

Decline of the North American Avifauna

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Abstract: Species extinctions have defined the global biodiversity crisis, but extinction begins with loss in abundance of individuals that can result in compositional and functional changes of ecosystems. Using multiple and independent monitoring networks, we report population losses across much of the North American avifauna over 48 years, including once common species and from most biomes. Integration of range-wide population trajectories and size estimates indicates a net loss approaching 3 billion birds, or 29% of 1970 abundance. A continent-wide weather radar network also reveals a similarly steep decline in biomass passage of migrating birds over a recent 10-year period. This loss of bird abundance signals an urgent need to address threats to avert future avifaunal collapse and associated loss of ecosystem integrity, function and services.

One Sentence Summary: Cumulative loss of nearly three billion birds since 1970, across most North American biomes, signals a pervasive and ongoing avifaunal crisis.

Main Text:

5 Slowing the loss of biodiversity is one of the defining environmental challenges of the 21st
century (1–5). Habitat loss, climate change, unregulated harvest, and other forms of human-
caused mortality (6, 7) have contributed to a thousand-fold increase in global extinctions in the
Anthropocene compared to the presumed prehuman background rate, with profound effects on
ecosystem functioning and services (8). The overwhelming focus on species extinctions,
10 however, has underestimated the extent and consequences of biotic change, by ignoring the loss
of abundance within still-common species and in aggregate across large species assemblages (2,
9). Declines in abundance can degrade ecosystem integrity, reducing vital ecological,
evolutionary, economic, and social services that organisms provide to their environment (8, 10–
15). Given the current pace of global environmental change, quantifying change in species
abundances is essential to assess ecosystem impacts. Evaluating the magnitude of declines
requires effective long-term monitoring of population sizes and trends, data which are rarely
available for most taxa.

Birds are excellent indicators of environmental health and ecosystem integrity (16, 17), and our
ability to monitor many species over vast spatial scales far exceeds that of any other animal
group. We evaluated population change for 529 species of birds in the continental United States
and Canada (76% of breeding species), drawing from multiple standardized bird-monitoring
20 datasets, some of which provide close to fifty years of population data. We integrated range-wide
estimates of population size and 48-year population trajectories, along with their associated
uncertainty, to quantify net change in numbers of birds across the avifauna over recent decades
(18). We also used a network 143 weather radars (NEXRAD) across the contiguous U.S. to
estimate long-term changes in nocturnal migratory passage of avian biomass through the airspace
25 in spring from 2007 to 2017. The continuous operation and broad coverage of NEXRAD provide
an automated and standardised monitoring tool with unrivaled temporal and spatial extent (19).
Radar measures cumulative passage across all nocturnally migrating species, many of which
breed in areas north of the contiguous U.S. that are poorly monitored by avian surveys. Radar
thus expands the area and the proportion of the migratory avifauna that is sampled relative to
30 ground surveys.

Results from long-term surveys, accounting for both increasing and declining species, reveal a
net loss in total abundance of 2.9 billion (95% CI = 2.7–3.1 billion) birds across almost all
biomes, a reduction of 29% (95% CI = 27–30%) since 1970 (Figure 1; Table 1). Analysis of
NEXRAD data indicate a similarly steep decline in nocturnal passage of migratory biomass, a
35 reduction of $13.6 \pm 9.1\%$ since 2007 (Figure 2A). Reduction in biomass passage occurred across
the eastern U.S. (Figure 2 C,D), where migration is dominated by large numbers of temperate-
and boreal-breeding songbirds; we observed no consistent trend in the Central or Pacific flyway
regions (Figure 2B,C,D, Table S5). Two completely different and independent monitoring
techniques thus signal major population loss across the continental avifauna.

40 Species exhibiting declines (57%, 303/529) based on long-term survey data span diverse
ecological and taxonomic groups. Across breeding biomes, grassland birds showed the largest
magnitude of total population loss since 1970—more than 700 million breeding individuals
across 31 species—and the largest proportional loss (53%); 74% of grassland species are
declining. (Figure 1; Table 1). All forest biomes experienced large avian loss, with a cumulative
45 reduction of more than 1 billion birds. Wetland birds represent the only biome to show an overall

net gain in numbers (13%), led by a 56% increase in waterfowl populations (Figure 3, Table 1). Surprisingly, we also found a large net loss (63%) across 10 introduced species (Figure 3D,E, Table 1).

5 A total of 419 native migratory species experienced a net loss of 2.5 billion individuals, whereas 100 native resident species showed a small net increase (26 million). Species overwintering in temperate regions experienced the largest net reduction in abundance (1.4 billion), but proportional loss was greatest among species overwintering in coastal regions (42%), southwestern aridlands (42%), and South America (40%) (Table 1; Figure S1). Shorebirds, most of which migrate long distances to winter along coasts throughout the hemisphere, are
10 experiencing consistent, steep population loss (37%).

More than 90% of the total cumulative loss can be attributed to 12 bird families (Figure 3A), including sparrows, warblers, blackbirds, and finches. Of 67 bird families surveyed, 38 showed a net loss in total abundance, whereas 29 showed gains (Figure 3B), indicating recent changes in avifaunal composition (Table S2). While not optimized for species-level analysis, our model
15 indicates 19 widespread and abundant landbirds (including 2 introduced species) each experienced population reductions of >50 million birds (Data S1). Abundant species also contribute strongly to the migratory passage detected by radar (19), and radar-derived trends provide a fully independent estimate of widespread declines of migratory birds.

Our study documents a long-developing but overlooked biodiversity crisis in North America—
20 the cumulative loss of nearly 3 billion birds across the avifauna. Population loss is not restricted to rare and threatened species, but includes many widespread and common species that may be disproportionately influential components of food webs and ecosystem function. Furthermore, losses among habitat generalists and even introduced species indicate that declining species are not replaced by species that fare well in human-altered landscapes. Increases among waterfowl
25 and a few other groups (e.g. raptors recovering after the banning of DDT) are insufficient to offset large losses among abundant species (Figure 3). Importantly, our population loss estimates are conservative since we estimated loss only in breeding populations. The total loss and impact on communities and ecosystems could be even higher outside the breeding season if we consider the amplifying effect of “missing” reproductive output from these lost breeders.

30 Extinction of the Passenger Pigeon (*Ectopistes migratorius*), once likely the most numerous bird on the planet, provides a poignant reminder that even abundant species can go extinct rapidly. Systematic monitoring and attention paid to population declines could have alerted society to its pending extinction (20). Today, monitoring data suggest that avian declines will likely continue without targeted conservation action, triggering additional endangered species listings at
35 tremendous financial and social cost. Moreover, because birds provide numerous benefits to ecosystems (e.g., seed dispersal, pollination, pest control) and economies (47 million people spend 9.3 billion U.S. dollars per year through bird-related activities in the U.S. (21)), their population reductions and possible extinctions will have severe direct and indirect consequences (10, 22). Population declines can be reversed, as evidenced by the remarkable recovery of
40 waterfowl populations under adaptive harvest management (23) and the associated allocation of billions of dollars devoted to wetland protection and restoration, providing a model for proactive conservation in other widespread native habitats such as grasslands.

Steep declines in North American birds parallel patterns of avian declines emerging globally (14, 15, 22, 24). In particular, depletion of native grassland bird populations in North America, driven by habitat loss and more toxic pesticide use in both breeding and wintering areas (25), mirrors loss of farmland birds throughout Europe and elsewhere (15). Even declines among introduced species match similar declines within these same species' native ranges (26). Agricultural intensification and urbanization have been similarly linked to declines in insect diversity and biomass (27), with cascading impacts on birds and other consumers (24, 28, 29). Given that birds are one of the best monitored animal groups, birds may also represent the tip of the iceberg, indicating similar or greater losses in other taxonomic groups (28, 30).

Pervasiveness of avian loss across biomes and bird families suggests multiple and interacting threats. Isolating spatio-temporal limiting factors for individual species and populations will require additional study, however, since migratory species with complex life histories are in contact with many threats throughout their annual cycles. A focus on breeding season biology hampers our ability to understand how seasonal interactions drive population change (31), although recent continent-wide analyses affirm the importance of events during the non-breeding season (19, 32). Targeted research to identify limiting factors must be coupled with effective policies and societal change that emphasize reducing threats to breeding and non-breeding habitats and minimizing avoidable anthropogenic mortality year-round. Endangered species legislation and international treaties, such as the 1916 Migratory Bird Treaty between Canada and the United States, have prevented extinctions and promoted recovery of once-depleted bird species. History shows that conservation action and legislation works. Our results signal an urgent need to address the ongoing threats of habitat loss, agricultural intensification, coastal disturbance, and direct anthropogenic mortality, all exacerbated by climate change, to avert continued biodiversity loss and potential collapse of the continental avifauna.

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Competing interests: Authors declare no competing interests.

Data and materials availability: All data and software are archived and available on Zenodo (DOI 10.5281/zenodo.3218403, 10.5281/zenodo.3369999, 10.5281/zenodo.3370005), and will

be published in future versions of the Avian Conservation Assessment Database
(<http://pif.birdconservancy.org/ACAD/>).

Supplementary Materials:

Materials and Methods

5 Figures S1-S7

Tables S1-S5

External Databases S1-S2

References (33-100)

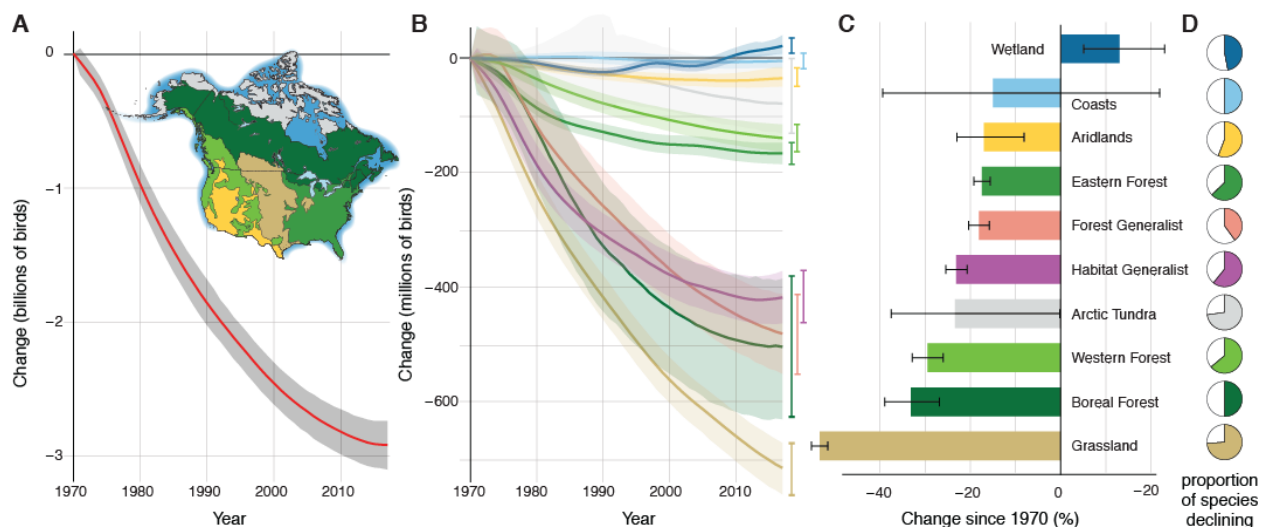


Fig. 1. Net population change in North American birds. (A) By integrating population size estimates and trajectories for 529 species (18), we show a net loss of 2.9 billion breeding birds across the continental avifauna since 1970. Gray shading represents ± 95% credible intervals around total estimated loss. Map shows color-coded breeding biomes based on Bird Conservation Regions and land cover classification (18). **(B)** Net loss of abundance occurred across all major breeding biomes except wetlands (see Table 1). **(C)** Proportional net population change relative to 1970, ±95% C.I. **(D)** Proportion of species declining in each biome.

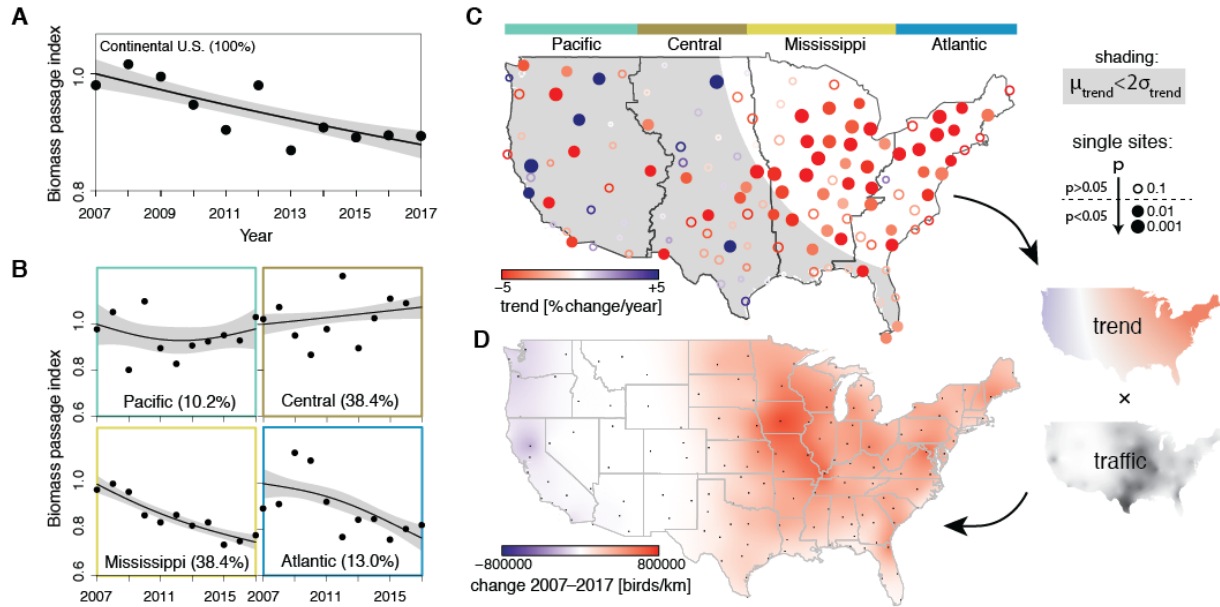


Fig. 2. NEXRAD radar monitoring of nocturnal bird migration across the contiguous U.S.

(A) Annual change in biomass passage for the full continental U.S. (black) and (B) the Pacific (green), Central (brown), Mississippi (yellow), and Atlantic (blue) flyways (borders indicated in panel C), with percentage of total biomass passage (migration traffic) for each flyway indicated; Declines are significant only for the full U.S. and the Mississippi and Atlantic flyways (Table S3-5). (C) Single-site trends in seasonal biomass passage at 143 NEXRAD stations in spring (1 Mar – 1 Jul), estimated for the period 2007-2017. Darker red colors indicate higher declines and loss of biomass passage, while blue colors indicate biomass increase. Circle size indicates trend significance, with closed circles being significant at a 95% confidence level. Only areas outside gray shading have a spatially consistent trend signal separated from background variability. (D) 10-year cumulative loss in biomass passage, estimated as the product of a spatially-explicit (generalized additive model) trend, times the surface of average cumulative spring biomass passage.

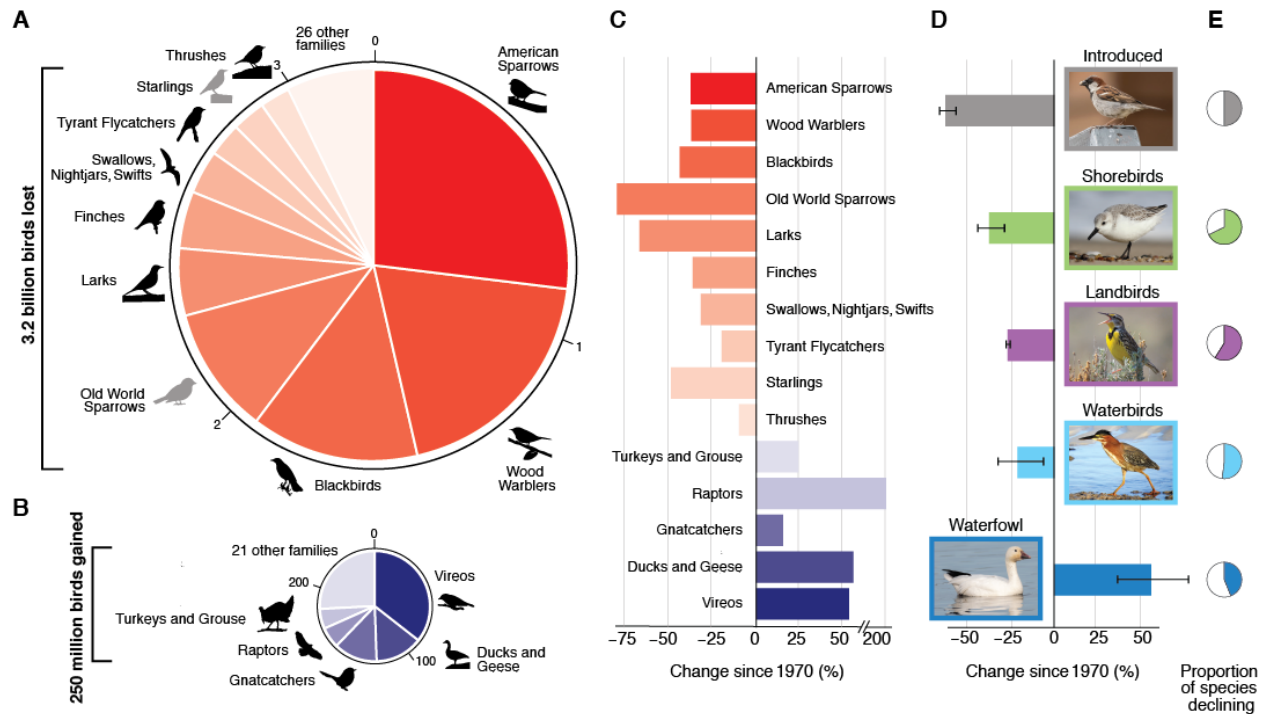


Fig. 3. Gains and losses across the North American avifauna over the last half

century. (A) Bird families were categorized as having a net loss (red) or gain (blue). Total loss of 3.2 billion birds occurred across 38 families; each family with losses greater than 50 million individuals is shown as a proportion of total loss, including two introduced families (gray). Swallows, nightjars, and swifts together show loss within the aerial insectivore guild. **(B)** 29 families show a total gain of 250 million individual birds; the five families with gains greater than 15 million individuals are shown as a proportion of total gain. Four families of raptors are shown as a single group. Note that combining total gain and total loss yields a net loss of 2.9 billion birds across the entire avifauna. **(C)** For each individually represented family in B and C, proportional population change within that family is shown. See Table S2 for statistics on each individual family. **(D)** *Left*, proportion of species with declining trends and, *Right*, percentage population change among introduced and each of four management groups (18). A representative species from each group is shown (top to bottom, house sparrow, *Passer domesticus*;

sanderling, *Calidris alba*; western meadowlark, *Sturnella neglecta*; green heron, *Butorides virescens*; and snow goose, *Anser caerulescens*).

Species Group	Number of Species	Net Abundance Change (Millions) & 95% CI			Percent Change & 95% CIs			Proportion Species in Decline
		Change	LC95	UC95	Change	LC95	UC95	
Species Summary								
All N. Am. Species	529	-2,911.9	-3,097.5	-2,732.9	-28.8%	-30.2%	-27.3%	57.3%
All Native Species	519	-2,521.0	-2,698.5	-2,347.6	-26.5%	-28.0%	-24.9%	57.4%
Introduced Species	10	-391.6	-442.3	-336.6	-62.9%	-66.5%	-56.4%	50.0%
Native Migratory Species	419	-2,547.7	-2,723.7	-2,374.5	-28.3%	-29.8%	-26.7%	58.2%
Native Resident Species	100	26.3	7.3	46.9	5.3%	1.4%	9.6%	54.0%
Landbirds	357	-2,516.5	-2,692.2	-2,346.0	-27.1%	-28.6%	-25.5%	58.8%
Shorebirds	44	-17.1	-21.8	-12.6	-37.4%	-45.0%	-28.8%	68.2%
Waterbirds	77	-22.5	-37.8	-6.3	-21.5%	-33.1%	-6.2%	51.9%
Waterfowl	41	34.8	24.5	48.3	56.0%	37.9%	79.4%	43.9%
Aerial Insectivores	26	-156.8	-183.8	-127.0	-31.8%	-36.4%	-26.1%	73.1%
Breeding Biome								
Grassland	31	-717.5	-763.9	-673.3	-53.3%	-55.1%	-51.5%	74.2%
Boreal forest	34	-500.7	-627.1	-381.0	-33.1%	-38.9%	-26.9%	50.0%
Forest Generalist	40	-482.2	-552.5	-413.4	-18.1%	-20.4%	-15.8%	40.0%
Habitat Generalist	38	-417.3	-462.1	-371.3	-23.1%	-25.4%	-20.7%	60.5%
Eastern Forest	63	-166.7	-185.8	-147.7	-17.4%	-19.2%	-15.6%	63.5%
Western forest	67	-139.7	-163.8	-116.1	-29.5%	-32.8%	-26.0%	64.2%
Arctic Tundra	51	-79.9	-131.2	-0.7	-23.4%	-37.5%	-0.2%	56.5%
Aridlands	62	-35.6	-49.7	-17.0	-17.0%	-23.0%	-8.1%	56.5%
Coasts	38	-6.1	-18.9	8.5	-15.0%	-39.4%	21.9%	50.0%
Wetlands	95	20.6	8.3	35.3	13.0%	5.1%	23.0%	47.4%
Nonbreeding Biome								
Temperate North America	192	-1,413.0	-1,521.5	-1,292.3	-27.4%	-29.3%	-25.3%	55.2%
South America	41	-537.4	-651.1	-432.6	-40.1%	-45.2%	-34.6%	75.6%
Southwestern Aridlands	50	-238.1	-261.2	-215.6	-41.9%	-44.5%	-39.2%	74.0%
Mexico-Central America	76	-155.3	-187.8	-122.0	-15.5%	-18.3%	-12.6%	52.6%
Widespread Neotropical	22	-126.0	-171.2	-86.1	-26.8%	-33.4%	-19.3%	45.5%
Widespread	60	-31.6	-63.1	1.6	-3.7%	-7.4%	0.2%	43.3%
Marine	26	-16.3	-29.7	-1.2	-30.8%	-49.1%	-2.5%	61.5%
Coastal	44	-11.0	-14.9	-6.7	-42.0%	-51.8%	-26.7%	68.2%
Caribbean	8	-6.0	1.4	-15.7	12.1%	-2.8%	31.7%	25.0%

Table 1. Net change in abundance across the North American avifauna, 1970-2017. Species are grouped into native and introduced species, management groups (landbirds, shorebirds, waterbirds, waterfowl), major breeding biomes, and nonbreeding biomes (see Data S1 in (18) for

5

assignments and definitions of groups and biomes). Net change in abundance is expressed in millions of breeding individuals, with upper and lower 95% credible intervals (CI) shown. Percentage of species in each group with negative trend trajectories are also noted. Rows colored in red indicate declines and loss; blue rows indicate gains.

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Science



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Supplementary Materials for

Decline of the North American Avifauna

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This PDF file includes:

- Materials and Methods
- Figs. S1 to S7
- Tables S1 to S5
- Caption for Data S1
- Caption for Data S2

Other Supplementary Materials for this manuscript include the following:

- Data S1
- Data S2

27 **Materials and Methods**

28

29 General approach to estimating long-term net population change

30 We compiled estimates of long-term population change and current population size for
31 529 species from a variety of sources (Table S1), as described below. For every species, we
32 selected the most appropriate data sources and assessed the quality of population size and change
33 estimates, based on sampling methodology, range coverage, and precision of the estimates. Our
34 primary source of population change estimates was the North American Breeding Bird Survey
35 (BBS) (33), which provides conservation assessment information for hundreds of bird species
36 (34). For our current analysis we relied on the full trajectory of population change for each
37 species, which we define as the scaled time-series of annual population indices derived from the
38 underlying trend model. Note that using the full trajectory provides much more information on
39 population change than the simple trend value (% change/yr) usually associated with survey data.
40 We used Partners in Flight's (PIF) recently published population size estimates for North
41 American landbirds (35), and we supplemented these with data from several other surveys (Table
42 S1). Values for all U.S./Canada population size estimates, along with their sources, are provided
43 in Data S1.

44 After compiling population size and trajectory estimates for all species (Data S1), we
45 integrated these into a single hierarchical Bayesian model that estimates the full time-series
46 (1970-2017) of population sizes for each species and for the overall avifauna. Because some
47 species are better monitored than others, the precision of estimates varied greatly among species
48 (Data S1). To reduce the effects of imprecise species-level estimates on our overall estimates of
49 population change, our model included a hierarchical structure that allowed for estimation of
50 composite change based on shrinkage estimators, in which imprecise species results are shrunk
51 toward species-group means based on common ecological biomes in which they breed and
52 overwinter (see below). For summaries, estimates of net population change were computed for
53 four general management categorizations (shorebirds, landbirds, waterbirds, waterfowl),
54 taxonomic families, and breeding and nonbreeding biomes.

55 Our hierarchical model of composite change is similar in concept to the bird-group
56 indicator models used to summarize the status of major bird groups at a national level in recent
57 State of the Birds reports in Canada and the United States (36, 37). These indicator models
58 estimate an average population trajectory with respect to a base-year, across species in a group.
59 To this basic group-level model, we added 4 major components: (1) we added a non-parametric
60 smooth to each species estimated population trajectory, accounting for the uncertainty of each
61 annual value, to emphasize the medium- and long-term changes in species populations and
62 reduce the effects of annual fluctuations; (2) we added a second layer to the hierarchical structure
63 to account for influences on each species population trajectory from across the full annual cycle
64 (both nonbreeding and breeding biome); (3) we used the species-level predictions, instead of the
65 group-level trajectories summarized for the State of the Birds reports, as improved estimates of a
66 species population trajectory; and (4) we integrated these improved species trajectories with the
67 species-level population size estimates, to sample the full posterior distribution of population
68 change estimates for each species. The model, an R-script to run it, and all of the original data are
69 available on GitHub (https://github.com/AdamCSmithCWS/Rosenberg_et_al).

70 Data included in the modeling were (1) species (s) population indices by year (y) and
71 associated variances ($\hat{I}_{s,y}, \hat{\sigma}_{s,y}^2$); (2) species population size estimates and associated variances
72 ($\hat{n}_s, \sigma_{n_s}^2$); (3) year(s) in which each species population size was estimated (e.g., most PIF

73 population estimates represent the species mean population size in the years 2006-2015; ($K_s =$
74 $10, k_s = 2006 - 2015$); and (4) information regarding wintering region and breeding biome
75 associations for each species (w = wintering region, b = breeding biome).

76

77 Non-parametric smoothing of species' trajectories, centering, and missing data

78 We used a generalized additive model (GAM) to smooth each species population
79 trajectory ($\hat{i}_{s,y}, \hat{\sigma}_{s,y}^2$) before including them in the main model, similar to (38). The GAM smooth
80 allowed us to accommodate the wide variation in the underlying population trajectory data and
81 models across the various datasets; for example, some species trajectories have gaps in the time-
82 series when data were not available in a particular year, but were available before and after, and
83 other trajectories are derived from models that allow annual values to fluctuate completely
84 independently, leading to extreme annual fluctuations in relation to other species. Modeling each
85 species trajectory with a flexible smoother retains the most important medium- and long-term
86 patterns in the species' population, and reconciles the level of annual variation among species.
87 We used the R-package *mgcv* (39) to smooth each species trajectory, using a hierarchical
88 Bayesian GAM that accounted for the uncertainty of each annual index in the trajectory to model
89 most species, and for the few species where published estimates of uncertainty were not
90 available (N = 3, Trumpeter Swan, Emperor Goose, and American Woodcock), we used a
91 simpler non-Bayesian GAM function from the same package.

92 The annual predictions from the GAM smooth ($i_{s,y}, \sigma_{s,y}^2$) for each species and from each
93 data-source were in different units, e.g., BBS estimates are scaled to the number of birds seen on
94 a single route and CBC estimates are scaled to the number observed in an average count-circle.
95 To allow for the hierarchical structure of the model that pools information across groups of
96 species (e.g., grassland birds that winter in Mexico), each species' trajectory was re-scaled to a
97 common base-year (1970) and log-transformed.

98

$$99 \quad \hat{\theta}_{s,y} = \ln \left(\frac{i_{s,y}}{i_{s,1970}} \right)$$

100

101 Where, $\hat{\theta}_{s,y}$ is the log-transformed standardized annual estimate for year y and species s
102 ($i_{s,y}$) and represents the status of the species in year-y, as a proportion of the original estimate in
103 the base-year, 1970 ($i_{s,1970}$). We calculated the variance of $\hat{\theta}_{s,y}$ as the log transformation of the
104 variance of a ratio of two random variables (Cochran 1977, pg. 183), making the simplifying
105 assuming that the annual estimates are independent in time. We acknowledge that this
106 assumption of independent estimates in time is certainly invalid for adjacent years, but becomes
107 more plausible as length of the time-series increases

108

$$109 \quad \sigma_{\hat{\theta}_{s,y}}^2 = \ln \left(1 + \frac{\sigma_{i_{s,y}}^2}{i_{s,y}^2} + \frac{\sigma_{i_{s,1970}}^2}{i_{s,1970}^2} \right)$$

110

111 For 8% of species (43), population trajectories spanning 1970-2017 were not available.
112 About half have data-sources that started in the early 1970s and most of the remainder have
113 trajectories starting in the 1990s. In these cases, we assumed that the population did not change
114 during the missing years. Years with missing trajectory information at the beginning of the time-
115 series (e.g., no data before 1993 for some boreal species monitored by the BBS) were given

116 values equal to the first year with data (i.e. a conservative assumption of no overall change) but
 117 we increased the estimated variance ($\sigma_{\hat{\theta}_{s,y}}^2$) by the square of the number of years since non-
 118 missing data, so that these imputed data would have little overall effect on the final results. For
 119 these species and years, because of the extremely high variance and the hierarchical structure of
 120 the model, the modeled population trajectories and the annual number of birds were almost
 121 entirely determined by the group-level mean trajectories for the other species sharing the same
 122 wintering region and breeding biome.

123
 124 The primary model: population trajectories accounting for nonbreeding and breeding biome

125 Each species' estimated status in a given year ($\hat{\theta}_{s,y}$) was treated as a normal random
 126 variable with mean $\theta_{s,y}$ and a variance estimated from the species data ($\sigma_{\hat{\theta}_{s,y}}^2$).

127
 128
$$\hat{\theta}_{s,y} \sim N(\theta_{s,y}, \sigma_{\hat{\theta}_{s,y}}^2)$$

129 The the species status parameter $\theta_{s,y}$ was assumed to be normally distributed, governed
 130 by a hyperparameter ($\mu_{w,b,y}$) with year-specific variance ($\sigma_{\mu_y}^2$),

131
$$\theta_{s,y} \sim N(\mu_{w,b,y}, \sigma_{\mu_y}^2)$$

132
 133 representing mean status for all species with the same combination of wintering range
 134 and breeding biome (e.g., all species that winter in South American and breed in the boreal
 135 forest). This structure has the effect of shrinking each species population trajectory towards the
 136 mean trajectory for species in the same nonbreeding-by-breeding group. The mean trajectories
 137 for each group ($\mu_{w,b,y}$) were estimated using an additive sub-model that combined the effects of
 138 nonbreeding and breeding biomes. The biome-level components of the additive model were
 139 estimated using random-walk time-series for the effects of nonbreeding biomes ($\omega_{w,y}$) and
 140 breeding biomes ($\beta_{b,y}$).

