo philadelphicus*	478	2.649	0.664	4.303	3.546	1.186	6.101
Red-eyed Vireo	*Vireo olivaceus*	3,248	0.739	0.538	0.939	0.859	0.565	1.134
Black-whiskered Vireo	*Vireo altiloquus*	15	–	–	–	−0.616	−2.43	1.182
Gray Jay	*Perisoreus canadensis*	890	−0.121	−1.054	0.59	0.302	−0.662	1.296
Green Jay	*Cyanocorax yncas*	30	9.16	5.769	12.592	11.577	6.631	17.286
Pinyon Jay	*Gymnorhinus cyanocephalus*	288	−3.548	−4.64	−2.38	−3.332	−4.547	−1.729
Steller's Jay	*Cyanocitta stelleri*	664	−0.193	−0.503	0.11	−0.294	−0.711	0.112
Blue Jay	*Cyanocitta cristata*	3,090	−0.663	−0.757	−0.577	−0.545	−0.675	−0.416
Florida Scrub-Jay	*Aphelocoma coerulescens*	12	–	–	–	−2.797	−2.797	−2.796
Western Scrub-Jay	*Aphelocoma californica*	498	−0.187	−0.626	0.237	−0.339	−0.933	0.227
Mexican Jay	*Aphelocoma wollweberi*	13	–	–	–	−1.614	−1.614	−1.614
Clark's Nutcracker	*Nucifraga columbiana*	414	0.107	−0.76	0.961	0.614	−0.482	1.741
Black-billed Magpie	*Pica hudsonia*	1,167	−0.474	−0.798	−0.152	0.099	−0.306	0.503
Yellow-billed Magpie	*Pica nuttalli*	47	−2.892	−3.967	−1.835	−3.756	−5.467	−2.171
American Crow	*Corvus brachyrhynchos*	4,150	0.093	−0.024	0.201	−0.008	−0.141	0.121
Northwestern Crow	*Corvus caurinus*	77	−0.212	−1.133	0.592	0.829	−0.351	1.293
Fish Crow	*Corvus ossifragus*	847	0.539	0.129	0.978	1.072	0.48	1.673
Chihuahuan Raven	*Corvus cryptoleucus*	173	−0.307	−1.482	0.621	−0.121	−1.684	1.098
Common Raven	*Corvus corax*	2,706	2.144	1.541	2.561	2.702	2.202	3.116
Horned Lark	*Eremophila alpestris*	2,630	−2.46	−2.839	−2.138	−2.255	−2.624	−1.876
Purple Martin	*Progne subis*	2,351	−0.841	−1.22	−0.524	−0.119	−0.533	0.284
Tree Swallow	*Tachycineta bicolor*	3,228	−1.283	−1.668	−0.941	−0.542	−0.898	−0.186
Violet-green Swallow	*Tachycineta thalassina*	1,046	−0.664	−1.145	−0.227	−0.667	−1.227	−0.133
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	3,214	−0.437	−0.776	−0.128	0.018	−0.45	0.45
Bank Swallow	*Riparia riparia*	1,945	−4.916	−5.986	−3.899	−3.621	−5.158	−1.905
Cliff Swallow	*Petrochelidon pyrrhonota*	3,133	0.694	−0.016	1.111	2.845	2.17	3.507
Cave Swallow	*Petrochelidon fulva*	118	22.493	18.155	26.717	13.854	6.307	21.107
Barn Swallow	*Hirundo rustica*	4,338	−1.18	−1.326	−1.036	−1.002	−1.17	−0.828
