National Park Service
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Natural Resource Stewardship and Science

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

2021 Field Season

Natural Resource Report NPS/NCPN/NRR—2022/2216



ON THE COVER

Mourning dove. NPS photo.

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Executive Summary

In 2021, the University of Delaware, in cooperation with the National Park Service (NPS), completed the sixteenth year of a habitat-based landbird monitoring program in park units of the Northern Colorado Plateau Network. 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 2021, university biologists surveyed 44 (of 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 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 16 years of data collection, 15,139 point-count surveys have been conducted in 11 NCPN units, detecting 178 unique species. During the 2021 field season, 656 point-count surveys were conducted, detecting 105 unique species.

Using data from 2005 to 2021, 117 population-density trends were estimated across the three habitats. Eight of the estimated density trends were significant (p-value < 0.05), including six negative trends (mourning dove [*Zenaida macroura*] in low-elevation riparian and pinyon-juniper, white-throated swift [*Aeronautes saxatalis*] in low-elevation riparian and pinyon-juniper, rock wren [*Salpinctes obsoletus*] in low-elevation riparian and sagebrush shrubland) and two positive trends (vesper sparrow [*Pooecetes gramineus*] in pinyon-juniper and lark sparrow [*Chondestes grammacus*] in sagebrush shrubland). 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 the 2019, Rosenberg et al. (2019) 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 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 National Park Service (NPS) Northern Colorado Plateau Network (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 sagebrush shrubland. Using modified methods, monitoring is also conducted at Pipe Spring National Monument, in Arizona. 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 the NCPN landbird monitoring. In 2021, the University of Delaware, in cooperation with the NPS, completed the sixteenth year of a habitat-based landbird monitoring program in NPS units of the NCPN.

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 (Figure 2-1; Table 2-1). Each transect consists of 15 point-count locations, each 250 meters apart (Figures 2-2 to 2-4).

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 that 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.

Since 2005, all 45 transects have remained in place and are 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).

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).

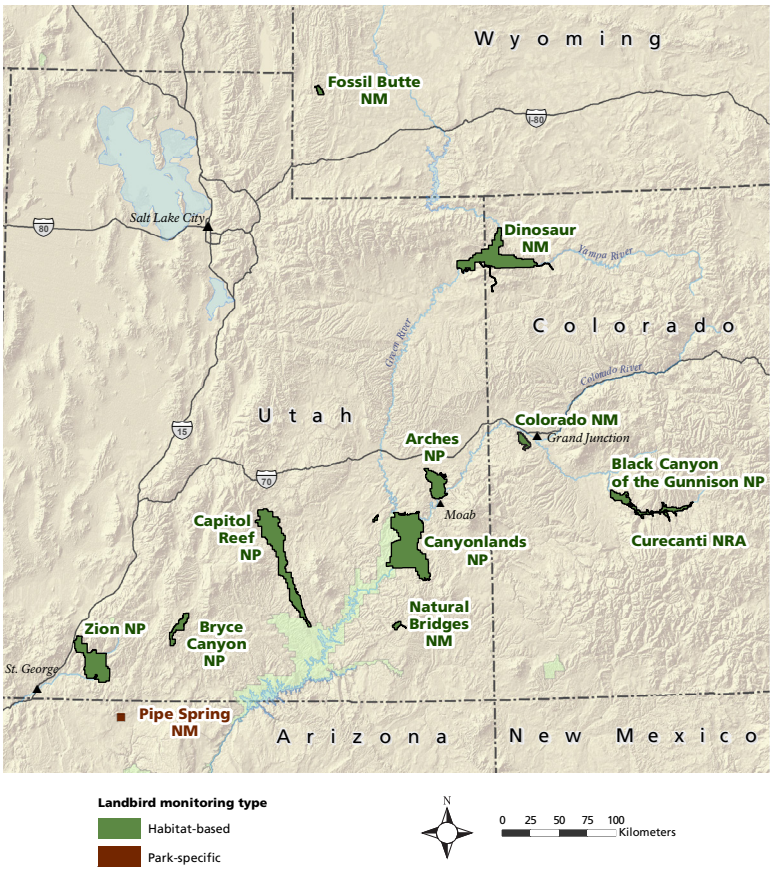


Figure 2-1. Northern Colorado Plateau Network parks where landbirds are monitored.

Table 2-1. 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

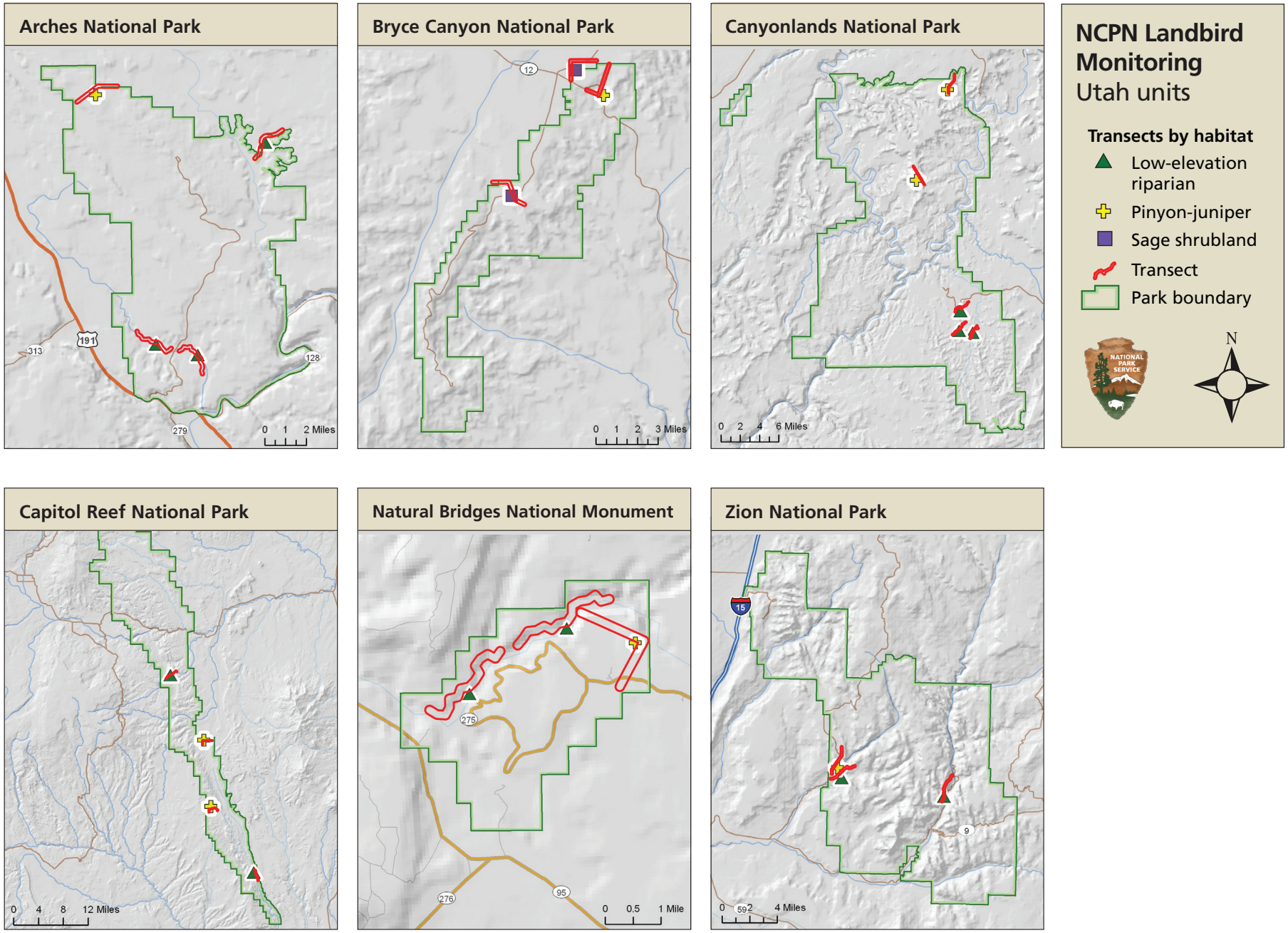


Figure 2-2. Transect locations by habitat, Utah units.

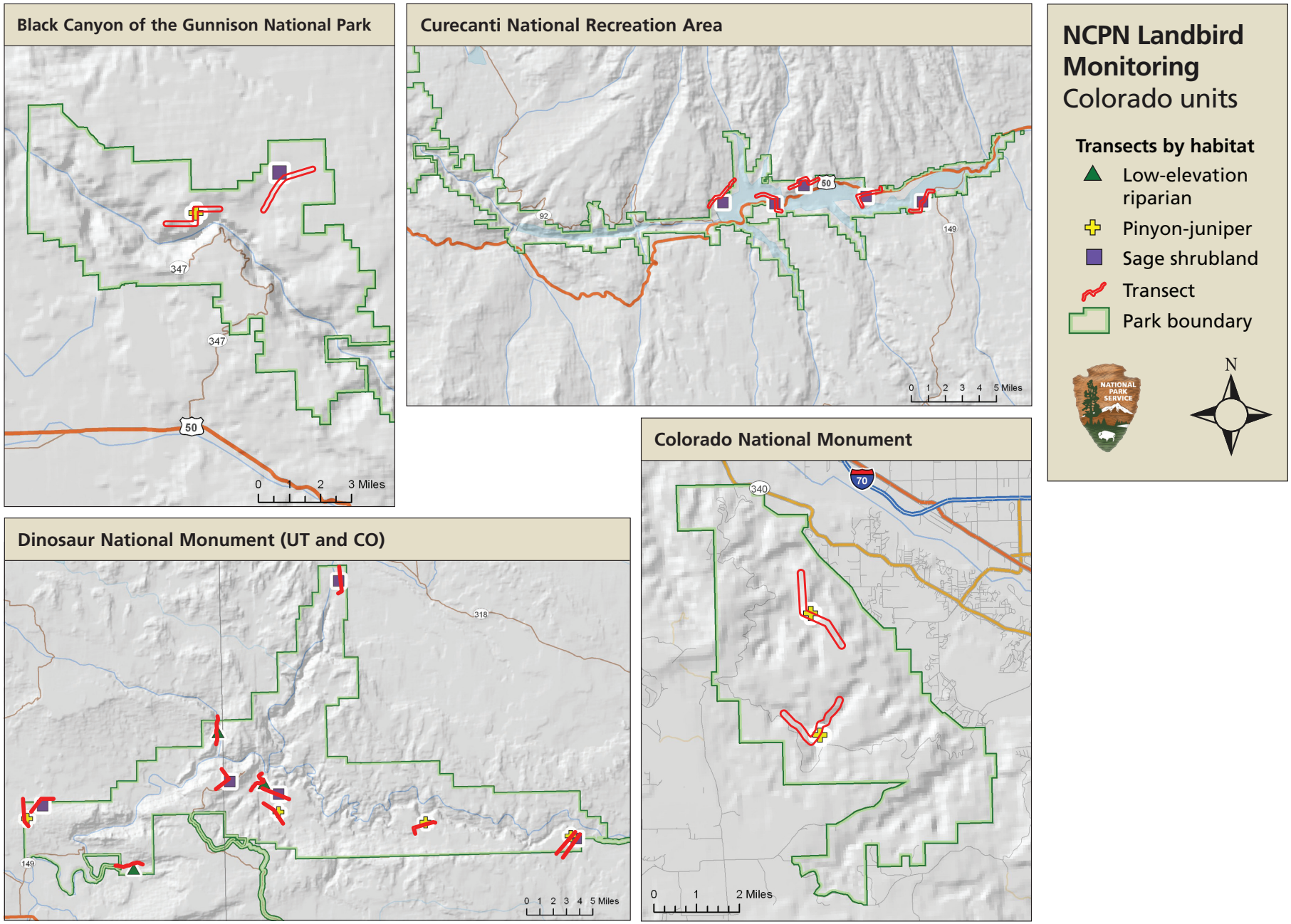


Figure 2-3. Transect locations by habitat, Colorado units.