141
$$\mu_{w,b,y} = \omega_{w,y} + \beta_{b,y}$$

142
 143
$$\omega_{w,y} = N(\omega_{w,y-1}, \sigma_{\omega_w}^2)$$

 144
$$\omega_{w,1970} = 0$$

145
 146
$$\beta_{b,y} = N(\beta_{b,y-1}, \sigma_{\beta_y}^2)$$

 147
$$\beta_{b,1970} = 0$$

 148
 149

150 The random-walk structure has the effect of slightly smoothing large annual fluctuations
 151 in the wintering-group annual means, while also allowing for non-linear temporal changes across
 152 the 48-year time series.

153
 154 Integrating the population sizes and population trajectories

155
 156 Each species' population size estimate was incorporated in the model as the mean (\hat{n}_s) and
 157 variance ($\sigma_{n_s}^2$) of a normal distribution. Random draws from those distributions (n_s) allowed the
 158 model to incorporate the uncertainty around each species' population estimate. We used the

159 estimated population sizes and the population trajectories during the relevant years represented by
 160 each species' population estimate to calculate a scaling factor (ψ_s) that allowed us to re-scale the
 161 species estimated population trajectory (θ_{s,y_i}) to an estimated number of birds in each year of the
 162 time-series ($v_{s,y}$). Each population estimate was related to a specific year or range of years; e.g.,
 163 all PIF population estimates reflect the species' mean population size between 2006 and 2015
 164 ($K_s = 10, k = 2006 - 2015$). We estimated the scaling factors by averaging the ratio across the
 165 relevant span of years, with $K_s = 3$ as a minimum in a few cases where the species' estimated
 166 population reportedly related to a single year.
 167

$$\psi_s = \frac{\sum_{y_i}^{y_k} \left(\frac{n_s}{\exp(\theta_{s,y_i})} \right)}{K_s}$$

$$v_{s,y} = \psi_s * \theta_{s,y}$$

172 All precision parameters were given diffuse gamma prior distributions, with scale and
 173 shape parameters set to 0.001. Formal measures of model fit are difficult to implement for complex
 174 hierarchical models, and are generally not presented for analyses of complex surveys (40). We
 175 used graphical comparisons between data and predictions (see additional figures available in the
 176 data and code repository) to ensure there was no important lack of fit between the model and the
 177 data.
 178

179 Annual number of birds and overall population change

180 We calculated the overall population change by species (λ_s) using the posterior distribution
 181 of the difference between the estimated number of birds in 1970 and the number in 2017. We
 182 calculated the estimated number of birds in the North American avifauna for each year (N_y) using
 183 the posterior distribution of the annual sums of all species estimates. We calculated the overall net
 184 change in the North American avifauna using the posterior distribution of the sum of the species-
 185 level change estimates (Λ). Estimates of the annual number of birds (N_y) and overall change (Λ)
 186 by family, nonbreeding biome (Figure S1), breeding biome (Figure 1A), and combinations of
 187 nonbreeding and breeding biome (Figure S2) were made from the posterior distribution of group-
 188 level summaries across all S-species in a group.
 189

$$\lambda_s = v_{s,1970} - v_{s,2017}$$

$$N_y = \sum_{s_i}^S (v_{s,y})$$

$$\Lambda = \sum_{s_i}^S (\lambda_s)$$

194 Sources of Population Trajectories for North American Birds

195 We compiled long term population trajectories for 529 species, based on the best available
 196 survey data for each species (Table S1; see Data S1 for species-specific information). We note that
 197 this compilation reflects standard data sources used by North American bird conservation and
 198 management (23, 36, 41–45). We are fortunate that standardized, long-term survey data exist for
 199 a majority of North American bird species, perhaps the best-monitored group of organisms

200 globally. We used trajectory estimates based on surveys of breeding populations whenever
201 possible; however not all species are well-monitored during the breeding season, and for 18% of
202 species we relied on surveys from migration periods or winter (Table S1). In all cases, trajectories
203 and population estimates for each species were calculated from data during the same season (i.e.,
204 breeding to breeding, winter to winter). We could not find credible surveys for estimation of
205 continent-scale trajectories for oceanic birds, many coastal-nesting seabirds, and other rare,
206 secretive, range-restricted or nocturnal species. However, our synthesis includes 76% of species
207 that breed regularly in the continental U.S. and Canada (46), and these species likely account for
208 95%-99% of total breeding abundance across the North American avifauna (i.e., most species
209 omitted have very small populations in the U.S. and Canada).

210 For 434 species (82% of 529 species considered) we used trajectories from BBS data, most
211 of which are updated annually and publicly available at <https://www.mbr-pwrc.usgs.gov/>. For
212 species surveyed by the BBS, a hierarchical model (47) was used to estimate annual indices of
213 abundance. In our hierarchical analysis, annual indices are based on regional fits within states and
214 provinces that are weighted by area and local abundance to accommodate differences in population
215 sizes among strata. For a majority of species (415) we used data from the ‘core’ BBS area from
216 1970-2017, based on road-based survey routes in the contiguous U.S. and southern Canada. For
217 19 species with restricted or northern breeding distributions (See Data S1), we used data from an
218 expanded analysis beginning in 1993, including additional BBS routes in Alaska and northern
219 Canada (48). The proportion of each species’ breeding range covered by the BBS is provided in
220 (33), and all metadata and data are available (<https://www.pwrc.usgs.gov/bbs/>).

221 Potential limitations or biases in BBS trends (overall rates of change across the trajectories)
222 have been extensively examined and documented (e.g., (33, 49)). In general, there is no evidence
223 to suggest that estimates of population trends from the BBS are systematically biased across large
224 spatial areas or across many species. Published studies that have examined the potential roadside
225 bias in BBS trends have found that the magnitudes of bias in the sampling of habitat-change are
226 generally small, e.g. (50–53), that potential biases vary in space (e.g., contrasting biases in the
227 regions used in (54), or in (55)), and that they vary among species (i.e., if biases exist, some
228 species’ trends may be underestimated and others overestimated, e.g., (55, 56)). Overall, BBS
229 routes survey a reasonably representative sample of the overall habitat in the landscape at the broad
230 spatial and temporal scales, for which the BBS was designed (50).

231 National Audubon Society Christmas Bird Counts (57) provided trajectory data for 58
232 species; these are primarily species that breed in northern regions not surveyed by the BBS, but
233 are encountered in CBCs because they spend the non-breeding season primarily within the U.S.
234 and southern Canada. The CBC protocols are less standardized than BBS, but annual winter-season
235 counts in fixed 15-mile diameter circles cover a large portion of the U.S. and Canada, especially
236 in coastal regions. Trajectories from CBC data were estimated using a hierarchical model that
237 controlled for effort (57). Annual indices to compute trajectories from the CBC for the 1970-2017
238 period were provided to us by Tim Meehan (National Audubon).

239 Trajectories for 20 species of long-distance migrant shorebirds came from an analysis of
240 migration monitoring surveys carried out across Canada and the United States (58, 59). The
241 shorebird migration surveys used here are part of the International Shorebird Survey, coordinated
242 by Manomet, and the Atlantic Canada and Ontario Shorebird Surveys, coordinated by
243 Environment and Climate Change Canada. Volunteers carry out surveys every 10 days in spring
244 and fall, at sites distributed across Canada and the United States but concentrated primarily in the
245 eastern half of the continent. Analyses of shorebird trajectories from fall count data, 1974-2016,

246 were carried out using hierarchical Bayesian models similar to those used for the BBS (47), with
247 an additional General Additive Model (GAM) component to describe variation in birds' abundance
248 during the period of migratory passage. The model assumes that counts follow an overdispersed
249 Poisson distribution, and includes terms for a long-term, log-linear trend, year-effects and site-
250 level abundance. Sites were grouped into biologically relevant regions, and trend terms within
251 each region were estimated as hierarchical random effects distributed around a mean, continental
252 trend. Methods and survey coverage are described in more detail at wildlife-
253 species.canada.ca/bird-status (<https://tinyurl.com/yak95ssn>). For one shorebird species, American
254 Woodcock, we made use of Singing-ground Survey estimates from the 2017 American Woodcock
255 Status report (60).

256 For nine species of intensely managed waterfowl we relied on trajectory data from the U.S.
257 Fish and Wildlife Service (USFWS) (61), and trajectories for nine additional waterfowl species
258 came from other species-specific sources (see Table S1, Data S1). Trajectories for many waterfowl
259 species were computed using population estimates from Spring Breeding Ground Surveys, which
260 use a combination of aerial and ground-based counts in late spring, covering 2.0 million square
261 miles in Alaska, Canada, and the northern U.S. (Table c3 in (61)). For a small subset of species,
262 we employed other sources of trajectory information where this resulted in better coverage of
263 North American populations, and/or more current information. For all goose species we relied on
264 estimated trajectories from the same sources of information on population trends reported for
265 North American goose populations by Fox and Leafloor (62); these sources represent the most
266 appropriate survey for each species as determined by experts on goose populations. Finally, for
267 Trumpeter Swans we relied on values in the 2015 North American Trumpeter Swan Survey report
268 (63).

269 Sources of Population Size Estimates and Variances

271 We relied on the best available data sources and published estimates of North American
272 breeding population size and variance for all species with credible data (Table S1; Data S1). The
273 largest source of population estimates for our current analysis (65% of species) was the recently
274 published PIF estimates for 344 landbird species (35). The PIF estimates were based on
275 extrapolations from BBS count data from 2006-2015, using previously described methods (64-
276 67). Averaged annual BBS counts were converted to a regional (landscape-scale) abundance
277 estimate through the application of detectability adjustment factors for time-of-day, detection
278 distance, and likelihood of both members of a pair being detected on BBS routes, and extrapolation
279 from BBS count area to area of the region. These regional estimates are calculated for each state,
280 province and territory portion of each Bird Conservation Region (BCR), and then summed across
281 regions to derive U.S.-Canada population estimates. Estimates incorporated uncertainty in the
282 estimation components, resulting in confidence bounds around the final estimates (35). Population
283 estimates are therefore adjusted for detection, account for variation in relative abundance across
284 the species' range, and are accompanied by a measure of uncertainty. This approach to estimation
285 of total population size has been widely adopted in conservation planning (35), and is considered
286 to be conservative, likely underestimating true population size due to sampling concerns associated
287 with BBS data (67).

288 The PIF methods for estimating population size have historically been applied only to
289 landbirds (41, 42). For this analysis, we determined that the BBS also provides adequate survey
290 coverage for 46 waterbirds, and 6 waterfowl that otherwise were lacking useful population
291 estimates (see Data S1 for sources by species), and we applied the PIF approach for calculating

292 population size estimates to data for these species. Adjustment factors used in the estimation of
293 U.S.-Canada population sizes for the current analysis, based on BBS relative abundances, are
294 provided in Table S2. More details on the use of adjustment factors and their ranges of uncertainty
295 for landbirds can be found in (35).

296 Estimates of population size for many shorebirds and waterfowl came from published
297 sources that rely on other surveys. Estimates for 12 waterfowl species were from the 2017 USFWS
298 Waterfowl Status Report (61) (7 species from traditional area surveys, 2 from eastern survey area,
299 2 summed from traditional and eastern surveys, and 1 from western survey area) – for these
300 species, we used an average of published estimates across the last 5 years (2013-2017) to smooth
301 out annual variance in population sizes. Estimates for 14 additional waterfowl species were based
302 on a 2007 Seaduck Joint Venture Report (68). All 45 shorebird species estimates were North
303 American population estimates (69) from the Shorebird Flyway Population Database (70).

304 Other estimates of population size came from species-specific sources (Table S1; Data S1):
305 We used published estimates from Birds of North America (BNA) accounts (71) for 33 species; a
306 Conservation of Arctic Flora and Fauna (CAFF) 2018 report provided current estimates for 7 goose
307 species (62); estimates for 17 landbird species without useful BBS-based estimates were taken
308 from the Avian Conservation Assessment Database ACAD (46, 72), which itself relied on a variety
309 of sources; the 2015 North American Trumpeter Swan Survey (63) was used for Trumpeter Swan,
310 and the Waterbird Population Estimates database (WPE5) provided estimates for Arctic Tern (73).

311 Most sources of population estimates also provided estimates of variance in population
312 size, which we incorporated into our analysis. For those that did not, we estimated a range of
313 variance based on a description of methods used for population estimation. For example, we
314 applied a range 10% below and above the mean for species if estimates were based on well-
315 designed surveys with good population coverage, versus 75% below and above the mean for
316 species with ballpark estimates and/or low coverage of relevant populations, with an intermediate
317 range of variance if limitations were between those two.

318 Note that our goal was to compile and use the most current estimates of breeding population
319 size for each species; i.e., the number of breeding adult individuals in the population. We did not
320 attempt to estimate the annual increase in population size due to the influences of reproductive
321 output, as this will likely vary greatly across species and years and be subject to density-dependent
322 effects. Total population size varies throughout the annual cycle, but post-breeding total population
323 could increase as much as four to five times the size of the pre-breeding population size depending
324 on recruitment success of young of the year. Estimating this annual variation for individual species
325 is currently impossible, but it is important to point out that the cumulative impact of population
326 loss on ecosystems throughout the year could be quite significant. Our estimates of population
327 change are therefore conservative.

328

329 Assigning species to management and biome categories

330 For the purpose of summarizing changes in abundance across the North American
331 avifauna, we recognize four broad species categories used for management and conservation
332 planning: *Landbirds* are defined by Partners in Flight (41, 42) as all birds occupying terrestrial
333 habitats and a few species from primarily terrestrial bird families that use wetland habitats (e.g.,
334 Marsh Wren, *Cistothorus palustris*). The ACAD lists (448) native landbirds breeding in the U.S.
335 and Canada; in this paper we include 366 landbird species with adequate population size and
336 trajectory data, including 9 introduced species. *Shorebirds* include all sandpipers, plovers, stilts,
337 avocets, and oystercatchers that are considered under the U.S. Shorebird Conservation Partnership

338 (43); we had adequate data for 45 shorebird species for the current analysis. *Waterfowl* include all
339 ducks, geese, and swans, which are managed separately under the North American Waterfowl
340 Management Plan; most species have populations that are adaptively managed for sport hunting
341 (23). We had adequate data for 42 species in the current analysis, including 1 introduced species.
342 Other *Waterbird* species that are not specifically covered by the three plans above are included
343 under the Waterbird Conservation for the Americas initiative (44); these include colonial-nesting
344 seabirds, herons, beach-nesting species and secretive marshbirds. *Waterbirds* are most poorly
345 represented in our dataset, as many species are poorly monitored. We had adequate data for 77
346 species in the current analysis.

347 We assigned each species to a primary breeding biome and a primary nonbreeding biome,
348 using the Avian Conservation Assessment Database. The ACAD provides broad breeding-habitat
349 categories (e.g., forests, grasslands, oceans) derived from similar categories used to develop habitat
350 indicators for State of the Birds reports in the U.S. and Canada (e.g., (36, 45)), as well as more
351 descriptive sub-categories within major habitats (e.g., Temperate Eastern Forest; Desert Scrub,
352 Freshwater Marsh). All category assignments were based on literature review (primarily BNA
353 accounts) or expert knowledge and underwent extensive review as part of the ACAD process (66).
354 Species that use three or more broad habitats in similar importance were considered habitat
355 generalists.

356 For this paper, we used a combination of *Primary Breeding Habitat* and *Breeding Habitat*
357 *Description* sub-categories defined in the ACAD to derive a single set of unique breeding biome
358 categories across the North American avifauna (shown in Figure 1A), as follows:
359

- 360 • *Wetlands* = freshwater, inland wetlands; does not include coastal marshes or Arctic tundra.
- 361 • *Coasts* = all habitats associated with the Coastal zone, including saltmarsh, beach and tidal
362 estuary, mangroves, and rocky cliffs and islands; includes birds that forage primary in the
363 marine zone
- 364 • *Tundra* = Alpine tundra and Arctic tundra, including upland and low, seasonally wet tundra
- 365 • *Grasslands* = native grassland, prairie, pasture, and agriculture that supports grassland
366 birds
- 367 • *Aridlands* = all arid shrub-dominated communities; primarily in southwestern U.S. and
368 northwestern Mexico; includes ACAD sub-categories of sagebrush, chaparral, desert
369 scrub, barren rocky cliffs, and extensions of tropical dry forest (thornscrub) in southern
370 Texas
- 371 • *Boreal forest* = "True" boreal forest of Canada and Alaska; note that some boreal-forest
372 birds also use the boreal zone (primarily spruce-fir) of high mountains in the western and
373 northeastern U.S.
- 374 • *Eastern forest* = all temperate forest types of eastern U.S. and southeastern Canada (south
375 of the boreal), including northern hardwoods, oak-hickory, pine-oak, southern pine, and
376 bottomland hardwood associations
- 377 • *Western forest* = all temperate forest types of western U.S. and Canada (south of the boreal)
378 and extending in high mountains south into northwestern Mexico; includes Pacific
379 Northwest rainforest, all western conifer, oak-dominated, and riparian forests, pinyon-
380 juniper, juniper-oak woodlands of Edward's Plateau, pine-oak and high-elevation conifer
381 forests of northwestern Mexico
- 382 • *Forest generalist* = occurs in similar abundance in two or more forest biomes as described
383 above

- 384 • *Habitat Generalist* = occurs in similar abundance in three or more major habitat types,
385 usually including forest and non-forest categories
386

387 The ACAD database also lists *Primary Wintering Regions*, in which a majority of the population
388 of each species spends the stationary nonbreeding period during the boreal winter. For this paper
389 we modified and lumped ACAD regions into broader nonbreeding biome categories, using
390 published range maps and eBird distributional data (<https://ebird.org/explore>), as follows:
391

- 392 • *Temperate North America* = broad region encompassing all of Canada and most of the
393 U.S., excluding arid regions in the Southwest
- 394 • *Southwestern Aridlands* = arid regions of southwestern U.S., northwestern Mexico and
395 Mexican Plateau; included species that winter in arid Chihuahuan grassland habitat
- 396 • *Mexico-Central America* = combination of ACAD regions within Mexico and Central
397 America, including *Pacific Lowlands*, *Gulf-Caribbean Lowlands*, *Mexican Highlands*, and
398 species from *Central and South American Highlands* that winter primarily in Central
399 America
- 400 • *South America* = includes *South American Lowlands*, species from *Central and South*
401 *American Highlands* that winter primarily in South America, and *Southern Cone* ACAD
402 regions
- 403 • *Caribbean* = West Indies region, including Cuba, Bahamas, Greater and Lesser Antilles
- 404 • *Widespread Neotropical* = occurs in similar numbers in two or more biome regions within
405 the Neotropics
- 406 • *Coastal* = coastline habitats throughout the western Hemisphere from Arctic to Atlantic
407 and Pacific Coasts of North, Middle, and South America; eastern Hemisphere coastlines
408 were included to incorporate the main wintering grounds of Pacific Golden-Plover
- 409 • *Marine* = littoral zone; area of oceans influenced by continental coastlines; includes bays
410 and deep estuaries (includes a few species that are largely pelagic in the nonbreeding
411 season)
- 412 • *Widespread* = occurs in similar abundance in 3 or more nonbreeding biomes, usually
413 encompassing both temperate North American and Neotropical regions
- 414 • *Southeast Asia* = overwintering region for Arctic Warbler (and additional Arctic-breeding
415 species not included in the present analysis); note that this nonbreeding biome is not
416 included in summaries presented in Table 1 and Figure S1, but data for Arctic Warbler
417 (Data S1) and included in higher level summaries of population change for all birds,
418 breeding biomes, etc.

419 Computing vertical profile time series of birds from NEXRAD radar data

421 While designed to monitor meteorological phenomena (e.g., precipitation, tornados, hail),
422 weather radars routinely detect migrating birds. Weather radar infrastructure represents a
423 biological monitoring tool that achieves an unprecedented spatial and temporal coverage for
424 studying bird migration (74). The NEXRAD weather radar network consists of 143 radars in the
425 contiguous US that continuously survey the airspace above the US (75). Each of these radars was
426 used to estimate vertical profiles of birds , which summarize a radar’s scans completed at a given
427 timestep into the amount, speeds, and directions of birds aloft as a function of altitude. Profile data
428 can be used to accurately estimate migratory biomass abundance and its change throughout the
429 year at comprehensive continental scales (19, 77), an approach we extended here to detect long-

430 term change in migratory passage across the full US. We restricted our analysis to spring data only
431 (Mar 1 to Jul 1), which is the migratory period closest in time to the breeding bird surveys by BBS.
432 Also, aerial insects are far less numerous in the airspace in early spring as compared to autumn,
433 therefore the spring period allows us to obtain the cleanest bird signal from NEXRAD (see final
434 paragraph of section “Calculating biomass passage from vertical profile time series” below).

435 Data were obtained from the NOAA-nexrad-level2 public S3 bucket on Amazon Web
436 Services (78). Data were analyzed for the period 2007-2018, the period after the Open RDA
437 deployment in NEXRAD (RDA build 7.0), which was a significant upgrade to the Radar Data
438 Acquisition (RDA) functional area of the WSR-88D. In particular, it implemented Gaussian Model
439 Adaptive Processing (GMAP) (79, 80), replacing and improving over the legacy ground clutter
440 filter (81) by Doppler filtering. We did not include older potentially lower quality data in the
441 analysis to limit the possibility of legacy filter settings affecting our results. Trend analyses (see
442 following sections for details) controlled for two important data acquisition updates, the gradual
443 upgrades to superresolution (2008-2009) and dual-polarization (2010-2013). The superresolution
444 upgrade increased the azimuthal resolution from 1 to 0.5 degree and range resolution from 1 km
445 to 250 m. The dual-polarization upgrade added functionality to receive horizontally and vertically
446 polarized electromagnetic waves independently, which provided additional products that greatly
447 simplify the classification of meteorological and biological scatterers (82).

448 Night-time polar volumes (level-II data) were processed for all 143 radars in the contiguous
449 US at half-hour interval from 2007-2018 using the vol2bird algorithm (version 0.4.0) (76, 83, 84),
450 available in R-package bioRad (version 0.4.0) (83, 85). Using cloud computing with 1000 parallel
451 cores on Amazon Web Services (AWS) we reduced this computational task of ~ 4 years on a single
452 CPU to less than a day. Data were processed using the vol2bird algorithm in single-polarization
453 mode (76), which requires radial velocity and reflectivity factor information only and no dual-
454 polarization data. Dual-polarization data became available only after mid-2013, and therefore
455 cannot be used for analyses involving older data. In single-polarization mode, resolution samples
456 with high reflectivity values are masked out (η above $36000 \text{ cm}^2/\text{km}^3$, i.e., 31 dBZ at S-band / 20
457 dBZ at C-band, cf. algorithm parameter ETAMAX and paragraph 3.2 in (76)), since such high
458 reflectivities are typically associated with precipitation (76). The algorithm also identifies
459 contiguous areas of direct neighbors (in a queen’s case sense; i.e., diagonal pixels are included as
460 direct neighbors) of reflectivity above 0 dBZ, denoted as reflectivity cells. Cells with a mean
461 reflectivity above $11500 \text{ cm}^2/\text{km}^3$ (i.e., 26 dBZ at S-band / 15 dBZ at C-band, cf. algorithm
462 parameter ETACELL and Z_{cell} in (76)) are masked from the data. Following recommendations for
463 S-band data discussed in (83), we used $\text{sd_vvp_threshold}=1 \text{ m/s}$ (cf. Eq. A2 in (76)) and
464 $\text{STDEV_CELL}=1 \text{ m/s}$ (cf. Eq. A3 in (76)) to limit masking based on radial velocity texture at S-band.

465 At S-band, single-polarization mode masks out only the strongest precipitation areas, and
466 weaker precipitation may remain (83) (see Figure S3C/E). Precipitation is generally easily
467 identifiable in vertical profiles by experts, based on high reflectivities extending over a relatively
468 large portion of the altitude column (see Figure S3D). Such precipitation cases stand out from bird
469 migration cases, which are characterized by low reflectivities that typically decrease with altitude
470 (see Figure S3A). We used machine learning to develop a full-profile classifier that automatically
471 identifies precipitation-contaminated profiles, as follows.

472 Years when dual-polarization data were available (2014-2017) were processed a second
473 time in dual-polarization mode (19, 83), which adequately removes precipitation based on high
474 correlation coefficient values (19, 82). These precipitation-free profile data were paired with the
475 single-polarization profile data. By comparing the precipitation-free reflectivity (η_{dualpol} , cf.

476 Figure S3A) with the total reflectivity including precipitation (η_{total} derived from reflectivity factor
477 DBZH, cf. Figure S3D), we defined a measure that indicates the range of altitudes H (m) likely
478 containing precipitation, as follows:

479

$$480 \quad H = \sum_{i=1}^{n_{\text{layer}}} (\text{if } \eta_{\text{total},i} - \eta_{\text{dualpol},i} > \Delta \text{ then } w_{\text{layer}} \text{ else } 0)$$

481

482 with $\Delta=50 \text{ cm}^2 \text{ km}^{-3}$ (corresponding to 3 dBZ at S-band), and w_{layer} the width of a single altitude
483 layer (200 m). The value of Δ amounts to a fairly low threshold value for classifying potential
484 precipitation, as meteorologists typically assume weak precipitation to start at 7 dBZ (86) (133
485 $\text{cm}^2 \text{ km}^{-3}$ at a 10 cm S-band wavelength), and therefore the vast majority of rain events will show
486 differences in reflectivity exceeding Δ . We labelled all single-polarization profiles in the 4-year
487 dataset with their corresponding H value.

488 Next, we used gradient boosted trees to detect rain-contaminated profiles computed in
489 single-polarization mode automatically in an unsupervised learning approach, using the H value
490 as our labeling of profiles, with higher H values indicating a wider altitudinal range containing
491 precipitation. We used the R implementation of XGBoost, a highly efficient and scalable gradient
492 boosting algorithm, which can deal with complex nonlinear interactions and collinearity among
493 predictors (87, 88). We used default hyperparameter settings of the xgboost algorithm (learning
494 rate $\eta=0.3$, tree depth $\text{max_depth}=6$, $\text{min_child_weight}=1$, $\text{gamma}=1$, $\text{colsample_bytree}=1$, and
495 $\text{subsample}=1$). Full-profile classifiers were trained for each radar separately. Response variable
496 was the range of altitudes with precipitation H. Predictors included total reflectivity factor (DBZH),
497 precipitation-filtered reflectivity in single-polarization mode (η), ground speed components
498 (u,v), all at each of the 20 profiles altitude layers, as well as day of year (1-366) and time of day
499 (UTC time). Profiles of each radar were randomly assigned to training (75%) and testing (25%)
500 datasets.

501 Finally, we determined the parameter H_{max} as the value of H above which profiles are
502 removed in order to discard precipitation contaminations. The value of H_{max} was determined using
503 Figure S4, showing an R-squared measure that quantifies the correspondence between the seasonal
504 migration traffic MT (see next paragraph for definition) of the single-polarization vertical profile
505 time series (with contaminated profiles removed by the full-profile classifier), and the seasonal
506 migration traffic of the reference computed in dual-polarization mode. This R-squared measure
507 amounts to the the coefficient of determination of the scatter points in Figure S5 for a given value
508 of H_{max} . We choose the value of $H_{\text{max}}=1600$ m, producing the best correspondence between the
509 dual-polarization reference and our new single-polarization method. Gaps in a radar's profile time
510 series (after removal of rain-contaminated profiles) of less than 4 hours were filled by linearly
511 interpolating between the neighboring profiles directly before and after the gap.

512 Applying this value of H_{max} and the full-profile classifier on the testing dataset, we find a
513 precision to correctly classify a profile as rain-contaminated of 99.2%, and a recall of rain-
514 contaminated cases of 97.4%. Precision and recall (89) did not depend strongly on the value of the
515 H_{max} threshold, e.g., for $H_{\text{max}} = 800$ m we have a precision of 97.0 % and recall of 99.0%. Our
516 classification performance therefore did not depend critically on the adopted value of the H_{max}
517 parameter.

518

519 Calculating biomass passage from vertical profile time series

520 Nightly reflectivity traffic (RT) (83) was calculated for the vertical profile time series of
521 each station for each night with the `integrate_profile()` function in `bioRad` (version 0.4.0) (83, 85),
522 which equals the total reflectivity crossing the radar stations per season per one kilometer transect
523 perpendicular to the ground speed direction of movement. Reflectivity traffic is closely related to
524 the amount of biomass that has passed the radar station (83). It can be converted to migration traffic
525 (MT), the number of individual birds having passed the radar station per km transect, under
526 assumption of radar cross section (RCS) per individual bird, as in $MT = RT/RCS$. To express RT
527 in a more intuitive unit, we report MT values in figures using a constant seasonal mean $RCS = 11$
528 cm^2 for an individual bird. This value was determined in a calibration experiment spanning a full
529 spring and autumn migration season (76), corresponding to passerine-sized birds (10-100 g range)
530 (90), which represents the highest-abundance species group dominating our radar signals (19). As
531 additional quality control for non-avian signals, we only included altitude layers of profiles for
532 which the ground speed direction was in the northward semicircle surrounding a radar, since
533 migratory bird movements in spring are expected to fall within this semicircle.

534 Spatial interpolations across the contiguous US of nightly migration traffic were estimated
535 by ordinary kriging with a spherical variogram model, using the R package `gstat` (91). We clipped
536 water areas after interpolating, leaving land areas of the contiguous United States. Missing
537 estimates of nightly migration traffic (e.g., due to temporary radar down time) were imputed from
538 nightly kriging-interpolated maps of MT based on operational stations, imputing the MT value at
539 the location of the inactive radars. Parameters of the spherical variogram model were estimated
540 for each night. In cases where the variogram fit did not converge - typically during nights with
541 very limited migration - we used variogram parameters fit to the average seasonal spring migration
542 traffic (partial sill = 0.577, range = 1093 km). Radar availability was very high, therefore only a
543 small percentage of in total 2.8% of nightly MT values were imputed by this procedure.

544 Total seasonal migration traffic was calculated as the sum of nightly MT values within a
545 season from Mar 1 to Jul 1. Radar seasons were excluded from trend analysis entirely if data
546 availability dropped below 80% in the period 1 Mar – 1 Jul (4.8% of radar seasons for 143 stations
547 during 11 spring seasons).

548 While traffic rates suppress any non-migratory stationary signals, like those of non-directed
549 foraging movements of insects or bats (19), a small contribution of directed migratory movements
550 of bats or insects could remain in our data. Free-tailed bats in the south are known to show up in
551 radar (92) and have a population size estimated up to 100 million individuals (93), which amounts
552 to up to a few percent of the total migratory passage of several billion birds along the southern
553 border (19). In the North-East - where we observe strongest declines in biomass passage - several
554 migratory tree-dwelling bat species occur, but their population sizes are thought to be smaller than
555 of free-tailed bats. For the period 2013-2017 we have provided earlier a detailed quantitative
556 estimate of the upper limit to the migratory insect contribution to the migratory passage in autumn,
557 when insect abundances are highest. The estimated passage due to insects was 2.1 % (northern US
558 border) – 3.8 % (southern US border) (19). Our current study is conducted in spring when aerial
559 insect abundances are far lower (94), especially in the North East where we observe most declines,
560 and we estimate the insect contribution to the biomass passage to be on the order of a percent or
561 less.

