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Natural Resource Stewardship and Science

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

2022 Field Season

Natural Resource Report NPS/NCPN/NRR—2023/2522



ON THE COVER

Hairy woodpecker (*Leuconotopicus villosus*). US Fish and Wildlife Service/Tina Shaw.

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2022 Field Season

Natural Resource Report NPS/NCPN/NRR—2023/2522

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

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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 3
2.3 Data analysis 8

3 Results 11
3.1 Habitat-based density trends 11
3.2 Pipe Spring National Monument summary 14

4 Discussion 17

5 Literature Cited 19

Appendix A. Individual Species Habitat-based Density Trends by Habitat 21

Figures

Main Report

Figure 2-1. Northern Colorado Plateau Network parks where landbirds are monitored. 4
Figure 2-2. Transect locations by habitat, Utah units. 5
Figure 2-3. Transect locations by habitat, Colorado units. 6
Figure 2-4. Transect locations, Fossil Butte National Monument. 7

Appendix A

Figure A-1. Trend lines for species and habitats as shown in Table 3-2. 21
Figure A-2. Trend lines for species and habitats as shown in Table 3-2. 22
Figure A-3. Trend lines for species and habitats as shown in Table 3-2. 23
Figure A-4. Trend lines for species and habitats as shown in Table 3-2. 24
Figure A-5. Trend lines for species and habitats as shown in Table 3-2. 25
Figure A-6. Trend lines for species and habitats as shown in Table 3-2. 26
Figure A-7. Trend lines for species and habitats as shown in Table 3-2. 27
Figure A-8. Trend lines for species and habitats as shown in Table 3-2. 28
Figure A-9. Trend lines for species and habitats as shown in Table 3-2. 29
Figure A-10. Trend lines for species and habitats as shown in Table 3-2. 30
Figure A-11. Trend lines for species and habitats as shown in Table 3-2. 31
Figure A-12. Trend lines for species and habitats as shown in Table 3-2. 32
Figure A-13. Trend lines for species and habitats as shown in Table 3-2. 33
Figure A-14. Trend lines for species and habitats as shown in Table 3-2. 34
Figure A-15. Trend lines for species and habitats as shown in Table 3-2. 35
Figure A-16. Trend lines for species and habitats as shown in Table 3-2. 36

Tables

Table 2-1. The number of transects within each park by habitat 3
Table 2-2. Annual number of point visits within each habitat 7
Table 3-1 Significant density trends for landbird species in the Northern Colorado Plateau Network, 2022 11
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 sagebrush shrubland habitats in the Northern Colorado Plateau Network, 2005–2015 and 2017–2022 12
Table 3-3. Changes in trend resulting from the addition of density estimates for 2022 13
Table 3-4. Number of individuals detected during point counts and area searches in Pipe Spring National Monument, 2009–2022 14

Executive Summary

In 2022, the University of Delaware, in cooperation with the National Park Service (NPS), completed the seventeenth 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 2022, university biologists surveyed all 45 survey locations within 11 NPS units. Fifteen transects were located in each of the three habitats of interest: low-elevation riparian, pinyon-juniper, and sagebrush 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 17 years of data collection, 15,777 point-count surveys have been conducted in 11 NCPN units, detecting 179 unique species. During the 2022 field season, 638 point-count surveys were conducted, detecting 117 unique species. A total of 6,245 individual birds of 117 unique species were recorded. One new species was detected for this monitoring program: a Lewis's woodpecker (*Melanerpes lewis*) in Black Canyon of the Gunnison National Park. In addition, the following birds were detected in the following parks for the first time in this monitoring program: lazuli bunting (*Passerina amoena*), Black Canyon of the Gunnison National Park; summer tanager (*Piranga rubra*), Arches National Park; MacGillivray's warbler (*Geothlypis tolmiei*), Bryce Canyon National Park; red-naped sapsucker (*Sphyrapicus nuchalis*), Curecanti National Recreation Area, and Lincoln's sparrow (*Melospiza lincolnii*), Zion National Park.

Using data from 2005 to 2022, 118 population-density trends were estimated across the three habitats. Fifteen of the estimated density trends were significant (p-value <0.05), including seven negative trends:

- mourning dove (*Zenaida macroura*) and white-throated swift (*Aeronautes saxatalis*) in low-elevation riparian;
- mourning dove, white-throated swift, and mountain bluebird (*Sialia currucoides*) in pinyon-juniper; and
- rock wren (*Salpinctes obsoletus*) and western meadowlark (*Sturnella neglecta*) in sagebrush shrubland habitat.

There were also eight positive trends:

- hairy woodpecker (*Leuconotopicus villosus*) in low-elevation riparian;
- lazuli bunting (*Passerina amoena*), yellow-rumped warbler (*Setophaga coronata*), and vesper sparrow (*Pooecetes gramineus*) in pinyon-juniper; and
- house finch (*Haemorhous mexicanus*), western tanager (*Piranga ludoviciana*), Grace's warbler (*Setophaga graciae*) and lark sparrow (*Chondestes grammacus*) in sagebrush shrubland habitat.

There were sufficient sample sizes to estimate the densities of 61 species in at least one of the three habitats surveyed.

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).

In 2019, Rosenberg and others (2019) estimated a loss of nearly three 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 sagebrush 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.

The Northern Colorado Plateau Network (NCPN) landbird monitoring program is designed to provide managers of 11 national parks in Utah, Colorado, and Wyoming with long-term population-trend data for breeding birds in three habitats: low-elevation riparian, pinyon-juniper, and sagebrush shrubland. Starting in 2005, the Bird Conservancy of the Rockies (BCR) completed annual surveys for the program for 11 consecutive years, with a hiatus in 2016. In 2017, the University of Delaware resumed NCPN landbird monitoring.

In 2022, the University of Delaware, in cooperation with the National Park Service (NPS), completed the seventeenth year of the NCPN's habitat-based landbird monitoring program. 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.

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 sagebrush shrubland (SA). Even with some overlap, each of these habitats hosts a distinct suite of bird species. Across 11 NPS units, 45 transect locations were selected, with 15 transects established in each habitat (Table 2-1; Figure 2-1).

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 ground-truthed and reassigned if necessary. Each transect consists of 15 point-count locations, each 250 meters apart (Figures 2-2 to 2-4).

Since 2005, all 45 transects have remained in place; these are the sites of the annually scheduled surveys 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, with >75% of planned surveys completed annually (Table 2-2).

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.

Table 2-1. The number of transects within each park by habitat.

Park	Low-elevation riparian	Pinyon-juniper	Sagebrush shrubland
Arches National Park	3	1	0
Black Canyon of the Gunnison National Park	0	1	1
Bryce Canyon National Park	0	1	2
Canyonlands National Park	3	2	0
Capitol Reef National Park	2	2	0
Colorado National Monument	0	2	0
Curecanti National Recreation Area	0	0	5
Dinosaur National Monument	3	4	5
Fossil Butte National Monument	0	0	2
Natural Bridges National Monument	2	1	0
Zion National Park	2	1	0
Total	15	15	15

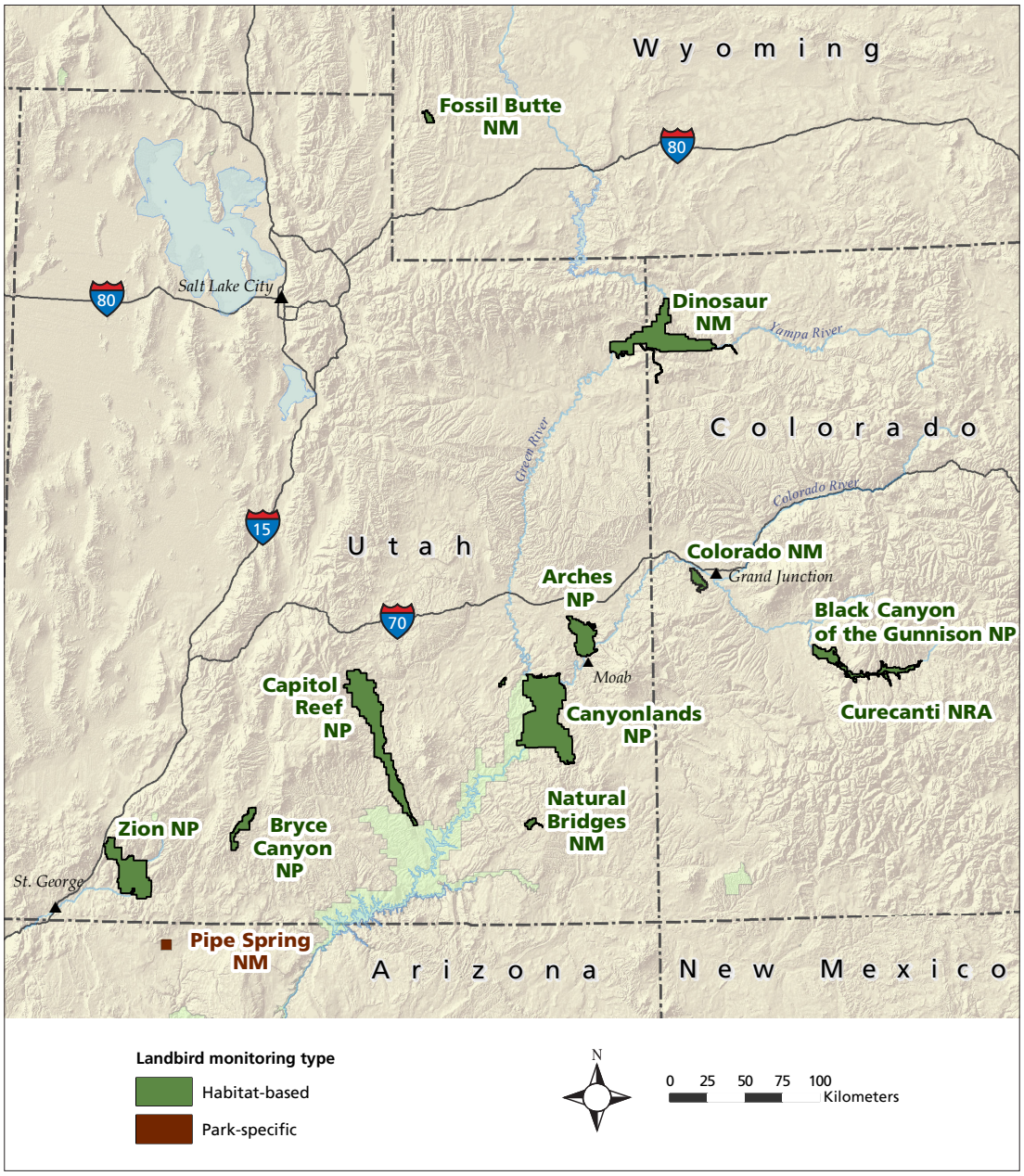


Figure 2-1. Northern Colorado Plateau Network parks where landbirds are monitored.