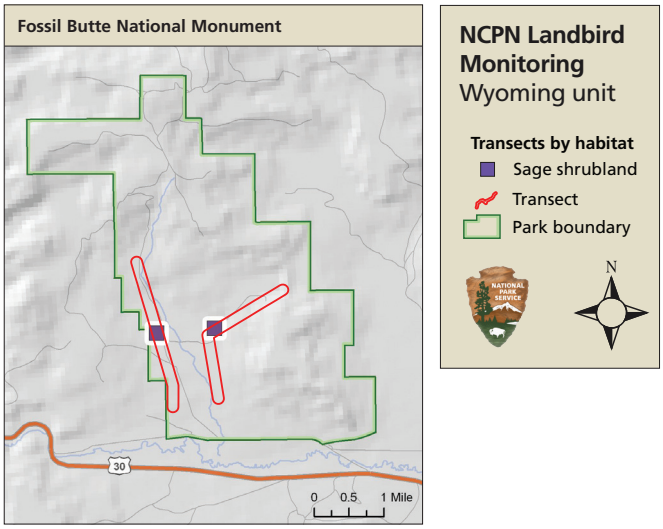


Figure 2-4. Transect locations, Fossil Butte National Monument.

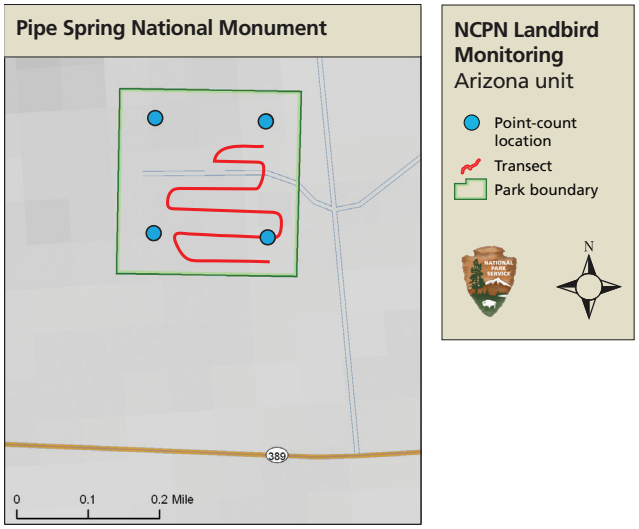


Figure 2-5. Point-count and area-search locations, Pipe Spring National Monument.

Table 2-2. Annual number of point visits within each habitat, 2005–2021 (when possible, points were visited twice from 2005 to 2013).

Year	Low-elevation riparian	Pinyon-juniper	Sagebrush 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
2020	0	0	210
2021	223	208	225

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.

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.

A single observer completes one transect per day, beginning within 30 minutes of sunrise and ending within five hours. Navigating to each point using a GPS unit, the observer walks 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, observer records 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, observer records the overstory seral stage, canopy cover, mean height, and relative abundance of the five most dominant tree or shrub species. Observer also records 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, the observer records all bird detections, regardless of distance to the observer. For each detection, observer records 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. Observer also records 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, observer records 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 (2020) and the NCPN website https://www.nps.gov/im/ncpn/landbirds.htm. 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; R Core Team (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 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 a species in a habitat that were based on at least 10 detections within the distance cut-off (125 meters). This was done because annual density estimates within a habitat that are based on a low number (<10) of annual detections can lead to inaccurate density estimates (MacKenzie et al. 2006) that are not appropriate to include.

3 Results

Over 16 years of data collection, 15,139 point-count surveys have been conducted in 11 NCPN units (see Table 2-1), detecting 178 unique species. Of those 178 species, 160 were within 125 meters of the observer, the established distance cut-off for our analyses (see Section 2.3.2).

In 2021, between May 8 and June 24, field technicians visited 44 of 45 planned habitat-based transects, for a total of 656 point-count surveys. A total of 5,131 individual birds of 105 unique species were recorded. Two new species were detected for this monitoring program: a Swainson's hawk (*Buteo swainsoni*) in Bryce Canyon National Park and a Wilson's snipe (*Gallinago delicata*) in Colorado National Monument. For the first time in this monitoring program a lazuli bunting (*Passerina amoena*) was detected in Bryce Canyon National Park, a northern mockingbird (*Mimus polyglottos*), a western kingbird (*Tyrannus verticalis*), and two Wilson's warblers (*Cardellina pusilla*) were detected in Colorado National Monument, and a Brewer's sparrow (*Spizella breweri*), brown-headed cowbird (*Molothrus ater*), and lark sparrow (*Chondestes grammacus*) were detected in Natural Bridges National Monument.

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 at least three annual densities of 61 species in at least one of the three habitats surveyed. In total, we estimated 117 population density trends across the three habitats. Eight of the estimated density trends were significant (p-value < 0.05), including six negative trends and two positive trends (Tables 3-1, 3-2).

With the addition of 2021 density estimates we saw the following trends change: the house wren (*Troglodytes aedon*) density trend has changed from significantly positive to non-significant in low-elevation riparian; the house finch (*Haemorhous mexicanus*) density trend has changed from significantly negative to non-significant in low-elevation riparian; the black-throated gray warbler (*Setophaga nigrescens*) density trend has changed from significantly negative to non-significant in pinyon-juniper; the western meadowlark (*Sturnella neglecta*) density trend has changed from significantly negative to non-significant in sagebrush shrubland; and the lark sparrow density trend has changed from non-significant to positively significant in sagebrush shrubland.

Table 3-1. Significant density trends by habitat for landbird species in the Northern Colorado Plateau Network, 2005–2021.

Species	Low-elevation riparian	Pinyon-juniper	Sagebrush shrubland
Mourning dove	↓	↓	–
White-throated swift	↓	↓	–
Rock wren	↓	–	↓
Vesper sparrow	–	↑	–
Lark sparrow	–	–	↑

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, in 2021 we decided to exclude hummingbirds from our trend estimates because point counts are not suited to detecting hummingbirds effectively. While some hummingbirds do sing and many perform mating displays, these behaviors are less frequent and consistent than that of most passerines (songbirds). Therefore, the detection of hummingbirds is most commonly due to their audible wing-whir, which can only be detected 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.

Table 3-2. Population-density trend slope, R^2 value, 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 2017–2021. Note that in 2020 only sagebrush shrubland transects were surveyed.

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	-0.9 [C]	0.67	13	-1.47 [D]	0.48	15	-0.04	0.01	10
White-throated swift	-0.96 [D]	0.42	15	-0.74 [D]	0.54	14	-1	0.12	4
Hairy woodpecker	-0.05	0.01	4	–	–	–	–	–	–
Northern flicker	–	–	–	–	–	–	-0.05	0.24	7
Western wood-pewee	0.08	0.01	12	–	–	–	–	–	–
Gray flycatcher	–	–	–	0.41	0.04	15	-0.02	0.02	8
Dusky flycatcher	–	–	–	-0.19	0.03	13	0.2	0.07	16
Black phoebe	0.16	0.02	7	–	–	–	–	–	–
Say's phoebe	-0.11	0.06	13	-0.13	0.68	4	0.04	0.15	6
Ash-throated flycatcher	0.05	0.00	15	0.14	0.02	15	-0.62	0.73	4
Gray vireo	0.15	0.37	8	0.36	0.17	15	–	–	–
Plumbeous vireo	0.08	0.01	15	0.11	0.04	14	0.15	0.29	3
Warbling vireo	0.02	0.00	15	–	–	–	0.09	0.22	5
Pinyon jay	–	–	–	-0.08	0.08	12	–	–	–
Woodhouse's scrub-jay	0.05	0.01	13	0.35	0.11	12	–	–	–
Black-billed magpie	–	–	–	–	–	–	-0.15	0.17	11
Horned Lark	–	–	–	–	–	–	0.11	0.04	11
Violet-green swallow	-0.58	0.04	12	0.22	0.02	13	0.14	0.08	12
Cliff swallow	–	–	–	–	–	–	-0.14	0.01	6
Mountain chickadee	–	–	–	0.17	0.09	11	–	–	–
Juniper titmouse	-0.29	0.08	10	-0.46	0.05	14	–	–	–
Bushtit	0.47	0.17	8	-0.64	0.05	7	–	–	–
White-breasted nuthatch	–	–	–	-0.01	0.00	10	–	–	–
Rock wren	-0.33 [E]	0.38	15	-0.22	0.17	12	-0.26 [D]	0.49	16
Canyon wren	-0.02	0.01	10	–	–	–	–	–	–
House wren	**0.7**	0.13	15	–	–	–	0.13	0.32	8
Bewick's wren	-0.27	0.06	13	-0.49	0.13	15	–	–	–
Blue-gray gnatcatcher	1.49	0.03	15	0.68	0.01	13	0.12	0.01	14
Western bluebird	–	–	–	–	–	–	0.25	0.38	3
Mountain bluebird	–	–	–	-0.37	0.29	11	0.05	0.01	15
Hermit thrush	–	–	–	-0.02	0.01	3	–	–	–
American robin	-0.01	0.00	8	0.34	0.23	9	0.03	0.00	12
Sage thrasher	–	–	–	–	–	–	-0.11	0.04	15
Lucy's warbler	1.53	0.28	10	–	–	–	–	–	–
Virginia's warbler	-0.25	0.11	10	0.33	0.23	12	0.1	0.14	16

[A]Slope without lettering = p-value > 0.05.
[B]Sample sizes are 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.
[C]Significant trend; p-value ≤ 0.001. Positive trends also appear in green. Negative trends appear in red.
[D]Significant trend; p-value ≤0.01. Positive trends also appear in green. Negative trends appear in red.
[E]Significant trend; p-value ≤0.05. Positive trends also appear in green. Negative trends appear in red.

