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[1]Starting with Vol. 42 both issues were combined..

Cover Figure: John James Audubon's "Carolina Parakeets" which is a part of the permanent collection at the New York Historical Society.

Frontispiece. Green Jays (*Cyanocorax yncas*) were detected on 3 East Foundation ranches during both the non-breeding and breeding seasons. Artwork by Lynn Delvin.

BULLETIN OF THE

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TEN-YEAR POPULATION TRENDS OF LAND BIRDS ON THREE EAST FOUNDATION RANCHES IN SOUTH TEXAS

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ABSTRACT— Large ranches in South Texas, such as the ranches owned by the East Foundation, help preserve large continuous tracts of land, but few long-term non-game bird studies exist from the region. To address this gap, non-breeding and breeding bird surveys were conducted on East Foundation properties in South Texas annually from 2010 to 2020 to document species occurrence, richness, and abundance. Surveys were conducted on El Sauz, San Antonio Viejo, and Santa Rosa ranches. Non-breeding bird surveys were conducted from August–April through the use of transect surveys. During May and June, breeding bird point count surveys were conducted. Two-hundred and seven bird species were documented throughout the study period. However, only 51 non-breeding and 36 breeding bird species were detected frequently enough to establish population trends. For the 10-year study period, 99% of the 51 species analyzed from the non-breeding bird surveys and 94% of 36 species analyzed from the breeding bird surveys had stable or increasing population trends. The East Foundation ranches have a unique mix of avian species and vast diversity of landscape types due to their varying locations. Long-term monitoring captures the natural rise and fall of population trends through time, which can help land stewards make informed management decisions.

Texas has a diverse array of bird populations: according to the Texas Bird Records Committee, over 650 bird species have been recorded in Texas, about half of which are migratory (Texas Bird Records Committee 2020). Large ranches, such as the ranches owned by the East Foundation, help conserve large continuous tracts of land that are critical to the survival of birds especially during migration. However, few long-term bird studies exist from the ranchlands of South Texas. Short-term research studies of 3 to 5 years are common because they are often the product of a three-year grant cycle and follow the period for graduate students to complete theses or dissertations. However, these short-term studies can give a partial or misleading picture (Wiens 2016). If we only had data from a brief period when a population was low, we might infer that the population is always

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low and, therefore, potentially make inappropriate management recommendations. Long-term data sets of 10 years or longer are rare, yet such data can provide unique insights into population dynamics and processes (Wiens 2016). Most importantly, long-term data sets capture natural rise and fall of population trends through time, allowing land stewards to make informed management decisions.

To better understand the health of a complex ecosystem, it may be necessary to use an indicator species. Indicator species are species that are used as a proxy to monitor the health of an environment (Mekonen 2017). Bird species are good ecological indicators because they occur across a range of diverse habitats, are sensitive to environmental change, and can easily be monitored (Mekonen 2017). Similar to other wildlife, bird species are sensitive to habitat fragmentation and changing habitat quality (LaSorte and Boecklen 2005; Carrara and Vázquez 2010; Seymour and Dean 2010). Climate change has caused changes in bird distribution (Hitch and Leberg 2006; Miller-Rushing et al. 2008; Visser et al. 2009; Møller 2010; Saino et al. 2011). Climate data must be better incorporated into bird research to better predict the impacts of environmental changes (Bateman et al. 2016; Ortiz 2018). Many bird species are at a critical point concerning the sustainability of their populations. Wild bird populations are under threat from many factors related to climate change, habitat fragmentation, invasive species, and human-caused disturbance (Calvert et al. 2013). This has led to a crisis for all bird communities globally (Rosenberg et al. 2019). The East Foundation ranches are unique and relatively undisturbed, which allows us to study bird populations in a region with limited urbanization and habitat fragmentation.

Objectives—Non-breeding and breeding bird surveys were conducted on three East Foundation properties from 2010 to 2020. This study focused on the general trends of all species surveyed. The objectives of this paper include:

1. Determine avian abundance trends throughout the study period.
2. Determine if breeding bird populations on the ranches reflect national breeding bird survey trends.

For the first objective, we hypothesized that trends in avian abundance would fluctuate in response to annual precipitation within the 10-year period. For the second objective, we hypothesized that the trends seen in the local breeding populations would differ from the National Breeding Bird Survey conducted by the United States Geological Survey (USGS), due to local populations having access to large, contiguous tracts of ranch land.

METHODS

Study Area—We conducted the study on three ranches of the East Foundation, which operates six working cattle ranches across 87,000 ha of South Texas. The Foundation was created from the estate of Robert C. East in 2008, with the mission of advancing land stewardship through ranching, science, and education (East Foundation 2019).

We conducted bird surveys from 2010 to 2020 on El Sauz, San Antonio Viejo, and Santa Rosa ranches (Fig. 1). These three East Foundation ranches comprise 78,800 ha of rangeland. South Texas has a subtropical climate, with hot summers and moderate winters (Fulbright and Bryant 1993). Both El Sauz and Santa Rosa ranches are in the Gulf Prairies and Marshes ecoregion, while San Antonio Viejo Ranch is in the South Texas Plain (Texas Parks and Wildlife 1984). Several grasslands are present in the study area including the Coastal Sand Plain, the lower Coastal Prairie, the Kenedy Sand Prairie, and the Bordas Escarpment (Smeins et al. 1991).

El Sauz was the second-largest ranch totaling around 10,984 ha, located in Willacy and Kenedy Counties along the South Texas coast. The dominant plant species included seacoast bluestem (*Schizachyrium littorale*), gulf dune paspalum (*Paspalum monostachyum*), honey mesquite (*Prosopis glandulosa*), spiny hackberry (*Celtis ehrenbergiana*), live oak woods (*Quercus virginiana*), and both native and non-native grasses (Fulbright and Bryant 2003; Snelgrove et al. 2013).

San Antonio Viejo was the largest of the three ranches totaling around 60,638 ha, located near Hebbronville in Jim Hogg and Starr counties. The dominant plant species included honey mesquite, blackbrush (*Acacia rigidul*), spiny hackberry, and both native and non-native grasses (Snelgrove et al. 2013).

Santa Rosa was the smallest of the three ranches totaling around 7,545 ha. It is located in Kenedy

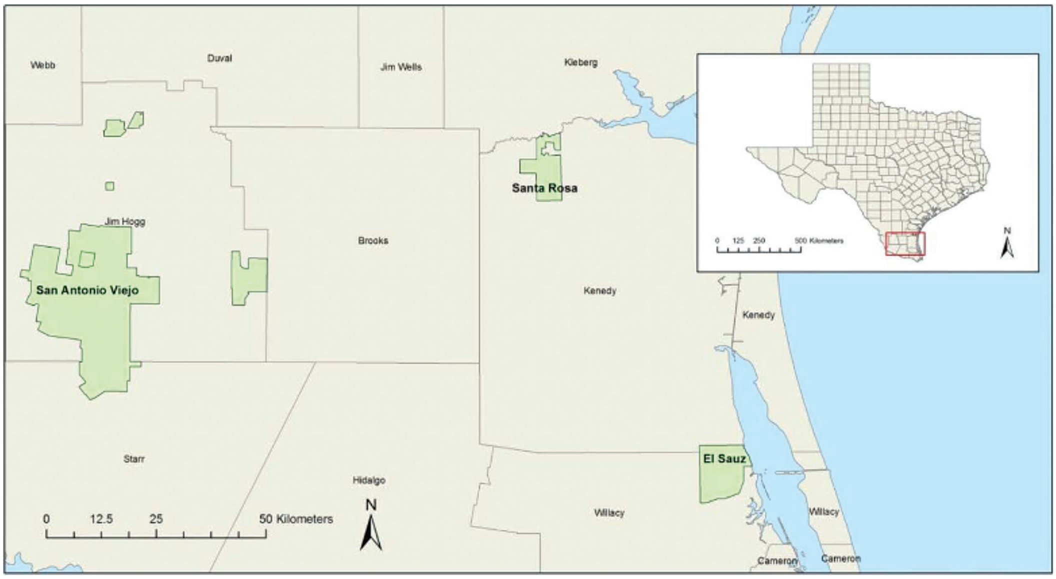

Figure 1. Map of East Foundation Properties

County (Snelgrove et al. 2013). The dominant plant species included honey mesquite, granjeno parks, live oak woods, and both native and non-native grasses (Fulbright and Bryant 2003; Snelgrove et al. 2013).

Non-breeding Bird Surveys—We conducted non-breeding bird survey transects from August to April (n = 3 transects at both El Sauz and Santa Rosa ranches, n = 5 transects at San Antonio Viejo Ranch). In 2010, transects were only surveyed for five months out of the year. (Lipschutz 2016). From 2011 on, we conducted surveys monthly.

We started the 500 m bird transects at the ranch road and walked east or west at a steady pace (Lipschutz 2016). We recorded the number and species of all birds seen and heard within a 200 m radius, estimated by the observer. We selected a 200 m radius due to the dense brush present on the ranches. Stopping along the transect was permitted, as was "pishing" to call in birds to confirm their identity. Transect surveys were conducted between sunrise and 1300 hours (Lipschutz 2016).

Breeding Bird Surveys—Survey routes and protocol were designed to mimic the official US Geological Service's North American Breeding Bird Survey (BBS) (USGS 2001). Routes chosen were 39.2 km long, with one point every 800 m totaling 50 points. While San Antonio Viejo Ranch was large enough to have 50 points neither Santa Rosa nor El Sauz ranches were. The number of points was reduced to 34 and 37 respectively to allow for the 800m distance between points.

Point count data were collected by authors and field technicians. A vehicle was used to travel from point to point. Once at a point, the observer recorded the number of individuals and species seen or heard in the habitat within the survey radius of 200 m (flyovers were included) during the 3-minute survey period, this was modified from the official BBS protocol due to the thick South Texas brush. Surveys started 30 minutes before sunrise and were to be completed within 6.5 hours. Routes were not surveyed in conditions of low visibility or with wind speeds greater than 4 on the Beaufort scale (13–18 mph/20–29 kph) as determined by environmental cues described by the Beaufort scale (Lipschutz 2016). The breeding bird survey was designed to serve as an index of avian abundance and diversity, not a complete count or estimate of density (USGS 2001).

Precipitation Data—Precipitation data were downloaded from the PRISM Climate Groups website (PRISM 2021) to determine annual precipitation for each year within the boundary of each of the ranches. Monthly precipitation values, in millimeters, were summed to get a total value for the year. July was excluded due to no surveys being conducted during this month.

Precipitation varied from 274 mm to 1091 mm on the coastal units (Santa Rosa and El Sauz ranches) to 264 mm to 785 mm in the drier inland unit of San Antonio Viejo Ranch (PRISM 2021).

Data Analysis—Each species' overall abundance was reported, as well as the species' relationship with annual precipitation. Despite supporting over 200 species across all three ranches, only 51 species during the non-breeding season and 36 species during the breeding season were detected frequently enough to establish trends throughout the study period. A species was defined as "frequent enough" if we detected individuals on at least 2 ranches in 5 out of 10 years of the project. This threshold was chosen to determine if trends were consistent across the region, i.e., a species was present on at least 2 ranches to be able to compare across the region and was detected at least 5 years to establish that the species was present on the ranches (and not a rare migrant).

To address the difference in the number of transects on each of the ranches, we standardized the data by dividing the total number of individuals of a species present on that ranch during that year by the number of transects on the ranch. For example, if there were 24 Northern Mockingbirds (*Mimus polyglottos*) recorded on El Sauz Ranch, the data would be standardized by dividing 24 by 3 transects. Doing this allows us to directly compare the ranches to each other. After standardization, the data was entered into Sigma Plot (Sigma Plot Version 14.6) and a graph was created. Once the graph was created, a trend line was fitted to the data and R^2, P-value (α = 0.05), and slope were calculated to determine if species trends were increasing, decreasing, or remaining stable. Significant P-values indicate that the slope of the trendline was different from zero.

A two-tailed, bivariate correlation was used to compute a Spearman's correlation coefficient to determine at what level species trends and annual precipitation were related. Spearman's correlation coefficient was chosen over Pearson's due to the data not being normally distributed. This process was completed using IBM's SPSS Statistics software (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp).

Each of the breeding bird species' trend results were descriptively compared to the North American Breeding Bird Survey trend results for Texas from 2010-2020 (Sauer et al. 2019). The USGS Patuxent Wildlife Research Center states that if zero falls outside of the 95% credible interval for the trend estimate then the trend result could be judged significant (Sauer et al. 2019).

RESULTS

Non-Breeding Bird Survey Trends

We detected 40,753 individual birds from 207 species during 601 non-breeding bird surveys over the 10-year study period. Fifty-one species were detected frequently enough on the non-breeding surveys to establish trends.

On El Sauz Ranch, the abundance of 43 species (84%) remained stable, 7 species (14%) had a significant increasing trend (Blue-gray Gnatcatcher, Crested Caracara, Field Sparrow, Green Jay, Killdeer, Lark Sparrow, and Olive Sparrow), one species (1%) had a significant decreasing trend (Cassin's Sparrow), and one species (1%) was not detected on the transects (Loggerhead Shrike). Of the 7 species that experienced a significant increasing trend, 3 were ground foragers, one was a mid-sized foliage gleaner, one was a scavenger, and one was a small-foliage gleaner. The species with a decreasing trend was a ground forager.

On the San Antonio Viejo Ranch transects, the abundance of 43 species (84%) remained stable, 8 species (16%) had a significant increasing trend (Couch's Kingbird, Golden-fronted Woodpecker, Green Jay, Harris's Hawk, Lark Sparrow, Lincoln's Sparrow, Northern Cardinal, and Red-tailed Hawk), zero species had a significant decreasing trend, and 2 species (4%) were not detected (Black-bellied Whistling-Duck and Black Vulture). Of the 8 species that experienced a significant increasing trend one was an aerial forager, one was a bark forager, 3 were ground foragers, one was a mid-sized foliage gleaner, and 2 were raptors.

On Santa Rosa Ranch, the abundance of 36 species (71%) remained stable, 15 species (29%) had a significant increasing trend (American Kestrel, Black-bellied Whistling-Duck, Blue-gray Gnatcatcher, Cassin's Sparrow, Crested Caracara, Grasshopper Sparrow, House Wren, Lark Sparrow, Long-billed Thrasher, Northern Cardinal, Northern Mockingbird, Olive Sparrow, Pyrrhuloxia, Red-tailed Hawk, and Wild Turkey), no species had a significant decreasing trend, and one species (1%) was not detected on the ranch (Cactus Wren). Of the 15 species that experienced an increasing trend one was a dabbler, 9 were ground foragers, 2 were raptors, one was a scavenger, and 2 were small-foliage gleaners.

The following section explains the details of the non-breeding survey data for each species organized by foraging strategy (Figs. 2 – 55). The figures display a trend line fitted to the average number of individuals detected per transect per year. Using a consistent scale across all graphs masked some of the variability, thus, to better illustrate the trends on each of the ranches, the scale may not be the same. Species are listed alphabetically by common name within each foraging strategy.

Aerial Diver.—Loggerhead Shrikes (Lanius ludovicianus) (Fig. 2) averaged 1 to 2 individuals per transect on San Antonio Viejo Ranch (Fig. 2a) and Santa Rosa Ranch (Fig. 2b) during the non-breeding season. However, they were not detected

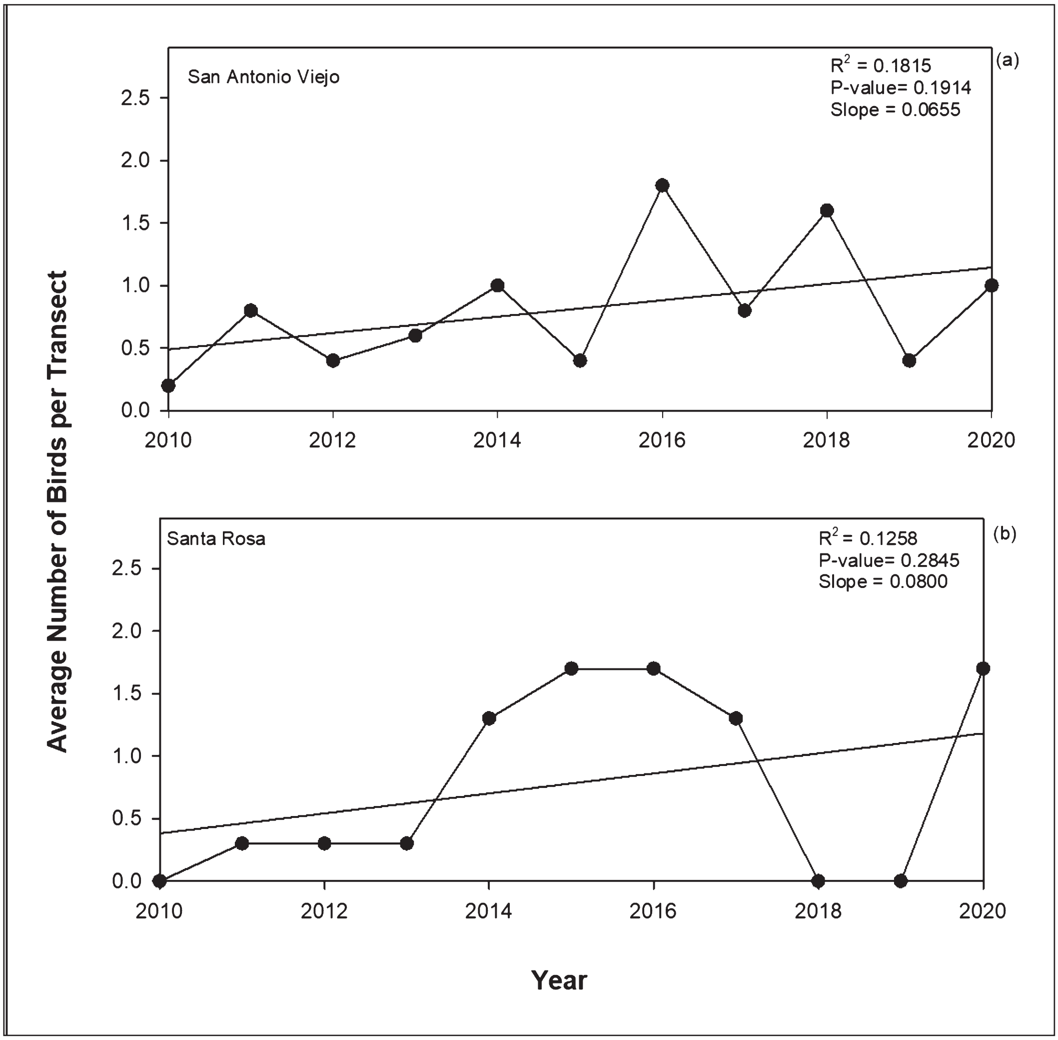

Figure 2. Non-breeding populations of Loggerhead Shrike on East Foundation ranches from 2010-2020.

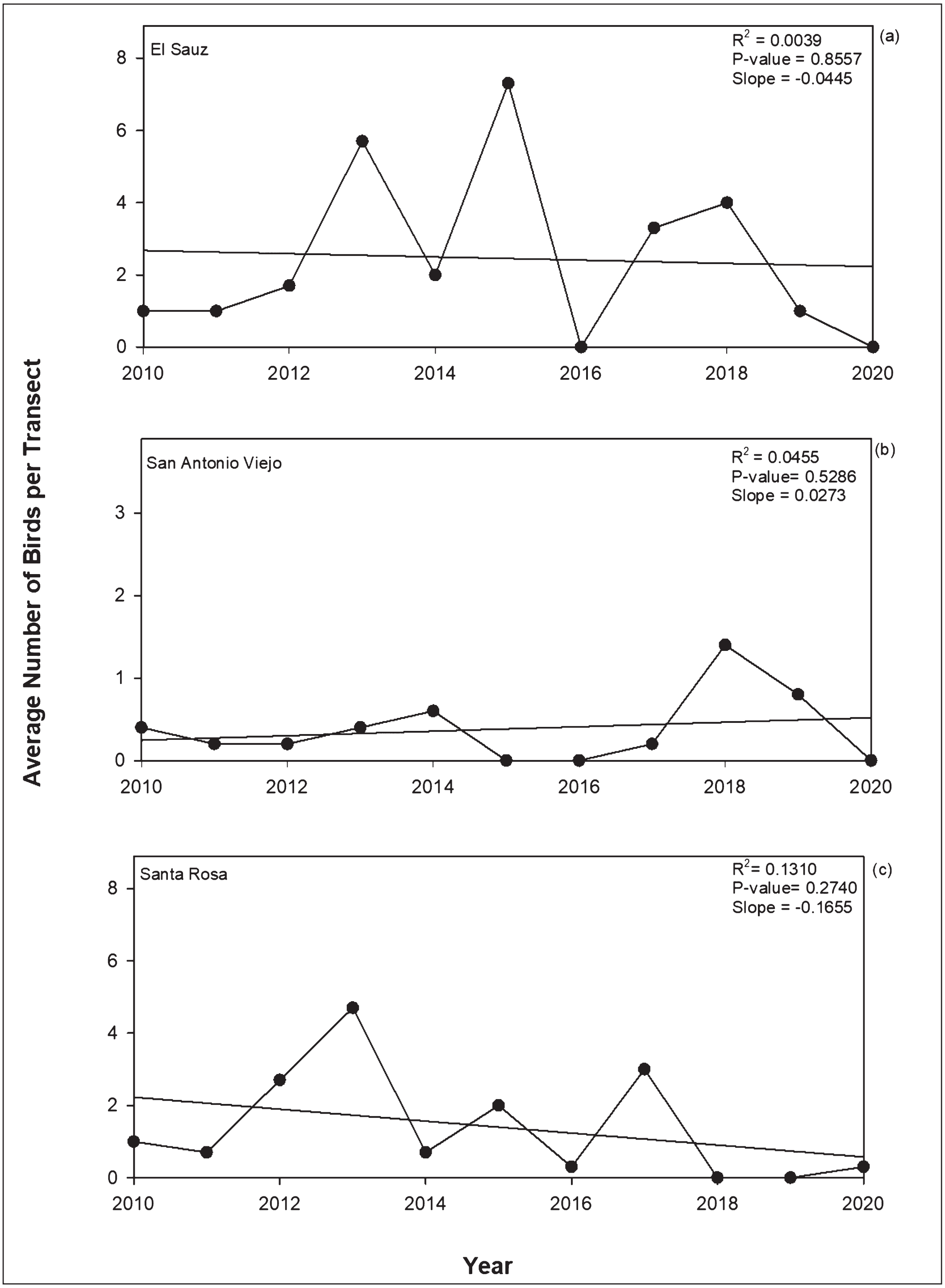

Figure 3. Non-breeding populations of Brown-crested Flycatcher on East Foundation ranches from 2010-2020.

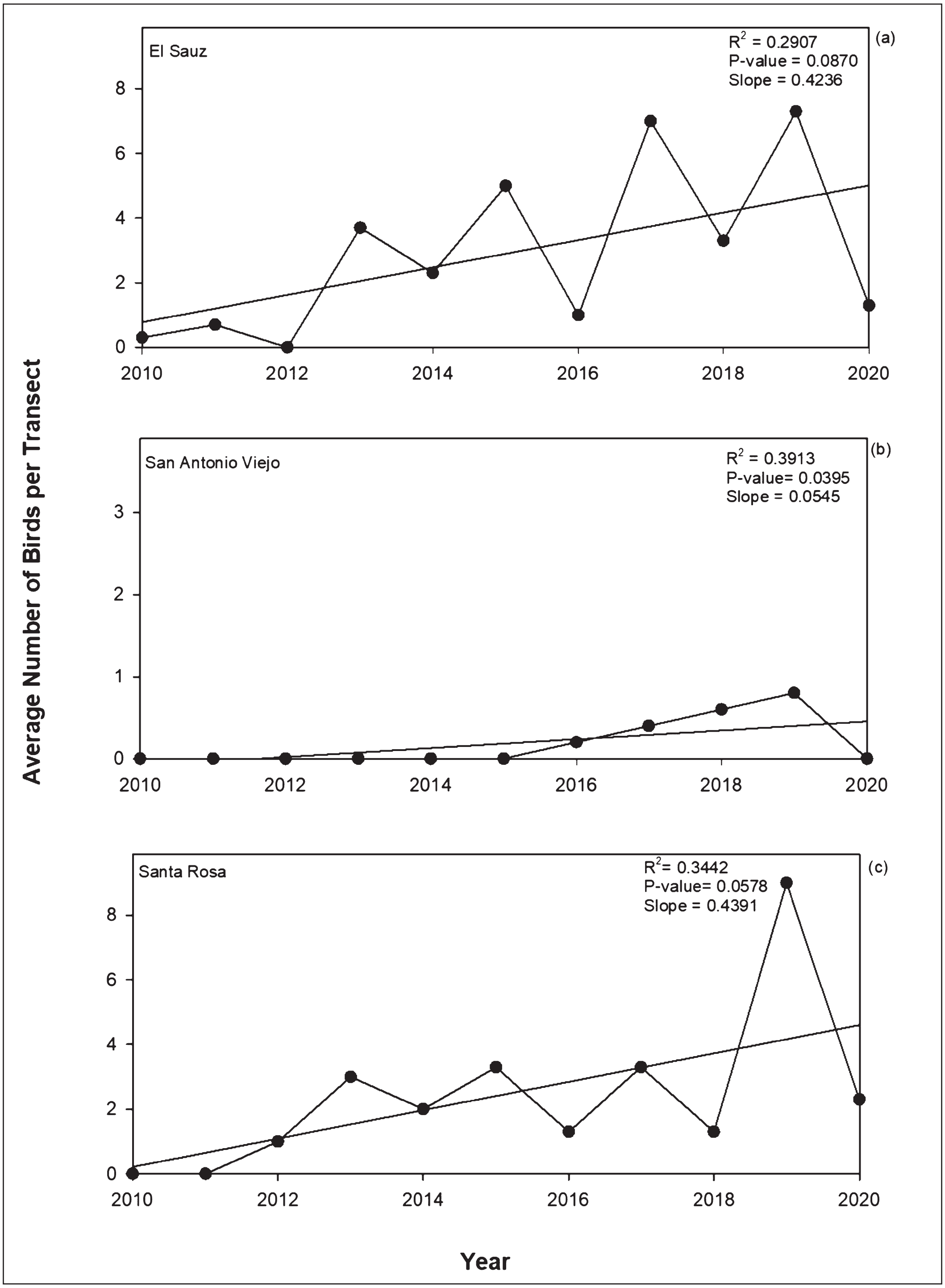

Figure 4. Non-breeding populations of Couch's Kingbird on East Foundation ranches from 2010-2020.

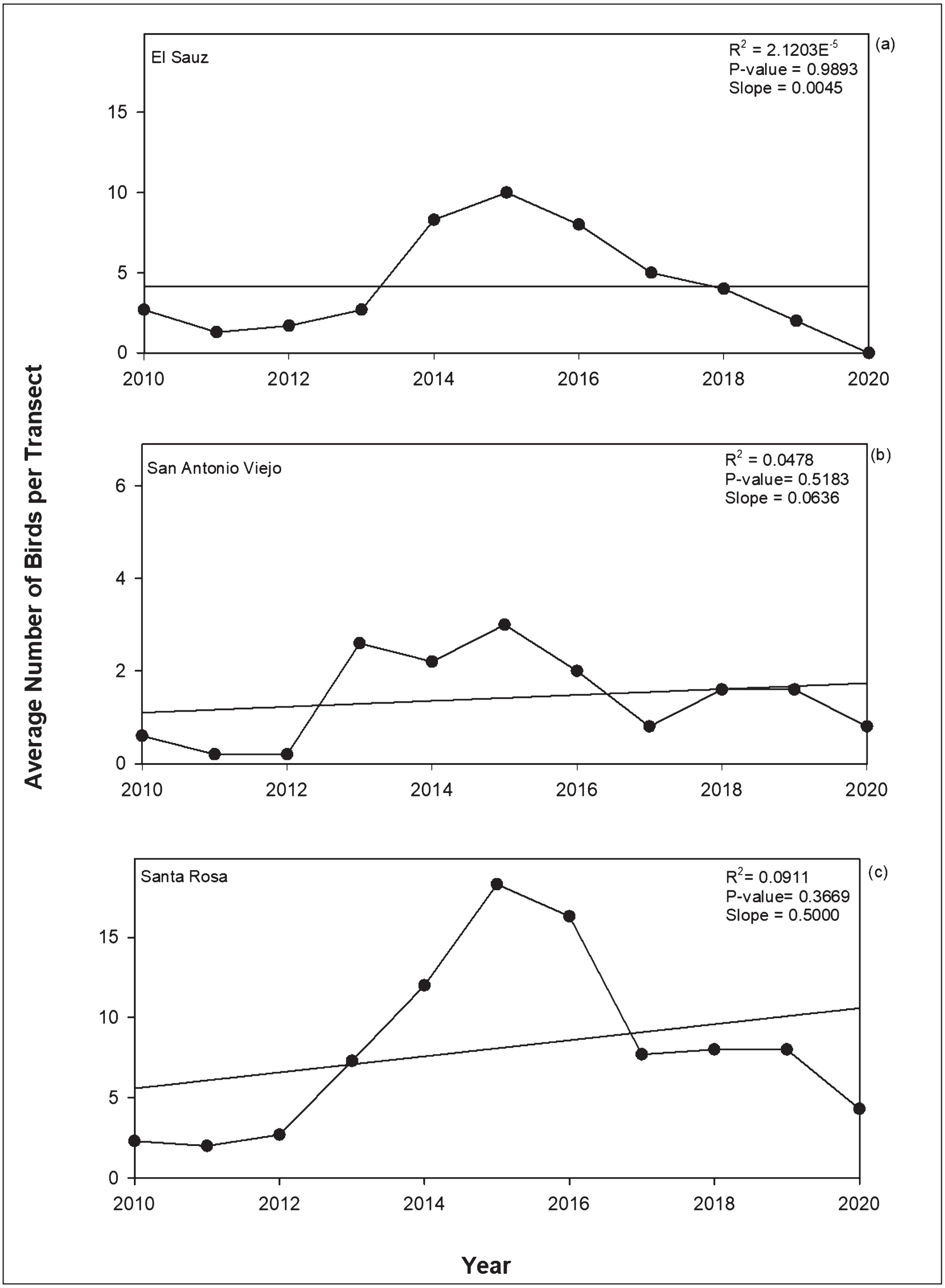

Figure 5. Non-breeding populations of Eastern Phoebe on East Foundation ranches from 2010-2020.

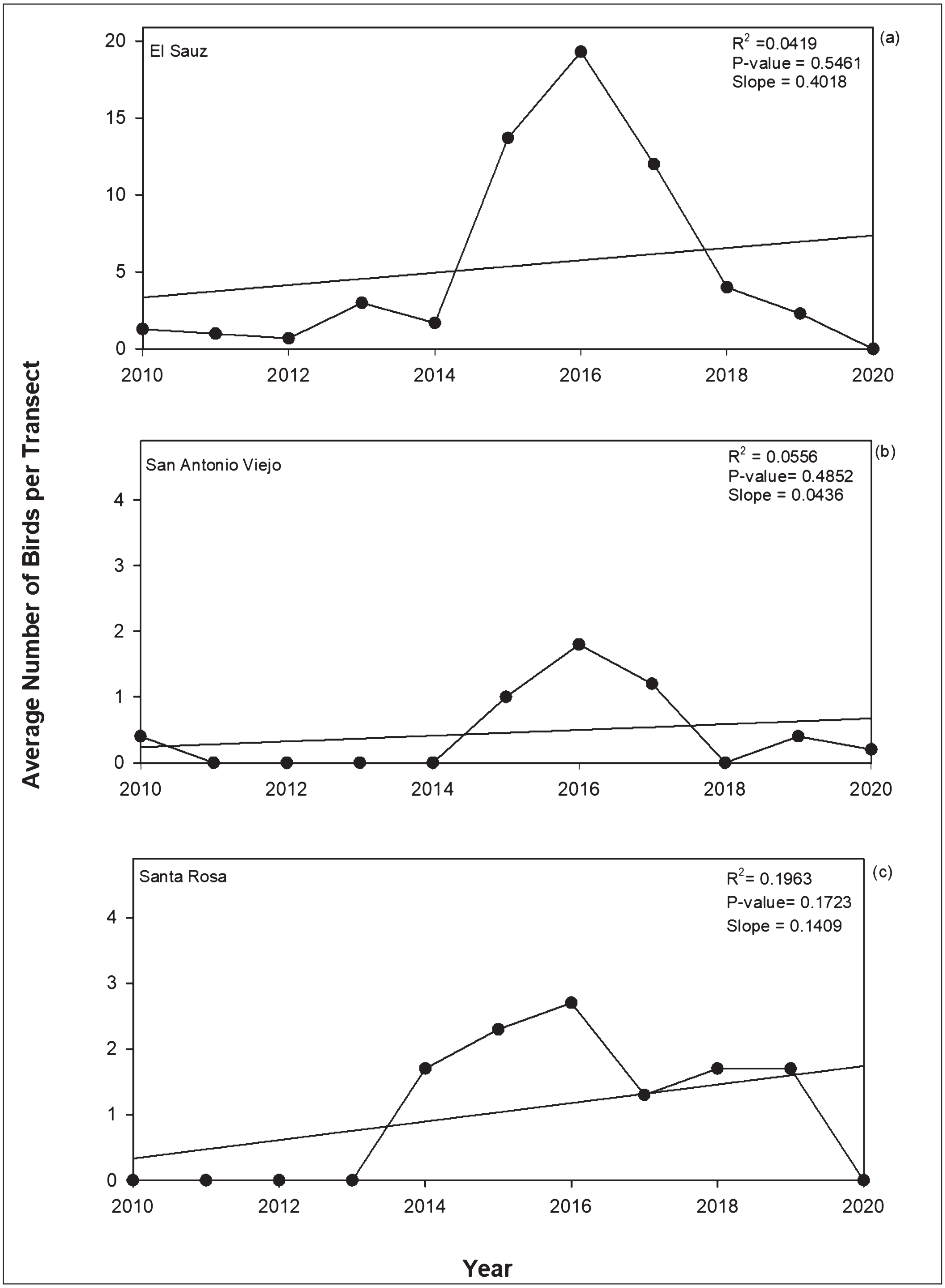

Figure 6. Non-breeding populations of Great Kiskadee on East Foundation ranches from 2010-2020.

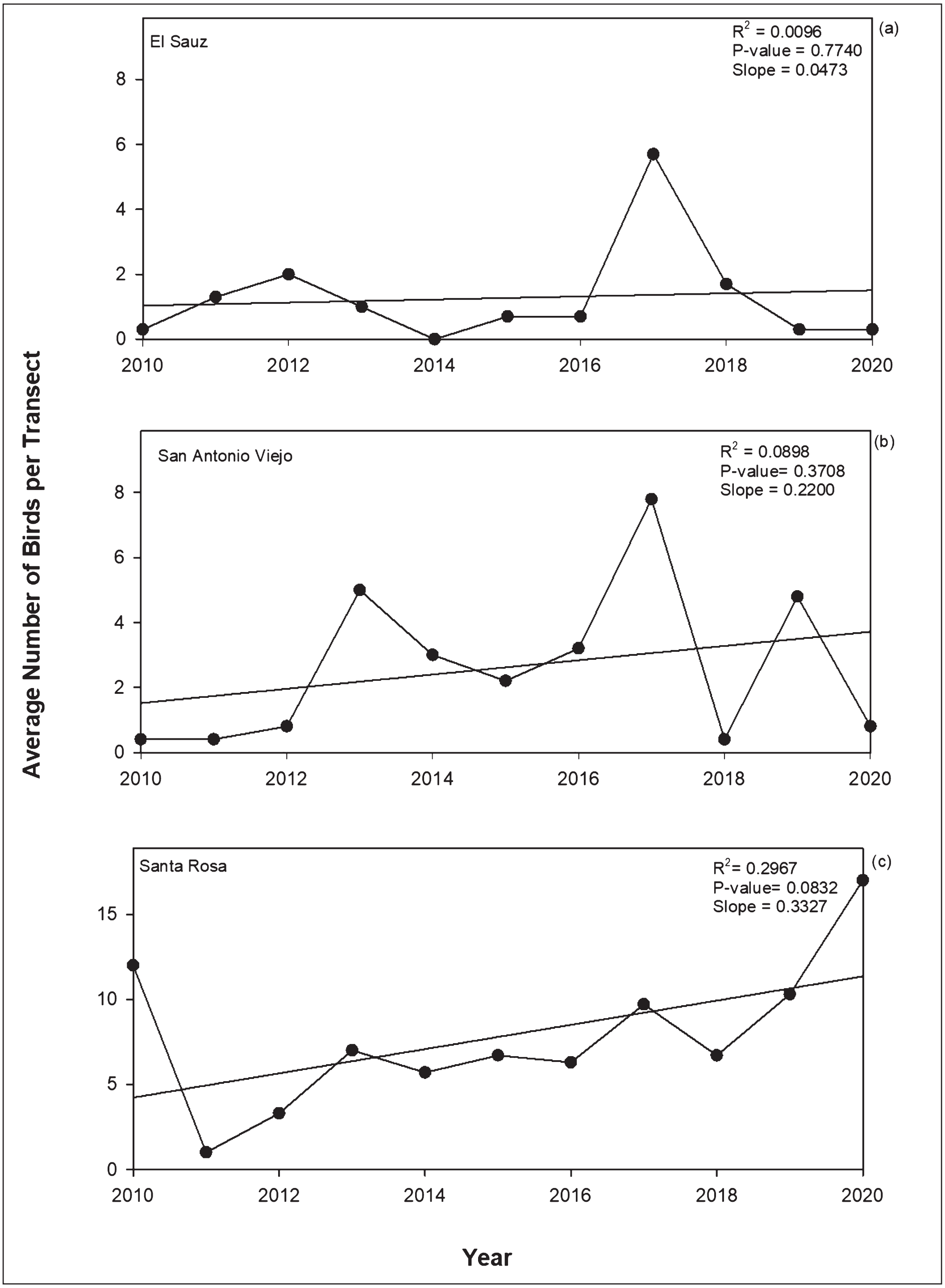

Figure 7. Non-breeding populations of Scissor-tailed Flycatcher on East Foundation ranches from 2010-2020.

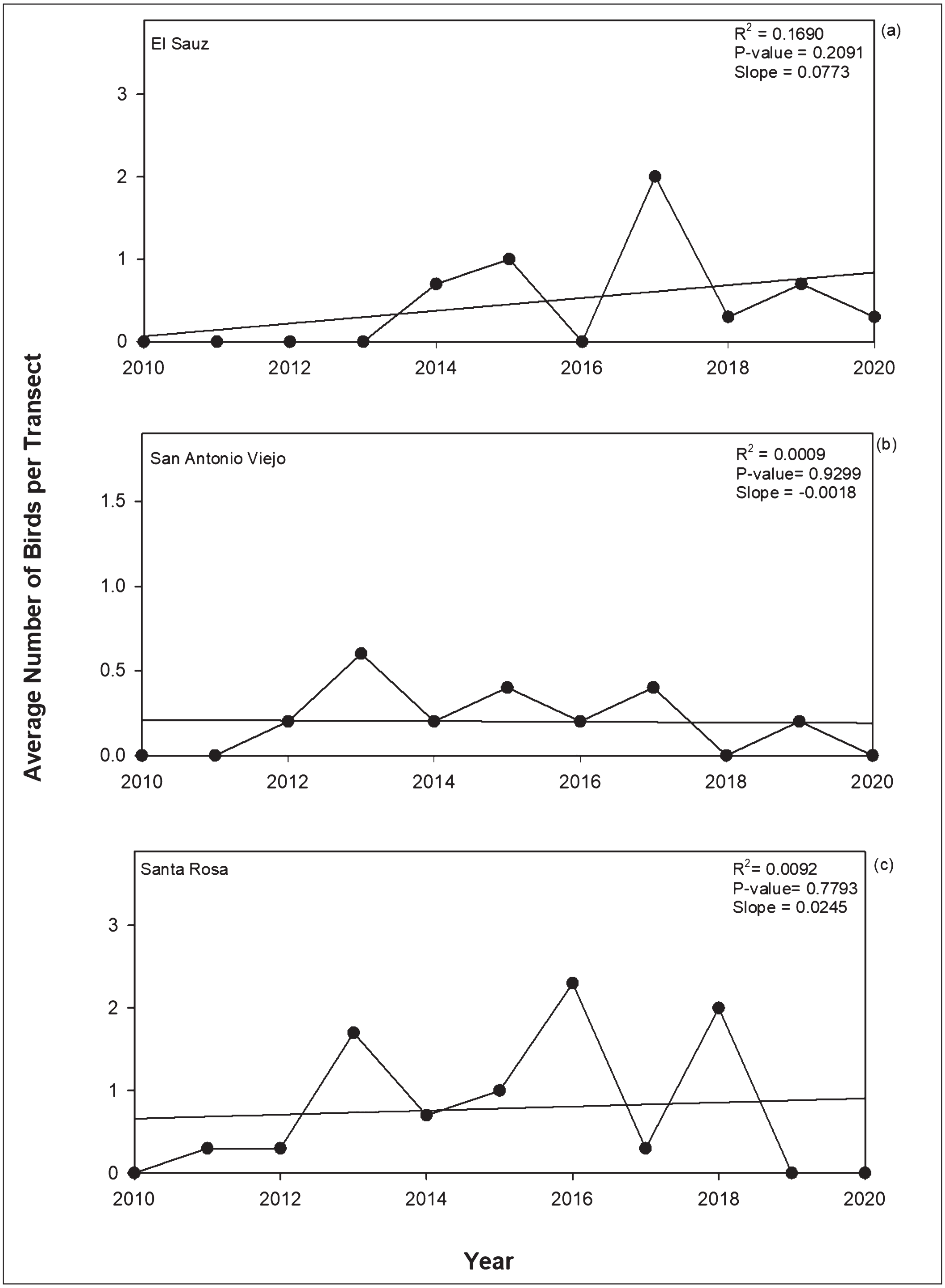

Figure 8. Non-breeding populations of Vermilion Flycatcher on East Foundation ranches from 2010-2020.