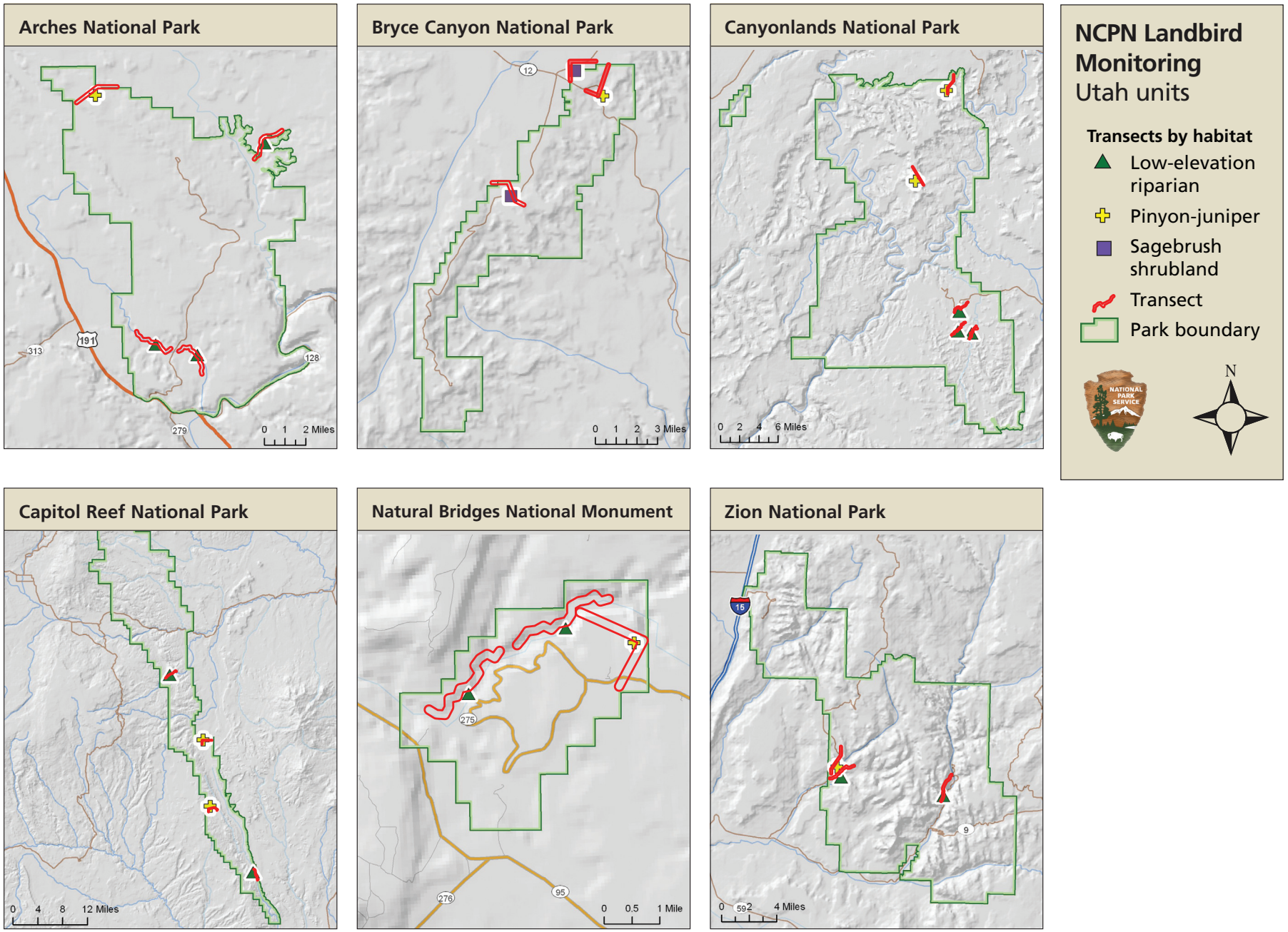


Figure 2-2. Transect locations by habitat, Utah units.

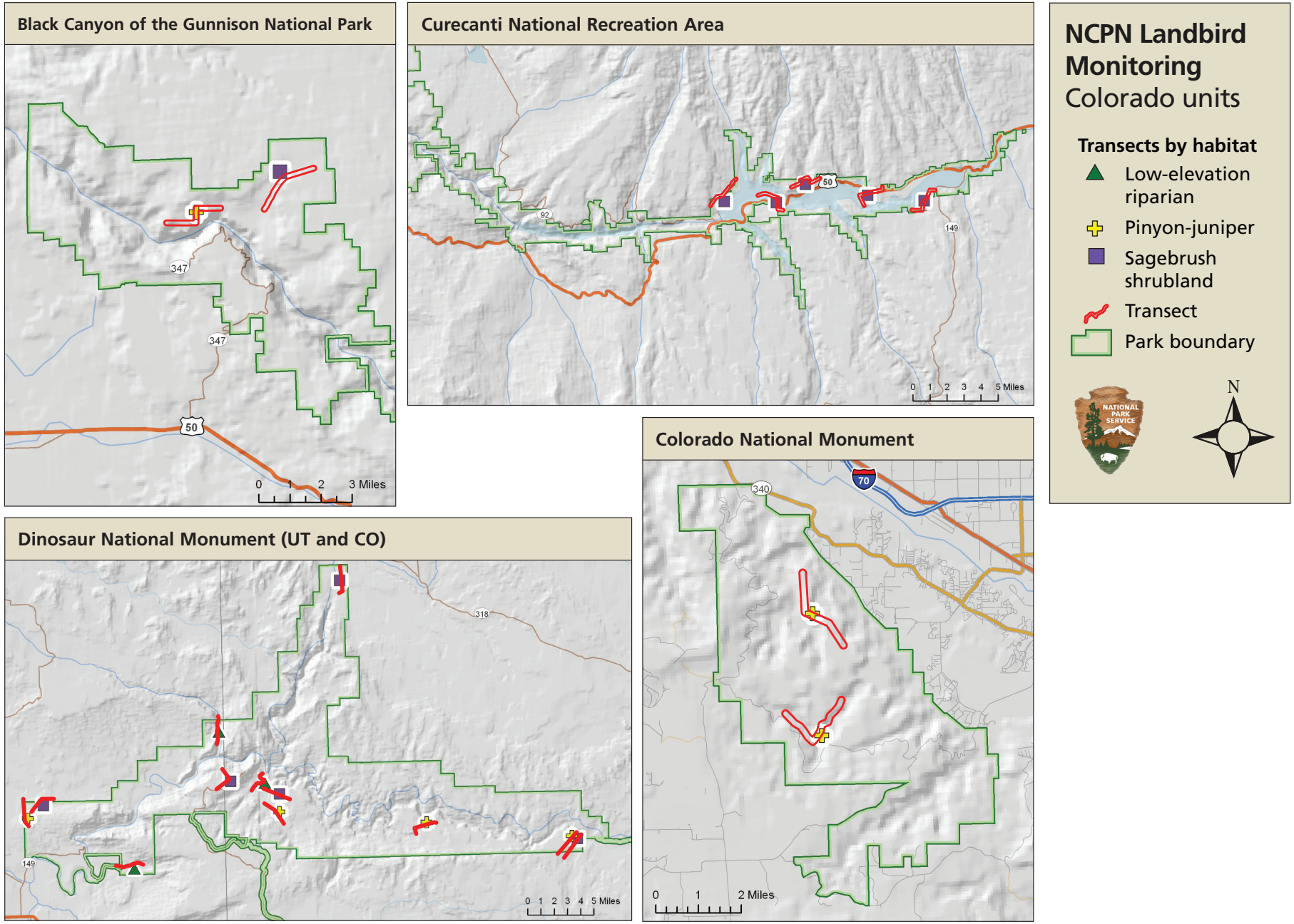


Figure 2-3. Transect locations by habitat, Colorado units.

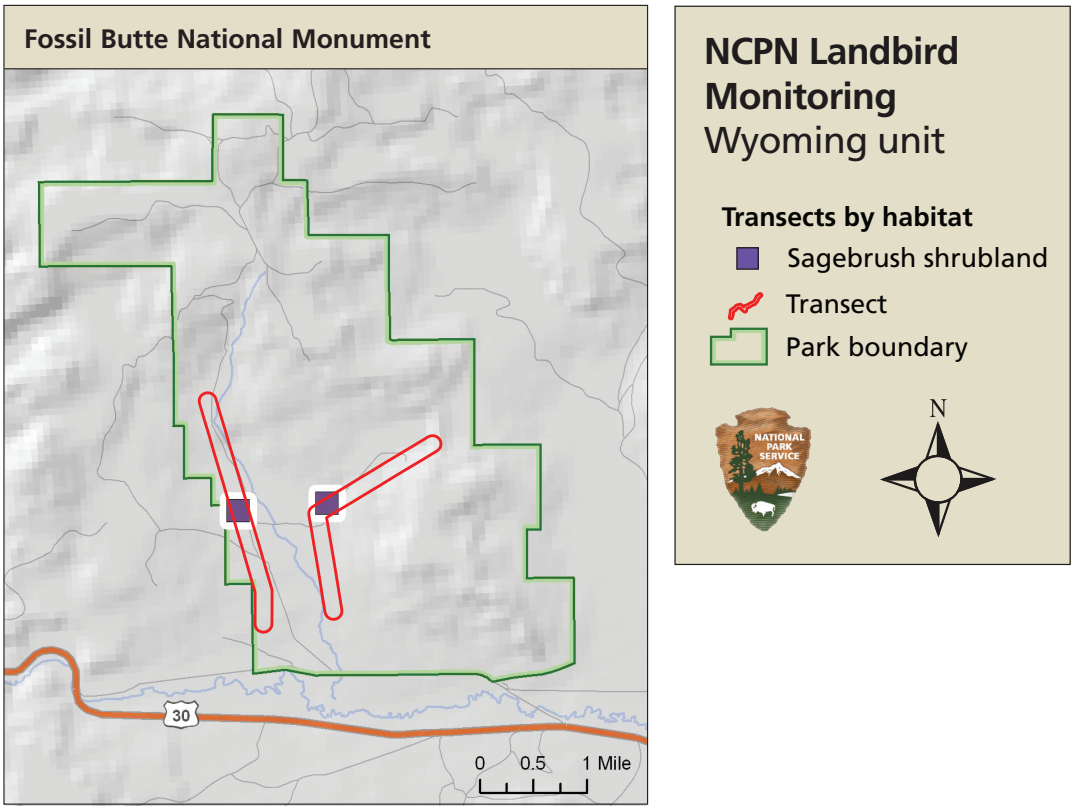


Figure 2-4. Transect locations, Fossil Butte National Monument.

Table 2-2. Annual number of point visits within each habitat.

Year	Low-elevation riparian	Pinyon-juniper	Sagebrush shrubland
2005[A]	439	450	441
2006[A]	443	443	450
2007[A]	449	447	450
2008[A]	450	415	420
2009[A]	381	409	401
2010[A]	389	432	441
2011[A]	408	390	435
2012[A]	371	422	444
2013[A]	326	337	398
2014	153	167	206
2015	158	153	196
2017	225	210	225
2018	220	201	223
2019	209	221	225
2020	0[B]	0[B]	210
2021	223	208	225
2022	209	209	220

[A]When possible, points were visited twice from 2005 to 2013.
[B]Surveys not conducted due to the covid-19 pandemic.

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 as 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 that are detected during the point counts but are 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.

For more detailed information about survey protocols, refer to Daw and others (2017) and the NCPN website. Links to past and current protocols and annual reports 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 be first be fit to distance-sampling data to describe the probability of detection of 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 habitat-based 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.

Because low detection probabilities can result in inaccurate density estimates, we established a detection-probability threshold of 0.05, removing density estimates with detection probabilities below this threshold. 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. In our trend analyses, we only included annual density estimates for individual species in habitats based on at least 10 detections within the distance cutoff (125 meters). This was done because annual density estimates within a habitat that are based on low numbers (<10) of annual detections can lead to inaccurate density estimates (MacKenzie et al. 2006) that are not appropriate to include.

3 Results

Over 17 years of data collection, 15,777 point-count surveys have been conducted in 11 NCPN units (see Table 2-1), detecting 179 unique species. Of those 179 species, 161 were within 125 meters of the observer, the established distance cut-off for our analyses (see Section 2.3.2).

In 2022, between May 7 and June 9, field technicians visited all 45 planned habitat-based transects, for a total of 638 point-count surveys. A total of 6,245 individual birds of 117 unique species were recorded. One new species was detected for this monitoring program: a Lewis's woodpecker (*Melanerpes lewis*) in Black Canyon of the Gunnison National Park. In addition, the following birds were detected in the following parks for the first time in this monitoring program: lazuli bunting (*Passerina amoena*), Black Canyon of the Gunnison National Park; summer tanager (*Piranga rubra*), Arches National Park; MacGillivray's warbler (*Geothlypis tolmiei*), Bryce Canyon National Park; red-naped sapsucker (*Sphyrapicus nuchalis*), Curecanti National Recreation Area, and Lincoln's sparrow (*Melospiza lincolnii*), Zion National Park.

3.1 Habitat-based density trends

Excluding density estimates with a detection probability coefficient of variance of >100, we had sufficient sample sizes to estimate at least three annual densities of 61 species in at least one of the three habitats surveyed. In total, we estimated 118 population density trends across the three habitats. Fifteen of the estimated density trends were significant (p-value <0.05), including seven negative trends and eight positive trends (Tables 3-1, 3-2). With the addition of 2022 density estimates, we saw changes in nine trends (Table 3-3).

We excluded raptors (i.e., hawks, eagles, and owls) and common raven (*Corvus corax*) from our density and trend estimates. While these larger avian species were included in previous years' analyses (with only enough detections of common raven to estimate trends in density), we do not believe this was appropriate, as our study design and the use of point counts as a monitoring method is not effective for species with minimal vocalizations and large territories, such as raptors and common ravens. Similarly, we excluded hummingbirds from our trend estimates because point counts are not suited to detect hummingbirds effectively. While some hummingbirds do sing and many perform mating displays, these behaviors are less frequent and consistent than those of most passerines (songbirds). Hummingbirds are most commonly detected due to their audible wing-whir, which can only be heard within a short distance from the observer. As a result of this exclusion, black-chinned hummingbird (*Archilochus alexandri*) and broad-tailed hummingbird (*Selasphorus platycercus*) trends are no longer present in this report.

