



Status and Trends of Landbird Populations in the Northern Colorado Plateau Network

2019 Field Season

Natural Resource Report NPS/NCPN/NRR—2020/2071



ON THE COVER

Bald eagle (*Haliaeetus leucocephalus*). US Fish and Wildlife Service/Karen Laubenstein.

Status and Trends of Landbird Populations in the Northern Colorado Plateau Network

2019 Field Season

Natural Resource Report NPS/NCPN/NRR—2020/2071

Prepared by

Samuel Roberts

Elizabeth Tymkiw

Zachary S. Ladin

Greg Shriver

250 Townsend Hall

Department of Entomology and Wildlife Ecology

University of Delaware

Newark, DE 19716-2160

Editing and Design

Alice Wondrak Biel

Northern Colorado Plateau Network

National Park Service

P.O. Box 848

Moab, UT 84532

February 2020

U.S. Department of the Interior

National Park Service

Natural Resource Stewardship and Science

Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Northern Colorado Plateau Network website, as well as at the Natural Resource Publications Management website. If you have difficulty accessing information in this publication, particularly if using assistive technology, please email irma@nps.gov.

Please cite this publication as:

Roberts, S., E. Tymkiw, Z. S. Ladin, and G. Shriver. 2020. Status and trends of landbird populations in the Northern Colorado Plateau Network: 2019 field season. Natural Resource Report NPS/NCPN/NRR—2020/2071. National Park Service, Fort Collins, Colorado.

Contents

Figures v

Tables v

Executive Summary vii

1 Introduction 1

2 Methods..... 3

 2.1 Study area and sampling design 3

 2.2 Field methods..... 7

 2.3 Data analysis..... 7

3 Results..... 9

 3.1 Habitat-based density trends 9

 3.2 Pipe Spring National Monument summary..... 9

4 Discussion 15

5 Literature Cited 17

Appendix A. Individual Species Density by Habitat..... 19

Figures

Figure 2-1. Northern Colorado Plateau Network parks where landbirds are monitored. 3

Figure 2-2. Transect locations by habitat, Utah units. 4

Figure 2-3. Transect locations by habitat, Colorado units. 5

Figure 2-4. Transect locations, Fossil Butte National Monument..... 6

Figure 2-5. Point-count and area-search locations, Pipe Spring National Monument. 6

Tables

Table 2-1. Annual number of point visits within each habitat (when possible, points were visited twice from 2005 to 2013). 3

Table 3-1. Significant density trends for landbird species in the Northern Colorado Plateau Network, 2019. 9

Table 3-2. Population-density trend slope, R² values, and sample size of estimated annual densities for individual species in low-elevation riparian, pinyon-juniper, and sage shrubland habitats in the Northern Colorado Plateau Network, 2005–2015 and 2017–2019. 10

Table 3-3. Number of individuals detected during point counts and area searches, Pipe Spring National Monument, 2009–2015 and 2017–2019. 12

Executive Summary

In 2019, the University of Delaware, in cooperation the National Park Service, completed the fourteenth year of a habitat-based landbird-monitoring program in park units of the Northern Colorado Plateau Network (NCPN). This program is designed to provide rigorous population-trend data for most diurnal, regularly occurring, breeding landbird species throughout the network. This population information is useful for land managers and supports the National Park Service's goal of long-term monitoring of biological indicators for network parks.

In 2019, university biologists surveyed 45 survey locations in 11 NCPN units. Fifteen transects were located in each of three habitats of interest: low-elevation riparian, pinyon-juniper, and sage shrubland. Each location was surveyed once. In addition to the habitat-based surveys, four point counts and an area search were conducted at Pipe Spring National Monument, using a modified monitoring design.

Over 14 years of data collection, 14,273 point-count surveys have been conducted in 11 NCPN units, detecting 173 unique species. During the 2019 field season, 655 point-count surveys were conducted, detecting 111 unique species. Five new species were detected for this monitoring program: a sora (*Porzana carolina*) in Arches National Park, a bald eagle (*Haliaeetus leucocephalus*) in Curecanti National Recreation Area, a northern saw-whet owl (*Aegolius acadicus*) and a purple martin (*Progne subis*) in Dinosaur National Monument (NM), and an American redstart (*Setophaga ruticilla*) in Canyonlands National Park. Northern saw-whet owl is listed as "present" on Dinosaur National Monument's NPSpecies list, while purple martin is listed as "unconfirmed." According to records from ebird (ebird.org, the world's largest biodiversity-related citizen science program), there are only two confirmed submissions of northern saw-whet owl detections and no previous confirmed detections of purple martin. American redstart is not included on the NPSpecies list for Canyonlands National Park, and has not been confirmed as detected in ebird records for the park, making this the first record of this species in this park.

In total, 134 population-density trends were estimated across the three habitats. Twenty-one of the estimated density trends were significant (p -value < 0.05), including 16 negative trends and five positive trends. There were sufficient sample sizes to estimate the densities of 63 species in at least one of the three habitats surveyed.

Using a modified monitoring design, landbird monitoring surveys were conducted in Pipe Spring National Monument for the tenth year since 2009. A total of 115 individuals of 30 species were recorded. Sample sizes were too low for density trends to be estimated for Pipe Spring National Monument.

Due to differences in distance-sampling methodology, all density estimates in this report should be considered to replace those found in previous reports.

1 Introduction

Detecting environmental change over broad temporal and spatial scales is an important goal of conservation science, especially in the face of climate change and other major anthropogenic disturbances. Through long-term data collection efforts, valuable ecological information about the causes and consequences of these changes can be gathered and used to inform natural-resource management.

Diurnal bird species are commonly used as indicators of environmental health because they are sensitive to environmental change and relatively easy to monitor (Canterbury et al. 2000, Gardali et al. 2006, Gardali and Holmes 2011). Through long-term monitoring of breeding-bird populations, we can estimate the population status and trends of individual species and bird communities in specific habitats, thus providing information about changes occurring in the surrounding landscape (Browder et al. 2002, Sauer et al. 2003, Gregory et al. 2007).

Rosenberg and others (2019) have estimated a loss of nearly 3 billion birds across North America since 1970. As bird populations decline, establishing and continuing long-term population monitoring is essential to finding causes and solutions for threatened, endangered, and declining populations.

Bird communities that rely on arid habitats, such as sage shrubland, are among the most vulnerable to population declines in an era of warming temperatures and increasing anthropogenic land use (Rosenberg et al. 2016). Habitat loss and degradation due to grazing and agriculture (Fleischner 1994, Rosenberg et al. 2016), the expansion of pinyon-juniper habitat (Miller and Wigand

1994, Baruch-Mordo et al. 2013), and the widespread threat of drought (Breshears et al. 2005) are among the major threats to arid landscapes and their inhabitants (Rosenberg et al. 2016). Public lands support more than half of the breeding range of 36 aridland-obligate species in the U.S. and Canada (Rosenberg et al. 2016), but threats of habitat loss and degradation remain. Concerted monitoring efforts are important for conserving bird communities in these areas.

In 2019, the University of Delaware, in cooperation with the National Park Service (NPS), completed the fourteenth year of a habitat-based landbird monitoring program in NPS units of the Northern Colorado Plateau Network (NCPN). Starting in 2005, surveys for the NCPN landbird monitoring program were completed annually for 11 consecutive years by the Bird Conservancy of the Rockies (BCR), with a hiatus in 2016. In 2017, the University of Delaware resumed NCPN landbird monitoring.

The NCPN landbird monitoring program is designed to provide managers of 11 national parks in Colorado, Utah, and Wyoming with long-term population trend data for breeding birds in three habitats: low-elevation riparian, pinyon-juniper, and sage shrubland. Using modified methods, monitoring is also conducted at Pipe Spring National Monument, in Arizona.

In this report, we use distance-sampling analysis to evaluate long-term density trends of all bird species present (with sufficient sample sizes) in the three focal habitats throughout the NCPN. In future analyses, we will evaluate the driving landscape and climate variables affecting long-term, transect-level bird population trends of the species in greatest decline.

2 Methods

2.1 Study area and sampling design

Three habitats were selected for NCPN landbird monitoring when the program was established in 2005: low-elevation riparian (LR), pinyon-juniper (PJ), and sage shrubland (SA). Even with some overlap, each of these habitats hosts a distinct suite of bird species. Across 11 NPS units (Figure 2-1), 45 transect locations were selected, with 15 transects established in each habitat. Each transect consists of 15 point-count locations, each 250 meters apart (Figures 2-2 to 2-4; see page 4).

The NPS and BCR used GIS and the Southwest Regional Re-GAP Analysis Project to randomly select PJ and SA transect locations (Lowry et al. 2005). Within those habitats, they excluded areas with >50% slope to ensure each transect could be accessed on foot. Because of the scarcity of riparian habitat in the NCPN, LR transect locations were manually selected. Sites with crossable streams were chosen, excluding the Colorado, Green, Gunnison, and Virgin rivers. Transects were groundtruthed and reassigned if necessary.

Since 2005, all 45 transects have remained in place and are the annually scheduled survey locations for this program. From 2005 to 2013, field teams surveyed each transect twice annually. Starting in 2014, survey effort was reduced to one visit per year. The number of completed surveys varied by year (Table 2-1), with >75% of planned surveys completed annually.

In 2009, Pipe Spring National Monument was added to the monitoring program. However, due to the park's small size, only four point-count locations were established, each at least 250 meters apart (Figure 2-5). These point-count locations were placed in a mixture of pinyon-juniper, low-elevation riparian, and semi-desert shrubland habitats. In 2011, to increase bird-monitoring efforts in the park, a 1,200-meter area-search transect was added to the program.

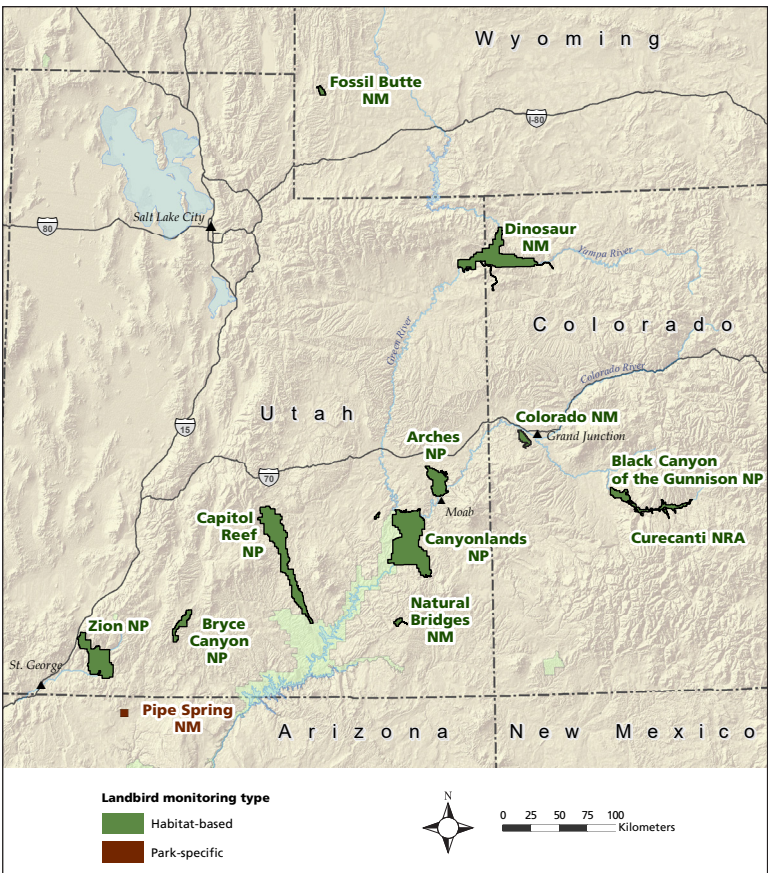


Figure 2-1. Northern Colorado Plateau Network parks where landbirds are monitored.

Table 2-1. Annual number of point visits within each habitat (when possible, points were visited twice from 2005 to 2013).

Year	Low-elevation riparian	Pinyon-juniper	Sage shrubland
2005	439	450	441
2006	443	443	450
2007	449	447	450
2008	450	415	420
2009	381	409	401
2010	389	432	441
2011	408	390	435
2012	371	422	444
2013	326	337	398
2014	153	167	206
2015	158	153	196
2017	225	210	225
2018	220	201	223
2019	209	221	225

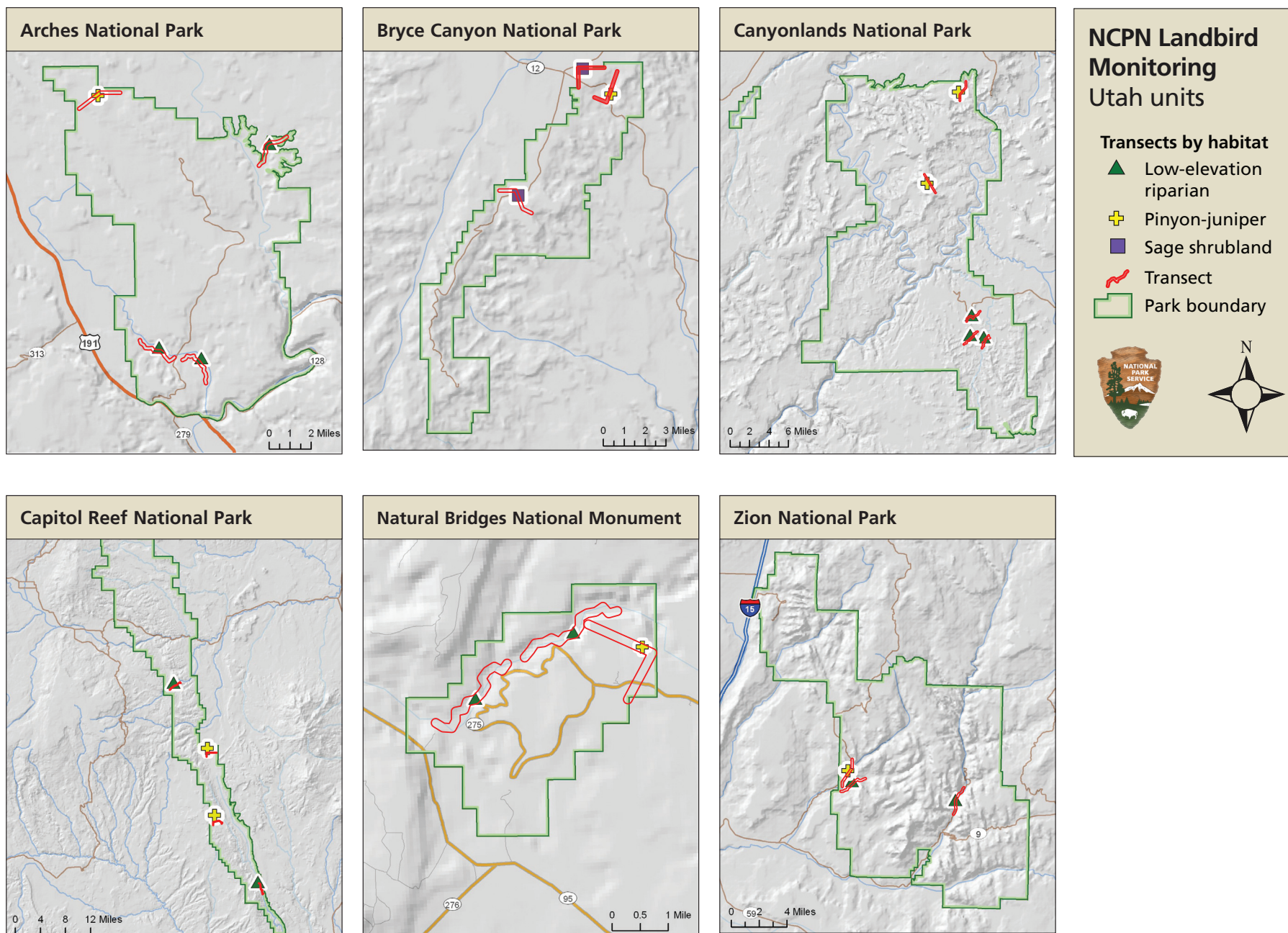


Figure 2-2. Transect locations by habitat, Utah units.