Carolina Chickadee	*Poecile carolinensis*	1,322	−0.333	−0.518	−0.155	−0.335	−0.597	−0.076
Black-capped Chickadee	*Poecile atricapillus*	2,477	0.646	0.377	0.907	0.999	0.674	1.332
Mountain Chickadee	*Poecile gambeli*	580	−1.279	−1.814	−0.849	−1.113	−1.721	−0.501
Chestnut−backed Chickadee	*Poecile rufescens*	276	−1.408	−2.291	−0.569	−0.968	−2.061	0.086
Boreal Chickadee	*Poecile hudsonicus*	529	−0.131	−1.006	0.678	1.069	−0.442	2.709
Bridled Titmouse	*Baeolophus wollweberi*	15	–	–	–	−0.929	−1.007	−0.84
Oak Titmouse	*Baeolophus inornatus*	155	−1.581	−2.242	−0.908	−1.738	−2.663	−0.826
Juniper Titmouse	*Baeolophus ridgwayi*	179	0.539	−0.598	1.694	0.916	−0.387	2.357
Tufted Titmouse	*Baeolophus bicolor*	2,022	1.099	0.932	1.258	1.226	1.017	1.435
Verdin	*Auriparus flaviceps*	198	−1.703	−2.813	−0.659	−0.938	−2.127	0.35
Bushtit	*Psaltriparus minimus*	485	−0.694	−1.891	0.337	−0.666	−2.182	0.893
Red-breasted Nuthatch	*Sitta canadensis*	1,821	0.842	0.248	1.348	−0.334	−0.958	0.258
White-breasted Nuthatch	*Sitta carolinensis*	2,658	1.822	1.564	2.067	2.12	1.805	2.447
Pygmy Nuthatch	*Sitta pygmaea*	244	−0.596	−2.002	0.815	−0.473	−2.051	1.146
Brown-headed Nuthatch	*Sitta pusilla*	508	−0.407	−0.874	0.061	0.201	−0.471	0.894
Brown Creeper	*Certhia americana*	1,165	0.594	0.083	1.038	1.035	0.363	1.664
Rock Wren	*Salpinctes obsoletus*	961	−0.781	−1.333	−0.247	−0.585	−1.28	0.112
Canyon Wren	*Catherpes mexicanus*	352	0.221	−0.601	1.065	0.888	−0.149	2.009
House Wren	*Troglodytes aedon*	3,025	0.267	0.095	0.429	−0.042	−0.266	0.174
Pacific Wren	*Troglodytes pacificus*	354	−0.625	−1.392	0.102	−0.171	−1.533	2.158
Winter Wren	*Troglodytes hiemalis*	900	0.23	−0.662	1.042	−1.753	−2.742	−0.81
Sedge Wren	*Cistothorus platensis*	658	0.51	−0.397	1.261	0.176	−0.837	1.157
Marsh Wren	*Cistothorus palustris*	746	1.923	1.108	2.706	2.568	1.332	3.824
Carolina Wren	*Thryothorus ludovicianus*	1,778	1.065	0.876	1.247	0.529	0.318	0.745
Bewick's Wren	*Thryomanes bewickii*	952	−0.975	−1.552	−0.415	−0.713	−1.354	−0.016
Cactus Wren	*Campylorhynchus brunneicapil*	251	−1.527	−2.437	−0.68	−2.036	−3.107	−0.951
Blue-gray Gnatcatcher	*Polioptila caerulea*	2,180	0.443	0.205	0.677	0.48	0.15	0.796

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APPENDIX. Continued.