562 Calculating trends from seasonal biomass passage values

564 To correct for potential radar sensitivity changes related to radar processing upgrades, we
565 determined the timing of the upgrade to super-resolution and the upgrade to dual-polarization for

566 each station. Radar seasons for which the upgrade fell within a migration period were excluded
567 from the analysis. The mode of operation was classified as “legacy” (before superresolution
568 upgrade), “superres” (after superresolution upgrade, before dual-polarization upgrade) or
569 “dualpol” (after dual-polarization upgrade), and stored as a factor variable ‘mode’ having three
570 factor levels to denote each mode of operation. Variable ‘mode’ was included in models to correct
571 for changes in operational mode. We also tested for the effect of dual-polarization and
572 superresolution upgrade separately. In these cases, factor variable ‘mode’ was replaced with a
573 logical explanatory variable ‘dualpol’ (true after dual-polarization upgrade, otherwise false) or
574 ‘superres’ (true after superresolution upgrade, otherwise false) in the trend models. The total model
575 candidate set thus contained 4 models, encompassing all combinations of possible corrections for
576 mode of operation, including no correction.

577 We estimated geographically varying trend patterns using a spatial GAM (95) using the
578 *mgcv* package in R (39). Seasonal migration traffic was standardized to each radar’s 11-year mean,
579 stored as variable ‘index’. We then modeled the spatial trend using an offset tensor product smooth
580 $te(lon,lat)$ and a tensor smooth representing a spatially varying linear trend with year
581 $te(lon,lat,by=year)$ on the linear predictor scale (see Table S3). We used a Gamma distribution
582 with log-link, such that our linear trend smooth term on the linear predictor scale represents a
583 spatially varying annual rate of change μ_{trend} (with standard deviation σ_{trend}) on the response scale.
584 The Gamma distribution accommodates a small right-skew in our continuous positive response
585 variable and warrants normality of deviance residuals, as inspected using QQ plots. Plots of the
586 spatial trend surfaces estimated for the models in Table S3 are shown in Figure S7.

587 Changes in seasonal migration traffic (Table S4, Figure 2D) were calculated as the GAM
588 prediction for year 2007 minus 2017 (the proportional loss over 11 years), times the 11-year
589 average seasonal migratory traffic (MT) of each station. The surface of average migratory traffic
590 was obtained from a kriging interpolation of the 11-year mean seasonal MT value for each station
591 (see Figure S6, 2). Average trends for the entire US (see main text and Table S3) were averaged
592 over all pixels of these spatially-explicit decline and loss surfaces across the contiguous US, using
593 arithmetic mean and harmonic mean for calculating mean and variance values, respectively,
594 effectively weighing the trend by passage of biomass. The trend value reported in the main text
595 refers to this biomass-weighted average trend for a model average of all GAM models in our
596 candidate set (listed in Table S3). Models were averaged using package *MuMIn* (96), which
597 averages models based on AIC (97).

598 We also estimated continental-wide trends in migratory passage and trends for four flyway
599 regions: Atlantic, Mississippi, Central and Western, following the definitions of the US Fish and
600 Wildlife Service, REF (cf. Figure 2B,C). We fitted generalized linear mixed models using R-
601 package *lme4* (98), including radar station as a random offset, and region and the interaction
602 year:region as fixed effects, see Table S4 for model structures and Table S5 for estimated model
603 parameters. Like in the GAM analysis, the candidate model set equaled for 4 models, containing
604 all combinations of possible corrections for operational mode.

605 Regional biomass passage indices (Figure 2A,B) were calculated as the yearly sum of
606 seasonal migration traffic values MT for the radars within each region, standardized by the sum of
607 seasonal migration traffic values MT for all radars in the network of the first year (2007). Values
608 of regionalized decline rates (Atlantic, Mississippi, Central and Western) in the main text are based
609 on the model average (96) of all GLMs in the candidate set. Reported errors represent standard
610 errors at a 95% confidence level.

611 Our GAM analysis (Table S3) and GLM analysis (Table S5) both found support for the
612 dual-polarization upgrade affecting the value of MT, but not for the superresolution upgrade:
613 including variable ‘mode’ did not produce a more informative model relative to a model with
614 variable ‘dualpol’ that makes no distinction between “legacy” and “superresolution” data. Effect
615 of the dual-polarization upgrade was a reduction in seasonal migration traffic by a factor $0.85 \pm$
616 0.03 (regionalized GLM) or 0.88 ± 0.05 (spatial GAM). Accounting for potential changes in
617 detectability effectively reduced the steepness of decline rates and biomass loss. Both the
618 superresolution and dual-polarization upgrades were designed to prevent changes in detectability
619 and minimize bias effects for meteorological echoes as much as possible, and it is not known
620 whether including correction terms for biological echoes is required. We report versions of the
621 models with and without correction terms such that the effects of these corrections can be
622 compared. By including correction terms, potentially part of the declines in seasonal migration
623 traffic are modelled by the detection-related explanatory variables, and our estimates of decline of
624 models with most information-theoretic support (model 1, model 5) are thus potentially too
625 conservative. Importantly, the presence of an average decline in the passage of migratory biomass
626 is robust to inclusion of correction terms for changes in operational mode of the radar, and even
627 our most conservative rates of decline are alarming.

628

629

630 **Supplementary References**

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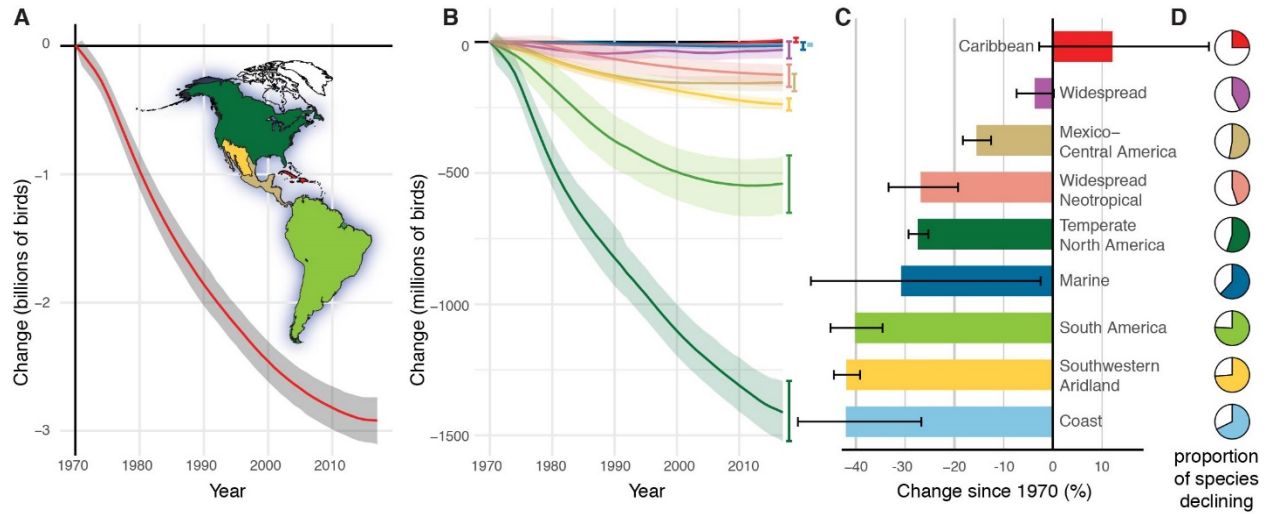
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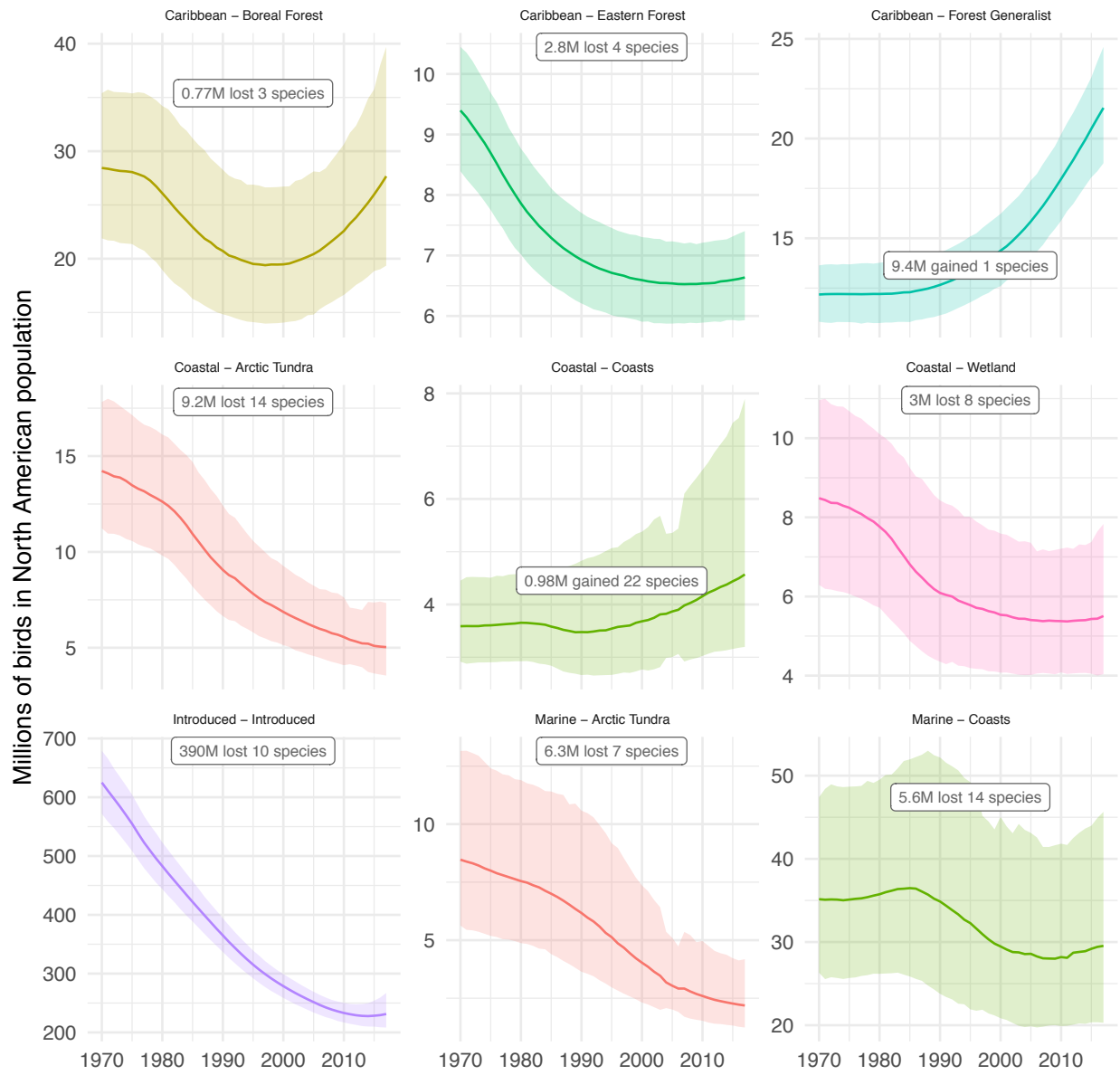
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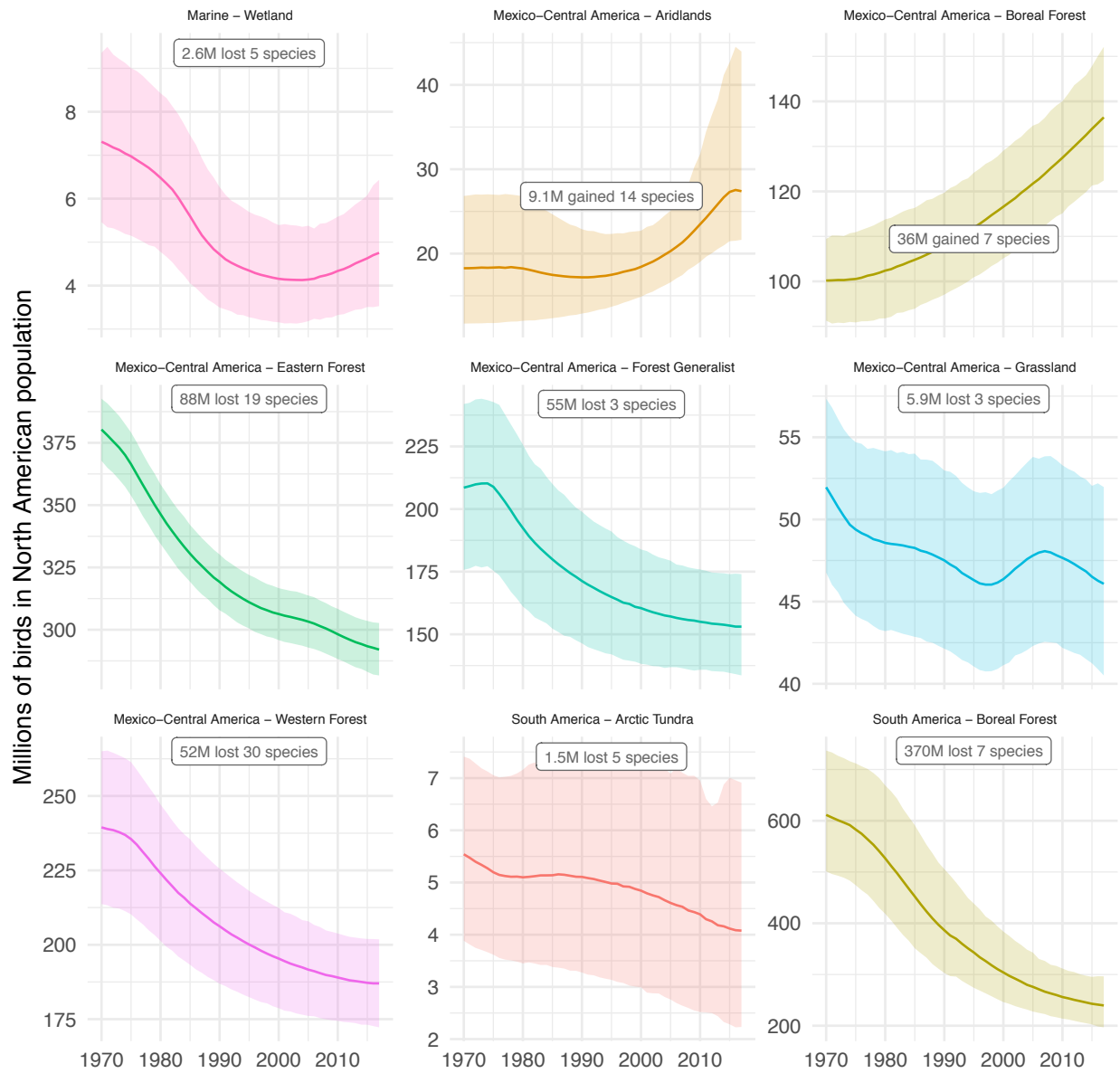


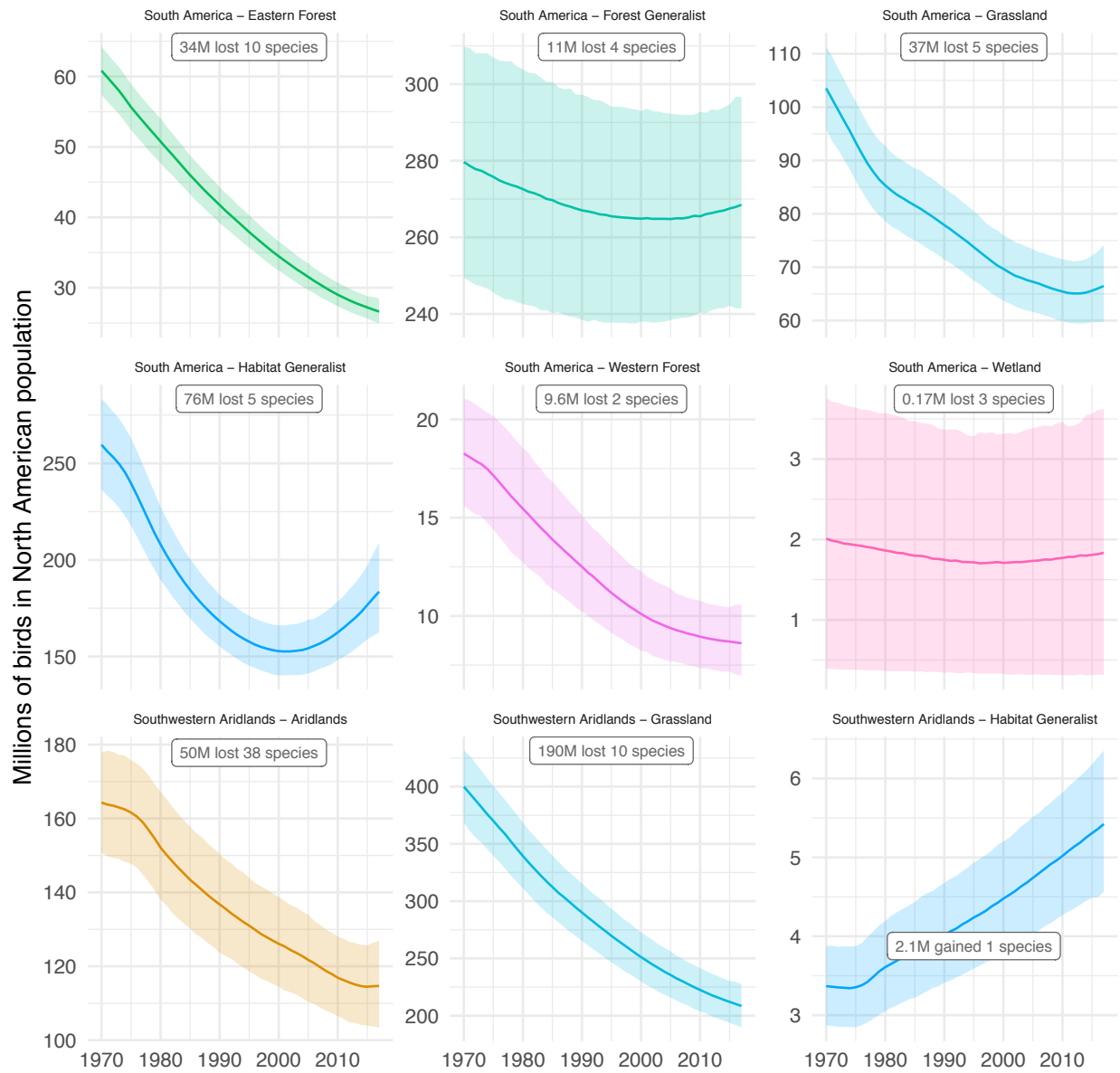
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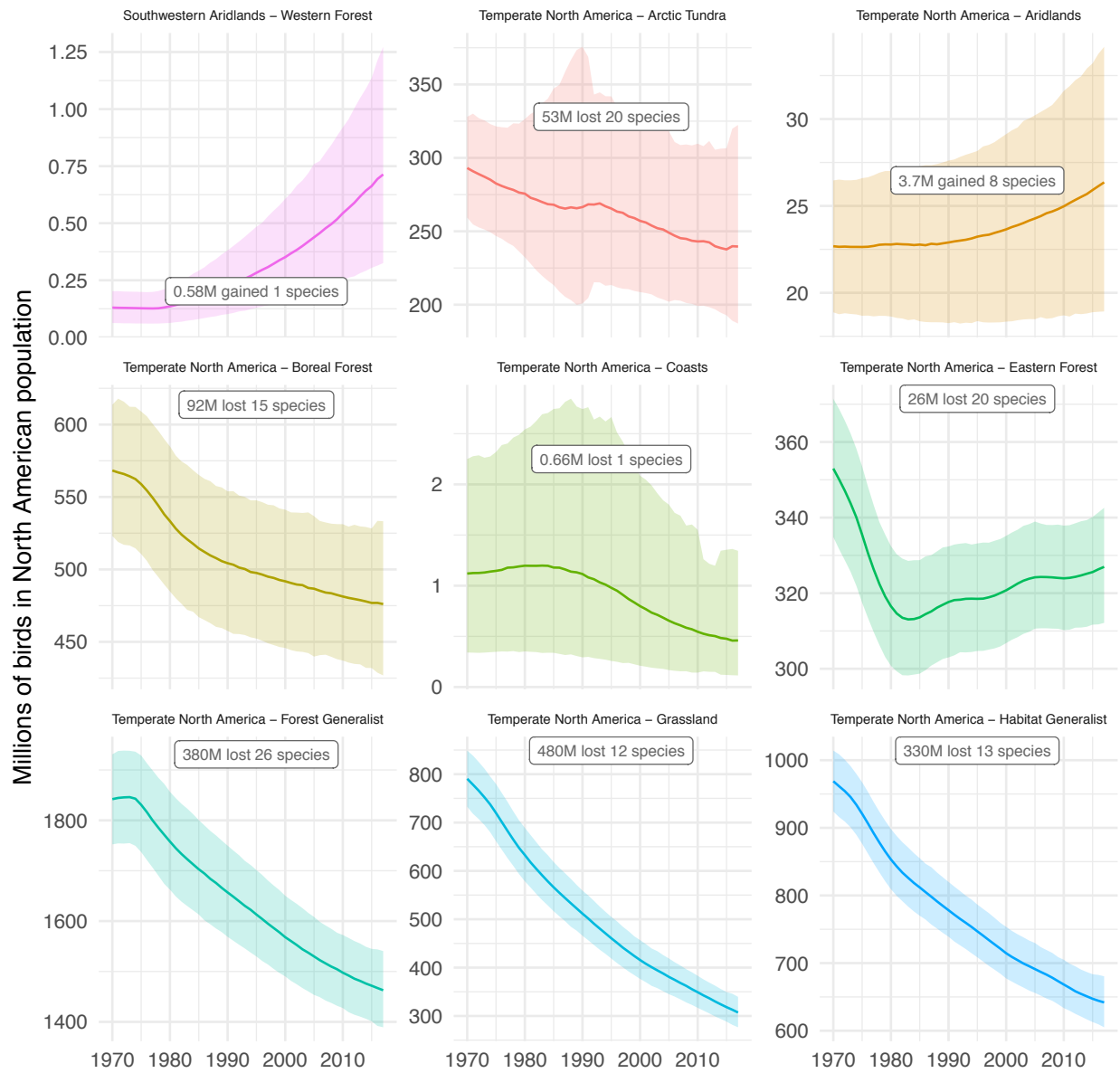
792 **Fig. S1. Net population change in North American migratory birds grouped by non-**
793 **breeding biome.** (A) By integrating breeding-season population trajectory and size estimates for
794 529 species (see Methods), we show the continental avifauna lost > 2.9 billion breeding birds
795 since 1970. Gray shaded region represents $\pm 95\%$ credible intervals around total estimated loss.
796 Map shows color-coded non-breeding biomes based on primary overwinter distributions of each
797 species (See Methods). (B) Net loss of abundance occurred across all major non-breeding
798 biomes, except Caribbean (see Table 1). (C) Proportional population loss, $\pm 95\%$ C.I. (D)
799 Proportion of species declining in each biome.

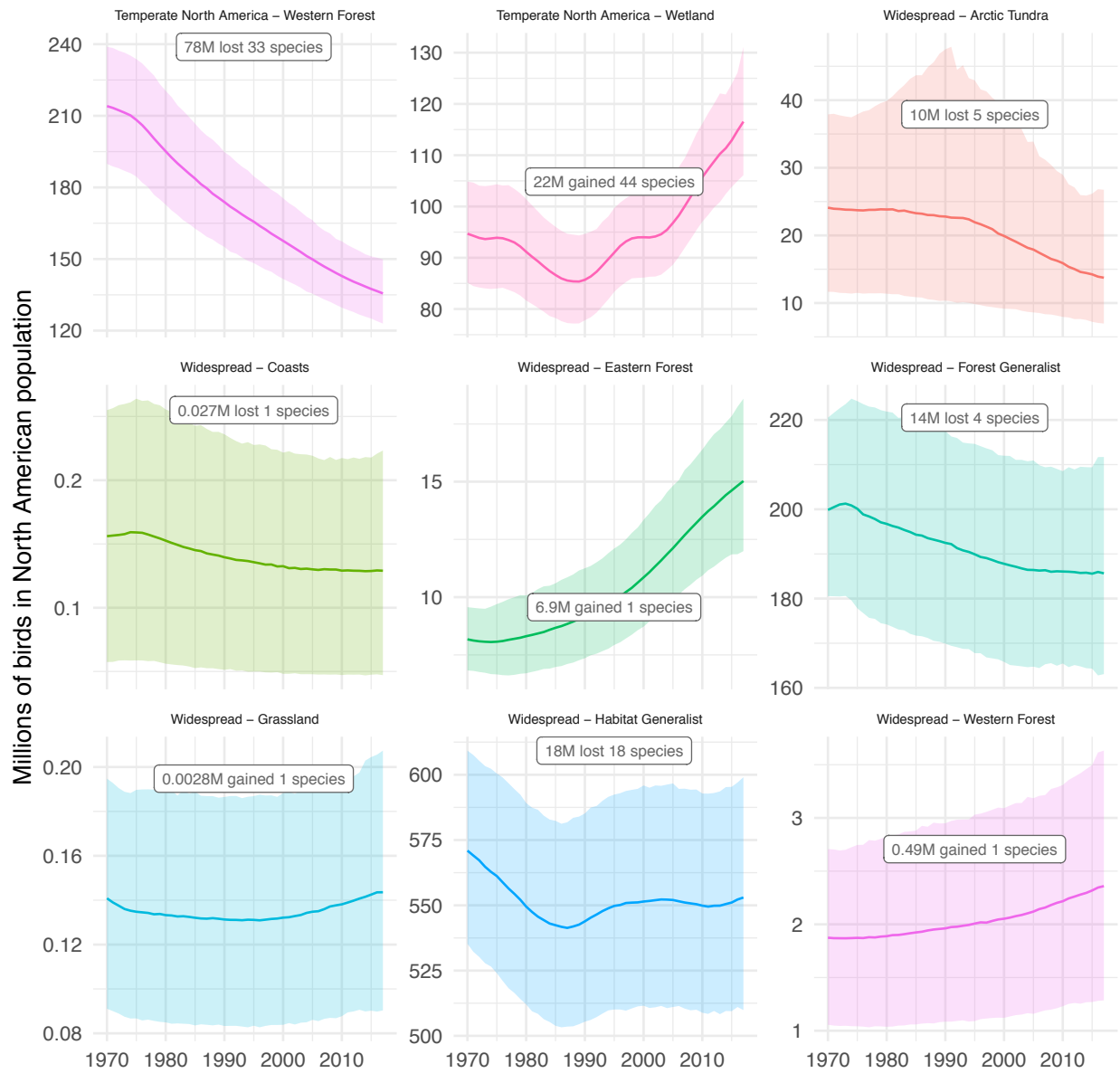
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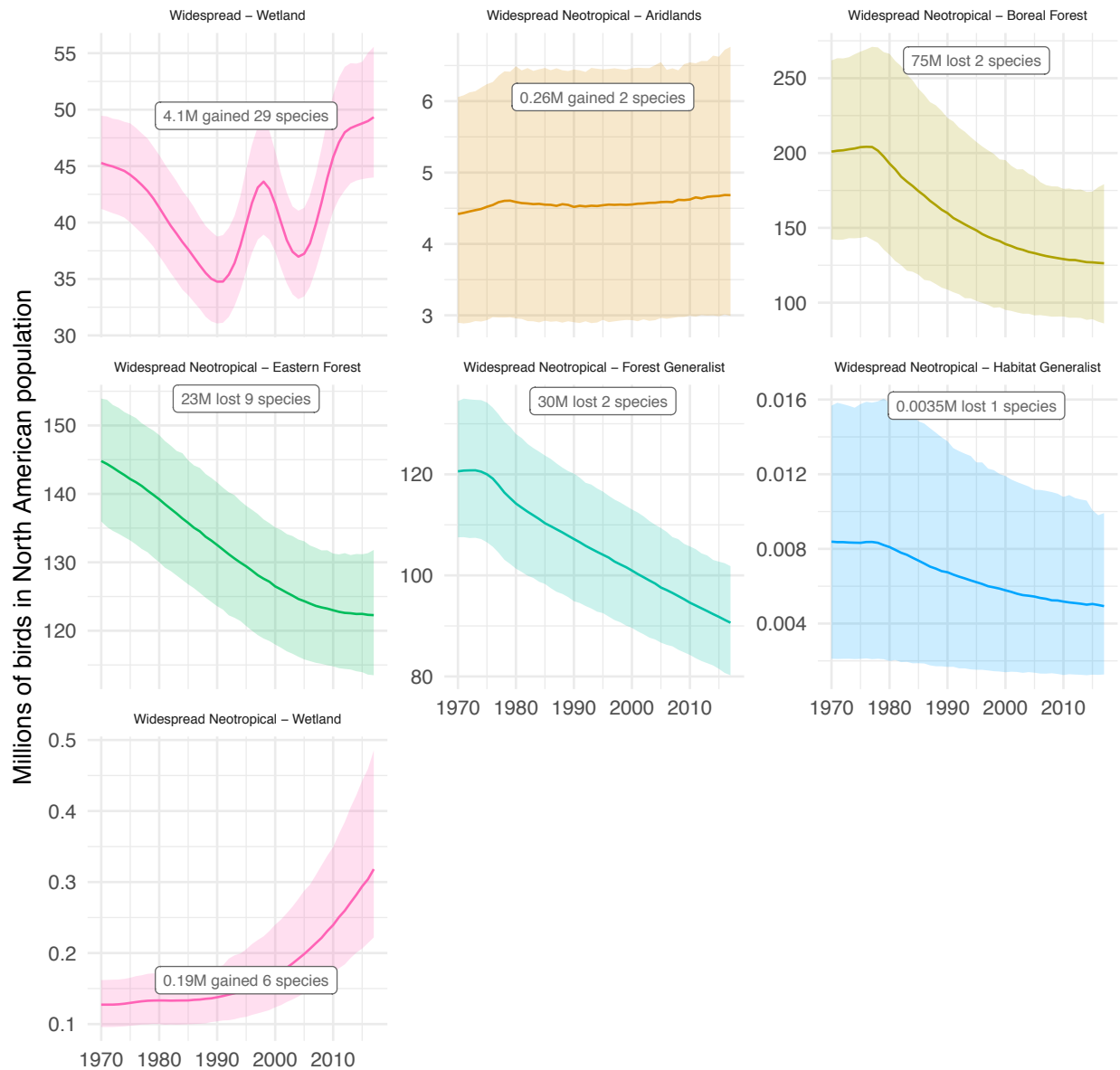








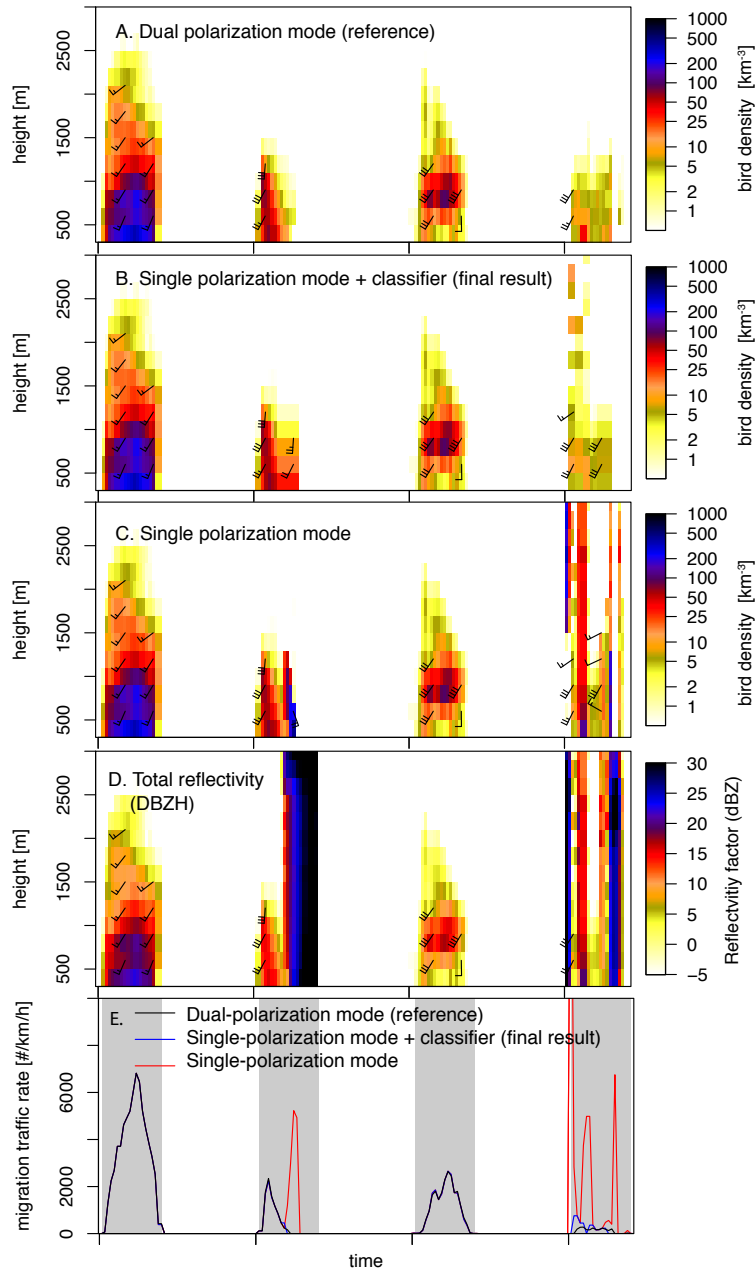




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807 **Fig. S2.**

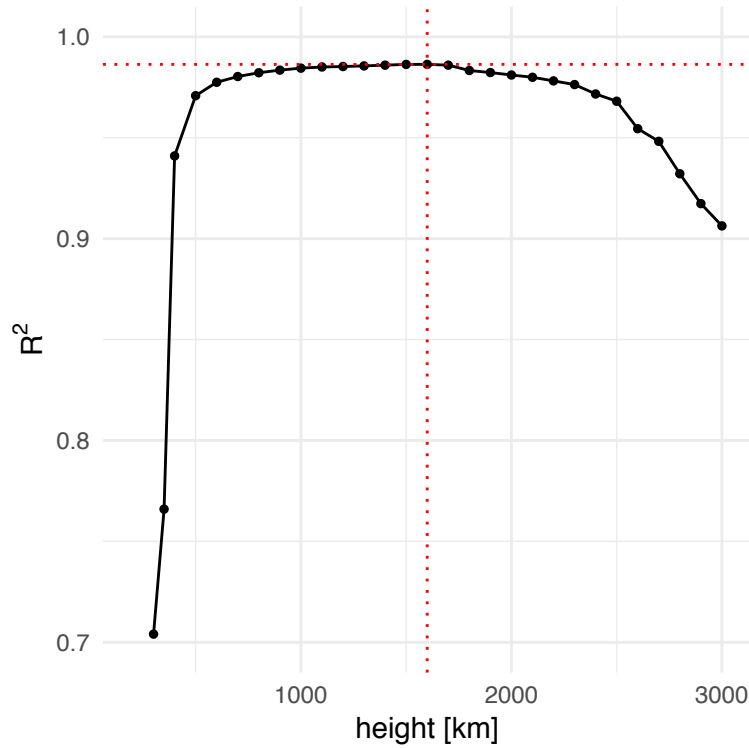
808 Change in number of birds in North America by combined nonbreeding and breeding biomes
 809 from 1970–2017. Each panel of the figure shows the 1970–2017 trajectory of summed abundance
 810 across the species that share a given combination of nonbreeding and breeding biomes (e.g., the
 811 first panel shows the trajectory in summed abundance across the 3 species that winter in the
 812 Caribbean and breed in the boreal forest). The panel title indicates the wintering biome followed
 813 by the breeding biome; labels within the plots show the estimated change in total abundance in
 814 millions (M) of birds between 1970 and 2017, and the number of species included in the group.
 815 Colored lines and the colored uncertainty bounds represent the median and 95% C.I. of the
 816 posterior distribution from the hierarchical Bayesian model. The panels are sorted by
 817 nonbreeding biome and the lines are coloured based on the breeding biome.