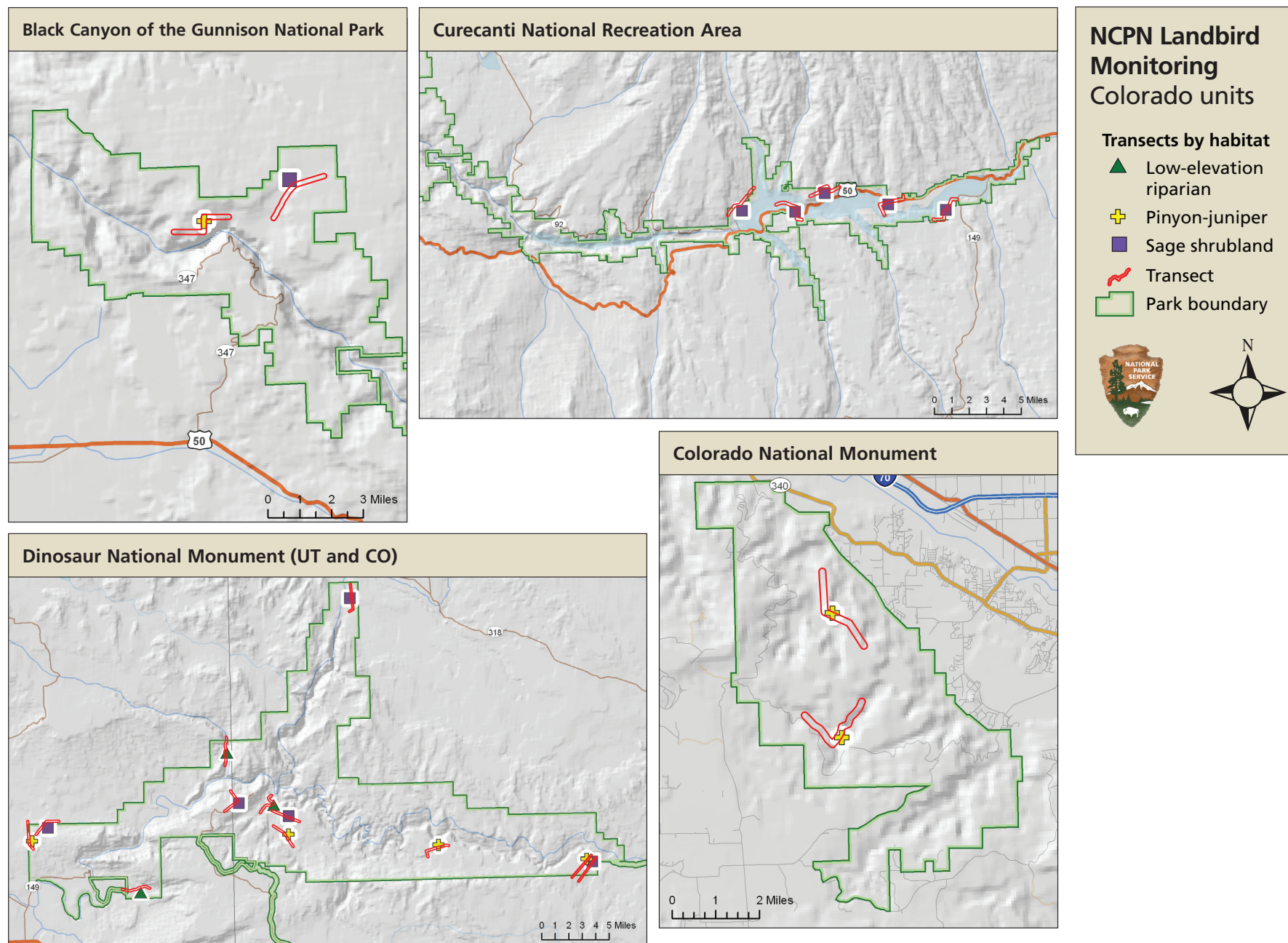


Figure 2-3. Transect locations by habitat, Colorado units.

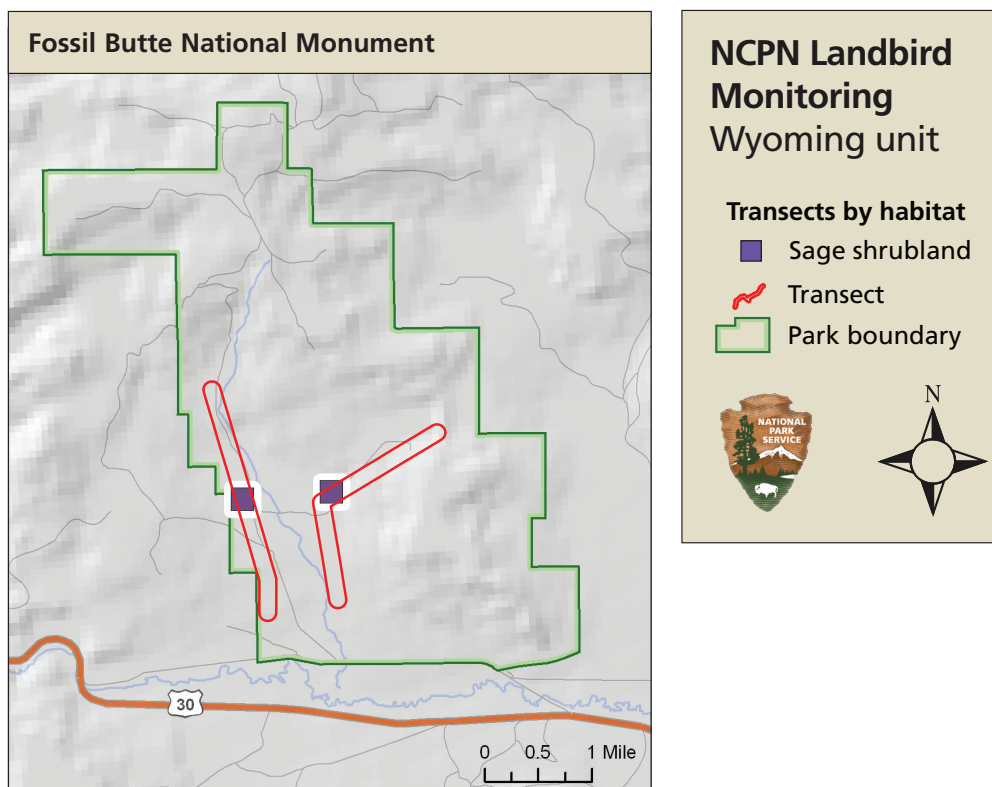


Figure 2-4. Transect locations, Fossil Butte National Monument.

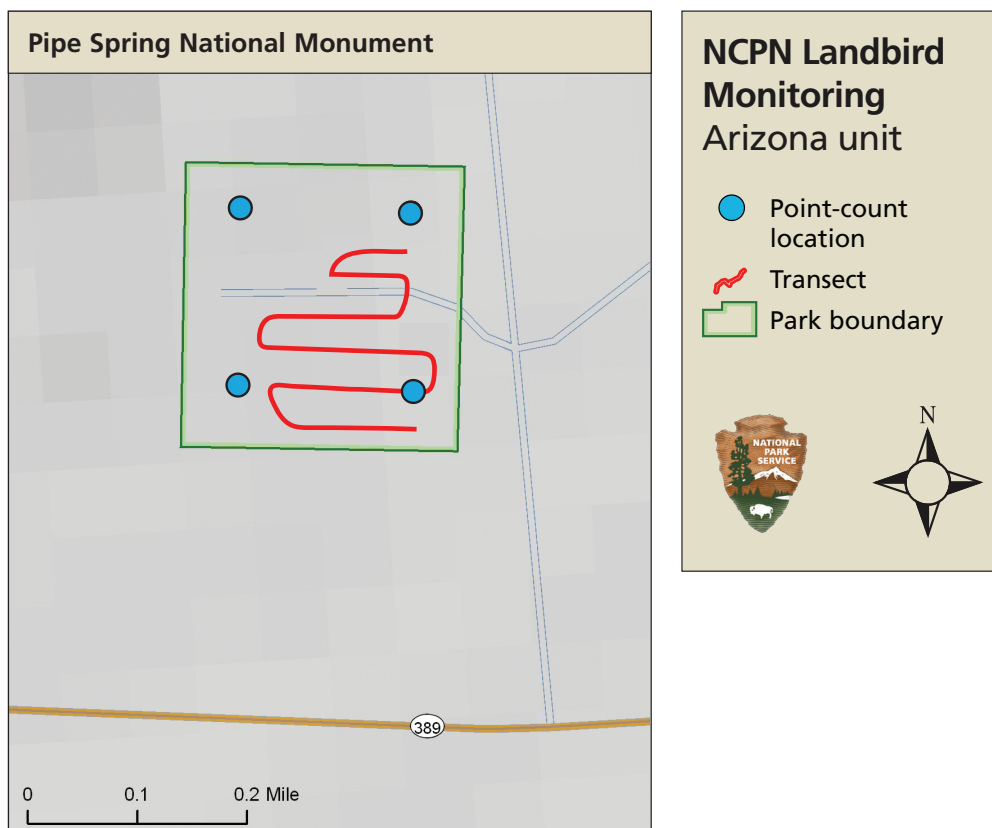


Figure 2-5. Point-count and area-search locations, Pipe Spring National Monument.

2.2 Field methods

Each year, field technicians attend a week-long training session to practice bird and plant identification, review field protocols, and hone distance-estimation skills (see Section 2.3.1). All transects are completed during the breeding season, which occurs between May 1 and July 15, depending on transect location. The elevation and latitudinal position of each transect are considered during the scheduling of each field season. The goal is to survey transects during the peak breeding season at each location.

Observers complete one transect per day, beginning within 30 minutes of sunrise and ending within five hours. Navigating to each point using a GPS unit, observers walk the transect, stopping at each of 15 point-count stations to record weather data, conduct a habitat assessment, and complete a five-minute point count.

At the beginning and end of each transect, observers record the following weather data: temperature, percent cloud cover, precipitation type, and estimated wind speed using the Beaufort scale. Surveys are not conducted if winds exceed 13–18 mph or precipitation is heavier than a drizzle.

During habitat assessments, observers record the overstory seral stage, canopy cover, mean height, and relative abundance of the five most-dominant tree or shrub species. Observers also record the seral stage, volume, mean height, and relative abundance of the five most-dominant species in the understory layer. Groundcover data and the presence of additional, non-dominant habitat types are also recorded.

During the five-minute point count, observers record all bird detections, regardless of distance to the observer. For each detection, observers record species, sex, horizontal distance to the bird, method of detection (visual, call, song, or other), and, if applicable, the number of birds within a cluster. Clusters are defined as groups of conspecific birds in close proximity to each other that are not considered separate, independent observations. The exact distance to each bird or cluster of birds is estimated using

a laser rangefinder. Observers also record flyovers, defined as individuals or clusters detected during point counts but not using the immediate surrounding landscape.

During the walk between point-count stations, observers record detections of low-density and difficult-to-detect species as a method of bolstering the sample sizes for these groups.

Habitat assessments and point counts at Pipe Spring National Monument follow the methods described above. In addition, observers continuously walk the 1,200-meter area-search transect during the time remaining after completing the point counts, recording the same data for all bird detections as are collected during point counts.

For more detailed information about survey protocols, refer to Daw and others (2017) and BCR's Northern Colorado Plateau Network Point Transect Protocol on the Rocky Mountain Avian Data Center website. Links to past and current protocols and data sheets may also be found at that site.

2.3 Data analysis

2.3.1 Distance sampling

We used the “Distance” package in program R (version 3.1.3; RCoreTeam 2014), which utilizes Distance 6.2 (Thomas et al. 2010) to estimate detection probabilities and bird population densities. Distance sampling relies on three main assumptions, which we met using established field protocols and training:

1. All objects at the sampling location are detected,
2. Objects are stationary or detected before movement occurs, and
3. Distances to objects are measured accurately.

In distance sampling, the distribution of observed distances of objects is dependent on the actual distribution of objects with respect to the observer and the detectability of an object. As such, detection functions must

first be fit to distance-sampling data to describe the probability of detecting an object. The selected detection function is then used to estimate an average probability of detection, which allows for observed counts to be corrected and used for density estimation.

2.3.2 *Habitat-based density trends*

Our initial analysis focused on estimating densities within each of the three habitat types for the full range of species present. We excluded flyovers, migrants, and juveniles from our analyses. With survey locations only 250 meters apart, there can be double-counting of individuals from multiple points. To avoid including double-counted individuals in our analyses, we set a cut-off distance of 125 meters, only including detections within this distance in our analyses.

To ensure sufficient sample sizes, we only estimated densities of species for which there were at least 80 independent detections within a habitat across all years within the distance cut-off. For each eligible species

within a habitat each year, we fit a series of five pre-selected detection-function models to the distribution of distances observed:

1. Uniform function with cosine series adjustments,
2. Half normal key function with no adjustments,
3. Half normal key function with cosine series adjustments,
4. Half normal key function with “observer” as a covariate, and
5. Hazard rate key function with cosine series adjustments

We ranked models using Akaike’s Information Criterion (AICc), selecting the top model as the most parsimonious detection function for each species (Burnham and Anderson 2002). We used the top detection function for each species in each habitat in each year to estimate density. We then fit a simple linear model to the annual densities for each species to determine trend direction and significance.

3 Results

Over 14 years of data collection, 14,273 point-count surveys have been conducted in 11 NCPN units (see Table 2-1), detecting 173 unique species. Of those 173 species, 157 were within 125 meters of the observer, the established distance cut-off for our analyses (see Section 2.3.2). In 2019, between May 7 and June 21, field technicians completed 44 of 45 planned habitat-based transects, for a total of 655 point-count surveys. A total of 5,030 individual birds of 111 unique species were recorded.