			1966–2015			1993–2015		
Common name	Scientific name	*N*	Trend (% change yr^{-1})	2.5%	97.5%	Trend (% change yr^{-1})	2.5%	97.5%
California Gnatcatcher	*Polioptila californica*	5	–	–	–	−5.382	−5.976	2.881
Black-tailed Gnatcatcher	*Polioptila melanura*	118	−0.026	−1.843	1.773	0.311	−1.639	2.333
American Dipper	*Cinclus mexicanus*	238	−0.204	−0.956	0.501	−0.26	−1.186	0.804
Golden-crowned Kinglet	*Regulus satrapa*	1,179	−1.217	−1.925	−0.553	−0.383	−1.341	0.728
Ruby-crowned Kinglet	*Regulus calendula*	1,388	0.38	−0.406	1.081	0.734	−0.236	1.667
Arctic Warbler	*Phylloscopus borealis*	30	–	–	–	−4.765	−8.706	−0.646
Wrentit	*Chamaea fasciata*	170	−0.726	−1.197	−0.263	−0.646	−1.29	0.025
Bluethroat	*Luscinia svecica*	7	–	–	–	4.807	−4.569	16.395
Northern Wheatear	*Oenanthe oenanthe*	4	–	–	–	1.969	−7.931	4.199
Eastern Bluebird	*Sialia sialis*	2,559	1.526	1.319	1.727	1.421	1.134	1.717
Western Bluebird	*Sialia mexicana*	473	0.846	0.087	1.479	1.074	0.21	1.882
Mountain Bluebird	*Sialia currucoides*	870	−0.419	−0.905	0.083	−0.541	−1.14	0.045
Townsend's Solitaire	*Myadestes townsendi*	562	0.573	0.013	1.072	1.076	0.28	1.843
Veery	*Catharus fuscescens*	1,477	−1.157	−1.426	−0.857	−0.872	−1.307	−0.345
Gray-cheeked Thrush	*Catharus minimus*	120	–	–	–	−0.529	−11.191	4.179
Bicknell's Thrush	*Catharus bicknelli*	21	–	–	–	−3.678	−5.569	−2.524
Swainson's Thrush	*Catharus ustulatus*	1,488	−0.692	−1.123	−0.305	0.078	−0.454	0.548
Hermit Thrush	*Catharus guttatus*	1,790	0.34	−0.283	0.879	0.345	−0.598	1.2
Wood Thrush	*Hylocichla mustelina*	2,144	−1.894	−2.051	−1.737	−1.949	−2.16	−1.732
American Robin	*Turdus migratorius*	4,393	0.12	0.028	0.21	0.185	0.022	0.348
Varied Thrush	*Ixoreus naevius*	440	−2.381	−3.097	−1.689	−1.145	−2.018	−0.335
Gray Catbird	*Dumetella carolinensis*	2,942	−0.011	−0.113	0.086	0.288	0.142	0.434
Curve-billed Thrasher	*Toxostoma curvirostre*	226	−1.116	−2.145	−0.199	−0.32	−1.248	0.881
Brown Thrasher	*Toxostoma rufum*	2,802	−1.042	−1.164	−0.93	−0.89	−1.058	−0.724
Long-billed Thrasher	*Toxostoma longirostre*	42	6.245	4.889	7.362	6.415	5.098	7.843
Bendire's Thrasher	*Toxostoma bendirei*	72	−4.019	−5.687	−2.258	−3.068	−5.157	−0.082
California Thrasher	*Toxostoma redivivum*	103	−2.02	−2.052	−1.416	−1.903	−1.928	−1.149
Le Conte's Thrasher	*Toxostoma lecontei*	54	−2.622	−4.057	−0.721	−2.661	−5.523	−0.393
Crissal Thrasher	*Toxostoma crissale*	81	−0.503	−1.233	0.336	0.172	−0.651	1.09
Sage Thrasher	*Oreoscoptes montanus*	461	−1.213	−1.96	−0.463	−1.426	−2.241	−0.546
Northern Mockingbird	*Mimus polyglottos*	2,717	−0.465	−0.638	−0.306	−0.244	−0.426	−0.065