3.2 Pipe Spring National Monument summary

In 2022, we completed all four point-count surveys and the area search at Pipe Spring National Monument. We detected a total of 106 individuals of 24 species during surveys (Table 3-4). Sample sizes were too low for density trends to be estimated. Surveys were not conducted in Pipe Spring National Monument in 2016 or 2020.

Table 3-1 Significant density trends for landbird species in the Northern Colorado Plateau Network, 2022.

Species	Habitat[A]		
	Low-elevation riparian	Pinyon-juniper	Sagebrush shrubland
Mourning dove	↓	↓	–
White-throated swift	↓	↓	–
Hairy woodpecker	↑	NA	NA
Rock wren	–	–	↓
Mountain bluebird	NA	↓	–
Yellow-rumped warbler	–	↑	–
Grace's warbler	NA	–	↑
Vesper sparrow	NA	↑	–
Lark sparrow	NA	–	↑
Western tanager	–	–	↑
Lazuli bunting	–	↑	–
Western meadowlark	NA	–	↓
House finch	–	–	↑

[A]NA = not enough data available; – = no trend

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 sagebrush shrubland habitats in the Northern Colorado Plateau Network, 2005–2015 and 2017–2022.

Common name	Low-elevation riparian			Pinyon-juniper			Sagebrush shrubland		
	Slope[A]	R^2	Sample size[B]	Slope[A]	R^2	Sample size[B]	Slope[A]	R^2	Sample size[B]
Mourning dove	–0.78[C]	0.64	14	–1.31[D]	0.47	16	–0.14	0.13	11
White-throated swift	–0.87[D]	0.42	16	–0.62[D]	0.48	15	–1	0.12	4
Hairy woodpecker	0.8[E]	0.82	5	NA	NA	NA	NA	NA	NA
Northern flicker	NA	NA	NA	NA	NA	NA	–0.05	0.24	7
Western wood-pewee	0.08	0.01	12	NA	NA	NA	NA	NA	NA
Gray flycatcher	NA	NA	NA	0.19	0.01	16	0.01	0.00	9
Dusky flycatcher	NA	NA	NA	–0.18	0.04	14	0.39	0.20	17
Black phoebe	0.16	0.02	7	NA	NA	NA	NA	NA	NA
Say's phoebe	–0.14	0.14	14	–0.13	0.68	4	0.02	0.05	7
Ash-throated flycatcher	–0.02	0.00	16	0.03	0.00	16	–0.62	0.73	4
Gray vireo	0.13	0.38	9	0.18	0.05	16	NA	NA	NA
Plumbeous vireo	0.01	0.00	16	0.18	0.13	15	0.15	0.29	3
Warbling vireo	0.18	0.04	16	NA	NA	NA	0.17	0.56	6
Pinyon jay	NA	NA	NA	–0.07	0.09	13	NA	NA	NA
Woodhouse's scrub-jay	0.05	0.02	14	0.18	0.04	13	NA	NA	NA
Black-billed magpie	NA	NA	NA	NA	NA	NA	–0.1	0.17	12
Horned lark	NA	NA	NA	NA	NA	NA	–0.05	0.01	12
Violet-green swallow	–4.79	0.07	14	0.11	0.01	14	0.15	0.12	13
Cliff swallow	NA	NA	NA	NA	NA	NA	–0.14	0.01	6
Mountain chickadee	NA	NA	NA	–0.03	0.00	12	NA	NA	NA
Juniper titmouse	–0.29	0.08	10	–0.71	0.13	15	NA	NA	NA
Bushtit	0.54	0.26	9	–0.44	0.01	12	NA	NA	NA
White-breasted nuthatch	NA	NA	NA	–0.01	0.00	10	NA	NA	NA
Rock wren	–0.15	0.08	16	–0.11	0.06	13	–0.18[E]	0.26	17
Canyon wren	–0.02	0.01	10	NA	NA	NA	NA	NA	NA
House wren	0.53	0.09	16	NA	NA	NA	0.13	0.32	8
Bewick's wren	–0.27	0.06	13	–0.55	0.19	16	NA	NA	NA
Blue-gray gnatcatcher	0.71	0.01	16	–0.1	0.00	16	0.53	0.14	15
Western bluebird	NA	NA	NA	NA	NA	NA	0.25	0.38	3
Mountain bluebird	NA	NA	NA	–0.35[E]	0.36	12	0.18	0.07	16
Hermit thrush	NA	NA	NA	–0.02	0.01	3	NA	NA	NA
American robin	–0.63	0.20	9	0.34	0.23	9	0.87	0.20	14
Sage thrasher	NA	NA	NA	NA	NA	NA	–0.05	0.01	16
Lucy's warbler	1.6	0.36	11	NA	NA	NA	NA	NA	NA
Virginia's warbler	–0.08	0.02	11	0.33	0.27	13	0.09	0.15	17
Common yellowthroat	–0.16	0.01	11	NA	NA	NA	NA	NA	NA
Yellow warbler	1.95	0.20	16	NA	NA	NA	0.32	0.34	7
Yellow-rumped warbler	0.11	0.00	6	0.67[E]	0.71	6	0.38	0.27	6
Grace's warbler	NA	NA	NA	0.1	0.05	7	0.14[E]	0.86	5
Black-throated gray warbler	–0.1	0.02	15	–0.1	0.00	16	0.1	0.09	9
Yellow-breasted chat	0.3	0.25	15	NA	NA	NA	NA	NA	NA
Green-tailed towhee	NA	NA	NA	0.24	0.82	4	0.49	0.03	17

Table 3-2, cont. Population-density trend slope, R^2 values, and sample size of estimated annual densities for individual species in low-elevation riparian, pinyon-juniper, and sagebrush shrubland habitats in the Northern Colorado Plateau Network, 2005–2015 and 2017–2022.

Common name	Low-elevation riparian			Pinyon-juniper			Sagebrush shrubland		
	Slope[A]	R^2	Sample size[B]	Slope[A]	R^2	Sample size[B]	Slope[A]	R^2	Sample size[B]
Spotted towhee	0.16	0.00	16	0.58	0.18	16	0.12	0.03	17
Chipping sparrow	–1.3	0.32	7	–0.04	0.00	15	0.11	0.01	16
Brewer's sparrow	NA	NA	NA	NA	NA	NA	–0.16	0.00	17
Vesper sparrow	NA	NA	NA	0.33[D]	0.69	9	–0.69	0.11	17
Lark sparrow	NA	NA	NA	0.14	0.06	11	0.73[D]	0.42	17
Black-throated sparrow	–0.04	0.00	14	0.1	0.01	15	0.18	0.21	6
Sagebrush sparrow	NA	NA	NA	NA	NA	NA	–0.25	0.29	6
Song sparrow	0.3	0.03	13	NA	NA	NA	NA	NA	NA
Dark-eyed junco	NA	NA	NA	–0.13	0.02	4	NA	NA	NA
Western tanager	0.17	0.20	6	0.1	0.17	10	0.13[E]	0.67	6
Black-headed grosbeak	–0.04	0.01	11	0.26	0.33	7	–0.02	0.07	3
Blue grosbeak	0.4	0.24	10	NA	NA	NA	NA	NA	NA
Lazuli bunting	–0.39	0.01	15	1.52[E]	0.53	9	0.24	0.11	9
Western meadowlark	NA	NA	NA	–0.45	0.27	6	–0.21[E]	0.24	17
Brewer's blackbird	NA	NA	NA	NA	NA	NA	0.03	0.01	10
Brown-headed cowbird	–0.24	0.04	7	0.18	0.02	8	0.03	0.01	8
Bullock's oriole	0.17	0.18	8	NA	NA	NA	NA	NA	NA
House finch	–0.86	0.19	15	0.08	0.00	15	0.2[E]	0.35	12
Lesser goldfinch	–0.2	0.01	14	0.38	0.07	5	NA	NA	NA

[A]Sample sizes are the number of years in which densities could be estimated. Models could not be fit for each species-habitat combination for all years due to low detection sample sizes. Note that in 2020 only sagebrush shrubland transects were surveyed.
[B]Slope with no asterisks = p-value >0.05.
[C]p-value ≤0.001.
[D]p-value ≤0.01.
[E]p-value ≤0.05.

Table 3-3. Changes in trend resulting from the addition of density estimates for 2022.

Habitat	Species	From	To	Direction
Low-elevation riparian	hairy woodpecker	non-significant	significantly positive	up
Low-elevation riparian	rock wren	significantly negative	non-significant	up
Pinyon-juniper	lazuli bunting	non-significant	significantly positive	up
Pinyon-juniper	yellow-rumped warbler	non-significant	significantly positive	up
Pinyon-juniper	mountain bluebird	non-significant	significantly negative	down
Pinyon-juniper	Grace's warbler	non-significant	significantly positive	up
Sagebrush shrubland	western meadowlark	non-significant	significantly negative	down
Sagebrush shrubland	western tanager	non-significant	significantly positive	up
Sagebrush shrubland	house finch	non-significant	significantly positive	up

Table 3-4. Number of individuals detected during point counts and area searches in Pipe Spring National Monument, 2009–2022.

Species	Point counts		Area searches		Total
	2009–2021	2022	2009–2021	2022	
Mallard	0	0	1	0	1
Mallard (domestic)	0	0	10	0	10
Gambel's quail	48	2	42	2	94
Black-crowned night-heron	1	0	12	0	13
Cooper's hawk	1	2	2	1	6
Red-tailed hawk	1	0	2	2	5
Eurasian collared-dove	52	1	85	2	140
Mourning dove	31	1	50	0	82
Greater roadrunner	0	0	1	0	1
Great horned owl	0	0	1	0	1
Common poorwill	0	0	3	0	3
White-throated swift	20	0	4	0	24
Black-chinned hummingbird	2	0	0	2	4
Broad-tailed hummingbird	0	1	4	0	5
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	1	0	2
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	29	4	26	4	63
Ash-throated flycatcher	32	4	24	3	63
Cassin's kingbird	56	6	36	1	99
Western kingbird	43	0	40	2	85
Gray vireo	7	0	2	0	9
Warbling vireo	0	0	4	0	4
Pinyon jay	1	0	1	0	2
Woodhouse's scrub-jay	3	0	7	0	10
Common raven	39	3	28	2	72
Violet-green swallow	30	0	69	2	101
Northern rough-winged swallow	11	0	6	0	17
Cliff swallow	0	0	2	0	2
Barn swallow	2	0	0	0	2
Juniper titmouse	6	0	1	0	7
Bushtit	0	0	1	0	1
Rock wren	24	2	4	2	32
Canyon wren	2	0	1	0	3
House wren	2	0	2	0	4
Bewick's wren	21	3	33	2	59
Blue-gray gnatcatcher	8	0	5	0	13
Ruby-crowned kinglet	0	0	1	0	1
American robin	3	0	0	0	3

Table 3-4, cont. Number of individuals detected during point counts and area searches in Pipe Spring National Monument, 2009–2022.

Species	Point counts		Area searches		Total
	2009–2021	2022	2009–2021	2022	
Northern mockingbird	29	0	5	0	34
Sage thrasher	1	0	0	0	1
European starling	27	0	92	0	119
Cedar waxwing	0	0	3	0	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	2	0	7	1	10
Yellow warbler	12	3	60	20	95
Yellow-rumped warbler	2	0	4	0	6
Black-throated gray warbler	5	0	2	0	7
Wilson's warbler	0	0	8	0	8
Yellow-breasted chat	0	0	2	0	2
Green-tailed towhee	3	0	6	2	11
Spotted towhee	6	0	0	0	6
Chipping sparrow	1	0	1	0	2
Brewer's sparrow	5	0	3	0	8
Lark sparrow	1	0	22	0	23
Black-throated sparrow	98	3	49	1	151
Lincoln's sparrow	0	0	1	0	1
White-crowned sparrow	24	2	67	3	96
Summer tanager	1	0	0	0	1
Western tanager	3	0	7	0	10
Black-headed grosbeak	7	0	10	1	18
Blue grosbeak	5	0	5	0	10
Lazuli bunting	2	0	7	1	10
Red-winged blackbird	1	0	0	0	1
Western meadowlark	2	0	1	0	3
Yellow-headed blackbird	1	0	1	0	2
Brown-headed cowbird	16	0	18	0	34
Bullock's oriole	33	0	31	0	64
House finch	138	3	105	2	248
Pine siskin	2	0	31	0	33
Lesser goldfinch	10	0	11	0	21
House sparrow	8	0	53	0	61
Total	945	40	1,166	58	2,209

4 Discussion

As the western landscape continues to change due to anthropogenic land use and climate change, bird populations that are unable to adapt are at risk for decline. With gradual changes affecting habitat integrity for bird populations, such as pinyon-juniper encroachment on sagebrush 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 17-year population-density trends within low-elevation riparian, pinyon-juniper, and sagebrush shrubland habitats for 61 species (a total of 118 species/habitat combinations; see Table 3-2 and Appendix A). The majority of density trend estimates were non-significant, indicating the potential for stable populations for many species.