Five new species were detected for this monitoring program: a sora (*Porzana carolina*) in Arches National Park, a bald eagle (*Haliaeetus leucocephalus*) in Curecanti National Recreation Area, a northern saw-whet owl (*Aegolius acadicus*) and a purple martin (*Progne subis*) in Dinosaur National Monument, and an American redstart (*Setophaga ruticilla*) in Canyonlands National Park. Northern saw-whet owl is listed as “present” on Dinosaur National Monument’s NPSpecies list, while purple martin is listed as “unconfirmed.” According to records from ebird (ebird.org, the world’s largest biodiversity-related citizen science program), there are only two confirmed submissions of northern saw-whet owl detections and no previous confirmed detections of purple martin. American redstart is not included on the NPSpecies list for Canyonlands National Park, and has not been confirmed as detected in ebird records for the park, making this the first record of this species in this park.

3.1 Habitat-based density trends

We excluded density estimates with a detection-probability coefficient of variance of >100. We had sufficient sample sizes to estimate the densities of 64 species in at least one of the three habitats surveyed. In total, we estimated 134 population-density trends across the three habitats. Twenty-one of the estimated density trends were significant (p-value <0.05), including 16 negative trends and five positive trends (Tables 3-1, 3-2).

Table 3-1. Significant density trends for landbird species in the Northern Colorado Plateau Network, 2019.

Species	Habitat		
	LR	PJ	SA
Mourning dove	↓	↓	–
White-throated swift	↓	↓	–
Bushtit	–	↓	–
Rock wren	↓	–	↓
House wren	↑	–	↑
Mountain bluebird	–	↓	–
Yellow warbler	–	–	↑
Grace’s warbler	–	↓	–
Black-throated gray warbler	–	↓	–
Green-tailed towhee	–	↑	–
Sagebrush sparrow	–	–	↓
Dark-eyed junco	–	↓	–
Black-headed grosbeak	↓	↑	–
Western meadowlark	–	↓	–
Brown-headed cowbird	↓	–	–
House finch	↓	–	–

3.2 Pipe Spring National Monument summary

In 2019, we completed all four point-count surveys and the area search in Pipe Spring National Monument. We detected a total of 115 individuals of 30 species during surveys (Table 3-3). Sample sizes were too low for density trends to be estimated.

Table 3-2. Population-density trend slope, R² values, and sample size of estimated annual densities for individual species in low-elevation riparian, pinyon-juniper, and sage shrubland habitats in the Northern Colorado Plateau Network, 2005–2015 and 2017–2019.

Common name	Low-elevation riparian			Pinyon-juniper			Sage shrubland		
	Slope ^a	R ²	Sample size ^b	Slope ^a	R ²	Sample size ^b	Slope ^a	R ²	Sample size ^b
Mourning dove	-1.07***	0.71	13	-1.6**	0.46	14	-0.22	0.26	12
White-throated swift	-1.04*	0.40	14	-0.84**	0.53	14	-0.38	0.17	11
Black-chinned hummingbird	-1.83	0.06	13	8.6	0.34	11	–	–	–
Broad-tailed hummingbird	2.43	0.19	14	-1.25	0.05	10	0.87	0.13	13
Hairy woodpecker	0.18	0.14	11	–	–	–	–	–	–
Northern flicker	0.15	0.25	13	-0.02	0.00	12	0.01	0.01	13
Western wood-pewee	0.08	0.01	12	–	–	–	0.01	0.01	13
Gray flycatcher	0.02	0.02	10	-0.18	0.01	14	0.04	0.02	14
Dusky flycatcher	–	–	–	-0.23	0.04	13	0.13	0.02	14
Black phoebe	-0.31	0.09	14	–	–	–	–	–	–
Say's phoebe	-0.16	0.15	14	-0.05	0.18	11	-0.02	0.03	12
Ash-throated flycatcher	-0.55	0.12	14	-0.29	0.14	14	0.02	0.00	12
Gray vireo	-0.01	0.00	13	0.36	0.14	14	–	–	–
Plumbeous vireo	-0.2	0.03	14	0.11	0.04	14	-0.04	0.03	13
Warbling vireo	0.19	0.04	14	–	–	–	0.07	0.10	13
Pinyon jay	–	–	–	-0.16	0.23	14	0.03	0.23	7
Woodhouse's scrub-jay	0.02	0.00	14	0.16	0.02	13	-0.02	0.00	11
Black-billed magpie	–	–	–	–	–	–	-0.13	0.26	14
Common raven	-0.11	0.15	14	-0.04	0.15	14	-0.05	0.12	12
Horned lark	–	–	–	–	–	–	-0.05	0.01	14
Violet-green swallow	-4.74	0.04	12	0.44	0.06	13	0.25	0.17	13
Cliff swallow	–	–	–	–	–	–	-0.54	0.25	12
Mountain chickadee	–	–	–	0.1	0.03	14	–	–	–
Juniper titmouse	-0.32	0.11	14	-0.25	0.01	13	–	–	–
Bushtit	0.12	0.01	10	-3.16*	0.34	12	–	–	–
White-breasted nuthatch	–	–	–	-0.11	0.04	12	–	–	–
Rock wren	-0.42**	0.47	14	-0.21	0.12	12	-0.28*	0.42	14
Canyon wren	-0.03	0.01	14	-0.01	0.02	12	–	–	–
House wren	1.23*	0.33	14	–	–	–	0.23**	0.62	13
Bewick's wren	-0.35	0.12	14	-0.8	0.27	14	–	–	–
Blue-gray gnatcatcher	1.66	0.03	14	1.38	0.03	14	-0.02	0.00	12
Mountain bluebird	–	–	–	-0.41*	0.36	13	0.01	0.00	14
Hermit thrush	–	–	–	0.08	0.15	8	–	–	–
American robin	-0.48	0.29	13	-0.05	0.01	13	-0.12	0.05	14
Sage thrasher	–	–	–	–	–	–	-0.21	0.11	13
Lucy's warbler	1.49	0.19	12	–	–	–	–	–	–
Virginia's warbler	-0.29	0.12	13	0.41	0.27	12	0.15	0.23	14
Common yellowthroat	-0.4	0.03	13	–	–	–	–	–	–
Yellow warbler	1.03	0.05	14	–	–	–	0.2*	0.43	12
Yellow-rumped warbler	0.67	0.10	13	0.39	0.22	11	-0.01	0.00	12
Grace's warbler	–	–	–	-0.14*	0.35	14	-0.03	0.09	14
Black-throated gray warbler	-0.28	0.09	13	-2.23*	0.39	14	-0.14	0.23	12

Table 3-2. Population-density trend slope, R^2 values, and sample size of estimated annual densities for individual species in low-elevation riparian, pinyon-juniper, and sage shrubland habitats in the Northern Colorado Plateau Network, 2005–2015 and 2017–2019, cont.

Common name	Low-elevation riparian			Pinyon-juniper			Sage shrubland		
	Slope ^a	R ²	Sample size ^b	Slope ^a	R ²	Sample size ^b	Slope ^a	R ²	Sample size ^b
Yellow-breasted chat	0.21	0.10	13	–	–	–	0.1	0.26	10
Green-tailed towhee	–	–	–	0.35*	0.44	13	-0.45	0.03	14
Spotted towhee	0.1	0.00	14	0.77	0.20	14	0.11	0.02	14
Chipping sparrow	-1.07	0.28	12	-0.68	0.11	13	-0.5	0.14	13
Brewer's sparrow	–	–	–	–	–	–	0.98	0.03	14
Vesper sparrow	–	–	–	0.14	0.16	13	-1.15	0.19	14
Lark sparrow	-0.01	0.00	13	-0.1	0.02	14	0.4	0.18	14
Black-throated sparrow	-0.3	0.05	13	-0.43	0.13	13	0.13	0.12	12
Sagebrush sparrow	–	–	–	–	–	–	-0.21*	0.47	13
Song sparrow	-0.66	0.15	13	–	–	–	–	–	–
Dark-eyed junco	–	–	–	-0.18*	0.38	11	–	–	–
Western tanager	0.15	0.11	12	0.02	0.00	13	-0.03	0.15	13
Black-headed grosbeak	-0.34*	0.50	12	0.28*	0.36	13	-0.01	0.00	10
Blue grosbeak	0.05	0.00	14	–	–	–	–	–	–
Lazuli bunting	-1.2	0.10	13	0.5	0.15	12	0.06	0.01	13
Western meadowlark	–	–	–	-0.25*	0.43	13	-0.24	0.23	14
Brewer's blackbird	–	–	–	–	–	–	0.06	0.03	14
Brown-headed cowbird	-0.63*	0.39	11	0	0.00	14	-0.14	0.16	14
Bullock's oriole	-0.05	0.01	10	–	–	–	–	–	–
House finch	-1.85***	0.65	13	-0.2	0.01	13	-0.18	0.17	12
Lesser goldfinch	-0.35	0.02	13	-0.07	0.01	12	–	–	–

^ano asterisks = p-value >0.05; * = p-value ≤ 0.05; ** = p-value ≤ 0.01; *** = p-value ≤ 0.001. Significant trends (those with asterisks) are also colored red.

^bSample size represents the number of years for which densities could be estimated. Models could not be fit for each species-habitat combination for all years due to low detection sample sizes for some combinations.

Table 3-3. Number of individuals detected during point counts and area searches, Pipe Spring National Monument, 2009–2015 and 2017–2019.

Species	Point counts		Area searches		Total
	2009–2015, 2017–2018	2019	2009–2015, 2017–2018	2019	
Mallard	0	0	1	0	1
Mallard (domestic)	0	0	10	0	10
Gambel's quail	48	0	38	1	87
Black-crowned night-heron	1	0	11	0	12
Cooper's hawk	1	0	1	0	2
Red-tailed hawk	1	0	1	1	3
Eurasian collared-dove	52	0	85	0	137
Mourning dove	26	1	45	1	73
Great horned owl	0	0	1	0	1
Common poorwill	0	0	3	0	3
White-throated swift	20	0	3	1	24
Black-chinned hummingbird	2	0	0	0	2
Broad-tailed hummingbird	0	0	4	0	4
Downy woodpecker	1	0	0	0	1
Hairy woodpecker	1	0	1	0	2
American kestrel	5	0	11	0	16
Peregrine falcon	5	0	0	0	5
Prairie falcon	1	0	0	0	1
Western wood-pewee	3	0	8	0	11
Gray flycatcher	1	0	2	0	3
Black phoebe	6	0	18	0	24
Say's phoebe	27	1	24	1	53
Ash-throated flycatcher	27	1	19	2	49
Cassin's kingbird	56	0	36	0	92
Western kingbird	38	5	34	5	82
Gray vireo	7	0	2	0	9
Warbling vireo	0	0	4	0	4
Pinyon jay	1	0	0	1	2
Woodhouse's scrub-jay	3	0	7	0	10
Common raven	39	0	25	1	65
Violet-green swallow	14	0	53	14	81
Northern rough-winged swallow	9	0	4	1	14
Cliff swallow	0	0	1	1	2
Barn swallow	2	0	0	0	2
Juniper titmouse	6	0	1	0	7
Bushtit	0	0	0	1	1
Rock wren	21	2	3	1	27
Canyon wren	2	0	1	0	3
House wren	1	1	1	0	3
Bewick's wren	19	1	29	3	52
Blue-gray gnatcatcher	7	0	2	2	11
American robin	3	0	0	0	3
Northern mockingbird	29	0	5	0	34
Sage thrasher	1	0	0	0	1

Table 3-3. Number of individuals detected during point counts and area searches, Pipe Spring National Monument, 2009–2015 and 2017–2019, cont.

Species	Point counts		Area searches		Total
	2009–2015, 2017–2018	2019	2009–2015, 2017–2018	2019	
European starling	22	4	89	2	117
Cedar waxwing	0	0	2	1	3
Northern waterthrush	0	0	1	0	1
Orange-crowned warbler	0	0	2	0	2
Macgillivray's warbler	2	0	0	0	2
Common yellowthroat	0	0	3	0	3
Yellow warbler	11	1	45	4	61
Yellow-rumped warbler	1	1	3	0	5
Black-throated gray warbler	4	0	1	0	5
Wilson's warbler	0	0	3	0	3
Yellow-breasted chat	0	0	1	0	1
Green-tailed towhee	2	0	4	1	7
Spotted towhee	6	0	0	0	6
Chipping sparrow	1	0	1	0	2
Brewer's sparrow	3	2	0	1	6
Lark sparrow	1	0	22	0	23
Black-throated sparrow	93	4	44	3	144
Lincoln's sparrow	0	0	1	0	1
White-crowned sparrow	15	7	40	20	82
Summer tanager	1	0	0	0	1
Western tanager	3	0	7	0	10
Black-headed grosbeak	6	0	10	0	16
Blue grosbeak	5	0	5	0	10
Lazuli bunting	2	0	6	0	8
Red-winged blackbird	1	0	0	0	1
Western meadowlark	1	1	0	0	2
Yellow-headed blackbird	1	0	1	0	2
Brown-headed cowbird	16	0	17	1	34
Bullock's oriole	29	2	27	1	59
House finch	130	4	95	4	233
Pine siskin	2	0	29	2	33
Lesser goldfinch	10	0	10	0	20
House sparrow	8	0	53	0	61
Total	862	38	1,016	77	1,993

4 Discussion

As anthropogenic land use and climate change continue to re-shape the western landscape, bird populations unable to adapt are at risk for decline. The focal habitats of this study are dominant throughout the western U.S., and are among the most likely to change. With gradual changes affecting habitat integrity for bird populations, such as pinyon-juniper encroachment on sage shrubland (Miller and Wigand 1994, Baruch-Mordo et al. 2013) and increases in regional drought (Breshears et al. 2005), long-term monitoring of bird populations is essential for detecting gradual shifts in populations.

In this report, we present 14-year population-density trends within low-elevation riparian, pinyon-juniper, and sage shrubland habitats for 63 species (a total of 134 species/habitat combinations; Appendix A). The majority of density trend estimates were non-significant, indicating the potential for stable populations for many species.

Of the 134 trend estimates, 21 were significant, with 16 negative trends and five positive trends. While this study does not explore specific factors linked to bird-population trends in the NCPN, we provide evidence of long-term regional declines and increases in individual bird populations within three important habitats. Continued monitoring of these populations will be essential to acquiring significant trend esti-

mates for a larger suite of species. With each year of additional monitoring, we will also be able to more confidently assess the causes of longer-term changes to bird populations relative to surrounding landscapes and climate variables.

It should be noted that because of the nature of low-elevation riparian, pinyon-juniper, and sage shrubland habitat in this region, many transects in this study may contain components of more than one of these three habitat types. For example, all riparian transects in the region are thin strips of riparian vegetation fed by intermittent streams within a matrix of pinyon-juniper or sage shrubland. As such, many species detected within 125 meters of an observer during riparian point counts are not directly using riparian habitat. While species may show significant trends within a specific habitat, caution should be used when interpreting the biological relevance of these trends.