Table 3-2 (continued). Population-density trend slope, R^2 value, 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 2017–2021. Note that in 2020 only sagebrush shrubland transects were surveyed.

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]
Common yellowthroat	0.7	0.20	9	–	–	–	–	–	–
Yellow warbler	1.69	0.13	15	–	–	–	0.05	0.03	6
Yellow-rumped warbler	0.11	0.00	6	1.58	0.77	5	0.38	0.27	6
Grace's warbler	–	–	–	0.1	0.05	7	0.13	0.30	4
Black-throated gray warbler	-0.24	0.09	14	-0.61	0.03	15	-0.33	0.28	8
Yellow-breasted chat	0.33	0.24	14	–	–	–	–	–	–
Green-tailed towhee	–	–	–	0.24	0.82	4	-0.36	0.03	16
Spotted towhee	0.8	0.02	15	0.62	0.17	15	-0.01	0.00	16
Chipping sparrow	-1.3	0.32	7	-0.51	0.08	14	0.17	0.01	15
Brewer's sparrow	–	–	–	–	–	–	-0.16	0.00	16
Vesper sparrow	–	–	–	0.33 [D]	0.69	9	-0.76	0.12	16
Lark sparrow	–	–	–	0.49	0.24	10	0.63 [E]	0.33	16
Black-throated sparrow	0.08	0.00	13	0.24	0.02	14	0.18	0.21	6
Sagebrush sparrow	–	–	–	–	–	–	-0.25	0.29	6
Song sparrow	-0.38	0.07	12	–	–	–	–	–	–
Dark-eyed junco	–	–	–	-0.13	0.02	4	–	–	–
Western tanager	0.17	0.20	6	0.17	0.20	9	-0.01	0.01	5
Black-headed grosbeak	-0.22	0.28	10	0.52	0.59	6	–	–	–
Blue grosbeak	0.39	0.19	9	–	–	–	–	–	–
Lazuli bunting	-1.36	0.16	14	0.67	0.42	7	0.03	0.00	8
Western meadowlark	–	–	–	-0.45	0.27	**6**	-0.22	0.21	16
Brewer's blackbird	–	–	–	–	–	–	0.03	0.01	10
Brown-headed cowbird	-0.17	0.01	6	0.18	0.02	8	0.06	0.01	7
Bullock's oriole	0.3	0.33	7	–	–	–	–	–	–
House finch	**-0.91**	0.17	14	0.28	0.03	14	0.09	0.08	11
Lesser goldfinch	-0.35	0.02	13	0.38	0.07	5	–	–	–

[A]Slope without lettering = p-value > 0.05.
[B]Sample sizes are 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.
[C]Significant trend; p-value ≤ 0.001. Positive trends also appear in green. Negative trends appear in red.
[D]Significant trend; p-value ≤0.01. Positive trends also appear in green. Negative trends appear in red.
[E]Significant trend; p-value ≤ 0.05. Positive trends also appear in green. Negative trends appear in red.

3.2 Pipe Spring National Monument summary

In 2021 we completed all four point count surveys and the area search in Pipe Spring National Monument. We detected a total of 118 individuals of 34 species during surveys in the monument (Table 3-3). For the first time in this monitoring program we detected greater roadrunner (*Geococcyx californianus*) and ruby-crowned kinglet (*Regulus calendula*) in Pipe Spring National Monument. Sample sizes were too low for density trends to be estimated for the monument.

Table 3-3. Number of individuals detected during point counts and area searches in Pipe Spring National Monument, 2009–2021. Surveys were not conducted in Pipe Spring National Monument in 2016 or 2020.

Species	Point counts		Area searches		Total
	2009–2019	2021	2009–2019	2021	
Mallard	0	0	1	0	1
Mallard (domestic)	0	0	10	0	10
Gambel's quail	48	0	39	3	90
Black-crowned night-heron	1	0	11	1	13
Cooper's hawk	1	0	1	1	3
Red-tailed hawk	1	0	2	0	3
Eurasian collared-dove	52	0	85	0	137
Mourning dove	27	4	46	4	81
Greater roadrunner	0	0	0	1	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	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	1	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	28	1	25	1	55
Ash-throated flycatcher	28	4	21	3	56
Cassin's kingbird	56	0	36	0	92
Western kingbird	43	0	39	1	83
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	0	26	2	67
Violet-green swallow	14	16	67	2	99
Northern rough-winged swallow	9	2	5	1	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	23	1	4	0	28
Canyon wren	2	0	1	0	3
House wren	2	0	1	1	4
Bewick's wren	20	1	32	1	54
Blue-gray gnatcatcher	7	1	4	1	13
Ruby-crowned kinglet	0	0	0	1	1

Table 3-3 (continued). Number of individuals detected during point counts and area searches in Pipe Spring National Monument, 2009–2021. Surveys were not conducted in Pipe Spring National Monument in 2016 or 2020.

Species	Point counts		Area searches		Total
	2009–2019	2021	2009–2019	2021	
American robin	3	0	0	0	3
Northern mockingbird	29	0	5	0	34
Sage thrasher	1	0	0	0	1
European starling	26	1	91	1	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	0	2	3	4	9
Yellow warbler	12	0	49	11	72
Yellow-rumped warbler	2	0	3	1	6
Black-throated gray warbler	4	1	1	1	7
Wilson's warbler	0	0	3	5	8
Yellow-breasted chat	0	0	1	1	2
Green-tailed towhee	2	1	5	1	9
Spotted towhee	6	0	0	0	6
Chipping sparrow	1	0	1	0	2
Brewer's sparrow	5	0	1	2	8
Lark sparrow	1	0	22	0	23
Black-throated sparrow	97	1	47	2	147
Lincoln's sparrow	0	0	1	0	1
White-crowned sparrow	22	2	60	7	91
Summer tanager	1	0	0	0	1
Western tanager	3	0	7	0	10
Black-headed grosbeak	6	1	10	0	17
Blue grosbeak	5	0	5	0	10
Lazuli bunting	2	0	6	1	9
Red-winged blackbird	1	0	0	0	1
Western meadowlark	2	0	0	1	3
Yellow-headed blackbird	1	0	1	0	2
Brown-headed cowbird	16	0	18	0	34
Bullock's oriole	31	2	28	3	64
House finch	134	4	99	6	243
Pine siskin	2	0	31	0	33
Lesser goldfinch	10	0	10	1	21
House sparrow	8	0	53	0	61
Total	900	45	1093	73	1993

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 16-year population-density trends within low-elevation riparian, pinyon-juniper, and sagebrush shrubland habitats for 61 species (a total of 117 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 117 trend estimates, eight were significant. Six of these eight were negative trends (mourning dove [*Zenaida macroura*] in low-elevation riparian and pinyon-juniper, white-throated swift [*Aeronautes saxatalis*] in low-elevation riparian and pinyon-juniper, rock wren [*Salpinctes obsoletus*] in low-elevation riparian and sagebrush shrubland) and two were positive trends (vesper sparrow [*Pooecetes gramineus*] in pinyon-juniper and lark sparrow in sagebrush shrubland). 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 the 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 enable 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.

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 m 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. Springer, New York.

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. 2020. Landbird monitoring protocol narrative for park units in the Northern Colorado Plateau Network: Version 1.04. Natural Resource Report NPS/NCPN/NRR—2020/2119. 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. RS/GIS Laboratory, Utah State University, Logan.

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. Elsevier/Academic Press, Burlington, Massachusetts.

Miller, R. F., and P. E. Wigand. 1994. Holocene changes in semiarid pinyon-juniper woodlands. BioScience 44:465–474.

R Core Team. 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.

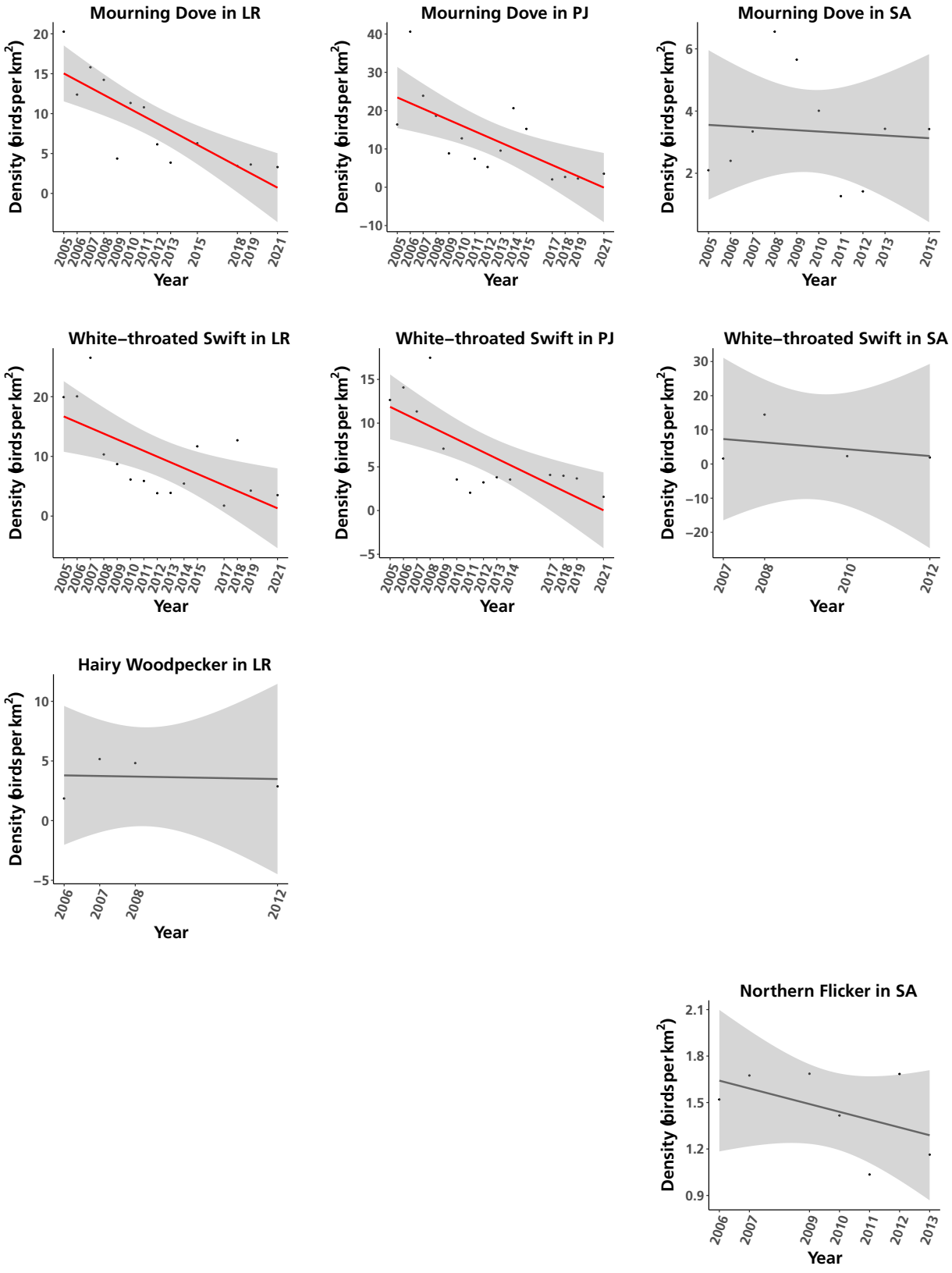
Sauer, J. R., J. E. Fallon, and R. Johnson. 2003. Use of North American Breeding Bird Survey data to estimate population change for bird conservation regions. The Journal of Wildlife Management 67:372–389.