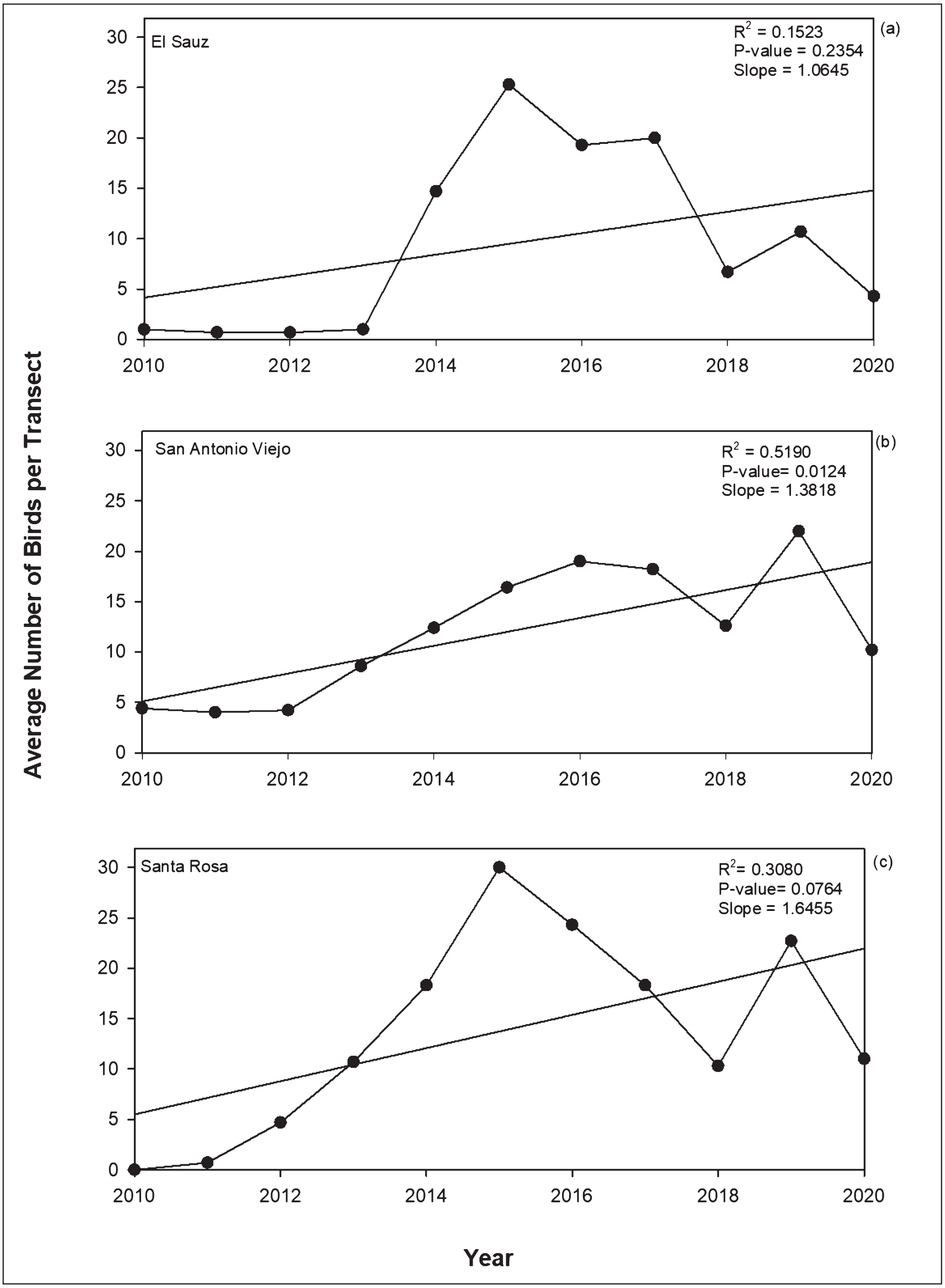

Figure 9. Non-breeding populations of Golden-fronted Woodpecker on East Foundation ranches from 2010-2020.

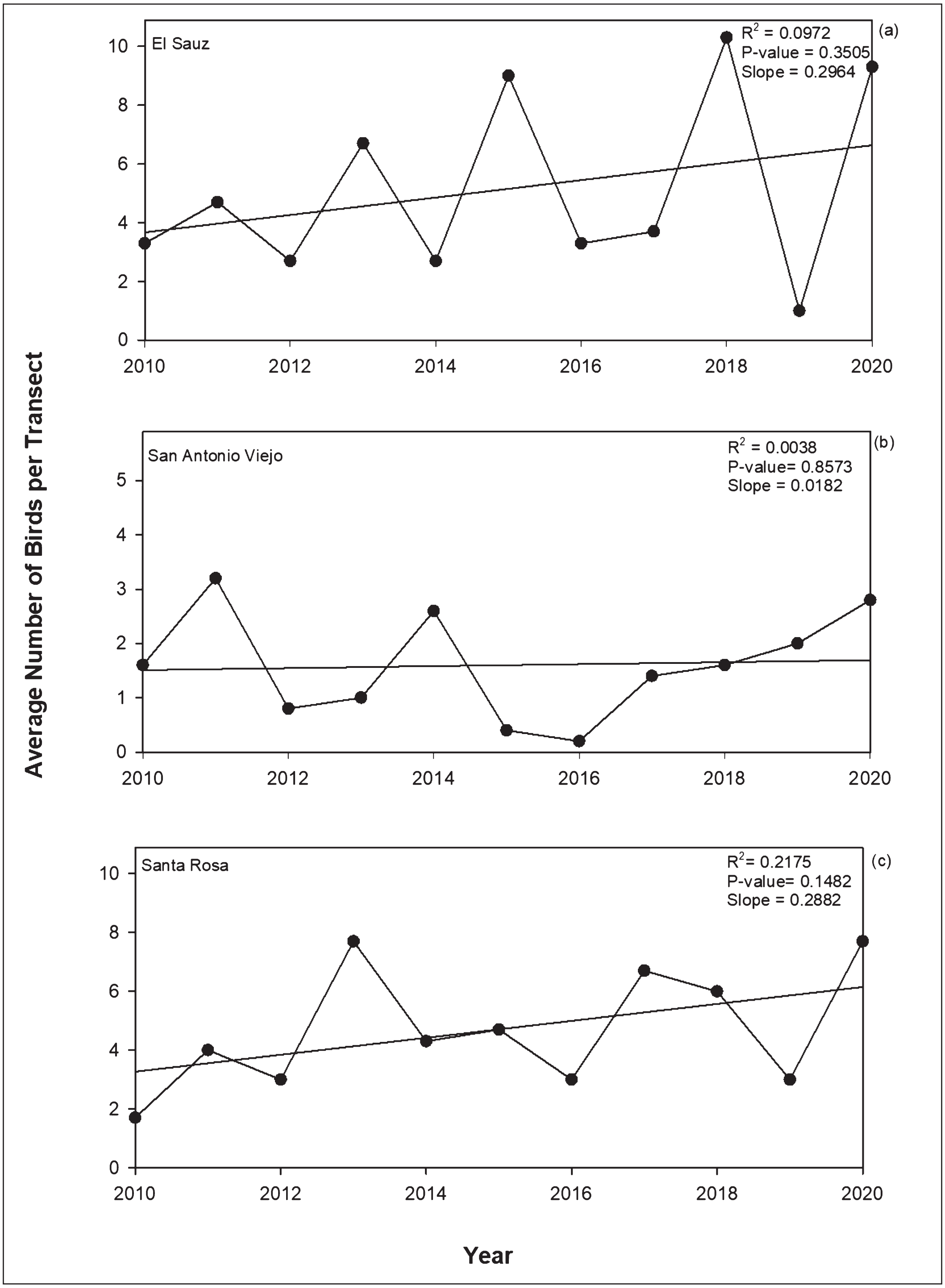

Figure 10. Non-breeding populations of Ladder-backed Woodpecker on East Foundation ranches from 2010-2020.

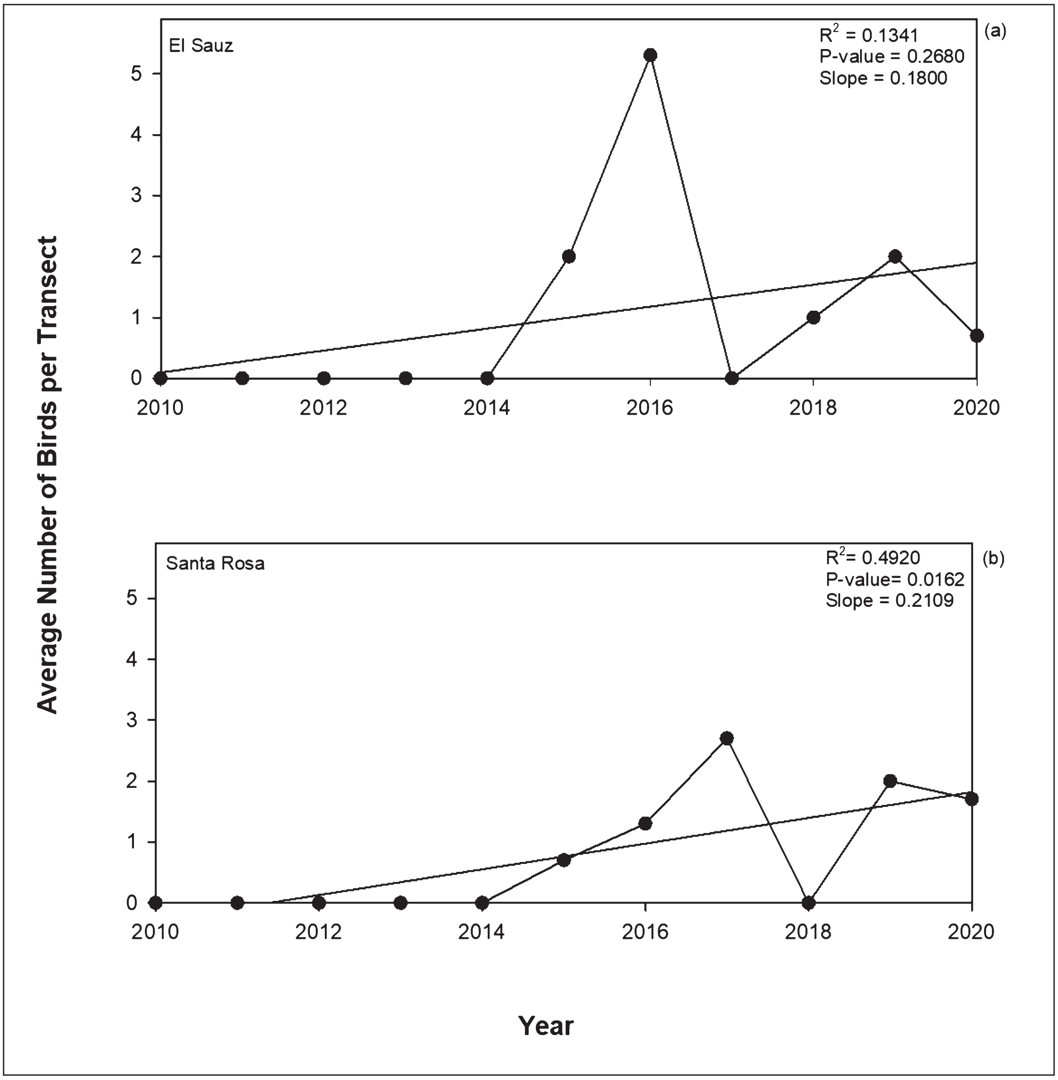

Figure 11. Non-breeding populations of Black-bellied Whistling-Duck on East Foundation ranches from 2010-2020.

on El Sauz Ranch. The population on San Antonio Viejo Ranch seemed to fluctuate more than the population on Santa Rosa Ranch but population changes during the study period were not significant.

Aerial Foragers.—Brown-crested Flycatchers (*Myiarchus tyrannulus*) (Fig. 3) were detected on all three ranches during the non-breeding season. The overall detections of Brown-crested Flycatchers on El Sauz Ranch (Fig. 3a) and Santa Rosa Ranch (Fig. 3c) were on average double the number of detections on San Antonio Viejo Ranch (Fig. 3b). The average number of individuals per transect ranged from zero to 7, but there were no significant population changes.

Couch's Kingbirds (*Tyrannus couchii*) (Fig. 4) were detected on all three ranches during the non-breeding season of the study period. They were detected more regularly and in greater numbers on El Sauz Ranch (Fig. 4a) and Santa Rosa Ranch (Fig. 4c) than on San Antonio Viejo Ranch (Fig. 4b). Couch's Kingbirds were not detected at San Antonio Viejo Ranch from 2010 to 2015 and in 2020 but experienced a slight increasing trend (P = 0.0395) from 2016 to 2019.

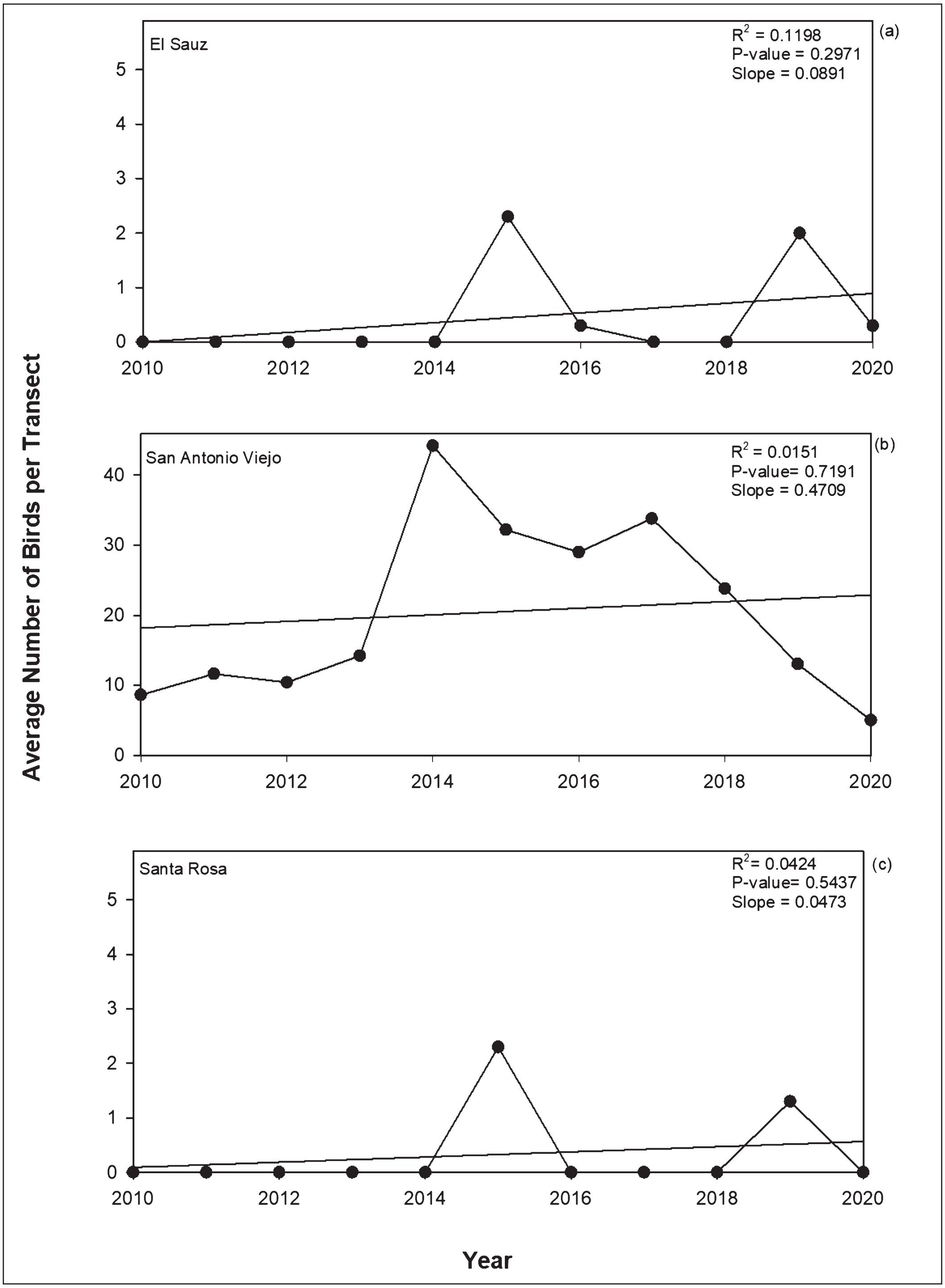

Figure 12. Non-breeding populations of Black-throated Sparrow on East Foundation ranches from 2010-2020.

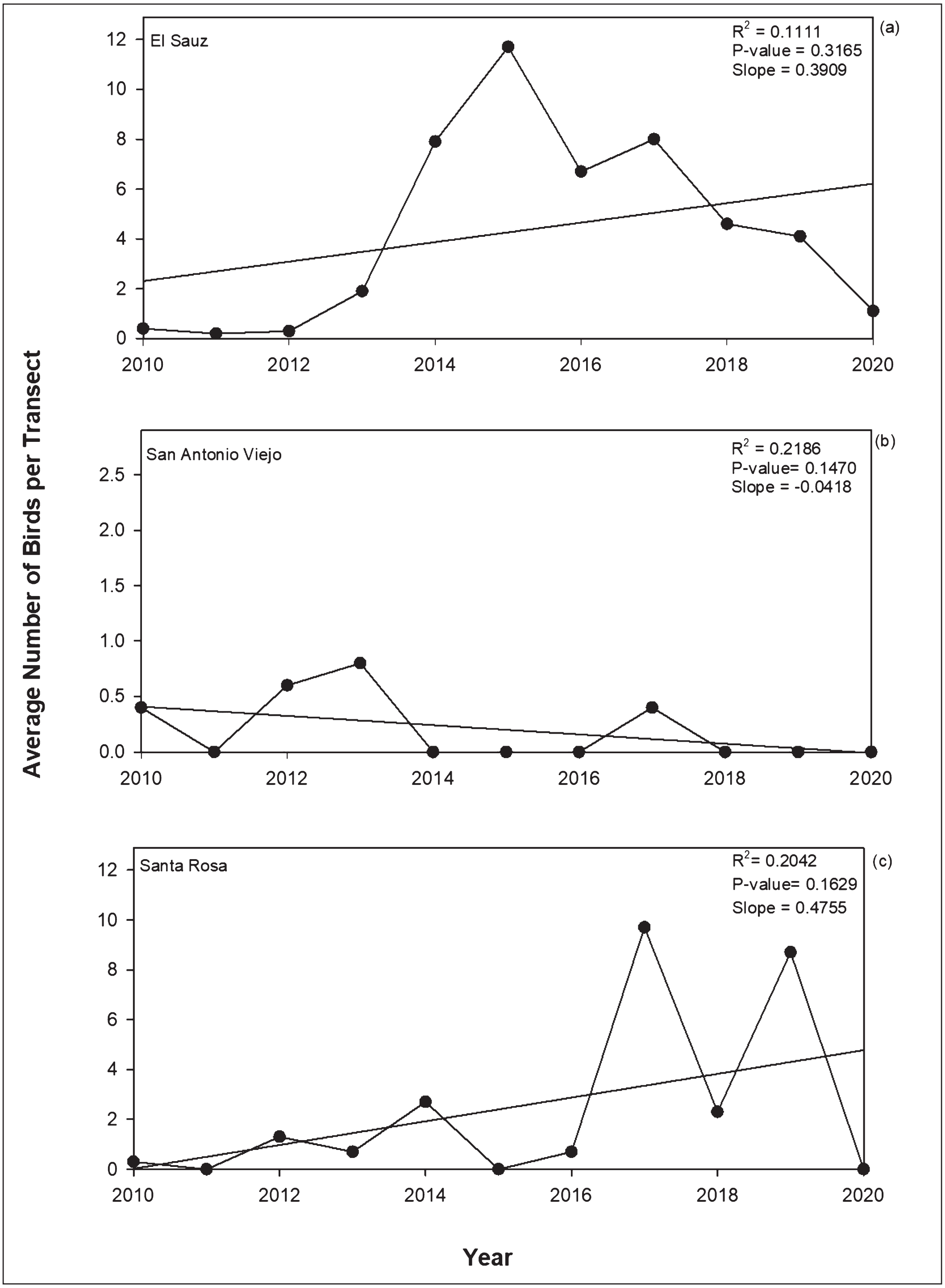

Figure 13. Non-breeding populations of Bronzed Cowbird on East Foundation ranches from 2010-2020.

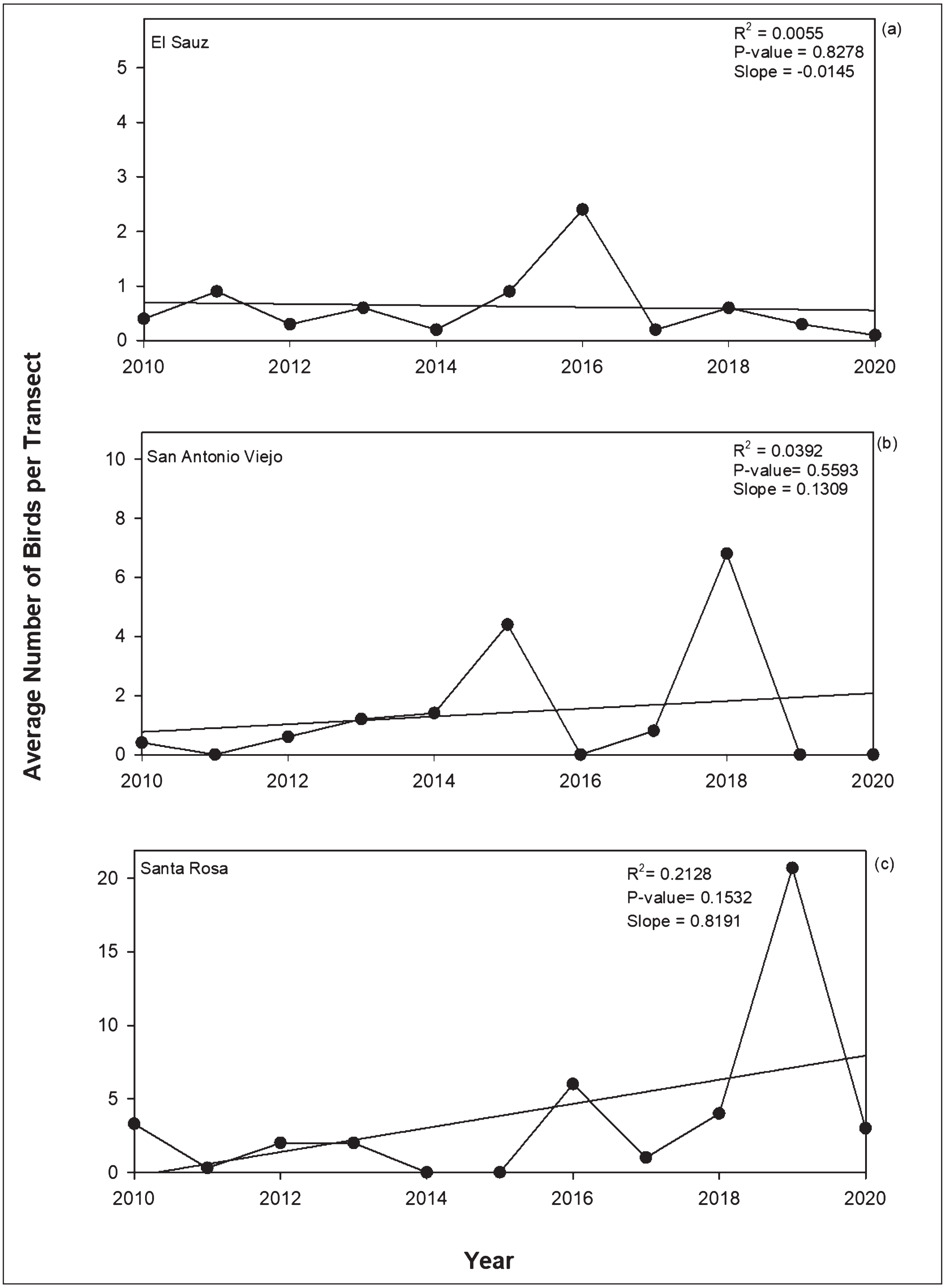

Figure 14. Non-breeding populations of Brown-headed Cowbird on East Foundation ranches from 2010-2020.

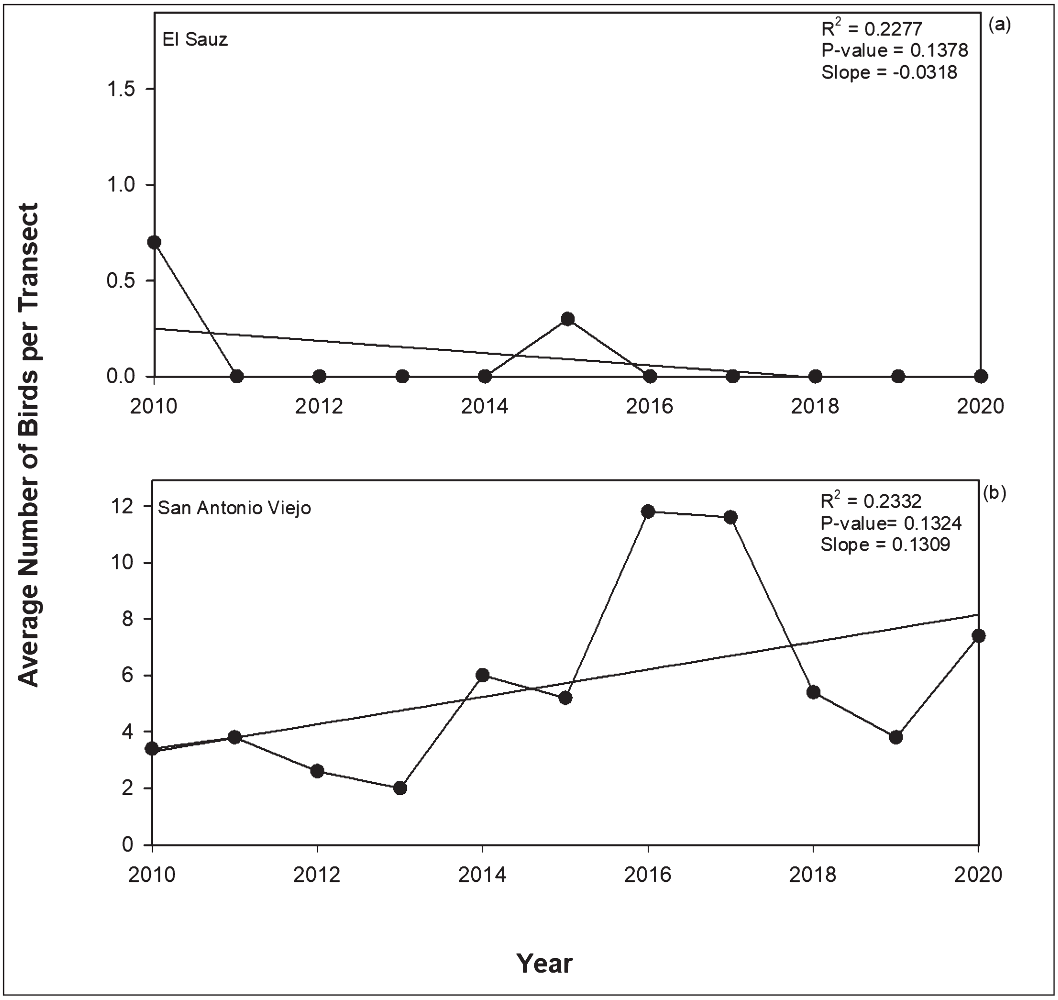

Figure 15. Non-breeding populations of Cactus Wren on East Foundation ranches from 2010-2020.

Eastern Phoebes (Sayornis phoebe) (Fig. 5) were detected on all three ranches during the non-breeding season. They were found more commonly on El Sauz Ranch (Fig. 5a) and Santa Rosa Ranch (Fig. 5c) than on San Antonio Viejo Ranch (Fig. 5b). Despite having no statistically significant trend, the populations on all three ranches experienced a peak in 2015.

Great Kiskadees (*Pitangus sulphuratus*) (Fig. 6) were detected on all three ranches during the non-breeding season. The overall abundance of Great Kiskadees was greater on El Sauz Ranch (Fig. 6a) than on San Antonio Viejo Ranch (Fig. 6b) and Santa Rosa Ranch (Fig. 6c). This could be due to El Sauz Ranch having more of their preferred habitat types. Very few individuals were detected along our transects from 2010 to 2014. However, there was a slight increase in 2015 and all three ranches experienced a peak in 2016, but there was no significant trend overall.

Scissor-tailed Flycatchers (*Tyrannus forficatus*) (Fig. 7) were detected on all three ranches during the non-breeding season. Scissor-tailed Flycatchers were more common on Santa Rosa Ranch (Fig. 7c) than on El Sauz Ranch (Fig. 7a) and San Antonio Viejo Ranch (Fig. 7b), but there were no significant trends in population numbers over time.

Vermillion Flycatchers (*Pyrocephalus rubinus*) (Fig. 8) were detected in low numbers (often fewer

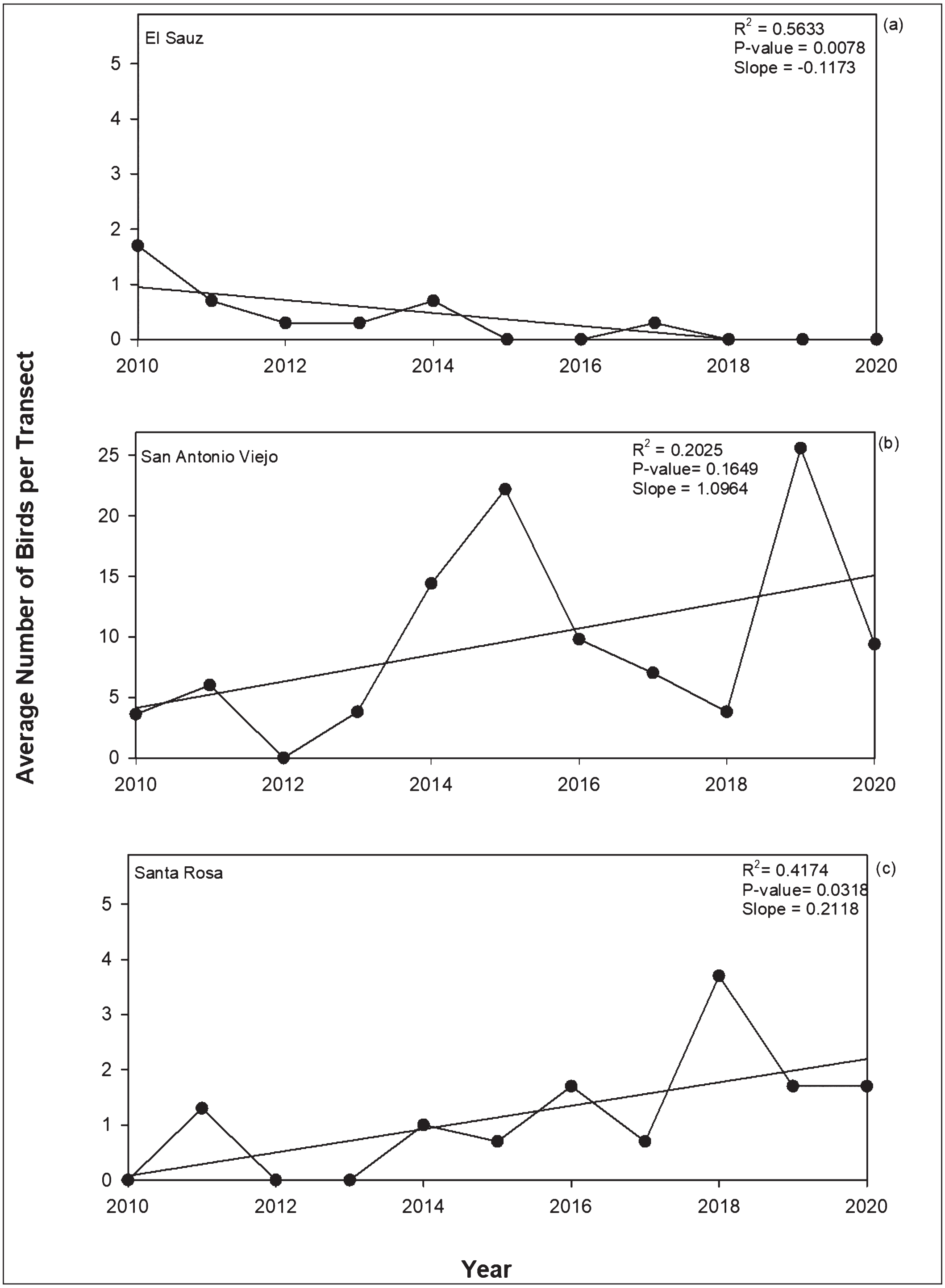

Figure 14. Non-breeding populations of Brown-headed Cowbird on East Foundation ranches from 2010-2020.

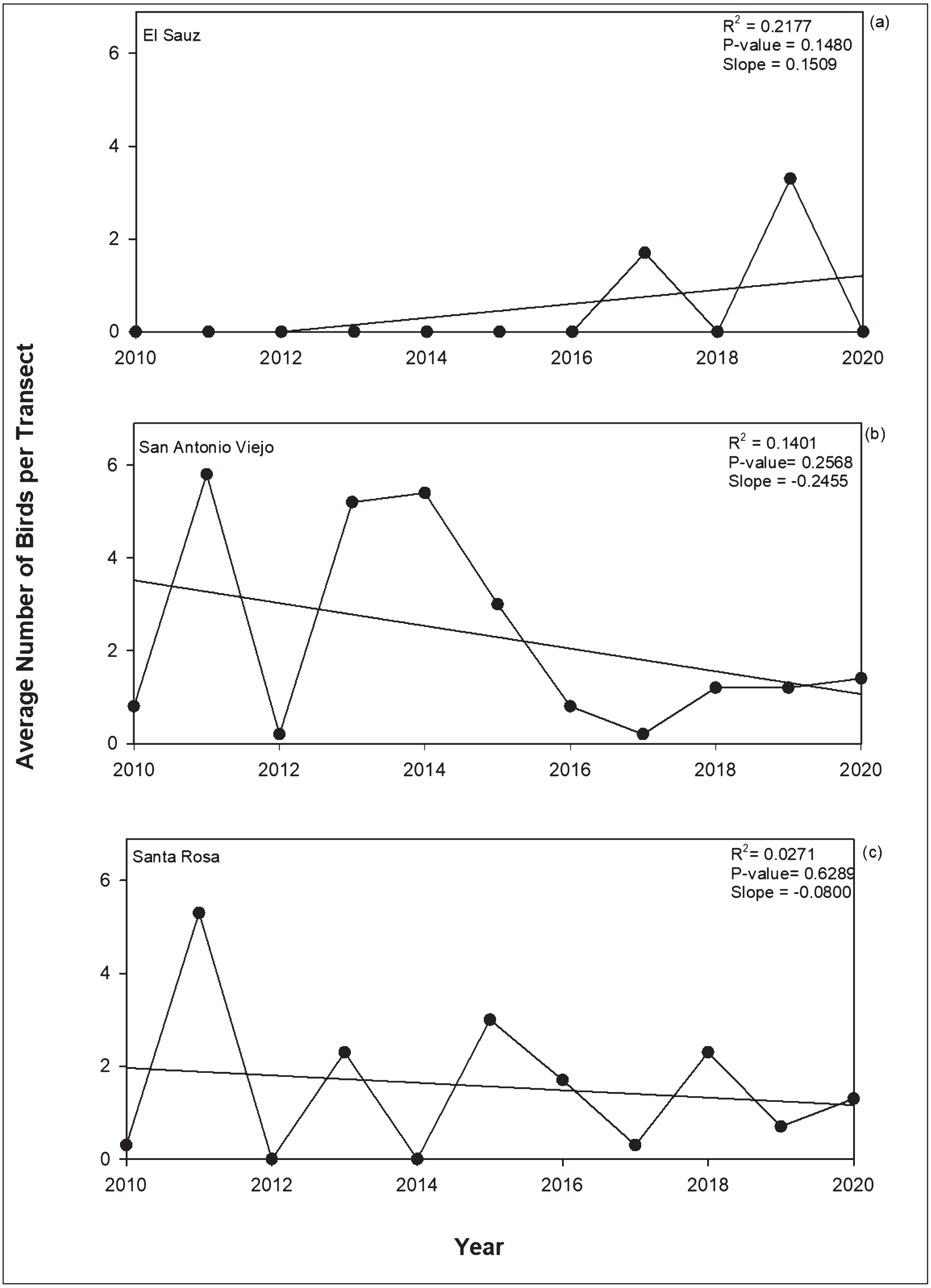

Figure 17. Non-breeding populations of Clay-colored Sparrow on East Foundation ranches from 2010-2020.

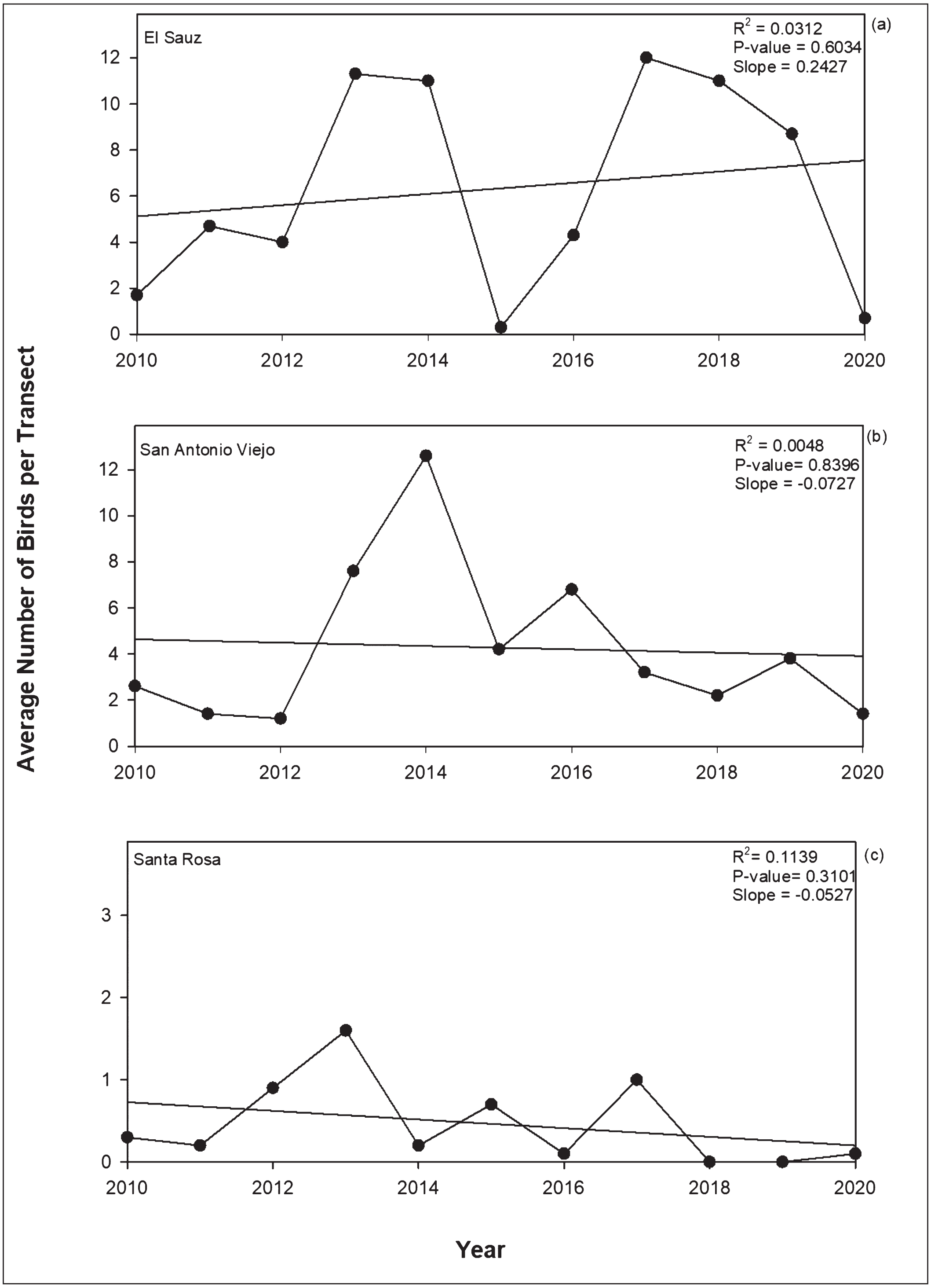

Figure 18. Non-breeding populations of Common Ground Dove on East Foundation ranches from 2010-2020.