Future studies using these data will seek to estimate population-density trends for individual species at the transect level. Transect-level estimates will provide a finer-scale view of population trends to complement the region-wide analyses presented in this report. Using land-cover and climate variables, we will evaluate the drivers of density trends for individual species, allowing us to identify prominent threats to declining species and estimate causes of variance in these trends across the NCPN.

5 Literature Cited

- Baruch-Mordo, S., J. S. Evans, J. P. Severson, D. E. Naugle, J. D. Maestas, J. M. Kiesecker, M. J. Falkowski, C. A. Hagen, and K. P. Reese. 2013. Saving sage-grouse from the trees: A proactive solution to reducing a key threat to a candidate species. *Biological Conservation* 167:233–241.
- Breshears, D. D., N. S. Cobb, P. M. Rich, K. P. Price, C. D. Allen, R. G. Balice, W. H. Romme, J. H. Kastens, M. L. Floyd, J. Belnap, J. J. Anderson, O. B. Myers, and C. W. Meyer. 2005. Regional vegetation die-off in response to global-change-type drought. *Proceedings of the National Academy of Sciences of the United States of America* 102:15144–15148.
- Browder, S. F., D. H. Johnson, and I. J. Ball. 2002. Assemblages of breeding birds as indicators of grassland condition. *Ecological Indicators* 2:257–270.
- Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference: A practical information-theoretic approach. 2nd edition. New York: Springer.
- Canterbury, G. E., T. E. Martin, D. R. Petit, L. J. Petit, and D. F. Bradford. 2000. Bird communities and habitat as ecological indicators of forest condition in regional monitoring. *Conservation Biology* 14:544–558.
- Daw, S., M. Beer, and S. L. Garman. 2017. Landbird monitoring protocol narrative for park units in the Northern Colorado Plateau Network. Natural Resource Report NPS/NCPN/NRR—2017/1428. National Park Service, Fort Collins, Colorado.
- Fleischner, T. L. 1994. Ecological costs of livestock grazing in western North America. *Conservation Biology* 8:629–644.
- Gardali, T., and A. L. Holmes. 2011. Maximizing benefits from riparian revegetation efforts: Local- and landscape-level determinants of avian response. *Environmental Management* 48:28–37.
- Gardali, T., A. L. Holmes, S. L. Small, N. Nur, G. R. Geupel, and G. H. Golet. 2006. Abundance patterns of landbirds in restored and remnant riparian forests on the Sacramento River, California, U.S.A. *Restoration Ecology* 14:391–403.
- Gregory, R. D., P. Vorisek, A. Van Strien, A. W. Gmelig Meyling, F. Jiguet, L. Fornasari, J. Reif, P. Chylarecki, and I. J. Burfield. 2007. Population trends of widespread woodland birds in Europe. *Ibis* 149:78–97.
- Lowry, J. H., Jr., R. D. Ramsey, K. Boykin, D. Bradford, P. Comer, S. Falzarano, W. Kepner, J. Kirby, L. Langs, J. Prior-Magee, G. Manis, L. O'Brien, T. Sajwaj, K. A. Thomas, W. Rieth, S. Schrader, D. Schrupp, K. Schulz, B. Thompson, C. Velasquez, C. Wallace, E. Waller and B. Wolk. 2005. Southwest Regional Gap Analysis Project: Final report on land cover mapping methods. RS/GIS Laboratory, Utah State University, Logan, Utah.
- Miller, R. F., and P. E. Wigand. 1994. Holocene changes in semiarid pinyon-juniper woodlands. *BioScience* 44:465–474.
- RCoreTeam. 2014. R: A language and environment for statistical computing. Foundation for Statistical Computing, Vienna, Austria.
- Rosenberg, K. V., A. M. Dokter, P. J. Blancher, J. R. Sauer, A. C. Smith, P. A. Smith, J. C. Stanton, A. Panjabi, L. Helft, M. Parr, and P. P. Marra. 2019. Decline of the North American avifauna. *Science* 366:120–124.
- Rosenberg, K. V., J. A. Kennedy, R. Dettmers, R. P. Ford, D. Reynolds, J. D. Alexander, C. J. Beardmore, P. J. Blancher, R. E. Bogart, G. S. Butcher, A. F. Camfield, A. Couturier, D. W. Demarest, W. E. Easton, J. J. Giocomo, R. H. Keller, A. E. Min, A. O. Panjabi, D. N. Pashley, T. D. Rich, J. M. Ruth, H. Stabins, J. Stanton, and T. Will. 2016. Partners in Flight landbird conservation plan: 2016 revision for Canada and continental United States. Partners in Flight Science Committee. Page 119.
- Sauer, J. R., J. E. Fallon, and R. Johnson. 2003. Use of North American Breeding

Bird Survey data to estimate population change for bird conservation regions. *The Journal of Wildlife Management* 67:372–389.

Thomas, L., S. T. Buckland, E. A. Rexstad, J. L. Laake, S. Strindberg, S. L. Hedley,

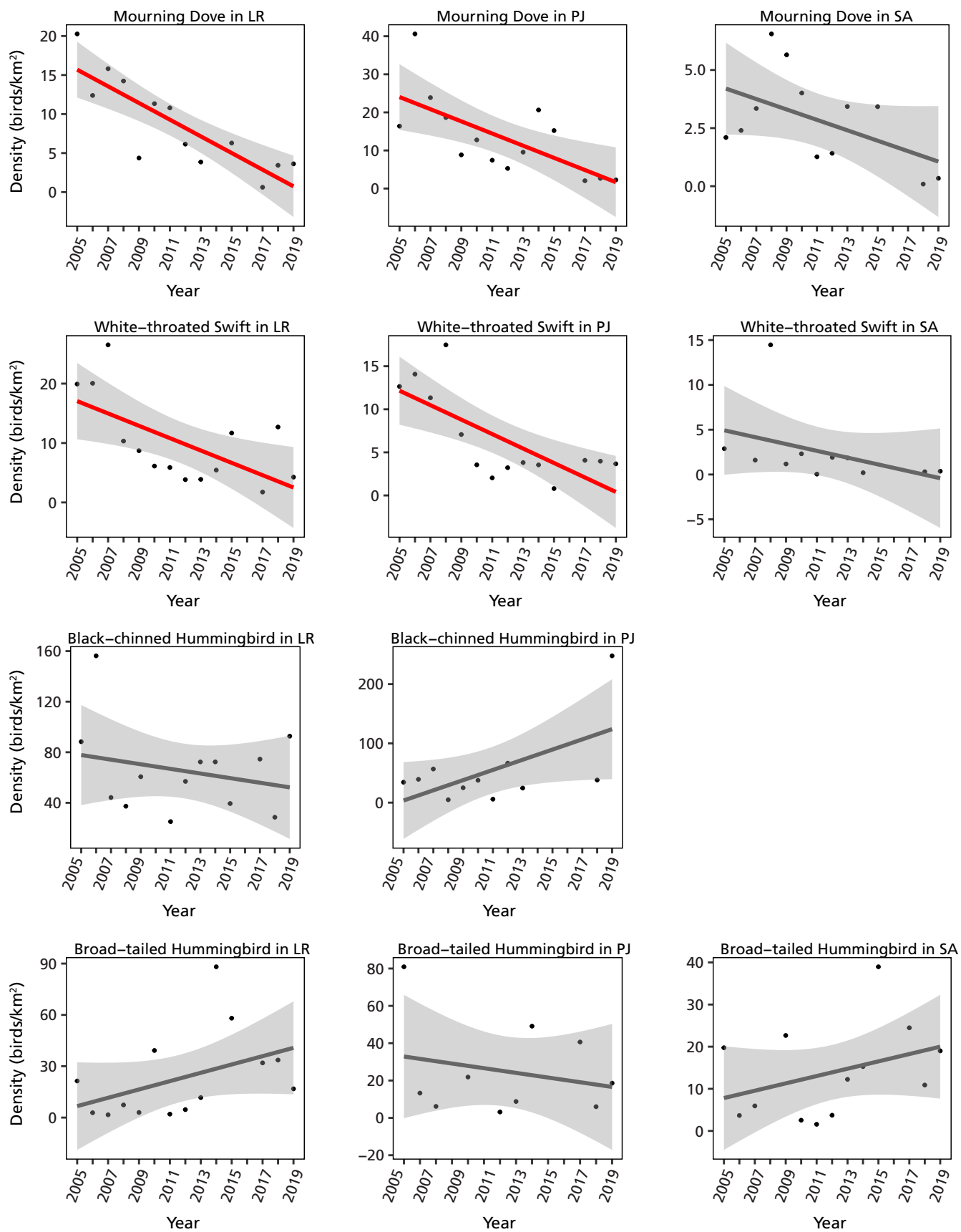
J. R. B. Bishop, T. A. Marques, and K. P. Burnham. 2010. Distance software: Design and analysis of distance sampling surveys for estimating population size. *Journal of Applied Ecology* 47:5–14.

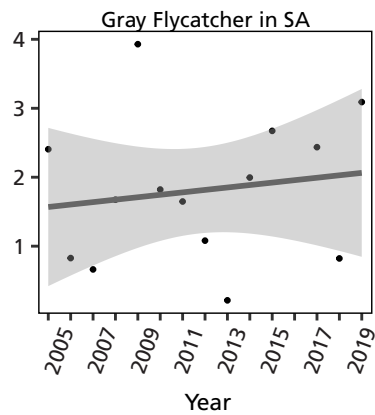
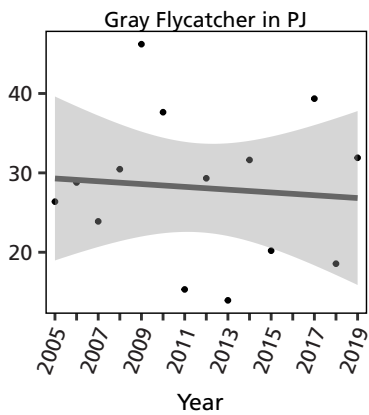
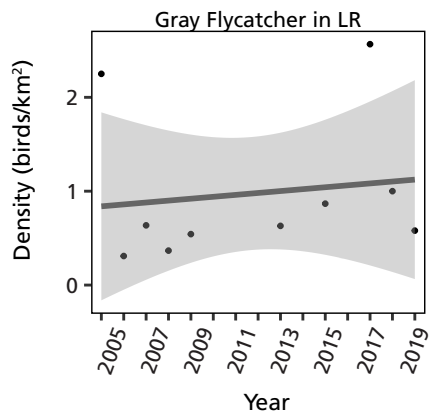
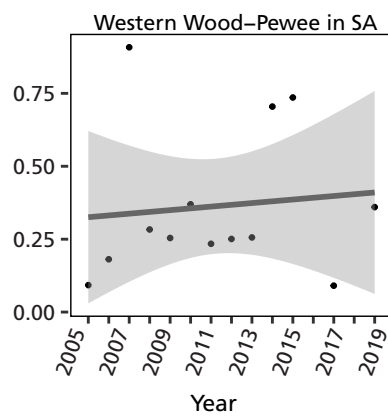
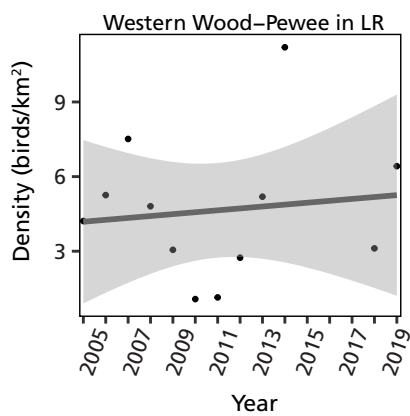
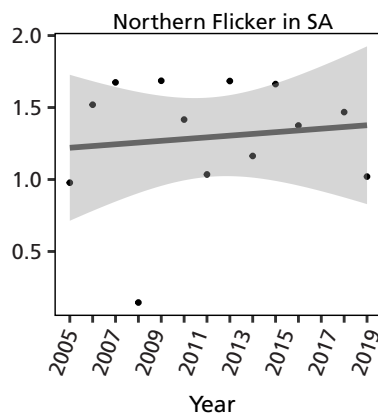
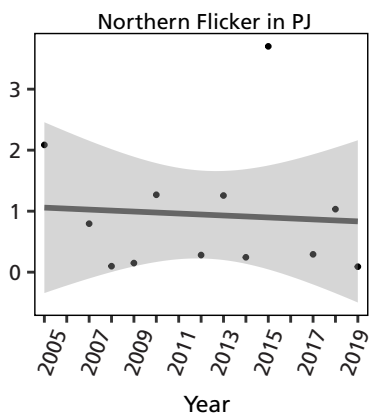
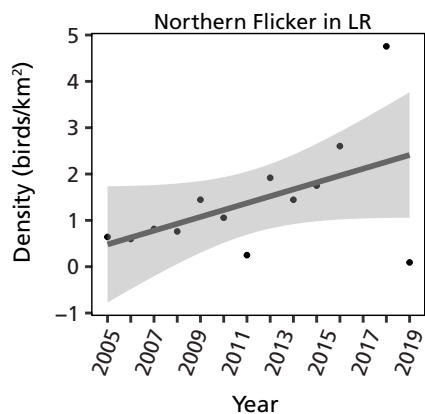
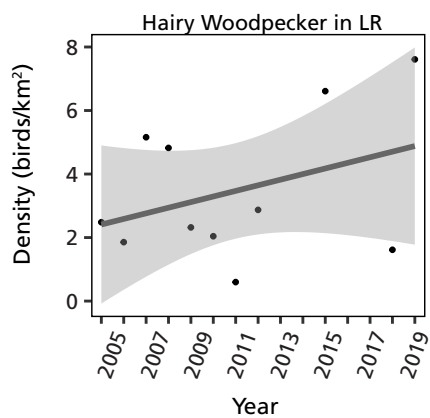
Appendix A. Individual Species Density by Habitat