818

819 **Fig. S3.**

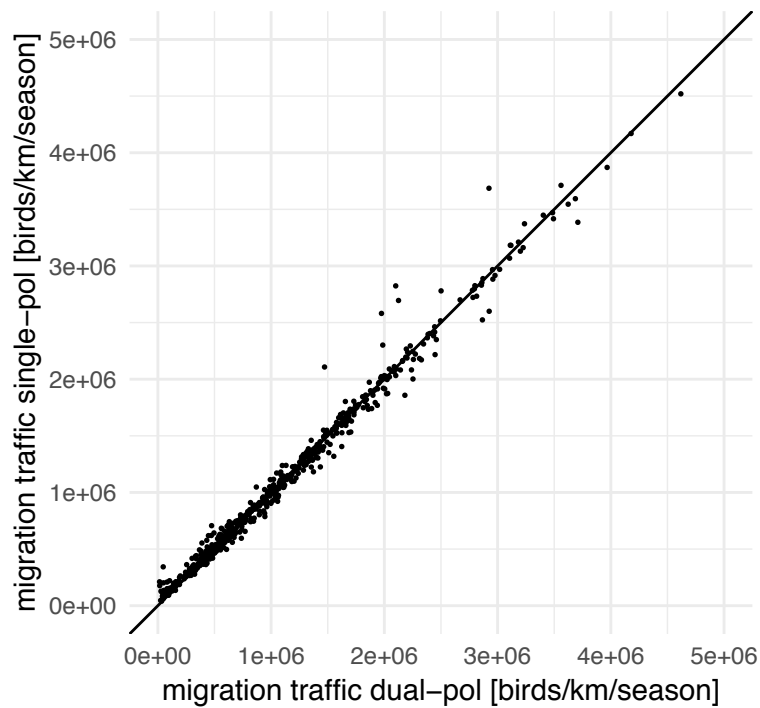
820 Example of vertical profile time series for bird density and speed retrieved in dual polarization
 821 mode (A, precipitation-free reference) and the final single-polarization product used in the study
 822 (B) for the KBGM radar from 28-31 May 2017. The full-profile classifier that screens
 823 precipitation uses the reflectivity product obtained in single-polarization mode (C) and the total
 824 reflectivity including precipitation (D). Precipitation is characterized by high reflectivities
 825 spanning a large part of the vertical air column (see D), as well by cases in which the single-
 826 polarization rain filter removes part (but not necessarily all) of the signal (C versus D). The final
 827 single-polarization product (B) closely matches the dual-polarization mode reference (A), see
 828 also E, black and blue lines closely overlapping).



829

830 **Fig. S4.**

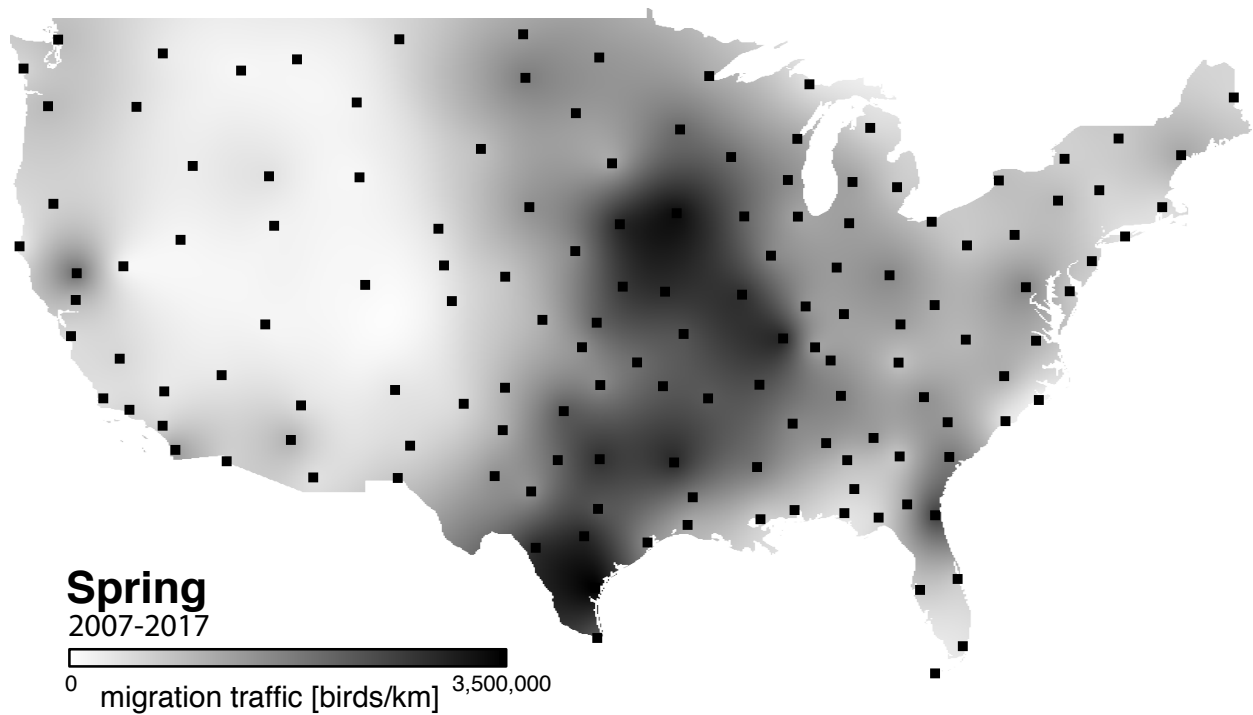
831 Coefficient of determination R^2 between full-spring seasonal migration traffic values calculated
 832 in single polarization mode (rain-filtered using full-profile classifier) and dual-polarization mode
 833 reference (R^2 based on $n=143$ stations * 4 years = 572 points), as a function of the classification
 834 threshold H_{\max} . The value of R^2 peaks at $H_{\max} = 1600$ m .
 835



836

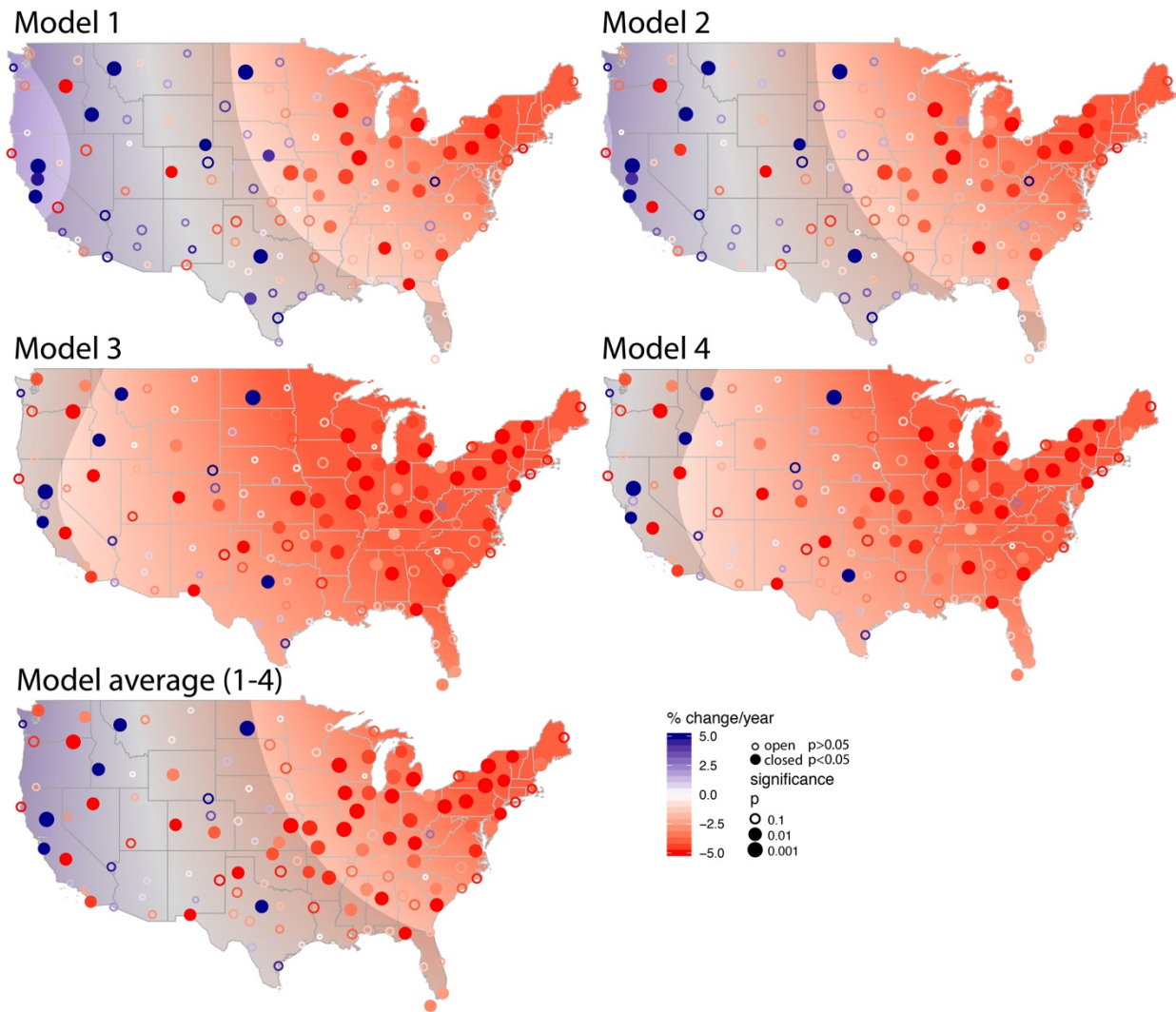
837 **Fig. S5.** Seasonal migration traffic (MT) as estimated in dual-polarization mode and in single-
 838 polarization mode (rain-filtered using full-profile classifier) for the years 2014-2017 (n=143
 839 stations * 4 year = 572 points). Solid line equals the $y=x$ line of perfect correspondence. This
 840 figure shows MT values for $H_{\max} = 1600$ m, which achieves the best correspondence with the
 841 dual-polarization reference mode (see Figure S4).

842



843

844 **Fig. S6.** Cumulated nocturnal migration traffic (biomass passage) MT in spring (1 Mar – 1 Jul)
 845 averaged over 11 seasons (2007-2017). Darker colors indicate more migratory biomass passage
 846 MT. Values give the numbers of birds passing per 1 km transect perpendicular to the migratory
 847 direction per spring season. Radar reflectivity was converted to bird numbers under the
 848 assumption of a constant radar cross section of 11 cm² per bird. Ordinary kriging was used to
 849 interpolate between radar stations. Dots indicate locations of radar station sites.
 850



851

852 **Fig. S7.** GAM spatial trend surfaces estimated for the models in Table S3 for the period 2007-
 853 2017. Darker red colors indicate higher declines and loss of migration traffic (biomass passage)
 854 MT, while blue colors indicate migration traffic increase. Gray shaded regions have an annual
 855 rate of change μ_{trend} that is smaller than twice the standard deviation in the rate of change σ_{trend} ,
 856 i.e. $\mu_{\text{trend}} < 2 * \sigma_{\text{trend}}$. Overlaid circles indicate single-site trend estimates (circle color) and their
 857 significance (circle area $\sim \log(1/p)$), with closed circles being significant at a 95% confidence
 858 level. Single site trends are fits to seasonal migration traffic data of each radar site separately,
 859 using a Generalized Linear Model (GLM) with a Gamma distributional family and log-link.
 860 Detectability effects as estimated by the GAM were accounted for in the single-site data prior to
 861 fitting the GLMs.

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868 **Table S1.**

869 Data sources for population size estimates and population trajectories for 529 North American
 870 bird species included in the net population change analysis for the present study. We used
 871 published sources of data wherever possible, and applied published methods to calculate
 872 estimates for the remaining species. Brief description of methodology, time-span, seasonal, and
 873 geographic coverage of surveys and other data sources provided, along with number of species
 874 for which that source was used and key citations.
 875

Data source	Years	Season	Methods	Coverage	N Spp. Trajectory	N Spp. Pop	Refs
North American Breeding Bird Survey (BBS)	1970-2017	Breeding	25-mile roadside surveys with 50 3-minute point counts	>4,100 routes in contiguous U.S., southern Canada	415	0	(33, 34, 47)
North American Breeding Bird Survey (BBS)	1993-2017	Breeding	25-mile roadside surveys with 50 3-minute point counts	Same as above, with additional routes in northern Canada and Alaska	19	0	(48)
Audubon Christmas Bird Count (CBC)	1970-2017	Winter	Non-standard counts within 15-mile diameter circles	1,500-2,000 circles in U.S. and Canada	58	0	(57)
Partners in Flight (PIF) Population Estimates	2006-2015	Breeding adults	Extrapolation from BBS and other survey count data	Same as BBS, above	0	399*	(35)
Arctic goose surveys (CAFF 2018)	1975-2014	Variable	Aerial or ground surveys or mark-recapture models, depending on species	Continentwide for each species	7	7	(62)
Shorebird Migration Surveys	1974-2016	Fall migration	Volunteer-conducted surveys at pre-determined sites	Canada and U.S., concentrated in eastern portion	20	0	(58, 59)
USFWS Breeding Waterfowl Surveys	1970-2017	Breeding	Aerial surveys corrected for detectability with ground surveys	2.0 million square miles in Alaska, Canada, and northern U.S.	9	13	(61)
North American Trumpeter Swan Survey	1968-2015	Breeding	Aerial surveys and ground counts	Rangewide	1	1	(63)
American Woodcock Singing Ground Survey	1968-2017	Breeding	3.6-mile roadside routes	1,500 routes in eastern North America	1	0	(60)
2007 Seaduck Joint Venture Report	1970-2007	Variable	Compilation of best available estimates	Continentwide for each species	0	14	(68)

Shorebird Flyway Population Database	2012	Breeding population	Compilation of best available estimates	Continentwide for each species	0	45	(69, 70)
Birds of North America (BNA) species accounts	1970-2007	Breeding adults	Variable; best for each species	Continentwide for each species	0	33	(71)
Avian Conservation Assessment Database (ACAD)	Variable	Breeding adults	Variable; compiled from other sources	North American estimates	0	17	(46)

876 * Estimates for 344 landbird species provided by (35); identical methods applied to 55 additional non-landbird
877 species in the present study.

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879

880 **Table S2.**

881 Net change in abundance across North American bird families, 1970-2017. Taxonomy and
 882 common names of families follow (99); families listed in order of greatest decline. Net change in
 883 abundance expressed in millions of breeding individuals, with upper and lower 90% credible
 884 intervals (CI) shown. Percentage of species in each group with negative trend trajectories also
 885 noted.
 886

Family	Common Name	N Spp	Net Abundance Change (Millions) & 90% CI			Percent Change & 90% CIs			% Spp in Decline
			Change	UC90	LC90	Change	LC90	UC90	
Passerellidae	New World Sparrows	38	-862.0	-925.7	-798.6	-38.0%	-40.1%	-35.8%	87%
Parulidae	New World Warblers	44	-617.5	-737.8	-509.0	-37.6%	-42.0%	-33.0%	64%
Icteridae	New World Blackbirds	18	-439.8	-467.8	-412.4	-44.2%	-45.9%	-42.4%	83%
Passeridae	Old World Sparrows	2	-331.0	-374.6	-290.2	-81.1%	-82.7%	-79.4%	50%
Alaudidae	Larks	1	-182.0	-207.2	-157.8	-67.4%	-70.9%	-63.7%	100%
Fringillidae	Finches and Allies	13	-144.6	-189.2	-91.9	-36.7%	-45.9%	-23.8%	62%
Tyrannidae	Tyrant Flycatchers	26	-88.2	-107.3	-69.5	-20.1%	-23.7%	-16.2%	50%
Sturnidae	Starlings	1	-83.2	-94.7	-72.6	-49.3%	-52.4%	-46.0%	100%
Turdidae	Thrushes	11	-77.6	-114.2	-38.1	-10.1%	-14.6%	-5.0%	55%
Hirundinidae	Swallows	8	-60.8	-86.7	-31.4	-22.1%	-30.1%	-11.9%	75%
Caprimulgidae	Nightjars	5	-39.3	-44.0	-34.9	-55.0%	-58.0%	-51.5%	60%
Calcariidae	Longspurs	5	-39.3	-79.0	34.3	-31.2%	-60.5%	26.8%	80%
Odontophoridae	New World Quail	5	-21.1	-32.6	-10.0	-51.6%	-61.2%	-35.7%	80%
Laridae	Gulls, Terns	22	-20.1	-27.6	-13.3	-50.5%	-58.4%	-39.9%	73%
Apodidae	Swifts	4	-19.2	-21.4	-17.1	-65.3%	-68.1%	-61.6%	100%
Trochilidae	Hummingbirds	8	-18.9	-36.0	-2.2	-17.0%	-27.7%	-2.6%	63%
Mimidae	Thrashers and Allies	10	-18.3	-22.1	-14.6	-19.4%	-22.9%	-16.0%	80%
Regulidae	Kinglets	2	-17.9	-47.6	12.1	-7.1%	-17.7%	5.0%	50%
Scolopacidae	Sandpipers	32	-15.4	-19.9	-11.1	-38.4%	-46.7%	-28.6%	72%
Cardinalidae	Cardinals and Allies	14	-10.8	-20.6	-1.0	-3.3%	-6.3%	-0.3%	43%
Laniidae	Shrikes	2	-10.3	-11.6	-9.0	-69.0%	-72.2%	-65.7%	100%
Cuculidae	Cuckoos	4	-8.9	-10.5	-7.4	-47.9%	-53.6%	-41.5%	75%
Motacillidae	Pipits, Wagtails	2	-8.1	-12.7	-2.4	-29.0%	-44.0%	-8.6%	100%
Corvidae	Jays, Crows	16	-6.6	-11.8	-1.2	-6.5%	-11.4%	-1.1%	69%
Phylloscopidae	Leaf Warblers	1	-6.4	-16.3	0.7	-50.4%	-76.8%	5.6%	100%
Paridae	Tits, Chickadees	10	-5.3	-11.4	0.8	-4.9%	-10.2%	0.7%	70%
Alcidae	Auks	11	-4.6	-16.8	9.0	-15.9%	-45.8%	33.4%	45%
Icteriidae	Yellow-breasted Chat	1	-3.9	-5.4	-2.5	-21.2%	-28.0%	-13.9%	100%
Ardeidae	Hérons	12	-3.4	-4.4	-2.4	-28.0%	-34.1%	-21.2%	58%
Remizidae	Penduline-Tits	1	-2.6	-4.0	-1.4	-42.0%	-53.2%	-28.0%	100%
Charadriidae	Plovers	8	-1.9	-3.1	-0.9	-38.6%	-47.4%	-32.0%	88%

Alcedinidae	Kingfishers	1	-1.6	-1.9	-1.3	-47.8%	-51.5%	-44.0%	100%
Procellariidae	Petrels	1	-1.0	-3.8	3.7	-33.8%	-79.3%	104.4%	100%
Aegithalidae	Long-tailed Tits	1	-0.9	-1.4	-0.3	-28.4%	-42.5%	-10.7%	100%
Podicipedidae	Grebes	6	-0.7	-2.6	1.9	-10.9%	-35.8%	35.7%	50%
Sylviidae	Sylviid Warblers	1	-0.6	-1.1	-0.3	-27.7%	-38.0%	-15.4%	100%
Cinclidae	Dippers	1	-0.03	-0.05	0.00	-15.5%	-27.2%	-2.0%	100%
Aramidae	Limpkin	1	0.00	-0.02	0.02	-15.0%	-62.1%	89.0%	100%
Ciconiidae	Storks	1	0.01	0.00	0.02	77.6%	18.3%	166.9%	0%
Haematopodidae	Oystercatchers	2	0.01	0.01	0.02	123.7%	59.5%	218.0%	0%
Falconidae	Falcons, Caracaras	6	0.03	-0.49	0.63	0.5%	-9.3%	12.6%	33%
Anhingidae	Aningas	1	0.03	0.02	0.04	109.1%	66.3%	164.5%	0%
Psittacidae	Parrots	1	0.1	0.0	0.3	>1000%	>1000%	>1000%	0%
Tytonidae	Barn Owls	1	0.1	0.1	0.2	211.6%	132.6%	317.8%	0%
Recurvirostridae	Avocets, Stilts	2	0.2	0.0	0.5	57.5%	16.2%	174.6%	0%
Ptiliogonatidae	Silky Flycatchers	1	0.3	0.0	0.7	26.4%	-3.8%	65.2%	0%
Sulidae	Boobies	1	0.4	0.2	0.7	988.6%	497.0%	1891.7%	0%
Gaviidae	Loons	3	0.4	0.1	0.8	32.6%	11.7%	60.7%	33%
Pandionidae	Osprey	1	0.4	0.3	0.5	304.4%	248.4%	370.3%	0%
Rallidae	Rails, Coots	7	0.6	-1.9	4.2	6.2%	-18.1%	40.5%	57%
Gruidae	Cranes	1	0.7	0.5	0.9	914.5%	743.0%	1119.1%	0%
Pelecanidae	Pelicans	2	0.7	0.5	1.2	810.4%	534.6%	1214.2%	0%
Phalacrocoracidae	Cormorants	4	0.8	0.4	1.3	152.3%	73.1%	267.3%	50%
Strigidae	Owls	11	1.7	0.5	3.4	15.9%	4.6%	30.1%	64%
Certhiidae	Treecreepers	1	2.5	1.5	3.7	33.6%	20.8%	47.9%	0%
Threskiornithidae	Ibises, Spoonbills	4	2.9	1.4	6.3	332.8%	167.3%	639.4%	0%
Columbidae	Doves, Pigeons	7	3.6	-17.4	43.3	1.9%	-9.0%	23.1%	57%
Accipitridae	Hawks	16	5.5	5.0	6.0	78.9%	71.8%	86.4%	19%
Bombycillidae	Waxwings	2	8.0	2.1	14.6	13.8%	3.6%	25.0%	50%
Cathartidae	New World Vultures	2	9.4	8.3	10.6	265.3%	238.7%	293.6%	0%
Troglodytidae	Wrens	10	13.3	6.5	20.7	13.8%	6.8%	21.5%	40%
Picidae	Woodpeckers	21	13.6	10.2	17.2	18.5%	13.9%	23.4%	33%
Sittidae	Nuthatches	4	14.4	11.0	18.4	66.6%	50.5%	85.0%	50%
Phasianidae	Grouse and Allies	12	15.2	2.9	36.6	24.3%	4.5%	56.4%	33%
Poliophtilidae	Gnatcatchers	2	31.9	12.7	54.5	15.6%	6.2%	26.3%	0%
Anatidae	Waterfowl	42	34.8	24.5	48.3	56.1%	37.9%	79.5%	43%
Vireonidae	Vireos	12	89.9	78.6	102.1	53.6%	46.7%	60.7%	17%

888 **Table S3.**

889 GAM spatial trend analysis and model comparison. AIC gives Akaike’s An Information Criterion.
 890 df gives degrees of freedom. Models significantly different according to a Chi-squared likelihood
 891 ratio test are labelled by different letters (a,b). Change in biomass traffic was calculated as a spatial
 892 mean of the multiplication of spatial trend and kriging-interpolated biomass passage. Changes in
 893 biomass traffic are based on spatial averages of the GAM predictions over the contiguous US, as
 894 detailed in the text. From left to right: % / yr = annual rate of decline in seasonal migration traffic,
 895 % = decline over the period 2007-2017, loss in seasonal migration traffic, p = significance of the
 896 te(lon,lat):year trend term. See Figure S7 for plots of the estimated smoothed spatial trend.
 897

Model*	Formula	AIC	df		change in biomass traffic 2007-2017			
					% / yr	%	10 ⁵ birds/km	p
1	index ~ te(lon,lat) + te(lon,lat):year + dualpol [†]	337	10	a	-1.2 ± 0.7	-11.6 ± 5.9	-1.4 ± 1.7	<0.0001
2	index ~ te(lon,lat) + te(lon,lat):year + mode [‡]	338	11	a	-1.6 ± 0.8	-14.8 ± 7.2	-1.8 ± 1.9	<0.0001
3	Index ~ te(lon,lat) + te(lon,lat):year + superres [§]	342	10	b	-2.9 ± 0.5	-25.6 ± 4.2	-3.2 ± 2.8	<0.0001
4	index ~ te(lon,lat) + te(lon,lat):year	360	9	c	-3.3 ± 0.6	-28.7 ± 4.1	-3.7 ± 3.1	<0.0001
1-4	(model average)				-1.5 ± 1.0	-13.6 ± 9.1	-1.7 ± 1.8	

898 *Family=Gamma(link=log)
 899 ‡mode is a factor variable with levels “legacy”, “superres” and “dualpol”, distinguishing the three time periods in
 900 which the radar acquired legacy, super-resolution and dual-polarization data. Note that the dual-polarization upgrade
 901 occurred after the super-resolution upgrade, and dual-polarization data includes super-resolution.
 902 †dualpol is a logical variable that is true after the dual-polarization upgrade, and false before
 903 §superres is a logical variable that is true after the superresolution upgrade, and false before
 904
 905
 906

907 **Table S4.**

908 Model comparison of regionalized generalized mixed models, differentiating in four geographic
 909 flyway regions: Atlantic, Mississippi, Central and Western (see Fig. XXX). AIC gives Akaike’s
 910 An Information Criterion, df degrees of freedom. Models significantly different according to a
 911 Chi-squared likelihood ratio test are labelled by different letters (a,b). We found support for an
 912 effect of dual-polarization upgrade on detected biomass passage (cf. model 5), but not for
 913 additional correction for the superresolution upgrade (model 6 did not improve over model 5). See
 914 Table S5 for fixed effect estimates.

915

Model*	Formula	AIC	df	
5	index ~ region + year:flyway + (1 radar) + dualpol [†]	338	11	a
6	index ~ region + year:flyway + (1 radar) + mode [‡]	340	12	a
7	Index ~ region + year:flyway + (1 radar) + superres	343	11	b
8	Index ~ region + year:flyway + (1 radar)	361	10	c

916

*Family=Gamma(link=log)

917

‡mode is a factor variable with levels “legacy”, “superres” and “dualpol”, distinguishing the three time periods in which the radar acquired legacy, super-resolution and dual-polarization data. Note that the dual-polarization upgrade occurred after the super-resolution upgrade, and dual-polarization data includes super-resolution.