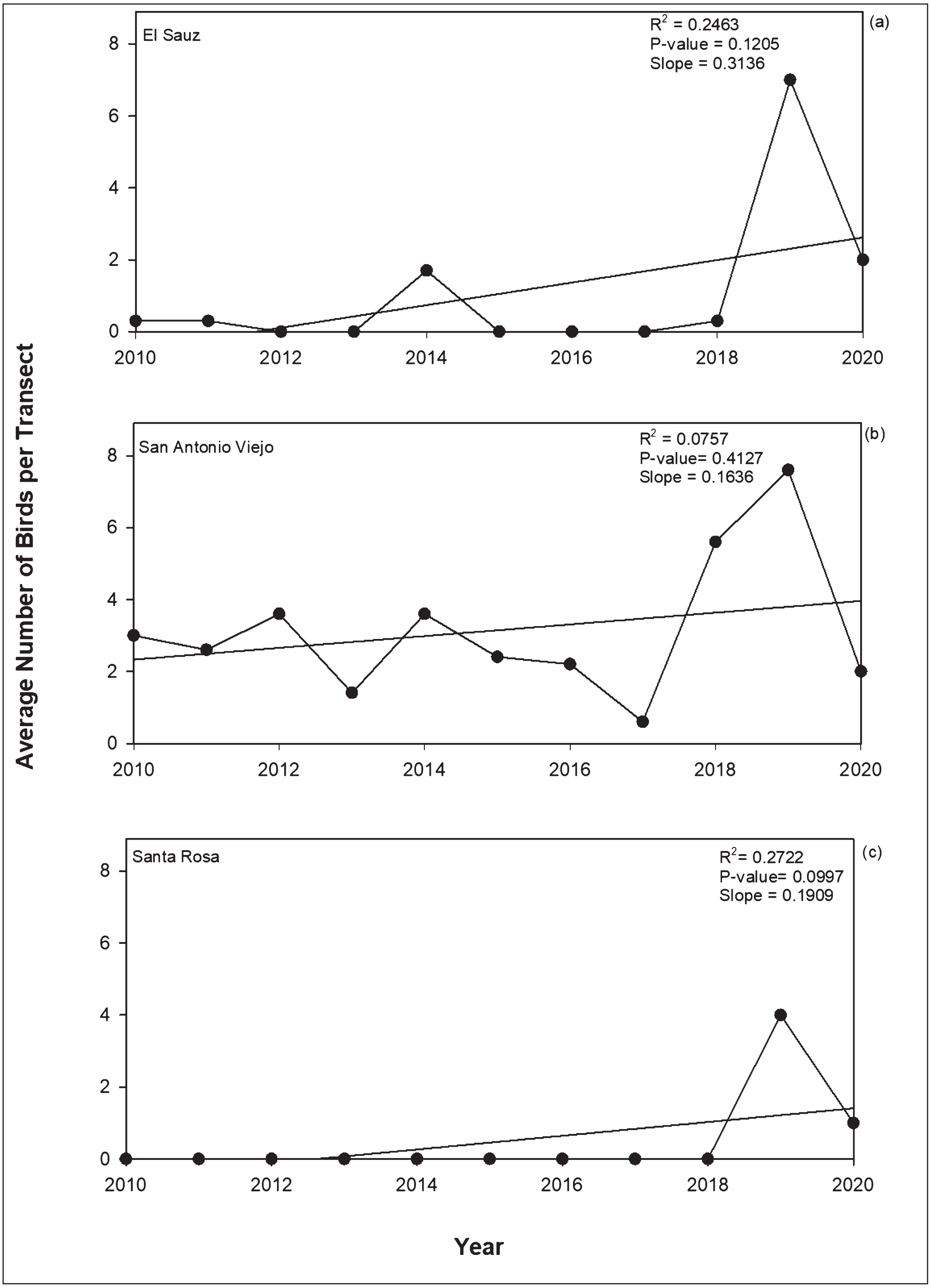

Figure 19. Non-breeding populations of Curve-billed Thrasher on East Foundation ranches from 2010-2020.

than 2 individuals per transect) on all three ranches during the non-breeding season, but population trends were not significant (Figs. 8a, 8b, and 8c).

Bark Foragers.—Golden-fronted Woodpeckers (*Melanerpes aurifrons*) (Fig. 9) were detected on all three ranches during the non-breeding season. The overall abundance of Golden-fronted Woodpeckers was roughly equal across all three ranches (Figs. 9a, 9b, and 9c). Likewise, the population numbers followed a similar increasing pattern from 2014 to 2017; however, only San Antonio Viejo Ranch experienced a significant increasing trend (P = 0.012)

Ladder-backed Woodpeckers (*Dryobates scalaris*) (Fig. 10) were detected every year on all three ranches during the non-breeding season. Ladder-backed Woodpeckers were more common on El Sauz Ranch (Fig. 10a) and Santa Rosa Ranch (Fig. 10c), averaging 4-5 individuals per transect, compared to an average of 1 to 2 individuals per transect on San Antonio Viejo Ranch (Fig. 10b). There were no significant population size trends for Ladder-backed Woodpeckers during the study period.

Dabbler.—Black-bellied Whistling-Ducks (*Dendrocygna autumnalis*) (Fig. 11) were detected on El Sauz Ranch (Fig. 11a) and Santa Rosa Ranch (Fig. 11b) during the non-breeding season starting in 2014. However, they were not detected at all on San Antonio Viejo Ranch (Fig. 11c). Although the population patterns were similar, only Santa Rosa Ranch experienced a significant increasing trend (P = 0.016).

Ground Foragers.—Black-throated Sparrows (*Amphispiza bilineata*) (Fig. 12) were present on every transect in every year on San Antonio Viejo Ranch and common there (Fig. 12b) but only detected in 2015 and 2019 on El Sauz Ranch (Fig. 12a) and Santa Rosa Ranch (Fig. 12c). This is consistent with their known distribution, as they tend to be found in drier climates further west and found infrequently along the coast. There were no significant population changes for this species during the study period.

Bronzed Cowbirds (*Molothrus aeneus*) (Fig. 13) were detected on all three ranches during the non-breeding season. Bronzed Cowbirds were more common on El Sauz Ranch (Fig. 13a) and Santa Rosa Ranch (Fig. 13c) than on San Antonio Viejo Ranch (Fig. 13b). None of the Bronzed Cowbird population changes were significant.

Brown-headed Cowbirds (*Molothrus ater*) (Fig. 14) were detected on all three ranches during the non-breeding season. Brown-headed Cowbirds were more common on San Antonio Viejo Ranch (Fig. 14b) and Santa Rosa Ranch (Fig. 14c) than on El Sauz Ranch (Fig. 14a), but none of the population changes were significant.

Cactus Wrens (*Campylorhynchus brunneicapillus*) (Fig. 15) were detected on El Sauz Ranch and San Antonio Viejo Ranch during the non-breeding season. On El Sauz Ranch the only recorded individuals were in 2010 and 2015 (Fig. 15a), while they were more common and reliably seen on all transects in all years on San Antonio Viejo Ranch (Fig. 15b). They were not detected on Santa Rosa Ranch, which borders their known range. There were no significant population changes noted for this species at these ranches during the study period.

Cassin's Sparrows (*Peucaea cassinni*) (Fig. 16) were detected on all three ranches during the non-breeding season. Cassin's Sparrows were more common on San Antonio Viejo Ranch (Fig. 16b) than on El Sauz Ranch (Fig. 16a) and Santa Rosa Ranch (Fig. 16c). This could be due to their preference for habitat types that are primarily found on San Antonio Viejo Ranch. Cassin's Sparrow populations experienced a different trend on each of the ranches. On El Sauz Ranch their population was significantly decreasing (P = 0.008), on San Antonio Viejo Ranch their population was stable (P = 0.165), and on Santa Rosa Ranch their population was significantly increasing (P = 0.032). The population on El Sauz Ranch ranged from zero to 2 average individuals per transect throughout the study period. Despite having no statistically significant trend, the population on San Antonio Viejo Ranch experienced two large peaks, in 2015 and 2019.

Clay-colored Sparrows (*Spizella pallida*) (Fig. 17) were detected on all three ranches during the non-breeding season. Clay-colored Sparrows were more common on San Antonio Viejo Ranch (Fig. 17b) and Santa Rosa Ranch (Fig. 17c) than on El Sauz Ranch (Fig. 17a). Clay-colored Sparrows were not detected on El Sauz Ranch until 2017 and 2019, where their population peaked with an average of 4 individuals seen per transect. There were no significant trends in any of the three populations of this species during the study period.

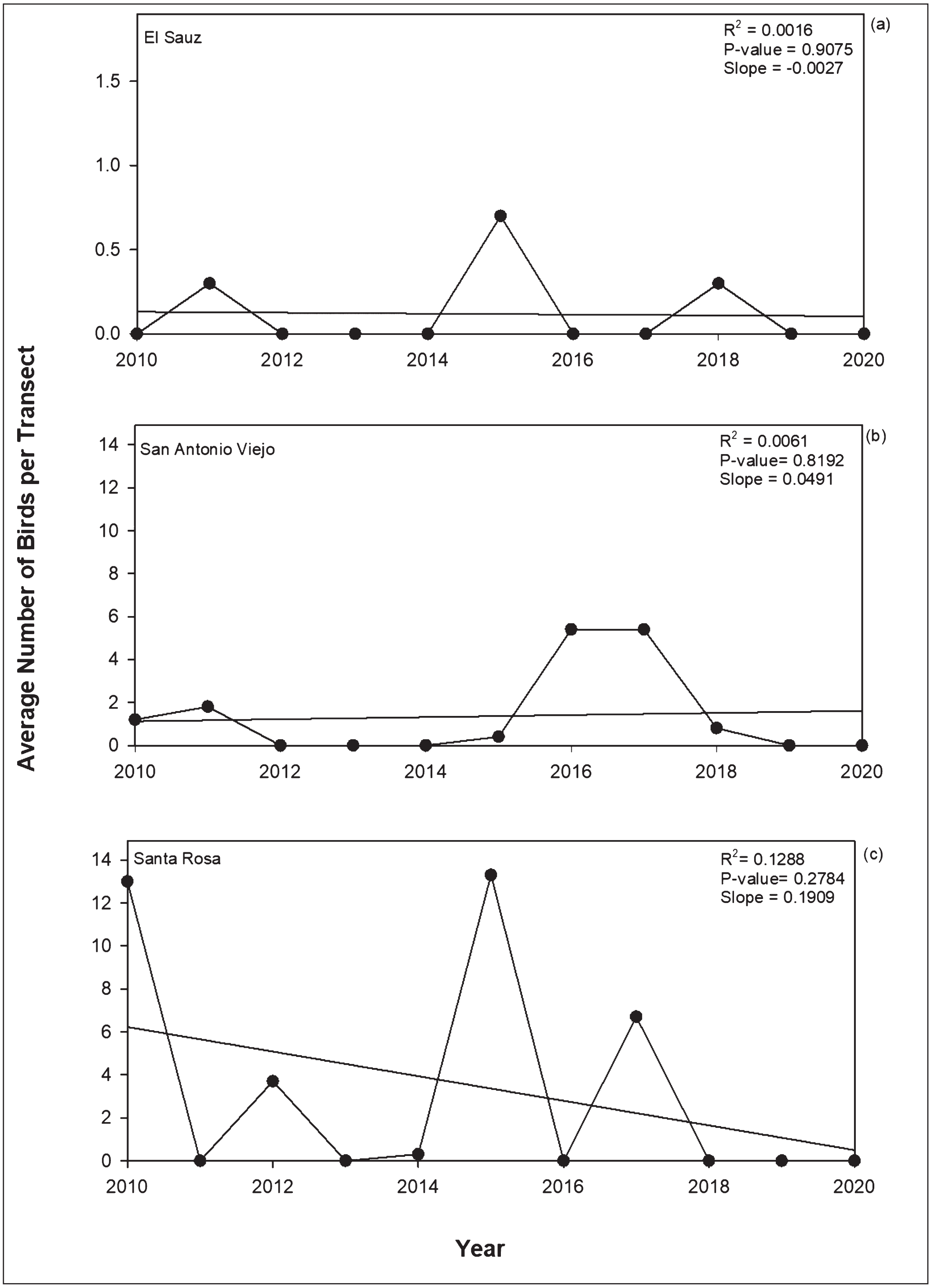

Figure 20. Non-breeding populations of Eastern Meadowlark on East Foundation ranches from 2010-2020.

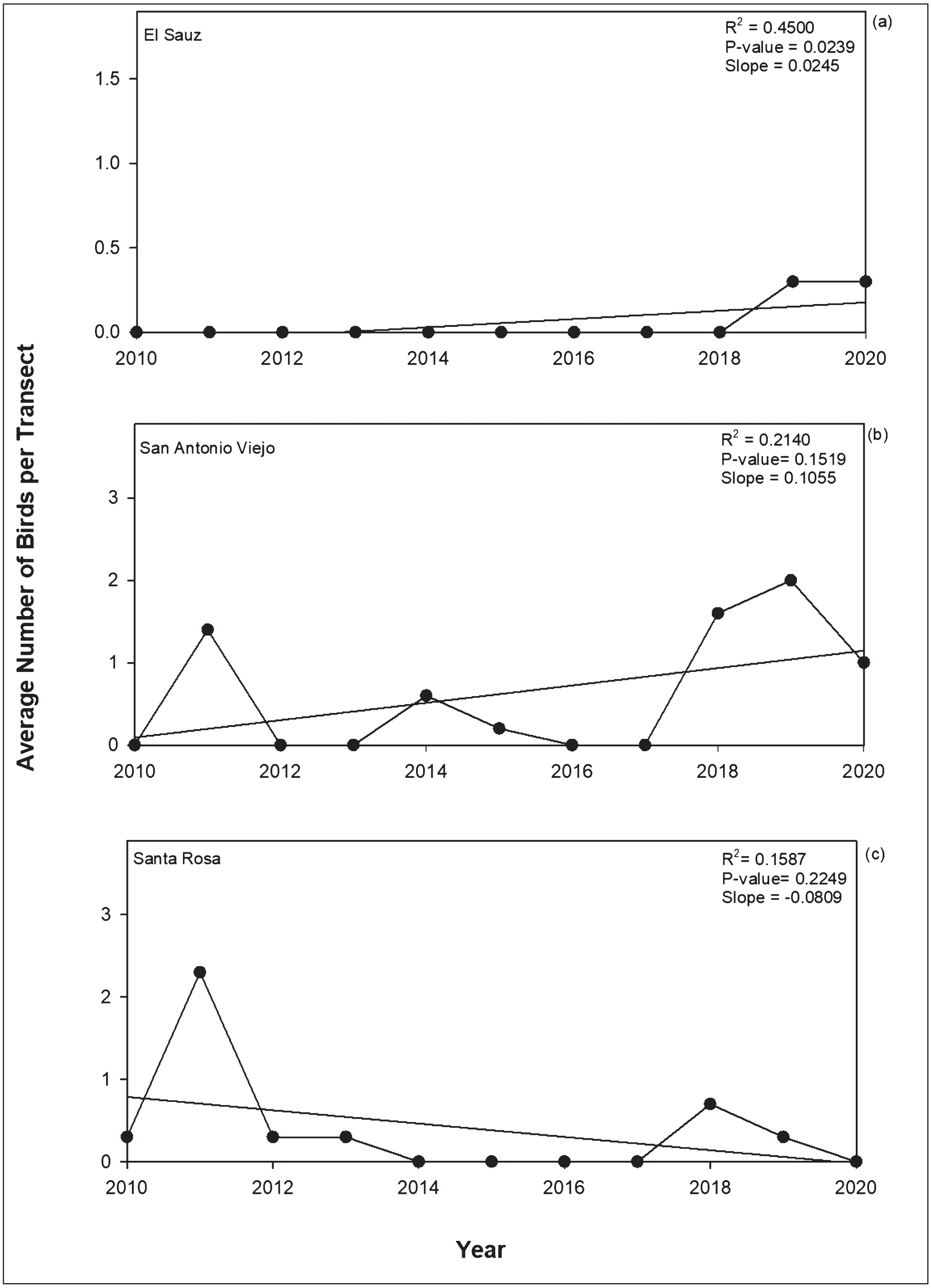

Figure 21. Non-breeding populations of Field Sparrow on East Foundation ranches from 2010-2020.

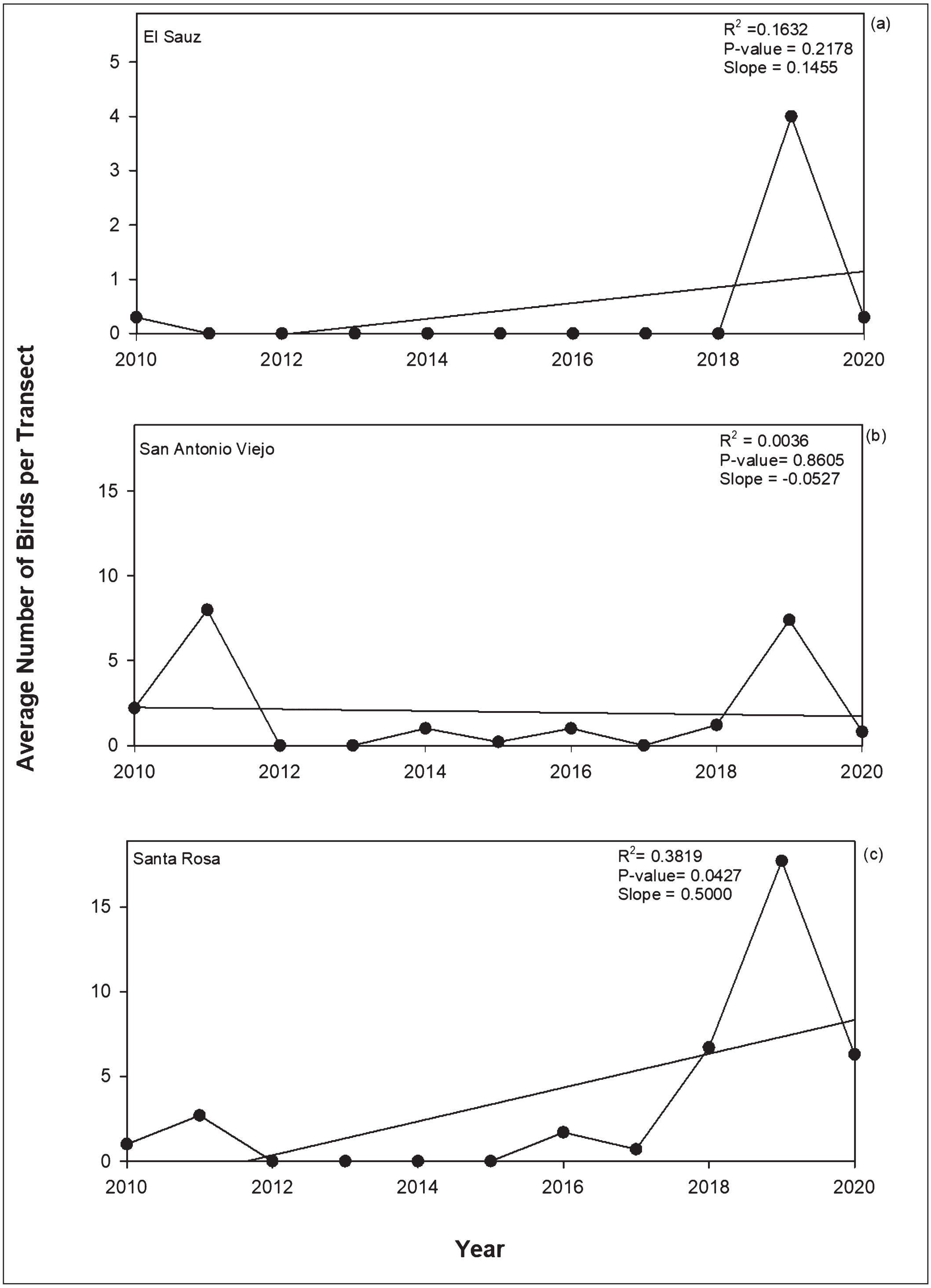

Figure 22. Non-breeding populations of Grasshopper Sparrow on East Foundation ranches from 2010-2020.

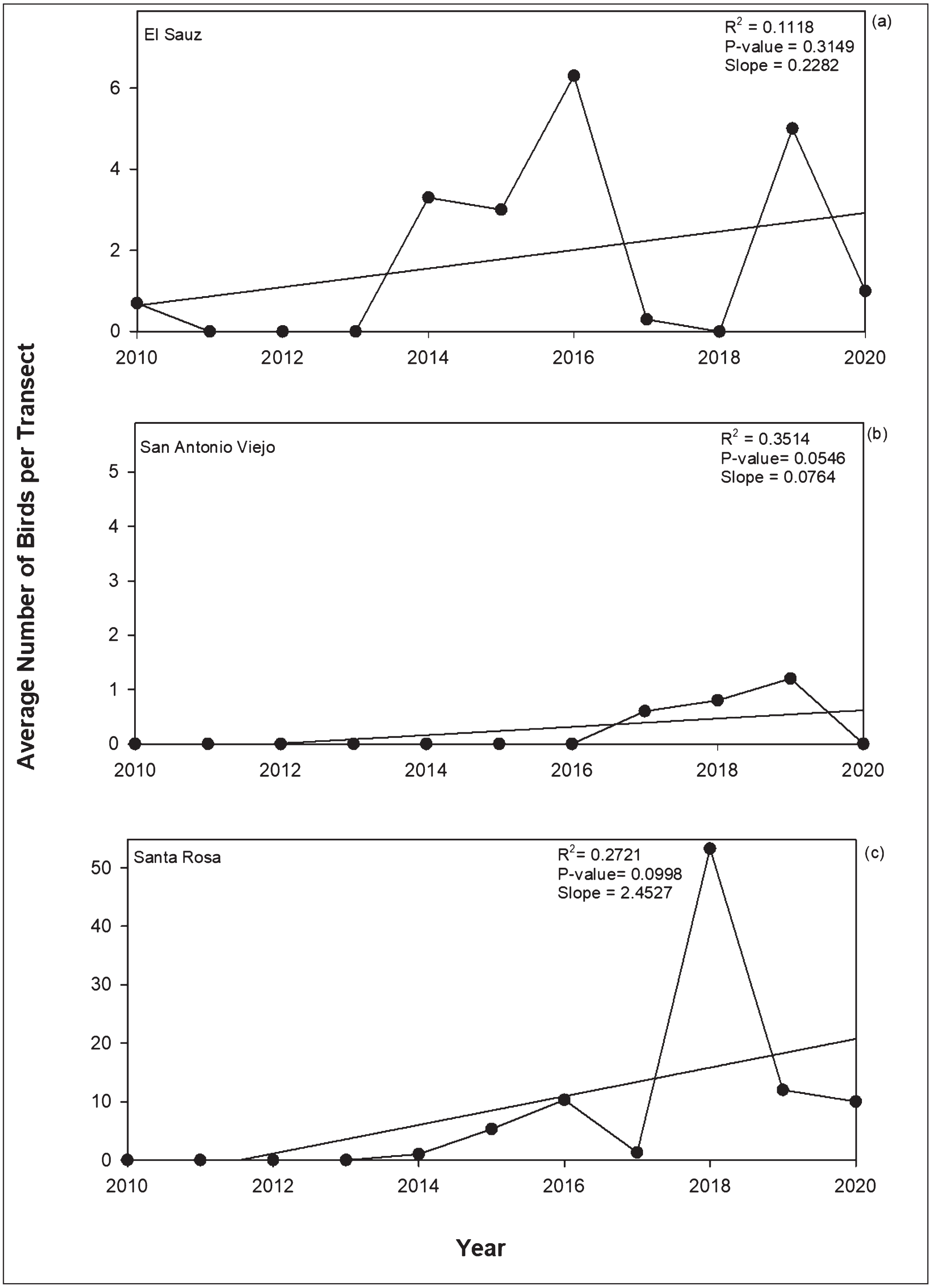

Figure 23. Non-breeding populations of Great-tailed Grackle on East Foundation ranches from 2010-2020.

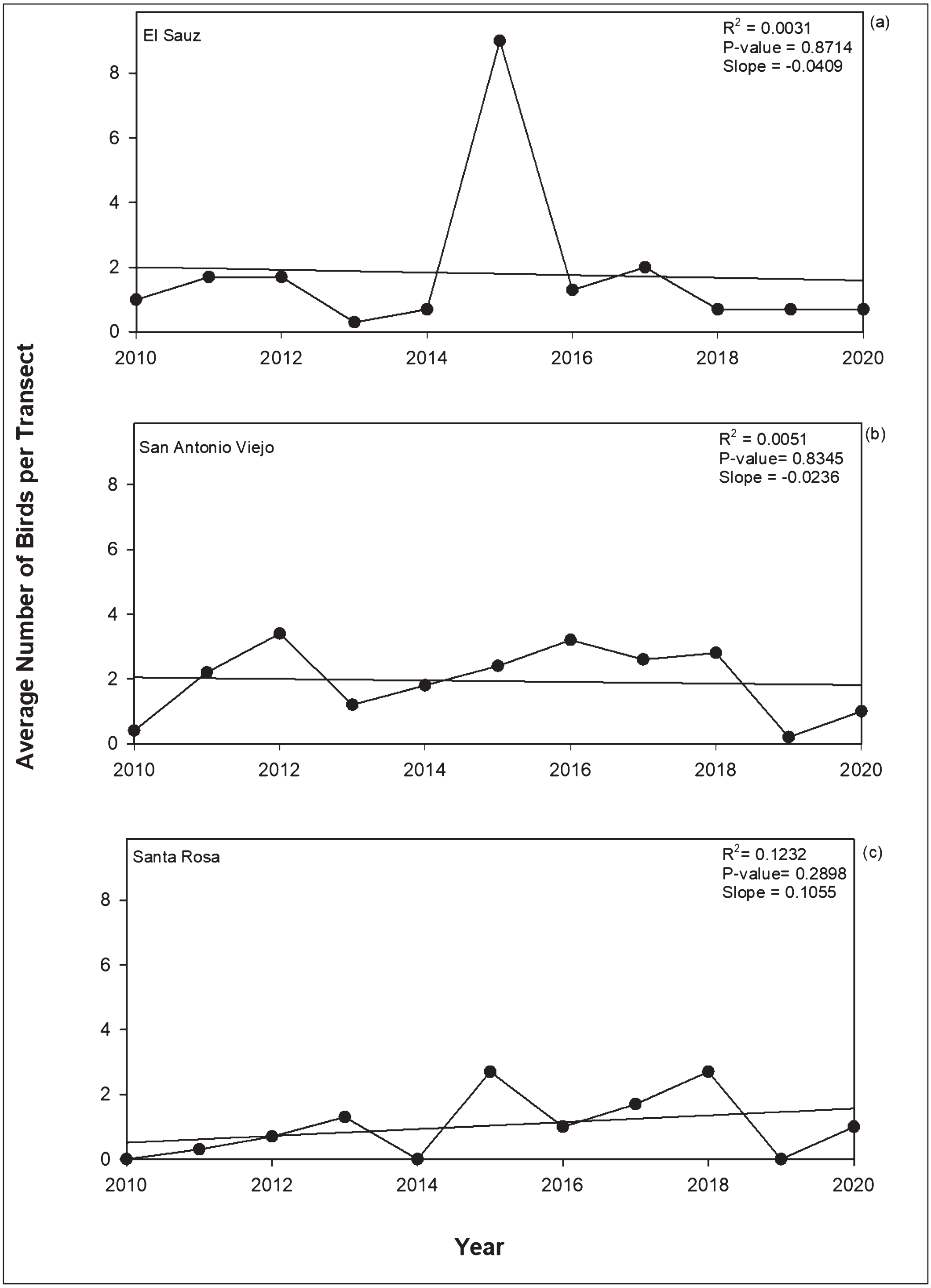

Figure 24. Non-breeding populations of Greater Roadrunner populations on East Foundation ranches from 2010-2020.

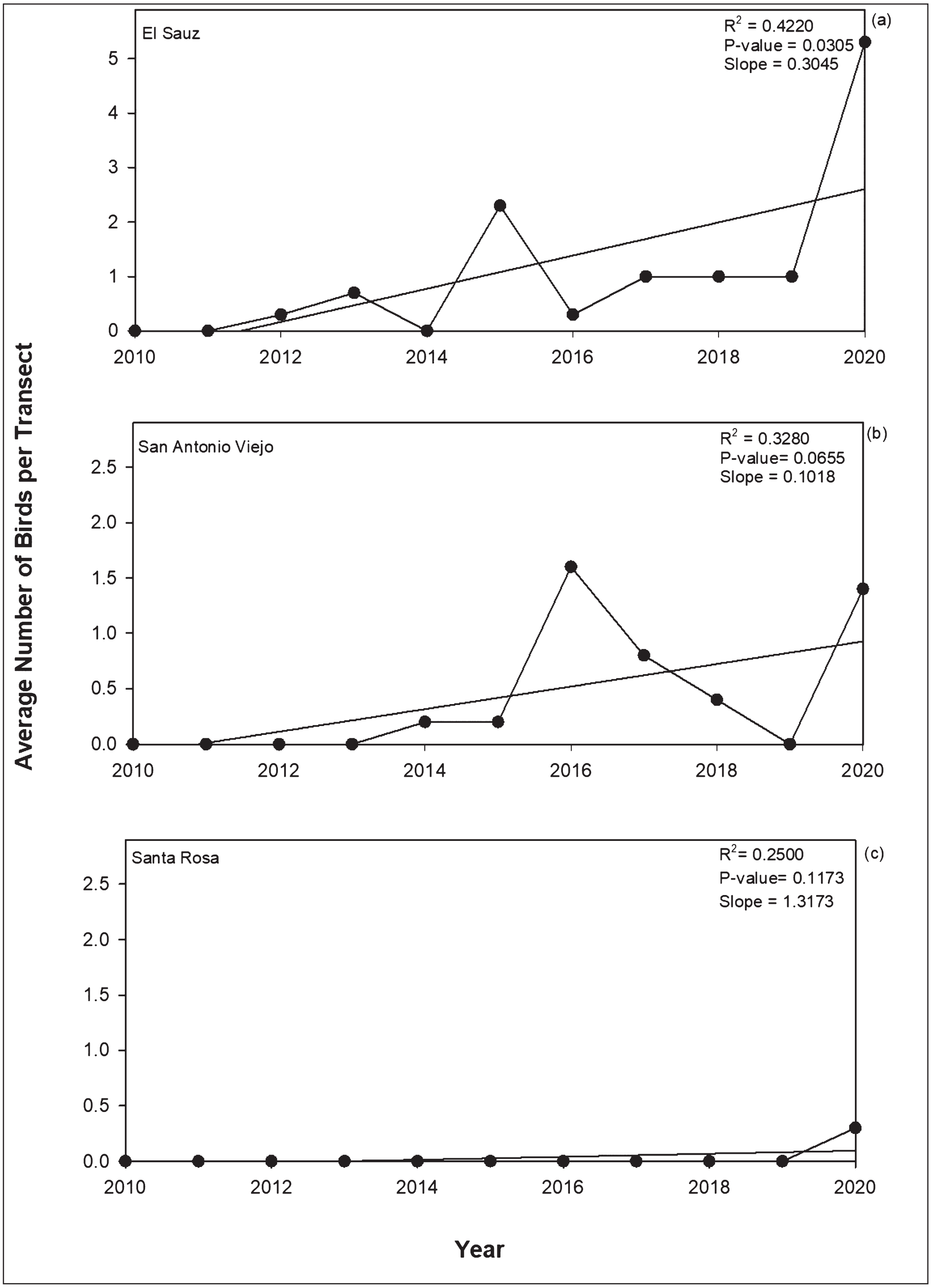

Figure 25. Non-breeding populations of Killdeer on East Foundation ranches from 2010-2020.

Common Ground Doves (*Columbina passerine*) (Fig. 18) were detected on all three ranches during the non-breeding season. They were more common on El Sauz Ranch (Fig. 18a) and San Antonio Viejo Ranch (Fig. 18b) than on Santa Rosa Ranch (Fig. 18c). There were no statistically significant trends on the average populations of Common Ground Dove.

Curve-billed Thrashers (*Toxostoma curvirostre*) (Fig. 19) were detected on all three ranches during the non-breeding season. Curve-billed Thrashers were more common on El Sauz Ranch (Fig. 19a) and San Antonio Viejo Ranch (Fig. 19b) than on Santa Rosa Ranch (Fig. 19c). On Santa Rosa Ranch they were only detected in 2019 and 2020. Despite having no statistically significant population trends, all three ranches experienced a peak in 2019.

Eastern Meadowlarks (*Sturnella magna*) (Fig. 20) were detected on all three ranches during the non-breeding season. They were more common on Santa Rosa Ranch (Fig. 20c) than on El Sauz Ranch (Fig. 20a) and San Antonio Viejo Ranch (Fig. 20b). Numbers varied from year to year and some years had no Meadowlark detections during our surveys, but there were no significant trends.

Field Sparrows (Spizella pusilla) (Fig. 21) were detected on all three ranches during the non-breeding season. Field Sparrows were more common on San Antonio Viejo and Santa Rosa ranches (Figs. 21b and 21c) than on El Sauz Ranch (Fig. 21a). The population on El Sauz Ranch experienced a significant increasing trend ($P = 0.024$), but there were no sightings until 2019 and 2020. The populations on San Antonio Viejo and Santa Rosa ranches experienced the bulk of their detections in 2011, 2018, and 2019, but there were no significant trends in these populations.

Grasshopper Sparrows (*Ammodramus savannarum*) (Fig. 22) were detected on all three ranches during the non-breeding season. Grasshopper Sparrows were more common on San Antonio Viejo and Santa Rosa ranches (Figs. 22b and 22c) than on El Sauz Ranch (Fig. 22a). However, the population on Santa Rosa Ranch experienced a significant increasing trend ($P = 0.043$), while the populations on El Sauz and San Antonio Viejo ranches had no statistically significant trends. On El Sauz Ranch Grasshopper Sparrows were only detected in 2010, 2019, and 2020. All three of the populations experienced peaks in their population in 2019. San Antonio Viejo and Santa Rosa ranches also experienced a small increase in average detections in 2011.

Great-tailed Grackles (*Quiscalus mexicanus*) (Fig. 23) were detected on all three ranches during the non-breeding season. Grackles were more frequently found on El Sauz Ranch (Fig. 23a) than the other ranches. They were not detected on Santa Rosa Ranch until 2014, but large groups were documented in 2018 (Fig. 23c). Great-tailed Grackles were recorded on our San Antonio Viejo Ranch surveys only in 2017, 2018, and 2019 (Fig. 23b). There were no significant changes in population numbers during the survey period.

Greater Roadrunners (*Geococcyx californiaus*) (Fig. 24) were detected on all three ranches during the non-breeding season. Greater Roadrunner detections were similar across the study period apart from one population peakon El Sauz Ranch in 2015 (Figs. 24a, 24b, and 24c). However, population changes were not statistically significant.

Killdeer (*Charadrius vociferus*) (Fig. 25) were detected on all three ranches during the non-breeding season. Killdeer were more common on El Sauz Ranch (Fig. 25a) than on San Antonio Viejo and Santa Rosa ranches (Figs. 25b and 25c). The population on El Sauz Ranch experienced a significant increasing trend ($P = 0.031$) with an average of 5 individuals per transect in 2020, while the populations on San Antonio Viejo and Santa Rosa ranches had no significant trends. On Santa Rosa Ranch, Killdeer were not detected during the study period until 2020.

Lark Sparrows (*Chondestes grammacus*) (Fig. 26) were detected on all three ranches during the non-breeding season. All three populations of Lark Sparrows experienced similar significant increasing trends over the study period. On El Sauz Ranch Lark Sparrows averaged less than 2 individuals per transect from 2011 to 2018 and rose to an average of 4 individuals per transect in 2020 (Fig. 26a; $P = 0.035$). On average less than 1 individual per transect was documented for 2011 and 2012 for San Antinio Viejo Ranch and by 2020 the average was 10 Lark Sparrows per transect (Fig. 26b; $P = 0.001$). Likewise, Santa Rosa Ranch had a similar pattern with a rise to an average of 17 Lark Sparrows per transect in 2020 (Fig. 26c; $P = 0.004$).

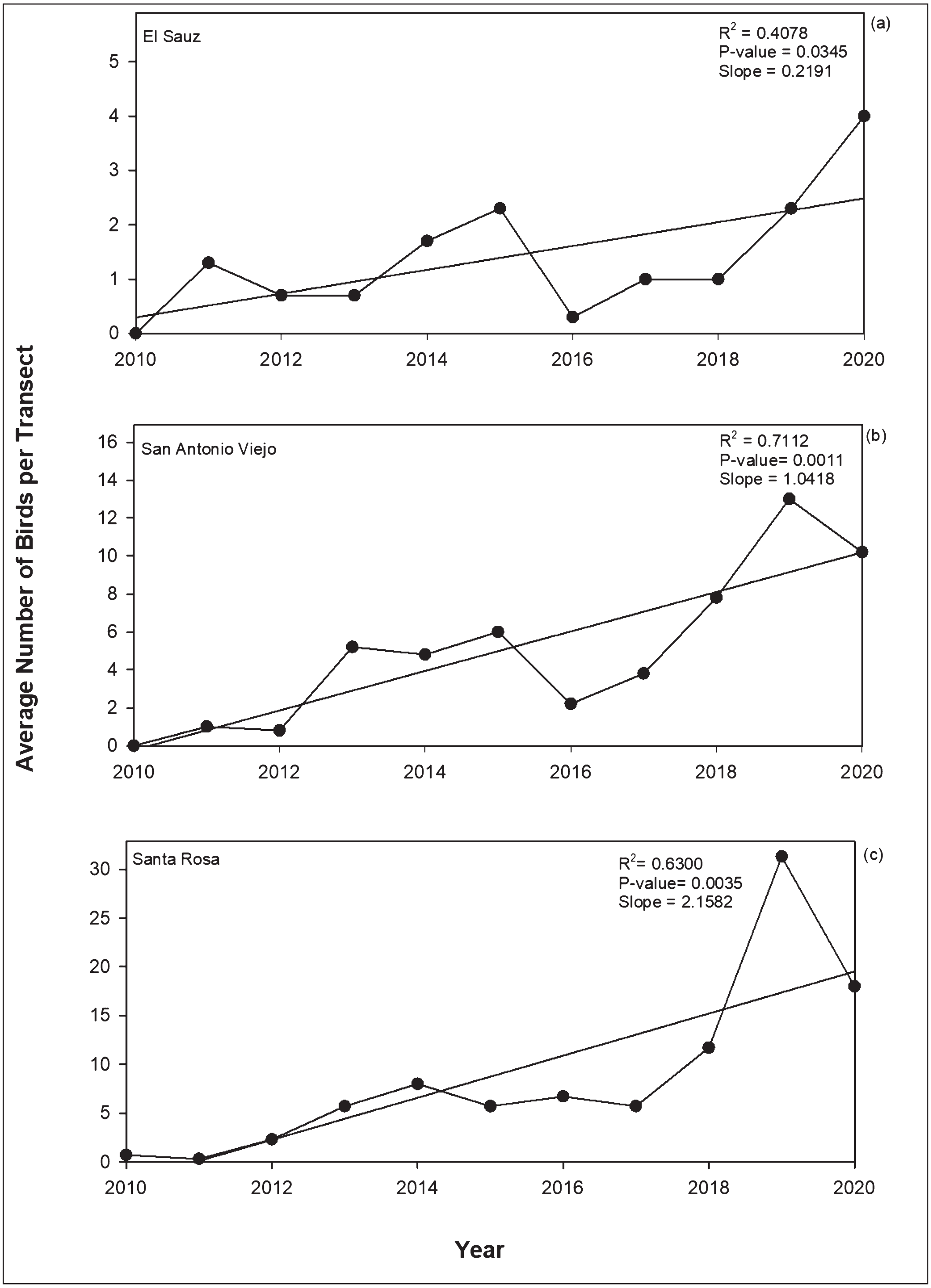

Figure 26. Non-breeding populations of Lark Sparrow on East Foundation ranches from 2010-2020.

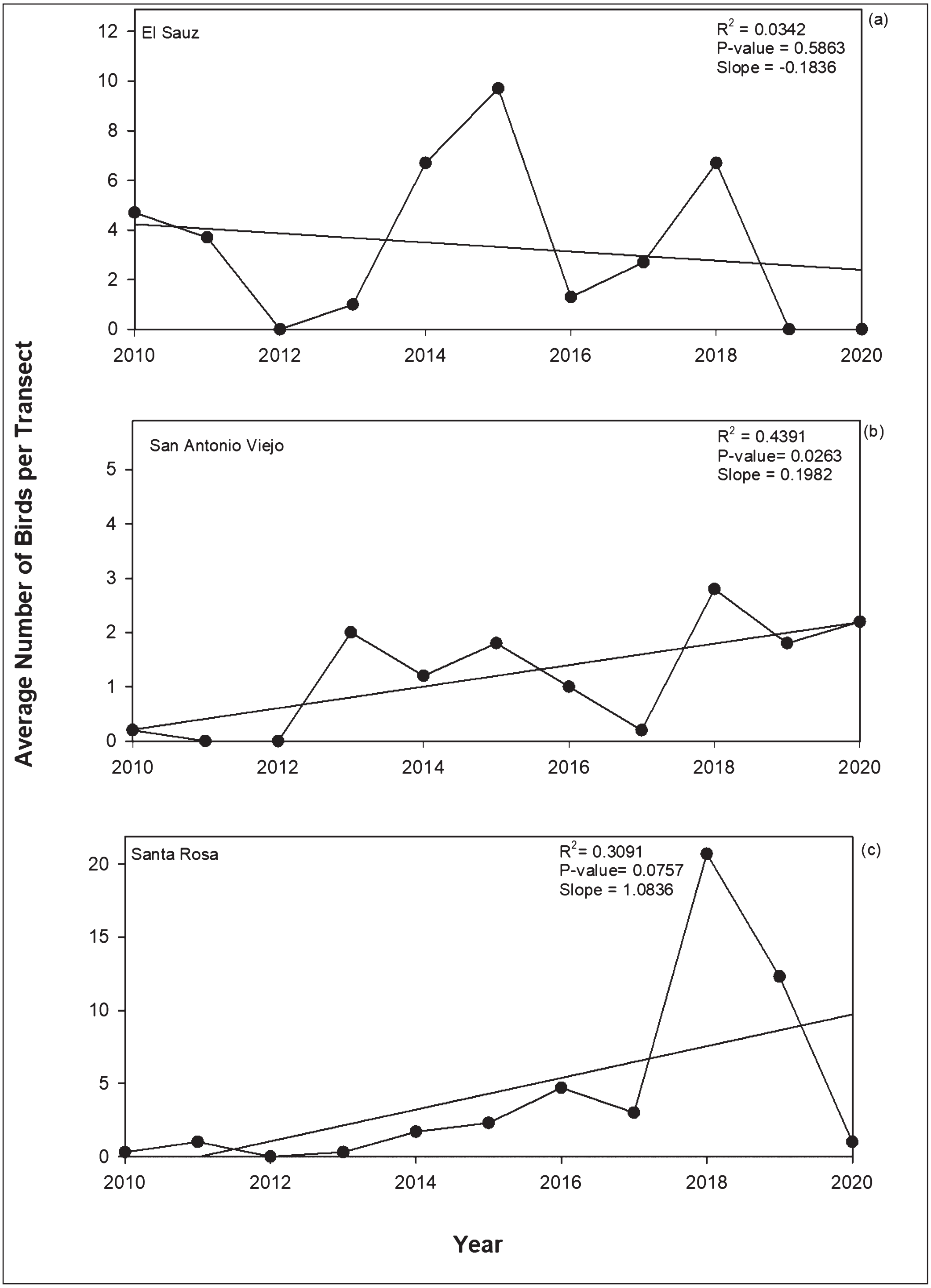

Figure 27. Non-breeding populations of Lincoln's Sparrow on East Foundation ranches from 2010-2020.