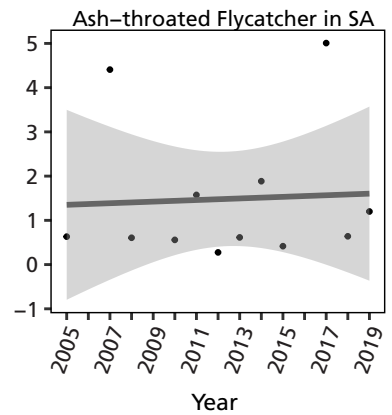
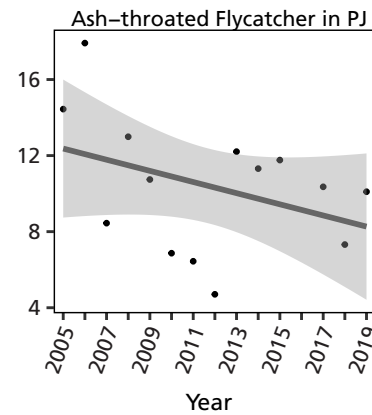
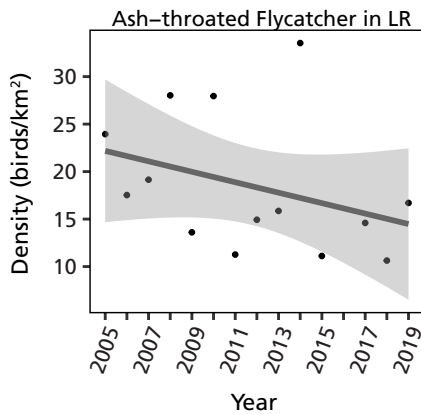
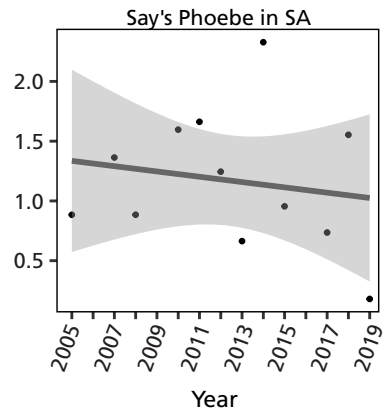
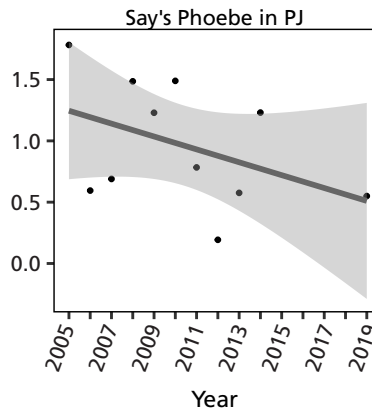
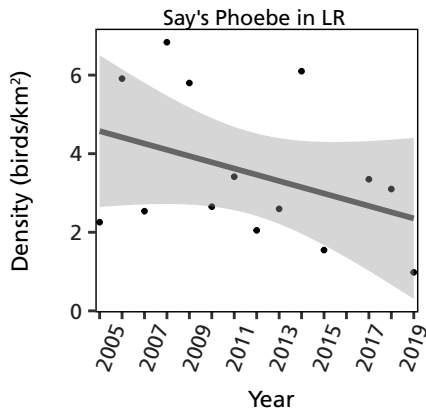
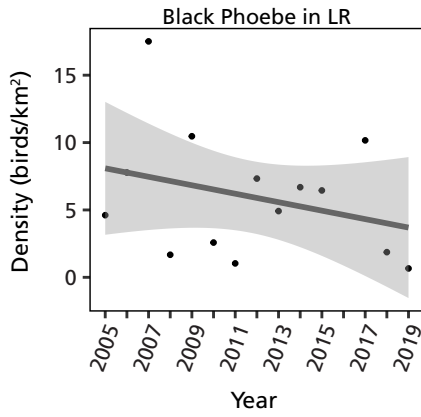
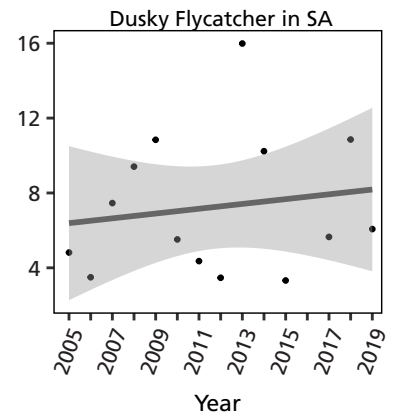
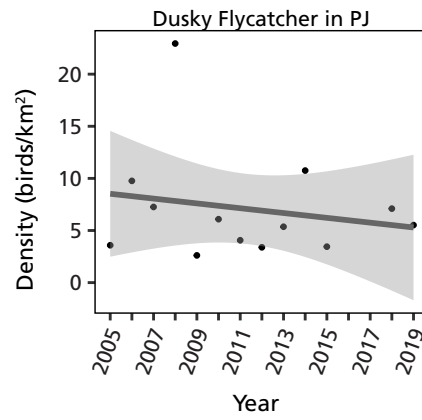
Graphics on the following pages show trend lines for species and habitats as shown in Table 3-2 (LR = low-elevation riparian, PJ = Pinyon-juniper, SA = sage shrubland). Red lines indicate significant trends from a simple linear regression model.

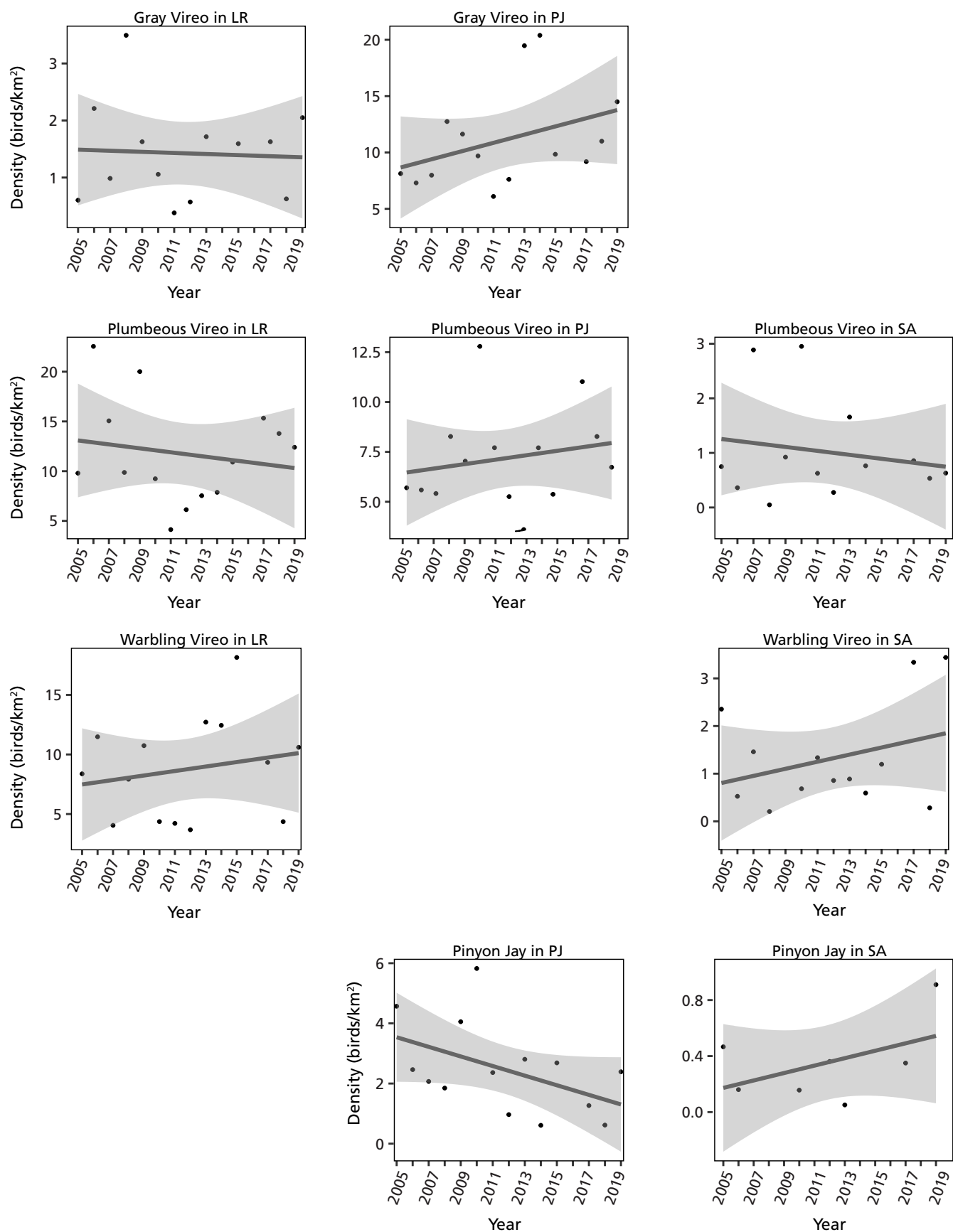
With the addition of the 2019 density estimates, the significance of some trends has changed since 2018, with new species showing significant trends and some previously significant trends becoming non-significant.

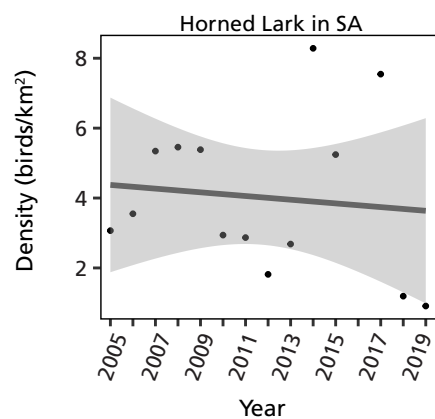
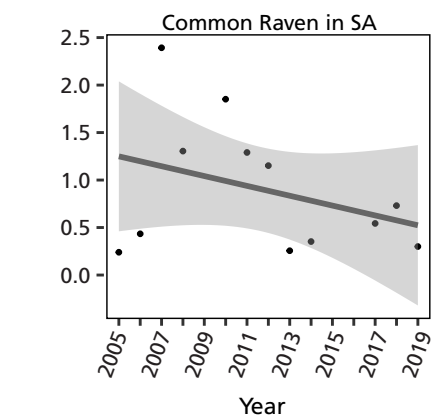
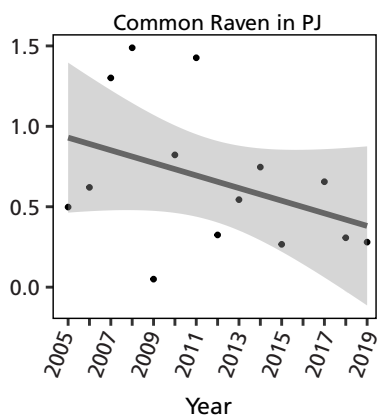
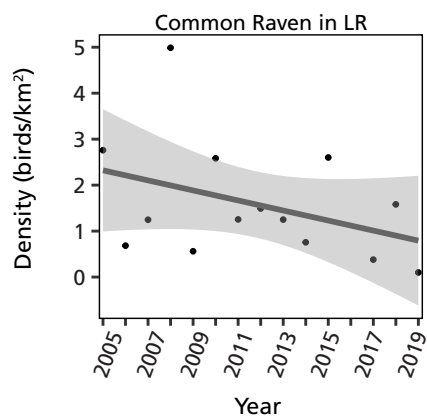
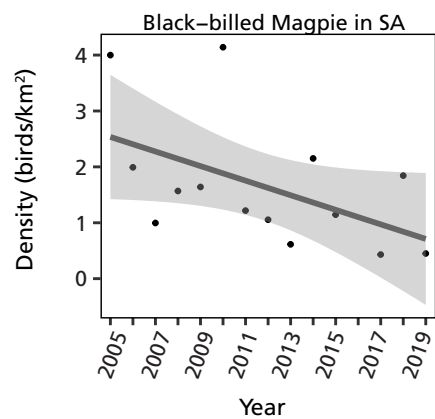
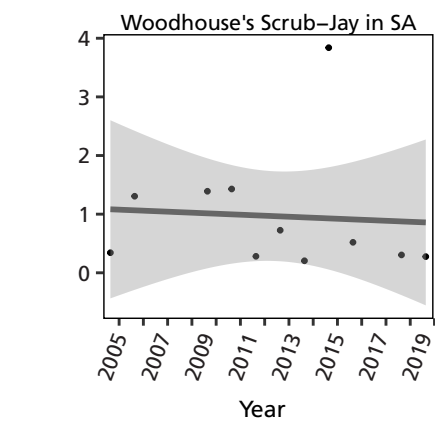
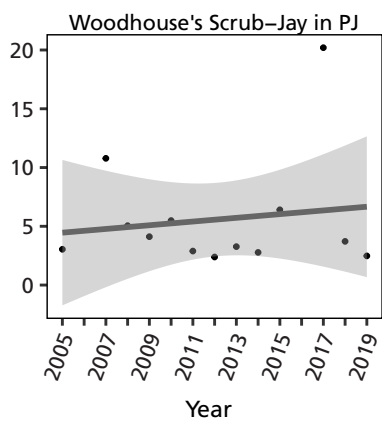
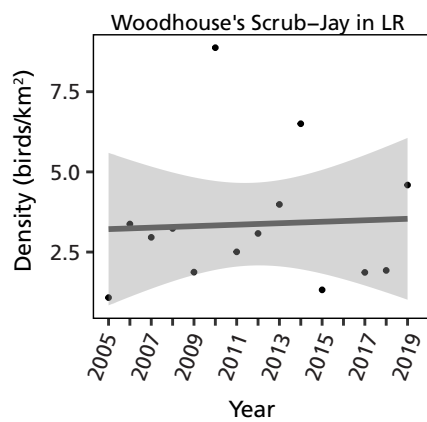
- In LR, house wren now has a significant positive trend and lazuli bunting has a non-significant negative trend.
- In PJ, bushtit, mountain bluebird, and Grace's warbler now have significantly negative trends, while spotted towhee and vesper sparrow have non-significant negative trends.
- In SA, black-throated gray warbler now has a non-significant negative trend and Virginia's warbler has a non-significant positive trend.