919

†dualpol is a logical variable that is true after the dual-polarization upgrade, and false before

920

§superres is a logical variable that is true after the superresolution upgrade, and false before

921

922

923

924 **Table S5.**

925 Parameter estimates of temporal and detection-related fixed effects, based on generalized mixed
 926 models differentiating in three geographic regions: west ($\text{lon} < -105^\circ$), central ($-105^\circ < \text{lon} < -95^\circ$)
 927 and east ($\text{lon} > -95^\circ$). Estimates of change in migratory biomass traffic are expressed as percentages
 928 change per year. Explanatory variable year was scaled to zero at 2007. Significant model terms are
 929 highlighted in **bold**. See Table S4 for model comparisons.
 930

Model	Fixed effect	Estimate	Unit	t	p
5	year:flyway_Atlantic	-3.0 ± 0.6	%/yr	-4.7	<0.0001
5	year:flyway_Mississippi	-2.7 ± 0.6	%/yr	-4.5	<0.0001
5	year:flyway_Central	0.6 ± 0.6	%/yr	1.0	0.3
5	year:flyway_Pacific	0.2 ± 0.6	%/yr	0.3	0.8
5	dualpol=TRUE	-16 ± 3	%	-5.0	<0.0001
6	year:flyway_Atlantic	-3.4 ± 0.7	%/yr	-4.5	<0.0001
6	year:flyway_Mississippi	-3.0 ± 0.7	%/yr	-4.2	<0.0001
6	year:flyway_Central	0.2 ± 0.7	%/yr	0.3	0.7
6	year:flyway_Pacific	0.1 ± 0.8	%/yr	-0.2	0.9
6	mode="superres"	25 ± 27	%	0.9	0.4
6	mode="dualpol"	-12 ± 5	%	-2.4	0.02
7	year:flyway_Atlantic	-4.7 ± 0.5	%/yr	-9.9	<0.0001
7	year:flyway_Mississippi	-4.4 ± 0.4	%/yr	-10.2	<0.0001
7	year:flyway_Central	-1.2 ± 0.4	%/yr	-2.7	0.007
7	year:flyway_Pacific	-1.5 ± 0.5	%/yr	-3.0	0.003
7	superres=TRUE	8 ± 2	%	4.4	<0.0001
8	year:flyway_Atlantic	-5.2 ± 0.5	%/yr	-10.9	<0.0001
8	year:flyway_Mississippi	-4.8 ± 0.4	%/yr	-11.3	<0.0001
8	year:flyway_Central	-1.5 ± 0.4	%/yr	-3.5	0.0004
8	year:flyway_Pacific	-1.9 ± 0.5	%/yr	-3.8	0.0001
5-8 (average)†	year:flyway_Atlantic	-3.2 ± 0.8	%/yr	4.1*	<0.0001
5-8 (average)†	year:flyway_Mississippi	-2.9 ± 0.7	%/yr	3.9*	0.0001
5-8 (average)†	year:flyway_Central	0.4 ± 0.8	%/yr	0.5*	0.6
5-8 (average)†	year:flyway_Pacific	0.3 ± 0.8	%/yr	0.0*	1.0

931 *z value instead of t value

932 †showing full model-averaged coefficients for temporal fixed effects only

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937 **Data S1. (separate file)**

938 **Species-specific data and results for analysis of net population change in the North American**
939 **avifauna.** Included are 529 species with common and scientific names, taxonomic sort number
940 (*100*), bird family, species group and biome assignments, absolute and proportional changes in
941 abundance with associated variance, start and end-year population estimates with variance, and
942 source data for population size estimates and population trajectories for each species. A separate
943 worksheet in the same file contains definitions of each column header.
944

945 **Data S2. (separate file)**

946 **Species-specific adjustment factors used in the calculation of Partners in Flight (PIF)**
947 **population size estimates based on BBS count data.** Included are 399 species, including 344
948 landbird species previously published in (35), and 55 additional non-landbird species for which
949 we estimated population size using identical methods. Unrounded population size estimates
950 (PopUsCa) are the same as in Data S1, and are provided here for easy reference. Adjustment factors
951 are further defined and described in (35).
952

952

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species	sci_name	sort	Breeding	Winter	Bio	Family	bird_group	Migrate	AI	native	popost	popestci	popuestci	first_year	last_year	p.Pop.source	Trajectory	Trajectory	Trajectory	Loss_med	Loss_lci	Loss_uci	Loss_lqrt	Loss_uqrt
Albert's Towhee	Melospiza	1817	Arlandis	Southwest	Passerellidae	landbird	R	other	native	892043	429538	1469410	2006	2015	PIF0615	BS87017	1970	2017	-271177	-726620	-261484	-399159	-168279	
Acadian Flycatcher	Empidonax	1303	Eastern	For	Mexico-Cer	Tyrannidae	landbird	M	other	native	5227721	4728009	5829898	2006	2015	PIF0615	BS87017	1970	2017	4701777	-305836	9447791	302529.3	6319050
Acorn Woodpecker	Melanerpes	939	Western	For	Widespread	Cuculidae	landbird	R	other	native	2226303	1452256	3390813	2006	2015	PIF0615	BS87017	1970	2017	-472997	-1177341	-379432	-676790	-308044
Allen's Hummingbird	Empidonax	1304	Boreal	For	South Amer	Tyrannidae	landbird	M	other	native	1.18E+08	99384651	1.41E+08	2006	2015	PIF0615	BS87017	1970	2017	43413071	28809038	59401956	38418052	481718058
Allen's Hummingbird	Empidonax	342	Arlandis	Southwest	Trochilidae	landbird	M	other	native	1484682	38005	471751	2006	2015	PIF0615	BS87017	1970	2017	405856	3133885	646877	234739	6507417	
American Avocet	Recurvirostris	444	Wetland	Widespread	Recurvirostris	shorebird	M	other	native	450000	180000	1125000	2011	2013	Shoreb12	BS87017	1970	2017	854871	-322752	3663752	-148701	-386194	
American Bittern	Botaurus	727	Wetland	Temperate	Ardeidae	waterbird	M	other	native	2507977	2005616	3117498	2006	2015	PIF0615	BS87017	1970	2017	7158974	1734831	1234861	5296102	894811.8	
American Black Duck	Anas rubripes	49	Wetland	Temperate	Anatidae	waterfowl	M	other	native	583500	500200	666800	2013	2017	FWS1317	BS87017	1970	2017	3405121	1778682	5056616	285366	396500.9	
American Coot	Fulica americana	435	Wetland	Widespread	Anatidae	waterfowl	M	other	native	5517522	4109506	7381712	2006	2015	PIF0615	BS87017	1970	2017	-181609	-3237243	1759719	-1047916	5420320.1	
American Crow	Corvus brachyrhynchos	1393	Habitat	For	Temperate	Corvidae	landbird	M	other	native	28047630	26447403	29639378	2006	2015	PIF0615	BS87017	1970	2017	-837553	-2431116	3747556	-1392338	-310653
American Dipper	Cinclus mexicanus	1514	Wetland	Temperate	Cinclidae	landbird	R	other	native	151919	114060	200186	2006	2015	PIF0615	BS87017	1970	2017	2718393	2510775	5252367	18845.9	35727.05	
American Golden-Plover	Pluvialis dominica	452	Arctic	Tund	South Amer	Charadriidae	shorebird	M	other	native	500000	294200	705800	2011	2013	Shoreb12	Mig7416	1974	2016	4780981	2040999	8276568	37772.4	587140.6
American Golden-Plover	Pluvialis dominica	1771	Forest	Gen	Temperate	Fringillidae	landbird	M	other	native	44092850	4554624	46767583	2006	2015	PIF0615	BS87017	1970	2017	2743107	1483054	6269189	1494909	3959385
American Kestrel	Falco sparverius	998	Habitat	For	Widespread	Falconidae	landbird	M	other	native	2827776	2564206	3116508	2006	2015	PIF0615	BS87017	1970	2017	1878754	1595457	2174950	1781703	1978651
American Osprey	Haematopus	446	Coasts	Coastal	Haematopidae	shorebird	M	other	native	114300	10700	131500	2011	2013	Shoreb12	BS87017	1970	2017	-362498	-10115.3	363.068	-5490.83	-2200.22	
American Pigmy Woodpecker	Empidonax	1678	Arctic	Tund	Temperate	Motacillidae	landbird	M	other	native	18034890	17874051	18354686	2006	2015	PIF0615	BS87017	1970	2017	4465486	-3215829	8819001	2742905	6050415
American Redstart	Setophaga ruticilla	1983	Eastern	For	Widespread	Parulidae	landbird	M	other	native	42464474	37027311	48475245	2006	2015	PIF0615	BS87017	1970	2017	4242063	-432721	8951280	276689	5863736
American Robin	Turdus migratorius	1603	Forest	Gen	Temperate	Turdidae	landbird	M	other	native	3.66E+08	3.37E+08	3.93E+08	2006	2015	PIF0615	BS87017	1970	2017	-2E+07	-3.7E+07	-3750046	-2.6E+07	-1.4E+07
American Three-toed Woodpecker	Picoides	958	Boreal	For	Temperate	Cuculidae	landbird	R	other	native	1564230	1108671	261048	2006	2015	PIF0615	BS87017	1970	2017	-1574551	-2608131	-875172	-1884774	-1298197
American Tree Sparrow	Spizella monticola	1828	Arctic	Tund	Temperate	Passerellidae	landbird	M	other	native	26412817	19492087	32600474	2006	2015	PIF0615	BS87017	1970	2017	29847392	19971565	40527844	26299536	33469530
American White Pelican	Pelecanus erythrorhynchos	724	Wetland	Temperate	Pelecanidae	waterfowl	M	other	native	414730	299521	546711	2006	2015	PIF0615	BS87017	1970	2017	-598862	-1038608	-340170	-722401	-492236	
American Wigeon	Marca americana	44	Wetland	Temperate	Anatidae	waterfowl	M	other	native	2997300	2640100	3354500	2013	2017	FWS1317	FWS7017	1970	2017	211210	-578048	904040	-51414.6	455778.9	
American Woodcock	Spizocopa monticola	512	Eastern	For	Temperate	Spizocopidae	shorebird	M	other	native	3500000	3000000	4000000	2011	2013	Shoreb12	SG56817	1970	2017	1664212	1325504	2031493	1544191	1785860
Ancient Murrelet	Synthliboramphus	555	Coasts	Marine	Alcidae	waterbird	M	other	native	1000000	500000	1500000	1990	1992	BNA2010	BS87017	1970	2017	-1738979	-4643318	-487306	-240071	-1914799	
Anhinga	Anhinga melanogaster	723	Wetland	Widespread	Anhinga	waterbird	M	other	native	27000	20000	34000	1978	1980	BNA2000	BS87017	1970	2017	-277968	-44385	-16120.8	-33010.8	-23330.6	
Anna's Hummingbird	Calypte anna	336	Arlandis	Temperate	Trochilidae	landbird	M	other	native	8772569	4880026	16549527	2006	2015	PIF0615	BS87017	1970	2017	4793952	-1.2E+07	-2325109	8504644	-5231861	
Anna's Hummingbird	Calypte anna	615	Arctic	Tund	Temperate	Haematopidae	shorebird	M	other	native	1900000	250000	250000	2004	2008	WIPES	BS87017	1993	2017	4948444	4594165	1165517	317837	698559.4
Arctic Warbler	Phylloscopus	1526	Arctic	Tund	Temperate	Phylloscopidae	landbird	M	other	native	8201201	2638973	16439186	2006	2015	PIF0615	BS87017	1970	2017	6128758	-474299	15763298	344084	9088913
Ash-throated Flycatcher	Melicospiza	1247	Arlandis	Mexico-Cer	Tyrannidae	landbird	M	other	native	6847348	5661743	8193938	2006	2015	PIF0615	BS87017	1970	2017	-2577423	-3580302	-1747990	-2909963	-271995	
Atlantic Puffin	Fratercula arctica	562	Coasts	Marine	Alcidae	waterbird	M	other	native	375000	350000	400000	1998	2000	BNA2002	BS87017	1970	2017	-509047	-1397635	-122553	-738613	-33445	
Bachman's Sparrow	Peucaea aedon	1825	Eastern	For	Temperate	Passerellidae	landbird	R	other	native	167964	102917	256160	2006	2015	PIF0615	BS87017	1970	2017	453787.5	24709.4	667229.6	379020.5	526396.1
Baird's Sandpiper	Calidris bairdii	500	Arctic	Tund	South Amer	Spizocopidae	shorebird	M	other	native	300000	120000	750000	2011	2013	Shoreb12	Mig7416	1974	2016	-7354	-38993	21388.27	-138017	-6211.9
Baird's Sparrow	Centronyx bairdii	1844	Grassland	Southwest	Passerellidae	landbird	M	other	native	3440174	2322349	4825899	2006	2015	PIF0615	BS87017	1970	2017	5962461	3593246	8610544	5113821	6841097	
Bald Eagle	Haliaeetus leucocephalus	795	Wetland	Temperate	Accipitridae	landbird	M	other	native	200000	100000	300000	2015	2017	ACAD	BS87017	1970	2017	-199325	-312190	-6947.8	-326329	-162465	
Baltimore Oriole	Icterus galbula	1922	Eastern	For	Widespread	Icteridae	landbird	M	other	native	11806322	10808329	12963225	2006	2015	PIF0615	BS87017	1970	2017	8601411	7298291	10202637	8136466	9067441
Band-tailed Pigeon	Patagioena	156	Western	For	Mexico-Cer	Columbidae	landbird	M	other	native	1455144	1049053	1990799	2006	2015	PIF0615	BS87017	1970	2017	1428395	8770562	2065349	1212143	1641593
Bank Swallow	Riparia riparia	1430	Habitat	For	South Amer	Hirundinidae	landbird	M	AI	native	7940368	6125188	10752527	2006	2015	PIF0615	BS87017	1970	2017	56359017	3979185	7392729	50452682	62176291
Barred Owl	Tyto alba	828	Habitat	For	Widespread	Tyrannidae	landbird	M	other	native	130571	81975	193386	2006	2015	PIF0615	BS87017	1970	2017	-108515	-190380	-54157.3	-132808	-87354
Barred Owl	Tyto alba	1423	Habitat	For	South Amer	Hirundinidae	landbird	M	AI	native	46855476	43409178	5012099	2006	2015	PIF0615	BS87017	1970	2017	26205491	23286215	30355890	2489553	2758443
Barn Swallow	Hirundo	860	Forest	Gen	Temperate	Strigidae	landbird	R	other	native	3457882	3024086	3952819	2006	2015	PIF0615	BS87017	1970	2017	-2129260	-2605653	-1721838	-2288824	-1980560
Barrow's Goldeneye	Bucephala	74	Wetland	Temperate	Anatidae	waterfowl	M	other	native	204250	102125	306375	2004	2006	SeDu07	BS87017	1970	2017	127372.1	44650.67	234717.3	96082.26	116408.1	
Bay-breasted Warbler	Setophaga ruticilla	1990	Boreal	For	Mexico-Cer	Parulidae	landbird	M	other	native	9892605	6894711	13872810	2006	2015	PIF0615	BS87017	1970	2017	1601578	-1778854	5466113	55700.7	2583102
Belted Kingfisher	Megascops asio	1840	Arlandis	Southwest	Passerellidae	landbird	M	other	native	214853	89930	390058	2006	2015	PIF0615	BS87017	1970	2017	15185.27	-51467.5	83358.42	-2835.01	35778.58	
Belted Kingfisher	Megascops asio	1349	Arlandis	Southwest	Certhiidae	landbird	M	other	native	4599734	3593221	5764813	2006	2015	PIF0615	BS87017	1970	2017	-1778207	-3052932	-840648	-2217275	-1425545	
Belted Kingfisher	Megascops asio	907	Wetland	Widespread	Alcedinidae	landbird	M	other	native	1847398	1568548	2159306	2006	2015	PIF0615	BS87017	1970	2017	1557332	1271728	1868622	1456772	3659761	
Bendire's Thrasher	Toxostoma	1625	Arlandis	Southwest	Mimidae	landbird	M	other	native	56338	30887	93302	2006	2015	PIF0615	BS87017	1970	2017	2727275	1204119	4299388	219764.2	127550.5	
Bewick's Wren	Thryomanes bewickii	1472	Arlandis	Temperate	Troglodytidae	landbird	M	other	native	4567446	3672732	5765760												

Caspian Tern	Hydroprog	608	Wetland	Coastal	Laridae	waterbird	M	other	native	78325	41255	130130	2006	2015	PIF0615	BBS7017	1970	2017	-26345.6	-67560.4	-4025.23	-38047.5	-16984.3	
Cassin's Auklet	Ptychoram	556	Coasts	Marine	Alcidae	waterbird	M	other	native	3200000	2400000	4000000	2007	2009	BNA2011	CBG7017	1970	2017	7699955.5	4784197	3699968	510120	1793900	
Cassin's Finch	Haemorhous	1751	Western For	Temperate	Fringillidae	landbird	M	other	native	3191950	2521299	4034002	2006	2015	PIF0615	BBS7017	1970	2017	4177144	3053576	5448139	3783289	4600123	
Cassin's Kingbird	Tyrannus cv	1275	Western For	Temperate	Tyrannidae	landbird	M	AI	native	2480328	1833328	3291285	2006	2015	PIF0615	BBS7017	1970	2017	-240693	-888876	2519998	-439888	-63998.3	
Cassin's Sparrow	Pyruncus	1824	Grassland	Southwest	Passerellidae	landbird	M	AI	native	9598748	7485112	12176616	2006	2015	PIF0615	BBS7017	1970	2017	3972623	1471435	6563651	3142413	4800656	
Cassin's Vireo	Vireo casid	1354	Western For	Temperate	Certhiidae	landbird	M	AI	native	4566260	3715715	5417290	2006	2015	PIF0615	BBS7017	1970	2017	-1670000	-2604824	2441422	-1857280	-1484222	
Cattle Egret	Bubulcus it	748	Wetland	Widespread	Ardeidae	waterbird	M	AI	native	2804856	2196814	3562031	2006	2015	PIF0615	BBS7017	1970	2017	2329124	1636274	3125673	2038580	2591015	
Cave Swallow	Petrochelid	1432	Aridlands	Mexico-Cer	Hirundinidae	landbird	M	AI	native	2769841	1680817	4047664	2006	2015	PIF0615	BBS7017	1970	2017	-5303540	-2.2E+07	-1299960	8684163	-3260894	
Cedar Waxwing	Bombycilla	1638	Forest	Temperate	Bombycillidae	landbird	M	other	native	63975308	58030057	70240507	2006	2015	PIF0615	BBS7017	1970	2017	-1.1E+07	-1.7E+07	-5022836	-1.3E+07	-8817489	
Cerulean Warbler	Setophaga	1986	Eastern For	South Amer	Parulidae	landbird	M	other	native	528920	363210	714480	2006	2015	PIF0615	BBS7017	1970	2017	1161090	765897.8	1565903	1202376	1295156	
Chestnut-backed C	Poocellif ruf	1439	Western For	Temperate	Paridae	landbird	R	other	native	12062590	8656647	16306921	2006	2015	PIF0615	BBS7017	1970	2017	9484800	6134406	13432190	8258732	1083610	
Chestnut-crowned	Chalcophaps	1774	Grassland	Southwest	Caprimulgidae	landbird	M	other	native	3095825	2018124	4336047	2006	2015	PIF0615	BBS7017	1970	2017	16283043	10349767	22493605	14189570	18417090	
Chestnut-sided	Wax Setophaga	1993	Eastern For	Mexico-Cer	Parulidae	landbird	M	other	native	18265512	16119410	20584431	2006	2015	PIF0615	BBS7017	1970	2017	11944485	9323966	14756127	10993907	12885820	
Chihuahuan	Van Sonopha	1406	Aridlands	Southwest	Corvidae	landbird	M	other	native	277286	193193	390354	2006	2015	PIF0615	BBS7017	1970	2017	32909.66	-38935.5	101245.3	10182.1	55890.5	
Chimney Swift	Chaetura p	260	Eastern For	South Amer	Apodidae	landbird	M	AI	native	8808551	8013311	9665731	2006	2015	PIF0615	BBS7017	1970	2017	17811323	15899653	19800343	17135664	18491796	
Chipping Sparrow	Spizella ps	1829	Forest	Temperate	Passerellidae	landbird	M	AI	native	2.31E+08	2.13E+08	2.5E+08	2006	2015	PIF0615	BBS7017	1970	2017	79503437	60736278	98183880	72857129	86031360	
Chuck-will's-widow	Antrozom ch	236	Eastern For	Mexico-Cer	Caprimulgidae	landbird	M	AI	native	5642111	4800407	6608314	2006	2015	PIF0615	BBS7017	1970	2017	9545319	7859201	11235616	8976951	10121135	
Chukar	Alectoris c	114	Introduced	Introduced	Phasianidae	waterfowl	M	Introduced	Introduced	392143	227755	612200	2006	2015	PIF0615	BBS7017	1970	2017	-188483	429208	51072.9	-256748	131675	
Cinnamon Teal	Spizula cy	39	Wetland	Temperate	Anatidae	waterfowl	R	other	native	442510	275337	612200	2006	2015	PIF0615	BBS7017	1970	2017	617237.2	32182.8	934033.3	515483.2	721892.7	
Clapper Rail	Rallus creph	409	Coasts	Coastal	Rallidae	waterbird	R	other	native	170587	8548	286396	2006	2015	PIF0615	BBS7017	1970	2017	58573.67	-2026.51	139222.7	36192.04	83942.73	
Clark's Grebe	Aechmoph	147	Wetland	Temperate	Podicipedidae	waterbird	M	other	native	71737	18009	161501	2006	2015	PIF0615	CBG7017	1970	2017	145485.8	98.41409	298343.6	94134.45	197216.1	
Clark's Nutcracker	Nucifraga c	1390	Western For	Temperate	Corvidae	landbird	R	other	native	290441	227717	363870	2006	2015	PIF0615	BBS7017	1970	2017	4313.497	-69708.9	65170.23	-17589	26032.34	
Clay-colored Spar	Spizella ps	1380	Grassland	Southwest	Passerellidae	landbird	M	other	native	9419306	51415968	69884231	2006	2015	PIF0615	BBS7017	1970	2017	43211619	33005069	54023773	39720474	46764935	
Cliff Swallow	Petrochelid	1431	Habitat	Western For	Hirundinidae	landbird	M	AI	native	77981069	67646472	89137460	2006	2015	PIF0615	BBS7017	1970	2017	-3.6E+07	-5.5E+07	-2E+07	-4.2E+07	-3E+07	
Common Eider	Somateria i	64	Coasts	Coastal	Anatidae	waterfowl	M	other	native	1264000	948000	1580000	2004	2006	SeDu07	CBG7017	1970	2017	-408544	-3419333	5920656	-1082415	21895.41	
Common Gallinule	Gallinula g	431	Wetland	Widespread	Rallidae	waterbird	M	other	native	500214	251427	938255	2006	2015	PIF0615	BBS7017	1970	2017	288652.9	83999.12	577977.6	209984.6	372618.9	
Common Goldeneye	Bucephala l	73	Wetland	Temperate	Anatidae	waterfowl	M	other	native	1300000	975000	1625000	2004	2006	SeDu07	BBS7017	1970	2017	-406337	-782874	132805	-523462	-302446	
Common Grackle	Quiscalus a	1939	Habitat	Temperate	Icteridae	landbird	M	other	native	6712396	6112337	7408533	2006	2015	PIF0615	BBS7017	1970	2017	82793226	7935359	9245560	7975616	86273630	
Common Ground-C	Columba g	170	Aridlands	Southwest	Columbidae	landbird	R	other	native	1589214	1585896	2440861	2006	2015	PIF0615	BBS7017	1970	2017	674901.6	312107	1051247	555725.6	798884.8	
Common Loon	Gavia imm	629	Wetland	Temperate	Gaviidae	waterbird	M	other	native	1108865	941048	1319057	2006	2015	PIF0615	BBS7017	1970	2017	-333381	-531502	-175052	-396892	-275644	
Common Merganser	Mergus me	77	Wetland	Temperate	Anatidae	waterfowl	M	other	native	1200000	600000	1800000	2004	2006	SeDu07	BBS7017	1970	2017	200412.6	-48845.5	491983.3	114195.7	292200.7	
Common Murre	Uria aalge	543	Coasts	Marine	Alcidae	waterbird	M	other	native	7400000	5550000	9250000	2006	2002	BNA2002	CBG7017	1970	2017	568368	9265601	5644138	-1867886	2468045	
Common Nighthawk	Chordeiles	227	Habitat	For	South Amer	Caprimulgidae	landbird	M	AI	native	21789605	19345867	24683737	2006	2015	PIF0615	BBS7017	1970	2017	25989826	22044493	30281368	24582541	27426270
Common Pipit	Phalaenopt	230	Aridlands	Southwest	Caprimulgidae	landbird	M	AI	native	1333400	965383	1769246	2006	2015	PIF0615	BBS7017	1970	2017	-202807	-480452	10986.41	-289595	-125091	
Common Raven	Corvus cr	1407	Habitat	For	Widespread	Corvidae	landbird	R	other	native	8250632	7605338	8984942	2006	2015	PIF0615	BBS7017	1970	2017	-6686854	-8000479	-5501274	-7108395	-6255039
Common Redpoll	Acantthis fr	1754	Arctic Tund	Temperate	Fringillidae	landbird	M	other	native	39008853	30299103	49713410	2006	2015	PIF0615	BBS9317	1993	2017	46969020	8989946	46984894	22622733	32523425	
Common Tern	Sterna hir	614	Wetland	Coastal	Laridae	waterbird	M	other	native	468971	175901	956061	2006	2015	PIF0615	BBS7017	1970	2017	616724.6	90869.32	1234947	429217.6	812831.4	
Common Yellowthroat	Geothlypis	1976	Habitat	For	Widespread	Parulidae	landbird	M	other	native	75588462	70946562	80532560	2006	2015	PIF0615	BBS7017	1970	2017	35511230	29893266	41334660	33528491	37463004
Connecticut Warbl	Oporornis s	1751	Forest	Temperate	Parulidae	landbird	M	other	native	1175133	970368	2678400	2006	2015	PIF0615	BBS7017	1970	2017	2197716	1102707	3439947	1806168	2609499	
Copier's Hawk	Accipiter c	790	Forest	Temperate	Accipitridae	landbird	M	other	native	644899	770821	925643	2006	2015	PIF0615	BBS7017	1970	2017	-797391	-923902	-681504	-838337	-756988	
Cordellian Flycatcher	Empidonax	1313	Western For	Mexico-Cer	Tyrannidae	landbird	M	other	native	1966693	1283176	2953557	2006	2015	PIF0615	BBS7017	1970	2017	247387.4	-60237.4	549889.6	142935.4	356938.9	
Costa's Hummingbird	Calypte co	337	Aridlands	Southwest	Trochilidae	landbird	M	other	native	1583926	611798	3182531	2006	2015	PIF0615	BBS7017	1970	2017	56114.03	-672530	672698.3	-113632	239452.4	
Couch's Kingbird	Tyrannus cc	1274	Aridlands	Mexico-Cer	Tyrannidae	landbird	R	AI	native	250613	133762	447501	2006	2015	PIF0615	BBS7017	1970	2017	-427145	-825298	-148229	-54236	-324956	
Crested Caracara	Caracara ch	994	Aridlands	Southwest	Falconidae	landbird	R	other	native	124568	87260	127235	2006	2015	PIF0615	BBS7017	1970	2017	-171252	-254350	-105082	-197860	-146735	
Crisal Thrasher	Toxostoma	1629	Aridlands	Southwest	Mimidae	landbird	R	other	native	82115	48009	124579	2006	2015	PIF0615	BBS7017	1970	2017	16571.07	-5673.59	41029.61	8892.396	24405.59	
Curve-billed Thrash	Toxostoma	1620	Aridlands	Southwest	Mimidae	landbird	R	other	native	1026123	728790	1467368	2006	2015	PIF0615	BBS7017	1970	2017	268031.1	78700.3	494623.1	200493.9	340084	
Dark-eyed Junco	Junco hinc	1861	Forest	Temperate	Passerellidae	landbird	M	other	native	2.24E+08	1.96E+08	2.54E+08	2006	2015	PIF0615	BBS7017	1970	2017	1.68E+08	1.37E+08	2.03E+08	1.57E+08	1.8E+08	
Dickcissel	Spiza amer	2306	Grassland	South Amer	Cardinalidae	landbird	M	other	native	27896722	23981764	32368972	2006	2015	PIF0615	BBS7017	1970	2017	4127773	-655746	8530709	2569466	5667241	
Doubled-crested	Cor Falacroco	719	Wetland	Temperate	Phalacrocoracidae	landbird	M	other	native	557887	365672	827251	2006	2015	PIF0615	BBS7017	1970	2017	6521575	-1142889	-3390907	-801521	-528934	
Dovekie	Alliella	542	Coasts	Marine	Alcidae	waterbird	M	other	native	1500	1125	14875	2006	2015	PIF0615	BBS7017	1970	2017	823.52	-713.022	19.908	451.759	1182.934	
Downy Woodpecker	Dryobates b	461	Forest	Temperate	Picidae	landbird	R	other	native	13422211	12764602	14412500	2006	2015	PIF0615	BBS7017	1970	2017	-273580	-113824	53594.21	-557746	3753.167	
Dunlin	Calidris alp	497	Arctic Tund	Widespread	Scopelidae	shorebird	M	other	native	1500000	744700	2750300	2011	2013	Shoreb12	Mig7416	1974	2016	2372383	766911.7	4447176	1780872	3007260	
Dusky Flycatcher	Empidonax	1310	Western For	Mexico-Cer	Tyrannidae	landbird	M	other	native	8797209	7024376	10767331	2006	2015	PIF0615	BBS7017	1970	2017	2698638	968664.3	4396337	2118391	3236639	
Dusky Grouse	Dendragap	132	Western For	Temperate	Phasianidae	landbird	R	other	native	300000	75000	525000												