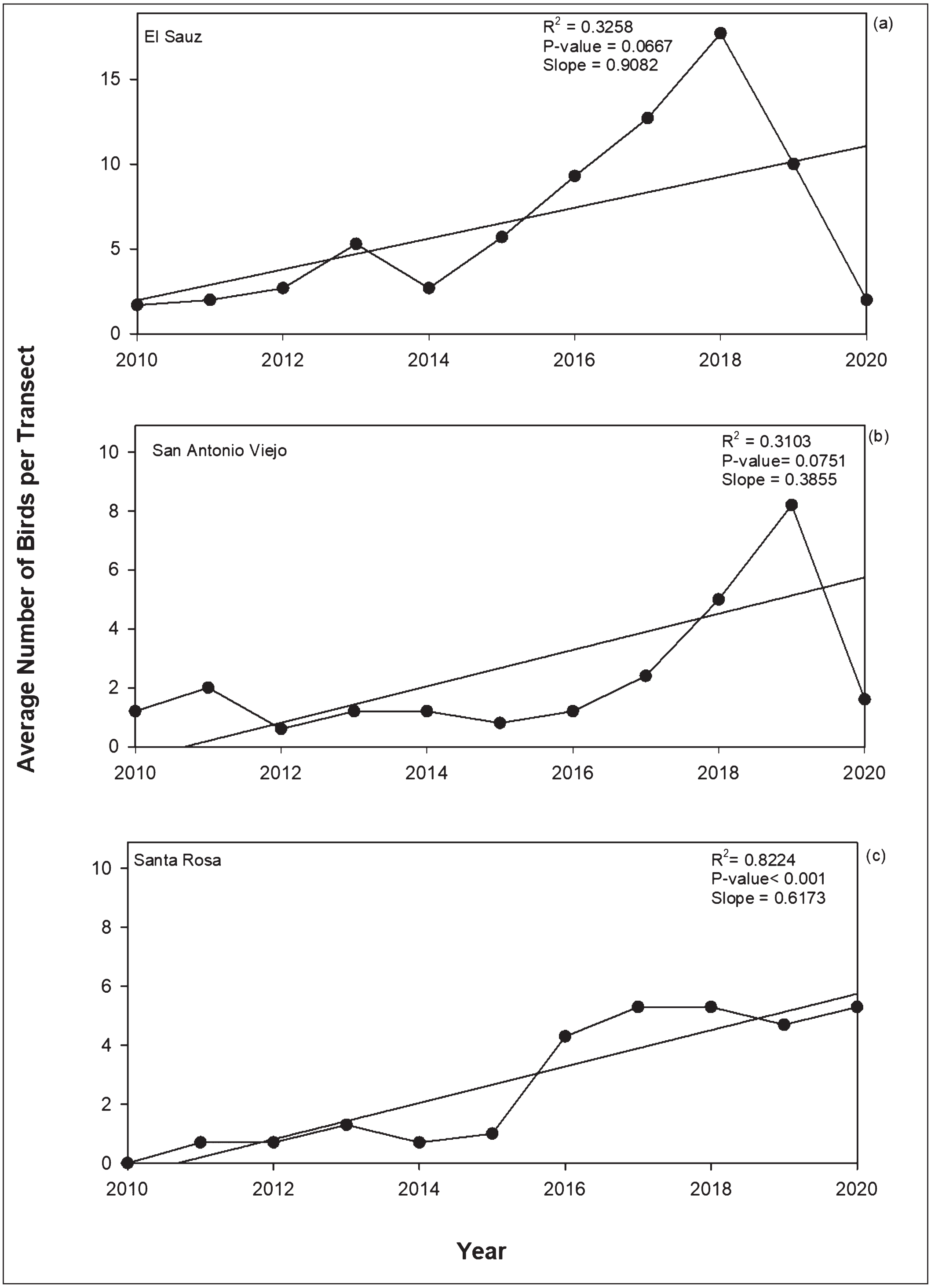

Figure 28. Non-breeding populations of Long-billed Thrasher on East Foundation ranches from 2010-2020.

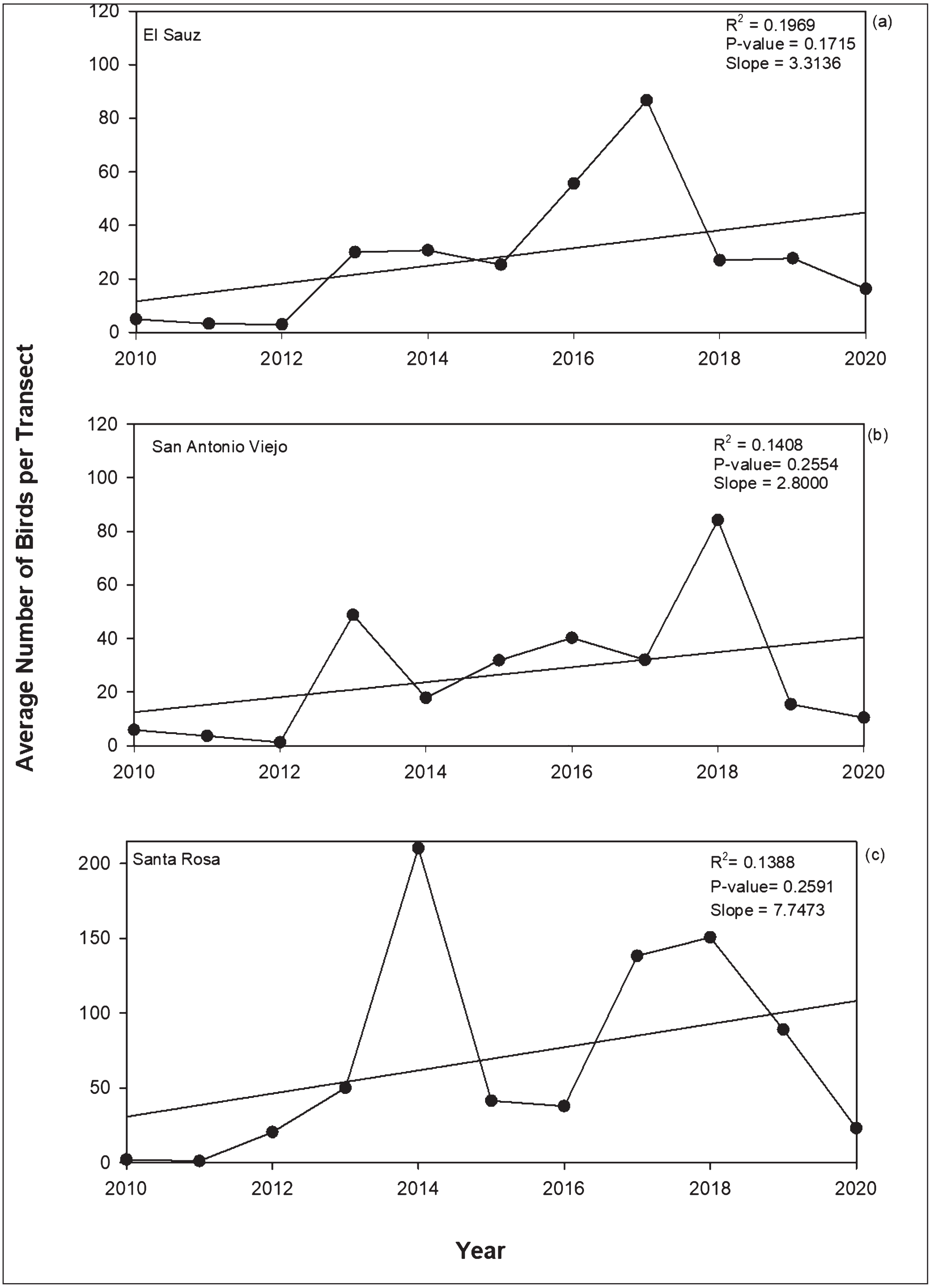

Figure 29. Non-breeding populations of Mourning Dove on East Foundation ranches from 2010-2020.

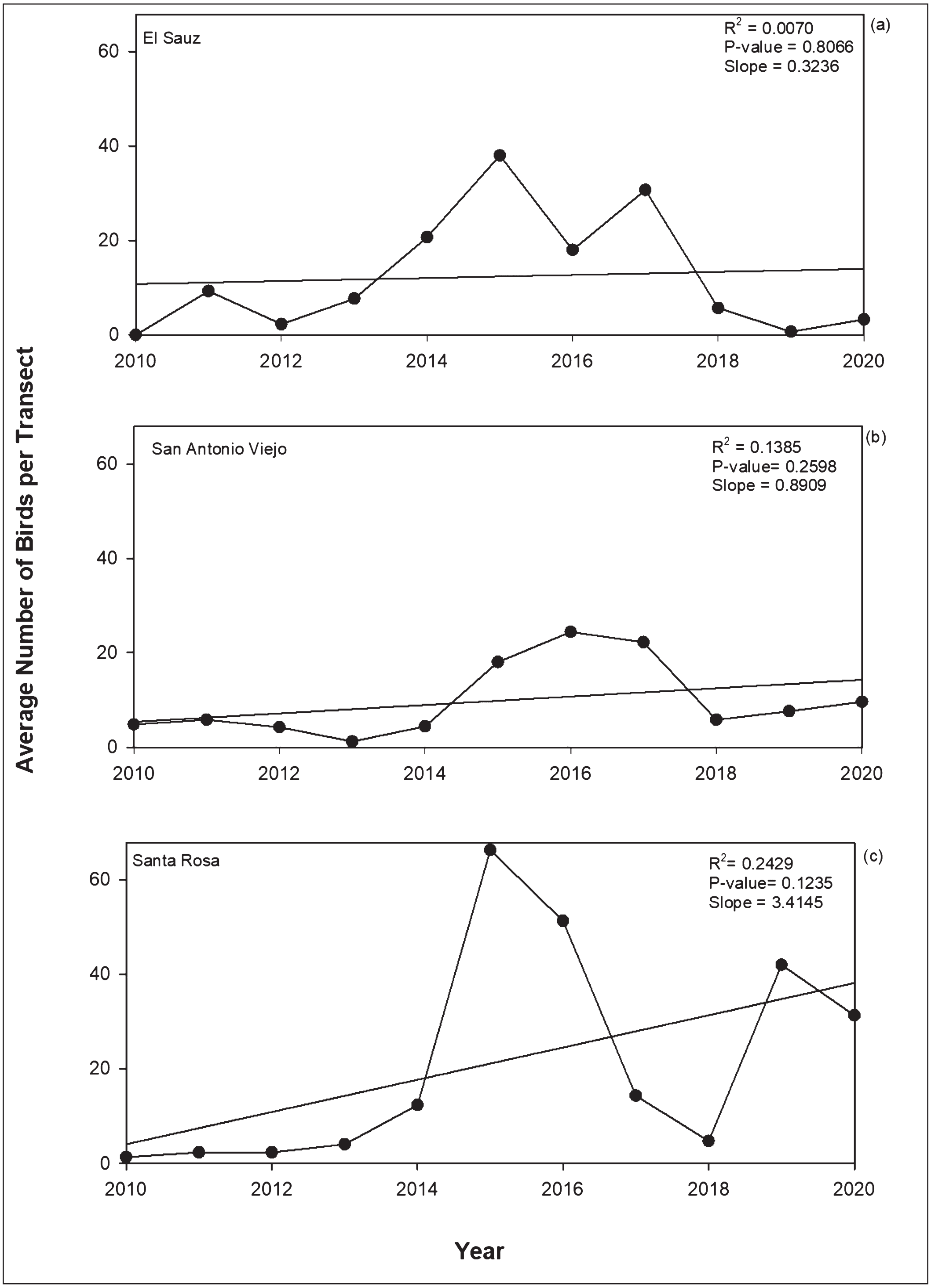

Figure 30. Non-breeding populations of Northern Bobwhite on East Foundation ranches from 2010-2020.

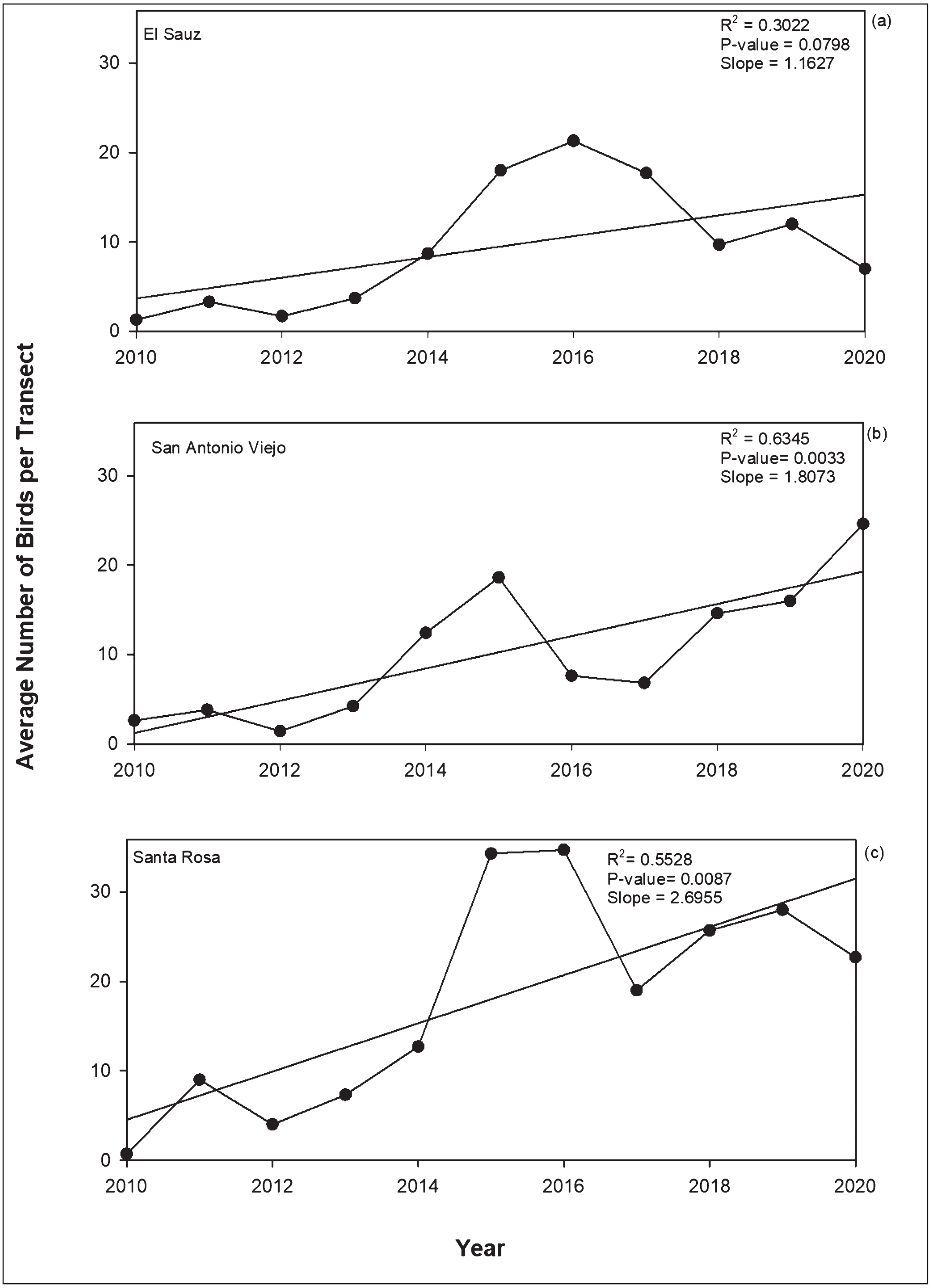

Figure 31. Non-breeding populations of Northern Cardinal on East Foundation ranches from 2010-2020.

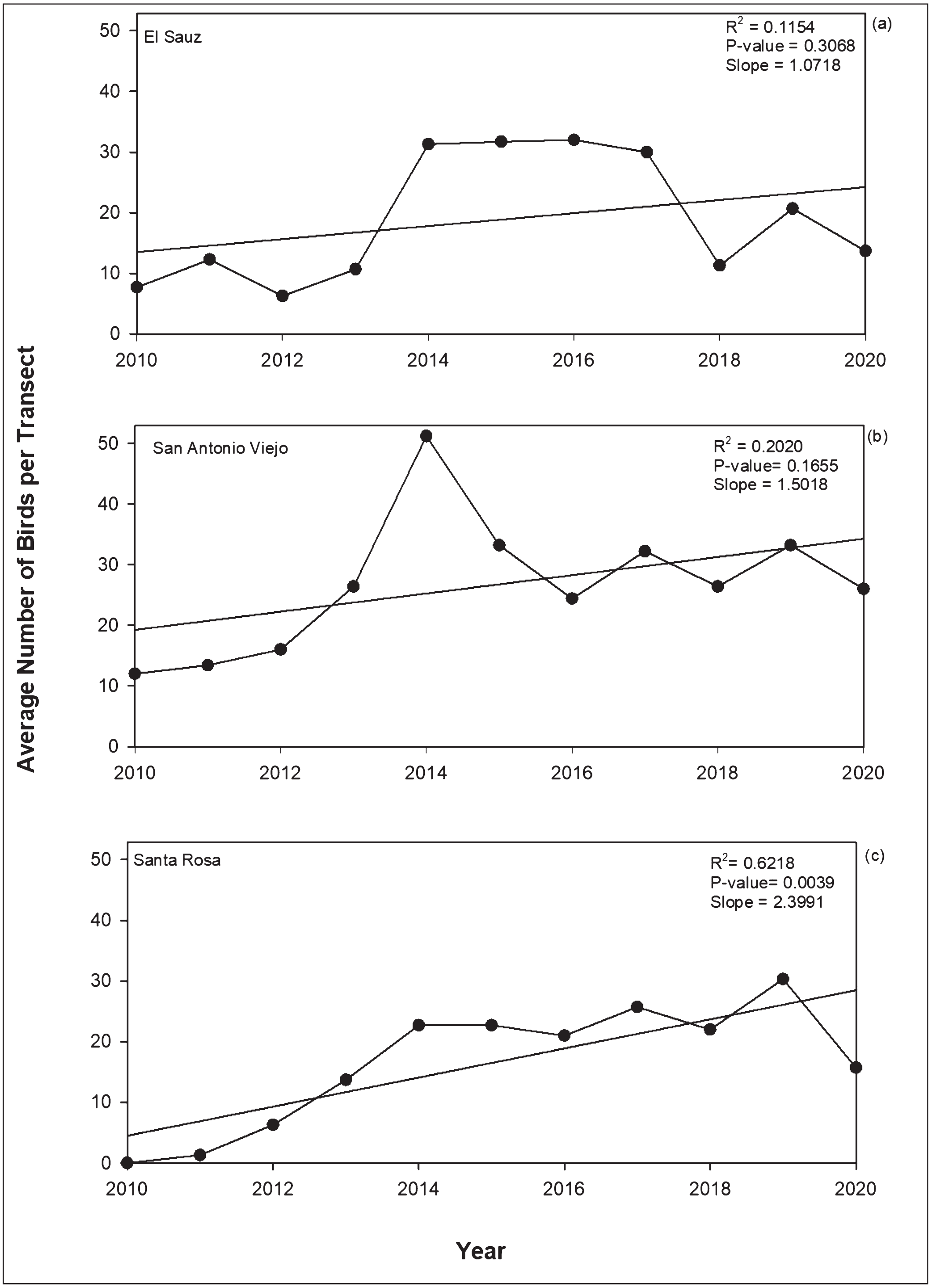

Figure 32. Non-breeding populations of Northern Mockingbird on East Foundation ranches from 2010-2020.

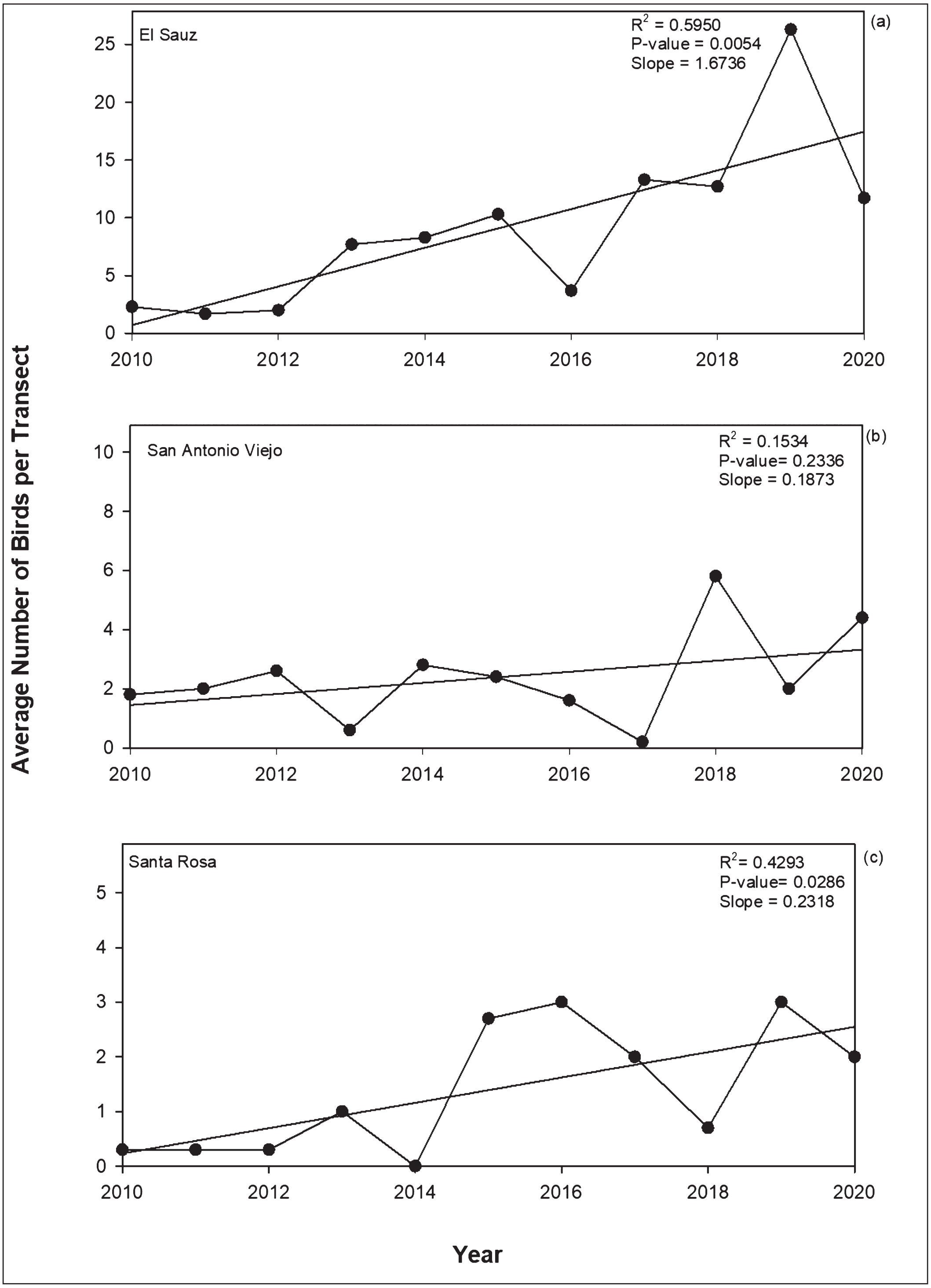

Figure 33. Non-breeding populations of Olive Sparrow populations on East Foundation ranches from 2010-2020.

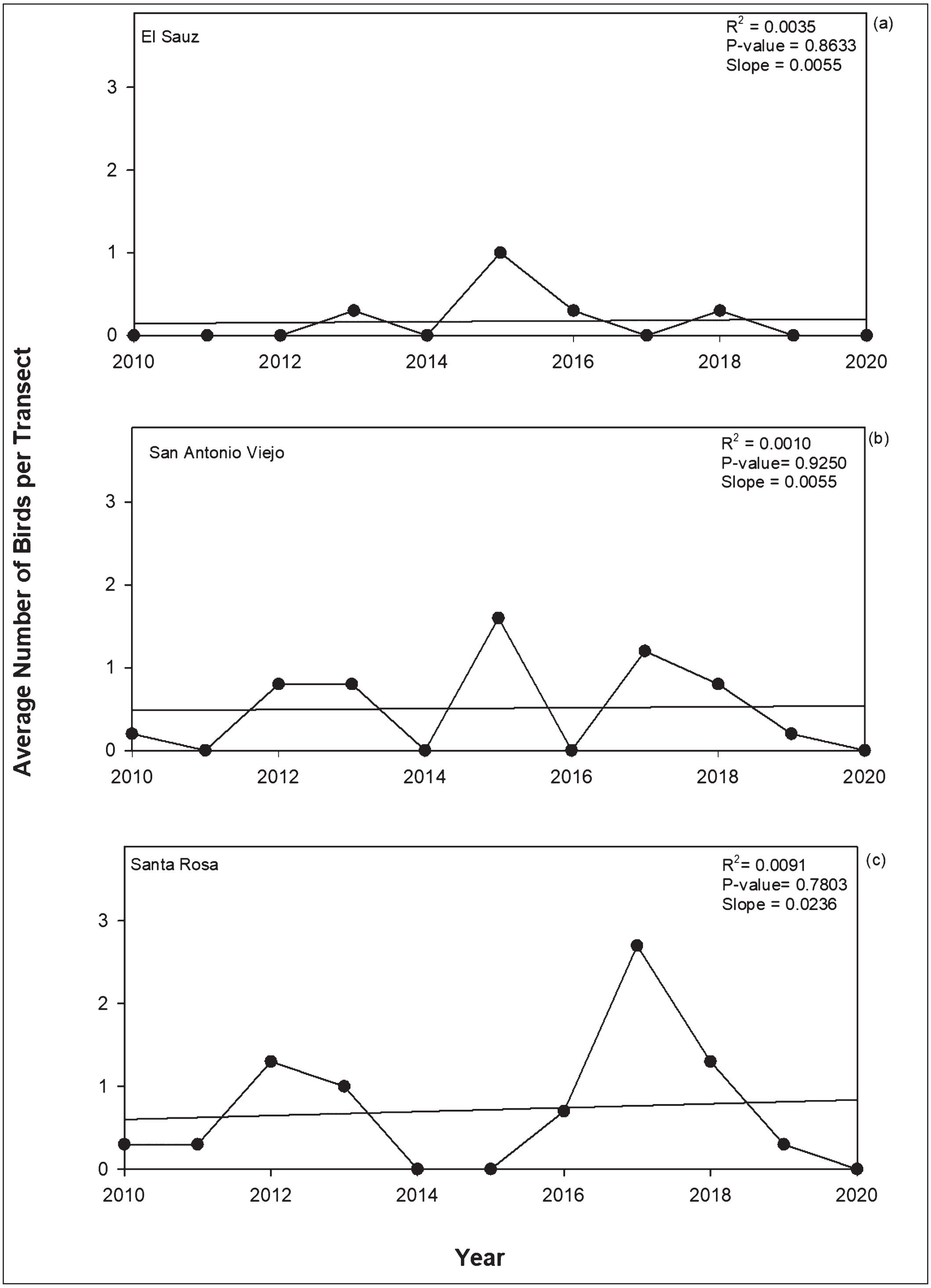

Figure 34. Non-breeding populations of Painted Bunting populations on East Foundation ranches from 2010-2020.

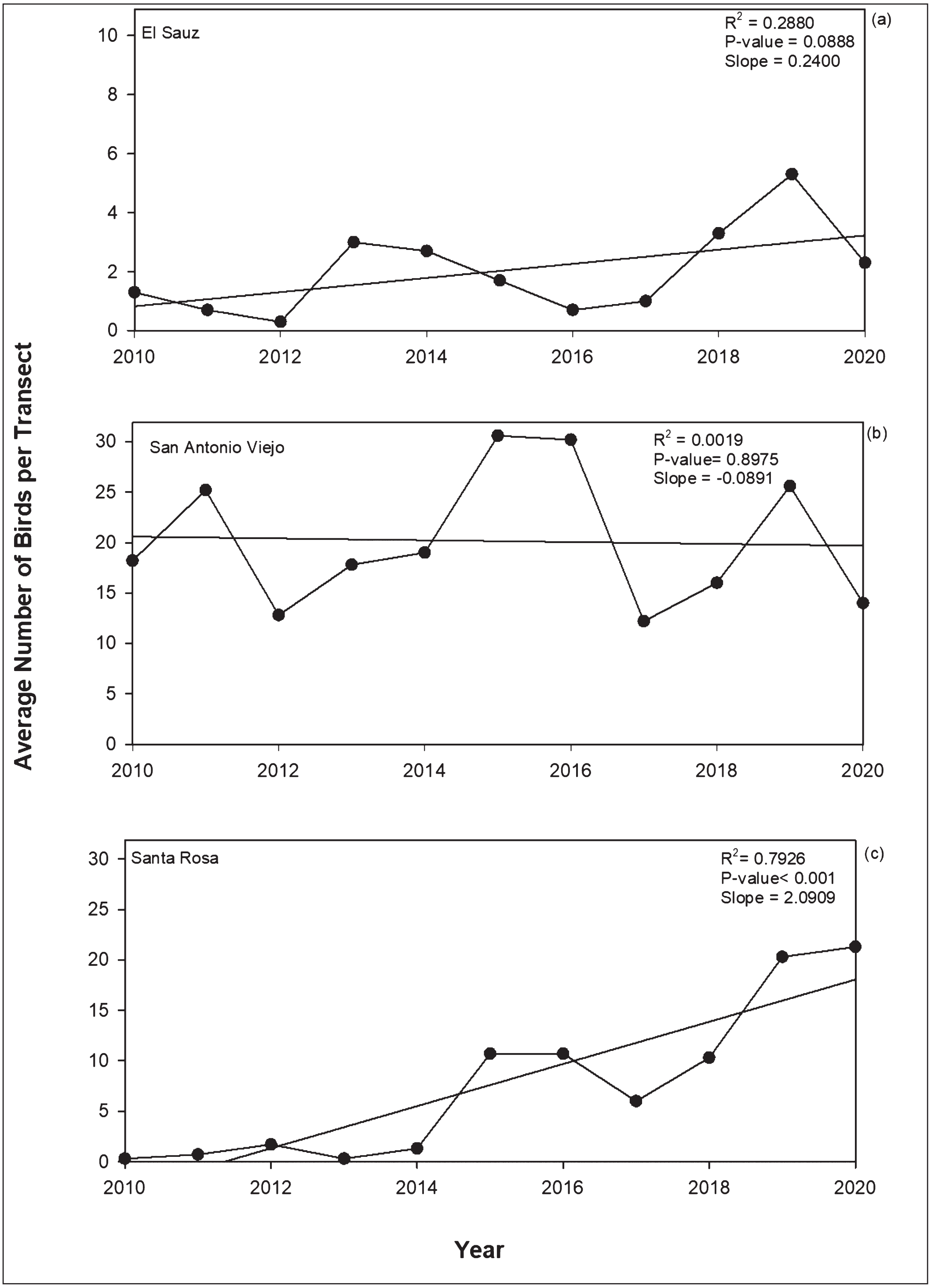

Figure 35. Non-breeding populations of Pyrrhuloxia on East Foundation ranches from 2010-2020.

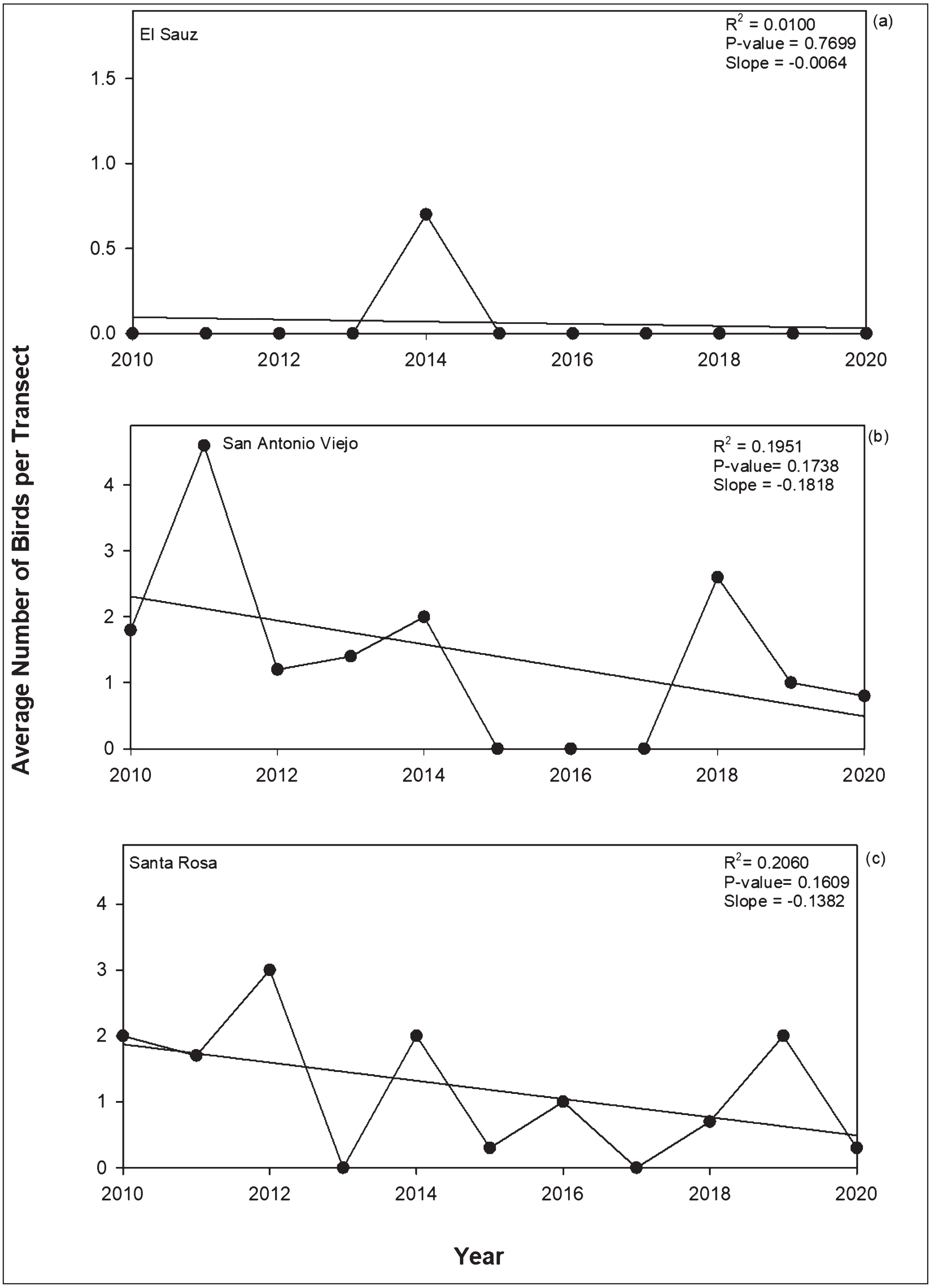

Figure 36. Non-breeding populations of Vesper Sparrow on East Foundation ranches from 2010-2020.

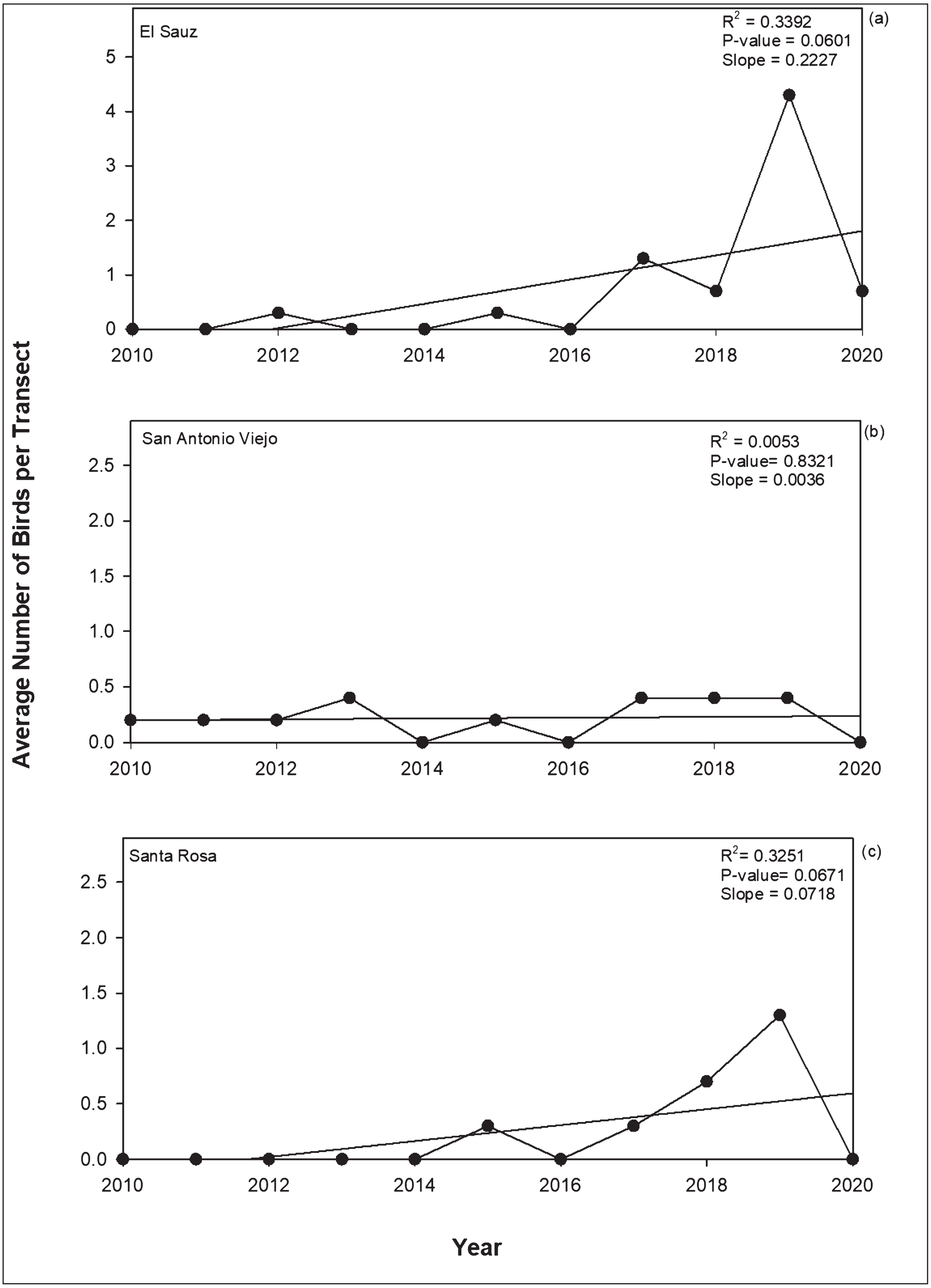

Figure 37. Non-breeding populations of White-tipped Dove on East Foundation ranches from 2010-2020.