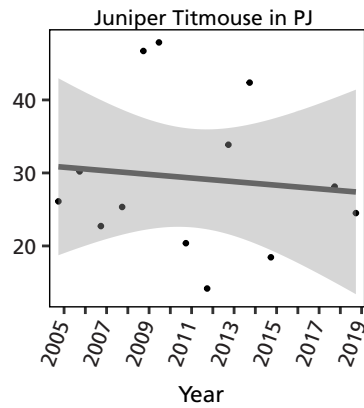
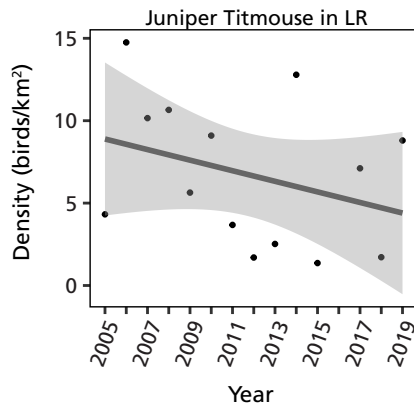
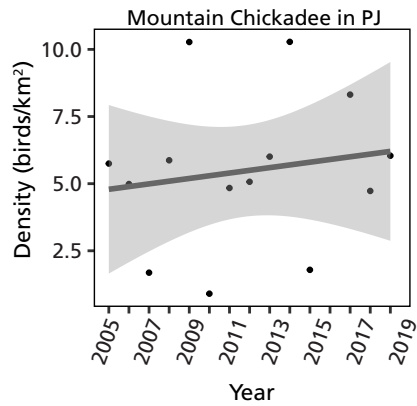
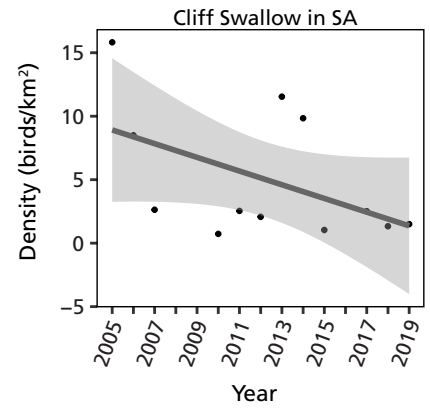
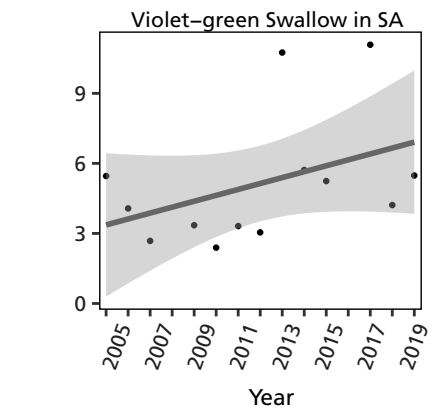
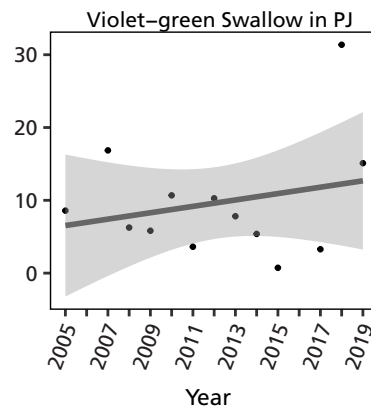
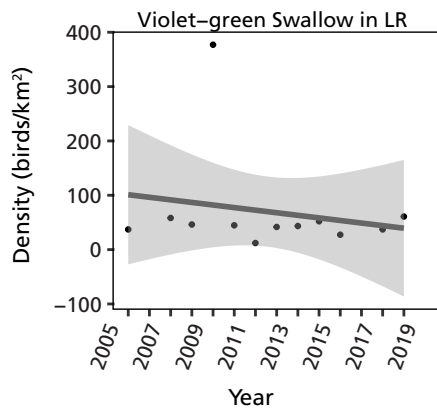


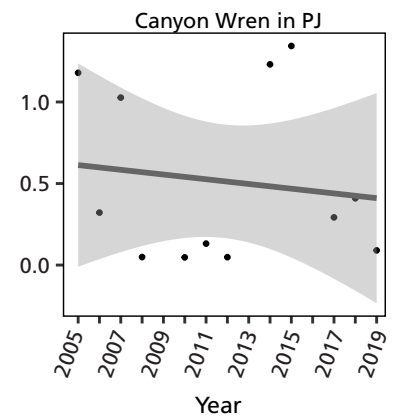
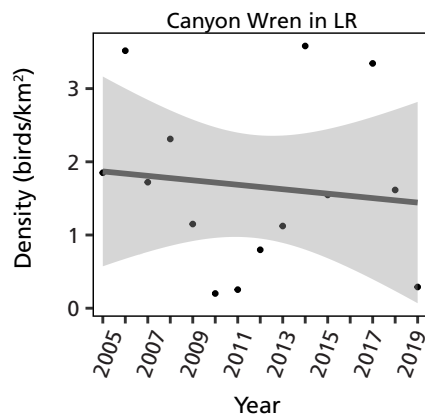
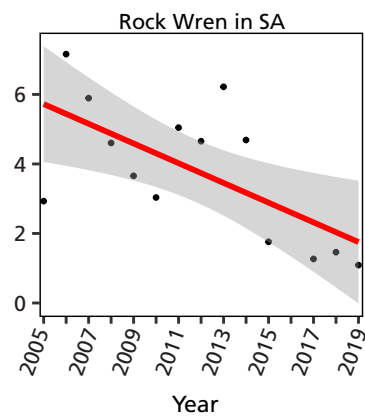
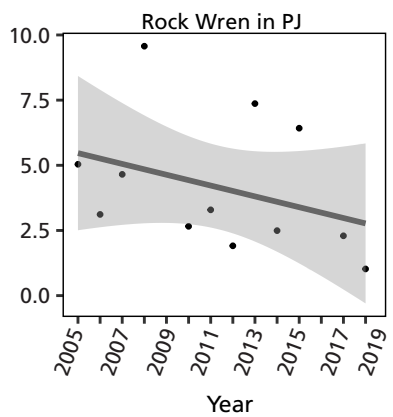
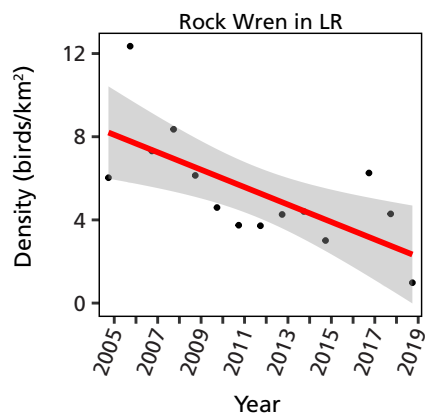
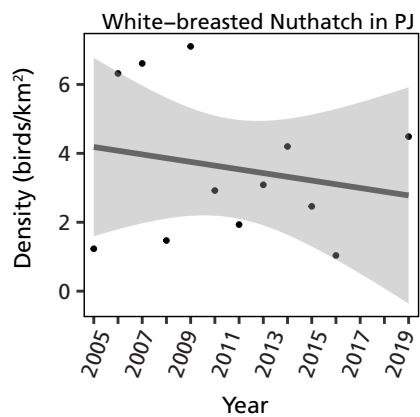
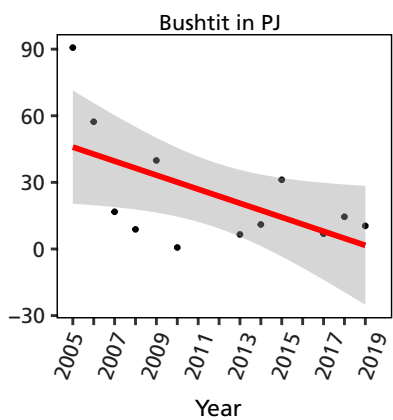
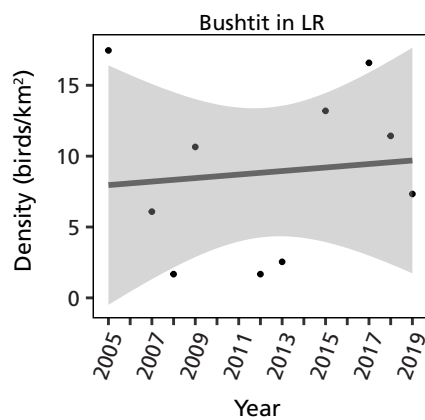


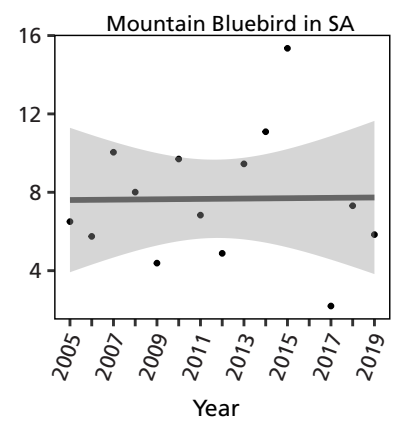
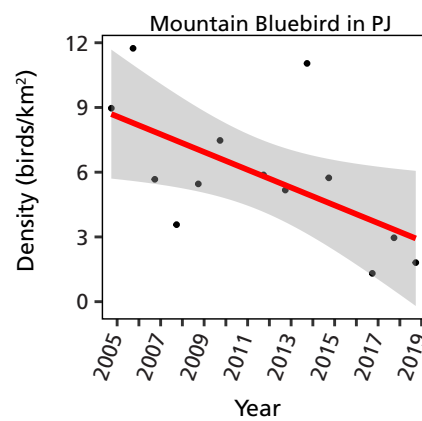
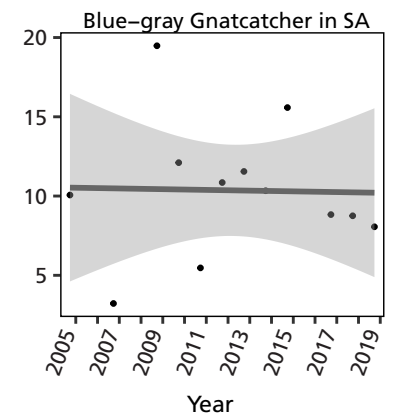
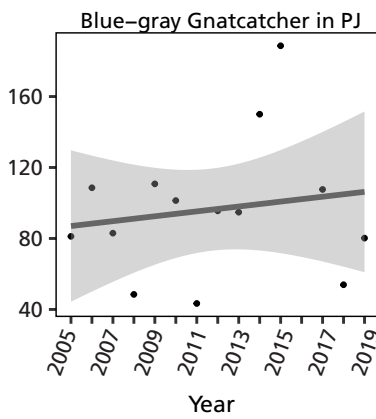
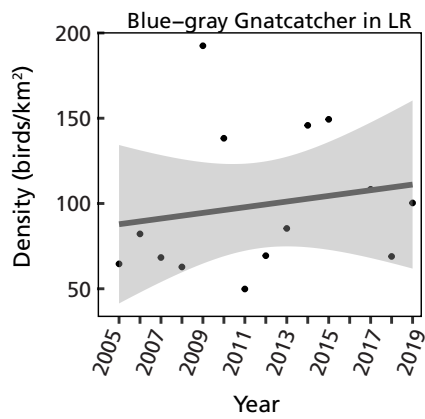
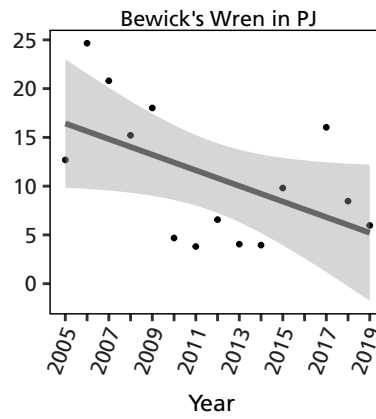
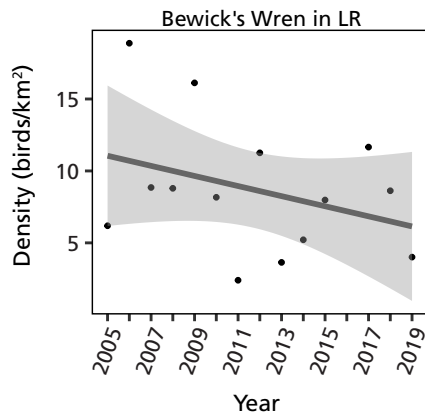
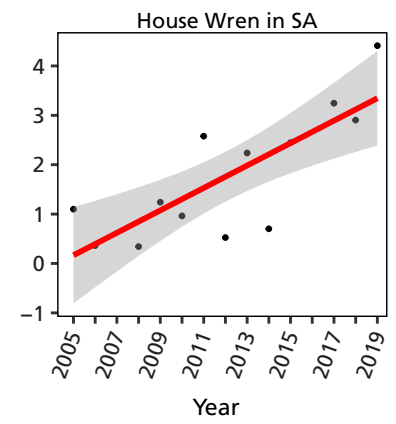
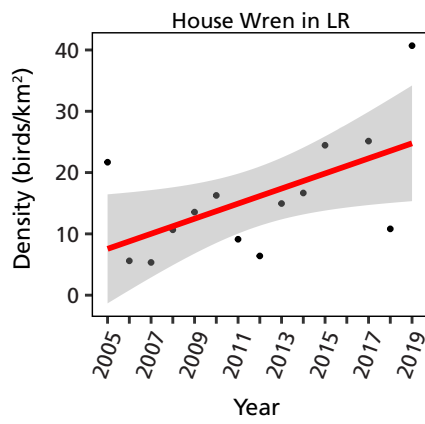


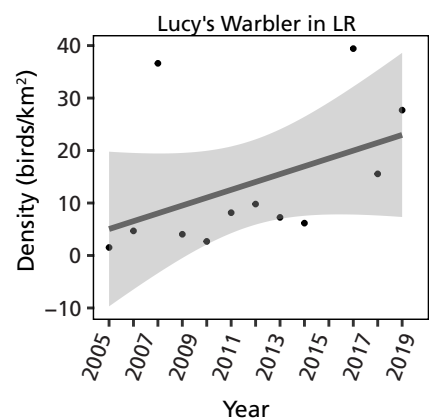
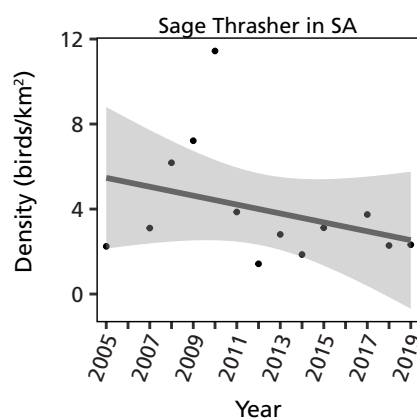
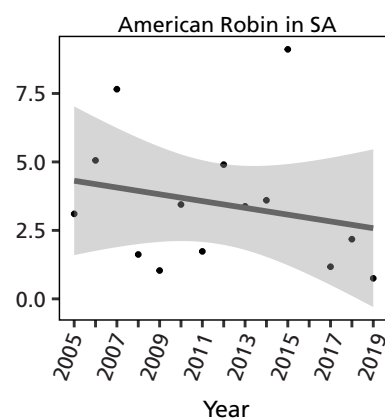
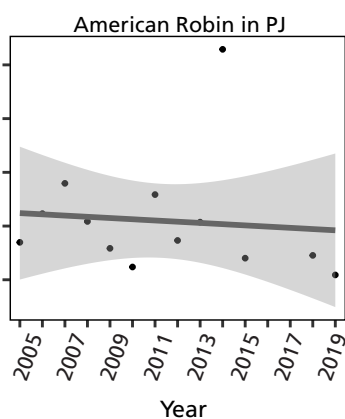
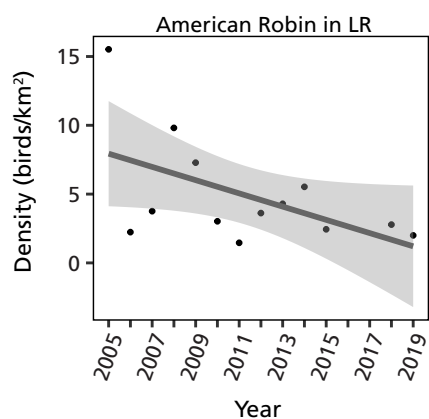
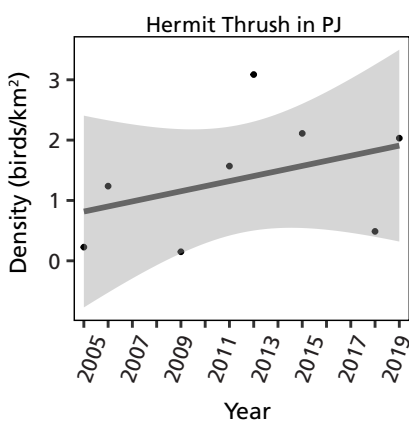