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.

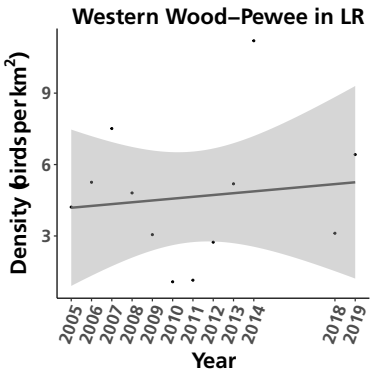
Appendix A. Density Trends by Species and Habitat

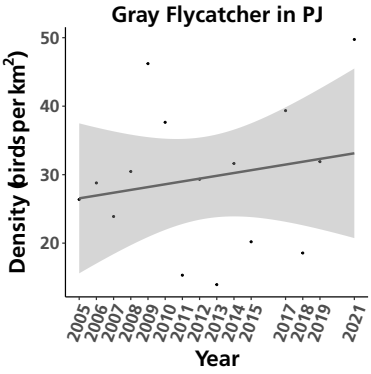
Graphics on the following pages show trend lines for species and habitats as shown in Table 3-2 (LR = low-elevation riparian, PJ = pinyon-juniper, SA = sage shrubland). Red lines indicate significant trends from a simple linear regression model.

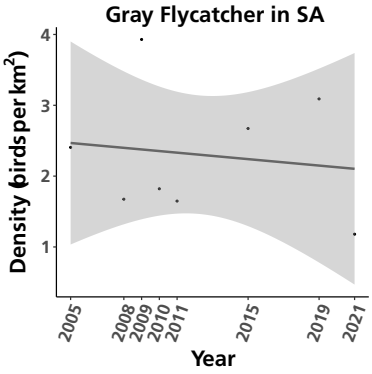
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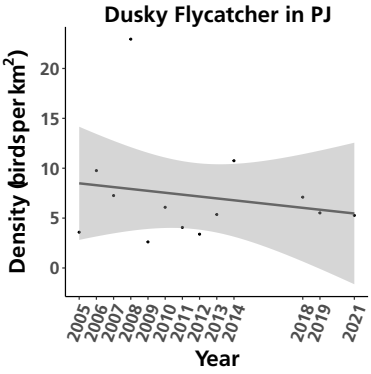


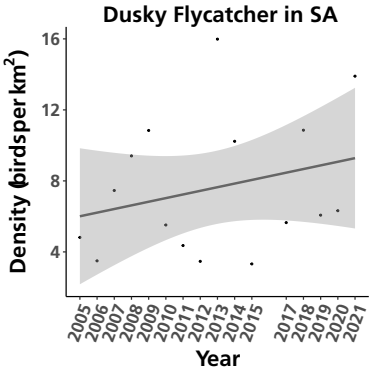
Trend lines for species and habitats as shown in Table 3-2.

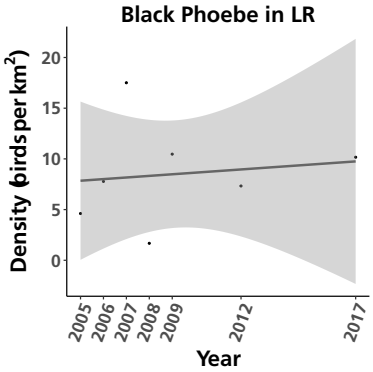




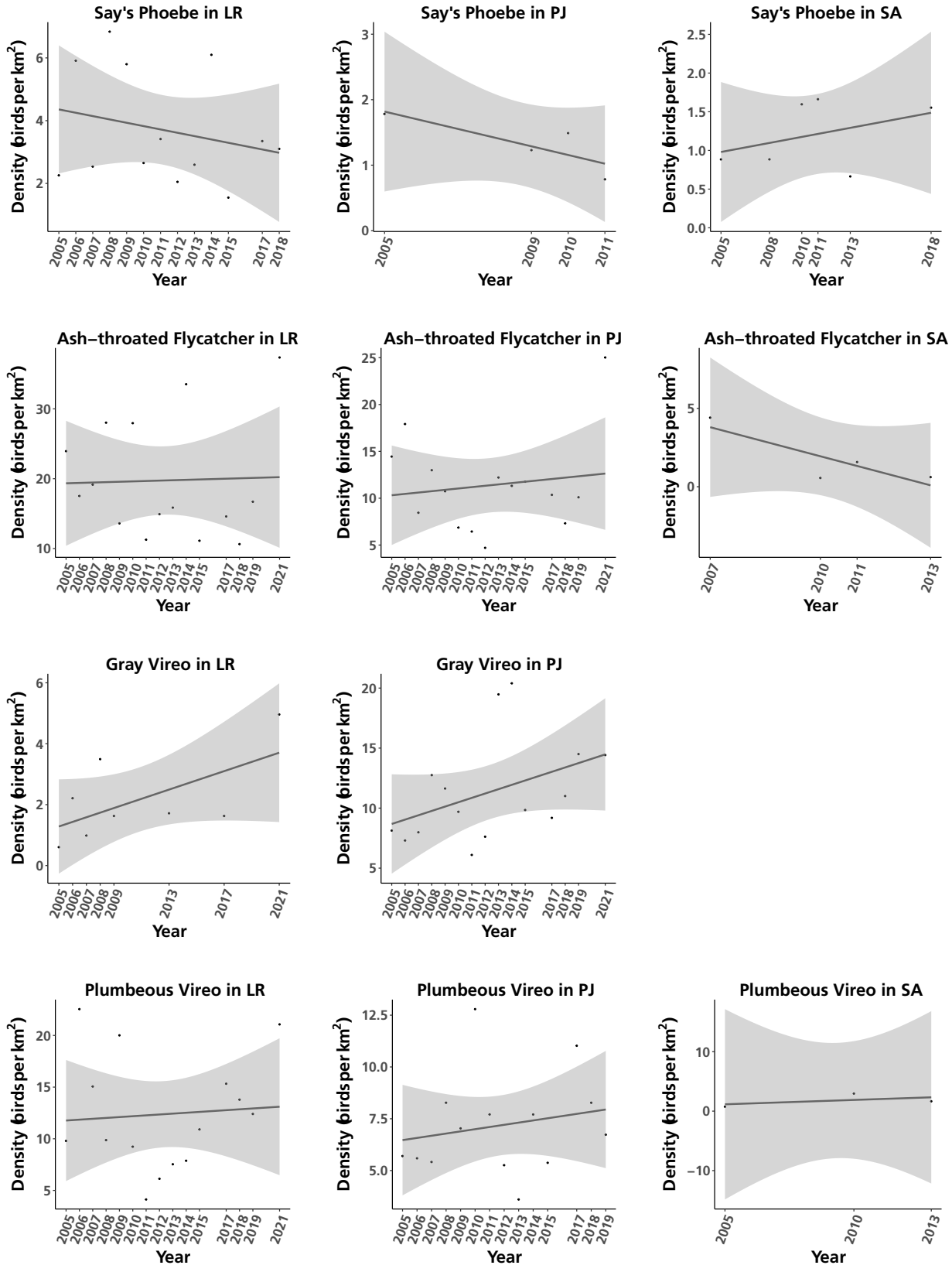




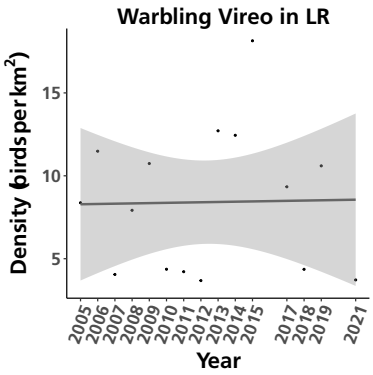


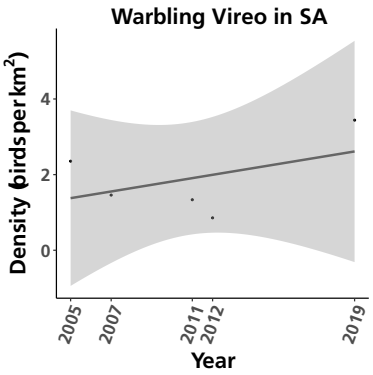


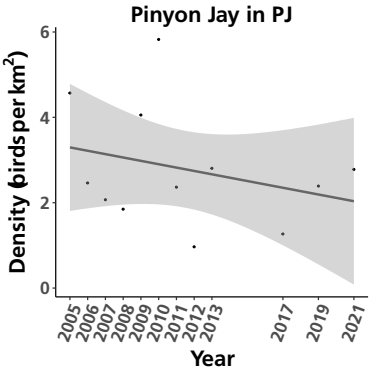
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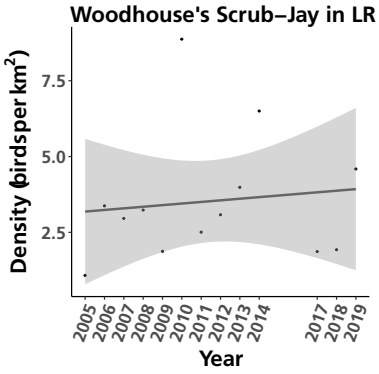