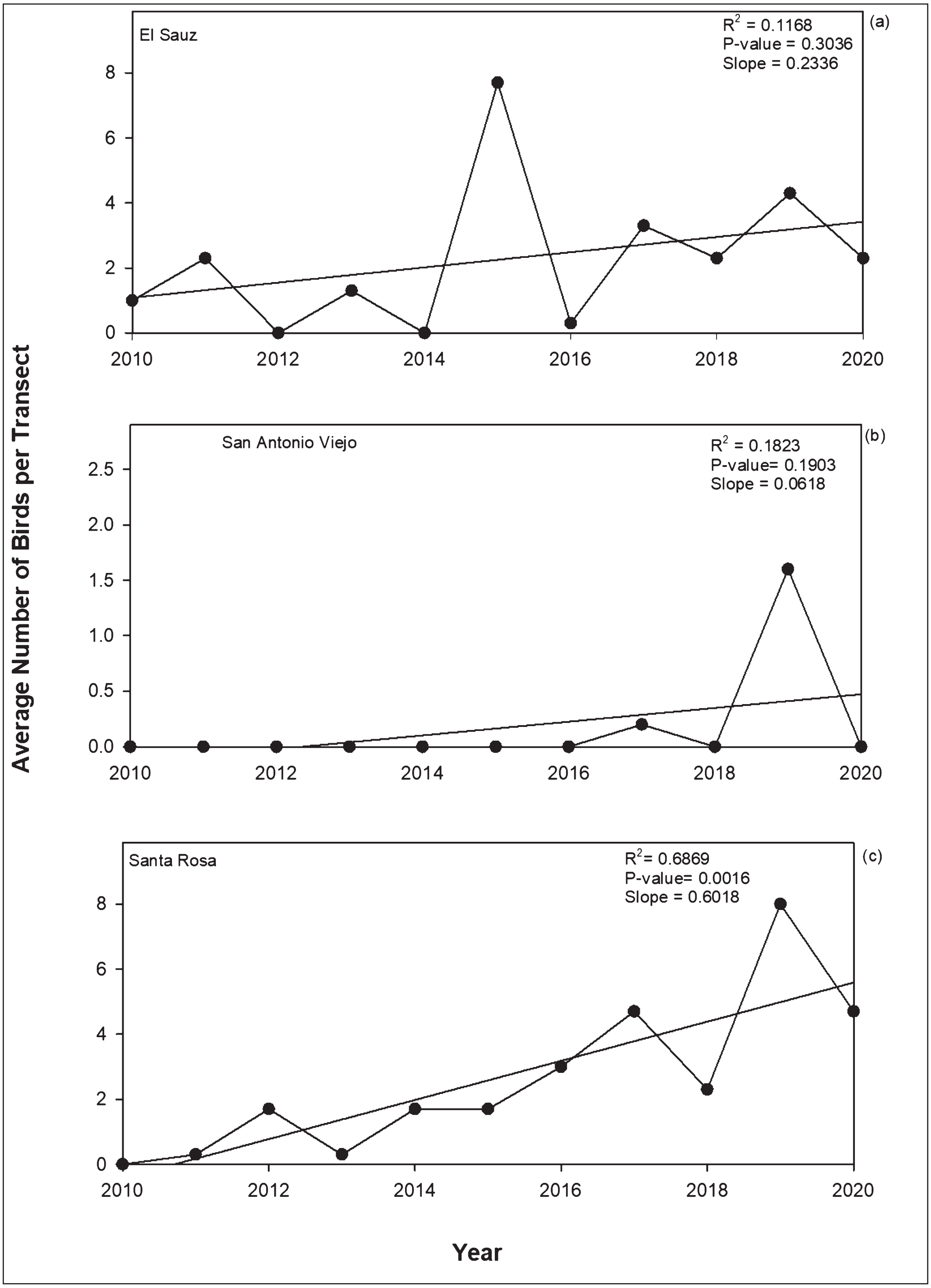

Figure 38. Non-breeding populations of Wild Turkey on East Foundation ranches from 2010-2020.

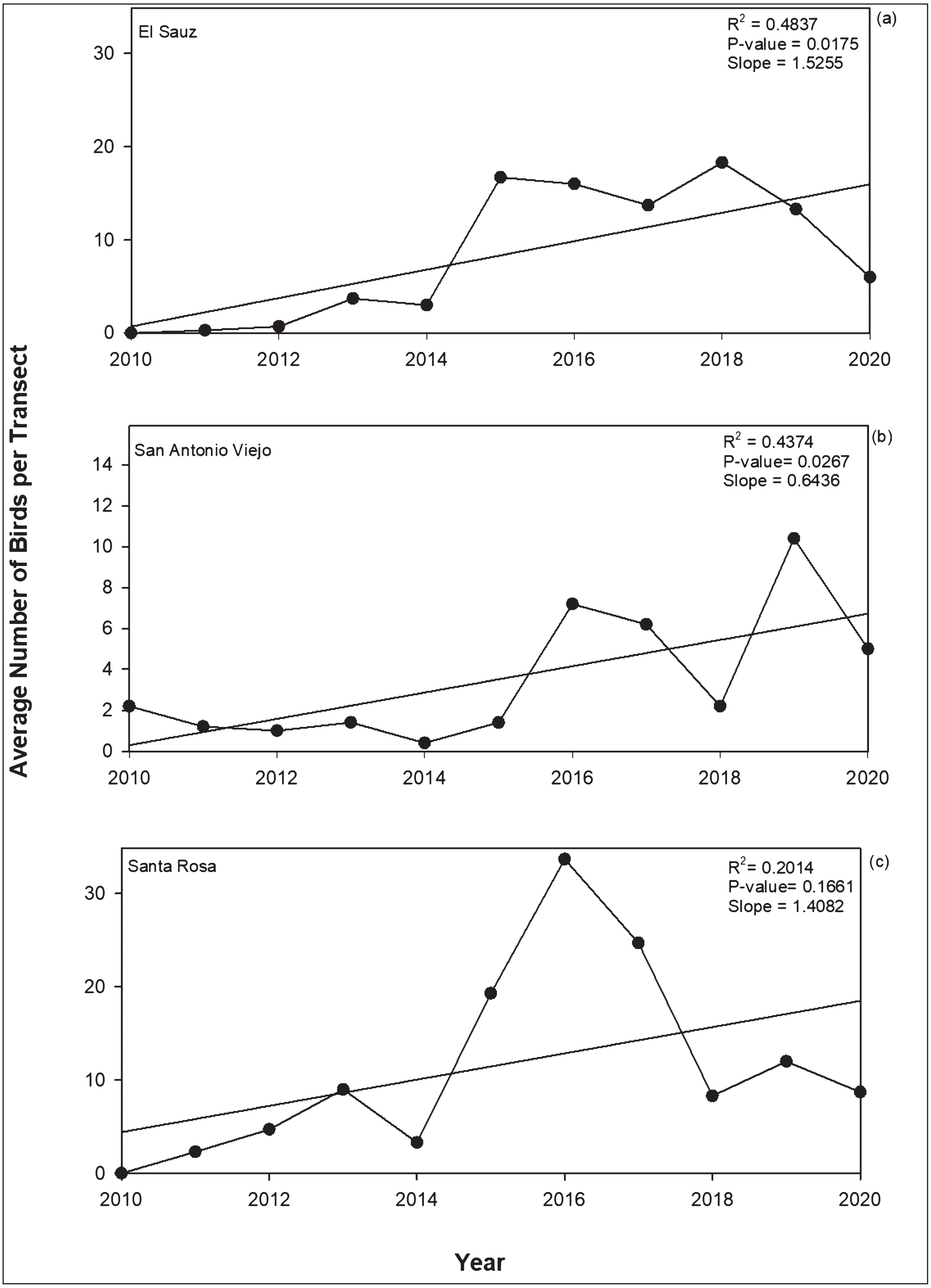

Figure 39. Non-breeding populations of Green Jay on East Foundation ranches from 2010-2020.

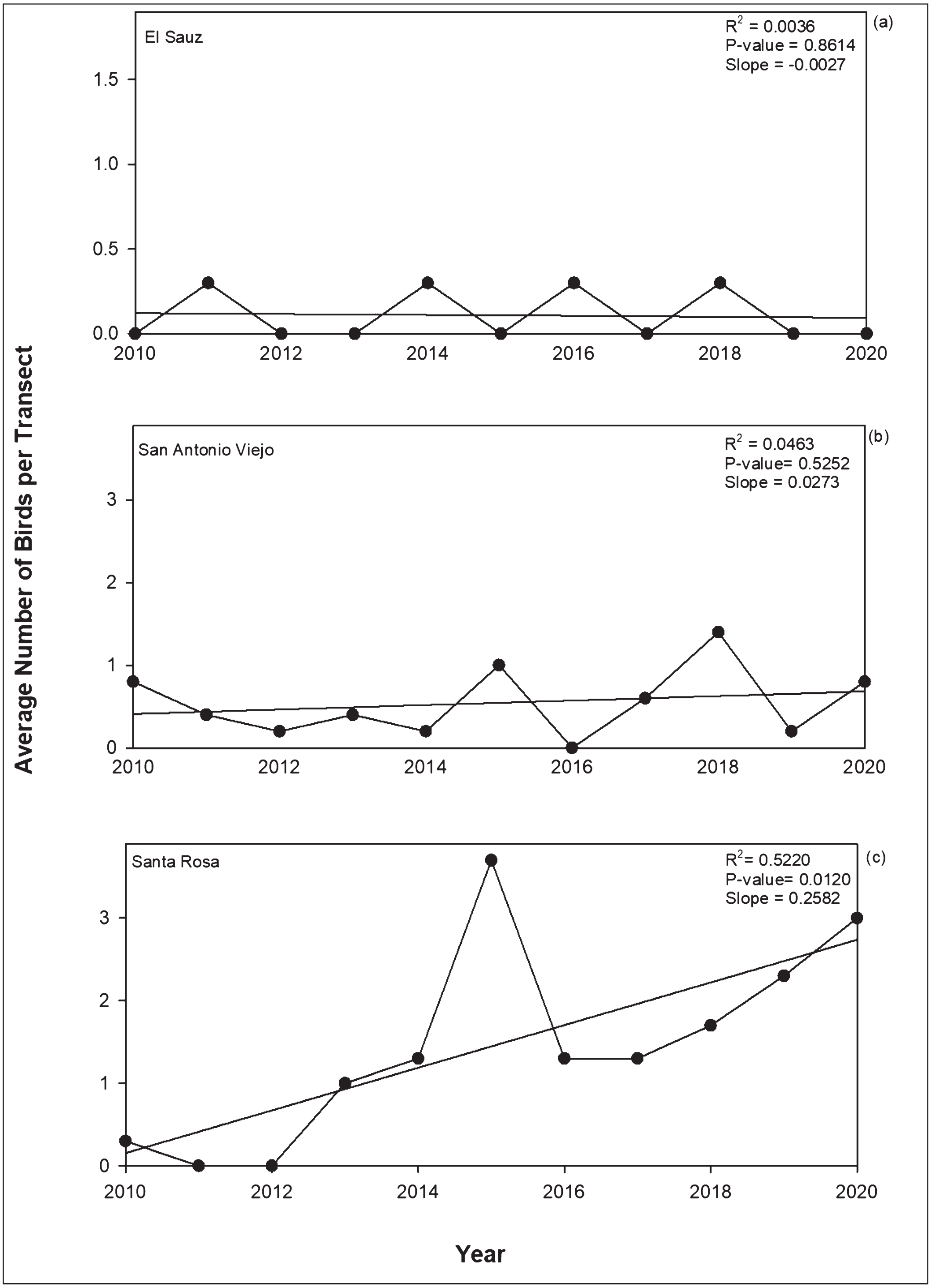

Figure 40. Non-breeding populations of American Kestrel on East Foundation ranches from 2010-2020.

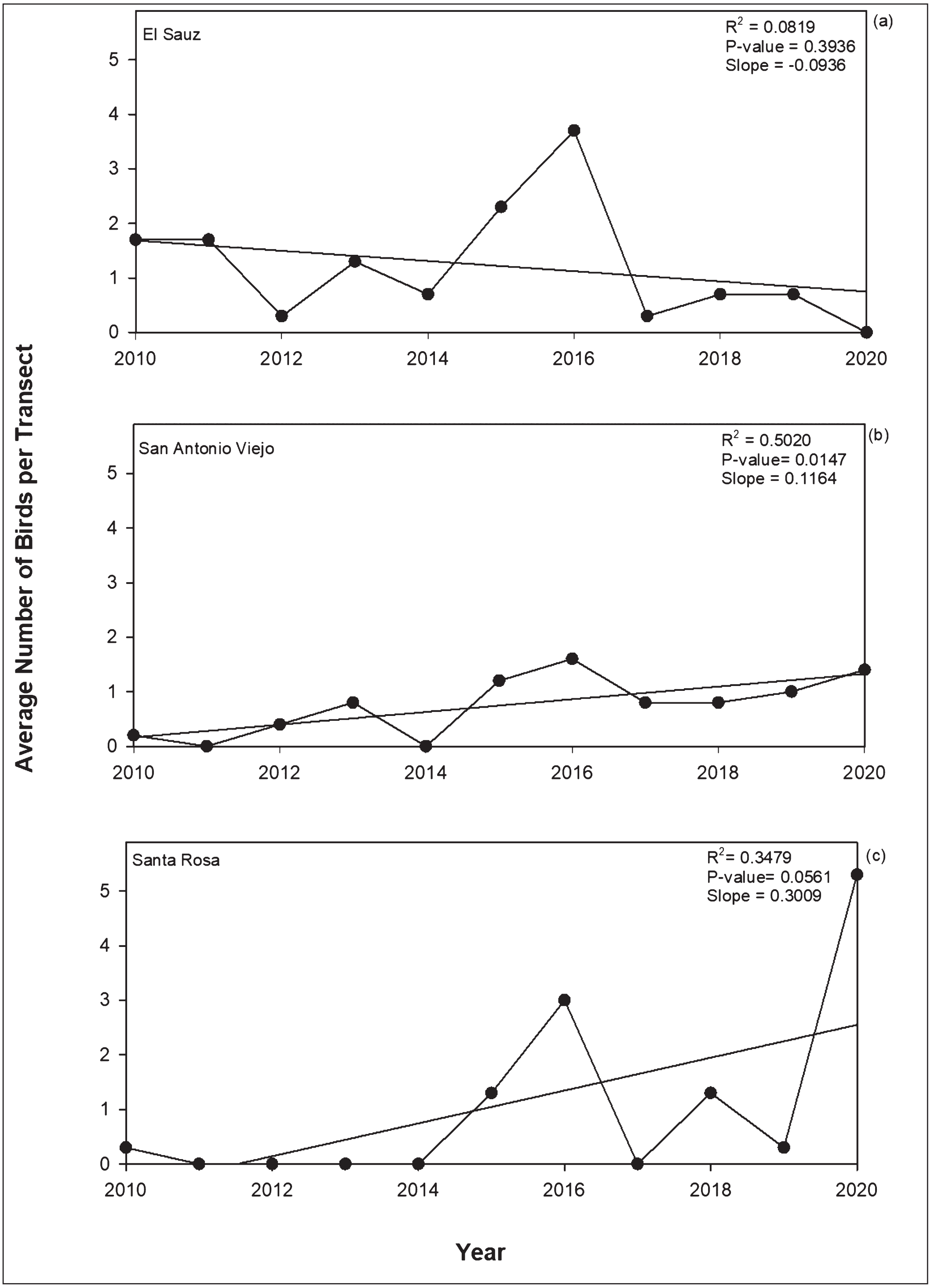

Figure 41. Non-breeding populations of Harris's Hawk on East Foundation ranches from 2010-2020.

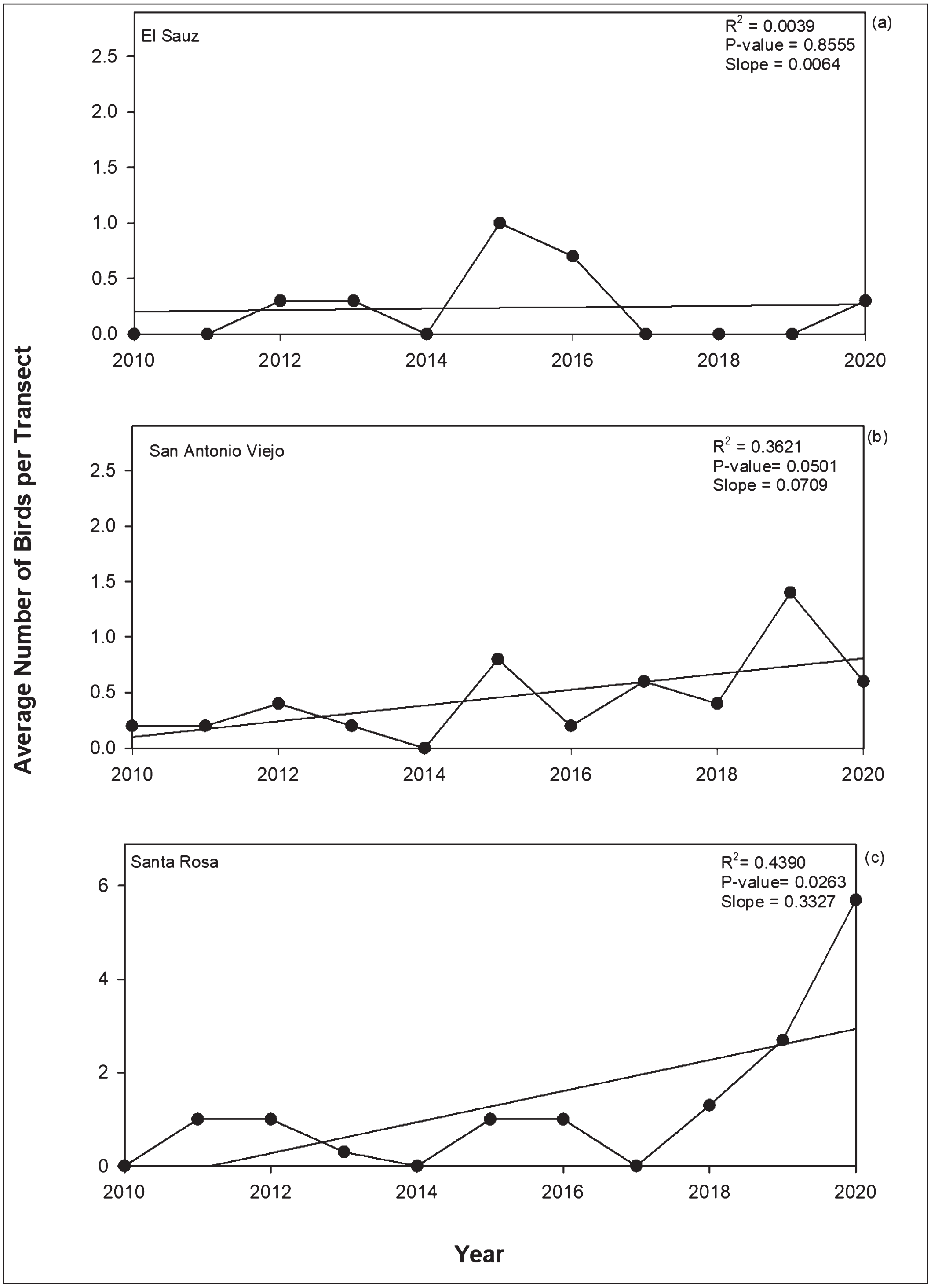

Figure 42. Non-breeding populations of Red-tailed Hawk on East Foundation ranches from 2010-2020.

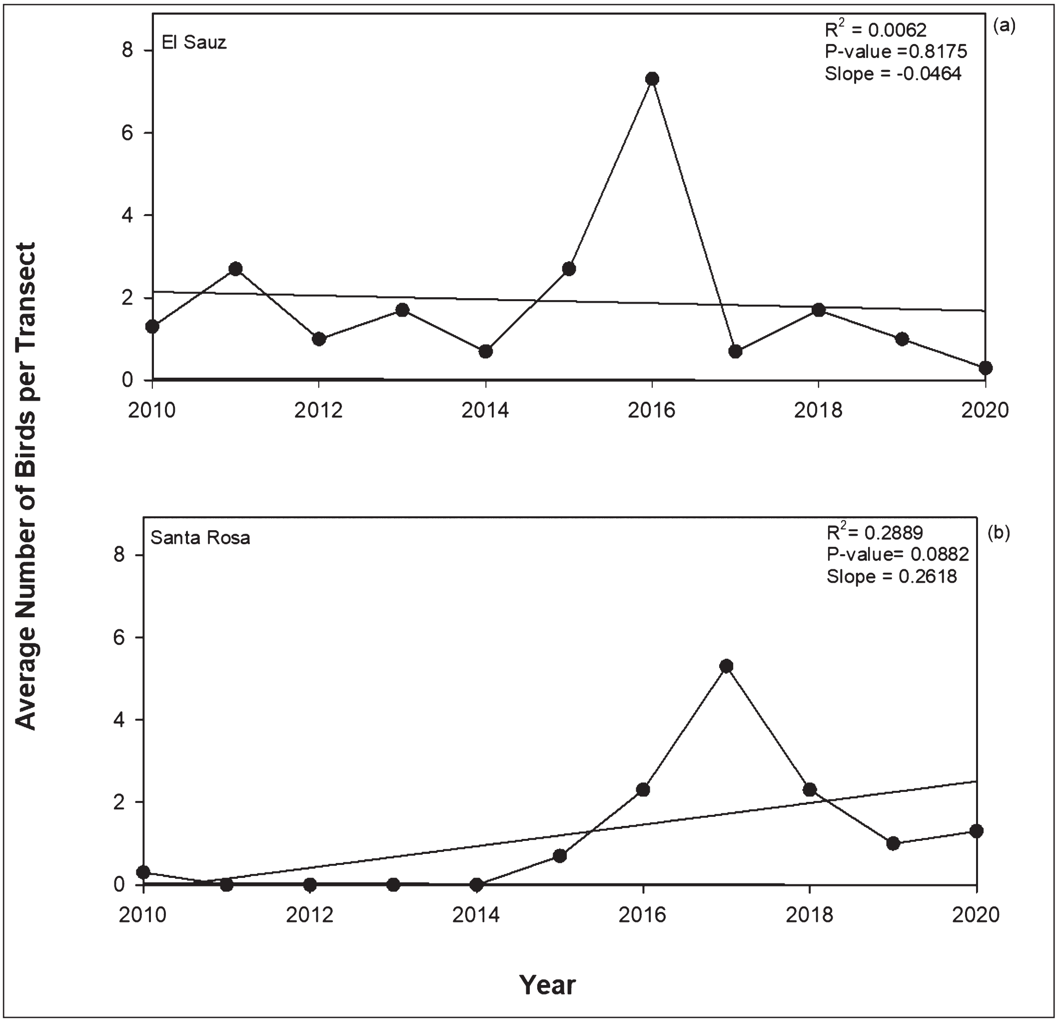

Figure 43. Non-breeding populations of Black Vulture on East Foundation ranches from 2010-2020.

Lincoln's Sparrows (*Melospiza lincolnii*) (Fig. 27) were detected on all three ranches during the non-breeding season. Lincoln's Sparrows detected more often on El Sauz and Santa Rosa ranches (Figs. 27a and 27c) than on San Antonio Viejo Ranch (Fig. 27b). However, the population on San Antonio Viejo Ranch experienced a significant increasing trend (P = 0.026), while the populations on El Sauz and Santa Rosa ranches had no significant trends. The population on Santa Rosa Ranch averaged between zero and 5 individuals per transect from 2010 to 2017, and in 2018 the population experienced a large increase to an average of 20 individuals per transect.

Long-billed Thrashers (*Toxostoma longirostre*) (Fig. 28) were detected on all three ranches during the non-breeding season. Long-billed Thrashers were more common on El Sauz Ranch (Fig. 28a) than on San Antonio Viejo and Santa Rosa ranches (Figs. 28b and 28c). The average number of Long-billed Thrashers per transect increased during 2016-2019 in all locations, but this trend was only significant for the Santa Rosa Ranch population (P < 0.001).

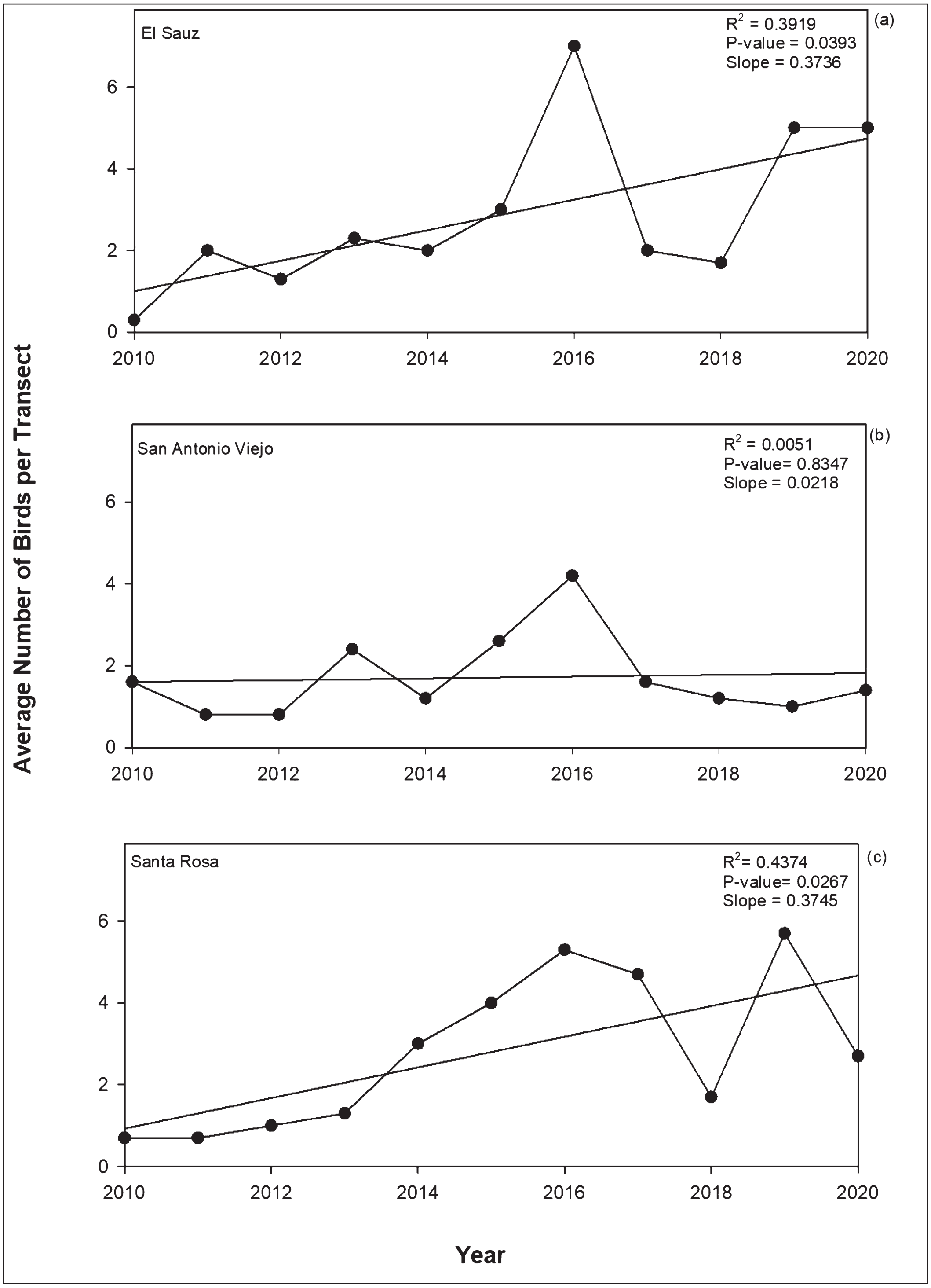

Figure 44. Non-breeding populations of Crested Caracara on East Foundation ranches from 2010-2020.

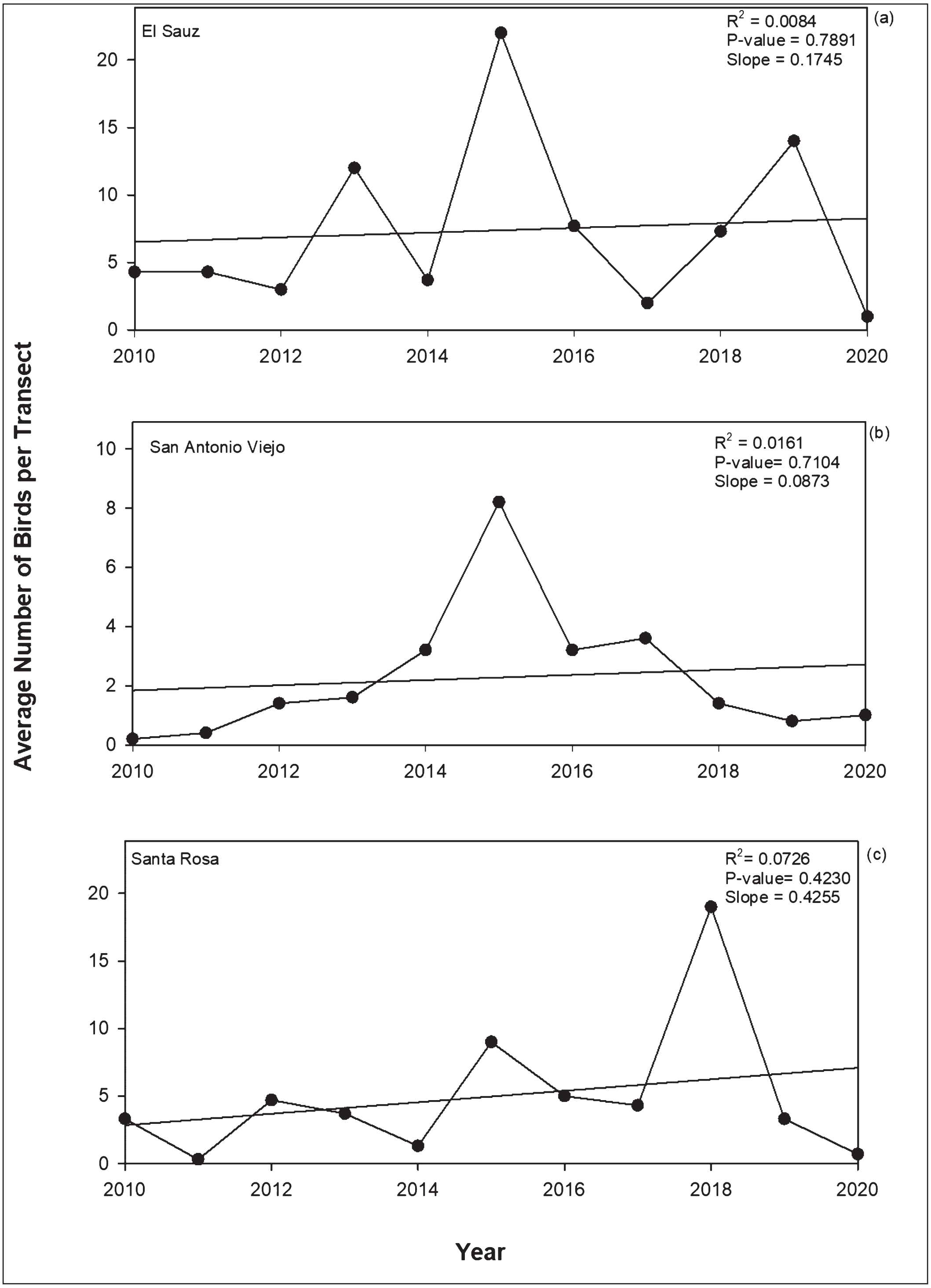

Figure 45. Non-breeding populations of Turkey Vulture on East Foundation ranches from 2010-2020.

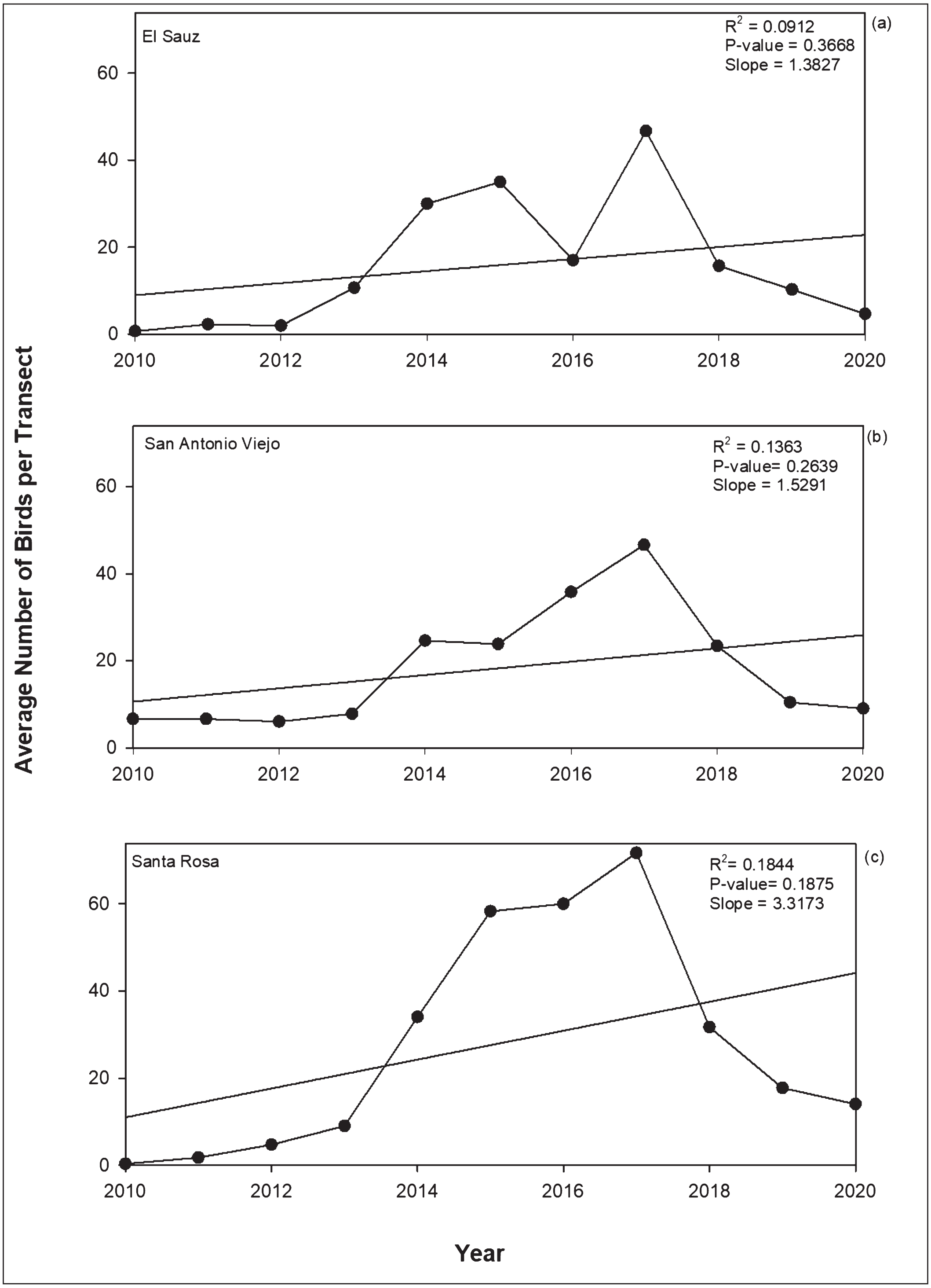

Figure 46. Non-breeding populations of Bewick's Wren on East Foundation ranches from 2010-2020.

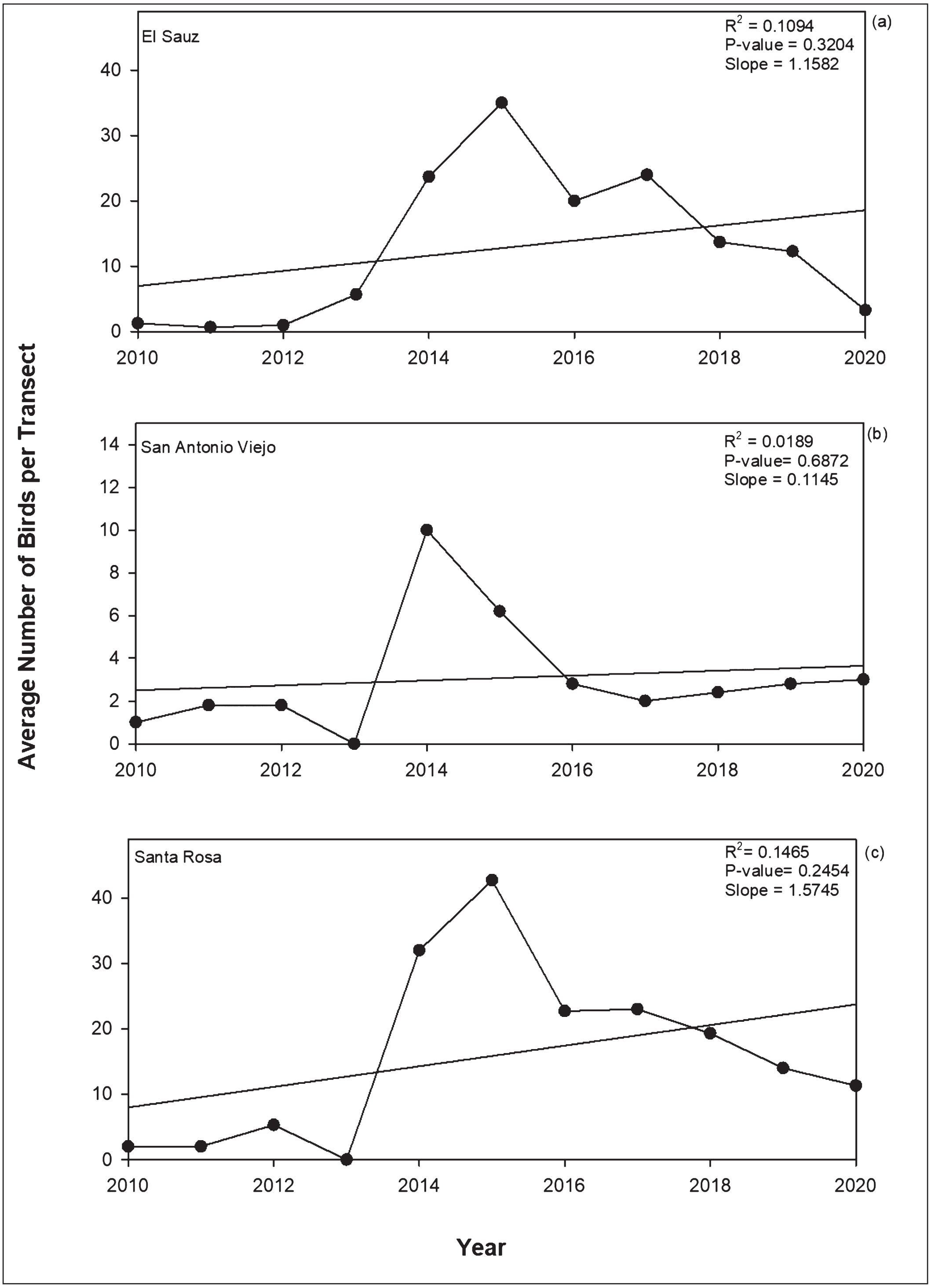

Figure 47. Non-breeding populations of Black-crested Titmouse on East Foundation ranches from 2010-2020.

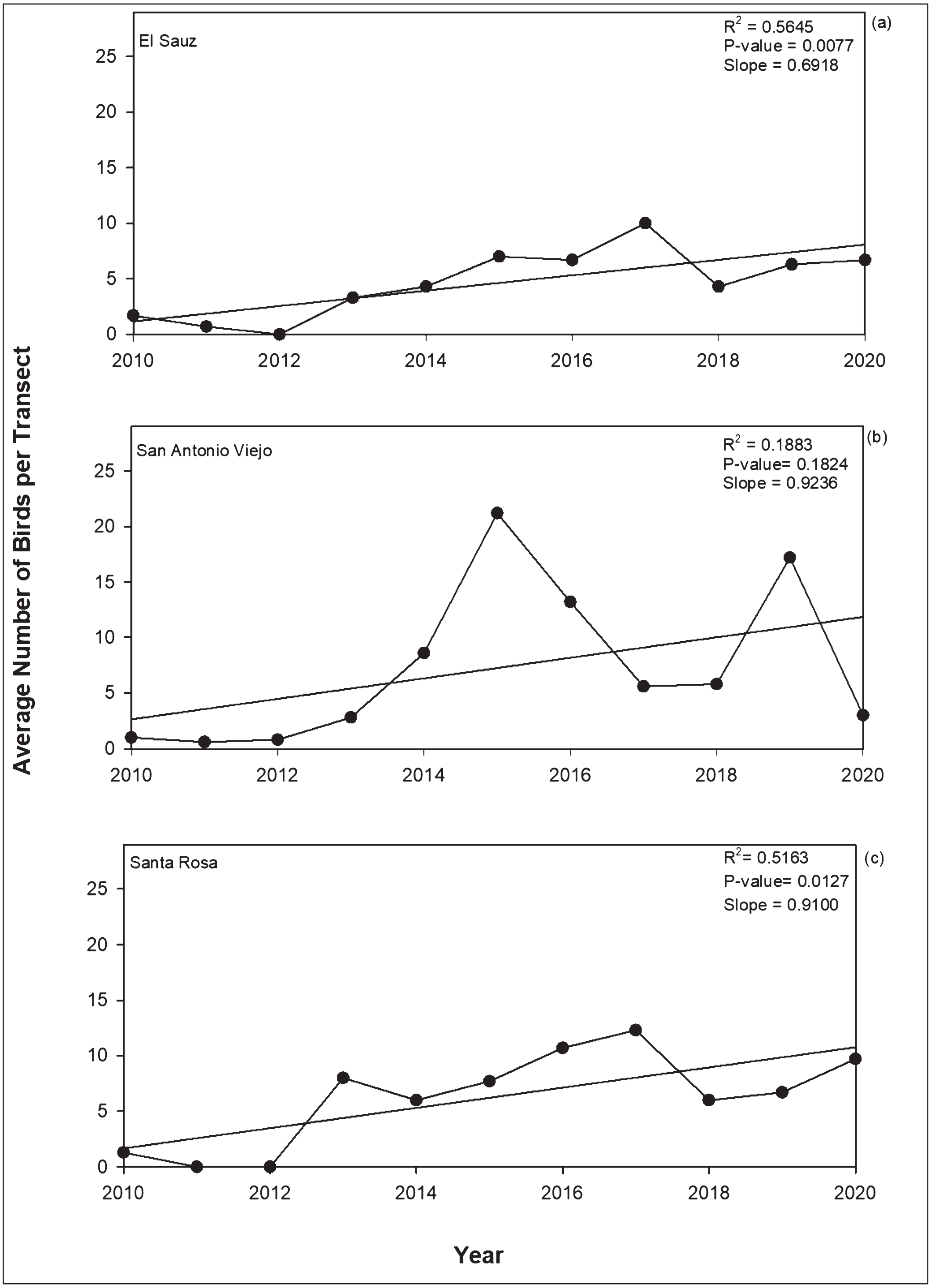

Figure 48. Non-breeding populations of Blue-gray Gnatcatcher on East Foundation ranches from 2010-2020.