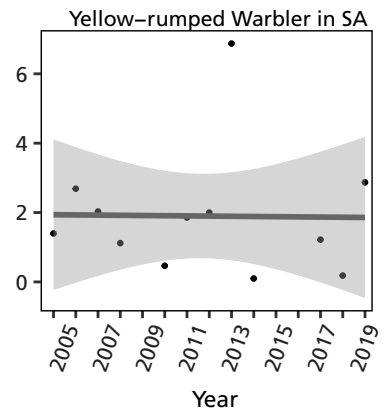
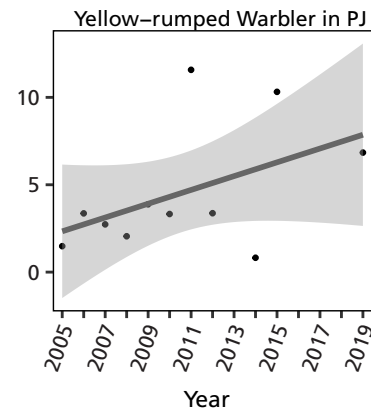
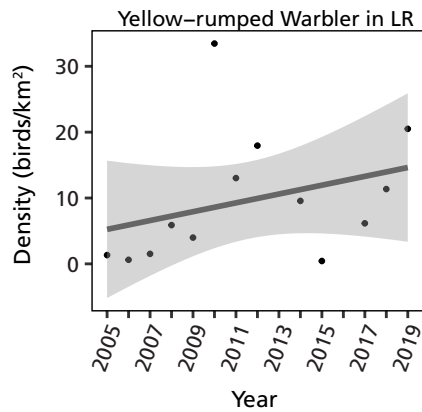
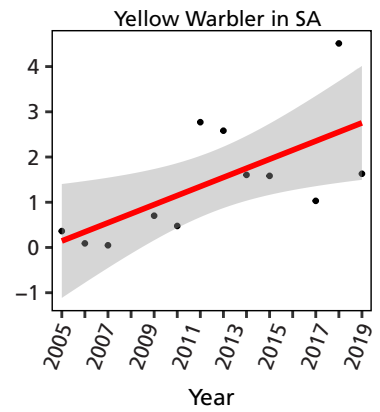
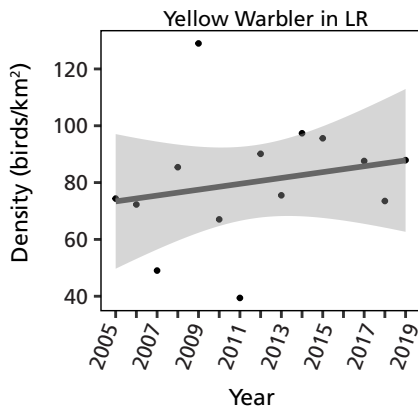
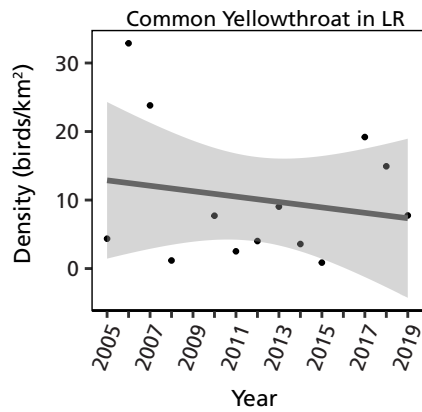
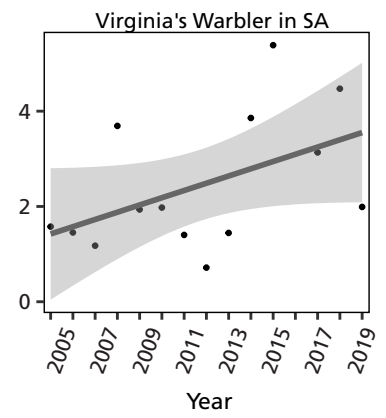
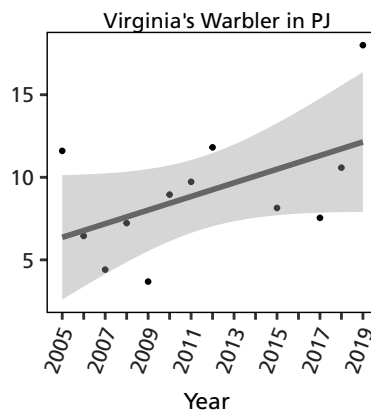
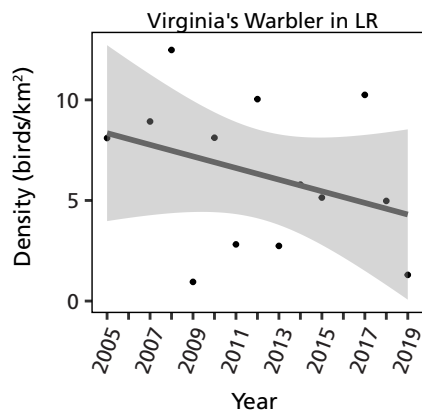


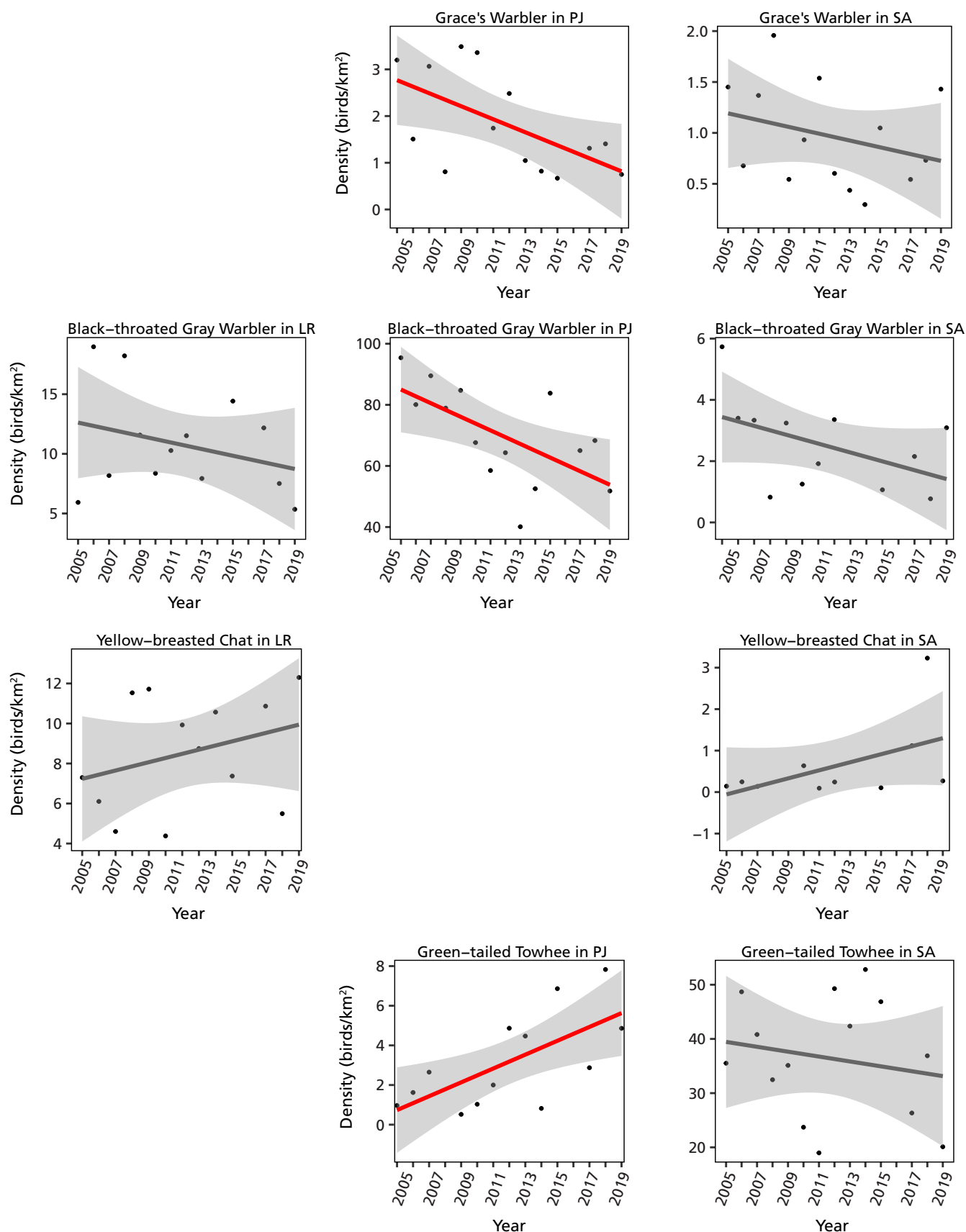


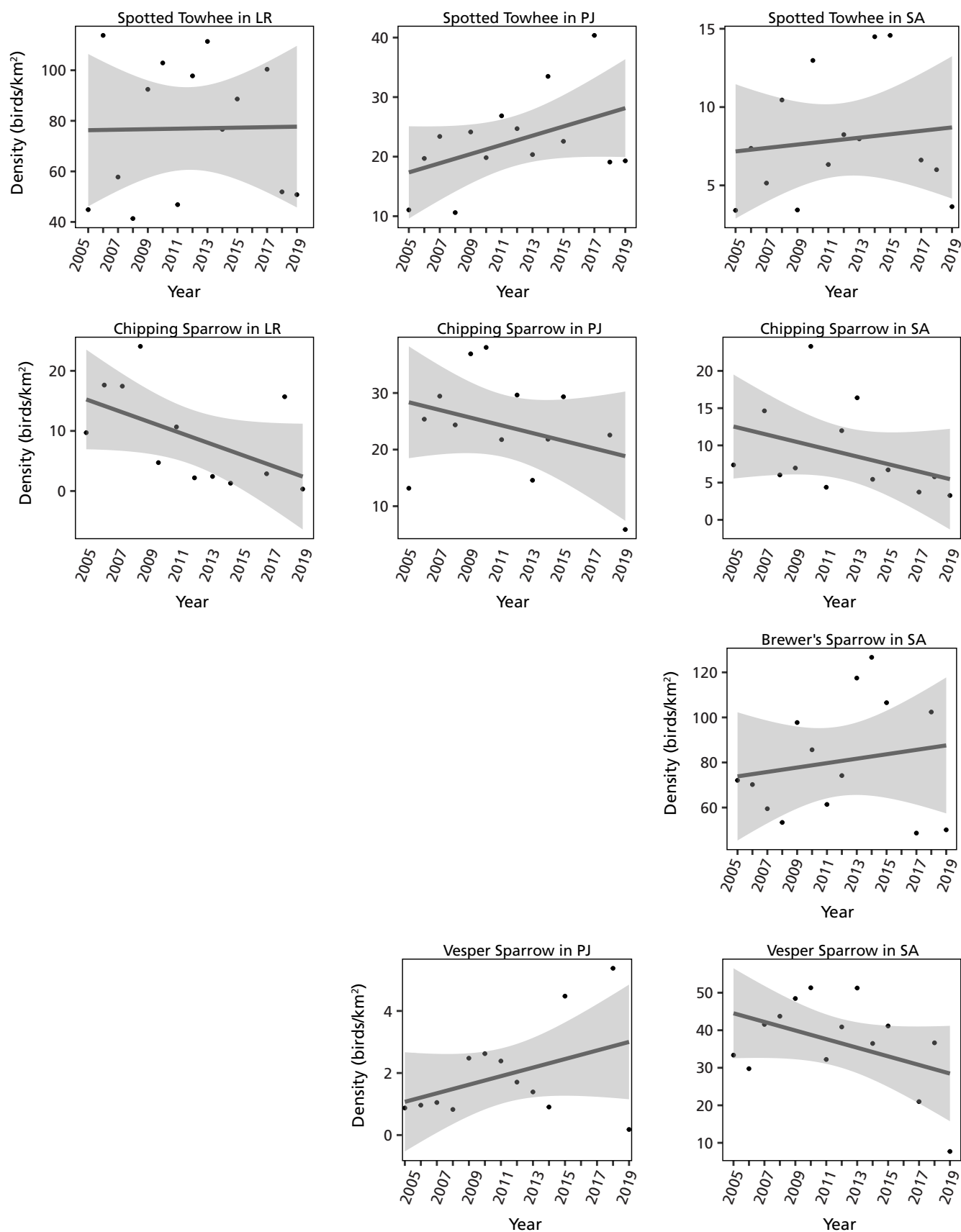


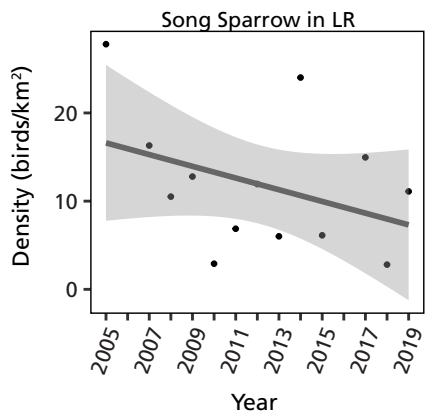
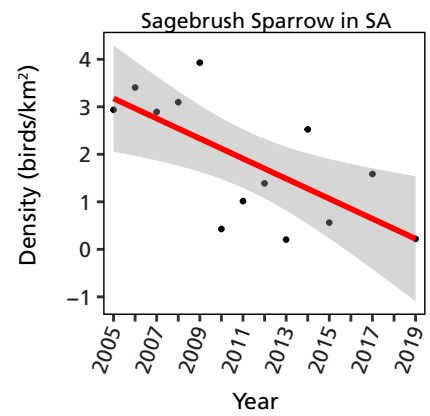
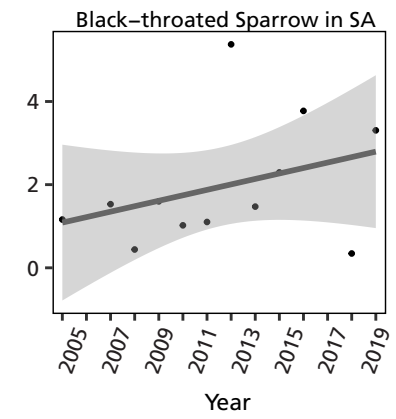
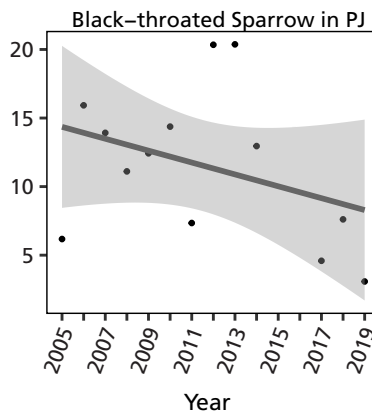
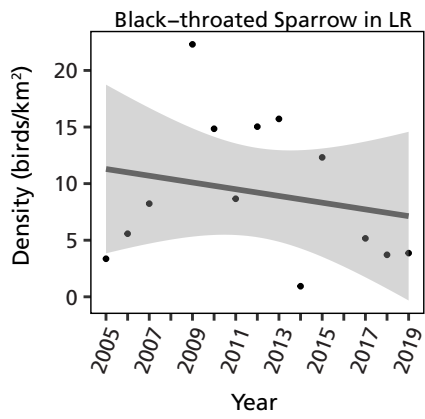
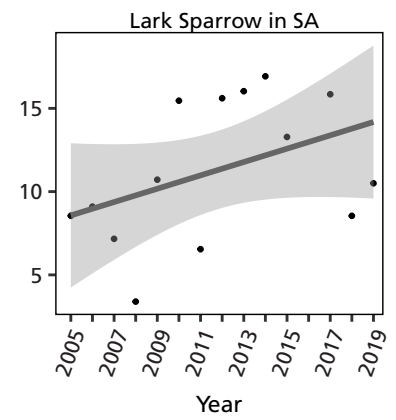
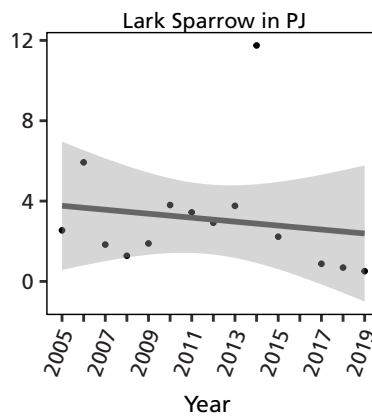
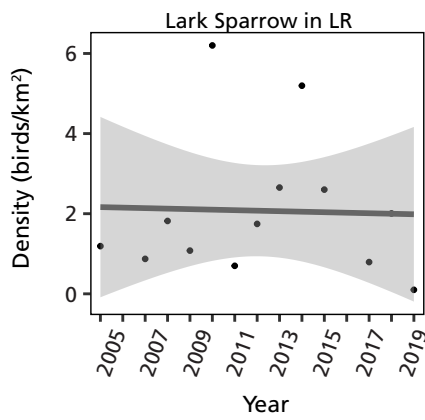