European Starling	*Sturnus vulgaris*	4,223	−1.433	−1.59	−1.295	−1.231	−1.422	−1.057
Eastern Yellow Wagtail	*Motacilla tschutschensis*	13	–	–	–	−4.178	−7.853	−3.359
American Pipit	*Anthus rubescens*	34	–	–	–	1.983	−3.829	7.444
Sprague's Pipit	*Anthus spragueii*	263	−3.064	−4.261	−1.968	−1.764	−3.461	−0.108
Bohemian Waxwing	*Bombycilla garrulus*	117	–	–	–	−4.006	−6.868	−0.942
Cedar Waxwing	*Bombycilla cedrorum*	2,803	0.281	−0.186	0.654	0.197	−0.361	0.691
Phainopepla	*Phainopepla nitens*	196	0.422	−0.976	1.771	1.134	−0.721	3.035
Olive Warbler	*Peucedramus taeniatus*	14	–	–	–	6.198	6.198	6.2
Lapland Longspur	*Calcarius lapponicus*	19	–	–	–	0.423	−2.52	4.189
Chestnut-collared Longspur	*Calcarius ornatus*	231	−4.176	−5.089	−3.293	−4.02	−5.242	−2.75
McCown's Longspur	*Rhynchophanes mccownii*	126	−4.64	−7.157	−2.387	−3.813	−6.953	−1.131
Ovenbird	*Seiurus aurocapilla*	2,030	−0.072	−0.323	0.171	−0.292	−0.672	0.058
Worm-eating Warbler	*Helmitheros vermivorum*	589	0.423	−0.01	1.067	1.209	0.569	2.071
Louisiana Waterthrush	*Parkesia motacilla*	944	0.614	0.25	0.967	1.081	0.643	1.564
Northern Waterthrush	*Parkesia noveboracensis*	1,208	1.021	0.423	1.555	0.996	0.02	1.861
Golden-winged Warbler	*Vermivora chrysoptera*	433	−2.45	−3.166	−1.767	−1.523	−2.763	−0.293
Blue-winged Warbler	*Vermivora cyanoptera*	703	−0.929	−1.468	−0.235	−0.782	−1.647	0.395
Black-and-white Warbler	*Mniotilta varia*	1,806	−0.858	−1.417	−0.414	−0.976	−1.667	−0.364
Prothonotary Warbler	*Protonotaria citrea*	719	−0.978	−1.428	−0.576	−0.634	−1.226	−0.094
Swainson's Warbler	*Limnothlypis swainsonii*	280	1.532	0.454	2.272	2.411	1.467	3.452
Tennessee Warbler	*Oreothlypis peregrina*	721	−0.932	−2.846	0.64	0.571	−3.051	3.871
Orange-crowned Warbler	*Oreothlypis celata*	929	−0.642	−1.25	−0.034	−0.205	−1.269	0.717
Lucy's Warbler	*Oreothlypis luciae*	65	1.073	−0.021	2.171	1.29	0.022	2.648
Nashville Warbler	*Oreothlypis ruficapilla*	1,192	0.002	−0.623	0.609	−0.292	−1.055	0.54
Virginia's Warbler	*Oreothlypis virginiae*	125	−2.598	−5.007	−1.435	−1.654	−2.533	−0.876
Connecticut Warbler	*Oporornis agilis*	245	−1.804	−2.893	−1.324	−1.297	−2.545	−0.715
MacGillivray's Warbler	*Geothlypis tolmiei*	665	−0.896	−1.303	−0.482	−0.881	−1.473	−0.349
Mourning Warbler	*Geothlypis philadelphia*	935	−1.092	−1.875	−0.434	−0.94	−1.924	−0.041
Kentucky Warbler	*Geothlypis formosa*	1,033	−0.933	−1.254	−0.572	−0.287	−0.752	0.244
Common Yellowthroat	*Geothlypis trichas*	3,924	−0.966	−1.149	−0.818	−0.822	−0.999	−0.652
Hooded Warbler	*Setophaga citrina*	971	1.404	1.011	1.827	1.729	1.197	2.329

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APPENDIX. Continued.