Hoary Redpoll	Acanthis h	1756	Arctic Tund	Temperate	Fringillidae	landbird	M	other	native	12815104	12474111	13252214	2006	2015	PIF0615	CB07017	1970	2017	-8412361	-3E+07	694118.2	-1.4E+07	-4425774	
Hooded Merganser	Lophodytes	76	Wetland	Temperate	Anatidae	waterfowl	M	other	native	485000	363750	606250	2004	2006	Seb007	BB57017	1970	2017	-745843	-1096337	-488242	-855318	-645439	
Hooded Oriole	Icterus cuc	1910	Aridlands	Temperate	Mexico-Cer	icteridae	landbird	M	other	native	350616	236805	494427	2005	2015	PIF0615	BB57017	1970	2017	-175616	-326439	-7910.12	-20080	-137726
Hooded Warbler	Setophaga	1982	Eastern For	Mexico-Cer	Parulidae	landbird	M	other	native	5185197	4523541	5902847	2006	2015	PIF0615	BB57017	1970	2017	-2623904	-9451278	-1911338	-2882650	-2363169	
Horned Grebe	Podiceps a	143	Wetland	Temperate	Podicipedidae	waterbird	M	other	native	246553	159574	364503	2006	2015	PIF0615	BB57017	1970	2017	202267	98469.34	325658.7	16474.7	242551.8	
Horned Lark	Emberiza	142	Grassland	Temperate	Alaudidae	landbird	M	other	native	1014508	902008	1135406	2006	2015	PIF0615	BB57017	1970	2017	182648	1558408	68873.8	1746408	1915408	
House Finch	Haemorh	1749	Habitat Gen	Widespread	Fringillidae	landbird	R	other	native	3242610	2954663	3799259	2006	2015	PIF0615	BB57017	1970	2017	-2183964	-6518744	1624152	-3574124	-819800	
House Sparrow	Passer dom	1668	Introduced	Introduced	Passeridae	landbird	R	Introduced	Introduced	9284201	8370306	1046408	2005	2015	PIF0615	BB57017	1970	2017	3131408	2898408	375E+08	316E+08	346E+08	
House Wren	Troglodytes	1461	Forest Gen	Temperate	Troglodytidae	landbird	M	other	native	4331858	39758949	47473572	2006	2015	PIF0615	BB57017	1970	2017	-6013779	-1E+07	-2356280	-7533318	-4734260	
Hudsonian Godwit	Limosa hae	440	Wetland	South	AmeScolopaci	shorebird	M	other	native	77000	56424	107100	2011	2013	Shoreb12	Mig7416	1974	2016	1204979	49346.02	218544.8	93566.59	150717.5	
Hutton's Vireo	Vireo hutch	1351	Western Fo	Temperate	Vireonidae	landbird	R	other	native	964653	744358	1213151	2006	2015	PIF0615	BB57017	1970	2017	-380352	-594853	-216543	-446999	-318451	
Inca Dove	Columba	169	Aridlands	Southwest	Columbidae	landbird	R	other	native	619057	491301	765612	2006	2015	PIF0615	BB57017	1970	2017	-318794	-535573	-173030	-384240	-262939	
Indigo Bunting	Passerina c	2060	Eastern For	Mexico-Cer	Cardinalis	landbird	M	other	native	77494167	73235841	82041052	2006	2015	PIF0615	BB57017	1970	2017	31485546	26846872	36179474	29841978	3309788	
Juniper Titmouse	Baeolophu	1444	Western Fo	Temperate	Paridae	landbird	R	other	native	291637	201086	392881	2006	2015	PIF0615	BB57017	1970	2017	-74868.8	-150299	-19346.6	-98465.7	-5367.6	
Kentucky Warbler	Geothlypis	1970	Eastern For	Mexico-Cer	Parulidae	landbird	M	other	native	2559606	2284175	2937212	2006	2015	PIF0615	BB57017	1970	2017	1206007	881477.7	1543746	1091370	1321873	
Killdeer	Charadrius	463	Habitat Gen	Widespread	Charadriidae	shorebird	M	other	native	2000000	800000	5000000	2011	2013	Shoreb12	Mig7416	1974	2016	1040697	0.561577	2162057	666955	1410229	
King Eider	Somateria	63	Arctic Tund	Marine	Anatidae	waterfowl	M	other	native	560000	280000	840000	2004	2006	Seb007	CB07017	1970	2017	2802961	1118325	611662	2120670	3704472	
King Rail	Tringaleg	412	Wetland	Temperate	Rallidae	waterbird	M	other	native	63219	25663	122039	2006	2015	PIF0615	BB57017	1970	2017	3278124	85077.59	588895.9	244932.6	16435.6	
Ladder-backed W	Dryobates	963	Aridlands	Southwest	Picidae	landbird	R	other	native	2377162	1983369	2827400	2006	2015	PIF0615	BB57017	1970	2017	-296494	-599888	-49055.9	-389432	-208196	
Lapland Longspur	Calcarius l	1773	Arctic Tund	Temperate	Calcariidae	landbird	M	other	native	6802356	6026577	8059022	2006	2015	PIF0615	BB59317	1993	2017	8825957	-6.1E+07	44827345	-9904095	2295177	
Lark Bunting	Calamospiz	1841	Grassland	Southwest	Passerellidae	landbird	M	other	native	11992598	1919489	15233820	2006	2015	PIF0615	BB57017	1970	2017	31580727	22361174	41702574	28384489	34870009	
Lark Sparrow	Chondestes	1836	Grassland	Mexico-Cer	Passerellidae	landbird	M	other	native	10638631	9078588	12343951	2006	2015	PIF0615	BB57017	1970	2017	4346085	3006262	5781341	3885459	4843317	
Laughing Gull	Leucophae	576	Coasts	Coastal	Laridae	waterbird	M	other	native	684463	425116	997966	2006	2015	PIF0615	BB57017	1970	2017	-405504	-985363	-109418	-58616	-279569	
Lawrence's Goldfin	Spinus law	1770	Aridlands	Southwest	Fringillidae	landbird	M	other	native	347128	188186	574120	2006	2015	PIF0615	BB57017	1970	2017	107567.7	-27113.4	259904.2	63032.14	154542.6	
Lazuli Bunting	Passerina w	2059	Western Fo	Mexico-Cer	Cardinalis	landbird	M	other	native	6453834	5417754	7643998	2006	2015	PIF0615	BB57017	1970	2017	-1172392	-2165694	-387823	-1470958	-874565	
Least Bittern	Icthyophag	729	Wetland	Widespread	Ardeidae	waterbird	M	other	native	131773	66196	217720	2006	2015	PIF0615	BB57017	1970	2017	-33842.4	-82827.4	-2668.34	-4909.5	-20955.6	
Least Flycatcher	Empidonax	1307	Eastern For	Mexico-Cer	Tyrannidae	landbird	M	other	native	27444220	24465739	30286260	2006	2015	PIF0615	BB57017	1970	2017	31461126	2785889	36051548	30008697	32067791	
Least Sandpiper	Calidris	502	Wetland	Widespread	Scolopaci	shorebird	M	other	native	700000	466667	1050000	2011	2013	Shoreb12	Mig7416	1974	2016	5850484	-373069	-67605.2	-56514.6	162582.9	
Least Tern	Sterna au	604	Coasts	Coastal	Laridae	waterbird	M	other	native	51692	21444	97858	2006	2015	PIF0615	BB57017	1970	2017	153306.4	38913.78	285908.5	113274	196866.9	
LeConte's Sparrow	Ampospiz	1846	Grassland	Temperate	Passerellidae	landbird	M	other	native	5128134	4121245	6262076	2006	2015	PIF0615	BB57017	1970	2017	8054350	6093973	10297475	735113	8798764	
LeConte's Thrasher	Toxostoma	1628	Aridlands	Southwest	Mimidae	landbird	R	other	native	45644	15853	93422	2006	2015	PIF0615	BB57017	1970	2017	60320.87	9103.802	11970.60	42057.64	79644.42	
Lesser Goldfinch	Spinus psal	1769	Western Fo	Temperate	Fringillidae	landbird	M	other	native	573877	4542330	7132984	2006	2015	PIF0615	BB57017	1970	2017	-2154906	-3396582	-1211644	-2545780	-1791371	
Lesser Nighthawk	Chordeiles	226	Aridlands	Widespread	Caprimulgidae	landbird	M	AI	native	3801395	2399615	5548633	2006	2015	PIF0615	BB57017	1970	2017	-150010	-1143791	649061.2	-449756	123724	
Lesser Scaup	Aythya affir	60	Wetland	Widespread	Anatidae	waterfowl	M	other	native	2626619	1903177	5311659	2006	2015	PIF0615	BB57017	1970	2017	1242205	37686.19	233275.8	87375.8	1609688	
Lesser Yellowlegs	Tringa flavir	524	Wetland	Widespread	Scolopaci	shorebird	M	other	native	660000	264000	1650000	2011	2013	Shoreb12	Mig7416	1974	2016	1066078	1.929816	2399662	665628.9	1496827	
Lewis's Woodpecke	Melanerpe	935	Western Fo	Temperate	Picidae	landbird	M	other	native	81507	52913	119611	2006	2015	PIF0615	BB57017	1970	2017	107348.7	60489.74	162068.4	90527.13	125402	
Lincoln's Sparrow	Melospiza l	1853	Arctic Tund	Widespread	Ardeidae	waterbird	R	other	native	9000	6000	12000	1993	1995	BNA2002	CB07017	1970	2017	1940327	-22315.1	14961.01	-3965.7	6634087	
Little Blue Heron	Egretta cae	745	Wetland	Widespread	Ardeidae	waterbird	M	other	native	88078735	78262006	98782601	2006	2015	PIF0615	BB57017	1970	2017	2035820	-1.6E+07	17157375	-3912516	7655356	
Loggerhead Shrike	Lanius lud	1325	Grassland	Temperate	Laniidae	landbird	M	other	native	27052	191382	368199	2006	2015	PIF0615	BB57017	1970	2017	223015.8	143146.1	315468.7	194465.2	25252.2	
Long-billed Curlew	Numenius	474	Grassland	Widespread	Scolopaci	shorebird	M	other	native	455475	4080246	5094115	2006	2015	PIF0615	BB57017	1970	2017	1035978	8901422	11521725	974610	10638184	
Long-billed Dowit	Limnodrom	509	Arctic Tund	Widespread	Scolopaci	shorebird	M	other	native	140000	80000	198000	2011	2013	Shoreb12	BB57017	1970	2017	114933.98	32314.4	20209.34	-12270.44	4495.726	
Long-billed Thrash	Xostoma	1623	Aridlands	Mexico-Cer	Mimidae	landbird	R	other	native	500000	333333	750000	2011	2013	Shoreb12	Mig7416	1974	2016	-39506.1	-1036346	248319.4	-212625	66896.05	
Long-eared Owl	Asio otus	863	Forest Gen	Temperate	Strigidae	landbird	M	other	native	95573	53639	153900	2006	2015	PIF0615	BB57017	1970	2017	-125260	-127240	-56871	-153318	-100220	
Long-tailed Duck	Clangula h	71	Arctic Tund	Marine	Anatidae	waterfowl	M	other	native	37007	15671	68758	2006	2015	PIF0615	CB07017	1970	2017	55291.04	16281.04	99923.41	41268.74	70079.11	
Louisiana Waterthr	Parus m	1949	Eastern For	Widespread	Parulidae	landbird	M	other	native	1800000	500000	1500000	2004	2006	Seb007	CB07017	1970	2017	1890498	463889.9	4335005	1352052	2543619	
Lucy's Warbler	Oreothlypis	1962	Aridlands	Mexico-Cer	Parulidae	landbird	M	other	native	446545	377921	529314	2006	2015	PIF0615	BB57017	1970	2017	-148890	-209781	-99305.1	-168683	-130753	
MacGillivray's Warl	Geothlypis	1968	Western Fo	Mexico-Cer	Parulidae	landbird	M	other	native	2829790	1620023	4473592	2006	2015	PIF0615	BB57017	1970	2017	-1092282	-2483918	-305531	-149820	-373738	
Magalloway Warbler	Setophaga	1989	Eastern For	Mexico-Cer	Parulidae	landbird	M	other	native	1191876	9091713	13546236	2006	2015	PIF0615	BB57017	1970	2017	5797877	4017461	7818029	5158532	6457462	
Manitowish Scaup	Setophaga	1989</																						

Red-breasted Sapsu Sphyrapicu	956	Western Fo	Temperate	Picidae	landbird	M	other	native	2755899	1872219	3799342	2006	2015	PIF0615	BBS7017	1970	2017	-1326732	-2228692	-716471	-1603251	-1086480	
Red-cockaded Wood Droyabates i	964	Eastern Fo	Temperate	Picidae	landbird	R	other	native	15000	11250	18750	2005	2007	ACAD	BBS7017	1970	2017	2033679	1016408	3161446	1678921	2399421	
Red-eyed Vireo	1360	Forest Gen	South Amer	Vireonidae	landbird	M	other	native	1.31e+08	1.21e+08	1.41e+08	2006	2015	PIF0615	BBS7017	1970	2017	-4.4e+07	-5.4e+07	-3.5e+07	-4.7e+07	-1.4e+07	
Red-faced Cormor	721	Coasts	Coastal	Phalacrocor	waterbird	R	other	native	84500	42250	126750	1992	1994	BNA2002	CBC7017	1970	2017	83285.86	6664.472	17794.2	57961.77	110021.37	
Red-faced Woodc	252600	70739	503841	2006	2015	PIF0615	BBS9317	1993	2017	7861.138	-123124	2860646	-24822.27	141427.8									
Red-headed Woodc	1802539	158799	2066531	2006	2015	PIF0615	BBS7017	1970	2017	2438936	2062909	884341	2303393	2577544									
Red-naped Sapsu	955	Western Fo	Temperate	Picidae	landbird	M	other	native	1974818	1956661	2425112	2006	2015	PIF0615	BBS7017	1970	2017	-831754	-1287221	-480910	-975677	-697846	
Red-necked Grebe	144	Wetland	Marine	Podicipedii	waterbird	M	other	native	377518	482463	5054730	2006	2015	PIF0615	BBS7017	1970	2017	-298300	-669475	-579236	-406750	-203238	
Red-shoudered Ha	818	Forest Gen	Temperate	Acciptrida	landbird	M	other	native	1827010	1607481	2085341	2006	2015	PIF0615	BBS7017	1970	2017	-1675497	-1996607	-1411910	-1771469	-1583843	
Red-tailed Hawk	825	Habitat	Gen	Widespreat	Acciptrida	landbird	M	other	native	2808115	2579824	3052334	2006	2015	PIF0615	BBS7017	1970	2017	-1649718	-1868102	-1451414	-1274270	-1577264
Red-throated Loon	626	Arctic Tun	Marine	Gaviidae	waterbird	M	other	native	358396	96811	792520	2006	2015	PIF0615	BBS9317	1993	2017	-64174.8	-471009	106769	-160451	-4466.97	
Red-winged Black	1926	Habitat	Gen	Temperate	Icteridae	landbird	M	other	native	1.73e+08	1.55e+08	1.97e+08	2006	2015	PIF0615	BBS7017	1970	2017	92754828	7718657	1019878	87286802	9822647
Red Crossbill	1757	Forest Gen	Temperate	Fringillidae	landbird	M	other	native	9585953	7856459	11542746	2006	2015	PIF0615	BBS7017	1970	2017	-521052	-3406695	-1659049	-1430356	-262580.4	
Red Knot	485	Arctic Tun	Coastal	Scopaciop	shorebird	M	other	native	139000	107715	196500	2011	2013	Shoreb12	Mig7416	1974	2016	786817	451716.6	1320313	658298.1	947035.5	
Reddish Egret	747	Coasts	Coastal	Ardeidae	waterbird	M	other	native	4000	3600	4400	1995	1997	BNA2002	CBC7017	1970	2017	-2169.74	-3844.42	-978.25	-2672.08	-1724.88	
Redhead	55	Wetland	Temperate	Anatidae	waterfowl	M	other	native	1216200	1022900	1505000	2013	2017	FWS1317	FWS7017	1970	2017	-614728	-815837	-384342	-703227	-528118	
Rhinoceros Auklet	561	Coasts	Marine	Alcidae	waterbird	M	other	native	900000	450000	1350000	1997	1999	BNA1993	CBC7017	1970	2017	-704894	-1937159	-153527	-1037267	-462626	
Ring-billed Gull	582	Wetland	Temperate	Laridae	waterbird	M	other	native	3740548	2829796	4916343	2006	2015	PIF0615	BBS7017	1970	2017	-2040795	-3250218	-1164597	-2416011	-1706859	
Ring-necked Duck	57	Wetland	Temperate	Anatidae	waterfowl	M	other	native	527400	370400	684300	2013	2017	FWS1317	BBS7017	1970	2017	-438992	-176450	-254593	-520050	-365060	
Ring-necked Pheas	123	Introduced	Introduced	Phasianida	other	Introduced	other	Introduced	16642331	14252196	19372599	2006	2015	PIF0615	BBS7017	1970	2017	4081809	1458413	6850717	3189837	5015259	
Rock Pigeon	149	Introduced	Introduced	Columbida	other	Introduced	other	Introduced	16195053	14584425	17988593	2006	2015	PIF0615	BBS7017	1970	2017	9716674	7473179	12160766	6923991	10507280	
Rock Sandpiper	498	Arctic Tun	Coastal	Scopaciop	shorebird	M	other	native	144800	67900	334400	2011	2013	Shoreb12	CBC7017	1970	2017	157006.2	-2757.1	476867.3	82353.48	249917.8	
Rock Wren	1454	Aridlands	Southwest	Troglodytic	landbird	M	other	native	3362014	2744880	4115789	2006	2015	PIF0615	BBS7017	1970	2017	2470864	1818269	3217035	2232387	2919010	
Rose-breasted Gros	2051	Eastern Fo	Widespreat	Cardinalia	landbird	M	other	native	4715373	4058034	5474473	2006	2015	PIF0615	BBS7017	1970	2017	1956505	1416636	2584608	1774278	2162243	
Roseate Spoonbill	764	Wetland	Widespreat	Threskiorn	waterbird	M	other	native	11000	8250	13750	1997	1999	BNA2000	BBS7017	1970	2017	-46069.7	-81166	-258408	-59000	-37477	
Ross's Goose	13	Arctic Tun	Temperate	Anatidae	waterfowl	M	other	native	2122006	1909805	2334207	2013	2015	CAFF18	CAFF	1989	2016	-1839191	-6621366	-442546	-2907504	-5114893	
Rough-legged Hawk	826	Arctic Tun	Temperate	Acciptrida	landbird	M	other	native	296141	248433	370060	2006	2015	PIF0615	CBC7017	1970	2017	-11203.7	-64564.2	34041.65	-28325.8	150113.77	
Royal Tern	617	Coasts	Coastal	Laridae	waterbird	M	other	native	35206	10179	70873	2006	2015	PIF0615	BBS7017	1970	2017	-2120.6	-39981.1	13520.05	-10540.9	3782584	
Ruby-crowned King	1518	Boreal Fore	Temperate	Regulida	landbird	M	other	native	99900936	90024695	1.11e+08	2006	2015	PIF0615	BBS7017	1970	2017	-2e+07	-3.7e+07	-4867386	-2.5e+07	-1.4e+07	
Ruby-throated Hum	332	Eastern Fo	Mexico-Cer	Certhiidae	landbird	M	other	native	5977711	41123669	40921667	2006	2015	PIF0615	BBS7017	1970	2017	-1.7e+07	-2.1e+07	-1.4e+07	-1.4e+07	-1.6e+07	
Ruddy Duck	80	Wetland	Widespreat	Anatidae	waterfowl	M	other	native	1334697	97049	1802652	2006	2015	PIF0615	BBS7017	1970	2017	-777078	-1362991	-388815	-952700	-616257	
Ruddy Turnstone	482	Arctic Tun	Coastal	Scopaciop	shorebird	M	other	native	245000	163333	367500	2011	2013	Shoreb12	Mig7416	1974	2016	1096850	608565.1	1756909	915241.9	1296343	
Ruffed Grouse	125	Forest Gen	Temperate	Phasianida	landbird	R	other	native	16500000	8250000	24750000	2004	2006	ACAD	BBS7017	1970	2017	-2277000	-6335635	376825.4	-3502130	-128649	
Rufous-crowned Sp	1808	Aridlands	Southwest	Passerellid	landbird	R	other	native	601135	407380	851057	2006	2015	PIF0615	BBS7017	1970	2017	222458.7	1738.16	399516	16878.28	27987.37	
Rufous Hummingbi	341	Western Fo	Mexico-Cer	Trochilidae	landbird	M	other	native	21694464	13724171	32781297	2006	2015	PIF0615	BBS7017	1970	2017	31516700	17402886	45836612	26540140	3651788	
Rusty Blackbird	1937	Boreal Fore	Temperate	Icteridae	landbird	M	other	native	6804603	491911	9459126	2006	2015	PIF0615	BBS7017	1970	2017	23805588	15151219	32032095	20793996	26957782	
Sage Thrasher	1630	Aridlands	Southwest	Minimidae	landbird	M	other	native	6362519	4673219	8479499	2006	2015	PIF0615	BBS7017	1970	2017	4306712	2678704	6236332	3712433	4930130	
Sagebrush Sparrow	1839	Aridlands	Southwest	Passerellid	landbird	M	other	native	5386123	3477545	8199885	2006	2015	PIF0615	BBS7017	1970	2017	396872.7	-1315488	1911859	-105161	890716.3	
Sanderling	496	Arctic Tun	Coastal	Scopaciop	shorebird	M	other	native	30000	120000	750000	2011	2013	Shoreb12	Mig7416	1974	2016	732200.7	3045663	1696297	492589.6	1072115	
Sandhill Crane	428	Wetland	Widespreat	Gruidae	waterbird	M	other	native	50000	45000	55000	2009	2011	BNA2014	BBS7017	1970	2017	-693623	-877673	549334	-751478	640981	
Sandwich Tern	619	Coasts	Coastal	Laridae	waterbird	M	other	native	93890	74018	117363	1984	1986	BNA2016	CBC7017	1970	2017	-56071.2	-174368	-14729.6	-74405.6	-40020.7	
Savannah Sparrow	1842	Grassland	Temperate	Passerellid	landbird	M	other	native	1.69e+08	1.44e+08	1.95e+08	2006	2015	PIF0615	BBS7017	1970	2017	1.4e+08	1.14e+08	1.69e+08	1.31e+08	1.5e+08	
Say's Phoebe	1319	Habitat	Gen	Southwest	Tyrannida	landbird	M	other	native	5044646	4348767	5764857	2006	2015	PIF0615	BBS7017	1970	2017	-2048911	-2653374	-1524270	-2253522	-185859
Scaled Quail	102	Aridlands	Southwest	Odontophi	landbird	R	other	native	2393345	1766520	3168001	2006	2015	PIF0615	BBS7017	1970	2017	1219606	-1903248	3266030	348096.3	1981454	
Scarlet Tanager	2034	Eastern Fo	South Amer	Certhiidae	landbird	M	other	native	2574915	2256623	2956329	2006	2015	PIF0615	BBS7017	1970	2017	301716.3	117878.6	497516.1	236828.3	36815.19	
Scissor-tailed Flyc	1282	Grassland	Mexico-Cer	Tyrannida	landbird	M	AI	native	7914013	6502356	9635329	2006	2015	PIF0615	BBS7017	1970	2017	2308550	1308705	3387566	1963949	2676523	
Scott's Oriole	124	Western Fo	Mexico-Cer	Icteridae	landbird	M	other	native	1721724	1338281	2134384	2006	2015	PIF0615	BBS7017	1970	2017	773869.9	439813	1148394	654043.9	894665.1	
Seaside Sparrow	1847	Coasts	Coastal	Passerellid	landbird	M	other	native	196782	32213	523319	2006	2015	PIF0615	BBS7017	1970	2017	-102593	-342228	-39529	-186331	-45587.7	
Sedge Wren	1469	Grassland	Temperate	Troglodytic	landbird	M	other	native	5017990	4252225	5954339	2006	2015	PIF0615	BBS7017	1970	2017	-1826929	-3149570	-829929	-2241364	-1548977	
Semipalmated Plo	460	Arctic Tun	Coastal	Laridae	waterbird	M	other	native	20000	80000	500000	2011	2013	Shoreb12	Mig7416	1974	2016	25352.6	-39981.1	13520.05	-10540.9	3782584	
Semipalmated San	506	Arctic Tun	Coastal	Scopaciop	shorebird	M	other	native	226000	1278400	2791600	2011	2013	Shoreb12	Mig7416	1974	2016	4759321	2635540	7463467	3998809	5598012	
Sharp-shinned Haw	789	Forest Gen	Widespreat	Acciptrida	landbird	M	other	native	405947	303414	524274	2006	2015	PIF0615	BBS7017	1970	2017	-183725	-261125	-121978	-208631	-160915	
Sharp-tailed Grou	214	Grassland	Temperate	Phasianida	landbird	R	other	native	761942	569396	957276	2006	2015	PIF0615	BBS7017	1970	2017	-258040	-494499	-9047.8	-331274	-192635	
Short-billed Dow	1508	Wetland	Coastal	Scopaciop	shorebird	M	other	native	153000	61200	382500	2011	2013	Shoreb12	Mig7416	1974	2016	1606364	0.59968	4783499	84331.32	251938.1	
Short-eared Owl	865	Habitat	Gen	Temperate	Strigidae	landbird	M	other	native	602353	485388	747895	2006	2015	PIF0615	BBS7017	1970	2017	5632323	309857.8	806621.3	479243.1	647091.4
Smith's Longspur	1775	Arctic Tun	Temperate	Calcariidae	landbird	M	other	native	75000	18750	131250	1992	1994	ACAD	CBC7017	1970	2017	-20269.5	-167427	32202.01	-53020.7	-670.689	
Snow Bunting	1777	Arctic Tun	Temperate	Calcariidae	landbird	M	other	native	14627309	14267309													

White-winged Scot	Melanitta	68	Wetland	Marine	Anatidae	waterfowl	M	other	native	400000	200000	600000	2004	2006	SeDu07	CBC7017	1970	2017	41189.93	-350756	288668.64	-56350.2	121532.4	
White Ibis	Eudocimus	757	Wetland	Widespread	Threskiornis	waterbird	M	other	native	1170987	807222	1696093	2006	2015	PIF0615	BBS7017	1970	2017	-1394174	-2587259	-682714	-1723512	-1106709	
Wild Turkey	Meleagris	137	Forest	Temperate	Phasianidae	landbird	R	other	native	6750000	6075000	7425000	2008	2010	BNA2014	BBS7017	1970	2017	-1.1E+07	-1.5E+07	-8873202	-1.2E+07	-1E+07	
Willet	Tringa	525	Wetland	Coastal	Scolopacidae	shorebird	M	other	native	250000	100000	625000	2011	2013	Shoreb12	BBS7017	1970	2017	66334.26	0.361178	166538.2	39646.7	96933.03	
Williamson's Sapsu	Sphyrapicus	953	Western Fo	Temperate	Picidae	landbird	M	other	native	294829	209789	398019	2006	2015	PIF0615	BBS7017	1970	2017	-32100.3	-109782	23124.9	-55295.1	-11888.6	
Willow Flycatcher	Empidonax	1305	Eastern For	Widespread	Tyrannidae	landbird	M	other	native	8095093	6902363	9486416	2006	2015	PIF0615	BBS7017	1970	2017	2940723	1949424	4016124	2588135	3308646	
Willow Ptarmigan	Lagopus	129	Arctic Tund	Temperate	Phasianidae	landbird	M	other	native	12784429	7232901	21298386	2006	2015	PIF0615	BBS9317	1993	2017	-306805	-1.9E+07	8120169	4398420	2794435	
Wilson's Phalarope	Phalaropus	532	Wetland	South Amer	Scolopacidae	shorebird	M	other	native	1500000	600000	3750000	2011	2013	Shoreb12	BBS7017	1970	2017	65525.64	-346015	559622.5	-20112.5	198928.8	
Wilson's Plover	Charadrius	458	Coasts	Coastal	Charadriidae	shorebird	M	other	native	8600	5733	12900	2011	2013	Shoreb12	CBC7017	1970	2017	7902.019	-454.683	16313.62	5246.921	10574.41	
Wilson's Snipe	Gallinago	516	Wetland	Widespread	Scolopacidae	shorebird	M	other	native	2000000	800000	5000000	2011	2013	Shoreb12	BBS7017	1970	2017	-356660	-1014232	-0.240669	-545459	-197857	
Wilson's Warbler	Cardellina	2023	Forest	Gen	Mexico-Cer	Parulidae	landbird	M	other	native	81271984	65743361	98288305	2006	2015	PIF0615	BBS7017	1970	2017	81257567	61964991	1.02E+08	74336542	88378279
Winter Wren	Troglodytes	1467	Boreal Fore	Temperate	Troglodytidae	landbird	M	other	native	11140437	9052643	13798379	2006	2015	PIF0615	BBS7017	1970	2017	-2182791	-5115623	23901.2	-3121130	-13507291	
Wood Duck	Aix sponsa	35	Wetland	Temperate	Anatidae	waterfowl	M	other	native	2148806	1930697	2371212	2006	2015	PIF0615	BBS7017	1970	2017	-1382266	-1651781	-1141445	-1472135	-1297891	
Wood Stork	Mycteria	706	Wetland	Widespread	Ciconiidae	waterbird	M	other	native	15700	12560	18840	1994	1996	BNA1999	BBS7017	1970	2017	-9686.47	-23040.5	-1877.7	-13538.1	-6586.39	
Wood Thrush	Hylocichla	1585	Eastern For	Mexico-Cer	Turdidae	landbird	M	other	native	12191387	10959424	13589692	2006	2015	PIF0615	BBS7017	1970	2017	15227071	13130268	17436955	14500401	15967893	
Woodhouse's Scrub	Aphelocoma	1386	Western Fo	Temperate	Corvidae	landbird	R	other	native	692935	476075	1023759	2006	2015	PIF0615	BBS7017	1970	2017	71987.24	-8413.72	167626.1	44321.77	101466.8	
Worm-eating Warb	Helminthoph	1948	Eastern For	Caribbean	Parulidae	landbird	M	other	native	784060	608710	988276	2006	2015	PIF0615	BBS7017	1970	2017	-145853	-276841	-411411.2	-188245	-108293	
Wrentit	Chamaea	1530	Aridlands	Temperate	Sylviidae	landbird	R	other	native	1753863	1095353	2807164	2006	2015	PIF0615	BBS7017	1970	2017	612755.7	257008.7	1078014	475683.6	758666.6	
Yellow-bellied Flyc	Empidonax	1302	Boreal Fore	Mexico-Cer	Tyrannidae	landbird	M	other	native	13047639	10169586	16383394	2006	2015	PIF0615	BBS7017	1970	2017	-1.1E+07	-1.7E+07	-6379784	-1.3E+07	-9032267	
Yellow-bellied Saps	Sphyrapicus	954	Eastern For	Widespread	Picidae	landbird	M	other	native	13523418	11628336	15891341	2006	2015	PIF0615	BBS7017	1970	2017	-6852842	-9680783	-4632455	-7769014	-6048174	
Yellow-billed Saps	Coccyzus	205	Eastern For	South Amer	Cuculidae	landbird	M	other	native	8358126	7571171	9214892	2006	2015	PIF0615	BBS7017	1970	2017	7765674	6309631	9265539	7259180	8257018	
Yellow-billed Loon	Gavia	630	Arctic Tund	Marine	Gaviidae	waterbird	M	other	native	12000	8000	16000	2013	2017	FWS2014	CBC7017	1970	2017	37697.22	21594.63	59920.24	31547.6	44723.16	
Yellow-billed Magp	Pica nuttall	1392	Western Fo	Temperate	Corvidae	landbird	R	other	native	396399	319891	491206	2007	2009	BNA2009	BBS7017	1970	2017	686814.7	501752	903559.9	619190.7	756379.6	
Yellow-breasted Ch	Icteria vire	1885	Eastern For	Mexico-Cer	Icteridae	landbird	M	other	native	15066335	13315869	16929873	2006	2015	PIF0615	BBS7017	1970	2017	3913521	2390558	5420511	3402197	4429401	
Yellow-crowned Nij	Nyctanassa	755	Coasts	Widespread	Ardeidae	waterbird	M	other	native	129442	72714	233481	2006	2015	PIF0615	BBS7017	1970	2017	23953.77	-5471.65	63560.05	13397.82	36092.5	
Yellow-headed Blac	Xanthoceph	1886	Wetland	Temperate	Icteridae	landbird	M	other	native	11338466	8566820	14826716	2006	2015	PIF0615	BBS7017	1970	2017	976561	-1180430	2942683	292291.1	1642615	
Yellow-rumped Wa	Setophaga	1999	Forest	Gen	Widespread	Parulidae	landbird	M	other	native	1.74E+08	1.56E+08	1.91E+08	2006	2015	PIF0615	BBS7017	1970	2017	7197191	-1.1E+07	24452427	927860.6	13250777
Yellow-throated Vi	Vireo flavif	1352	Eastern For	Mexico-Cer	Vireonidae	landbird	M	other	native	4705278	4235092	5161482	2006	2015	PIF0615	BBS7017	1970	2017	-2146791	-2589822	-1745190	-2293583	-2002721	
Yellow-throated W	Setophaga	2000	Eastern For	Caribbean	Parulidae	landbird	M	other	native	2039116	1732805	2359505	2006	2015	PIF0615	BBS7017	1970	2017	-768608	-1121737	-462950	-880751	-658077	
Yellow Warbler	Setophaga	1992	Forest	Gen	Widespread	Parulidae	landbird	M	other	native	92640979	83231903	1.03E+08	2006	2015	PIF0615	BBS7017	1970	2017	30516333	22777261	38840680	27767231	33373984