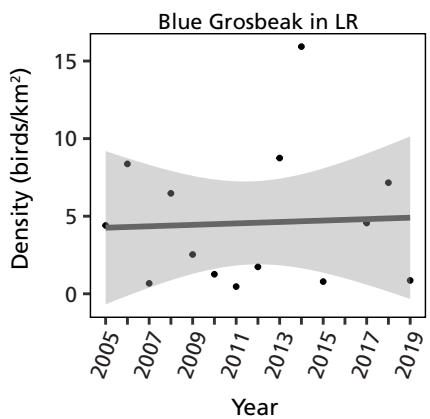
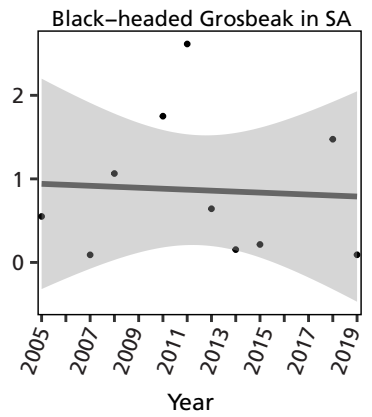
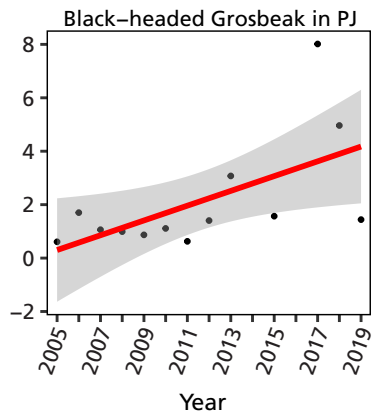
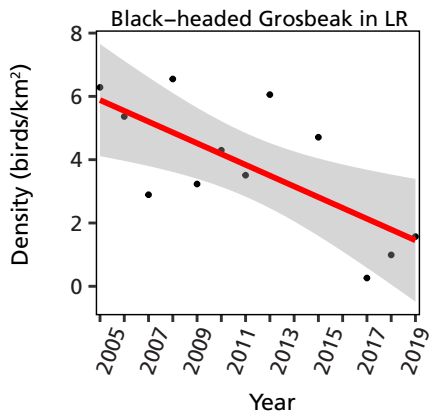
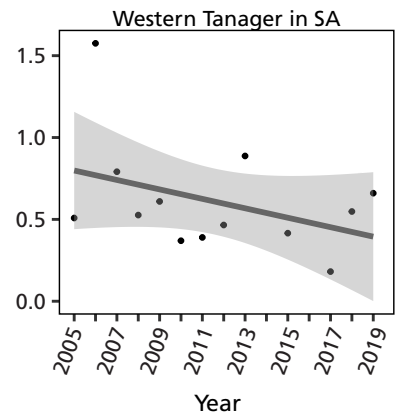
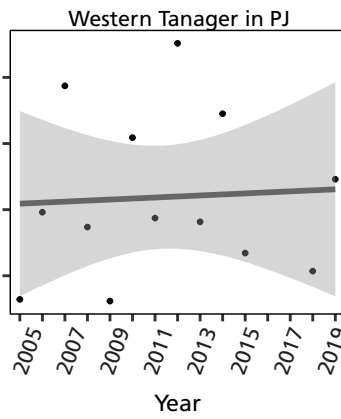
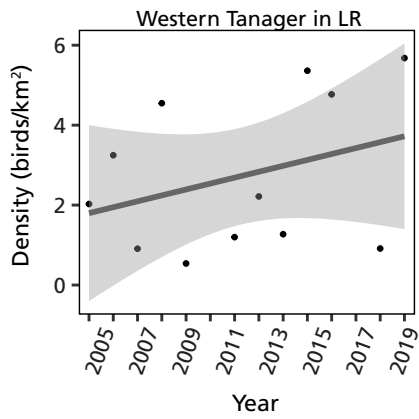
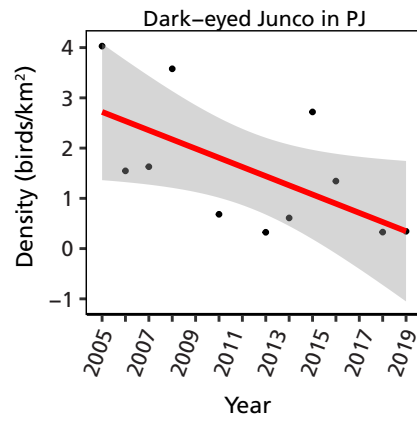


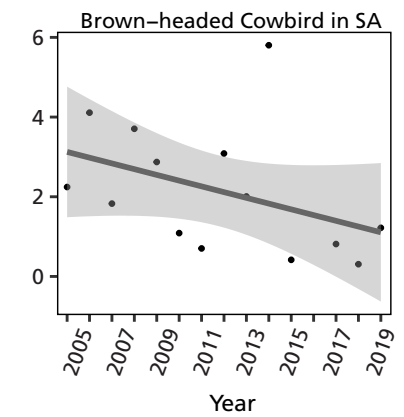
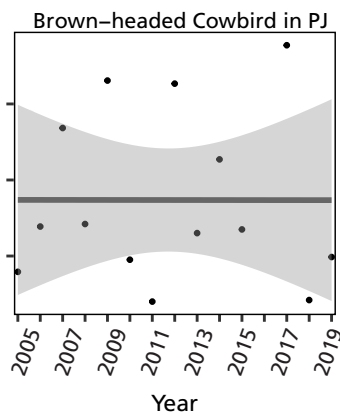
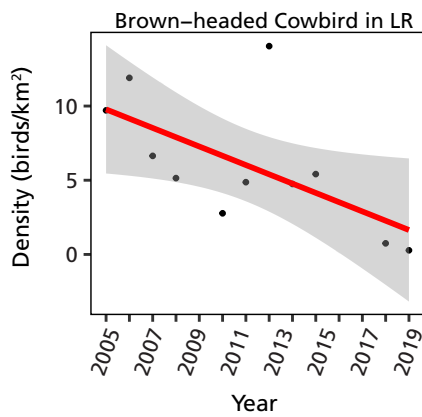
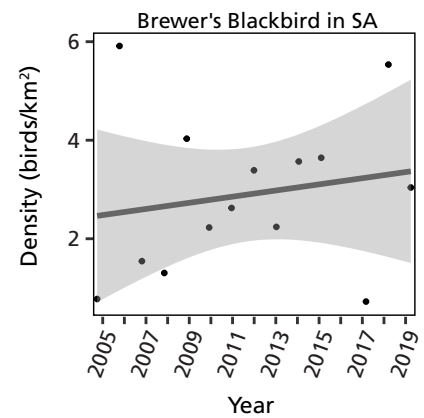
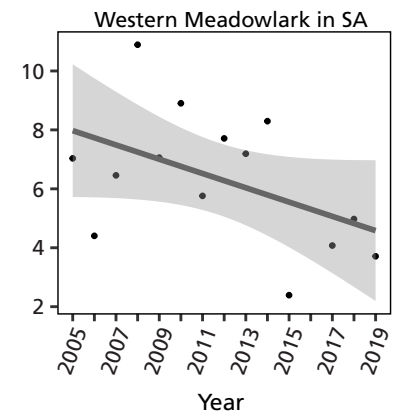
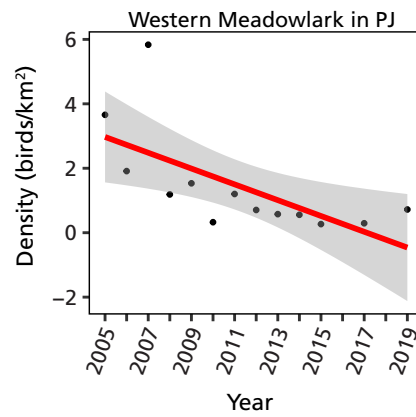
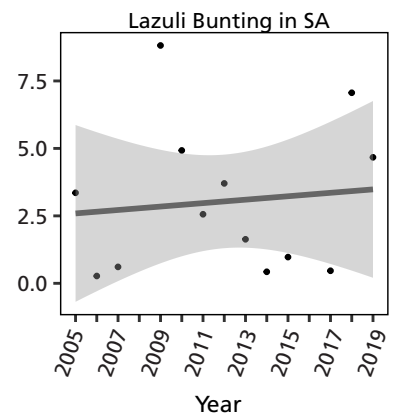
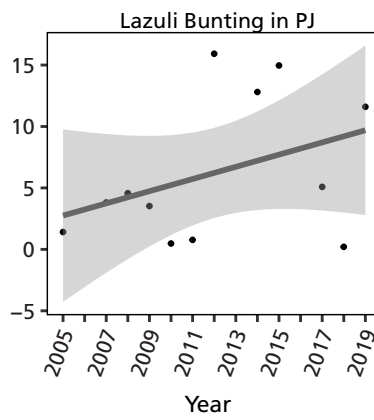
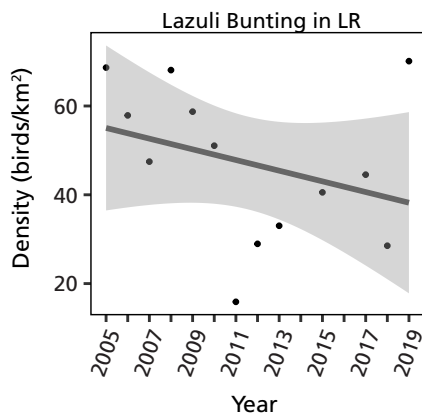


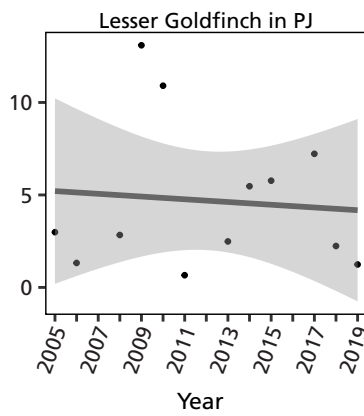
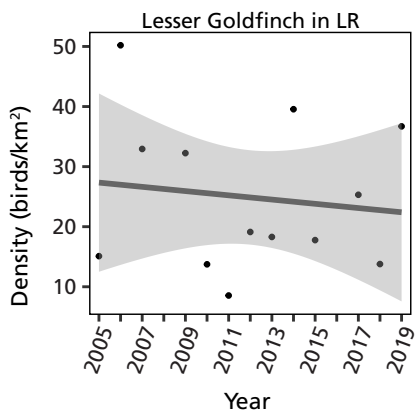
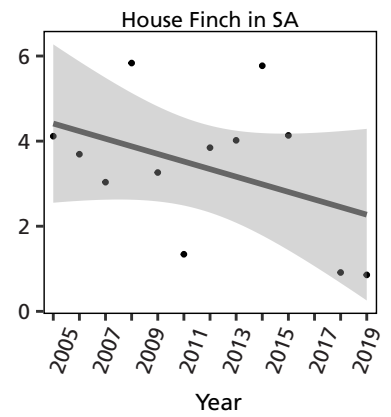
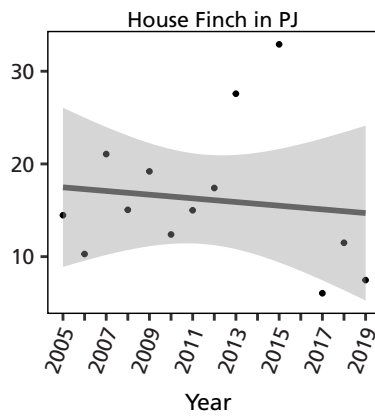
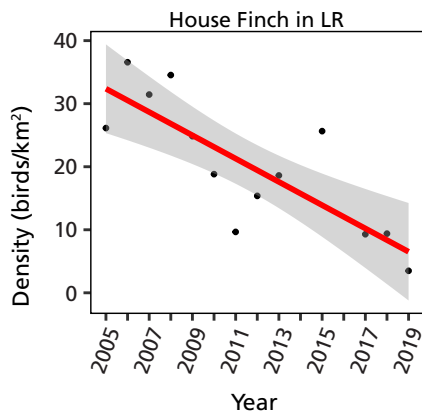
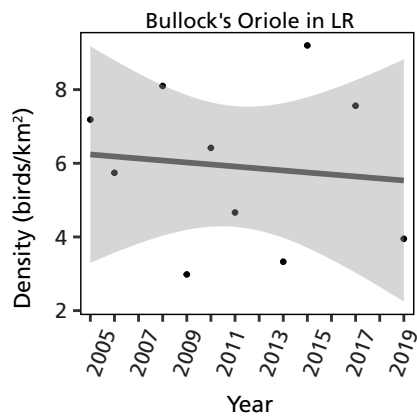












The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525

www.nature.nps.gov

EXPERIENCE YOUR AMERICA™