			1966–2015			1993–2015		
Common name	Scientific name	*N*	Trend (% change yr^{-1})	2.5%	97.5%	Trend (% change yr^{-1})	2.5%	97.5%
American Redstart	*Setophaga ruticilla*	2,113	−0.303	−0.679	0.042	−0.176	−0.747	0.397
Kirtland's Warbler	*Setophaga kirtlandii*	5	–	–	–	9.273	5.376	22.406
Cape May Warbler	*Setophaga tigrina*	497	−1.097	−3.074	0.72	1.16	−1.465	3.661
Cerulean Warbler	*Setophaga cerulea*	412	−2.716	−3.333	−2.009	−2.521	−3.327	−1.591
Northern Parula	*Setophaga americana*	1,749	1.179	0.886	1.46	2.06	1.706	2.422
Magnolia Warbler	*Setophaga magnolia*	973	0.807	0.312	1.358	1.08	0.358	1.895
Bay-breasted Warbler	*Setophaga castanea*	437	−0.332	−1.881	1.107	1.465	−1.285	4.042
Blackburnian Warbler	*Setophaga fusca*	813	0.306	−0.217	0.751	0.55	−0.155	1.074
Yellow Warbler	*Setophaga petechia*	3,594	−0.581	−0.791	−0.387	−0.02	−0.385	0.357
Chestnut-sided Warbler	*Setophaga pensylvanica*	1,226	−1.053	−1.698	−0.551	−0.622	−1.13	−0.144
Blackpoll Warbler	*Setophaga striata*	354	−4.535	−8.209	−1.716	−3.502	−6.252	−1.488
Black-throated Blue Warbler	*Setophaga caerulescens*	706	1.754	1.176	2.392	2.139	1.267	3.175
Palm Warbler	*Setophaga palmarum*	265	−0.251	−2.654	2.042	4.472	1.445	8.43
Pine Warbler	*Setophaga pinus*	1,412	0.959	0.641	1.27	0.483	0.086	0.872
(Myrtle Warbler) Yellow-rumped Warbler	*Setophaga coronata coronata*	1,911	−0.256	−0.755	0.136	0.016	−0.748	0.695
Yellow-throated Warbler	*Setophaga dominica*	838	1.022	0.594	1.407	1.635	1.108	2.166
Prairie Warbler	*Setophaga discolor*	1,113	−1.778	−2.064	−1.484	−0.961	−1.373	−0.522
Grace's Warbler	*Setophaga graciae*	71	−2.618	−5.063	−1.113	−1.737	−3.791	−0.133
Black-throated Gray Warbler	*Setophaga nigrescens*	396	−1.124	−1.953	−0.487	−1.32	−2.739	−0.412
Townsend's Warbler	*Setophaga townsendi*	351	−0.6	−1.108	−0.079	1.076	0.24	2.248
Hermit Warbler	*Setophaga occidentalis*	163	−0.09	−0.678	0.613	−0.346	−1.076	0.47
Golden-cheeked Warbler	*Setophaga chrysoparia*	10	–	–	–	3.299	3.299	3.3
Black-throated Green Warbler	*Setophaga virens*	1,054	0.295	−0.467	0.823	0.583	0.003	1.224
Canada Warbler	*Cardellina canadensis*	773	−2.192	−2.826	−1.592	−2.064	−2.963	−1.184
Wilson's Warbler	*Cardellina pusilla*	1,166	−1.701	−2.313	−1.158	−0.328	−1.186	0.61
Red-faced Warbler	*Cardellina rubrifrons*	16	–	–	–	−1.07	−1.867	−0.171
Painted Redstart	*Myioborus pictus*	12	–	–	–	0.044	−1.638	2.552
Yellow-breasted Chat	*Icteria virens*	2,016	−0.625	−0.806	−0.447	−0.285	−0.539	−0.024
Olive Sparrow	*Arremonops rufivirgatus*	35	3.291	1.681	4.916	3.371	1.07	6.1
Green-tailed Towhee	*Pipilo chlorurus*	449	−0.353	−0.805	0.127	0.075	−0.477	0.673