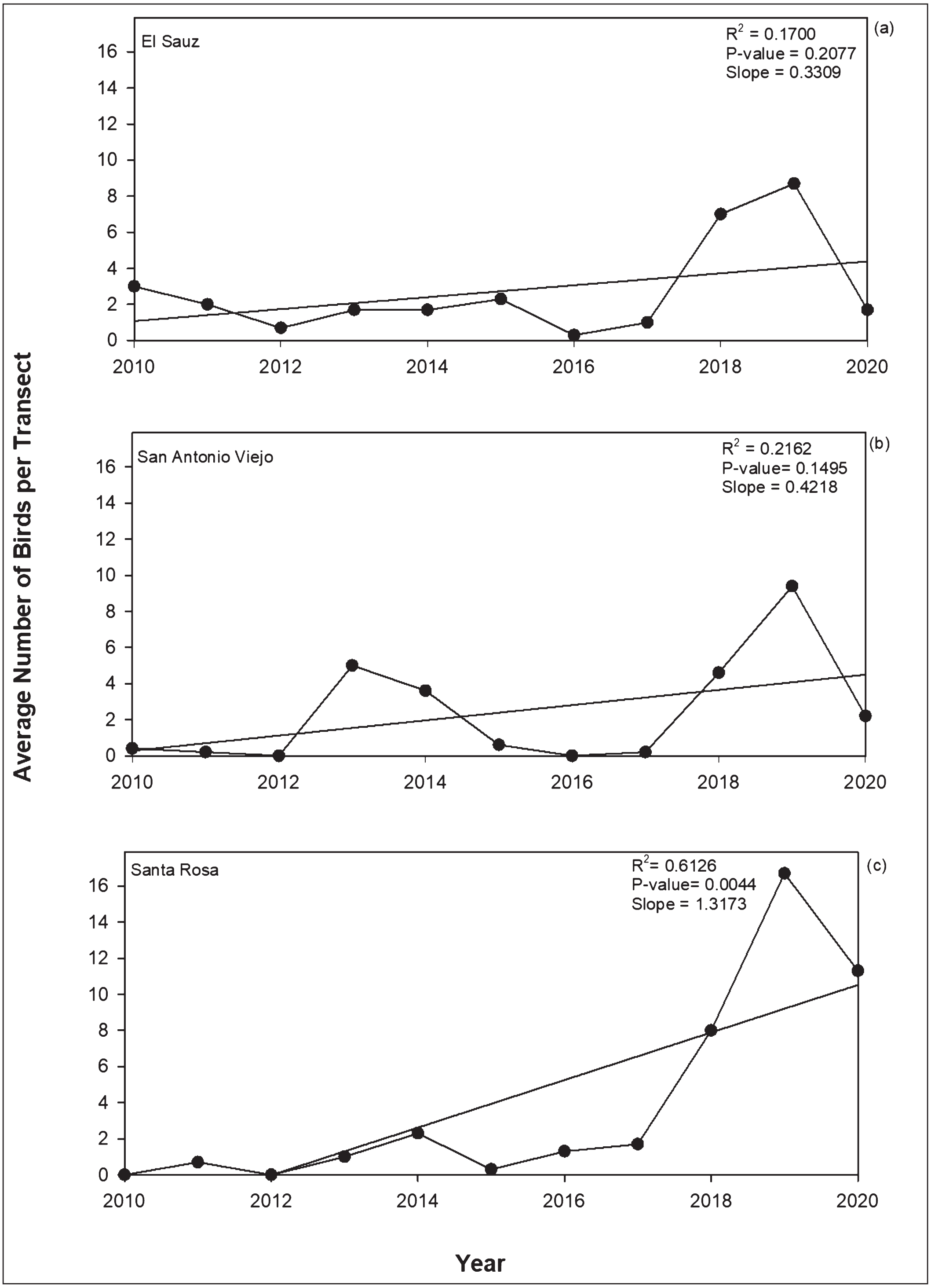

Figure 49. Non-breeding populations of House Wren on East Foundation ranches from 2010-2020.

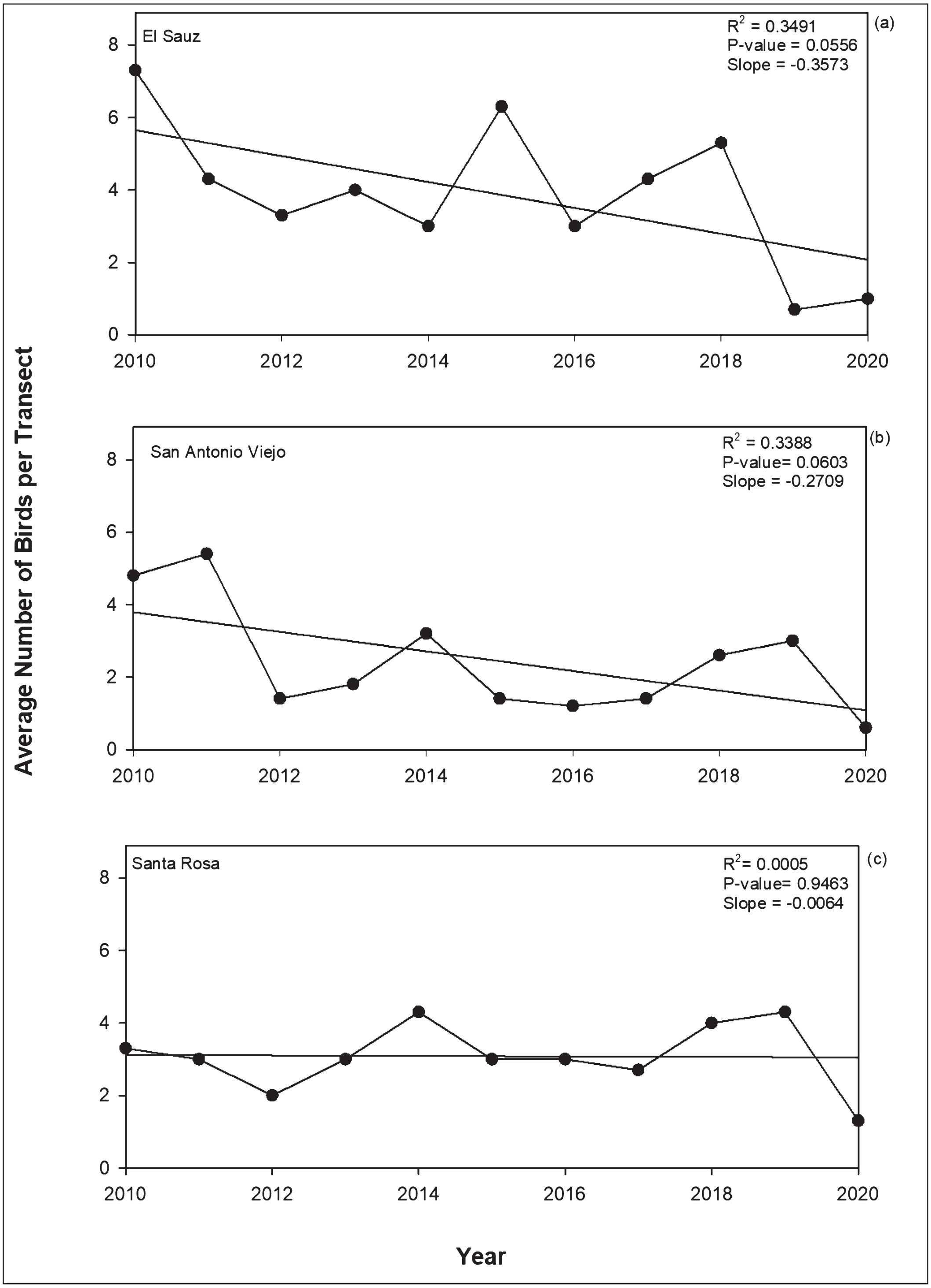

Figure 50. Non-breeding populations of Orange-crowned Warbler on East Foundation ranches from 2010-2020.

Mourning Doves (*Zenaida macroura*) (Fig. 29) were detected on all three ranches during the non-breeding season. Mourning Doves were very abundant on all three ranches. They were more common on Santa Rosa Ranch (Fig. 29c) compared to El Sauz and San Antonio Viejo ranches (Figs. 29a and 29b). In 2017 the El Sauz Ranch population peaked at an average of 90 individuals per transect. On San Antonio Viejo Ranch Mourning Doves experienced spikes in population in both 2013 and 2018. The population on Santa Rosa Ranch peaked in 2014 at an average of 210 individuals per transect. The population increased again in 2017 and 2018 to an average of 150 individuals per transect before decreasing to previous levels.

Northern Bobwhites (*Colinus virginianus*) (Fig. 30) were detected on all 3 ranches during the non-breeding season. Northern Bobwhites were common on all ranches but detected in greater numbers on El Sauz and Santa Rosa ranches (Figs. 30a and 30c) compared to San Antonio Viejo Ranch (Fig. 30b). The El Sauz and San Antonio Viejo ranches populations remained stable and followed similar patterns. The Santa Rosa Ranch population was relatively low (average of <5 individuals per transect) from 2010 to 2014. In 2015 the Santa Rosa Ranch population peaked at an average of 70 individuals per transect before dropping back down to pre 2015 levels. The population increased again in 2019 before tapering off in 2020. However, none of these changes were statistically significant.

Northern Cardinals (*Cardinalis cardinalis*) (Fig. 31) were detected on all three ranches during the non-breeding season. The populations on Santa Rosa Ranch (Fig. 31c; $P = 0.009$) and San Antonio Viejo Ranch (Fig. 31b; $P = 0.003$) experienced significant increasing trends. Despite having no statistically significant trend, the population on El Sauz Ranch experienced increasing abundance from 2010 to 2016, and after 2016 the population began to decrease.

Northern Mockingbirds (*Mimus polyglottos*) (Fig. 32) were detected on all three ranches during the non-breeding season. Northern Mockingbirds were more common on San Antonio Viejo Ranch (Fig. 32b) and El Sauz Ranch (Fig. 32a) than on and Santa Rosa Ranch (Fig. 32c). The population on Santa Rosa Ranch experienced a significant increasing trend ($P = 0.004$), while the population changes on El Sauz and San Antonio Viejo ranches were not significant. The survey detections seemed to follow similar patterns and increases in detections at all 3 ranches were seen in 2014.

Olive Sparrows (*Arremonops rufivirgatus*) (Fig. 33) were detected on all three ranches during the non-breeding season. Olive Sparrows were more common on El Sauz Ranch (Fig. 33a) than on San Antonio Viejo and Santa Rosa ranches (Figs. 33b and 33c). The populations on El Sauz Ranch ($P = 0.005$) and Santa Rosa Ranch ($P = 0.029$) experienced a significant increasing trend.

Painted Buntings (*Passerina ciris*) (Fig. 34) were detected on all three ranches during the non-breeding season. Painted Buntings were slightly more abundant on Santa Rosa Ranch (Fig. 34c) than on El Sauz and San Antonio Viejo ranches (Figs. 34a and 34b). Changes in all three non-breeding populations were not significant.

Pyrrhuloxia (*Cardinalis sinuatus*) (Fig. 35) were detected on all three ranches during the non-breeding season. The overall abundance of Pyrrhuloxia was greater on San Antonio Viejo Ranch (Fig. 35b) than on El Sauz and Santa Rosa ranches (Figs. 35a and 35c). Transects on San Antonio Viejo Ranch had an average of 10 or more individuals per transect throughout the study period. However, the population on Santa Rosa Ranch experienced a significant increasing trend ($P < 0.001$), while El Sauz and San Antonio Viejo ranches population changes were not significant.

Vesper Sparrows (*Pooecetes gramineus*) (Fig. 36) were detected on all three ranches during the non-breeding season. Vesper Sparrows were only detected on El Sauz Ranch in 2014 (Fig. 36a). They were more common on San Antonio Viejo and Santa Rosa ranches (Figs. 36b and 36c). None of the population changes were significant.

White-tipped Doves (*Leptotila verreauxi*) (Fig. 37) were detected on all three ranches during the non-breeding season. White-tipped Doves were more frequently detected on El Sauz Ranch (Fig. 37a) than on San Antonio Viejo and Santa Rosa ranches (Figs. 37b and 37c). Despite all populations having no statistically significant trend, both El Sauz and Santa Rosa ranches increased in their average abundances throughout the last half of the study period. The population on San Antonio Viejo Ranch remained low but relatively stable throughout the entire study period.

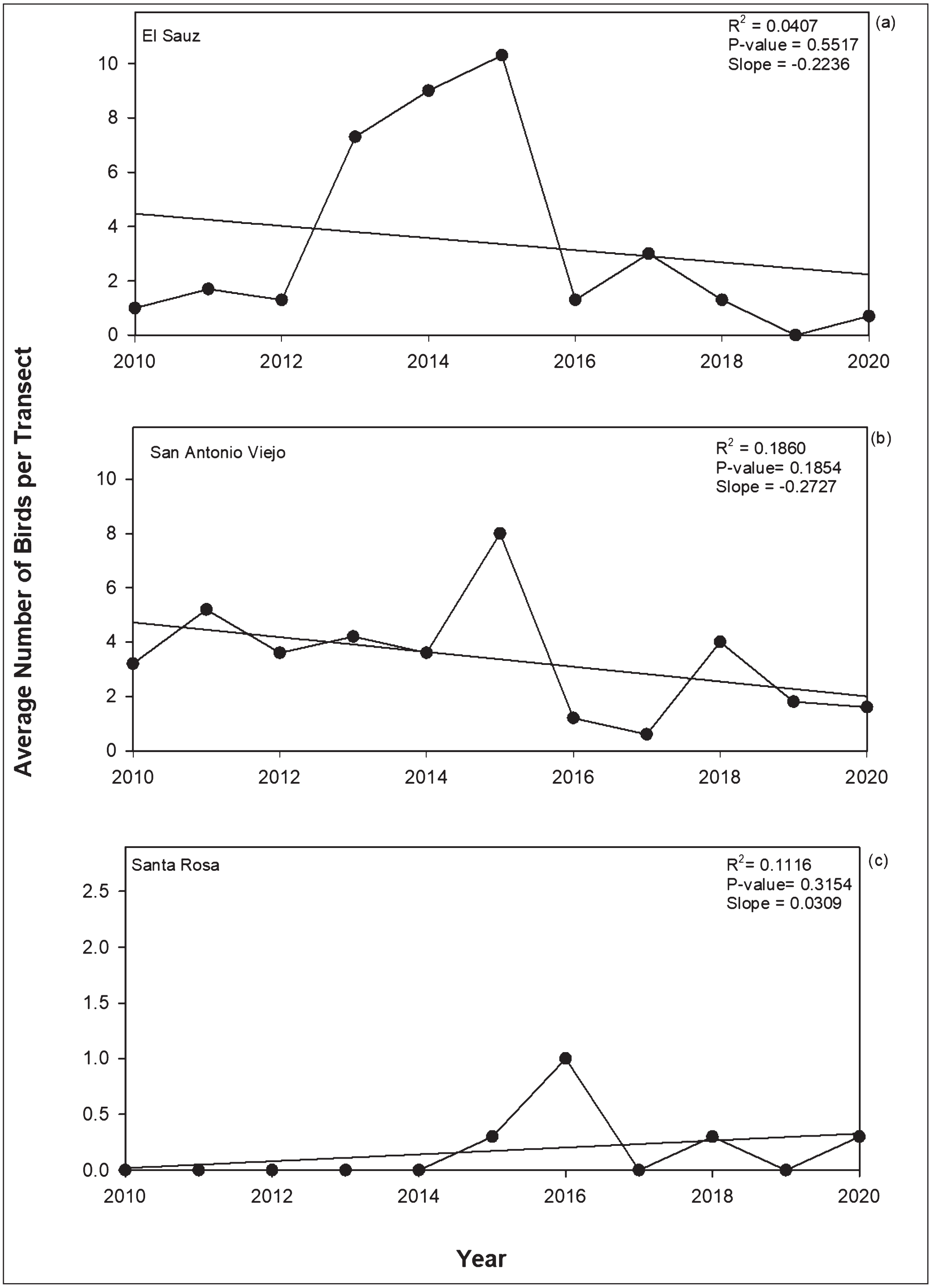

Figure 51. Non-breeding populations of Verdin on East Foundation ranches from 2010-2020.

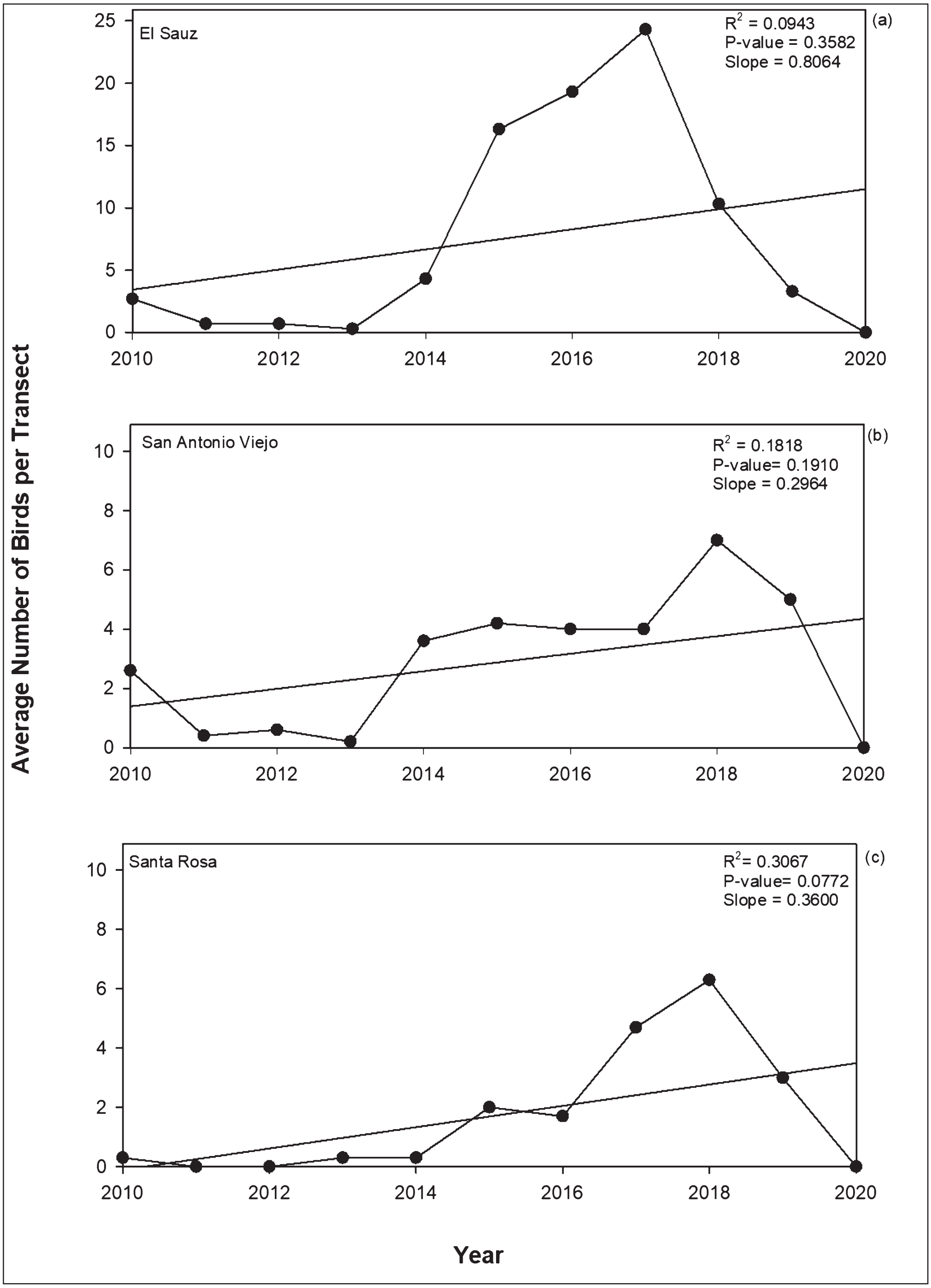

Figure 52. Non-breeding populations of White-eyed Vireo on East Foundation ranches from 2010-2020.

Wild Turkeys (*Meleagris gallopavo*) (Fig. 38) were detected on all three ranches during the non-breeding season. The overall abundance of Wild Turkeys was greater on El Sauz and Santa Rosa ranches (Figs. 38a and 38c) than on San Antonio Viejo Ranch (Fig. 38b). Wild Turkeys were only detected on our transects at San Antonio Viejo Ranch in 2017 and 2019. The population on Santa Rosa Ranch experienced a significant increasing trend, while the populations on El Sauz and San Antonio Viejo ranches had no significant changes.

Mid-Sized Foliage Gleaner.—Green Jays (*Cyanocorax yncas*) (Fig. 39) were detected on all three ranches during the non-breeding season. The overall abundance of Green Jays was greater on El Sauz and Santa Rosa ranches (Figs. 39a and 39c) than on San Antonio Viejo Ranch (Fig. 39b). Detections of Green Jays increased in 2015 and 2016, but only the populations on El Sauz Ranch (P = 0.018) and San Antonio Viejo Ranch (P = 0.027) experienced a significant increasing trend, while the population on Santa Rosa Ranch had no significant changes. Despite statistically increasing, the population on El Sauz Ranch began to decrease after 2018.

Raptors.—The average number of individuals per transect was rarely 3 or more individuals for raptors. This was expected due to their large home range sizes.

American Kestrels (*Falco sparverius*) (Fig. 40) were detected on all three ranches during the non-breeding season. American Kestrels were seen in slightly greater average numbers on San Antonio Viejo and Santa Rosa ranches (Figs. 40b and 40c) than on El Sauz Ranch (Fig. 40a). The population on Santa Rosa Ranch experienced a significant increasing trend (P = 0.012), while the populations on El Sauz and San Antonio Viejo ranches showed no significant trends.

Harris's Hawks (*Parabuteo unicinctus*) (Fig. 41) were detected on all ranches but slightly more frequently on El Sauz and Santa Rosa ranches (Figs. 41a and 41c) than on San Antonio Viejo Ranch (Fig. 41b) during the non-breeding season. The population on San Antonio Viejo Ranch experienced a significant increasing trend (P = 0.015), while the populations on El Sauz and Santa Rosa ranches showed no significant changes. On Santa Rosa Ranch their populations peaked in 2016 and 2020. Most of the sightings of Harris's Hawks on Santa Rosa Ranch were seen within the last five years of the study.

Red-tailed Hawks (*Bueto jamaicensis*) (Fig. 42) were detected on all three ranches during the non-breeding season. The overall abundance of Red-tailed Hawks was greater on Santa Rosa Ranch (Fig. 42c) than on El Sauz and San Antonio Viejo ranches (Figs. 42a and 42b). The population on Santa Rosa Ranch experienced a significant increasing trend (P = 0.026) with a peak in 2020, while the populations on El Sauz and San Antonio Viejo ranches showed no significant changes.

Scavengers.— Black Vultures (*Coragyps atratus*) (Fig. 43) were detected on El Sauz and Santa Rosa ranches, during the non-breeding season. Most individuals were recorded as they flew over the survey transect. They were not detected on the San Antonio Viejo Ranch survey, although, they were seen randomly on the ranch while traveling between transects. The overall abundance of Black Vultures was slightly greater on El Sauz Ranch (Fig. 43a) than on Santa Rosa Ranch (Fig. 43c), but there were no statistical differences in the population changes. The sightings on both El Sauz and Santa Rosa ranches experienced a peak in 2017 and 2016 respectively.

Crested Caracaras (*Caracara cheriway*) (Fig. 44) were detected on all three ranches during the non-breeding season. Crested Caracaras were more commonly detected on El Sauz and Santa Rosa ranches transects (Figs. 44a and 44c) than on San Antonio Viejo Ranch (Fig. 44b). The detections on El Sauz Ranch (P = 0.039) and Santa Rosa Ranch (P = 0.027) experienced a significant increasing trend, while the population on San Antonio Viejo Ranch had no significant changes. Despite both having statistically increasing trends, the populations on El Sauz and Santa Rosa ranches experienced a decrease in their abundance in 2018.

Turkey Vultures (*Cathartes aura*) (Fig. 45) were detected on all three ranches during the non-breeding season. Most individuals were recorded as they flew over the survey transect. However, Turkey Vultures were detected more frequently on El Sauz and Santa Rosa ranches (Figs. 45a and 45c) than on San Antonio Viejo Ranch (Fig. 45b). None of the changes in sightings were significant.

Small Foliage Gleaners.—Bewick's Wrens (*Thryomanes bewickii*) (Fig. 46) were detected on all three ranches during the non-breeding season. Bewick's Wrens were more abundant on Santa Rosa Ranch (Fig. 46c) than on El Sauz and San Antonio Viejo ranches (Figs. 46a and 46b). All

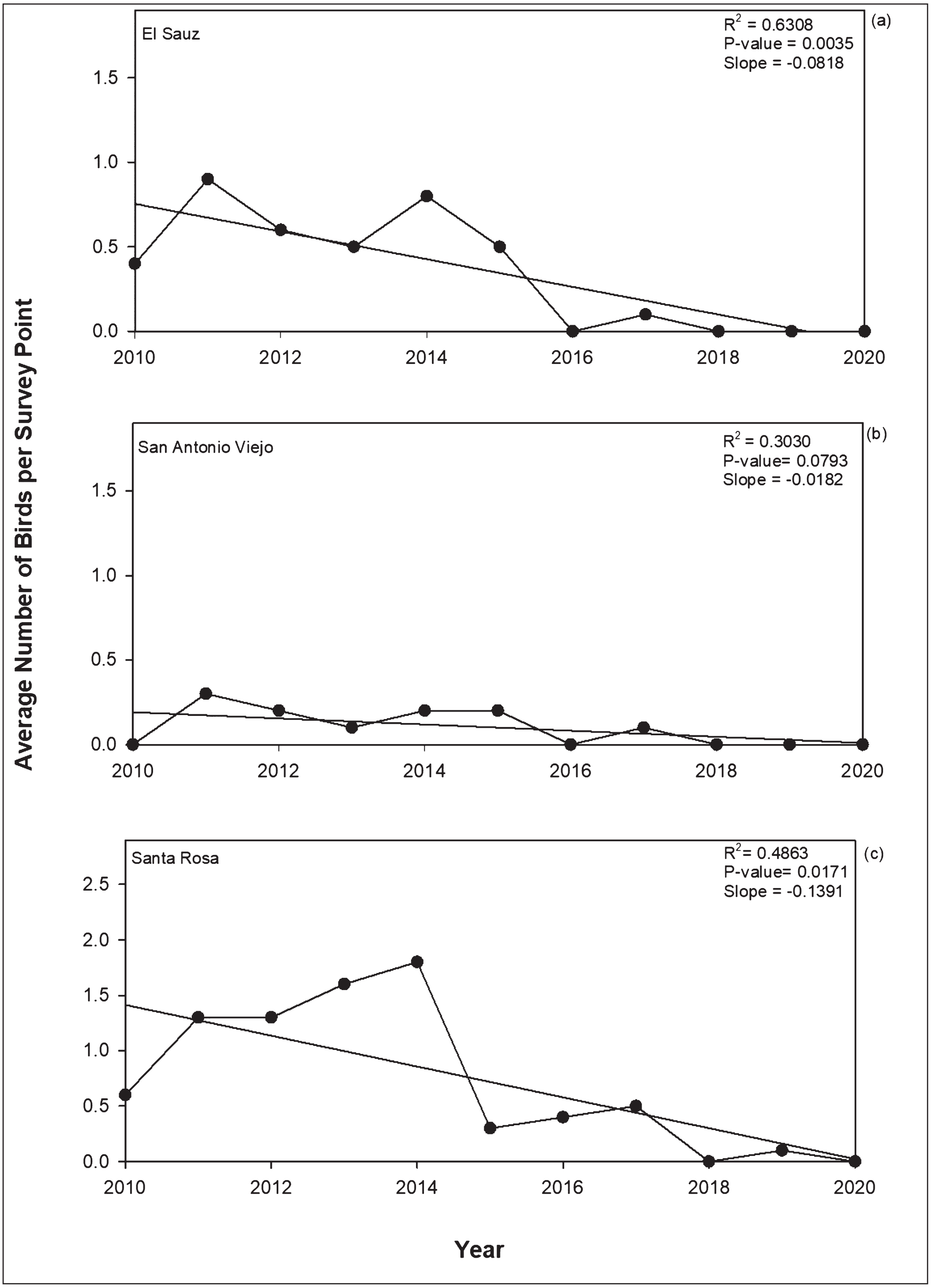

Figure 53. Breeding populations of Brown-crested Flycatcher on East Foundation ranches from 2010-2020.

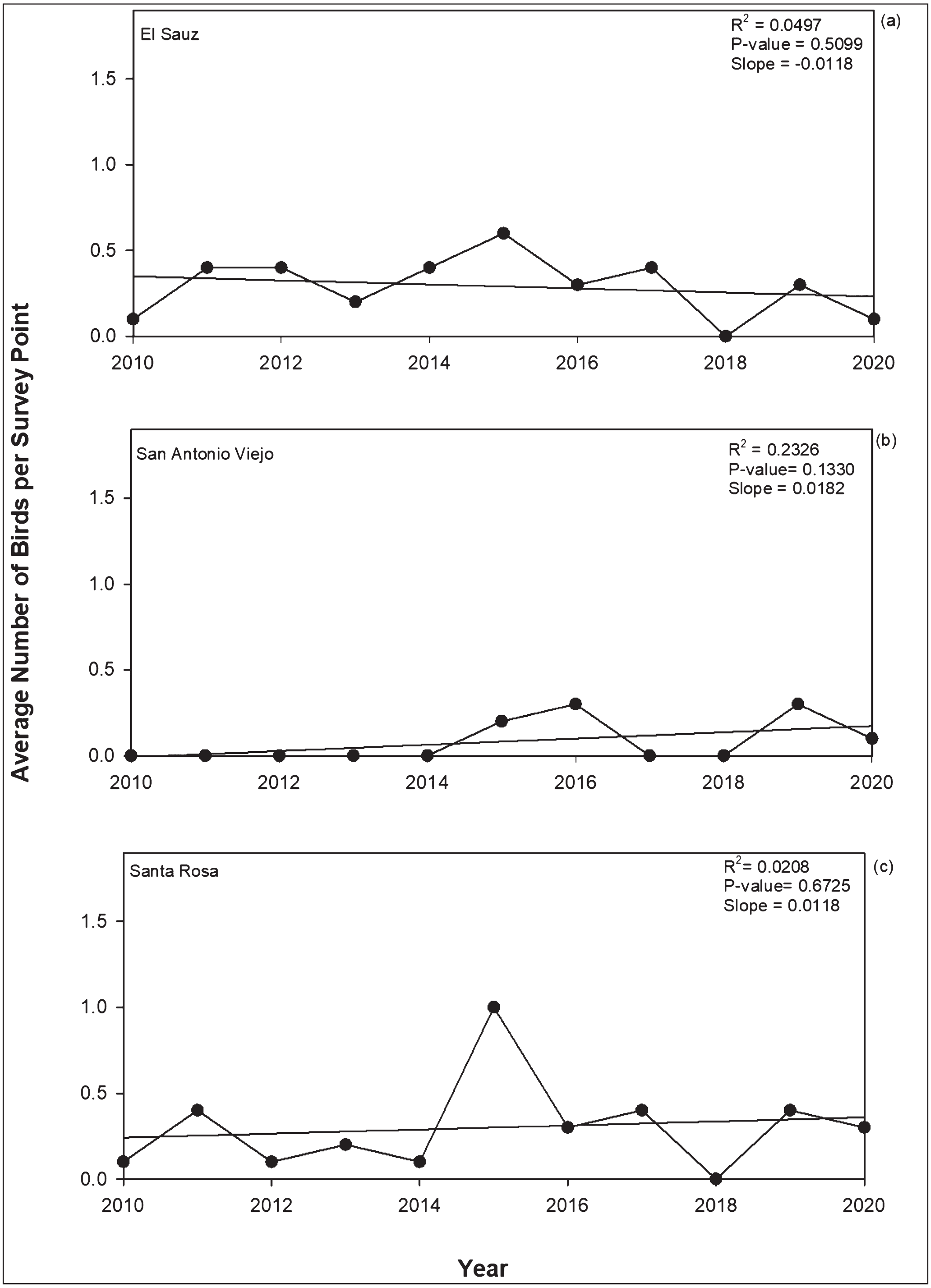

Figure 54. Breeding populations of Couch's Kingbird on East Foundation ranches from 2010-2020.

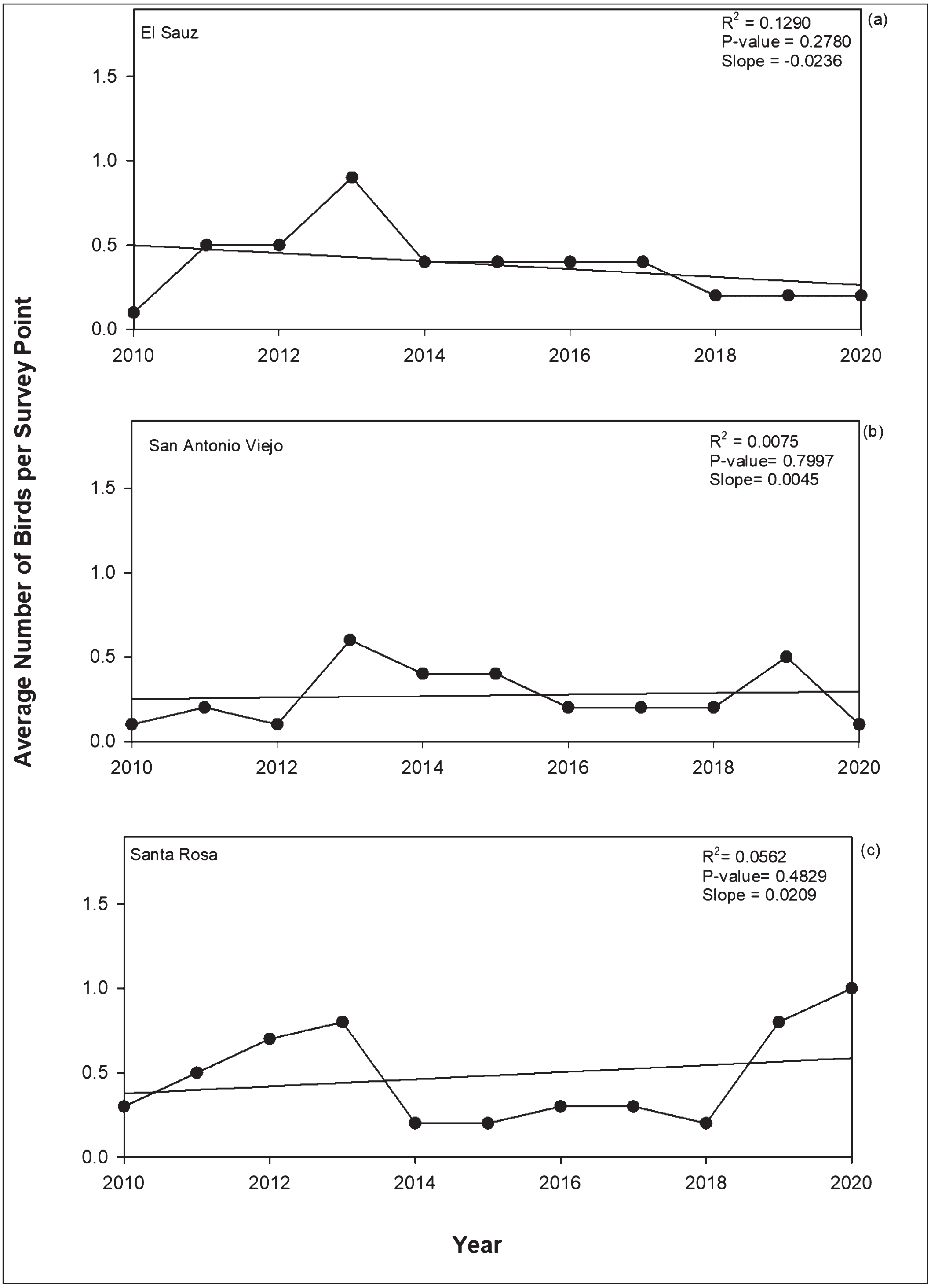

Figure 55. Breeding populations of Scissor-tailed Flycatcher on East Foundation ranches from 2010-2020.

three ranches experienced increases in their average individuals per transect for the first five years of the study and had a peak in their abundance in 2017, but population fluctuations were not significant.

Black-crested Titmice (*Baeolophus atricristatus*) (Fig. 47) were detected on all three ranches during the non-breeding season. Black-crested Titmice were more abundant on El Sauz and Santa Rosa ranches (Figs. 47a and 47c) than on San Antonio Viejo Ranch (Fig. 47b). Despite having no statistically significant trends, the populations on all three ranches experienced a peak in their population in the middle of the study. El Sauz and Santa Rosa ranches averaged between zero and 5 individuals per transect from 2010 to 2014 and experienced a peak of 35-40 individuals per transect in 2015. The population on San Antonio Viejo Ranch followed a similar pattern as the other two ranches but experienced a peak in 2014 of an average of 10 individuals per transect.

Blue-gray Gnatcatchers (*Polioptila caerulea*) (Fig. 48) were detected on all three ranches during the non-breeding season. The overall abundance of Blue-gray Gnatcatchers was greater on San Antonio Viejo Ranch (Fig. 48b) than on El Sauz and Santa Rosa ranches (Figs. 48a and 48c). The population on El Sauz Ranch ($P = 0.008$) and Santa Rosa Ranch ($P = 0.013$) experienced an increasing trend, while the populations on San Antonio Viejo Ranch had no significant population changes. Yet, the population on San Antonio Viejo Ranch peaked in 2015 and 2019, averaging between 15-20 individuals per transect.

House Wrens (*Troglodytes aedon*) (Fig. 49) were detected on all three ranches during the non-breeding season. The overall abundance of House Wrens was greater on Santa Rosa Ranch (Fig. 49c) than on El Sauz and San Antonio Viejo ranches (Figs. 49a and 49b). The population on Santa Rosa Ranch experienced a significant increasing trend ($P = 0.004$), while the populations on El Sauz and San Antonio Viejo ranches had no significant trends. All three populations increased in 2018 and peaked in 2019 before subsequently decreasing the next year, after remaining relatively stable for the entire study period.

Orange-crowned Warblers (*Leiothlypis celata*) (Fig. 50) were detected on all three ranches during the non-breeding season. Orange-crowned Warblers were more abundant on El Sauz Ranch (Fig. 50a) than on San Antonio Viejo and Santa Rosa ranches (Figs. 50b and 50c). Detections decreased over the study period on El Sauz and San Antionio Viejo ranches, but the trend was not statistically significant.

Verdins (*Auriparus flaviceps*) (Fig. 51) were detected on all three ranches during the non-breeding season. Verdins were more abundant on El Sauz and San Antonio Viejo ranches (Figs. 51a and 51b) than on Santa Rosa Ranch (Fig. 51c). Despite having no statistically significant population size trends, the populations on all three ranches experienced fluctuation in their year-to-year abundance during the study period. No Verdins were detected on Santa Rosa Ranch until 2015.

White-eyed Vireos (*Vireo griseus*) (Fig. 52) were detected on all three ranches during the non-breeding season. White-eyed Vireos were much more abundant on El Sauz Ranch (Fig. 52a) than on San Antonio Viejo and Santa Rosa ranches (Figs. 52b and 52c). Despite having no statistically significant population changes, each of the populations experienced an increase in abundance leading up to a peak in 2017 and 2018, but there were no White-eyed Vireos documented in 2020.

Non-Breeding Bird Abundance and Precipitation Correlations

Precipitation did not appear to have a significant effect on most bird species on our transects during this study. Nine species recorded during the non-breeding bird survey had a significant positive relationship between their abundance and annual precipitation on one of the three East Foundation ranches (Black-crested Titmouse, Brown-crested Flycatcher, Crested Caracara, Eastern Phoebe, Great Kiskadee, Lincoln's Sparrow, Mourning Dove, Turkey Vulture, and White-eyed Vireo) (Table 1). However, there were an additional 6 species (Bewick's Wren, Bronzed Cowbird, Brown-headed Cowbird, Cactus Wren, Ladder-backed Woodpecker, and Vermillion Flycatcher) that approached significance (P between 0.051 and 0.085) (Table 1). The Eastern Phoebe was the only species that had a significant positive relationship between its non-breeding survey detections and precipitation across all three of the East Foundation ranches (Table 1).

Breeding Bird Survey Trends

A total of 51,299 individual birds of 36 species were recorded during the 69 breeding bird surveys

Table 1. Rainfall correlation coefficients for non-breeding species on East Foundation ranches.