Of the 118 trend estimates, fifteen were significant (p-value <0.05), including seven negative trends (mourning dove and white-throated swift in low-elevation riparian; mourning dove, white-throated swift, and mountain bluebird in pinyon-juniper; and rock wren and western meadowlark in sagebrush shrubland) and eight positive trends (hairy woodpecker in low-elevation riparian; lazuli bunting, yellow-rumped warbler, and vesper sparrow in pinyon-juniper; and house finch, western tanager, Grace's warbler and lark sparrow in sagebrush shrubland) (see Tables 3-1 and 3-2).

There were sufficient sample sizes to estimate the densities of 61 species in at least one of the three habitats surveyed. It is possible that some species have a significantly negative or positive trend, but because annual density estimates were not estimated for species with fewer than 10 detections per habitat within a year, years with a low number of detections were excluded, leading to a non-significant trend. Of course, this is only relevant for difficult-to-detect and low-abundance species. Changes in trends of species with high abundance should be detected with the methods used in this study.

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 these three important habitats. Continued monitoring of these populations will be essential to acquiring significant trend estimates 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 landscape and climate variables.

It is important to note that because of the nature of low-elevation riparian, pinyon-juniper, and sagebrush 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 sagebrush 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 regionwide 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., 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. Utah State University RS/GIS Laboratory, Logan, Utah.

MacKenzie, D. I., J. D. Nichols, J. A. Royle, K. H. Pollock, L. L. Bailey, and J. E. Hines. 2006. Occupancy estimation and modeling: Inferring patterns and dynamics of species occurrence. Burlington, Mass.: Elsevier/Academic Press.

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. Butchcer, 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. https://partnersinflight.org/resources/the-plan/.

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 Habitat-based Density Trends by Habitat

Red lines indicate significant trends from a simple linear regression model (LR = low-elevation riparian, PJ = pinyon-juniper, SA = sagebrush shrubland) (Figures A-1 through A-16).

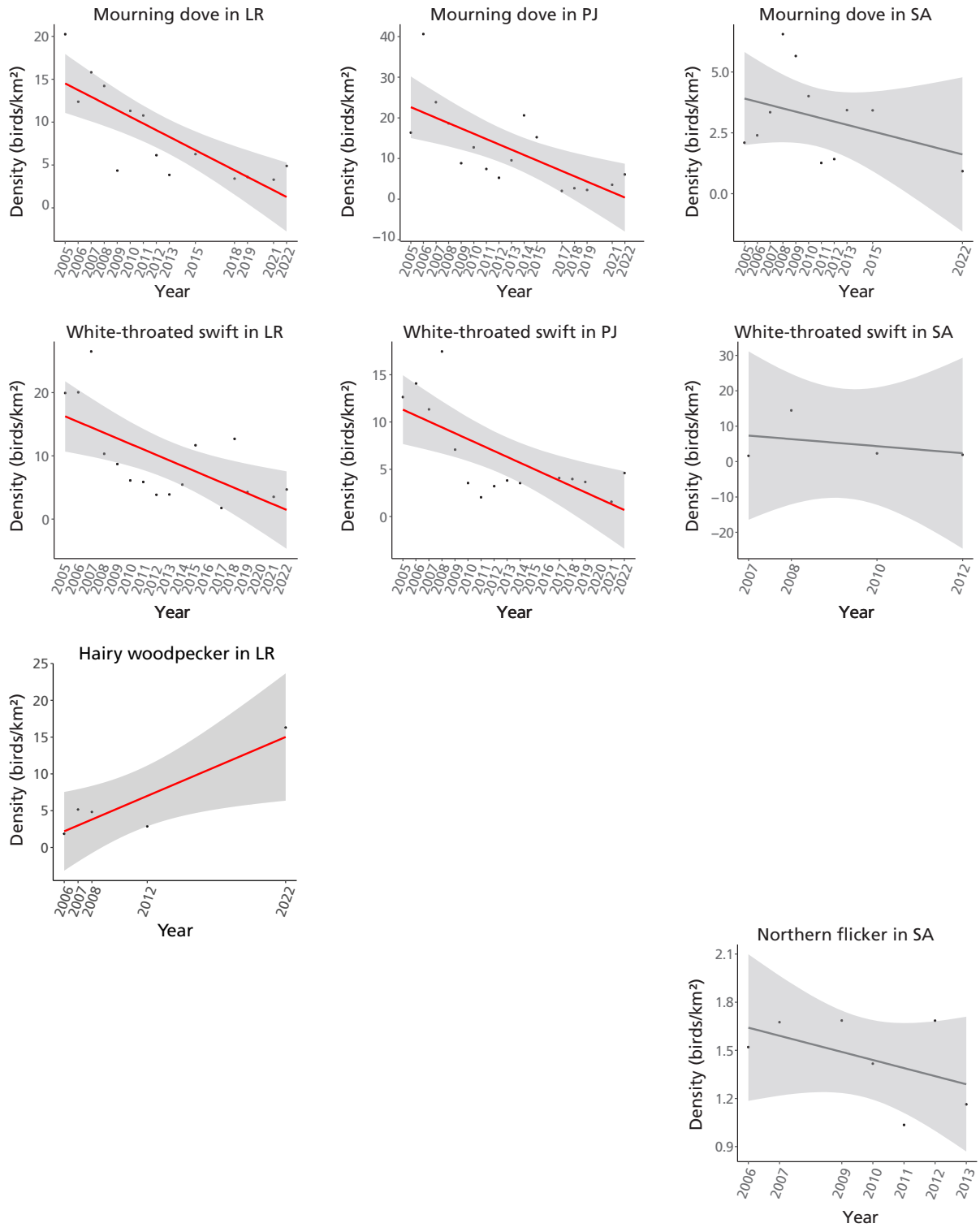


Figure A-1. Trend lines for species and habitats as shown in Table 3-2.

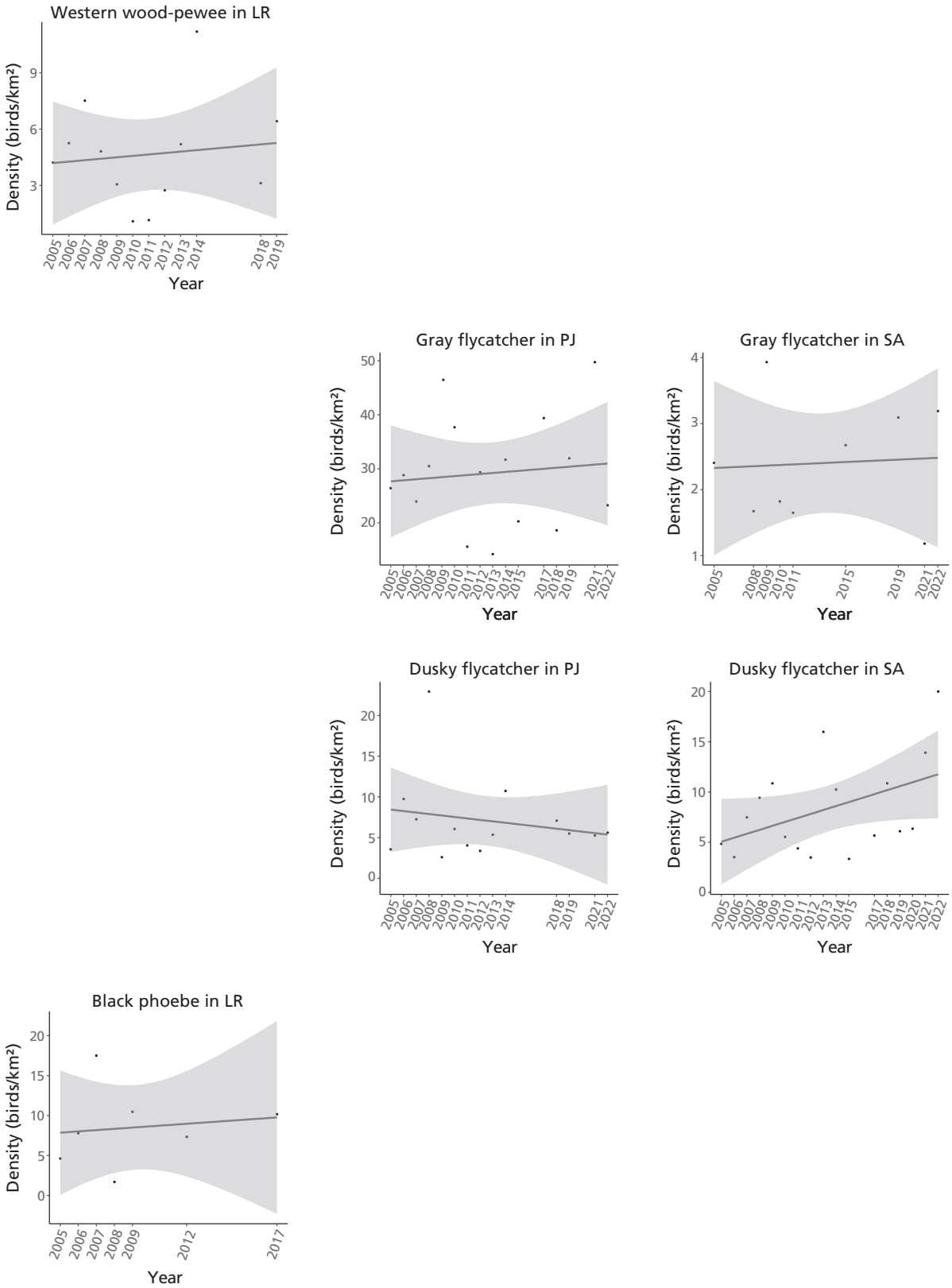


Figure A-2. Trend lines for species and habitats as shown in Table 3-2.

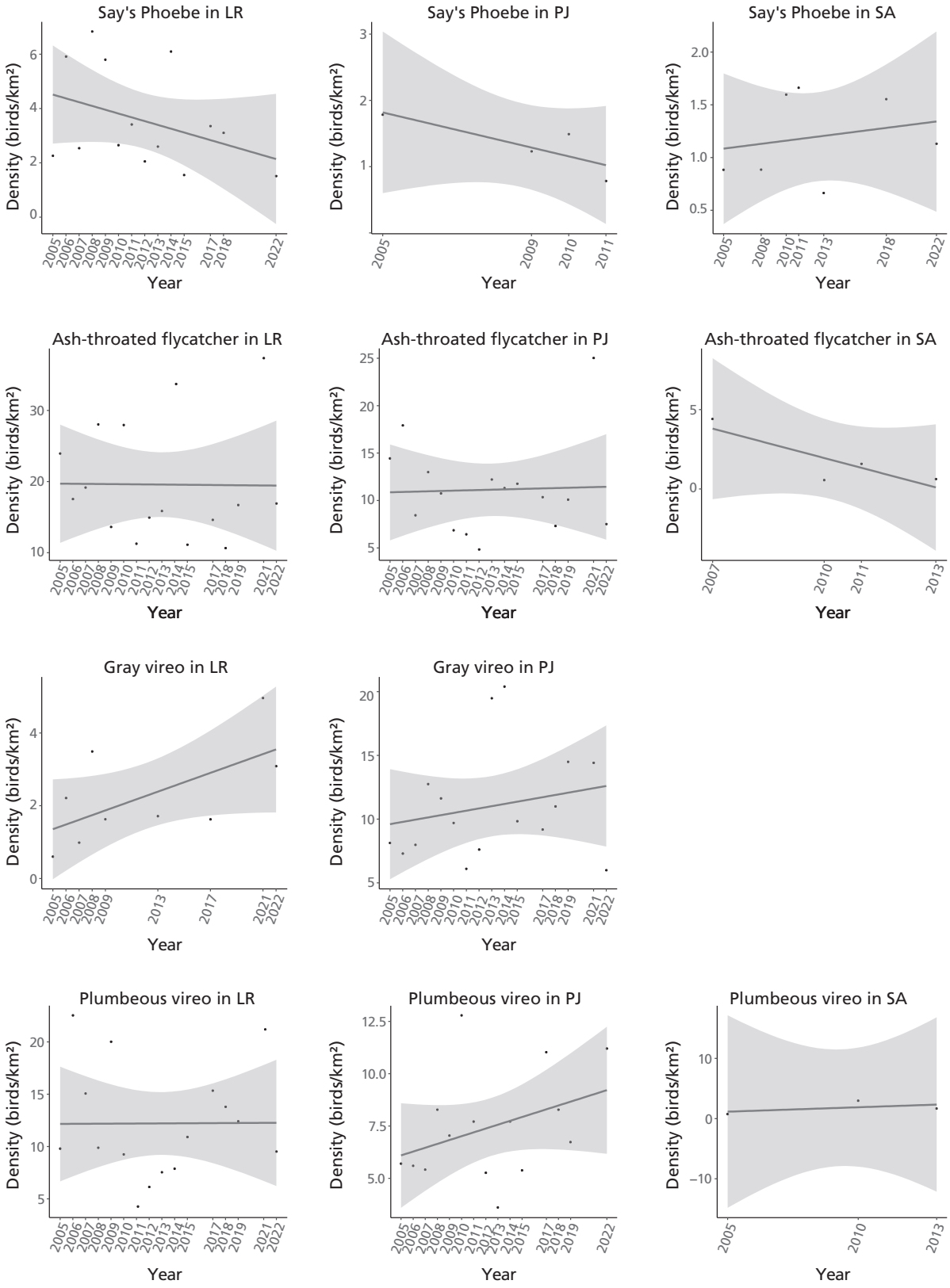


Figure A-3. Trend lines for species and habitats as shown in Table 3-2.