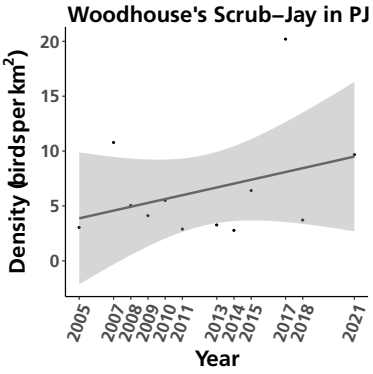
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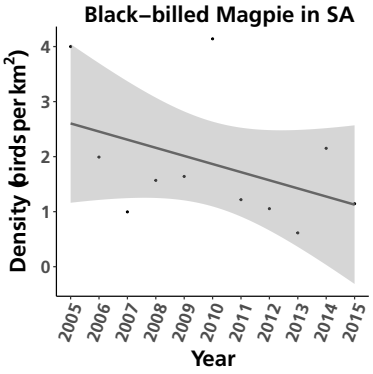




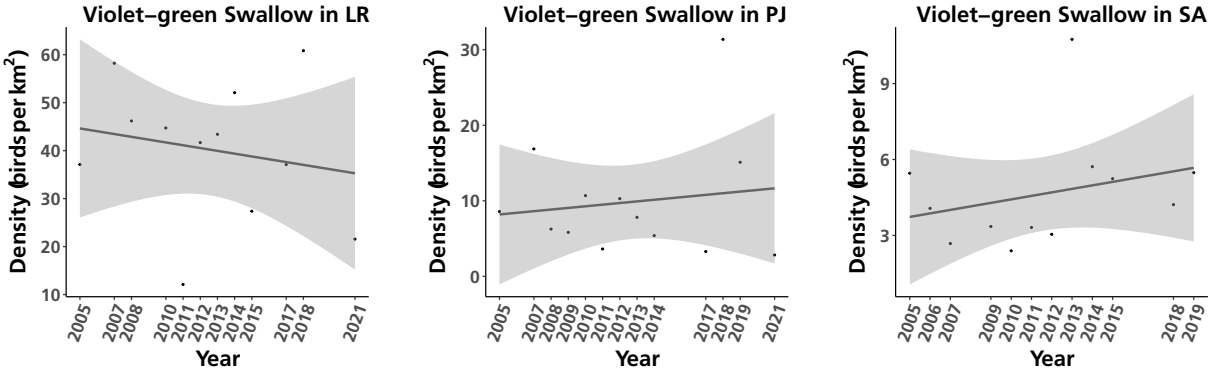


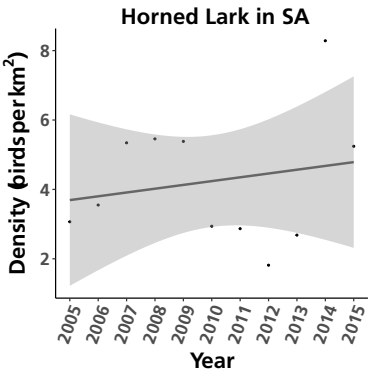


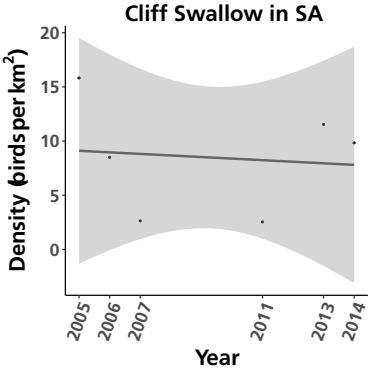


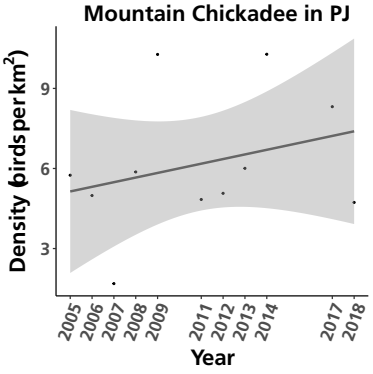


Trend lines for species and habitats as shown in Table 3-2.