Spotted Towhee	*Pipilo maculatus*	1,007	−0.134	−0.608	0.232	−0.132	−0.59	0.32
Eastern Towhee	*Pipilo erythrophthalmus*	2,062	−1.341	−1.471	−1.212	−0.879	−1.055	−0.708
Rufous-crowned Sparrow	*Aimophila ruficeps*	190	−0.941	−1.888	0.049	−1.131	−2.492	0.142
Canyon Towhee	*Melozone fusca*	181	−1.7	−3.011	−0.784	−1.201	−2.256	0.007
California Towhee	*Melozone crissalis*	154	−0.308	−0.706	0.13	−0.251	−0.789	0.363
Abert's Towhee	*Melozone aberti*	36	1.55	−0.373	3.525	1.014	−1.421	3.419
Rufous-winged Sparrow	*Peucaea carpalis*	9	–	–	–	10.181	10.179	10.221
Botteri's Sparrow	*Peucaea botterii*	11	–	–	–	5.281	1.801	5.298
Cassin's Sparrow	*Peucaea cassinii*	348	−0.515	−1.678	0.569	−1.209	−2.629	0.346
Bachman's Sparrow	*Peucaea aestivalis*	249	−3.134	−3.864	−2.516	−2.748	−3.968	−1.731
American Tree Sparrow	*Spizelloides arborea*	84	–	–	–	−1.783	−5.07	1.746
Chipping Sparrow	*Spizella passerina*	3,903	−0.558	−0.834	−0.333	−0.352	−0.818	0.1
Clay-colored Sparrow	*Spizella pallida*	901	−1.091	−1.424	−0.76	−0.774	−1.185	−0.368
Brewer's Sparrow	*Spizella breweri*	689	−0.995	−1.815	−0.239	−1	−2.07	0.029
Field Sparrow	*Spizella pusilla*	2,210	−2.354	−2.513	−2.197	−2.12	−2.359	−1.864
Black-chinned Sparrow	*Spizella atrogularis*	86	−2.028	−3.44	−0.468	−2.122	−4.027	−0.025
Vesper Sparrow	*Pooecetes gramineus*	2,312	−0.861	−1.127	−0.607	−0.501	−0.846	−0.165
Lark Sparrow	*Chondestes grammacus*	1,650	−0.745	−1.143	−0.359	0.027	−0.397	0.466
Black-throated Sparrow	*Amphispiza bilineata*	442	−0.961	−1.722	−0.236	−1.313	−2.486	−0.273
Lark Bunting	*Calamospiza melanocorys*	556	−2.698	−4.623	−1.265	−2.453	−4.401	−0.569
Savannah Sparrow	*Passerculus sandwichensis*	2,465	−1.358	−1.625	−1.09	−1.145	−1.61	−0.644
Grasshopper Sparrow	*Ammodramus savannarum*	2,191	−2.46	−2.97	−2.035	−1.729	−2.342	−1.114
Baird's Sparrow	*Ammodramus bairdii*	227	−2.055	−3.601	−0.623	−2.137	−4.193	−0.077
Henslow's Sparrow	*Ammodramus henslowii*	358	−1.425	−2.387	−0.434	2.77	1.071	4.639
Le Conte's Sparrow	*Ammodramus leconteii*	381	−2.234	−3.763	−0.786	−2.468	−4.21	−0.65
Nelson's Sparrow	*Ammodramus nelsoni*	210	1.482	0.553	2.451	2.304	1.502	3.716
Saltmarsh Sparrow	*Ammodramus caudacutus*	7	–	–	–	0.661	−2.006	7.974
Seaside Sparrow	*Ammodramus maritimus*	26	−0.326	−3.909	3.516	2.816	−2.061	8.905
Fox Sparrow	*Passerella iliaca*	613	−1.228	−2.856	−0.182	1.386	0.089	2.531
Song Sparrow	*Melospiza melodia*	3,413	−0.721	−0.853	−0.597	−0.966	−1.108	−0.823
Lincoln's Sparrow	*Melospiza lincolnii*	1,049	−0.087	−1.131	0.79	−0.02	−1.031	1.021

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APPENDIX. Continued.