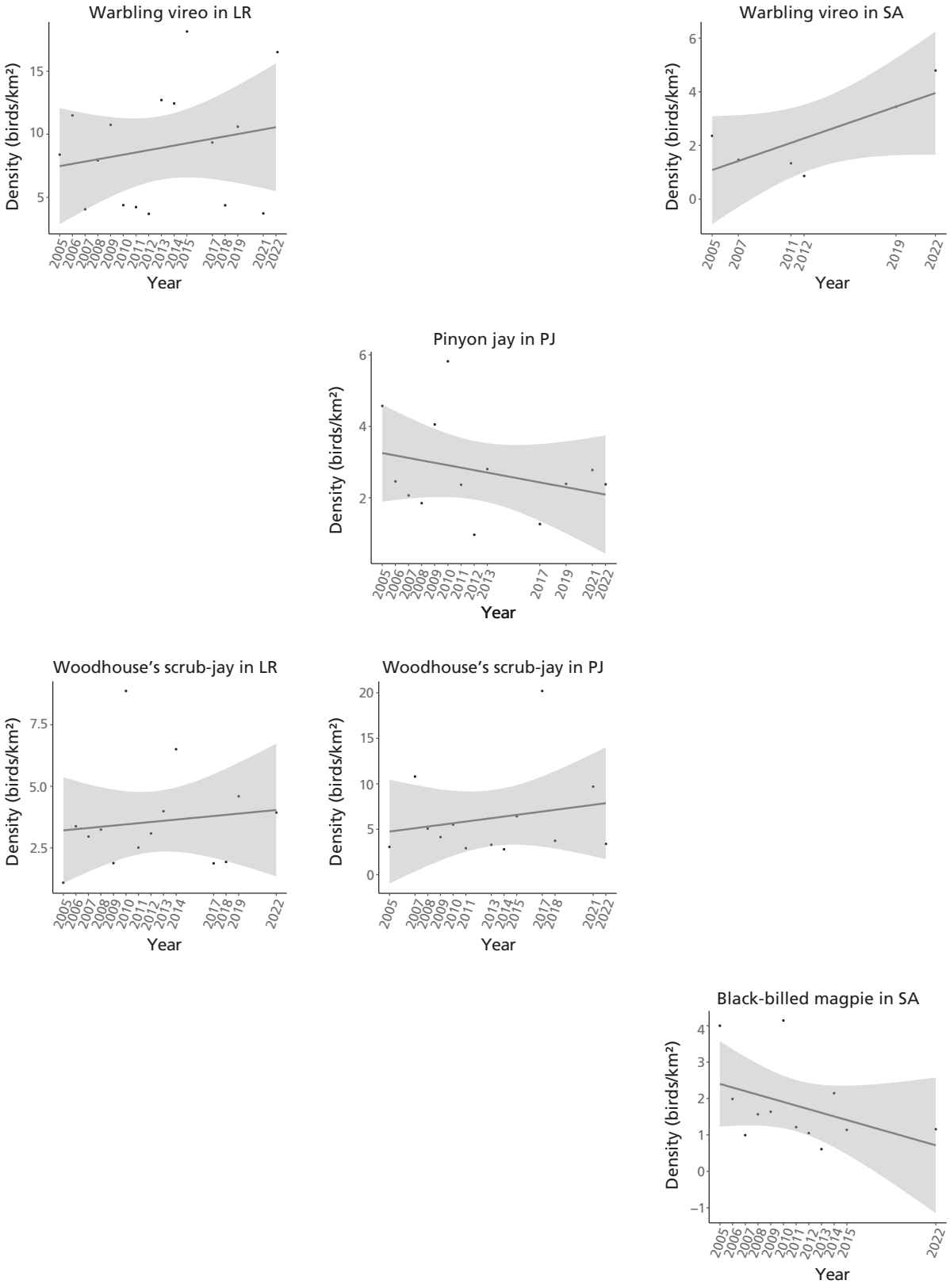


Figure A-4. Trend lines for species and habitats as shown in Table 3-2.

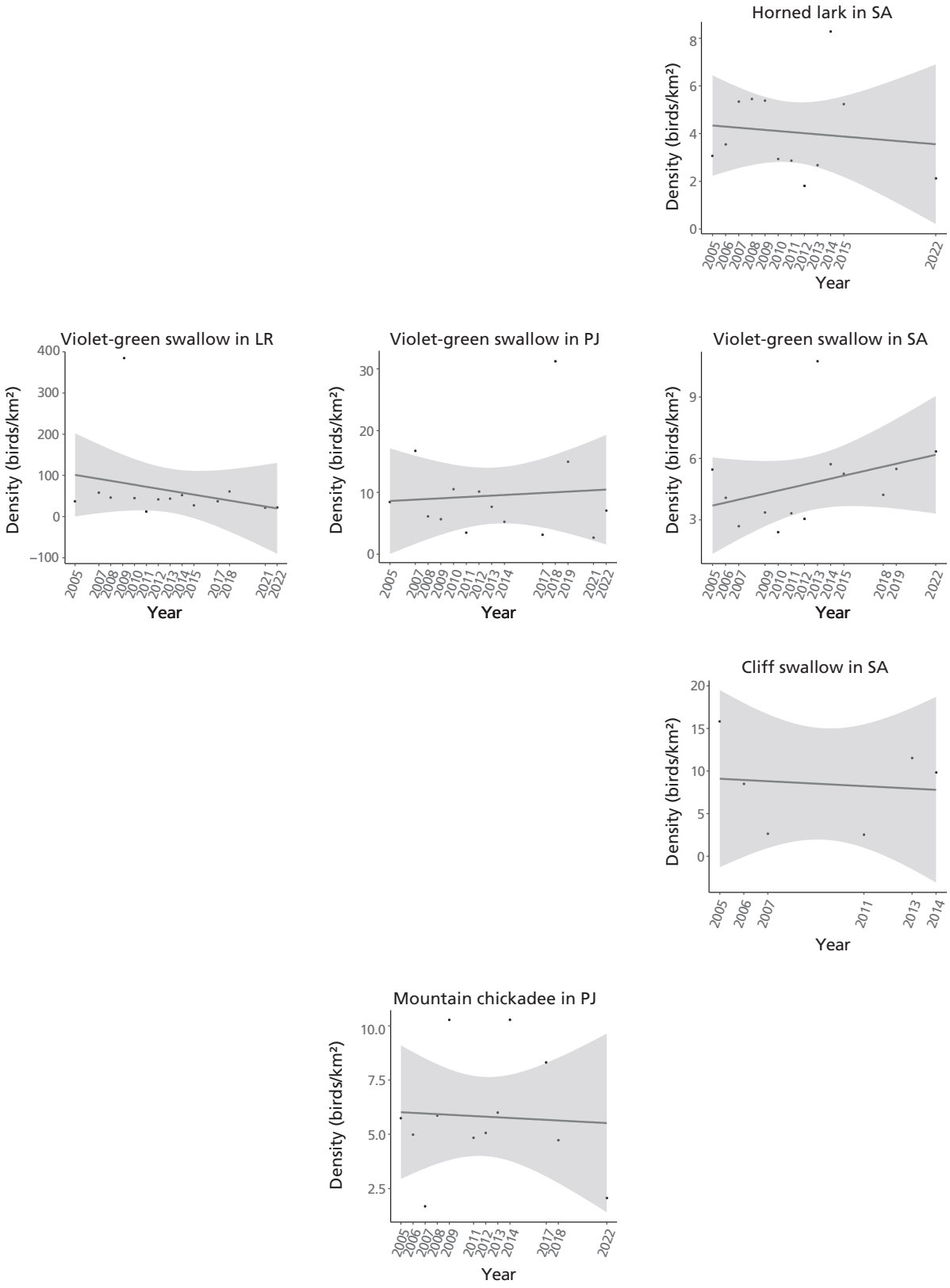


Figure A-5. Trend lines for species and habitats as shown in Table 3-2.

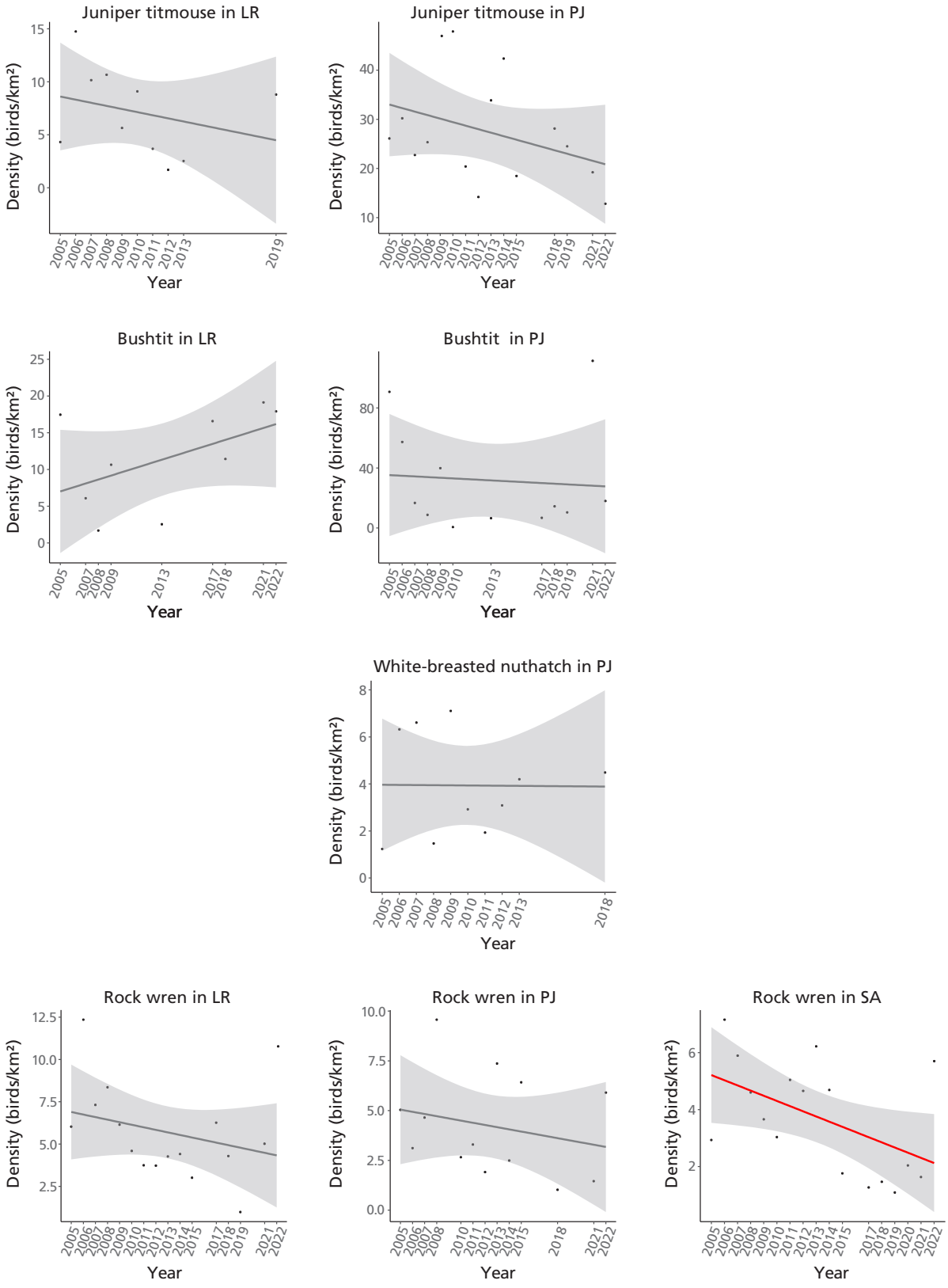


Figure A-6. Trend lines for species and habitats as shown in Table 3-2.