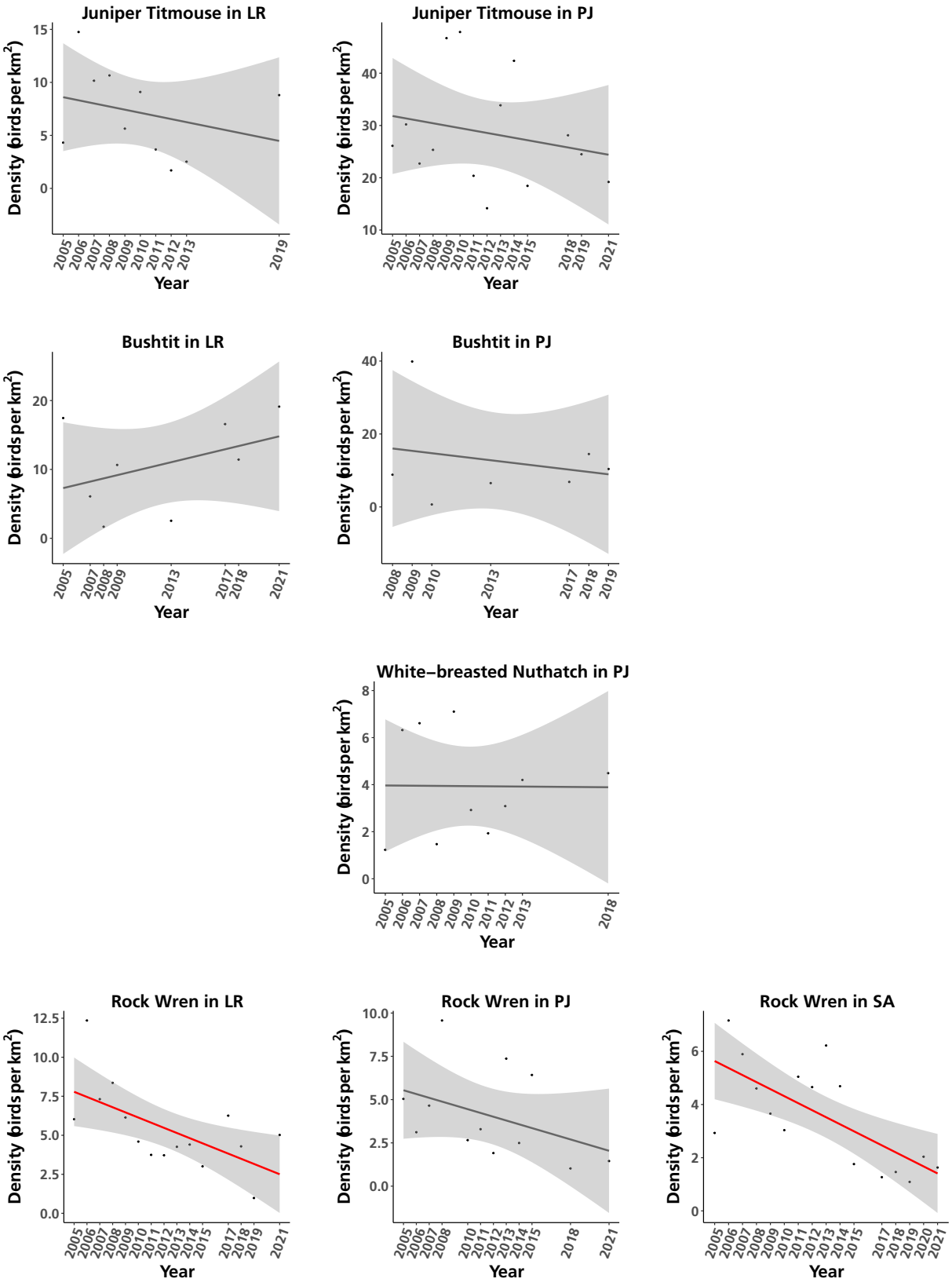




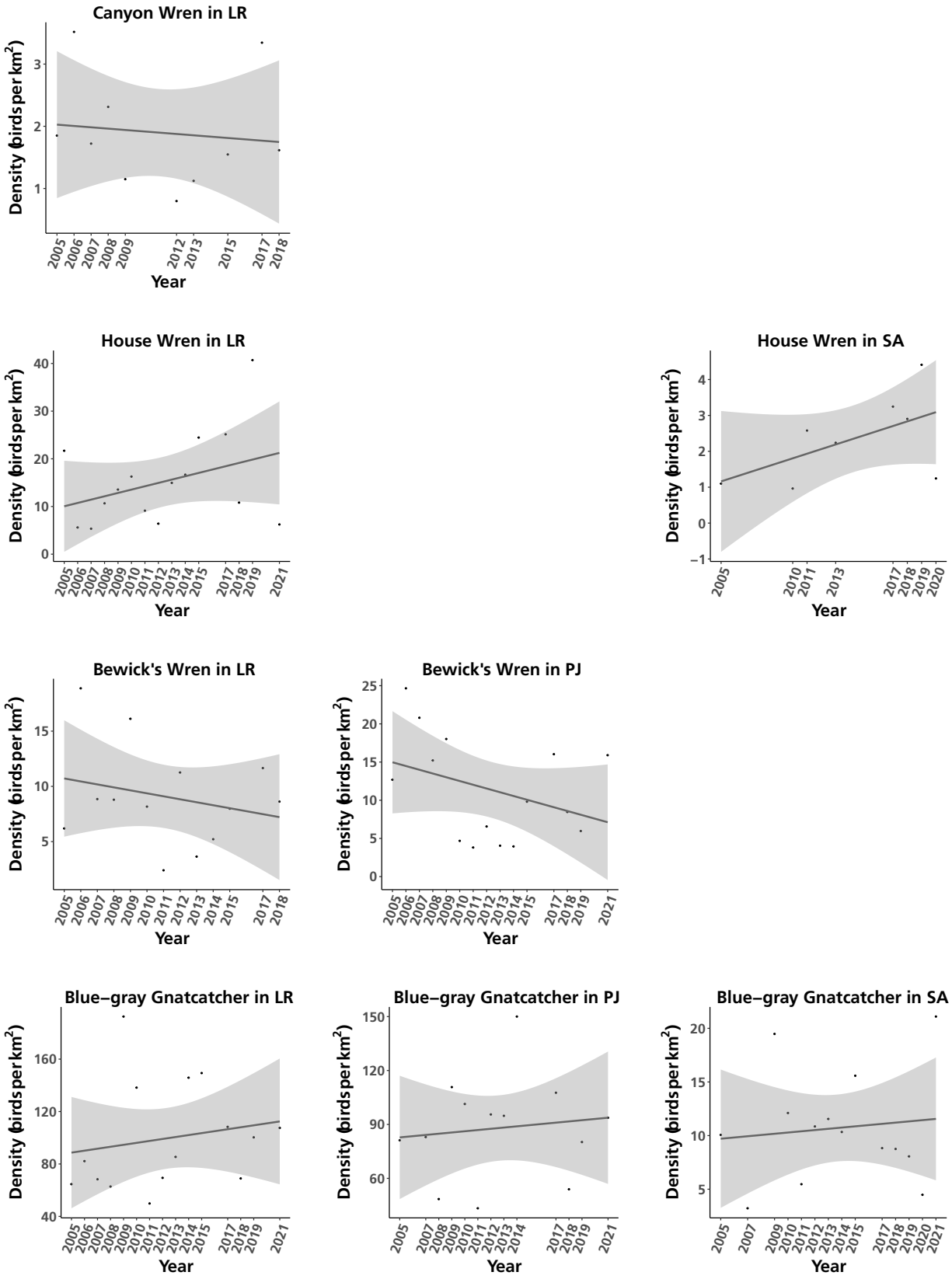




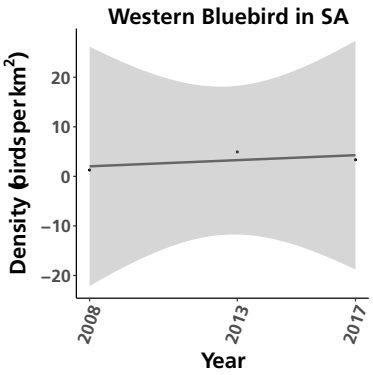
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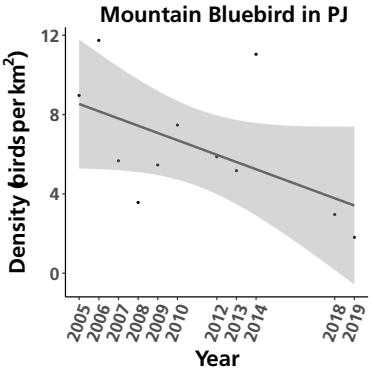


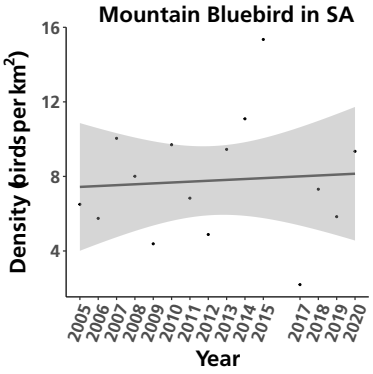
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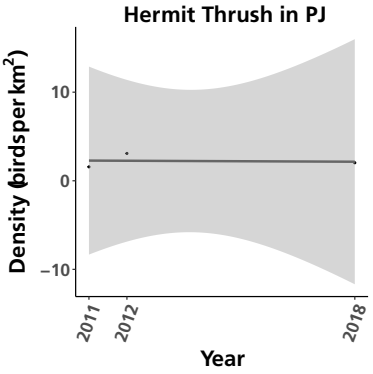


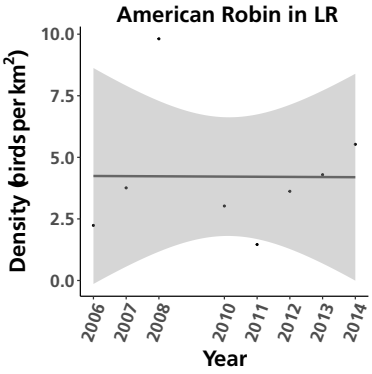
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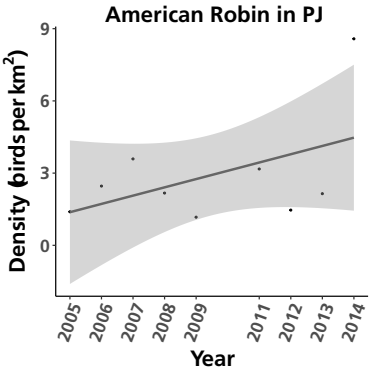


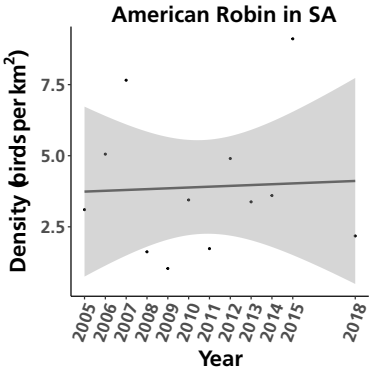




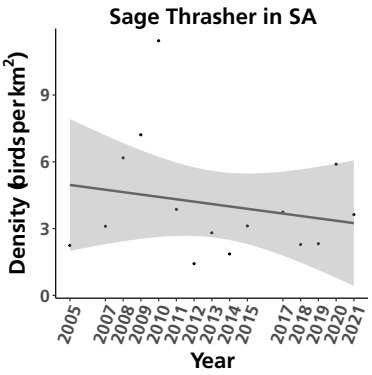


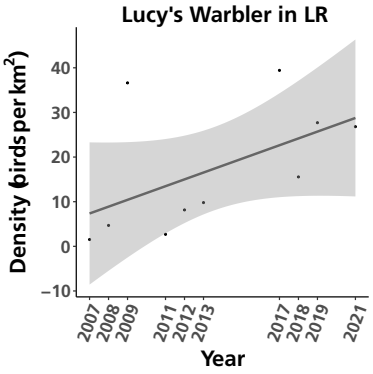


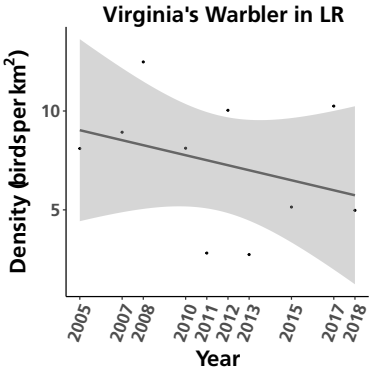


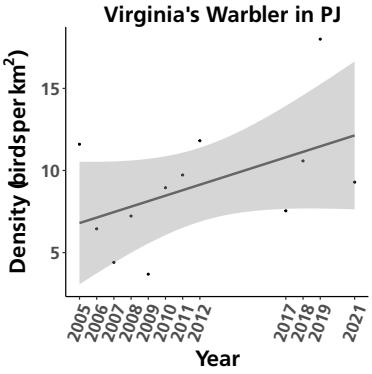


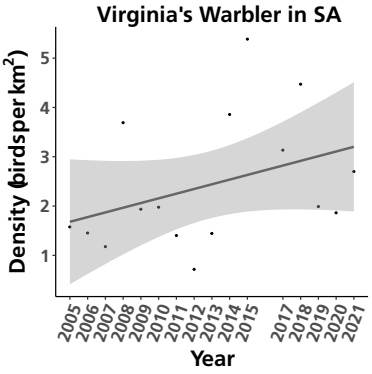
Trend lines for species and habitats as shown in Table 3-2.