Column Name	Meaning
species	English Name, according to 59th supplement of AOS checklist - this spreadsheet contains species that occur regularly in the USA and/or Canada, AND that have population estimates and trends
sci_name	Scientific Name, from AOS 59th supplement
sort	taxonomic sort order, based on AOS 59th supplement, for each species
Breeding.Biome	Breeding biome categories assigned to each species, used to summarize loss results across species groups
Winter.Biome	Non-breeding Region categories assigned to each species, used to summarize loss results across species groups
Family	Taxonomic Family, as assigned in the 59th supplement of the AOS checklist
bird.group	assignment to 1 of 4 bird groups: landbird, shorebird, waterbird, waterfowl
Migrate	Migration category, assigned to each species: "R" - year-round resident; "M" - migrant: includes partial migrants (substantial overlap of breeding and winter ranges, but some parts of range occupied only seasonally) and full migrants (little or no overlap of breeding and winter ranges)
AI	identifies species in the "Aerial Insectivore" group, birds that capture flying insects while in flight
native	identifies native and introduced species across U.S./Canada (from AOS 59th supplement)
popest	Estimated North American population during range of years between first_year_popest and last_year_popest
popestlci	Lower bound estimated North American population during range of years between first_year_popest and last_year_popest
popestuci	Upper bound estimated North American population during range of years between first_year_popest and last_year_popest
first_year_popest	beginning of the time-period to which the estimated population applies. Note for species where this first_year - last_year spans 3 years, the published estimate was reported to apply to the single year in the middle of the range, but for analysis purposes we averaged across a minimum of 3 years
last_year_popest	end of the time-period to which the estimated population applies. Note for species where this first_year - last_year spans 3 years, the published estimate was reported to apply to the single year in the middle of the range, but for analysis purposes we averaged across a minimum of 3 years
Pop.source	Source of recent population size estimates and variances for North America, as follows: ACAD - Avian Conservation Assessment Database BNA - Birds of North American accounts, various years CAFF18 - Conservation of Arctic Flora and Fauna 2018 report FWS1317 - average of 2013 to 2017 estimates from the 2017 USFWS Waterfowl Status Report FWS2014 - USFWS report on Yellow-billed Loon NATSS15 - North American Trumpeter Swan Survey, 2015 PIF0615 - Partners in Flight (PIF) calculated estimate, based mainly on BBS data from the years 2006-2015, as described by Stanton et al. 2019 SeDu07 - 2007 Seaduck Joint Venture Report Shoreb12 - Shorebird Flyway Population Database WPE5 - Waterbird Population Estimates Database see Supplemental Methods text for details
Trajectory_data_so	source of population trajectory for individual species in this analysis, as follows: BBS7017 - North American Breeding Bird Survey, 1970 to 2017 BBS9317 - North American Breeding Bird Survey, 1993 to 2017 CAFF - trends based on population change in CAFF 2018 report (Fox and Leafloor 2018); numbers after "CAFF" indicate start year and end year of estimates for each species, from which trend was estimated CBC7017 - Audubon Christmas Bird Count, 1970 to 2017 FWS7017 - US Fish & Wildlife Service waterfowl survey trends, 1970 to 2017 Mig7416 - Migration Monitoring of Shorebirds, 1974 to 2016 NATS6815 - Trumpeter Swan Survey trends, 1968-2015 SGS6817 - American Woodcock Singing Ground Survey trends, 1968 to 2017 see Supplemental Methods text for details
Trajectory_firstyear	first year of available estimates for the population trajectory
Trajectory_lastyear	first year of available estimates for the population trajectory
Loss_med	Estimated change in number of breeding individuals over the trend period (usually 1970-2017), based on a combination of current population estimates and long-term trajectories. Median of the posterior distribution from the hierarchical Bayesian model
Loss_lci	Lower bound (2.5 percentile of the posterior distribution) on the estimated change in number of breeding individuals over the trend period (usually 1970-2017), based on a combination of current population estimates and long-term trajectories. Median of the posterior distribution from the hierarchical Bayesian model
Loss_uci	Upper bound (97.5 percentile of the posterior distribution) on the estimated change in number of breeding individuals over the trend period (usually 1970-2017), based on a combination of current population estimates and long-term trajectories. Median of the posterior distribution from the hierarchical Bayesian model
Loss_lqrt	Lower quartile (25 percentile of the posterior distribution) on the estimated change in number of breeding individuals over the trend period (usually 1970-2017), based on a combination of current population estimates and long-term trajectories. Median of the posterior distribution from the hierarchical Bayesian model
Loss_uqrt	Upper quartile (75 percentile of the posterior distribution) on the estimated change in number of breeding individuals over the trend period (usually 1970-2017), based on a combination of current population estimates and long-term trajectories. Median of the posterior distribution from the hierarchical Bayesian model

see "Definitions" worksheet for meaning of column headers

Species	sci_name	sort	group	PopUsCa	PopLC95	PopUC95	TimeAdj.meanlog	TimeAdj.sdlog	Distance Adj.	Pair Adj.
Albert's Towhee	Melospiza aberti	1817	landbird	890,243	429,538	1,469,410	0.926068294	0.03279521	125	2
Acadian Flycatcher	Empidonax vireescens	1303	landbird	5,227,271	4,728,009	5,829,898	0.219216886	0.007581933	125	2
Acorn Woodpecker	Melanerpes formicivorus	939	landbird	2,226,303	1,452,256	3,390,813	0.261513967	0.032915038	200	1.75
Alder Flycatcher	Empidonax alnorum	1304	landbird	117,998,630	99,384,651	141,184,247	0.279321986	0.014289896	125	2
Allen's Hummingbird	Selasphorus sasin	342	landbird	1,484,682	348,049	4,475,111	0.291735312	0.022923659	50	1.25
American Crow	Corvus brachyrhynchos	1395	landbird	28,047,630	26,447,403	29,639,378	0.509424135	0.035825627	400	1.75
American Dipper	Cinclus mexicanus	1514	landbird	151,919	114,060	200,186	0.120627704	0.002232302	125	1.75
American Goldfinch	Spinus tristis	1771	landbird	44,092,850	41,554,624	46,767,583	0.311311237	0.018869851	125	1.25
American Kestrel	Falco sparverius	998	landbird	2,827,776	2,564,206	3,116,508	0.290453514	0.006693885	200	1.25
American Pipit	Anthus rubescens	1678	landbird	18,034,890	17,874,051	18,354,686	0.331264898	0.018339887	200	2
American Redstart	Setophaga ruticilla	1983	landbird	42,464,674	37,027,311	48,475,245	0.081164913	0.00961596	100	2
American Robin	Turdus migratorius	1603	landbird	366,076,928	337,429,985	392,723,825	0.816820459	0.040591642	200	2
American Three-toed Woodpecker	Picoides dorsalis	958	landbird	1,564,320	1,108,671	2,160,148	0.231914705	0.005639455	125	1.5
American Tree Sparrow	Spizelloides arborea	1828	landbird	26,412,817	19,492,087	36,200,474	0.48677923	0.263794299	200	2
Anna's Hummingbird	Calypte anna	336	landbird	8,772,569	4,880,026	16,549,527	0.188295714	0.007918482	50	2
Arctic Warbler	Phylloscopus borealis	1526	landbird	8,201,201	2,638,973	16,439,186	0.336241881	0.212251379	125	2
Ash-throated Flycatcher	Myiarchus cinerascens	1247	landbird	6,847,348	5,661,743	8,193,398	0.285893654	0.012720806	200	1.5
Bachman's Sparrow	Peucaea aestivalis	1825	landbird	167,964	102,917	256,160	0.353020961	0.010014486	200	2
Baird's Sparrow	Centronyx bairdii	1844	landbird	3,440,174	2,322,349	4,825,893	0.347885573	0.018872062	125	2
Baltimore Oriole	Icterus galbula	1922	landbird	11,806,532	10,808,329	12,963,225	0.141448158	0.008339067	125	1.75
Band-tailed Pigeon	Patagioenas fasciata	156	landbird	1,455,144	1,049,053	1,990,079	0.445606274	0.021296333	200	1.75
Bank Swallow	Riparia riparia	1430	landbird	7,940,368	6,125,188	10,752,527	0.642518351	0.054160354	200	2
Barn Owl	Tyto alba	828	landbird	130,751	81,975	193,386	1.639980926	0.005870793	200	2
Barn Swallow	Hirundo rustica	1433	landbird	46,855,476	43,409,178	50,012,099	0.288208703	0.028066320	200	1.5
Barred Owl	Strix varia	860	landbird	3,458,782	3,024,086	3,952,819	2.246063781	0.003138642	200	2
Bay-breasted Warbler	Setophaga castanea	1990	landbird	9,892,605	6,894,711	13,872,180	0.153659869	0.007650575	80	2
Bell's Sparrow	Artemisiospiza belli	1840	landbird	214,853	89,930	390,058	0.356608677	0.06387064	200	2
Bell's Vireo	Vireo bellii	1349	landbird	4,599,734	3,593,221	5,764,813	0.180378292	0.007557468	125	2
Belted Kingfisher	Megasceryle alcyon	907	landbird	1,843,798	1,568,548	2,159,306	0.290382383	0.001070783	200	2
Bendire's Thrasher	Toxostoma bendirei	1625	landbird	56,338	30,887	93,302	0.151208587	0.03780064	200	2
Bewick's Wren	Thryomanes bewickii	1472	landbird	4,567,446	3,627,322	5,765,670	0.263952086	0.012017096	200	1.75
Black Phoebe	Sayornis nigricans	1317	landbird	1,170,291	816,450	1,641,836	0.490597113	0.0123837	125	1.5
Black Swift	Cypseloides niger	253	landbird	88,506	34,390	198,559	0.419278592	0.342734085	200	1.25
Black Vulture	Coragyps atratus	765	landbird	1,864,137	1,555,779	2,249,923	1.046186196	0.034351103	400	1.5
Black-and-white Warbler	Mniotilta varia	1954	landbird	17,709,569	15,812,133	19,681,290	0.152823762	0.008002952	100	2
Black-backed Woodpecker	Picoides arcticus	959	landbird	1,734,181	1,251,409	2,296,411	0.427240724	0.004502838	125	1.5
Black-billed Cuckoo	Coccyzus erythrophthalmus	209	landbird	875,781	735,134	1,051,851	0.283172906	0.005624163	200	2
Black-billed Magpie	Pica hudsonia	1391	landbird	6,023,555	5,190,448	7,003,608	0.235896152	0.020103119	300	1.75
Black-capped Chickadee	Poecile atricapillus	1436	landbird	43,031,705	39,633,241	46,269,089	0.378610362	0.015744777	125	2
Black-chinned Hummingbird	Archilochus alexandri	333	landbird	8,179,118	5,809,219	10,961,926	0.261764193	0.005802987	50	1.5
Black-chinned Sparrow	Spizella atrogularis	1834	landbird	293,554	150,962	524,619	0.48677923	0.263794299	200	1.75
Black-crested Titmouse	Baeolophus atricristatus	1446	landbird	642,491	414,558	1,018,349	0.167287607	0.015324212	200	1.25
Black-headed Grosbeak	Pheucticus melanocephalus	2052	landbird	12,185,173	10,701,801	13,695,616	0.35677819	0.014358481	125	2
Black-tailed Gnatcatcher	Poliophtila melanura	1509	landbird	6,527,338	4,101,720	10,094,127	0.507418109	0.013481356	80	1.75
Black-throated Blue Warbler	Setophaga caerulescens	1995	landbird	2,415,903	2,069,260	2,822,969	0.123733234	0.007484617	125	2
Black-throated Gray Warbler	Setophaga nigrescens	2008	landbird	3,130,246	2,558,225	3,733,825	0.234857209	0.011166783	125	2
Black-throated Green Warbler	Setophaga virens	2012	landbird	9,177,716	7,924,382	10,581,319	0.123030348	0.008231303	125	2
Black-throated Sparrow	Amphispiza bilineata	1838	landbird	31,040,032	26,228,164	36,813,986	0.536376292	0.030266055	125	2
Black-whiskered Vireo	Vireo altiloquus	1362	landbird	84,242	1,998	207,072	0.252790135	0.052592429	125	2
Blackburnian Warbler	Setophaga fusca	1991	landbird	13,271,149	10,865,077	16,109,037	0.191437754	0.009454552	80	2
Blackpoll Warbler	Setophaga striata	1994	landbird	59,716,232	45,066,327	76,124,820	0.036936066	0.007389098	80	2
Blue Grosbeak	Passerina caerulea	2058	landbird	20,938,581	19,404,702	22,644,996	0.425252098	0.010625576	125	2
Blue Jay	Cyanocitta cristata	1382	landbird	17,238,587	15,864,197	18,715,069	0.196211491	0.011653135	200	1.25
Blue-gray Gnatcatcher	Poliophtila caerulea	1506	landbird	229,194,394	195,048,713	266,969,269	0.507549726	0.013481573	50	1.75
Blue-headed Vireo	Vireo solitarius	1355	landbird	12,765,014	11,050,138	14,721,085	0.191732584	0.009143537	125	2
Blue-winged Warbler	Vermivora cyanoptera	1953	landbird	684,415	578,230	803,348	0.245414125	0.00681225	125	2
Boat-tailed Grackle	Quiscalus major	1940	landbird	2,156,489	1,297,665	3,550,285	0.627797265	0.044839671	200	1.25
Bobolink	Dolichonyx oryzivorus	1887	landbird	10,195,298	8,796,086	11,917,384	0.240408992	0.018723365	200	1.75
Bohemian Waxwing	Bombycilla garrulus	1637	landbird	2,507,863	1,641,840	3,491,482	0.251637205	0.021009969	125	1.75
Boreal Chickadee	Poecile hudsonicus	1440	landbird	13,208,240	10,477,170	16,444,759	0.123606521	0.006154629	80	1.25
Brewer's Blackbird	Euphagus cyanocephalus	1938	landbird	23,324,285	20,136,678	27,110,785	0.285067694	0.042310849	200	1.25
Brewer's Sparrow	Spizella breweri	1831	landbird	16,834,981	13,155,782	21,238,196	0.554371096	0.03152307	200	2
Bridled Titmouse	Baeolophus wollweberi	1442	landbird	69,340	22,843	147,260	0.167287607	0.015324212	200	1.75
Broad-tailed Hummingbird	Selasphorus platycercus	340	landbird	8,804,795	5,880,867	12,313,443	0.270066821	0.013827063	80	1.75
Broad-winged Hawk	Buteo platypterus	820	landbird	1,804,126	1,598,612	2,029,385	0.923824468	0.001843574	125	2
Bronzed Cowbird	Molothrus aeneus	1932	landbird	816,191	439,751	1,339,476	0.196381735	0.015392618	125	1.25
Brown Creeper	Certhia americana	1453	landbird	9,484,338	7,757,209	11,639,138	0.327781306	0.007039325	80	2
Brown Thrasher	Toxostoma rufum	1622	landbird	6,168,180	5,625,720	6,771,313	0.141308812	0.007605114	200	1.5
Brown-crested Flycatcher	Myiarchus tyrannulus	1250	landbird	1,032,206	639,470	1,584,755	0.236362278	0.026662982	200	2
Brown-headed Cowbird	Molothrus ater	1933	landbird	126,705,388	117,868,557	135,950,409	0.196359385	0.015316476	125	1.75
Brown-headed Nuthatch	Sitta pusilla	1452	landbird	1,578,602	1,352,620	1,826,550	0.193256417	0.011315643	125	1.5
Bullock's Oriole	Icterus bullockii	1916	landbird	6,949,229	6,086,900	7,839,504	0.171626668	0.013381537	125	1.75
Burrowing Owl	Athene cucularia	856	landbird	987,921	625,174	1,537,376	0.248559878	0.013839293	200	1.75
Bushtit	Psaltriparus minimus	1448	landbird	2,310,447	1,807,618	2,949,870	0.180014259	0.016575529	125	1.5
Cactus Wren	Campylorhynchus brunneicapill	1482	landbird	3,034,276	2,268,727	4,012,714	0.389943466	0.015947778	200	1.5
California Quail	Callipepla californica	104	landbird	3,358,401	2,374,290	4,473,991	0.386160727	0.019277203	200	1.5
California Scrub-Jay	Aphelocoma californica	1385	landbird	1,346,997	859,873	2,030,181	0.162746	0.013553	200	1.25
California Thrasher	Toxostoma redivivum	1627	landbird	155,226	77,498	274,331	0.151208587	0.03780064	200	1.75
California Towhee	Melospiza crissalis	1816	landbird	5,247,688	3,750,592	7,222,092	0.953116186	0.024293546	125	2
Calliope Hummingbird	Selasphorus calliope	346	landbird	4,463,289	2,652,793	7,024,258	0.222786696	0.005361244	50	2
Canada Jay	Perisoreus canadensis	1364	landbird	26,652,111	23,501,504	30,178,807	0.206075389	0.008834811	125	1
Canada Warbler	Cardellina canadensis	2022	landbird	2,597,361	2,028,500	3,242,734	0.144498738	0.005886014	100	2
Canyon Towhee	Melospiza fusca	1814	landbird	2,792,820	2,085,096	3,605,781	0.901022212	0.013820457	125	2
Canyon Wren	Catherpes mexicanus	1457	landbird	423,956	325,189	554,507	0.627107745	0.00823747	200	2
Cape May Warbler	Setophaga tigrina	1985	landbird	7,043,668	4,900,702	9,894,881	0.325792288	0.005702945	80	2

Carolina Chickadee	Poecile carolinensis	1435	landbird	13,179,980	12,174,905	14,399,165	0.23301274	0.013259707	125	1.25
Carolina Wren	Thryothorus ludovicianus	1471	landbird	17,733,395	15,969,003	19,620,346	0.2685187	0.014746994	200	1.5
Cassin's Finch	Haemorrhous cassinii	1751	landbird	3,191,950	2,521,299	4,034,402	0.290200251	0.012993251	125	2
Cassin's Kingbird	Tyrannus vociferans	1275	landbird	2,480,328	1,833,328	3,291,825	0.429312979	0.017320122	200	2
Cassin's Sparrow	Peucaea cassinii	1824	landbird	9,598,748	7,485,112	12,176,616	0.324927907	0.022658797	200	1.75
Cassin's Vireo	Vireo cassinii	1354	landbird	4,560,260	3,775,193	5,412,799	0.29475794	0.011141985	125	2
Cave Swallow	Petrochelidon fulva	1432	landbird	2,769,841	1,680,817	4,407,644	0.601584903	0.097402064	200	1
Cedar Waxwing	Bombus cedrorum	1638	landbird	63,975,308	58,030,057	70,240,507	0.251384113	0.021058939	100	1.75
Cerulean Warbler	Setophaga cerulea	1986	landbird	528,920	363,210	714,480	0.214654972	0.006059708	100	2
Chestnut-backed Chickadee	Poecile rufescens	1439	landbird	12,062,509	8,656,467	16,306,921	0.172673671	0.018267892	80	1.25
Chestnut-collared Longspur	Calcarius ornatus	1774	landbird	3,095,825	2,101,824	4,336,047	0.47764042	0.035721667	200	1.5
Chestnut-sided Warbler	Setophaga pensylvanica	1993	landbird	18,265,512	16,119,410	20,584,431	0.207905027	0.009565074	125	2
Chihuahuan Raven	Corvus cryptoleucus	1406	landbird	277,286	193,193	390,354	0.246353299	0.018415724	400	1.75
Chimney Swift	Chaetura pelagica	260	landbird	8,808,551	8,013,311	9,665,731	0.281915163	0.018153048	200	1.75
Chipping Sparrow	Spizella passerina	1829	landbird	230,957,566	213,377,234	249,914,852	0.695273332	0.023465322	125	2
Chuck-will's-widow	Antrostomus carolinensis	236	landbird	5,642,111	4,800,407	6,606,314	3.018785009	0.008504079	300	2
Chukar	Alectoris chukar	114	landbird	392,143	227,755	612,200	0.516304491	0.161395519	300	2
Clark's Nutcracker	Nucifraga columbiana	1390	landbird	290,441	227,717	363,870	0.324373017	0.0131279	300	1.25
Clay-colored Sparrow	Spizella pallida	1830	landbird	60,149,306	51,415,968	69,884,231	0.399192981	0.026524177	125	2
Cliff Swallow	Petrochelidon pyrrhonota	1431	landbird	77,981,069	67,646,472	89,137,460	0.602018152	0.097550427	200	1
Common Grackle	Quiscalus quiscula	1939	landbird	67,132,986	61,123,537	74,085,853	0.408425194	0.055505963	200	1.25
Common Ground-Dove	Columbina passerina	170	landbird	1,989,124	1,585,896	2,440,861	0.505966382	0.012083732	125	1.5
Common Nighthawk	Chordeiles minor	227	landbird	21,789,605	19,345,867	24,683,737	2.15054635	0.015134556	300	2
Common Poorwill	Phalaenoptilus nuttallii	230	landbird	1,333,400	965,383	1,769,426	3.361205639	0.001459633	300	2
Common Raven	Corvus corax	1407	landbird	8,250,632	7,605,338	8,984,942	0.322897689	0.015933012	400	1
Common Redpoll	Acanthis flammea	1754	landbird	39,008,853	30,299,103	49,713,410	0.195174643	0.022312919	125	2
Common Yellowthroat	Geothlypis trichas	1976	landbird	75,588,462	70,946,562	80,532,206	0.105097389	0.010027601	125	2
Connecticut Warbler	Oporornis agilis	1966	landbird	1,751,333	970,368	2,676,400	0.251795457	0.006130415	125	2
Cooper's Hawk	Accipiter cooperii	790	landbird	844,899	770,821	925,643	0.266253374	0.002707433	125	2
Cordillera Flycatcher	Empidonax occidentalis	1313	landbird	1,966,693	1,283,176	2,953,557	0.286041028	0.009418091	125	2
Costa's Hummingbird	Calypte costae	337	landbird	1,583,926	611,798	3,182,531	0.282947489	0.030666539	50	1.25
Couch's Kingbird	Tyrannus couchii	1274	landbird	250,613	133,762	447,501	0.287611169	0.196137195	200	2
Crested Caracara	Caracara cheriway	994	landbird	124,568	87,260	172,735	0.263500335	0.064231078	300	1
Crissal Thrasher	Toxostoma crissale	1629	landbird	82,115	48,009	124,579	0.151208587	0.03780064	200	2
Curve-billed Thrasher	Toxostoma curvirostre	1620	landbird	1,026,123	728,790	1,467,368	0.288256196	0.01118764	200	2
Dark-eyed Junco	Junco hyemalis	1861	landbird	223,552,461	196,287,624	253,775,451	0.541617969	0.066552841	125	2
Dickcissel	Spiza americana	2065	landbird	27,896,722	23,981,764	32,368,972	0.149758908	0.022316003	200	1.75
Downy Woodpecker	Dryobates pubescens	961	landbird	13,422,111	12,764,602	14,141,250	0.297784285	0.00653134	125	2
Dusky Flycatcher	Empidonax oberholseri	1310	landbird	8,797,209	7,024,376	10,767,331	0.151740992	0.009723034	125	2
Eastern Bluebird	Sialia sialis	1557	landbird	21,439,020	20,142,880	22,957,637	0.161933803	0.010916627	125	1.5
Eastern Kingbird	Tyrannus tyrannus	1278	landbird	25,924,168	24,123,810	27,704,273	0.144573269	0.008622775	125	1.75
Eastern Meadowlark	Sturnella magna	1888	landbird	24,431,724	21,928,274	27,309,341	0.245182991	0.017067785	200	1.75
Eastern Phoebe	Sayornis phoebe	1318	landbird	34,684,436	32,601,625	37,210,378	0.898152488	0.011850315	125	2
Eastern Screech-Owl	Megascops asio	833	landbird	496,240	378,219	645,235	2.114649232	0.001820302	125	2
Eastern Towhee	Pipilo erythrophthalmus	1806	landbird	29,338,492	27,153,590	31,703,146	0.302646684	0.016049386	125	2
Eastern Whip-poor-will	Antrostomus vociferus	242	landbird	1,829,892	1,442,373	2,231,099	3.32522679	0.00433927	300	2
Eastern Wood-Pewee	Contopus virens	1296	landbird	6,454,082	5,897,588	7,036,229	0.110277554	0.008288144	200	2
Eurasian Collared-Dove	Streptopelia decaocto	165	landbird	8,716,074	7,657,339	10,020,862	0.353765248	0.013942027	200	1.75
Eurasian Tree Sparrow	Passer montanus	1669	landbird	147,064	83,601	235,172	0.237386145	0.043432442	125	1.75
European Starling	Sturnus vulgaris	1635	landbird	93,371,907	85,941,592	102,256,039	0.455644428	0.068393305	200	1
Evening Grosbeak	Coccothraustes vespertinus	1701	landbird	3,783,375	2,963,915	4,803,280	0.252268742	0.012436775	125	1.75
Ferruginous Hawk	Buteo regalis	827	landbird	109,004	86,288	135,921	0.136893402	0.004679038	300	1.25
Field Sparrow	Spizella pusilla	1832	landbird	9,333,611	8,343,751	10,393,211	0.080762136	0.009480465	200	2
Fish Crow	Corvus ossifragus	1404	landbird	466,887	400,029	541,005	0.487620817	0.015744456	400	1.25
Fox Sparrow	Passerella iliaca	1851	landbird	34,605,524	27,334,565	44,390,905	0.088786254	0.011202226	200	2
Gambel's Quail	Callipepla gambelii	105	landbird	5,196,496	3,616,310	7,051,087	0.617677484	0.028464202	200	1.75
Gila Woodpecker	Melanerpes uropygialis	948	landbird	589,899	288,218	1,038,427	0.327182639	0.046172265	200	1
Gilded Flicker	Colaptes chrysoides	978	landbird	192,377	84,549	358,522	0.262542044	0.045968827	200	1.25
Golden Eagle	Aquila chrysaetos	778	landbird	146,673	125,252	171,932	0.42719715	0.001560231	400	1.75
Golden-crowned Kinglet	Regulus satrapa	1517	landbird	133,267,079	103,060,126	168,352,603	0.19966966	0.011538985	50	2
Golden-crowned Sparrow	Zonotrichia atricapilla	1859	landbird	7,502,564	4,149,449	12,855,995	0.238439032	0.019158995	200	2
Golden-fronted Woodpecker	Melanerpes aurifrons	950	landbird	805,604	554,852	1,125,322	0.327182639	0.046172265	200	1
Golden-winged Warbler	Vermivora chrysoptera	1952	landbird	393,305	273,065	539,488	0.133705003	0.005624412	125	2
Grace's Warbler	Setophaga graciae	2007	landbird	1,513,808	887,803	2,350,028	0.152835663	0.065246383	125	2
Grasshopper Sparrow	Ammodramus savannarum	1843	landbird	33,439,280	29,662,396	37,709,841	0.391507599	0.013630016	125	2
Gray Catbird	Dumetella carolinensis	1614	landbird	28,700,211	26,885,945	30,804,790	0.424676515	0.013687414	125	2
Gray Flycatcher	Empidonax wrightii	1309	landbird	2,897,568	2,057,762	4,045,062	0.253852676	0.009005444	125	2
Gray Kingbird	Tyrannus dominicensis	1279	landbird	23,009	3,657	62,695	0.287611169	0.196137195	200	1.75
Gray Partridge	Perdix perdix	119	landbird	823,861	635,590	1,041,588	0.255873113	0.005627355	125	2
Gray Vireo	Vireo vicinior	1350	landbird	548,027	294,748	855,433	0.252790135	0.052592429	125	2
Gray-cheeked Thrush	Catharus minimus	1581	landbird	41,722,960	27,552,192	60,727,662	0.440536327	0.077167878	125	2
Great Crested Flycatcher	Myiarchus cinerascens	1249	landbird	8,799,301	7,950,620	9,769,449	0.223953898	0.009044568	200	1.75
Great Gray Owl	Strix nebulosa	862	landbird	71,240	34,370	122,631	0.788077555	0.005099447	200	2
Great Horned Owl	Bubo virginianus	845	landbird	3,784,896	3,310,994	4,288,285	2.450156066	0.003001912	300	2
Great-tailed Grackle	Quiscalus mexicanus	1941	landbird	8,242,011	5,511,749	11,832,954	0.355734022	0.028093388	200	1
Greater Prairie-Chicken	Tympanuchus cupido	135	landbird	360,504	197,651	635,645	0.30719296	0.010294537	200	2
Greater Roadrunner	Geococcyx californianus	220	landbird	841,270	686,699	1,023,445	0.413389213	0.006077421	200	2
Green Jay	Cyanocorax yncas	1375	landbird	56,639	30,791	92,979	0.196506623	0.024782332	200	1.5
Green-tailed Towhee	Pipilo chlorurus	1804	landbird	4,766,829	3,664,896	6,155,067	0.634658223	0.019805701	200	2
Gyr Falcon	Falco rusticolus	1005	landbird	41,722	33,772	57,859	0.26349032	0.064226508	300	1.5
Hairy Woodpecker	Dryobates villosus	965	landbird	8,681,068	7,874,994	9,508,689	0.249314168	0.004190679	125	2
Hammond's Flycatcher	Empidonax hammondi	1308	landbird	20,160,045	16,231,089	24,518,510	0.383876374	0.015184249	100	2
Harris's Hawk	Parabuteo unicinctus	812	landbird	51,689	29,505	86,815	0.393264523	0.22105359	300	1.5
Henslow's Sparrow	Centronyx henslowii	1845	landbird	408,187	290,235	547,708	0.678606158	0.010664453	125	2
Hepatic Tanager	Piranga flava	2032	landbird	411,228	263,215	591,940	0.249492464	0.139360358	125	2
Hermit Thrush	Catharus guttatus	1584	landbird	71,726,125	54,075,176	95,680,929	0.34889321	0.013521061	200	2
Hermit Warbler	Setophaga occidentalis	2010	landbird	2,525,603	1,808,648	3,357,140	0.169558798	0.01638279	125	2