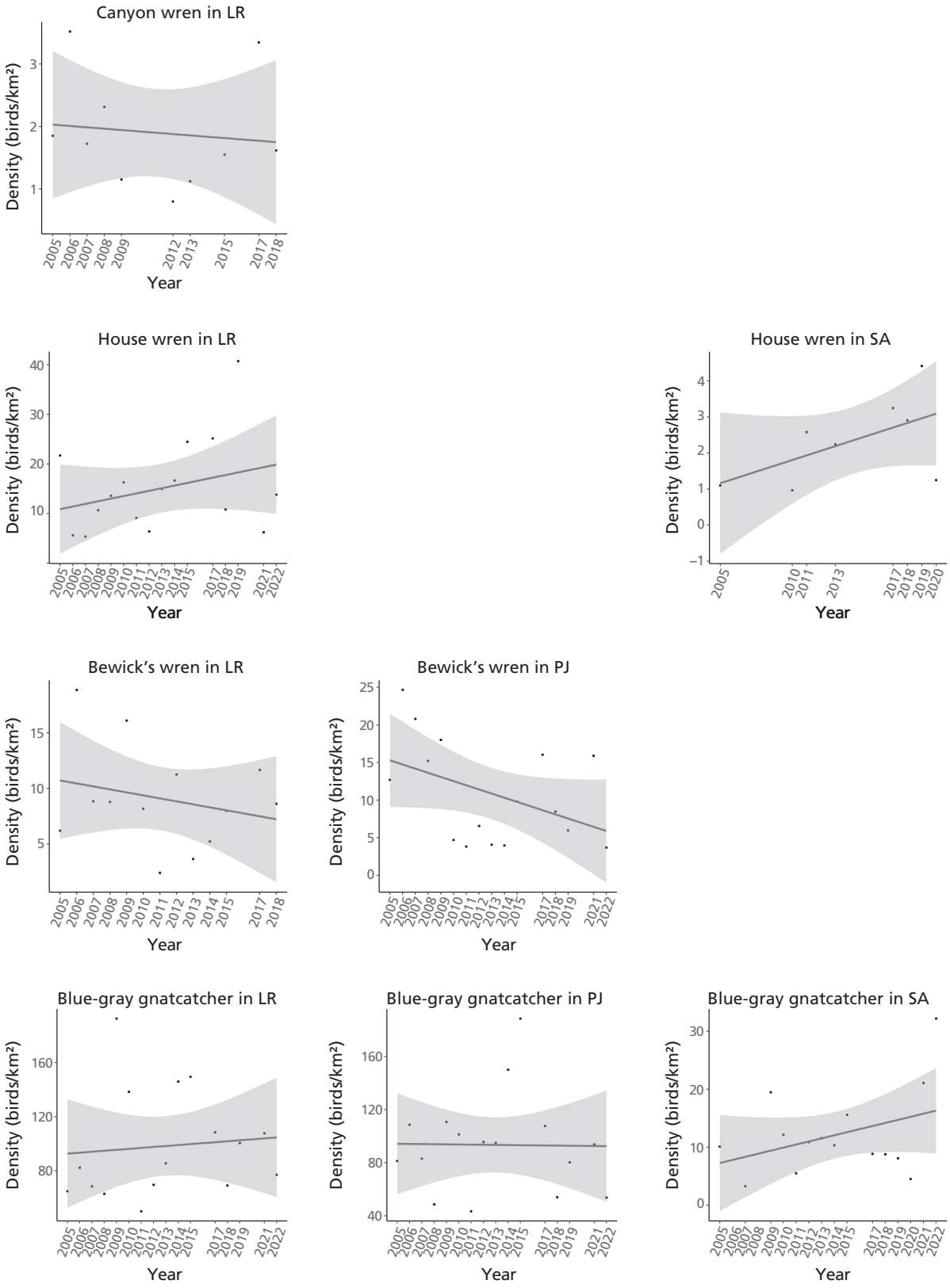


Figure A-7. Trend lines for species and habitats as shown in Table 3-2.

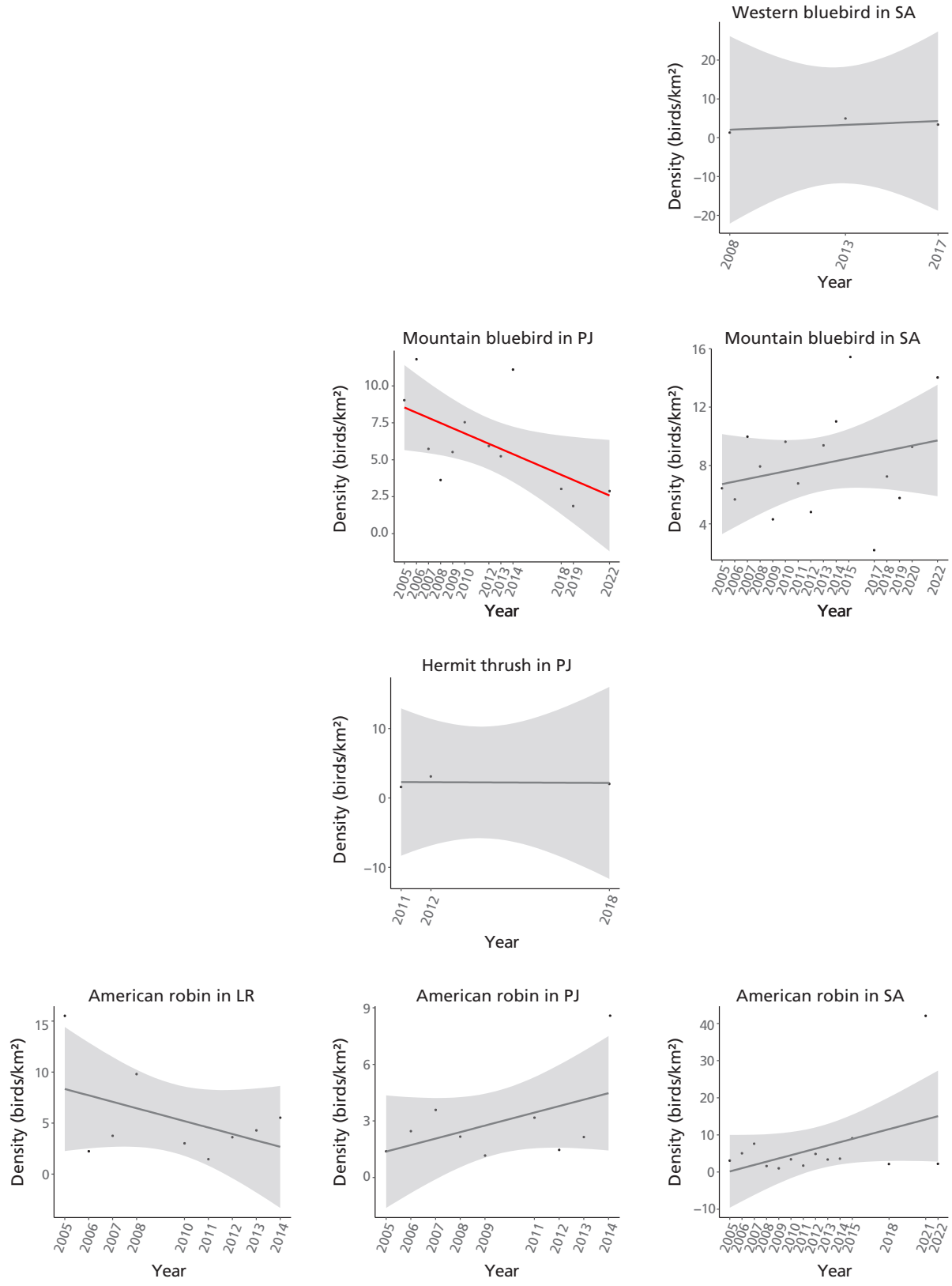


Figure A-8. Trend lines for species and habitats as shown in Table 3-2.

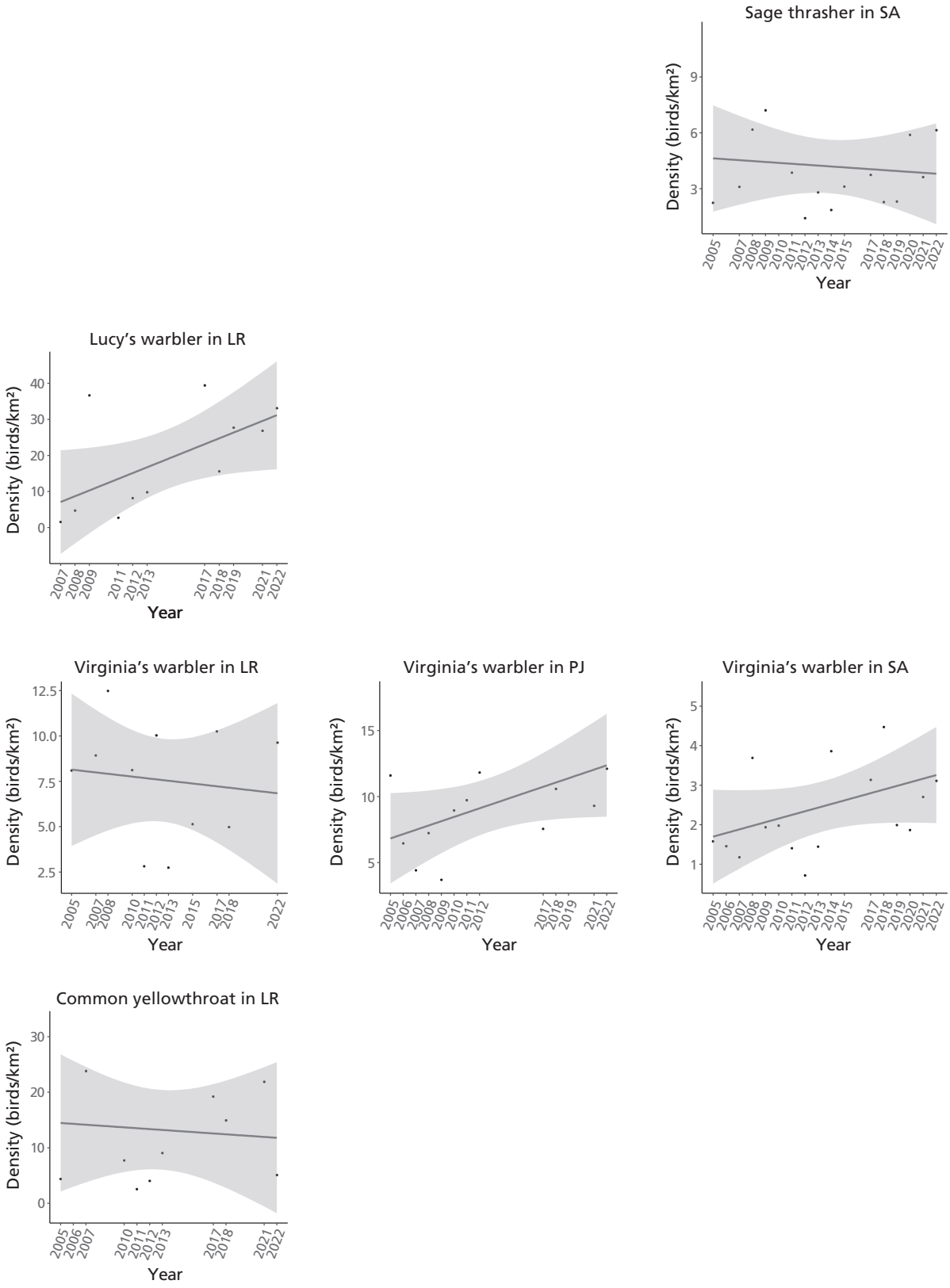


Figure A-9. Trend lines for species and habitats as shown in Table 3-2.