	El Sauz		San Antonio Viejo		Santa Rosa	
	Correlation Coefficient	P-Value	Correlation Coefficient	P-Value	Correlation Coefficient	P-Value
American Kestrel	−0.06	0.861	0.447	0.168	0.423	0.195
Bewick's Wren	0.409	0.212	0.369	0.264	0.573	0.066
Black Vulture	0.078	0.820	−0.300	0.370	0.289	0.388
Black-bellied Whistling-Duck	0.099	0.771	—	—	−0.084	0.805
Black-crested Titmouse	0.600	0.051	0.224	0.508	0.674*	0.023
Black-throated Sparrow	0.084	0.805	0.336	0.312	0.270	0.423
Blue-gray Gnatcatcher	0.192	0.572	0.473	0.142	0.196	0.563
Bronzed Cowbird	0.600	0.051	−0.116	0.734	0.179	0.598
Brown-crested Flycatcher	0.625*	0.040	−0.088	0.797	−0.055	0.873
Brown-headed Cowbird	0.078	0.820	0.582	0.061	−0.100	0.769
Cactus Wren	0.580	0.062	0.205	0.545	—	—
Cassin's Sparrow	0.053	0.877	0.041	0.905	0.070	0.839
Clay-colored Sparrow	−0.670	0.844	−0.027	0.936	0.037	0.915
Common Ground Dove	0.036	0.915	0.410	0.21	−0.055	0.873
Couch's Kingbird	0.373	0.259	−0.021	0.951	0.178	0.600
Crested Caracara	−0.184	0.588	0.732**	0.010	0.328	0.325
Curve-billed Thrasher	−0.039	0.910	−0.105	0.759	−0.431	0.185
Eastern Meadowlark	0.203	0.549	0.177	0.603	0.406	0.215
Eastern Phoebe	0.747**	0.008	0.636*	0.035	0.765**	0.006
Field Sparrow	−0.298	0.373	−0.229	0.499	−0.337	0.310
Golden-fronted Woodpecker	0.484	0.131	0.273	0.417	0.442	0.174
Grasshopper Sparrow	−0.058	0.865	−0.170	0.617	−0.261	0.439
Great Kiskadee	0.445	0.170	0.268	0.462	0.732**	0.010
Great-tailed Grackle	0.247	0.465	−0.150	0.659	0.372	0.260
Greater Roadrunner	−0.103	0.764	0.209	0.537	0.392	0.233
Green Jay	0.245	0.467	0.046	0.849	0.255	0.45
Harris's Hawk	0.313	0.348	0.372	0.259	0.268	0.425
House Wren	0.422	0.196	0.096	0.779	−0.027	0.936
Killdeer	0.014	0.968	0.406	0.215	−0.400	0.223
Ladder-backed Woodpecker	0.009	0.979	−0.547	0.082	−0.005	0.989
Lark Sparrow	−0.018	0.957	0.109	0.750	0.183	0.589
Lincoln's Sparrow	0.690*	0.019	0.490	0.126	0.470	0.144

Table 1. *Continued*.

	El Sauz		San Antonio Viejo		Santa Rosa	
	Correlation Coefficient	P-Value	Correlation Coefficient	P-Value	Correlation Coefficient	P-Value
Loggerhead Shrike	—	—	0.184	0.587	0.127	0.711
Long-billed Thrasher	0.201	0.554	−0.326	0.328	0.028	0.935
Mourning Dove	0.273	0.417	0.627	0.039	0.564	0.071
Northern Bobwhite	0.218	0.519	0.178	0.601	0.364	0.270
Northern Cardinal	0.209	0.537	0.300	0.370	0.409	0.212
Northern Mockingbird	0.191	0.574	0.146	0.668	0.401	0.222
Olive Sparrow	0.273	0.417	0.114	0.739	0.101	0.767
Orange-crowned Warbler	0.420	0.198	−0.257	0.446	0.466	0.148
Painted Bunting	0.426	0.191	0.306	0.360	−0.060	0.86
Pyrrhuloxia	0.487	0.128	0.282	0.401	0.050	0.883
Red-tailed Hawk	−0.025	0.942	−0.089	0.795	−0.287	0.393
Scissor-tailed Flycatcher	−0.354	0.285	−0.092	0.788	−0.032	0.926
Turkey Vulture	0.474	0.141	0.447	0.168	0.670*	0.024
Verdin	0.431	0.185	0.196	0.564	0.416	0.203
Vermillion Flycatcher	0.402	0.220	0.129	0.705	0.593	0.055
Vesper Sparrow	0.400	0.223	−0.202	0.552	−0.147	0.665
White-eyed Vireo	0.392	0.233	0.369	0.264	0.658*	0.028
White-tipped Dove	−0.105	0.758	−0.106	0.757	0.343	0.301
Wild Turkey	0.087	0.798	−0.458	0.156	−0.046	0.893

— denotes zero individuals of that species were observed on that property.
* denotes significance at $P \leq 0.05$ level
** denotes significance at $P \leq 0.01$ level

conducted during May and June from 2010 to 2020. Over the 10 year study period, over 7,000 minutes of surveys were conducted at 123 unique points. Despite supporting over 200 species across all three ranches, only 36 species were detected frequently enough throughout the study period to establish trends for the breeding bird survey. The graphs in Figs. 53 – 88 display the trends for the 36 species. As with the non-breeding survey, these graphs were not always kept at a consistent scale. Scaling the graph to individual ranch populations allows for some of the variability that was being masked over to present itself. Additionally, the scale on the breeding bird survey graphs is much lower than the non-breeding bird survey graphs because there were only 2 months (May and June) of breeding surveys for each year.

On El Sauz Ranch, the abundance of 34 species (94%) remained stable, zero species experienced an increasing trend, and 2 species (6%) experienced a decreasing trend (Brown-crested Flycatcher, an aerial forager and Brown-headed Cowbird, a ground forager).

On San Antonio Viejo Ranch, the abundance of 32 species (89%) remained stable, one species (3%) experienced an increasing trend (Northern Cardinal, a ground forager), one species (3%) experienced a significant decreasing trend (Brown-

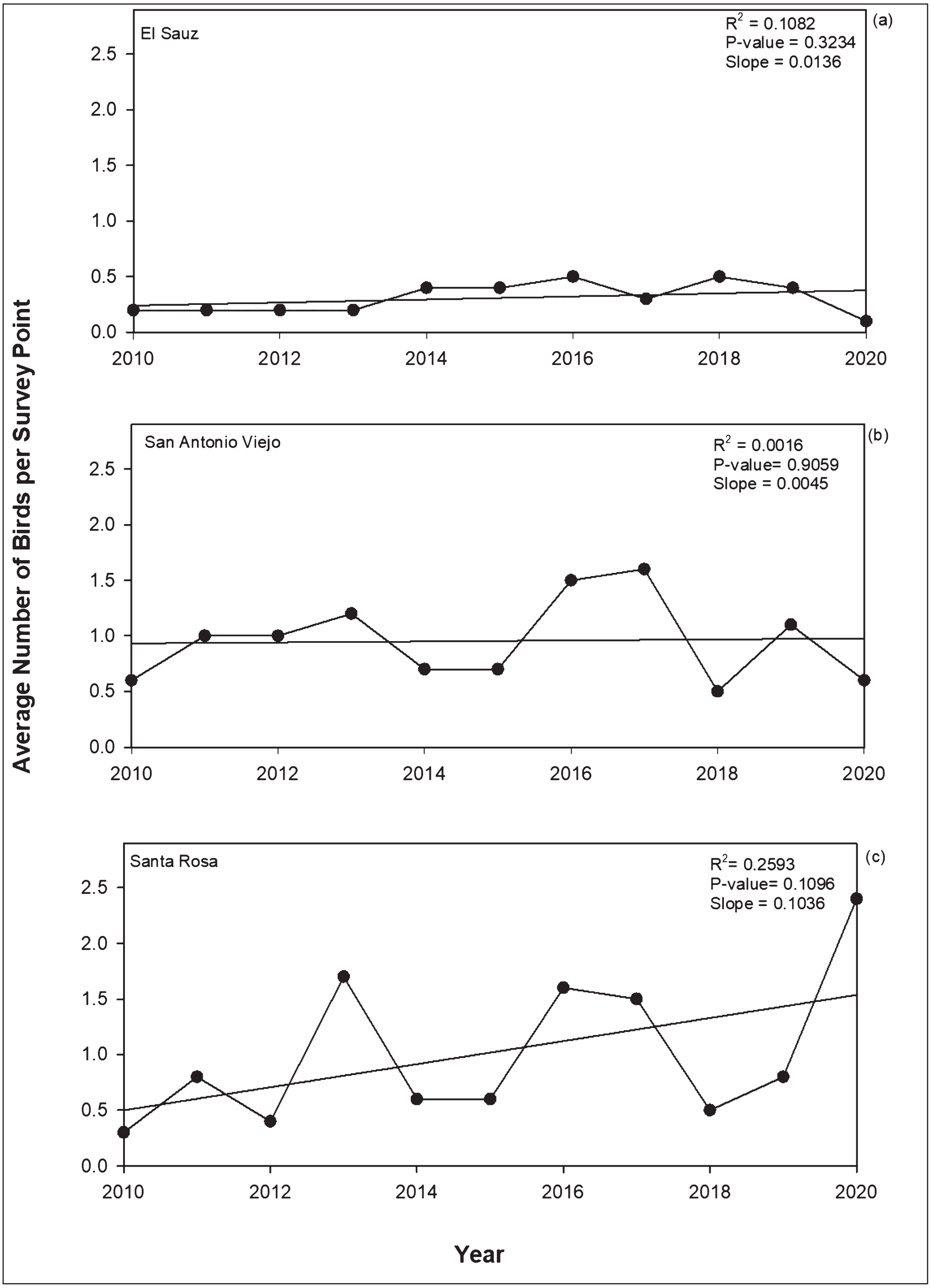

Figure 56. Breeding populations of Golden-fronted Woodpecker on East Foundation ranches from 2010-2020.

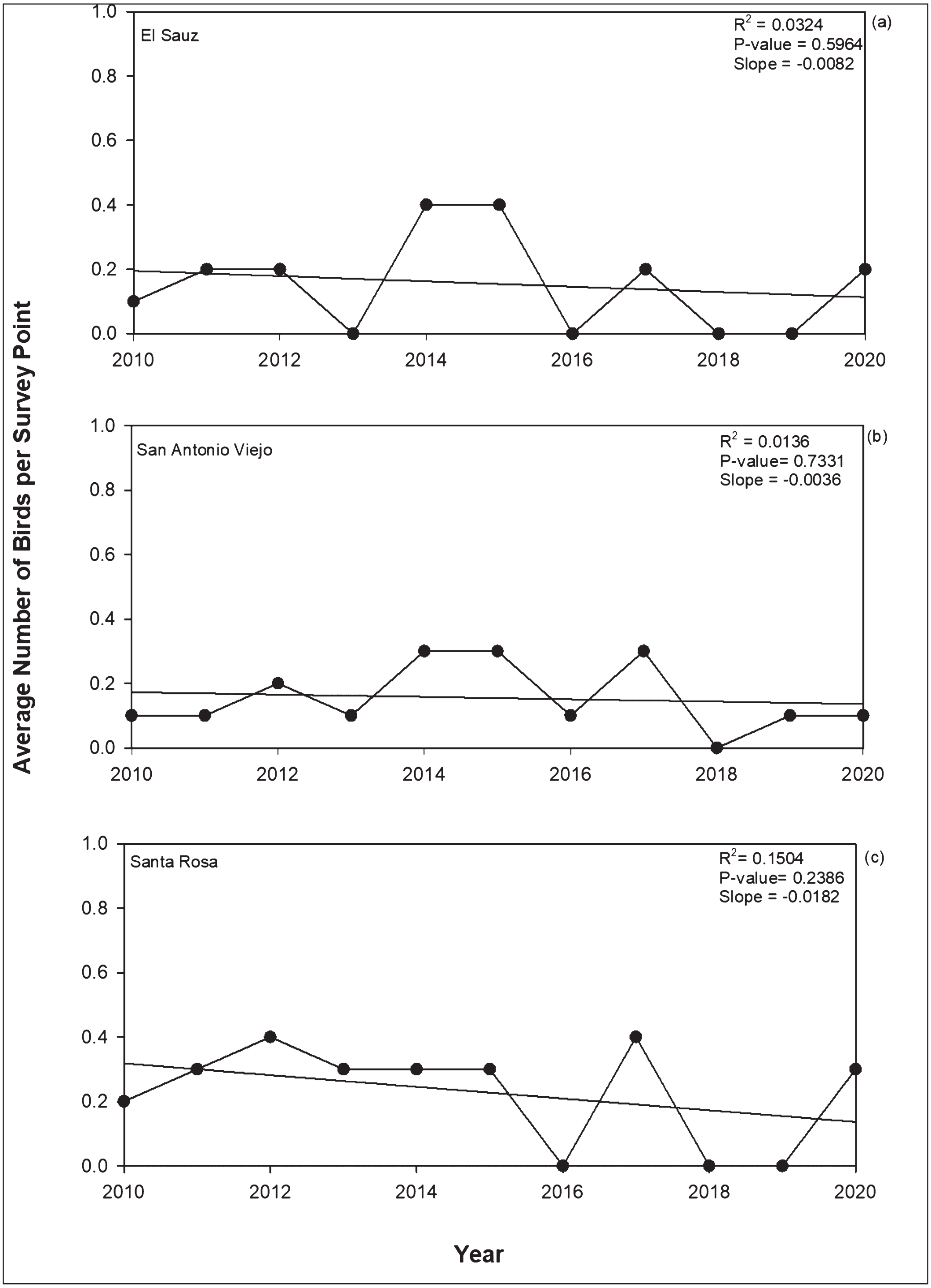

Figure 57. Breeding populations of Ladder-backed Woodpecker on East Foundation ranches from 2010-2020.

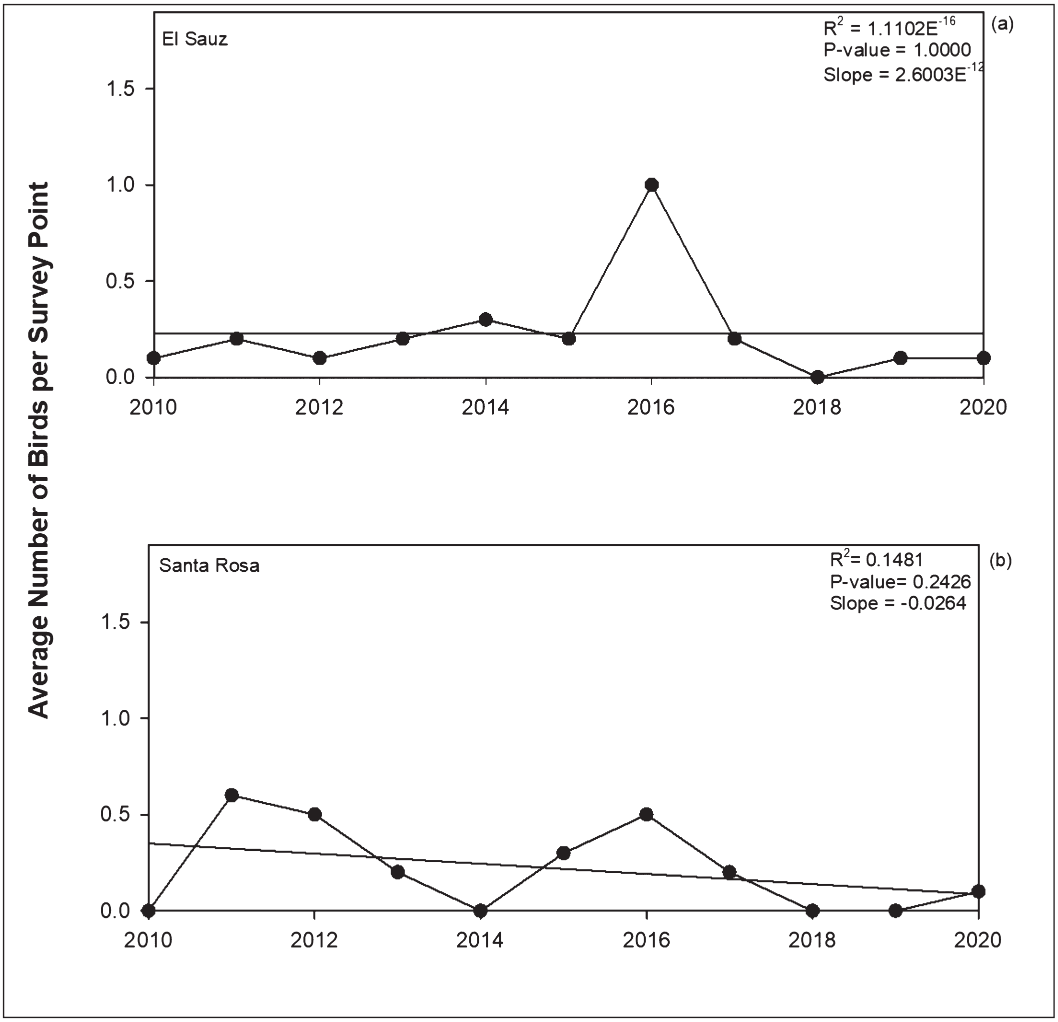

Figure 58. Breeding populations of Black-bellied Whistling-Duck on East Foundation ranches from 2010-2020.

headed Cowbird, a ground forager), and 2 species (6%) were not detected on the transects (Black-bellied Whistling-Duck and Black Vulture).

On the Santa Rosa Ranch transects, the abundance of 33 species (92%) remained stable, one species (3%) experienced a significant increasing trend (Northern Bobwhite, a ground forager), one species (3%) experienced a significant decreasing trend (Brown-crested Flycatcher, an aerial forager), and one species (3%) (Eastern Meadowlark) was not detected on the transects.

The following section explains the details of the breeding survey data in Figs. 53 – 88. The figures display a trend line fitted to the average number of individuals detected per breeding transect per year. Species are listed alphabetically within each foraging strategy.

Aerial Foragers.—Brown-crested Flycatchers (Fig. 53), were detected on all three ranches during the breeding season. Brown-crested Flycatchers were more abundant on San Antonio Viejo and Santa Rosa ranches (Figs. 53b and 53c) than on El Sauz Ranch (Fig. 53a). However, during the 10-year study period, the populations on El Sauz Ranch ($P = 0.004$) and Santa Rosa Ranch ($P = 0.017$) experienced a significant decreasing trend, while

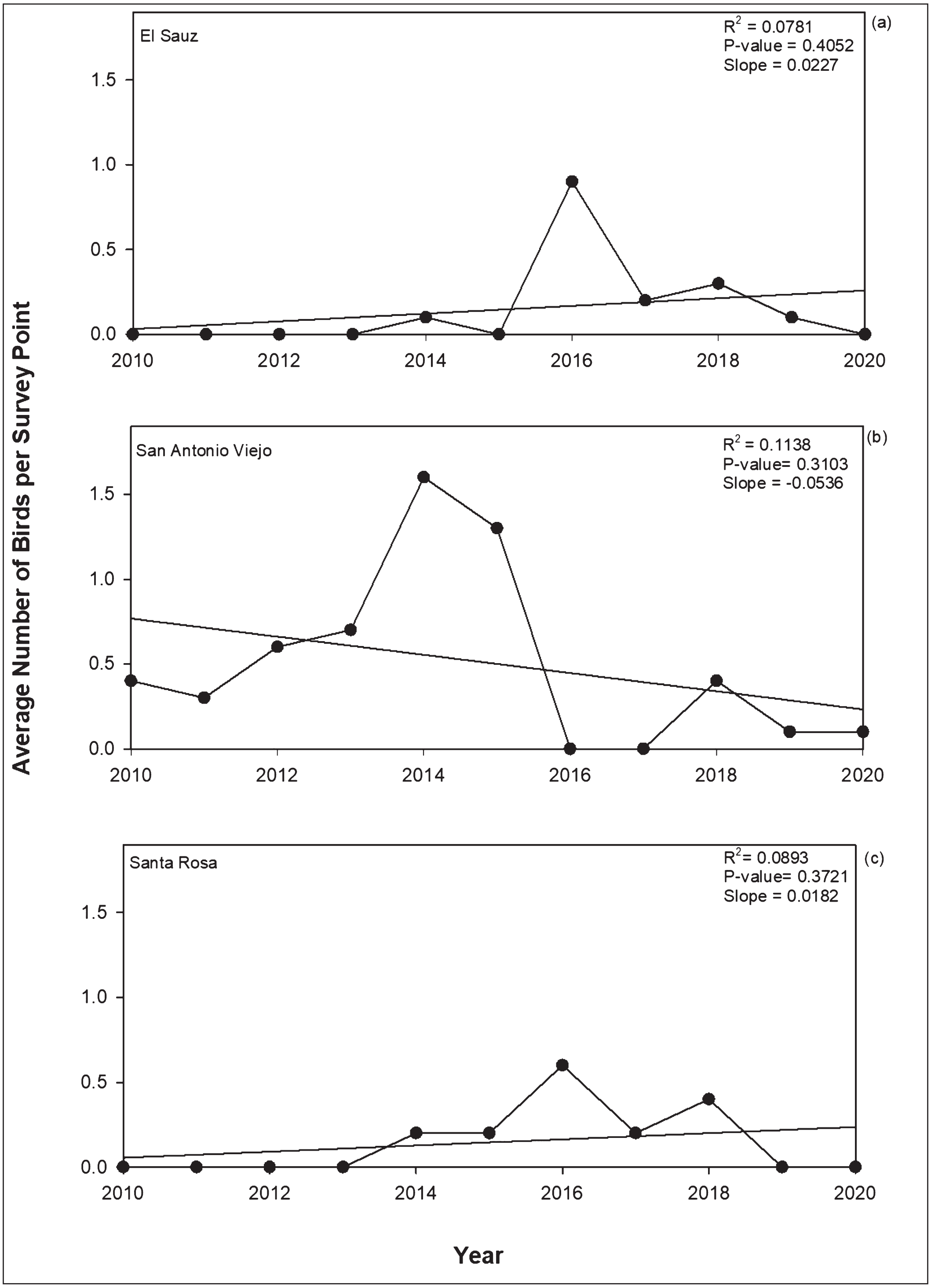

Figure 59. Breeding populations of Black-throated Sparrow on East Foundation ranches from 2010-2020.

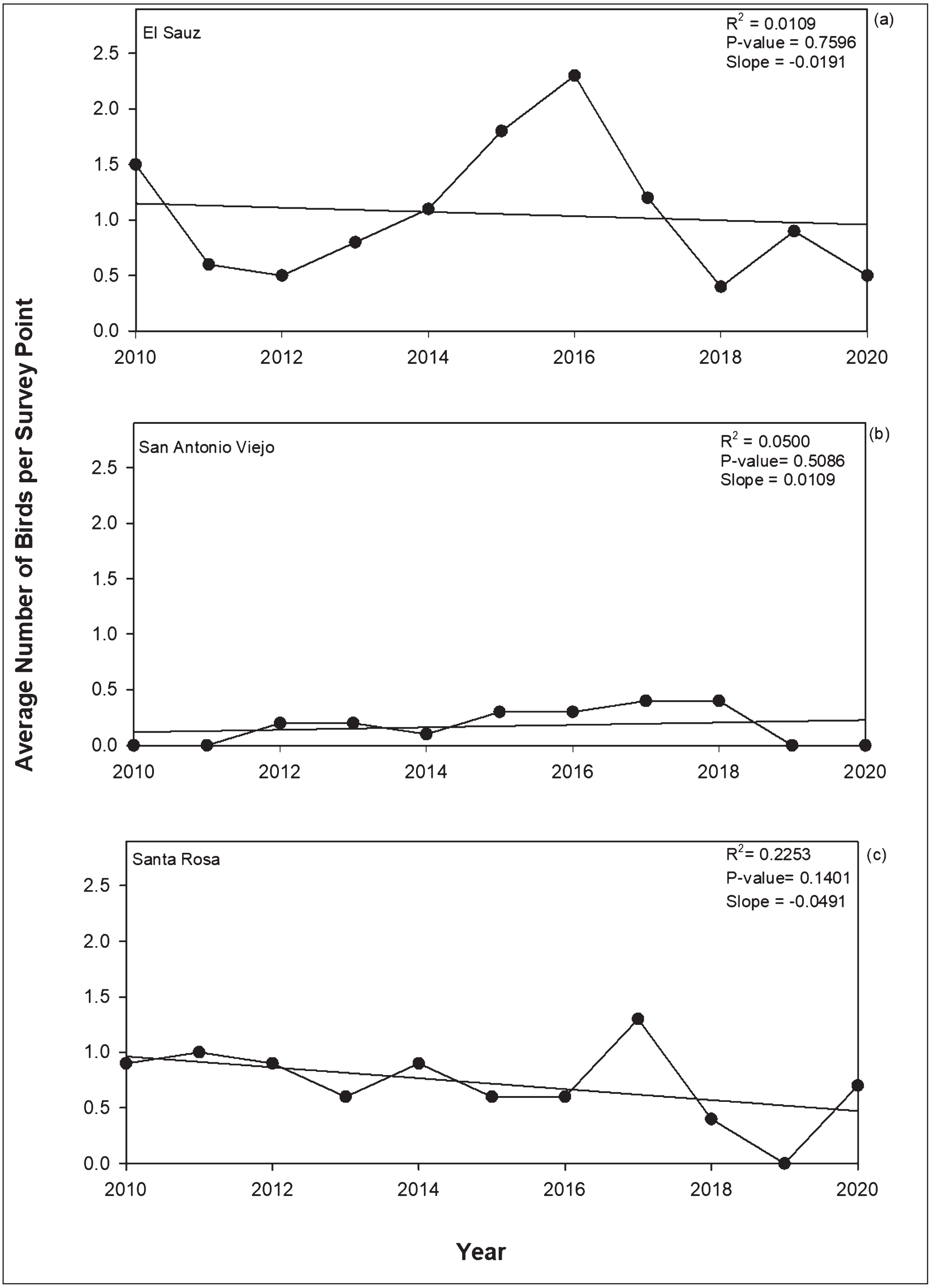

Figure 60. Breeding populations of Bronzed Cowbird on East Foundation ranches from 2010-2020.

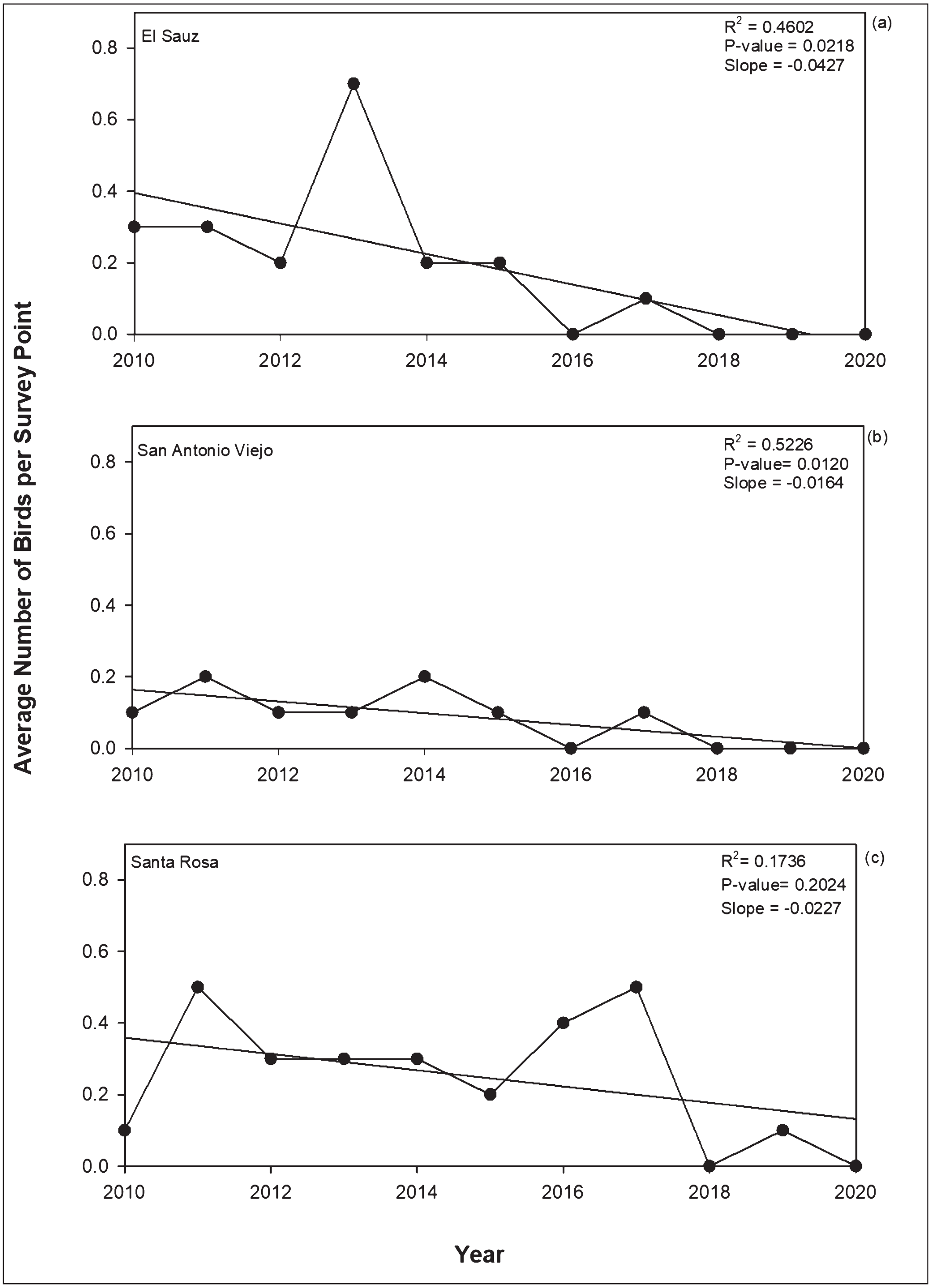

Figure 61. Breeding populations of Brown-headed Cowbird on East Foundation ranches from 2010-2020.

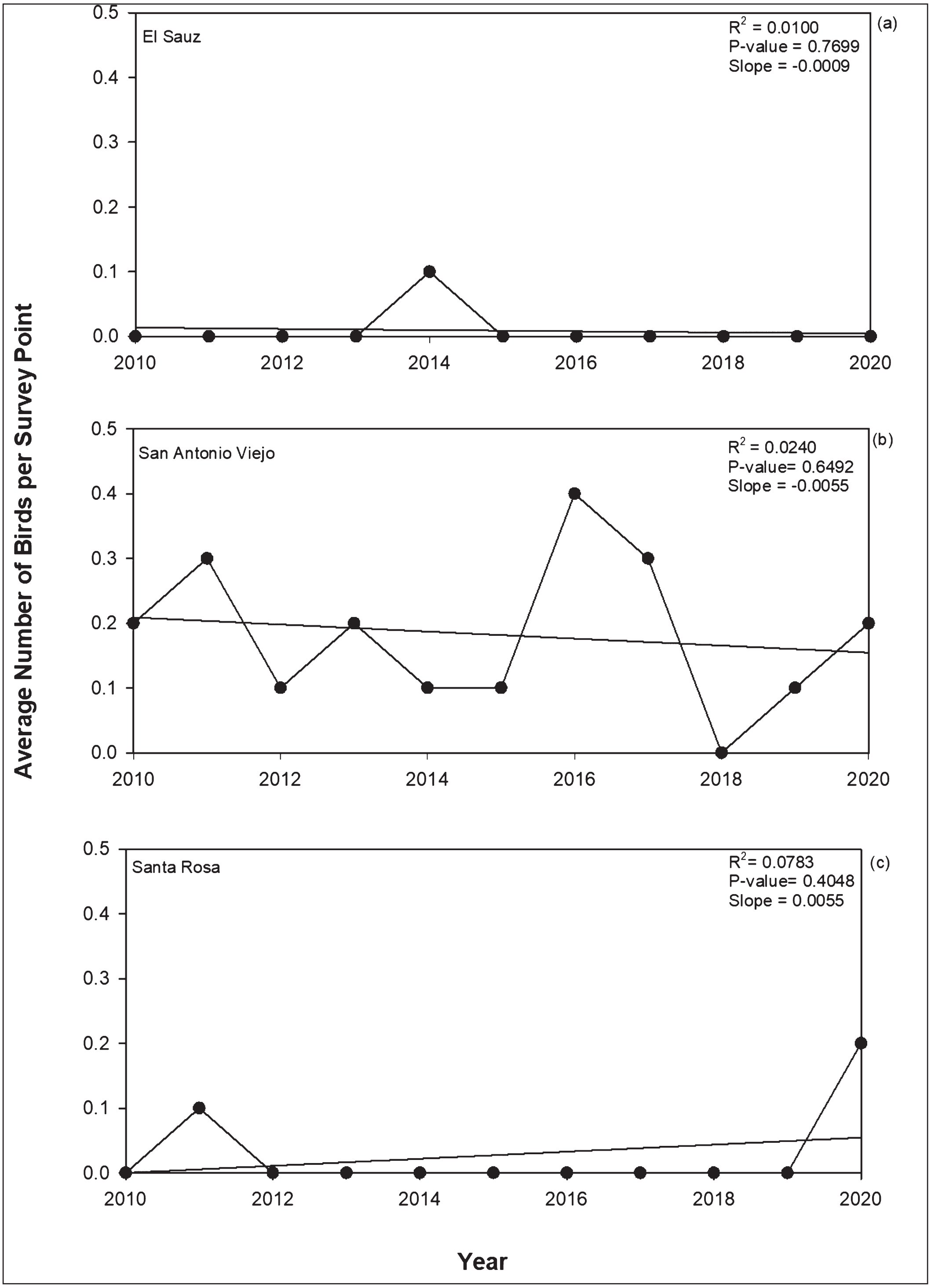

Figure 62. Breeding populations of Cactus Wren on East Foundation ranches from 2010-2020.

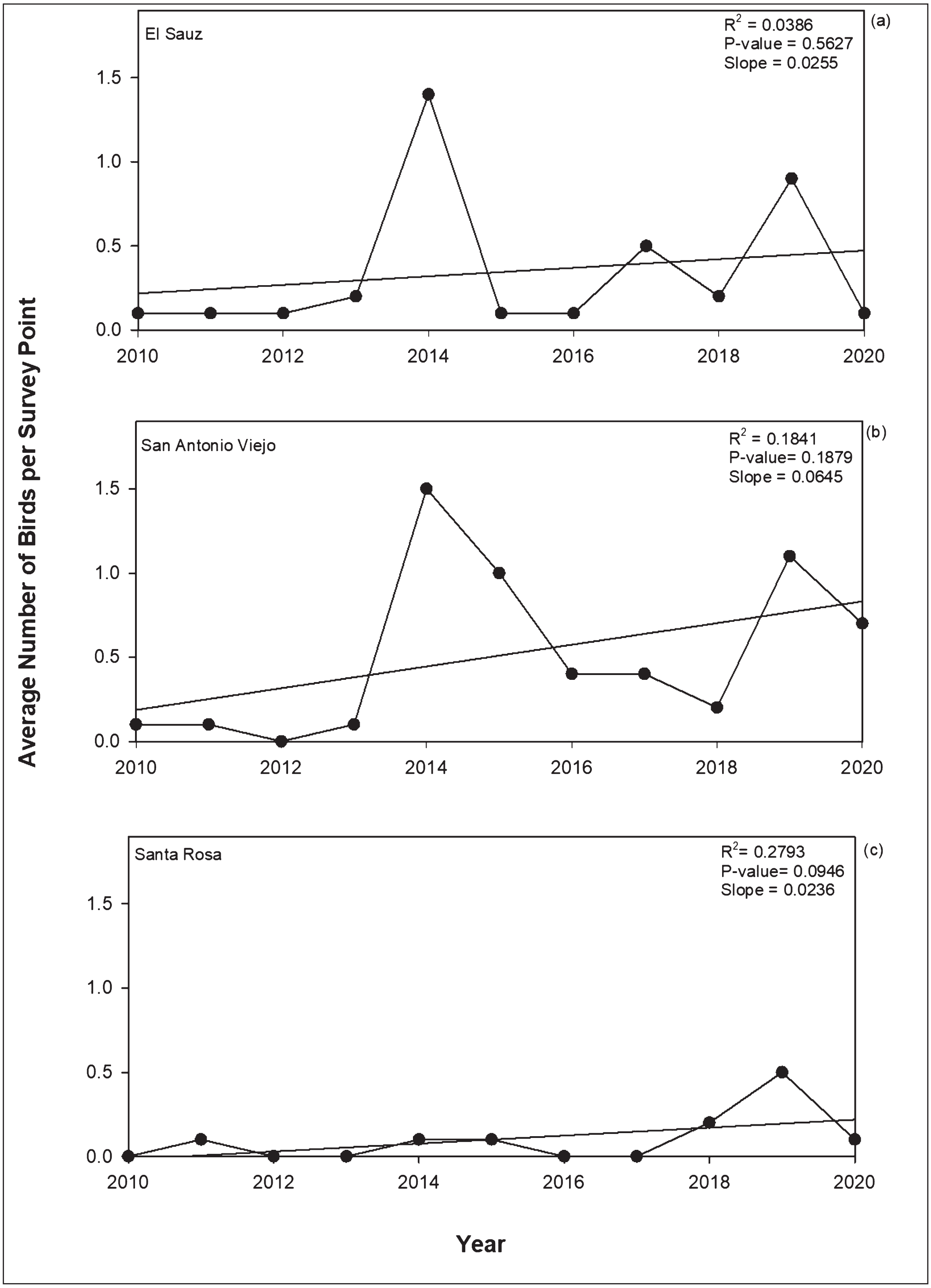

Figure 63. Breeding populations of Cassin's Sparrow on East Foundation ranches from 2010-2020.

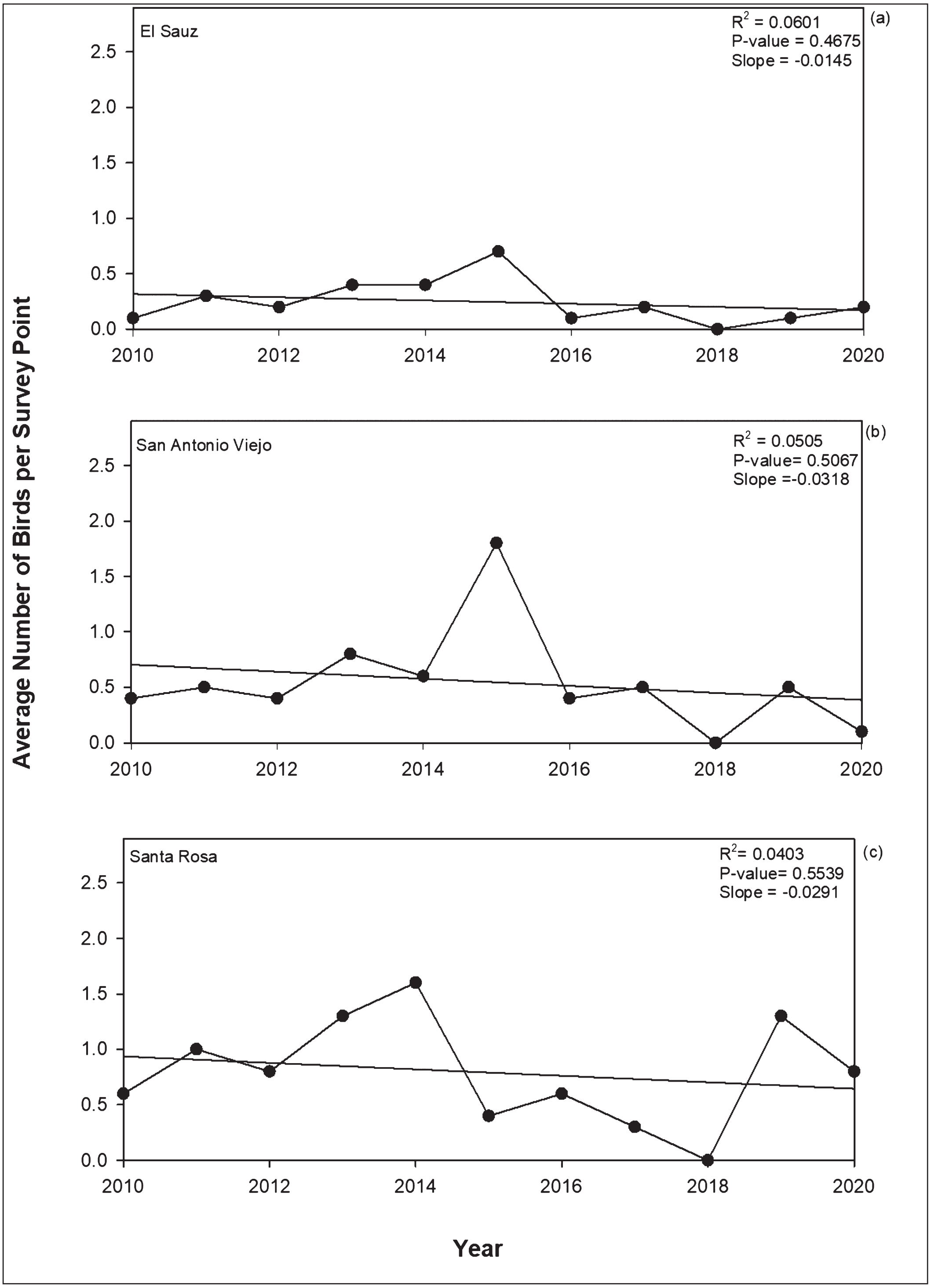

Figure 64. Breeding populations of Common Ground Dove on East Foundation ranches from 2010-2020.