Common name	Scientific name	*N*	1966–2015 Trend (% change yr^{-1})	1966–2015 2.5%	1966–2015 97.5%	1993–2015 Trend (% change yr^{-1})	1993–2015 2.5%	1993–2015 97.5%
Swamp Sparrow	*Melospiza georgiana*	1,276	1.067	0.131	1.755	1.292	0.206	2.282
White-throated Sparrow	*Zonotrichia albicollis*	1,131	−0.849	−1.339	−0.416	−1.127	−1.752	−0.546
White-crowned Sparrow	*Zonotrichia leucophrys*	664	−0.286	−1.24	0.249	−0.692	−1.889	0.505
Golden-crowned Sparrow	*Zonotrichia atricapilla*	67	–	–	–	−1.289	−2.683	−0.001
(Slate-colored Junco) Dark-eyed Junco	*Junco hyemalis hyemalis*	1,810	−1.346	−1.725	−0.968	−0.701	−1.489	−0.019
Yellow-eyed Junco	*Junco phaeonotus*	6	–	–	–	−4.899	−4.899	−4.899
Hepatic Tanager	*Piranga flava*	48	3.044	2.192	3.765	3.836	2.759	4.365
Summer Tanager	*Piranga rubra*	1,262	0.241	0.066	0.422	0.556	0.314	0.808
Scarlet Tanager	*Piranga olivacea*	1,763	−0.197	−0.383	−0.011	−0.063	−0.321	0.204
Western Tanager	*Piranga ludoviciana*	992	1.192	0.907	1.466	1.282	0.792	1.79
Northern Cardinal	*Cardinalis cardinalis*	2,449	0.326	0.245	0.407	0.393	0.281	0.506
Pyrrhuloxia	*Cardinalis sinuatus*	137	−1.538	−2.395	−0.696	−1.545	−2.719	−0.477
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	1,749	−0.82	−1.082	−0.564	−0.658	−1.038	−0.292
Black-headed Grosbeak	*Pheucticus melanocephalus*	983	0.549	0.102	0.867	0.854	0.482	1.22
Blue Grosbeak	*Passerina caerulea*	1,729	0.828	0.644	1.018	1.105	0.847	1.366
Lazuli Bunting	*Passerina amoena*	768	0.332	−0.15	0.735	0.845	0.212	1.35
Indigo Bunting	*Passerina cyanea*	2,561	−0.724	−0.81	−0.64	−0.628	−0.745	−0.51
Varied Bunting	*Passerina versicolor*	33	–	–	–	1.049	1.044	1.049
Painted Bunting	*Passerina ciris*	493	−0.09	−0.582	0.383	0.811	0.216	1.439
Dickcissel	*Spiza americana*	1,297	−0.328	−0.759	0.057	−0.078	−0.6	0.429
Bobolink	*Dolichonyx oryzivorus*	1,620	−2.02	−2.358	−1.664	−0.872	−1.363	−0.268
Red-winged Blackbird	*Agelaius phoeniceus*	4,446	−0.952	−1.08	−0.823	−0.645	−0.832	−0.458
Tricolored Blackbird	*Agelaius tricolor*	79	1.803	−1.686	2.909	3.299	−1.131	4.352
Eastern Meadowlark	*Sturnella magna*	2,541	−3.337	−3.65	−3.113	−3.303	−3.551	−3.029
Western Meadowlark	*Sturnella neglecta*	2,095	−1.304	−1.486	−1.127	−1.065	−1.286	−0.837
Yellow-headed Blackbird	*Xanthocephalus xanthocephalu*	1,058	−0.003	−0.789	0.766	0.785	−0.547	2.102
Rusty Blackbird	*Euphagus carolinus*	318	−3.488	−5.449	−1.955	−0.425	−2.67	2.115