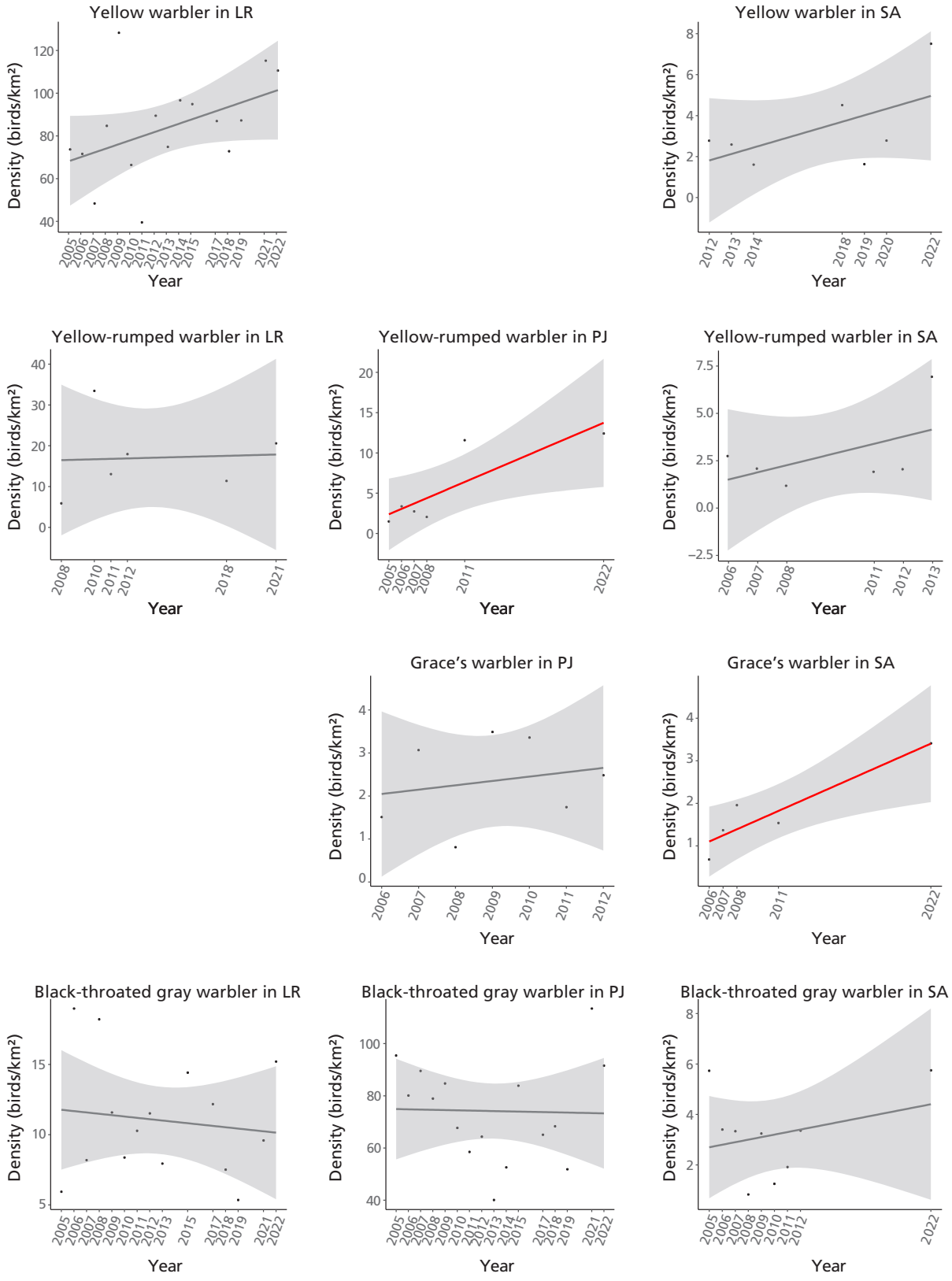


Figure A-10. Trend lines for species and habitats as shown in Table 3-2.

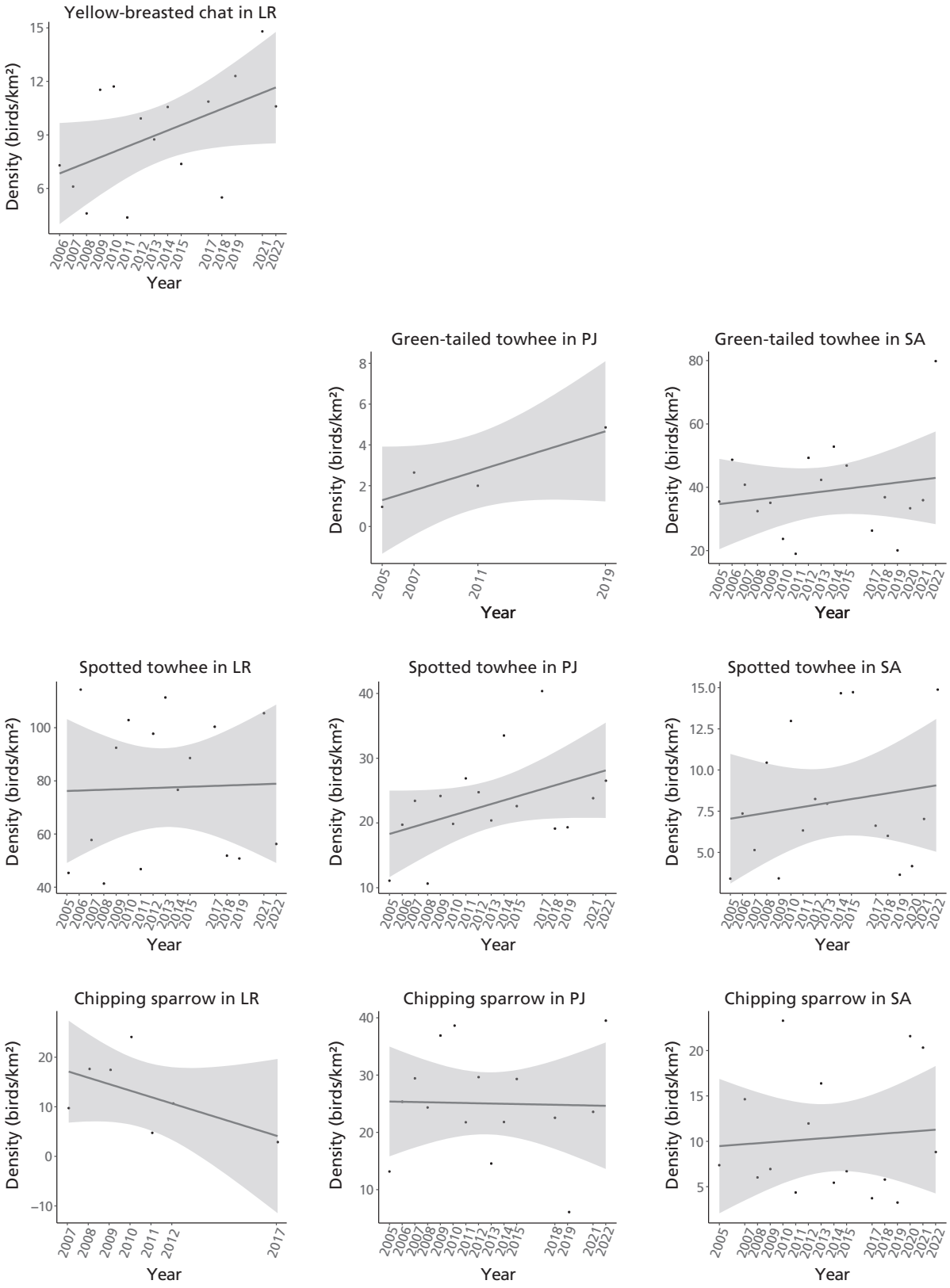


Figure A-11. Trend lines for species and habitats as shown in Table 3-2.

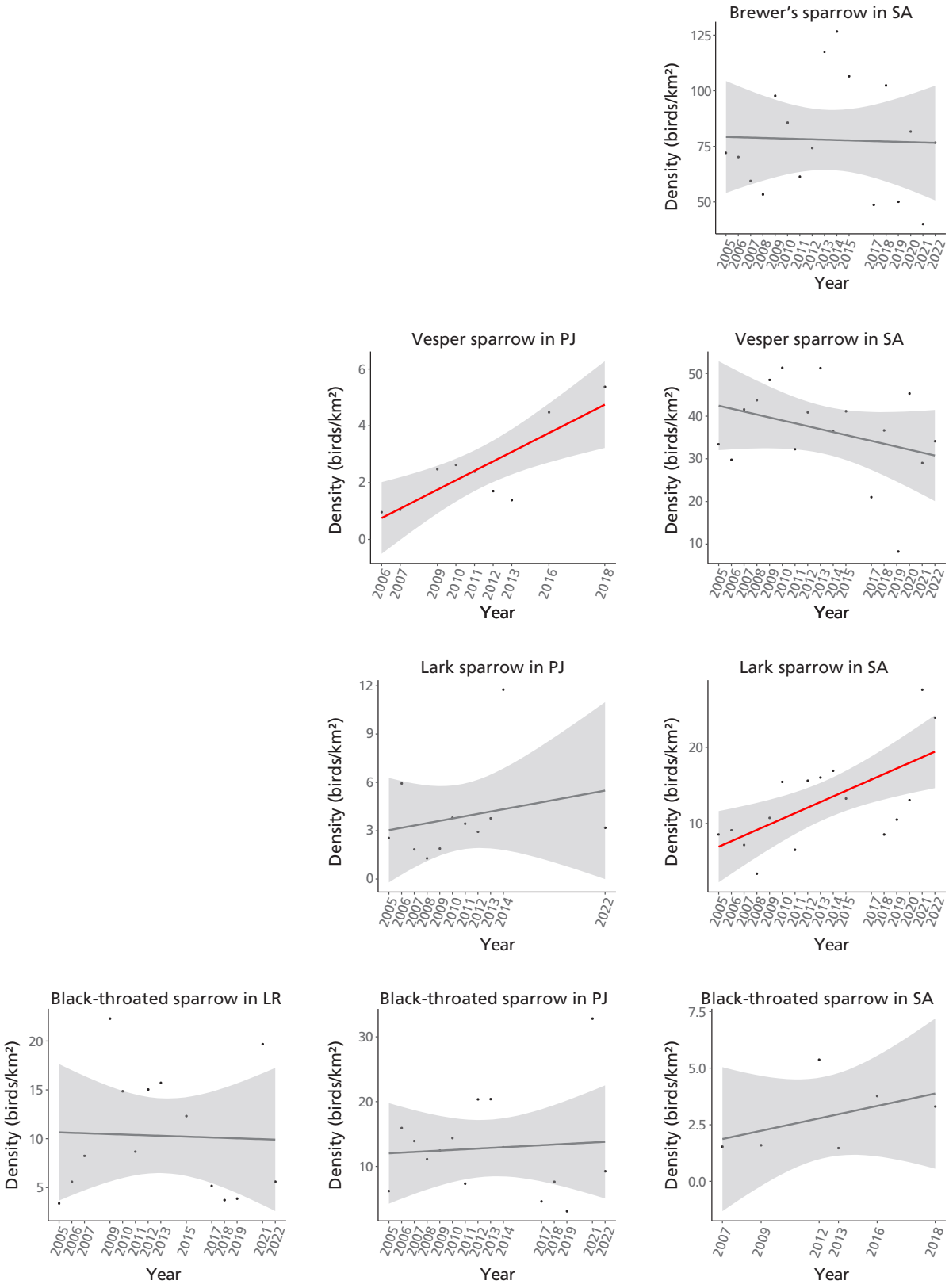


Figure A-12. Trend lines for species and habitats as shown in Table 3-2.