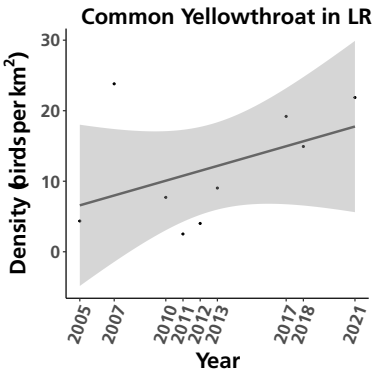




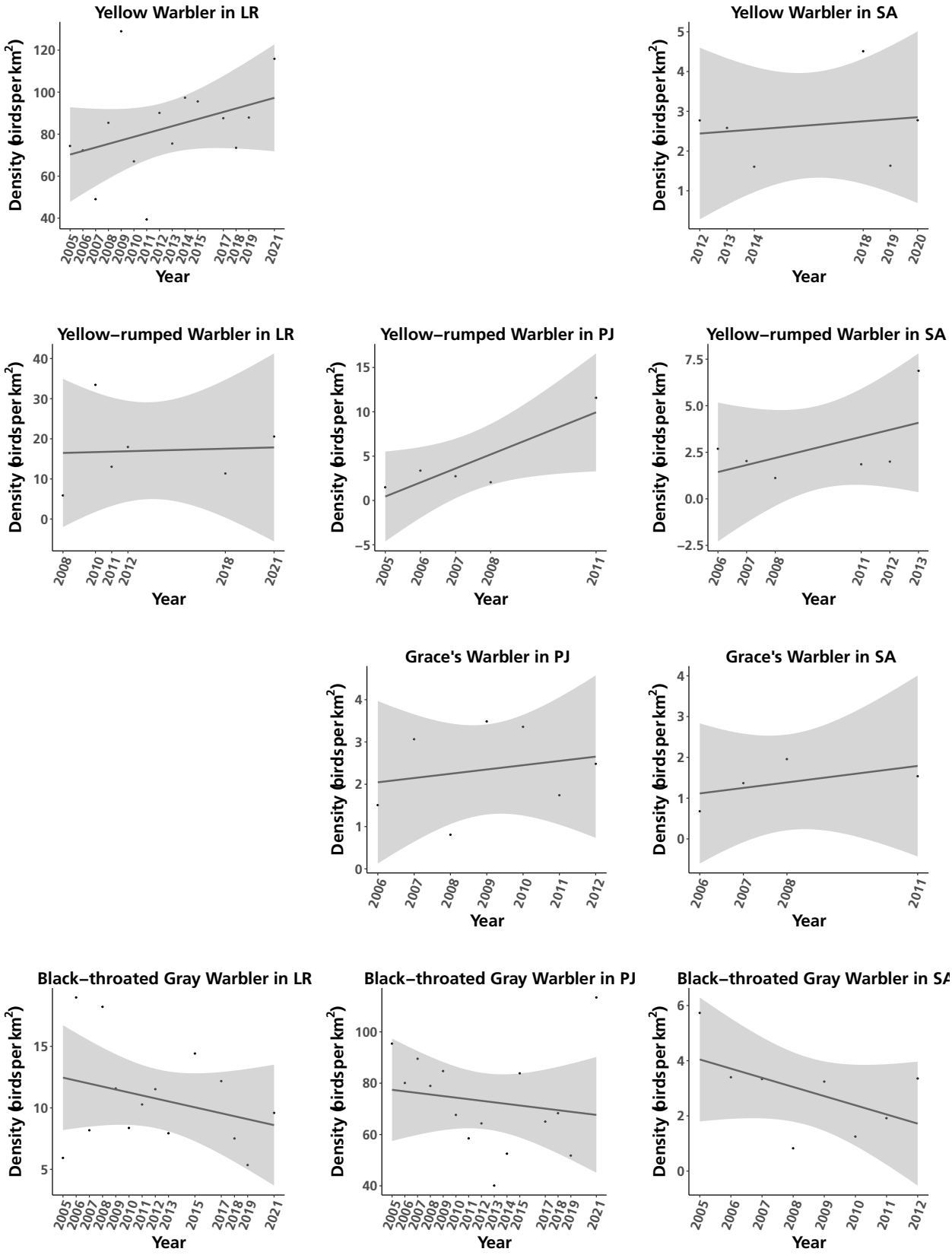




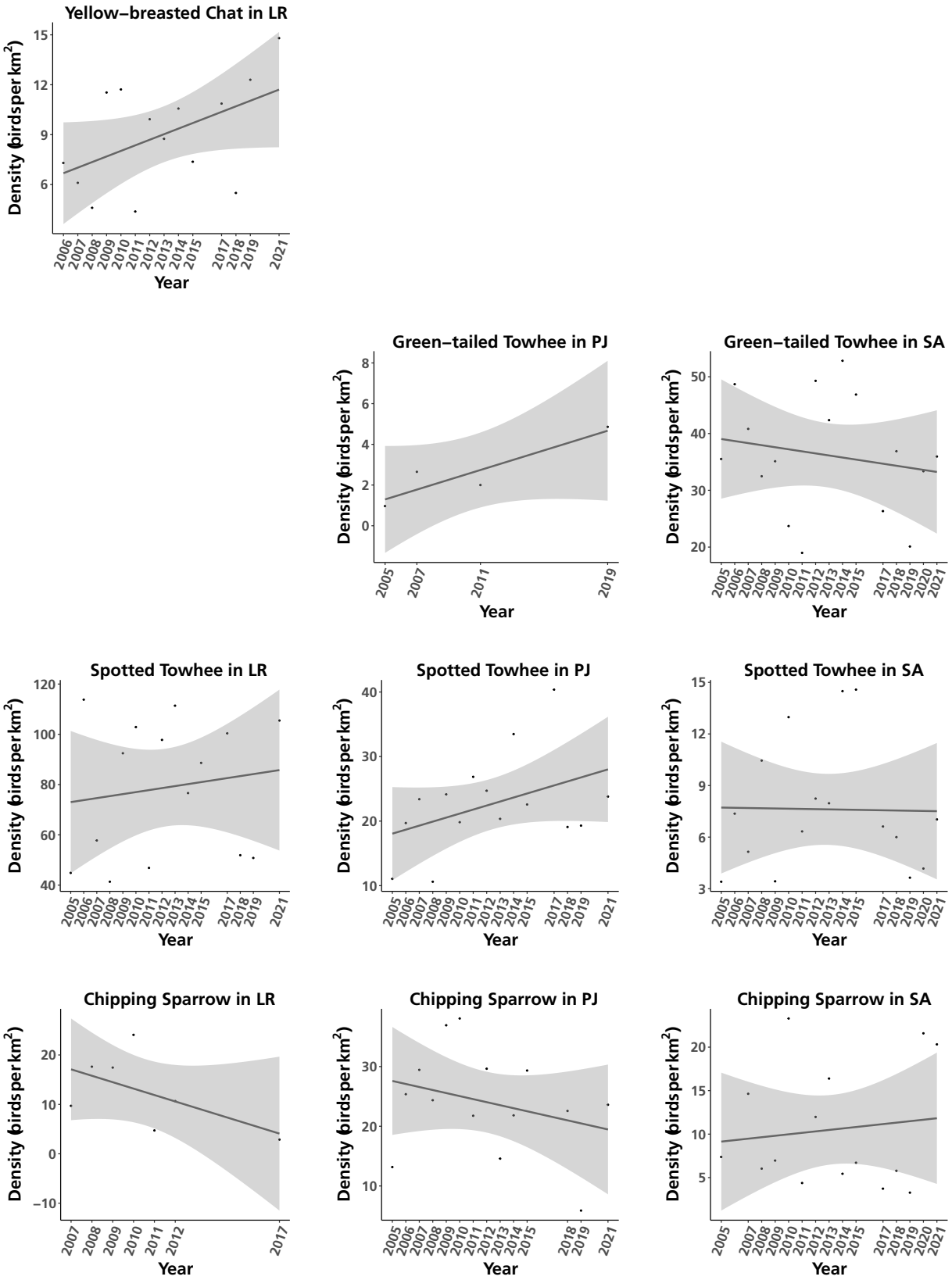




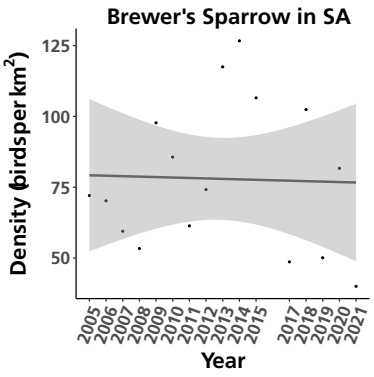
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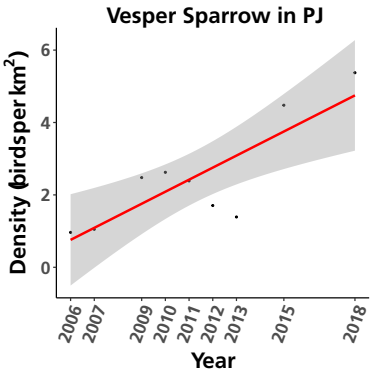


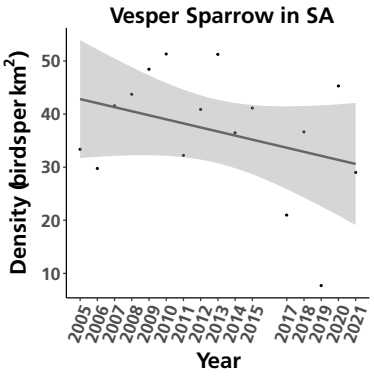
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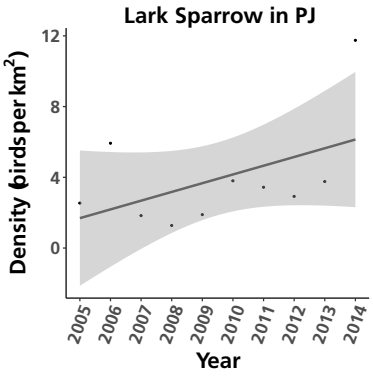


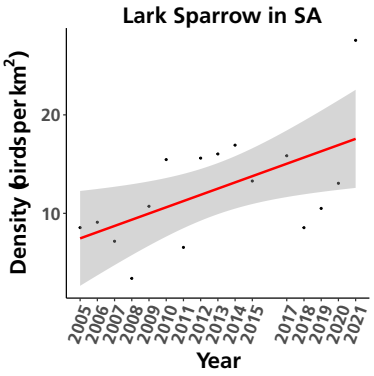
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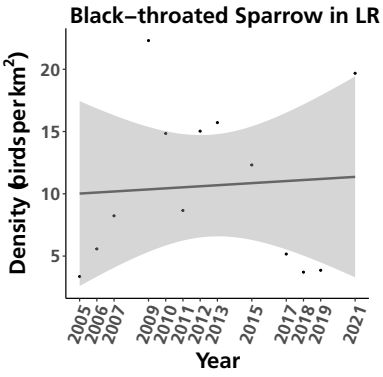


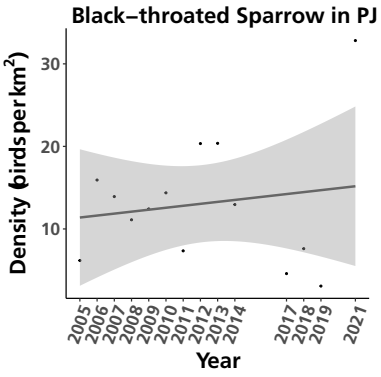


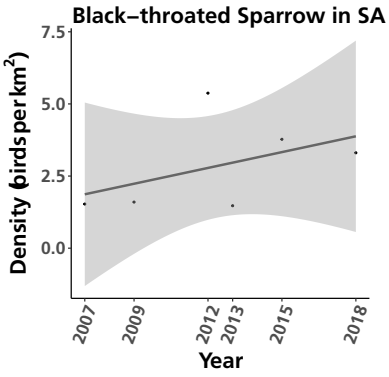




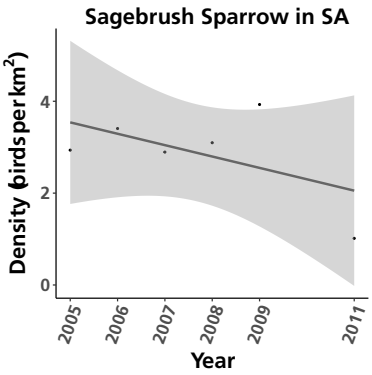


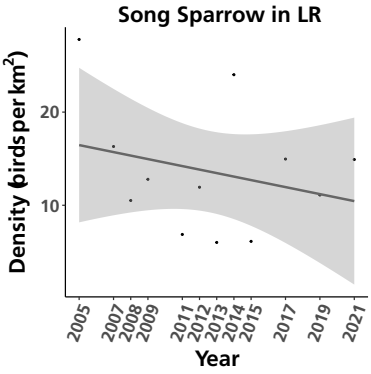


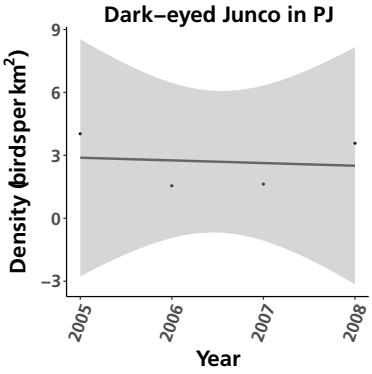


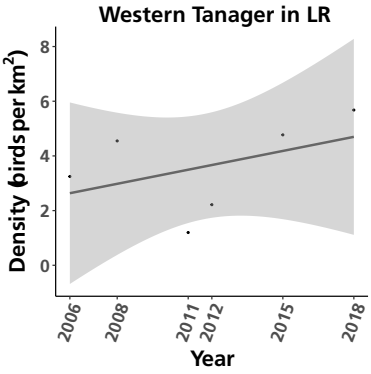


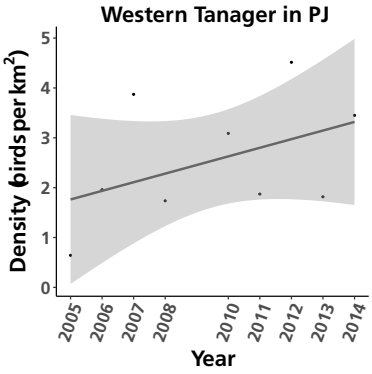
Trend lines for species and habitats as shown in Table 3-2.