Hoary Redpoll	Acanthis hornemanni	1756	landbird	12,815,104	12,474,111	13,252,214	0.195275926	0.022255784	125	2
Hooded Oriole	Icterus cucullatus	1910	landbird	350,616	236,805	494,427	0.134838091	0.034837138	125	1.75
Hooded Warbler	Setophaga citrina	1982	landbird	5,185,197	4,523,541	5,902,847	0.165781479	0.006677477	125	2
Horned Lark	Eremophila alpestris	1412	landbird	100,607,831	90,290,833	112,734,630	0.319579262	0.038106901	200	2
House Finch	Haemorrhous mexicanus	1749	landbird	33,246,130	29,546,633	37,992,529	0.106257564	0.012699766	125	1.75
House Sparrow	Passer domesticus	1668	landbird	92,842,101	83,703,006	104,203,385	0.23727539	0.043700479	125	1
House Wren	Troglodytes aedon	1461	landbird	43,318,358	39,758,949	47,473,572	0.157442539	0.010356315	125	2
Hutton's Vireo	Vireo huttoni	1351	landbird	964,653	744,358	1,213,151	0.412118002	0.007851349	125	2
Inca Dove	Columbina inca	169	landbird	619,057	491,301	765,612	0.259561594	0.009810166	125	1.25
Indigo Bunting	Passerina cyanea	2060	landbird	77,494,167	73,235,841	82,041,052	0.334016374	0.015511967	125	2
Juniper Titmouse	Baeolophus ridgwayi	1444	landbird	291,637	201,086	392,881	0.161396989	0.009527298	200	1.25
Kentucky Warbler	Geothlypis formosa	1970	landbird	2,595,606	2,284,175	2,937,212	0.165429467	0.007695189	125	2
Ladder-backed Woodpecker	Dryobates scalaris	963	landbird	2,377,162	1,983,369	2,827,402	0.335269007	0.009487836	125	2
Lapland Longspur	Calcarius lapponicus	1773	landbird	68,032,536	60,265,772	80,590,222	0.479198426	0.03584308	200	1.75
Lark Bunting	Calamospiza melanocorys	1841	landbird	11,992,598	9,194,389	15,233,830	0.286366646	0.05170139	200	1
Lark Sparrow	Chondestes grammacus	1836	landbird	10,638,361	9,078,588	12,343,951	0.14314708	0.013175516	200	1.5
Lawrence's Goldfinch	Spinus lawrencei	1770	landbird	347,128	188,186	574,120	0.312388451	0.021341133	125	1.75
Lazuli Bunting	Passerina amoena	2059	landbird	6,453,834	5,417,754	7,643,998	0.253922015	0.011131342	125	2
Least Flycatcher	Empidonax minimus	1307	landbird	27,244,220	24,465,739	30,286,260	0.087097838	0.009253083	125	2
LeConte's Sparrow	Ammospiza leconteii	1846	landbird	5,128,134	4,121,245	6,262,076	0.705896323	0.014200509	125	2
LeConte's Thrasher	Toxostoma lecontei	1628	landbird	45,644	15,853	93,422	0.151208587	0.03780064	200	1.75
Lesser Goldfinch	Spinus psaltria	1769	landbird	5,723,877	4,542,330	7,132,984	0.300588294	0.01824926	125	1.75
Lesser Nighthawk	Chordeiles acutipennis	226	landbird	3,801,395	2,399,615	5,545,863	2.125465631	0.019269463	300	2
Lewis's Woodpecker	Melanerpes lewis	935	landbird	81,507	52,913	119,611	0.0461722639	0.046172263	200	1.5
Lincoln's Sparrow	Melospiza lincolni	1853	landbird	88,078,735	78,262,006	98,782,691	0.650857783	0.015359268	125	2
Loggerhead Shrike	Lanius ludovicianus	1325	landbird	4,557,457	4,080,246	5,094,115	0.257515395	0.008301429	125	1.25
Long-billed Thrasher	Toxostoma longirostre	1623	landbird	95,573	53,639	153,900	0.151208587	0.03780064	200	2
Long-eared Owl	Asio otus	863	landbird	37,707	15,671	68,758	0.950630863	0.005753235	125	2
Louisiana Waterthrush	Parkesia motacilla	1949	landbird	446,545	377,921	529,134	0.327908312	0.00514556	200	2
Lucy's Warbler	Oreothlypis luciae	1962	landbird	2,829,708	1,620,023	4,473,592	0.213627285	0.029472214	125	2
MacGillivray's Warbler	Geothlypis tolmiei	1968	landbird	11,191,876	9,091,713	13,546,236	0.154940761	0.008899679	125	2
Magnolia Warbler	Setophaga magnolia	1989	landbird	38,757,259	33,706,369	44,351,863	0.128230092	0.011292731	125	2
Marsh Wren	Cistothorus palustris	1470	landbird	10,846,904	8,009,975	14,414,465	0.865362685	0.017776852	125	2
McCown's Longspur	Rhynchophanes mccownii	1776	landbird	844,821	487,327	1,322,335	0.477568371	0.036353088	200	1.5
Merlin	Falco columbarius	1000	landbird	1,620,998	1,325,156	1,975,531	0.136416034	0.001135255	125	2
Mexican Jay	Aphelocoma wollweberi	1388	landbird	142,059	31,219	355,566	0.162911473	0.013297024	200	1.25
Mississippi Kite	Ictinia mississippiensis	798	landbird	695,177	537,854	881,937	1.03847348	0.012618132	300	1.75
Monk Parakeet	Myiopsitta monachus	1010	landbird	59,268	1,094	158,202	0.336241881	0.212251379	125	1.5
Mountain Bluebird	Sialia currucoides	1559	landbird	5,568,751	4,615,920	6,673,385	0.561682314	0.019043058	200	2
Mountain Chickadee	Poecile gambeli	1437	landbird	7,855,197	6,597,745	9,279,875	0.281720767	0.014457926	125	1.25
Mountain Quail	Oreortyx pictus	94	landbird	250,825	174,335	348,548	0.40626839	0.014460376	300	2
Mourning Dove	Zenaidura macroura	198	landbird	133,072,464	123,233,806	143,006,188	0.316423592	0.022409558	200	1.75
Mourning Warbler	Geothlypis philadelphia	1969	landbird	13,827,473	11,375,932	16,818,340	0.259959923	0.011418499	125	2
Nashville Warbler	Oreothlypis ruficapilla	1963	landbird	39,717,135	34,046,329	46,021,851	0.213572778	0.014052851	125	2
Nelson's Sparrow	Ammospiza nelsoni	1848	landbird	1,012,433	860,211	1,182,894	0.571305714	0.009063602	125	2
Northern Cardinal	Cardinalis cardinalis	2047	landbird	118,228,958	107,977,674	129,207,132	0.866690425	0.028147857	200	2
Northern Flicker	Colaptes auratus	977	landbird	10,997,056	10,030,079	12,029,437	0.263105839	0.045989788	200	1.25
Northern Goshawk	Accipiter gentilis	793	landbird	205,103	144,935	279,609	0.350349154	0.002368837	125	2
Northern Harrier	Circus hudsonius	783	landbird	822,326	731,377	921,329	0.222768112	0.005077001	300	2
Northern Mockingbird	Mimus polyglottos	1634	landbird	33,748,673	30,589,410	37,047,818	0.099038838	0.013748544	200	1.5
Northern Parula	Setophaga americana	1987	landbird	18,173,930	16,508,547	19,946,040	0.165653455	0.008870983	125	2
Northern Pygmy-Owl	Glaucidium gnoma	848	landbird	129,397	77,555	214,434	1.056103865	0.003481108	200	2
Northern Rough-winged Swallow	Stelgidopteryx serripennis	1428	landbird	19,956,056	15,363,114	26,977,637	0.303402591	0.013563681	125	1.75
Northern Waterthrush	Parkesia noveboracensis	1950	landbird	17,166,584	14,259,921	20,524,318	0.108962749	0.006741665	200	2
Northwestern Crow	Corvus caurinus	1396	landbird	701,805	421,865	1,111,796	0.438962554	0.094806648	400	1.5
Nuttall's Woodpecker	Dryobates nuttallii	962	landbird	752,044	500,760	1,076,906	0.27959732	0.034920096	125	1.5
Oak Titmouse	Baeolophus inornatus	1443	landbird	706,717	407,725	1,196,605	0.203429085	0.015921436	200	1.25
Olive Sparrow	Arremonops rufivirgatus	1798	landbird	829,024	486,176	1,252,969	0.709359899	0.020977793	200	1.75
Olive-sided Flycatcher	Contopus cooperi	1291	landbird	1,916,763	1,576,589	2,322,865	0.109373062	0.006610393	300	2
Orange-crowned Warbler	Oreothlypis celata	1960	landbird	81,919,229	69,421,324	95,720,231	0.237215061	0.013613313	125	2
Orchard Oriole	Icterus spurius	1909	landbird	10,894,813	9,896,563	11,930,180	0.099898312	0.00769728	125	1.75
Osprey	Pandion haliaetus	770	landbird	399,228	328,092	483,403	0.49973566	0.00742224	300	1.25
Ovenbird	Seiurus aurocapilla	1947	landbird	26,312,390	22,777,813	30,231,156	0.214366322	0.014149396	200	2
Pacific Wren	Troglodytes pacificus	1466	landbird	7,528,567	5,392,359	10,095,516	0.513974173	0.013003866	200	1.75
Pacific-slope Flycatcher	Empidonax difficilis	1312	landbird	8,585,203	6,751,118	10,839,307	0.141806818	0.01059711	125	2
Painted Bunting	Passerina ciris	2064	landbird	12,778,114	10,848,520	14,991,104	0.219191714	0.013373231	125	1.75
Palm Warbler	Setophaga palmarum	1996	landbird	13,172,938	9,852,145	17,350,184	0.265520256	0.008448309	125	2
Phainopepla	Phainopepla nitens	1647	landbird	1,285,683	905,747	1,775,051	0.318642933	0.0145247	125	1.5
Philadelphia Vireo	Vireo philadelphicus	1357	landbird	3,968,582	3,039,944	5,019,728	0.179034235	0.008993391	125	2
Pileated Woodpecker	Dryocopus pileatus	983	landbird	2,648,713	2,398,947	2,931,122	0.531071086	0.007285076	300	2
Pine Grosbeak	Pinicola enucleator	1743	landbird	5,530,332	4,039,601	7,262,401	0.194545309	0.00688874	125	2
Pine Siskin	Spinus pinus	1763	landbird	44,719,558	37,972,998	52,314,211	0.320507011	0.025718467	125	1.5
Pine Warbler	Setophaga pinus	1998	landbird	13,108,682	11,923,661	14,327,429	0.092765876	0.010964286	125	2
Pinyon Jay	Gymnorhinus cyanocephalus	1380	landbird	755,415	525,819	1,068,774	0.276028144	0.039592912	300	1.25
Plumbeous Vireo	Vireo plumbeus	1356	landbird	2,999,048	2,194,985	3,986,302	0.328010835	0.012195375	125	2
Prairie Falcon	Falco mexicanus	1007	landbird	97,855	76,690	121,492	0.347099863	0.003094445	300	2
Prairie Warbler	Setophaga discolor	2003	landbird	3,555,356	3,156,416	4,009,433	0.199783094	0.00775599	125	2
Prothonotary Warbler	Protonotaria citrea	1955	landbird	2,069,931	1,633,108	2,645,686	0.170661673	0.007759922	125	2
Purple Finch	Haemorrhous purpureus	1750	landbird	6,539,107	5,746,681	7,363,210	0.208481863	0.010983563	125	2
Purple Martin	Progne subis	1413	landbird	8,728,591	7,776,376	9,841,533	0.24446211	0.028144531	200	1.25
Pygmy Nuthatch	Sitta pygmaea	1451	landbird	3,103,791	2,051,268	4,410,534	0.462447564	0.023220006	125	1.75
Pyrrhuloxia	Cardinalis sinuatus	2048	landbird	1,578,426	1,076,870	2,208,564	0.172854465	0.013073557	200	1.75
Red Crossbill	Loxia curvirostra	1757	landbird	9,585,953	7,856,459	11,542,746	0.337778176	0.023354528	125	1.5
Red-bellied Woodpecker	Melanerpes carolinus	1951	landbird	15,518,241	14,095,781	16,973,039	0.364972699	0.012239403	200	1.75
Red-breasted Nuthatch	Sitta canadensis	1449	landbird	19,689,413	17,772,520	21,658,078	0.218424232	0.008984852	125	1.75
Red-breasted Sapsucker	Sphyrapicus ruber	956	landbird	2,755,899	1,872,219	3,799,342	0.221030989	0.007558361	125	1.5
Red-eyed Vireo	Vireo olivaceus	1360	landbird	130,756,817	121,405,110	141,235,333	0.250511261	0.017879662	125	2

Red-faced Warbler	Cardellina rubrifrons	2024	landbird	252,600	70,739	503,841	0.148410299	0.009848297	125	2
Red-headed Woodpecker	Melanerpes erythrocephalus	938	landbird	1,802,639	1,587,954	2,066,531	0.27695727	0.007585097	200	1.25
Red-naped Sapsucker	Sphyrapicus nuchalis	955	landbird	1,974,818	1,596,661	2,425,112	0.203846865	0.008044308	125	2
Red-shoudered Hawk	Buteo lineatus	818	landbird	1,827,010	1,607,481	2,085,341	0.310636921	0.00749664	200	2
Red-tailed Hawk	Buteo jamaicensis	825	landbird	2,808,115	2,579,824	3,052,334	0.437107989	0.008314715	300	1.25
Red-winged Blackbird	Agelaius phoeniceus	1926	landbird	172,973,570	154,908,749	196,698,929	0.294722634	0.048341194	200	1.25
Ring-necked Pheasant	Phasianus colchicus	123	landbird	16,642,331	14,252,196	19,372,599	0.748822706	0.0176056	300	2
Rock Pigeon	Columba livia	149	landbird	16,195,053	14,584,425	17,988,593	0.541589606	0.032519759	200	1
Rock Wren	Salpinctes obsoletus	1454	landbird	3,362,014	2,744,880	4,115,789	0.245743709	0.009882728	200	2
Rose-breasted Grosbeak	Pheucticus ludovicianus	2051	landbird	4,715,733	4,058,034	5,474,743	0.152079089	0.007135443	200	2
Rough-legged Hawk	Buteo lagopus	826	landbird	296,141	248,433	370,060	0.429513809	0.219098555	300	2
Ruby-crowned Kinglet	Regulus calendula	1518	landbird	99,900,936	90,024,695	110,791,661	0.135844836	0.011392073	125	2
Ruby-throated Hummingbird	Archilochus colubris	332	landbird	35,777,111	31,236,693	40,921,667	0.296114683	0.004821445	50	2
Rufous Hummingbird	Selasphorus rufus	341	landbird	21,694,644	13,724,171	32,781,297	0.310051644	0.008407568	50	1.5
Rufous-crowned Sparrow	Aimophila ruficeps	1808	landbird	601,135	407,380	851,057	0.35990617	0.014617059	200	2
Rusty Blackbird	Euphagus carolinus	1937	landbird	6,804,603	4,919,111	9,459,126	0.355534902	0.008725154	125	1.75
Sage Thrasher	Oreoscoptes montanus	1630	landbird	6,362,519	4,673,219	8,479,429	0.1967526	0.015607969	200	2
Sagebrush Sparrow	Artemisiospiza nevadensis	1839	landbird	5,386,123	3,477,545	8,199,885	0.358413472	0.061624713	200	2
Savannah Sparrow	Passerculus sandwichensis	1842	landbird	168,676,799	144,322,771	195,333,538	0.357062427	0.025102403	125	2
Say's Phoebe	Sayornis saya	1319	landbird	5,044,646	4,348,767	5,764,857	0.942517033	0.009950062	200	2
Scaled Quail	Callipepla squamata	102	landbird	2,393,345	1,766,520	3,168,001	0.533186089	0.016925686	200	1.75
Scarlet Tanager	Piranga olivacea	2034	landbird	2,574,915	2,256,623	2,956,329	0.101735649	0.006773229	200	2
Scissor-tailed Flycatcher	Tyrannus forficatus	1282	landbird	7,914,013	6,502,356	9,635,329	0.27142701	0.021457588	200	2
Scott's Oriole	Icterus parisorum	1924	landbird	1,721,724	1,332,821	2,134,384	0.238065553	0.008735328	125	1.75
Seaside Sparrow	Ammospiza maritima	1847	landbird	196,782	32,213	523,319	0.457471505	0.125282849	125	1.25
Sedge Wren	Cistothorus platensis	1469	landbird	5,017,990	4,252,225	5,954,334	0.459508553	0.012025593	125	2
Sharp-shinned Hawk	Accipiter striatus	789	landbird	405,947	303,414	524,274	0.19572212	0.001721087	125	2
Sharp-tailed Grouse	Tympanuchus phasianellus	134	landbird	761,942	569,936	975,726	0.307188253	0.010358181	200	2
Short-eared Owl	Asio flammeus	865	landbird	602,353	485,388	747,895	0.381400506	0.008177428	200	1.75
Snow Bunting	Plectrophenax nivalis	1777	landbird	14,267,309	14,267,309	14,267,309	0.477568371	0.036353088	200	1.75
Song Sparrow	Melospiza melodia	1852	landbird	126,053,605	118,934,257	133,938,545	0.377871011	0.025177923	125	2
Spotted Towhee	Pipilo maculatus	1805	landbird	35,271,543	31,027,431	39,773,372	0.808232166	0.02023887	125	2
Sprague's Pipit	Anthus spragueii	1680	landbird	1,394,136	936,560	2,009,643	0.329678876	0.01811783	200	2
Steller's Jay	Cyanocitta stelleri	1381	landbird	2,705,843	2,239,068	3,237,856	0.183671434	0.011063169	200	1.25
Summer Tanager	Piranga rubra	2033	landbird	11,302,422	10,343,397	12,384,415	0.278798745	0.012069164	125	2
Swainson's Hawk	Buteo swainsoni	823	landbird	822,598	714,482	956,228	0.14557514	0.006763745	300	1.5
Swainson's Thrush	Catharus ustulatus	1583	landbird	121,704,609	102,456,492	144,203,885	0.516449016	0.025017579	200	2
Swainson's Warbler	Limnothlypis swainsonii	1956	landbird	156,081	99,540	235,309	0.334319283	0.004325713	200	2
Swamp Sparrow	Melospiza georgiana	1854	landbird	23,261,464	20,193,095	26,315,495	0.505455805	0.013070146	125	2
Tennessee Warbler	Oreothlypis peregrina	1959	landbird	111,454,361	80,906,890	149,074,619	0.19793209	0.016972245	125	2
Townsend's Solitaire	Myadestes townsendi	1560	landbird	1,050,595	834,475	1,298,011	0.117084632	0.005982225	200	2
Townsend's Warbler	Setophaga townsendi	2009	landbird	21,262,275	16,792,636	26,233,697	0.194158878	0.013715638	100	2
Tree Swallow	Tachycineta bicolor	1420	landbird	18,581,775	16,732,180	20,563,777	0.136023938	0.016419183	200	1.75
Tufted Titmouse	Baeolophus bicolor	1445	landbird	11,970,837	10,921,948	13,128,862	0.165596732	0.012740487	200	1.25
Turkey Vulture	Cathartes aura	766	landbird	8,418,387	7,705,474	9,163,886	1.094905764	0.02839236	400	1.75
Varied Bunting	Passerina versicolor	2063	landbird	69,313	27,061	135,722	0.342755297	0.067921347	125	1.75
Varied Thrush	Ixoreus naevius	1609	landbird	34,514,221	26,180,031	44,500,981	0.836969707	0.023621132	200	2
Vaux's Swift	Chaetura vauxi	261	landbird	418,576	284,294	607,235	0.81044058	0.01750757	200	1.75
Veery	Catharus fuscescens	1580	landbird	11,186,101	9,451,271	13,166,545	0.483652865	0.014851972	200	2
Verdin	Auriparus flaviceps	1447	landbird	3,810,209	2,615,935	5,392,903	0.216241891	0.01368995	125	1.5
Vermilion Flycatcher	Pyrocephalus rubinus	1320	landbird	538,032	324,197	798,482	0.309093639	0.270946381	125	2
Vesper Sparrow	Poocetes gramineus	1835	landbird	35,053,955	30,378,748	40,800,937	0.395480333	0.023570974	200	2
Violet-green Swallow	Zonotrichia thalassina	1423	landbird	6,724,535	5,560,970	8,017,545	0.195622727	0.024180882	200	1.5
Virginia's Warbler	Oreothlypis virginiae	1964	landbird	904,013	567,681	1,360,062	0.123544103	0.007611996	125	2
Warbling Vireo	Vireo gilvus	1358	landbird	52,333,042	46,022,570	58,752,802	0.230417562	0.011166342	125	2
Western Bluebird	Sialia mexicana	1558	landbird	5,661,189	4,392,144	7,058,744	0.696104544	0.017579858	125	2
Western Kingbird	Tyrannus verticalis	1277	landbird	28,830,127	24,939,575	33,543,450	0.592717171	0.021322477	200	2
Western Meadowlark	Sturnella neglecta	1889	landbird	95,124,368	83,326,234	107,339,715	0.27317075	0.029996622	200	1.5
Western Screech-Owl	Megascops kennicottii	832	landbird	240,461	121,691	401,313	2.687968772	0.002995476	125	2
Western Tanager	Piranga ludoviciana	2035	landbird	15,020,244	12,899,162	17,361,777	0.447457356	0.014480276	200	2
Western Wood-Pewee	Contopus sordidulus	1295	landbird	8,845,348	7,660,907	10,112,663	0.114093527	0.013682786	200	2
White-breasted Nuthatch	Sitta carolinensis	1450	landbird	10,035,072	9,249,484	10,873,200	0.300171347	0.007606023	125	1.5
White-crowned Sparrow	Zonotrichia leucophrys	1858	landbird	79,258,794	63,587,655	97,291,972	0.735826366	0.024616882	200	2
White-eyed Vireo	Vireo griseus	1340	landbird	22,090,753	20,223,913	24,179,468	0.345526823	0.014272054	125	2
White-headed Woodpecker	Dryobates albolarvatus	966	landbird	243,113	168,463	340,504	0.27959732	0.034920096	125	2
White-tailed Kite	Elanus leucurus	772	landbird	15,718	8,293	26,310	0.393264523	0.22105359	300	1.5
White-throated Sparrow	Zonotrichia albicollis	1856	landbird	162,847,702	138,867,549	189,194,261	0.810191169	0.028959236	200	2
White-throated Swift	Aeronautes saxatalis	274	landbird	2,382,771	1,600,983	3,298,803	1.446112641	0.03742553	200	1.25
White-winged Crossbill	Loxia leucoptera	1760	landbird	39,691,698	30,030,233	51,497,702	0.315993228	0.034746756	125	1.25
White-winged Dove	Zenaidura macroura	195	landbird	5,159,586	3,579,714	7,462,483	0.154560911	0.01908313	200	1.5
Williamson's Sapsucker	Sphyrapicus thyroideus	953	landbird	294,829	209,789	398,019	0.129722328	0.00726301	125	1.5
Willow Flycatcher	Empidonax traillii	1305	landbird	8,095,093	6,902,363	9,486,416	0.192252001	0.007418508	125	2
Willow Ptarmigan	Lagopus lagopus	129	landbird	12,784,429	7,232,901	21,298,386	0.516304491	0.161395519	125	2
Wilson's Warbler	Cardellina pusilla	2023	landbird	81,271,984	65,743,361	98,288,305	0.150728497	0.010994367	100	2
Winter Wren	Troglodytes hiemalis	1467	landbird	11,140,437	9,052,643	13,798,379	0.450595909	0.010210473	200	1.75
Wood Thrush	Hylocichla ustulata	1585	landbird	12,191,387	10,959,424	13,589,692	0.841982739	0.014786107	200	2
Woodhouse's Scrub-Jay	Aphelocoma woodhouseii	1386	landbird	692,935	476,075	1,023,759	0.162746	0.013553	200	1.25
Worm-eating Warbler	Helminthophila vermivorum	1948	landbird	784,060	608,710	988,276	0.308009094	0.006566743	125	2
Wrentit	Chamaea fasciata	1530	landbird	1,753,863	1,095,353	2,807,164	0.568239126	0.018344846	200	2
Yellow Warbler	Setophaga petechia	1992	landbird	92,640,979	83,231,903	102,629,283	0.100828316	0.012896374	125	2
Yellow-bellied Flycatcher	Empidonax flaviventris	1302	landbird	13,047,639	10,169,586	16,383,394	0.180646794	0.007272063	125	2
Yellow-bellied Sapsucker	Sphyrapicus varius	954	landbird	13,523,418	11,628,336	15,891,341	0.505398175	0.010805358	125	1.5
Yellow-billed Cuckoo	Coccyzus americanus	205	landbird	8,358,126	7,571,171	9,214,892	0.322683865	0.010071364	200	2
Yellow-breasted Chat	Icteria virens	1885	landbird	15,066,335	13,315,869	16,929,873	0.530142376	0.016546429	200	2
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	1886	landbird	11,338,466	8,566,820	14,826,716	0.352608969	0.031402487	200	1
Yellow-rumped Warbler	Setophaga coronata	1999	landbird	173,685,250	155,879,524	190,742,853	0.260143255	0.050020994	125	2
Yellow-throated Vireo	Vireo flavifrons	1352	landbird	4,705,278	4,250,092					

Yellow-throated Warbler	Setophaga dominica	2000	landbird	2,039,116	1,732,805	2,359,505	0.10886397	0.007825739	125	2
American Bittern	Botaurus lentiginosus	727	waterbird	2,507,797	2,005,616	3,117,498	0.527650945	0.011264365	200	2
American Coot	Fulica americana	435	waterbird	5,517,522	4,109,506	7,381,712	0.091181	0.028935	200	1.5
American White Pelican	Pelecanus erythrorhynchos	724	waterbird	414,730	299,521	546,711	0.084189689	0.025513834	400	1
Black Tern	Chlidonias niger	610	waterbird	2,331,116	1,695,896	3,119,894	0.055300719	0.022582891	200	1.5
Black-crowned Night-Heron	Nycticorax nycticorax	754	waterbird	419,820	292,104	595,456	0.271239784	0.036710416	200	1.5
Bonaparte's Gull	Chroicocephalus philadelphia	570	waterbird	785,266	442,937	1,198,079	0.050057063	0.099057022	200	1.5
California Gull	Larus californicus	585	waterbird	1,065,791	658,357	1,567,466	0.16502702	0.015519872	400	1.5
Caspian Tern	Hydroprogne caspia	608	waterbird	78,325	41,255	130,130	0.163403021	0.071489661	300	1.5
Cattle Egret	Bubulcus ibis	748	waterbird	2,804,856	2,196,814	3,562,031	0.201800416	0.011434455	400	1.5
Clapper Rail	Rallus crepitans	409	waterbird	170,587	85,438	286,396	0.309266965	0.061032497	125	2
Clark's Grebe	Aechmophorus clarkii	147	waterbird	71,737	18,009	161,501	0.327301587	0.071165835	200	1.5
Common Gallinule	Gallinula galeata	431	waterbird	500,214	251,427	938,525	0.332267887	0.047506546	125	1.5
Common Loon	Gavia immer	629	waterbird	1,108,865	941,048	1,319,057	0.240477867	0.013040758	400	1.5
Common Tern	Sterna hirundo	614	waterbird	468,971	175,901	985,601	0.320800777	0.042272434	300	1.5
Double-crested Cormorant	Phalacrocorax auritus	719	waterbird	557,887	365,672	827,251	0.103993752	0.100658	400	1
Eared Grebe	Podiceps nigricollis	145	waterbird	1,950,442	943,872	3,659,128	0.294673952	0.084976757	200	1.5
Forster's Tern	Sterna forsteri	616	waterbird	127,120	72,306	202,189	0.202232424	0.029298304	300	1.5
Franklin's Gull	Leucophaeus pipixcan	577	waterbird	2,329,478	1,604,153	3,238,650	0.091120732	0.032918325	400	1.5
Glaucous-winged Gull	Larus glaucescens	591	waterbird	436,461	249,983	673,385	0.322673266	0.123204805	400	1.5
Glossy Ibis	Plegadis falcinellus	759	waterbird	36,394	13,092	71,380	0.352951887	0.079788377	400	1.5
Great Black-backed Gull	Larus marinus	593	waterbird	145,361	70,184	251,320	0.030213943	0.023732224	400	1.5
Great Blue Heron	Ardea herodias	734	waterbird	618,606	552,453	698,624	0.071842395	0.009481229	400	1.5
Great Egret	Ardea alba	738	waterbird	712,641	580,603	863,838	0.175690938	0.013181371	400	1.5
Green Heron	Butorides virescens	750	waterbird	772,671	689,060	862,103	0.098627595	0.008045328	200	1.5
Horned Grebe	Podiceps auritus	143	waterbird	246,553	159,574	364,503	0.09042579	0.021862375	200	1.5
King Rail	Rallus elegans	412	waterbird	63,219	26,563	122,039	0.283911869	0.036458681	125	2
Laughing Gull	Leucophaeus atricilla	576	waterbird	684,463	425,116	997,966	0.21459953	0.021046466	400	1.5
Least Bittern	Ixobrychus exilis	729	waterbird	131,773	66,196	217,720	0.290920543	0.026400578	125	2
Least Tern	Sternula antillarum	604	waterbird	51,692	21,444	97,858	0.191317513	0.032927712	300	1.5
Little Blue Heron	Egretta caerulea	745	waterbird	270,582	191,382	368,199	0.342808263	0.021884574	400	1.5
Mew Gull	Larus canus	581	waterbird	1,286,450	659,195	2,419,626	0.441761548	0.041289721	400	1.5
Pied-billed Grebe	Podilymbus podiceps	141	waterbird	1,138,963	905,996	1,412,585	0.282039569	0.01985522	200	1.5
Purple Gallinule	Porphyrio martinicus	428	waterbird	19,522	9,167	33,564	0.332267887	0.047506546	125	1.5
Red-necked Grebe	Podiceps grisegena	144	waterbird	737,518	482,463	1,054,730	0.202501856	0.033230746	200	1.5
Red-throated Loon	Gavia stellata	626	waterbird	358,396	96,811	792,502	0.244497532	0.035106588	400	1.5
Ring-billed Gull	Larus delawarensis	582	waterbird	3,740,458	2,828,976	4,916,343	0.157577311	0.056544667	400	1.5
Royal Tern	Thalasseus maximus	617	waterbird	35,206	10,179	70,873	0.194921686	0.040665774	300	1.5
Snowy Egret	Egretta thula	744	waterbird	215,935	152,524	300,633	0.210499937	0.030390356	400	1.5
Sora	Porzana carolina	419	waterbird	4,428,137	3,481,892	5,601,019	0.288164849	0.012031816	200	2
Tricolored Heron	Egretta tricolor	746	waterbird	57,579	34,376	88,724	0.26703882	0.046543675	400	1.5
Virginia Rail	Rallus limicola	413	waterbird	232,547	160,326	321,031	0.252412972	0.03342029	125	2
Western Grebe	Aechmophorus occidentalis	146	waterbird	989,858	425,689	1,889,334	0.327301587	0.071165835	200	1.5
Western Gull	Larus occidentalis	583	waterbird	44,003	11,262	90,819	0.256373679	0.060149017	400	1.5
White Ibis	Eudocimus albus	757	waterbird	1,170,987	807,222	1,696,093	0.488264444	0.029355231	400	1.5
White-faced Ibis	Plegadis chihi	760	waterbird	1,332,908	700,651	2,146,390	0.379365235	0.051336527	400	1.5
Yellow-crowned Night-Heron	Nyctanassa violacea	755	waterbird	129,442	72,714	233,481	0.179941759	0.019799945	200	1.5
Cinnamon Teal	Spatula cyanoptera	39	waterfowl	442,510	275,337	674,629	0.027890615	0.019861372	200	1.5
Greater Scaup	Aythya marila	59	waterfowl	1,606,158	513,593	3,551,089	0.141999695	0.032817988	200	1.5
Lesser Scaup	Aythya affinis	60	waterfowl	2,626,619	1,903,177	3,511,659	0.066772453	0.033750911	200	1.5
Mottled Duck	Anas fulvigula	50	waterfowl	238,785	148,277	355,630	0.185317762	0.042453552	200	1.5
Ruddy Duck	Oxyura jamaicensis	80	waterfowl	1,334,697	970,409	1,802,652	0.155034166	0.041770739	200	1.5
Wood Duck	Aix sponsa	35	waterfowl	2,148,806	1,930,697	2,371,212	0.255417551	0.006689409	125	1.5

Column Name	Meaning
Species	English Name, according to 59th supplement of AOS checklist - this spreadsheet contains species that occur regularly in the USA and/or Canada, AND that have population estimates and trends
sci_name	Scientific Name, from AOS 59th supplement
sort	taxonomic sort order, based on AOS 59th supplement, for each species
group	assignment to 1 of 4 bird groups: landbird, shorebird, waterbird, waterfowl
PopUsCa	Population estimate of individuals in the United States and Canada, normally based on breeding season surveys, sometimes approximated depending on information provided by source
PopLC95	lower end of a 95% range of variation around population estimate
PopUC95	upper end of a 95% range of variation around population estimate
TimeAdj.meanlog	mean log of time-of-day adjustment factor, which is the ratio of peak/mean detection rates across 50 BBS stops
TimeAdj.sdlog	standard deviation of above mean log time-of-day adjustment factor
Distance Adj.	distance adjustment factor: A categorical adjustment assigned to each species to modify the presumed sampling radius and adjust density estimates based on expected detection
Pair Adj.	pair adjustment factor, based on proportion of males and females detected on surveys; ranges from 1 (both sexes detected equally) to 2 (only males detected)