Brewer's Blackbird	*Euphagus cyanocephalus*	1,682	−2.111	−2.426	−1.852	−1.593	−1.906	−1.308
Common Grackle	*Quiscalus quiscula*	3,450	−1.747	−1.885	−1.613	−1.548	−1.74	−1.349
Boat-tailed Grackle	*Quiscalus major*	187	−0.99	−1.804	0.154	−0.464	−1.518	0.776
Great-tailed Grackle	*Quiscalus mexicanus*	528	2.166	0.881	3.433	3.312	1.383	5.009
Bronzed Cowbird	*Molothrus aeneus*	123	−0.245	−1.919	1.404	−0.639	−3.356	1.957
Brown-headed Cowbird	*Molothrus ater*	4,427	−0.693	−0.833	−0.552	−0.451	−0.678	−0.223
Orchard Oriole	*Icterus spurius*	2,066	−0.807	−1.048	−0.582	0.21	−0.097	0.527
Hooded Oriole	*Icterus cucullatus*	141	0.875	−0.199	1.619	2.071	0.912	2.864
Bullock's Oriole	*Icterus bullockii*	1,089	−0.568	−0.896	−0.268	−0.189	−0.554	0.213
Spot-breasted Oriole	*Icterus pectoralis*	5	–	–	–	−7.558	−7.558	−7.558
Altamira Oriole	*Icterus gularis*	6	–	–	–	−3.452	−27.657	5.046
Audubon's Oriole	*Icterus graduacauda*	20	–	–	–	3.99	3.99	3.99
Baltimore Oriole	*Icterus galbula*	2,249	−1.361	−1.653	−1.115	−0.935	−1.21	−0.662
Scott's Oriole	*Icterus parisorum*	227	−0.806	−1.606	−0.062	−0.796	−1.815	0.27
Pine Grosbeak	*Pinicola enucleator*	344	−0.992	−3.088	1.303	0.92	−1.759	4.451
House Finch	*Haemorhous mexicanus*	3,088	0.069	−0.414	0.478	−0.641	−1.049	−0.232
Purple Finch	*Haemorhous purpureus*	1,471	−1.249	−1.742	−0.776	−0.735	−1.438	0.198
Cassin's Finch	*Haemorhous cassinii*	468	−2.257	−3.002	−1.466	−2.007	−2.875	−1.156
Red Crossbill	*Loxia curvirostra*	854	−0.081	−1.659	1.272	1.054	−1.173	4.219
White-winged Crossbill	*Loxia leucoptera*	526	2.807	−0.842	6.04	2.981	−4.46	10.919
Common Redpoll	*Acanthis flammea*	144	–	–	–	−2.251	−4.516	−0.091
Hoary Redpoll	*Acanthis hornemanni*	6	–	–	–	33.959	5.51	33.977
Pine Siskin	*Spinus pinus*	1,546	−3.326	−4.628	−2.257	−2.281	−3.92	−0.446
Lesser Goldfinch	*Spinus psaltria*	583	0.984	0.304	1.648	1.807	0.891	2.833
Lawrence's Goldfinch	*Spinus lawrencei*	89	−0.591	−2.294	1.399	0.103	−2.247	3.053
American Goldfinch	*Spinus tristis*	3,426	−0.136	−0.305	0.028	0.044	−0.171	0.259
Evening Grosbeak	*Coccothraustes vespertinus*	1,037	−5.034	−6.387	−3.87	−5.893	−7.381	−4.353
House Sparrow	*Passer domesticus*	3,817	−3.598	−3.757	−3.441	−3.317	−3.53	−3.102
Eurasian Tree Sparrow	*Passer montanus*	41	6.116	4.509	7.234	6.165	4.634	7.542

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