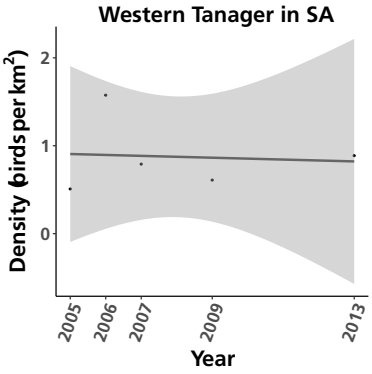




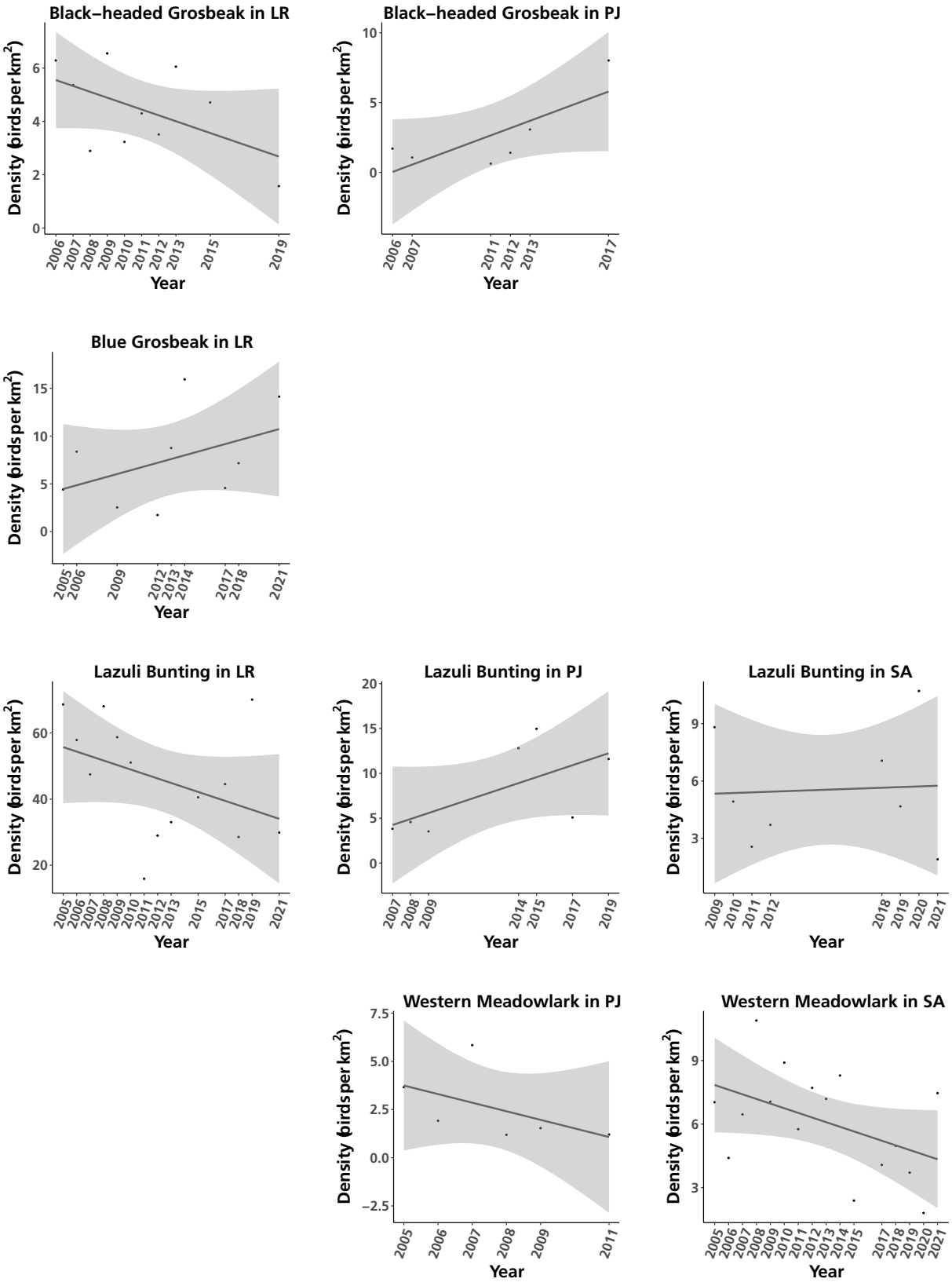




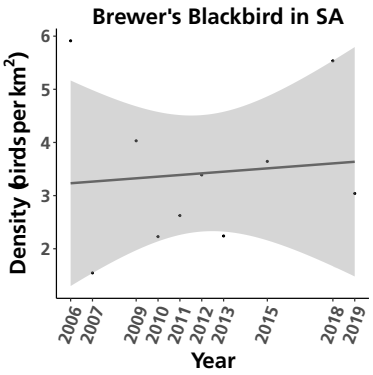


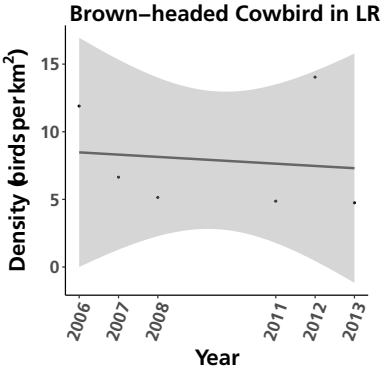


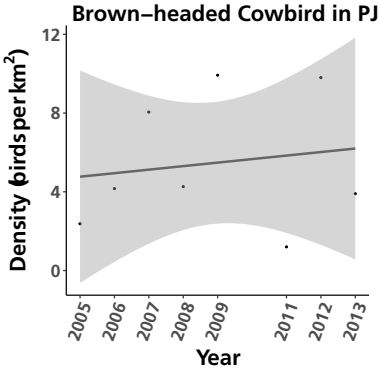
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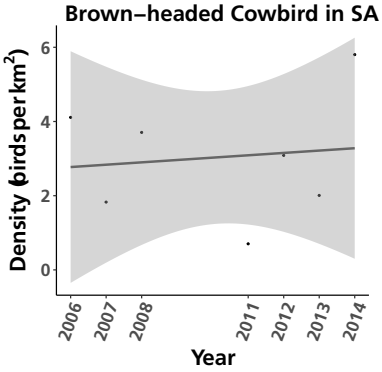


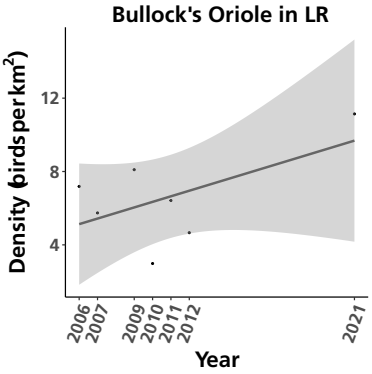
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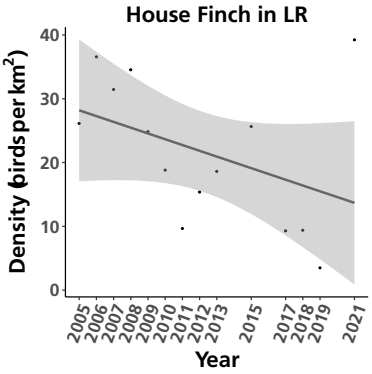


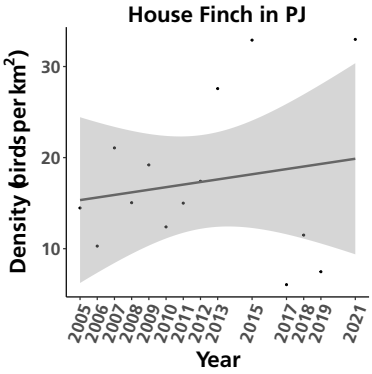


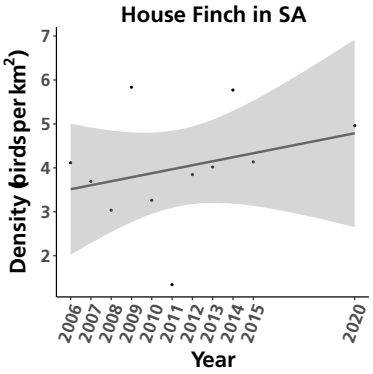




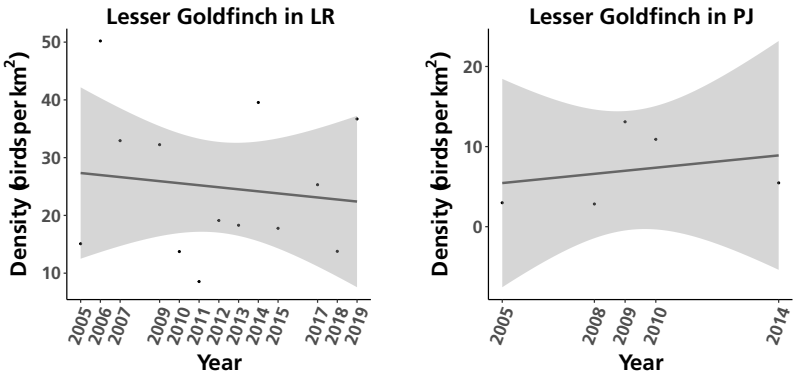








Trend lines for species and habitats as shown in Table 3-2.



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

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.

NPS 968/182679, June 2022

National Park Service
U.S. Department of the Interior

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