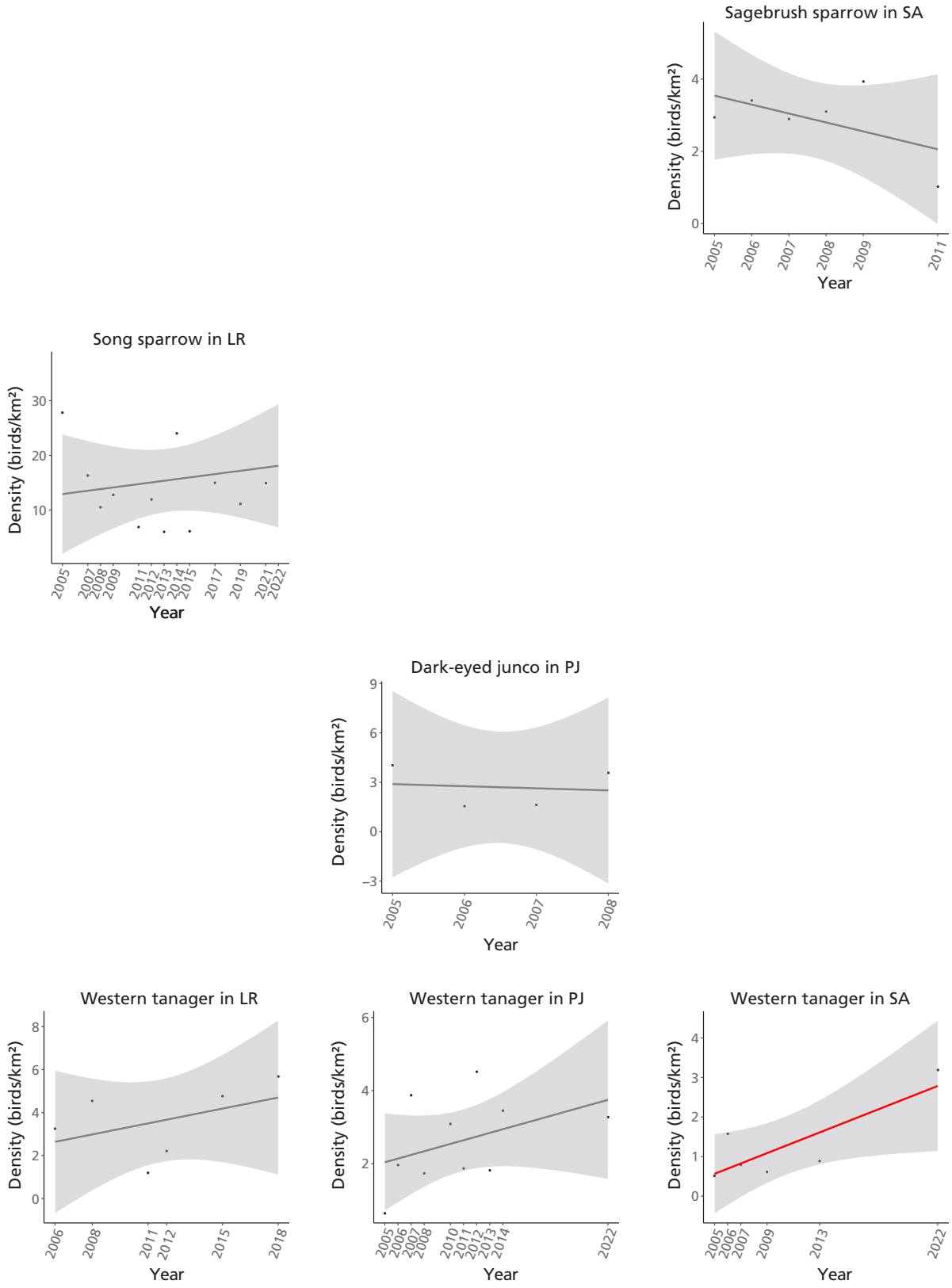


Figure A-13. Trend lines for species and habitats as shown in Table 3-2.

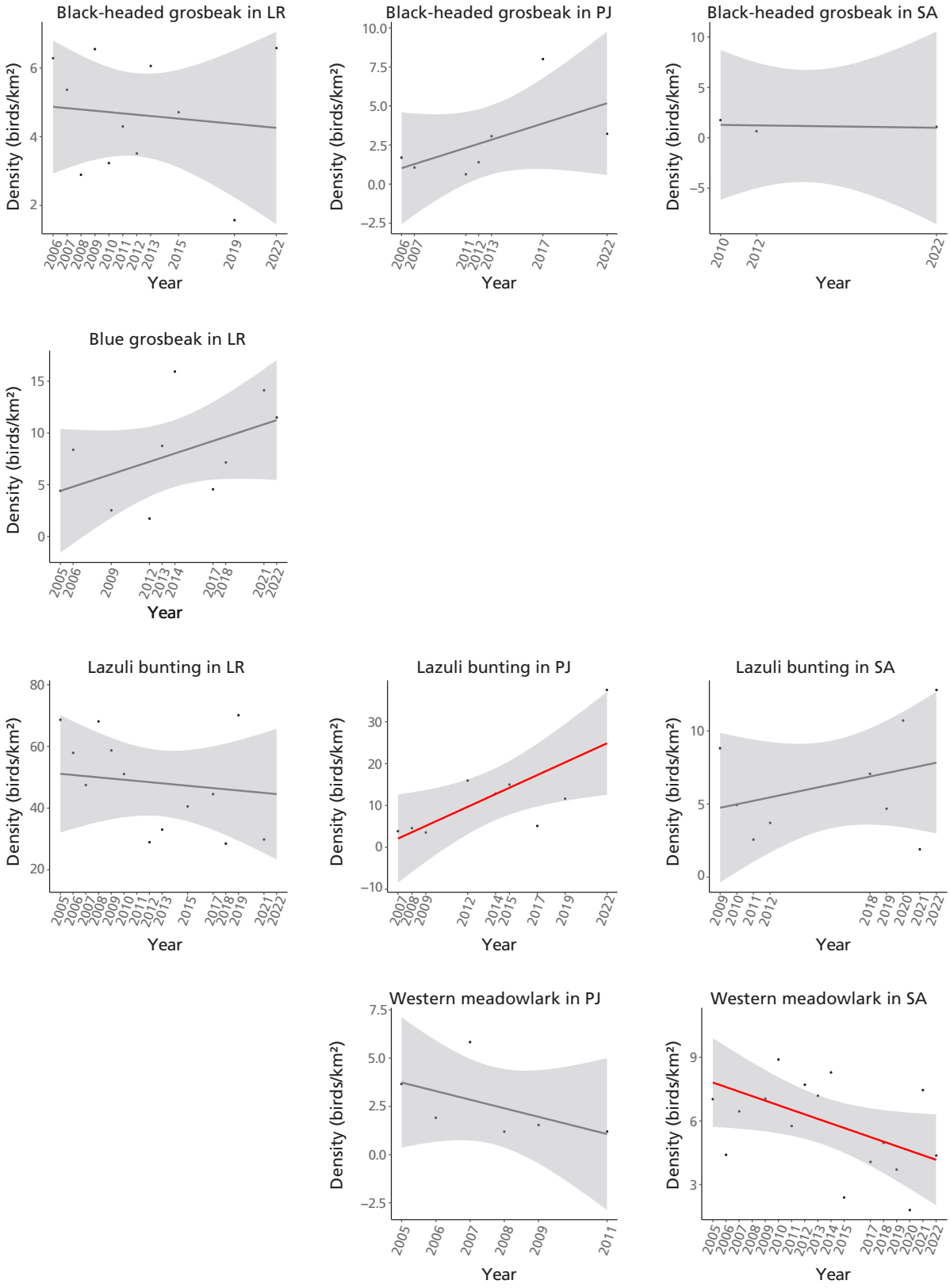


Figure A-14. Trend lines for species and habitats as shown in Table 3-2.

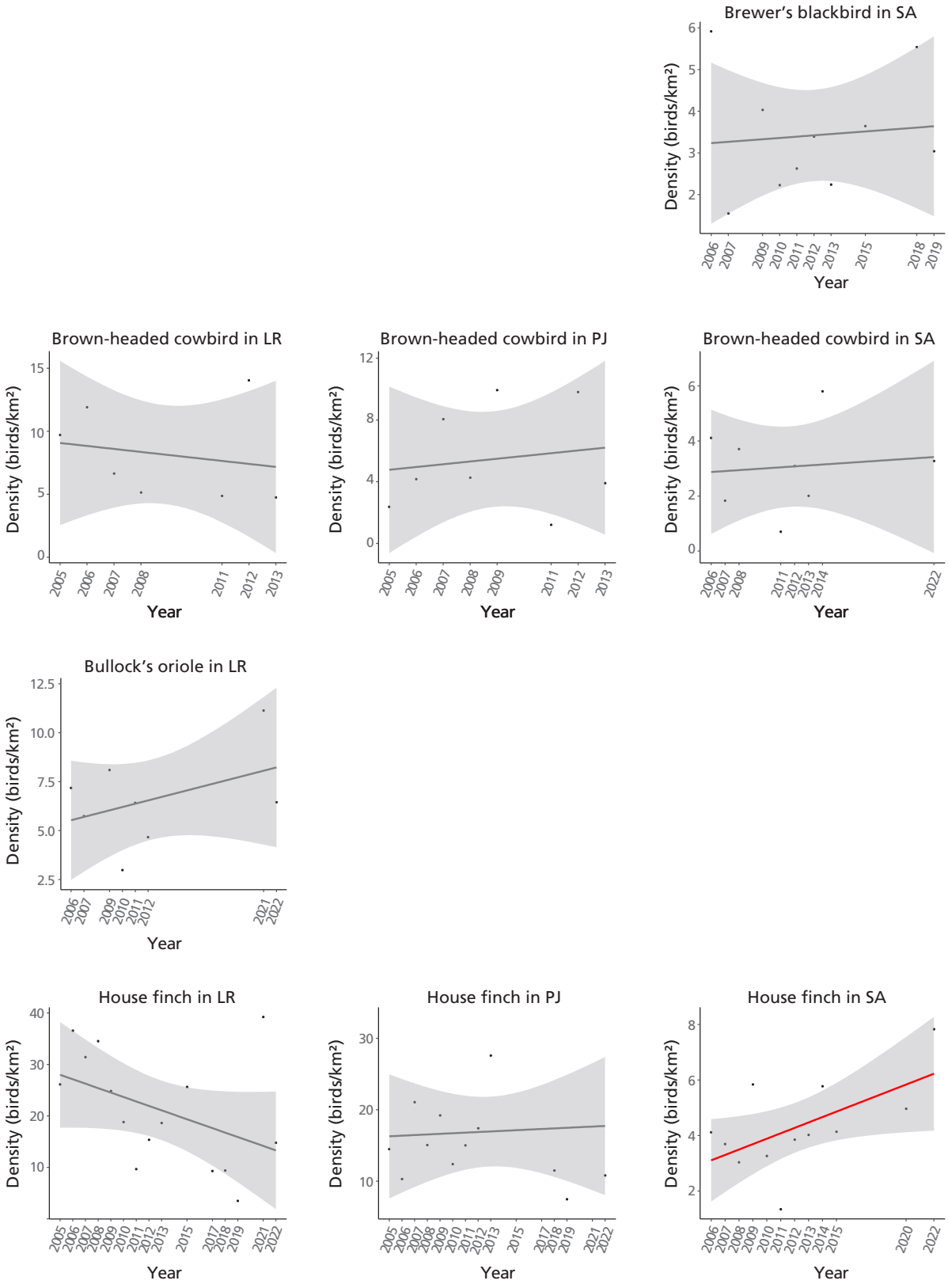


Figure A-15. Trend lines for species and habitats as shown in Table 3-2.

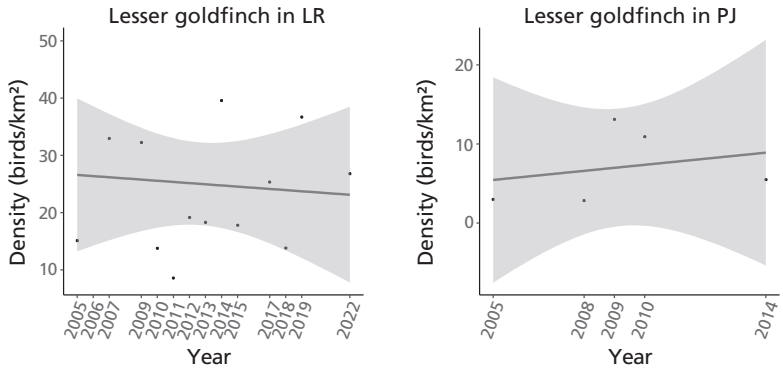


Figure A-16. Trend lines for species and habitats as shown in Table 3-2.

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Natural Resource Stewardship and Science
1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525