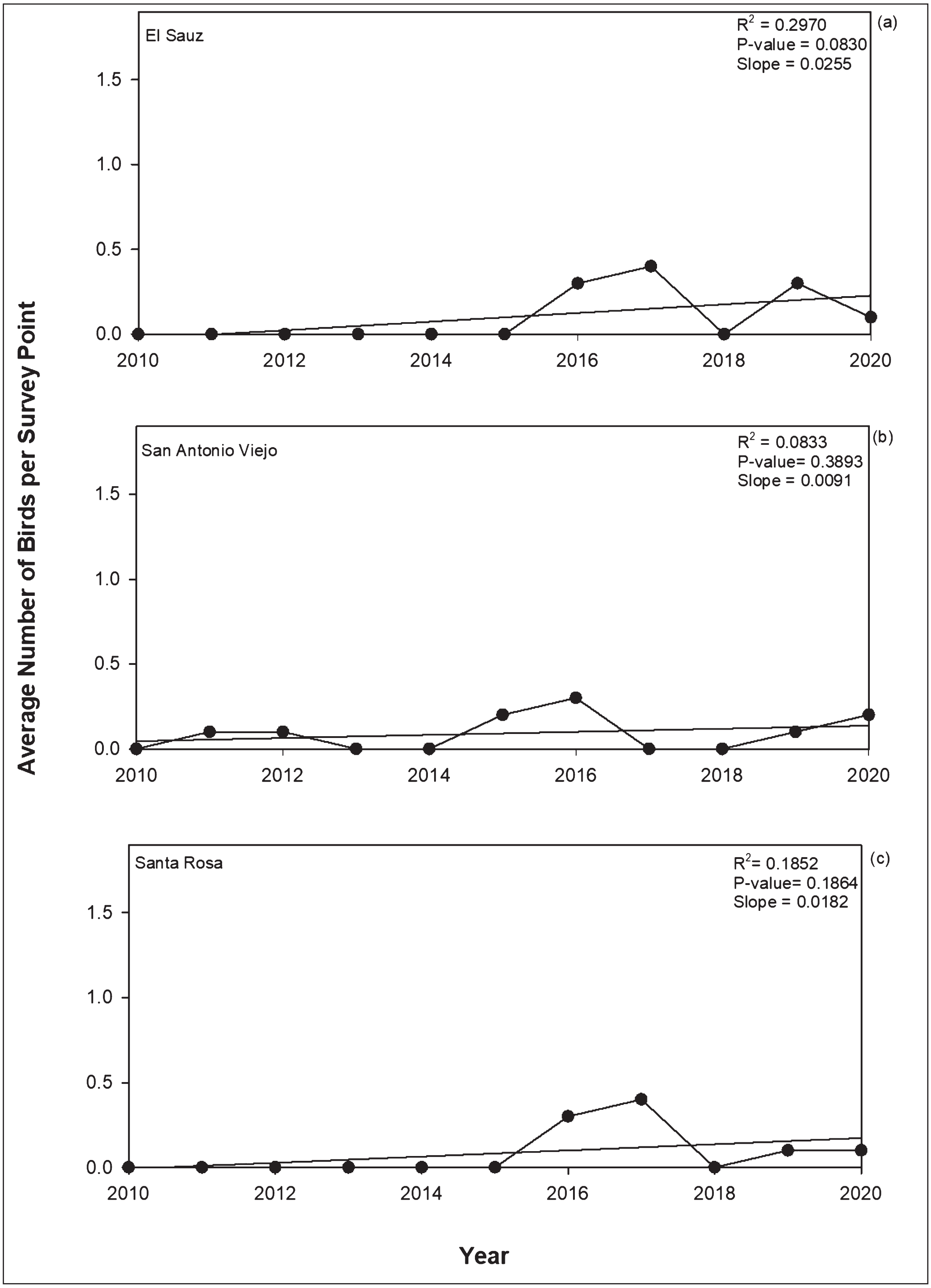

Figure 65. Breeding populations of Curve-billed Thrasher on East Foundation ranches from 2010-2020.

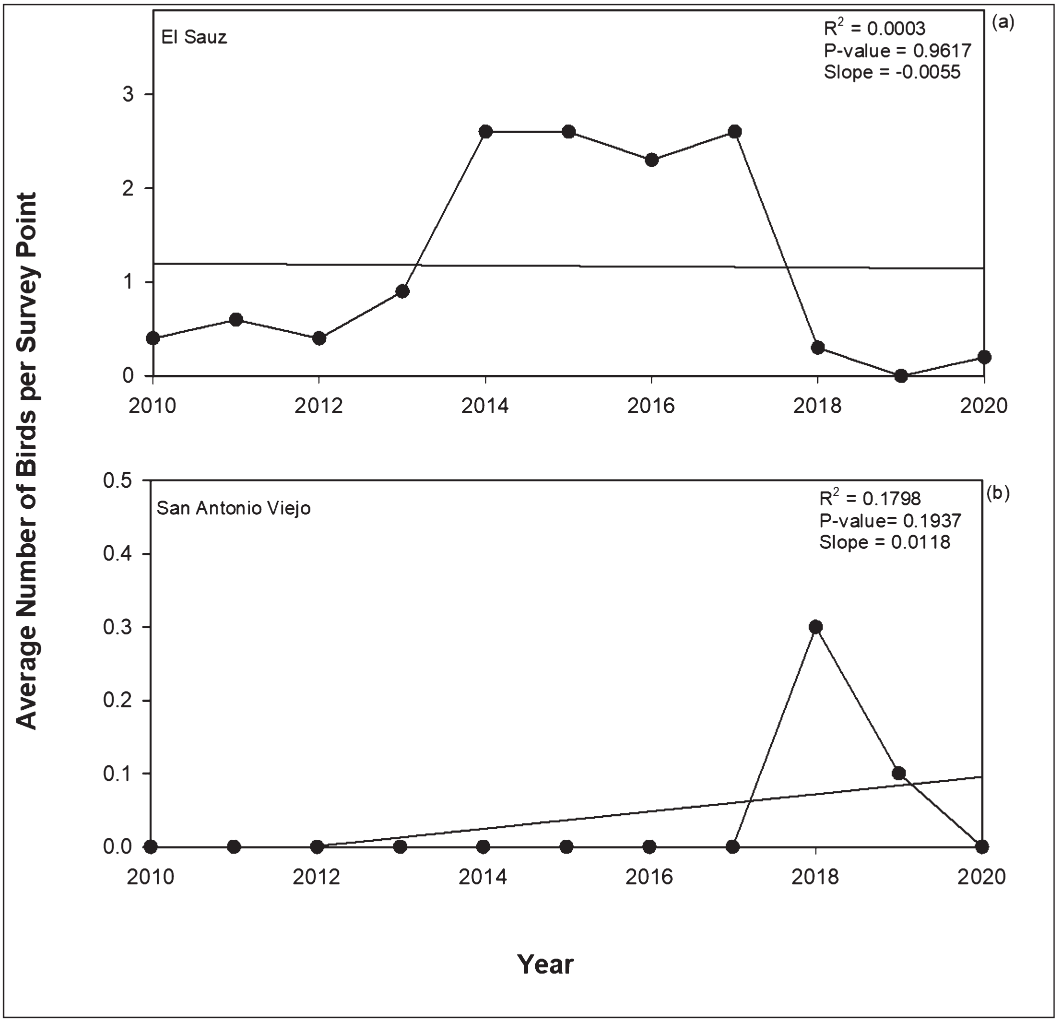

Figure 66. Breeding populations of Eastern Meadowlark on East Foundation ranches from 2010-2020.

the population on San Antonio Viejo Ranch had no significant trend. Across the state, Brown-crested Flycatcher populations have remained stable in the BBS (Sauer et al. 2019).

Couch's Kingbirds (Fig. 54) and Scissor-tailed Flycatchers (Fig. 55) were detected on all three ranches during the breeding season. There were no statistically significant tends for Couch's Kingbird or Scissor-tailed Flycatcher observations in our surveys. Across the state, in the BBS, Couch's Kingbird populations have remained stable while Scissor-Tailed Flycatcher populations have decreased (Sauer et al. 2019).

Bark Foragers.—Golden-fronted Woodpeckers (Fig. 56) and Ladder-backed Woodpeckers (Fig. 57) were detected on all three ranches during the breeding season. Their population changes were not significant during our breeding bird surveys. Likewise, there were no significant trends for these species for the state BBS (Sauer et al. 2019).

Dabbler.—Black-bellied Whistling-ducks (Fig. 58) were detected on El Sauz and Santa Rosa ranches during the breeding season. However, they were not detected on San Antonio Viejo Ranch. None of these populations had significant population changes in our study or for the state BBS (Sauer et al. 2019).

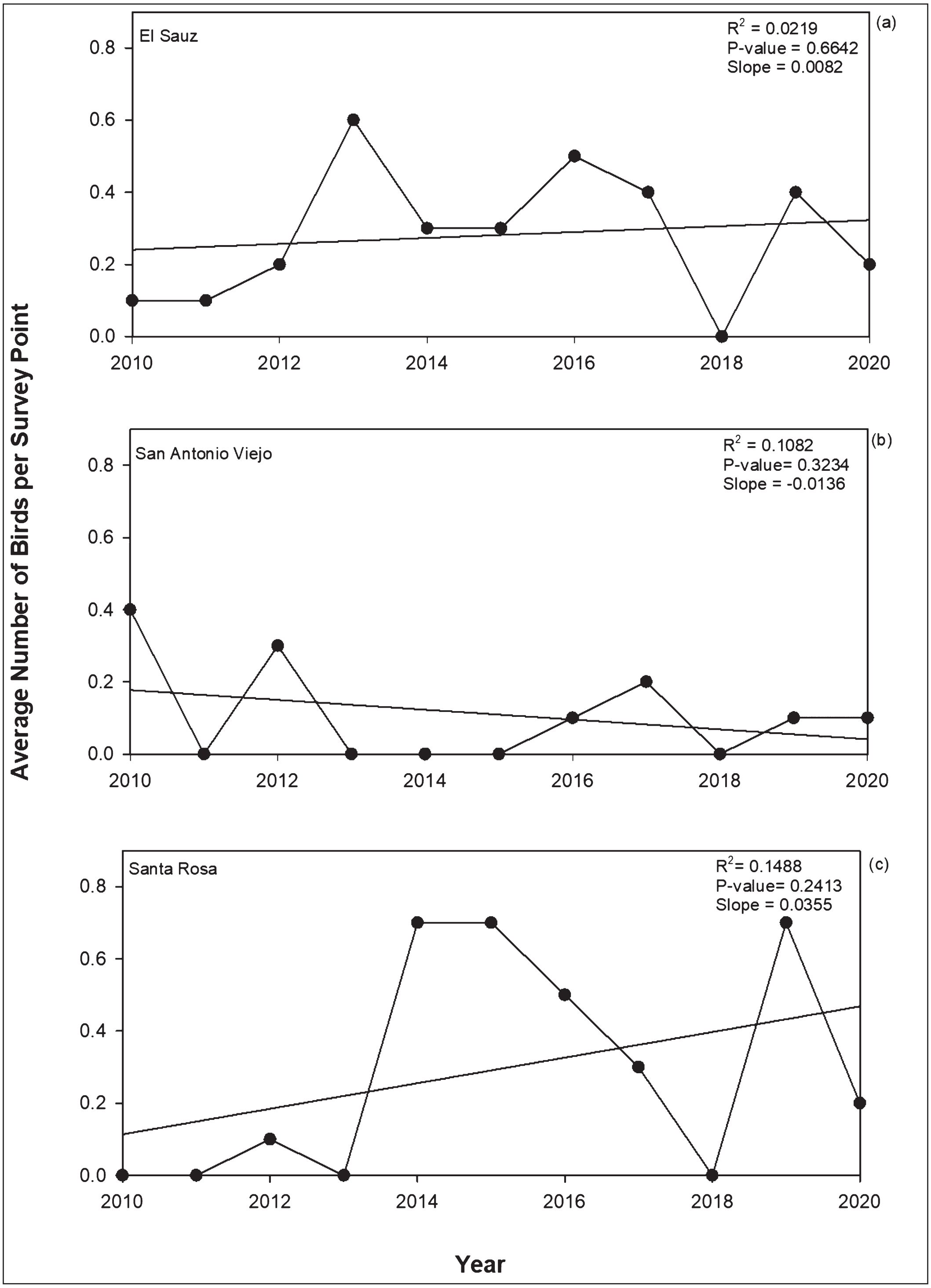

Figure 67. Breeding populations of Great-tailed Grackle

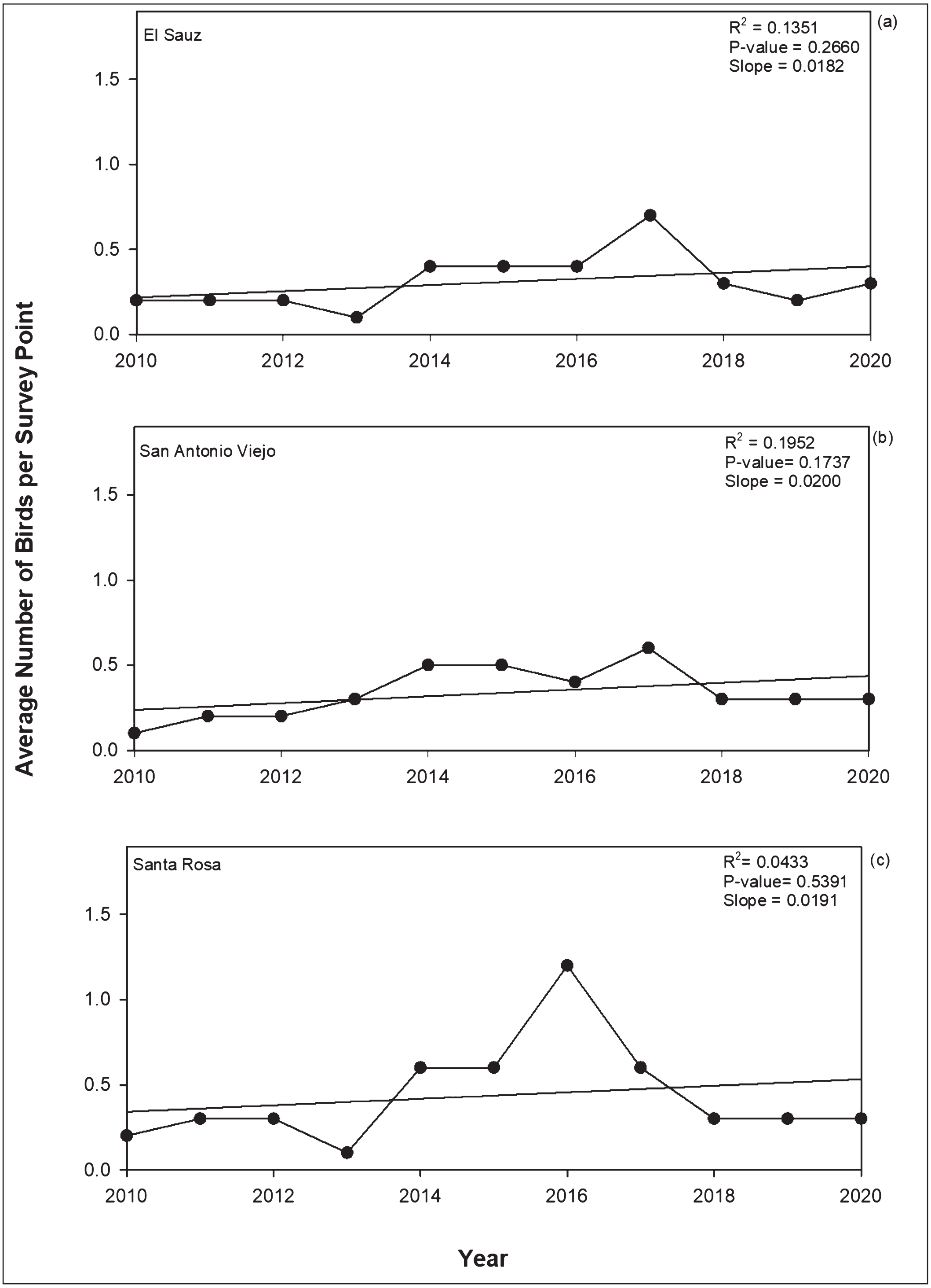

Figure 68. Breeding populations of Greater Roadrunner on East Foundation ranches from 2010-2020.

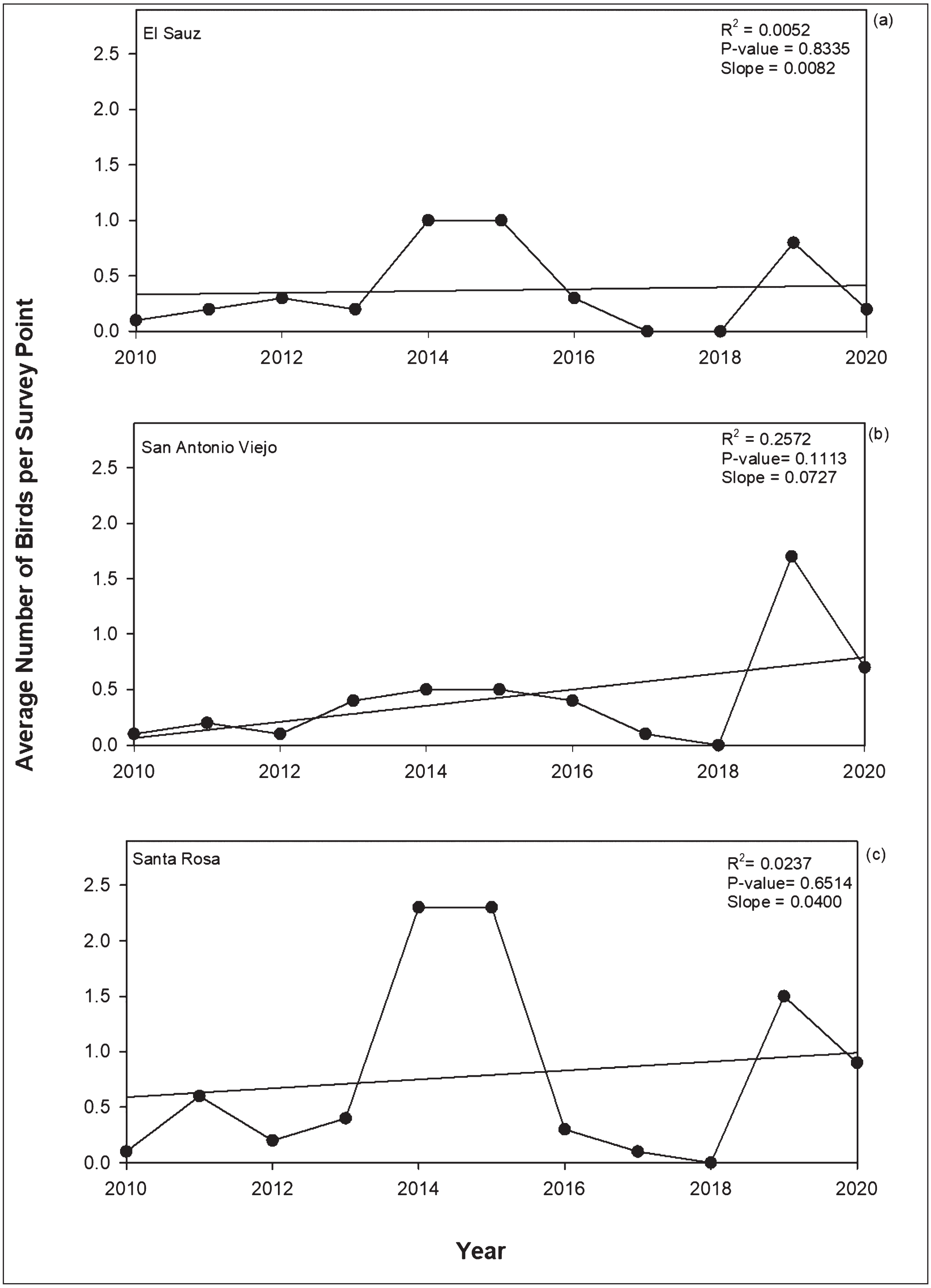

Figure 69. Breeding populations of Lark Sparrow on East Foundation ranches from 2010-2020.

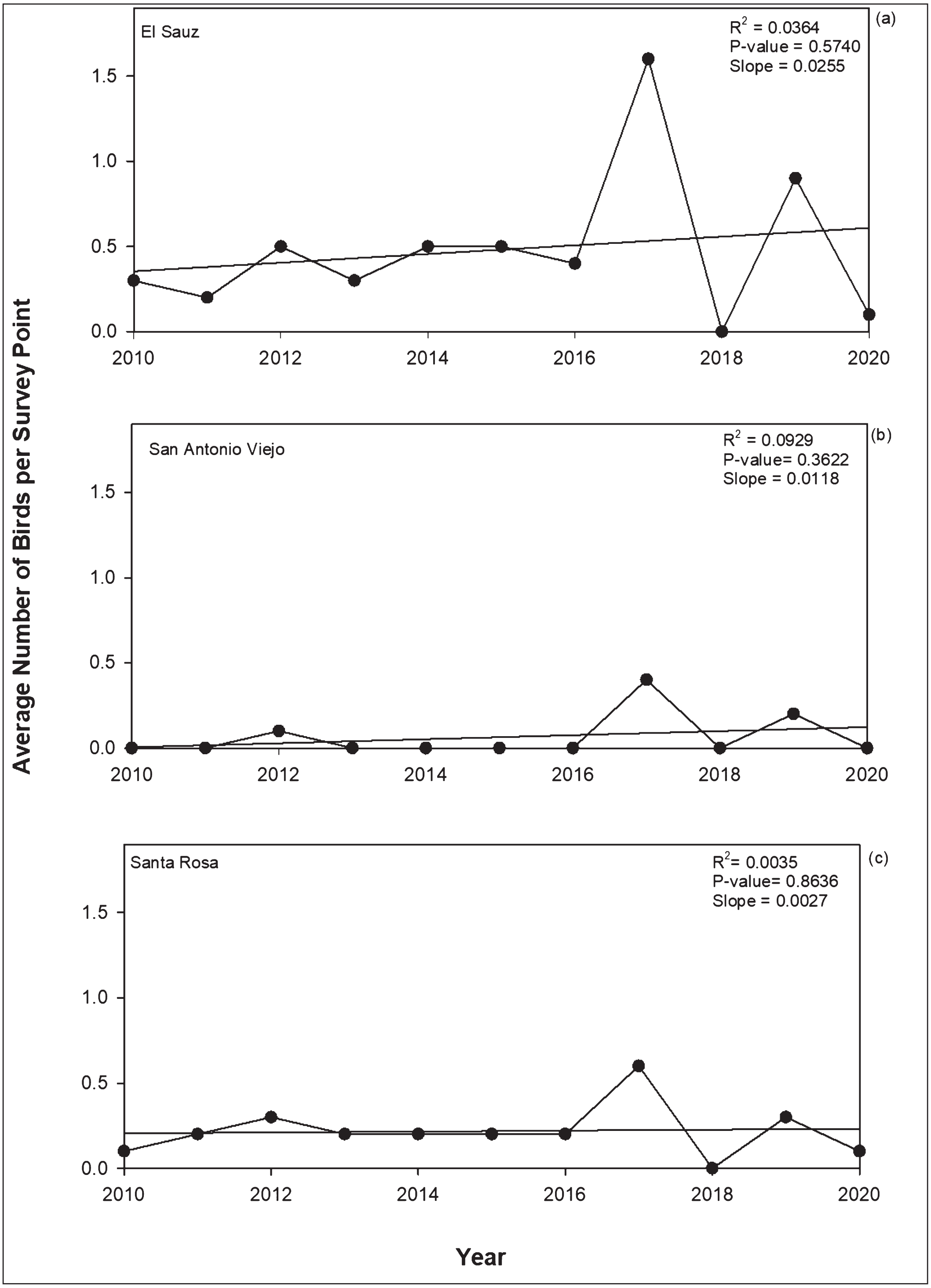

Figure 70. Breeding populations of Long-billed Thrasher on East Foundation ranches from 2010-2020.

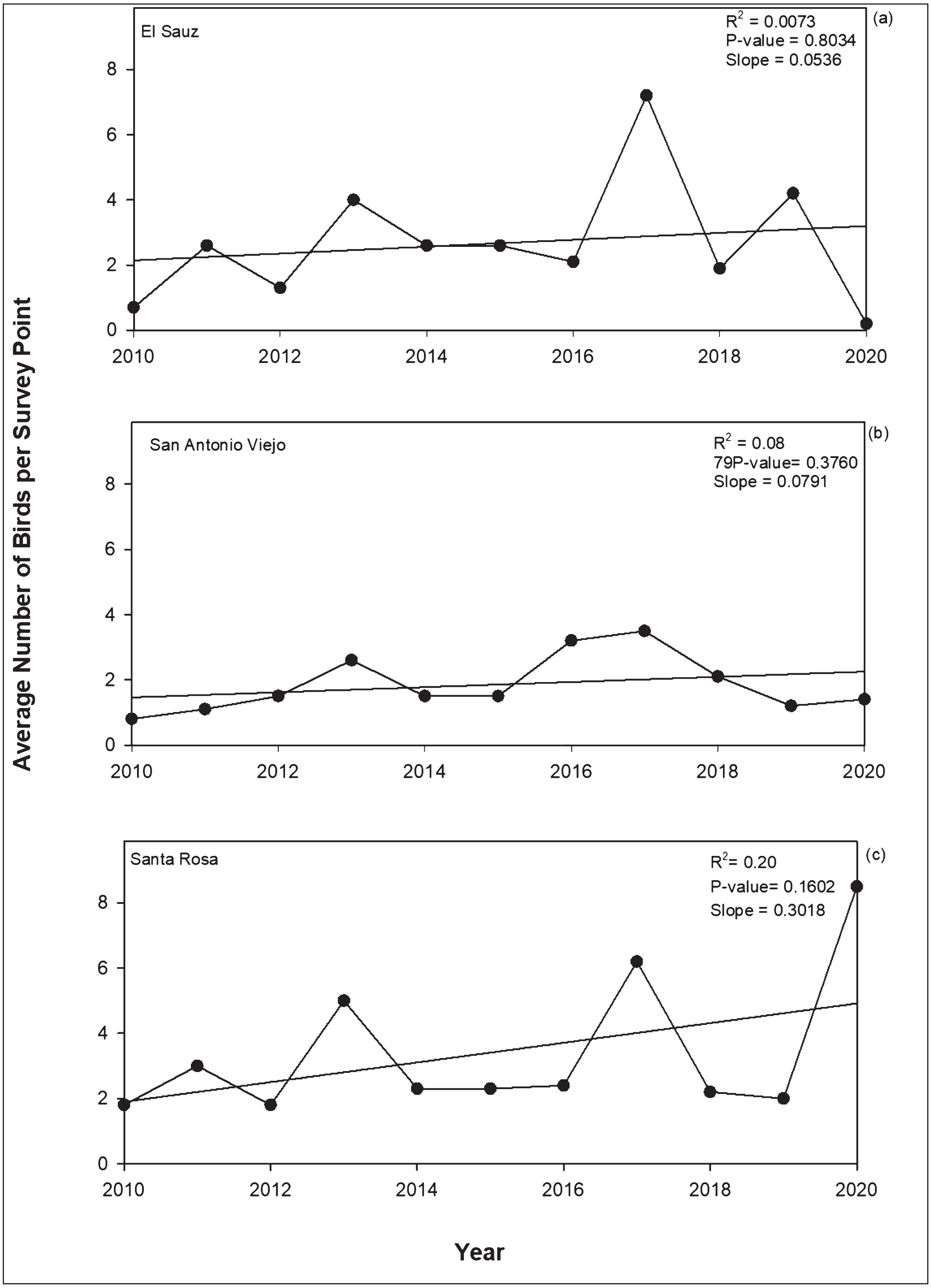

Figure 71. Breeding populations of Mourning Dove on East Foundation ranches from 2010-2020.

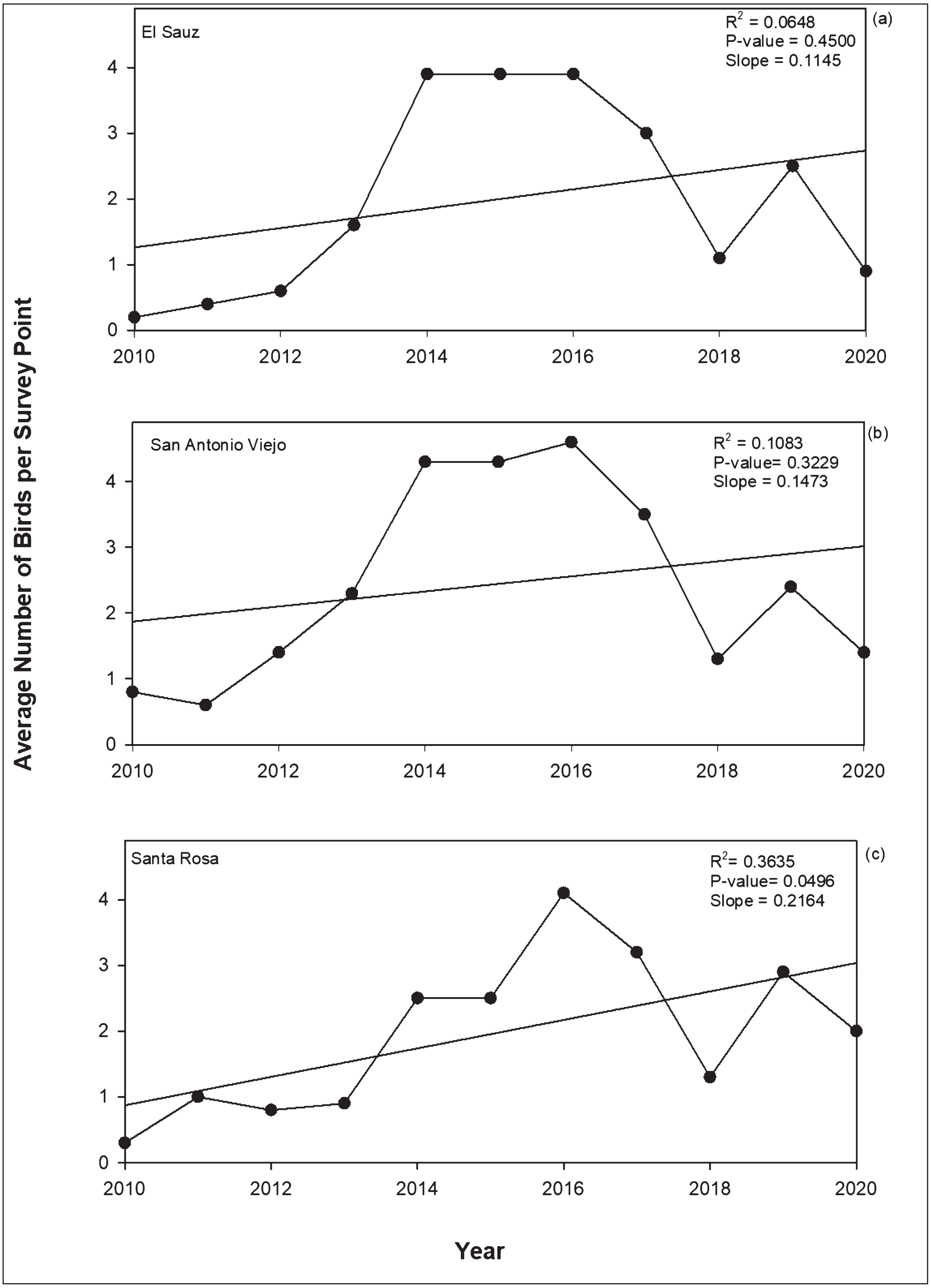

Figure 72. Breeding populations of Northern Bobwhite on East Foundation ranches from 2010-2020.

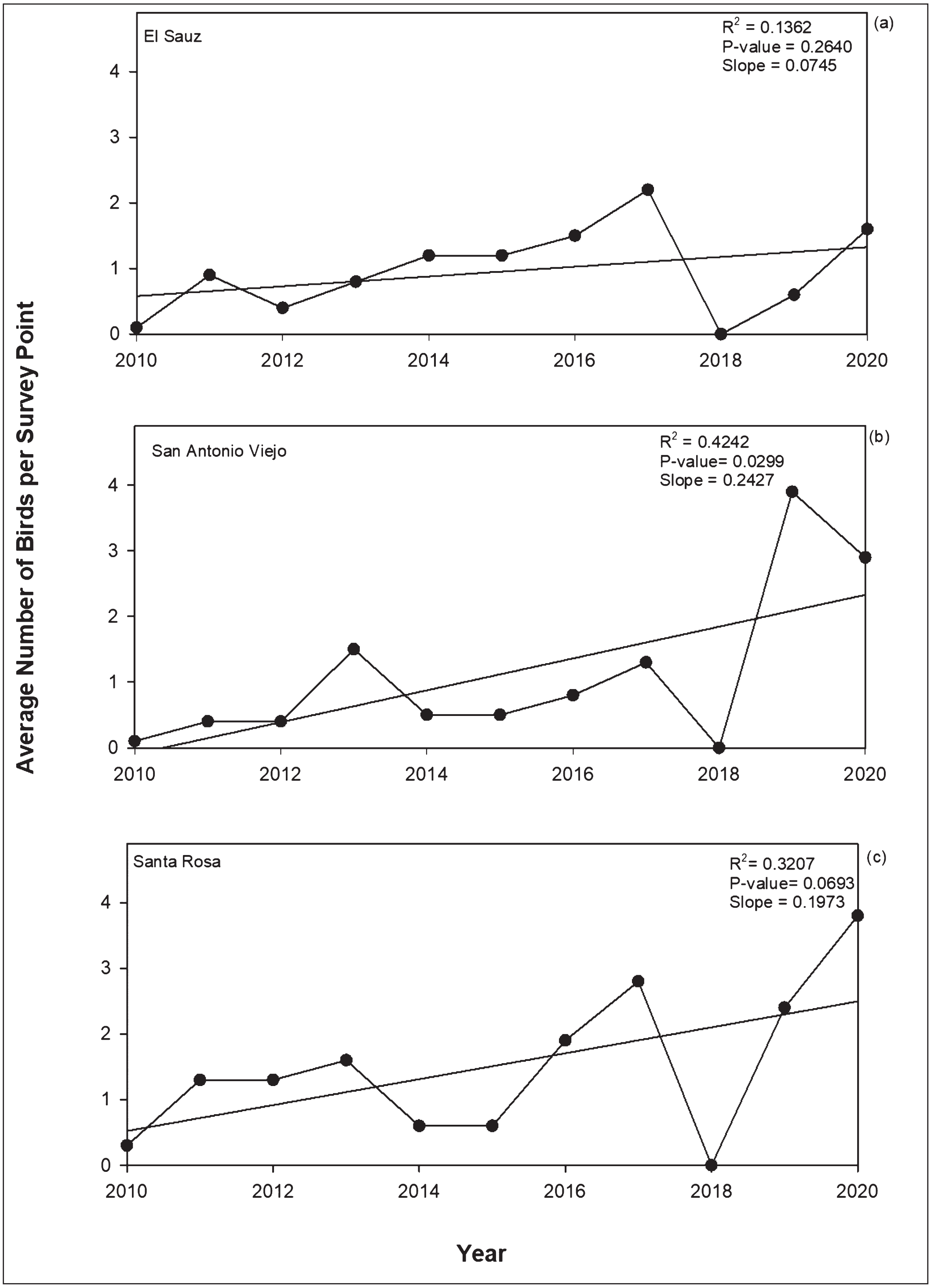

Figure 73. Breeding populations of Northern Cardinal on East Foundation ranches from 2010-2020.

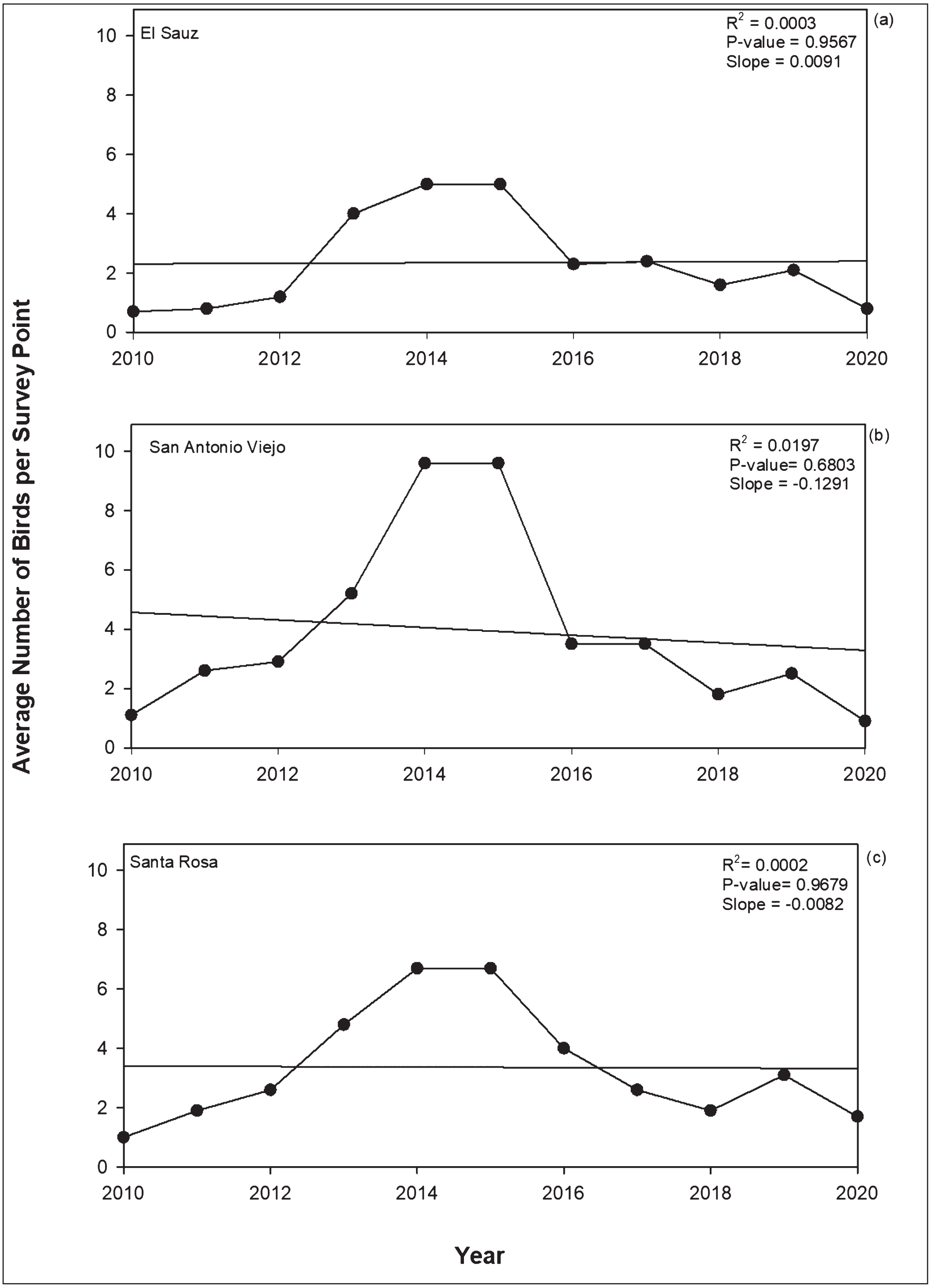

Figure 74. Breeding populations of Northern Mockingbird on East Foundation ranches from 2010-2020.

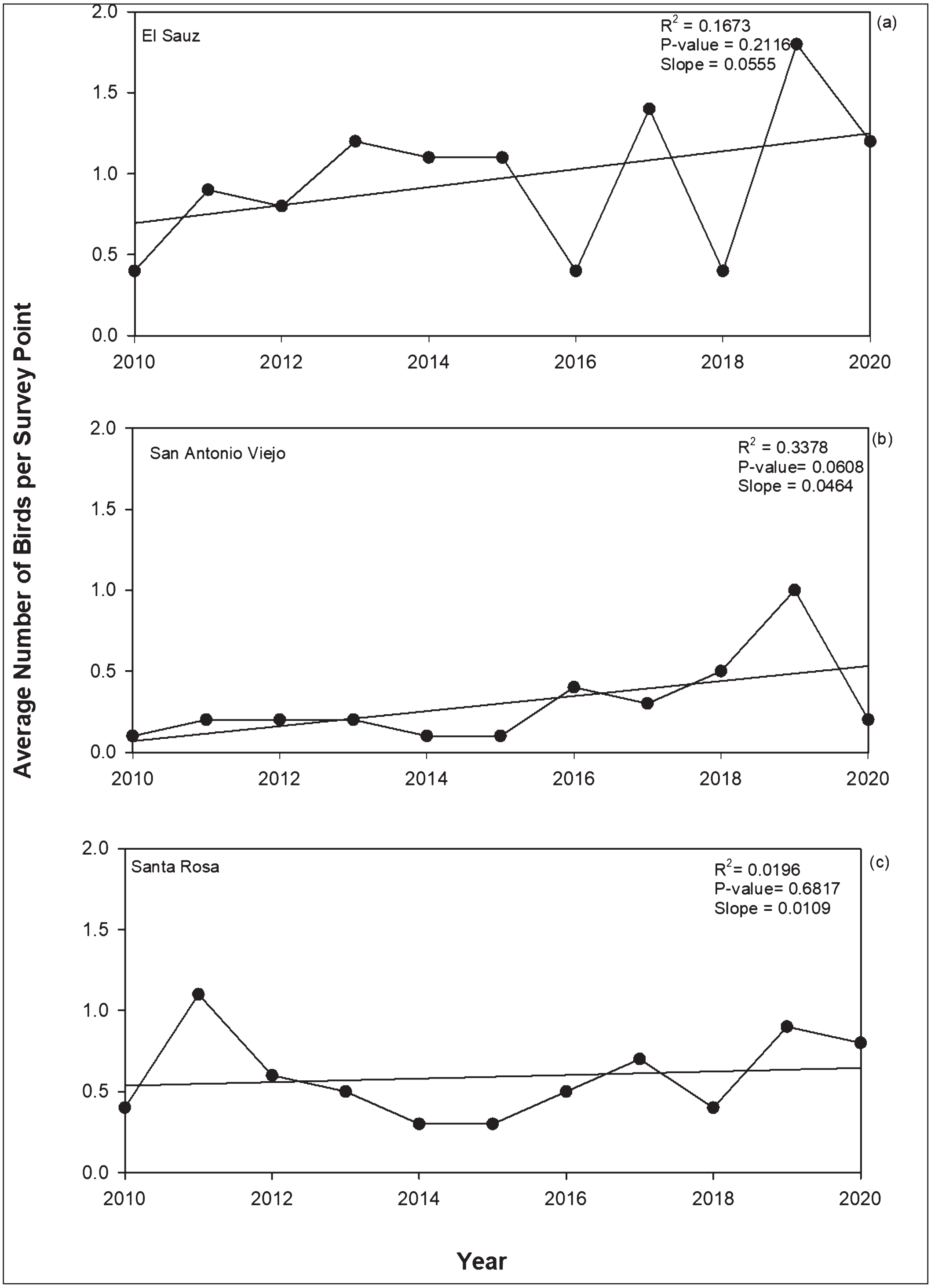

Figure 75. Breeding populations of Olive Sparrow on East Foundation ranches from 2010-2020.

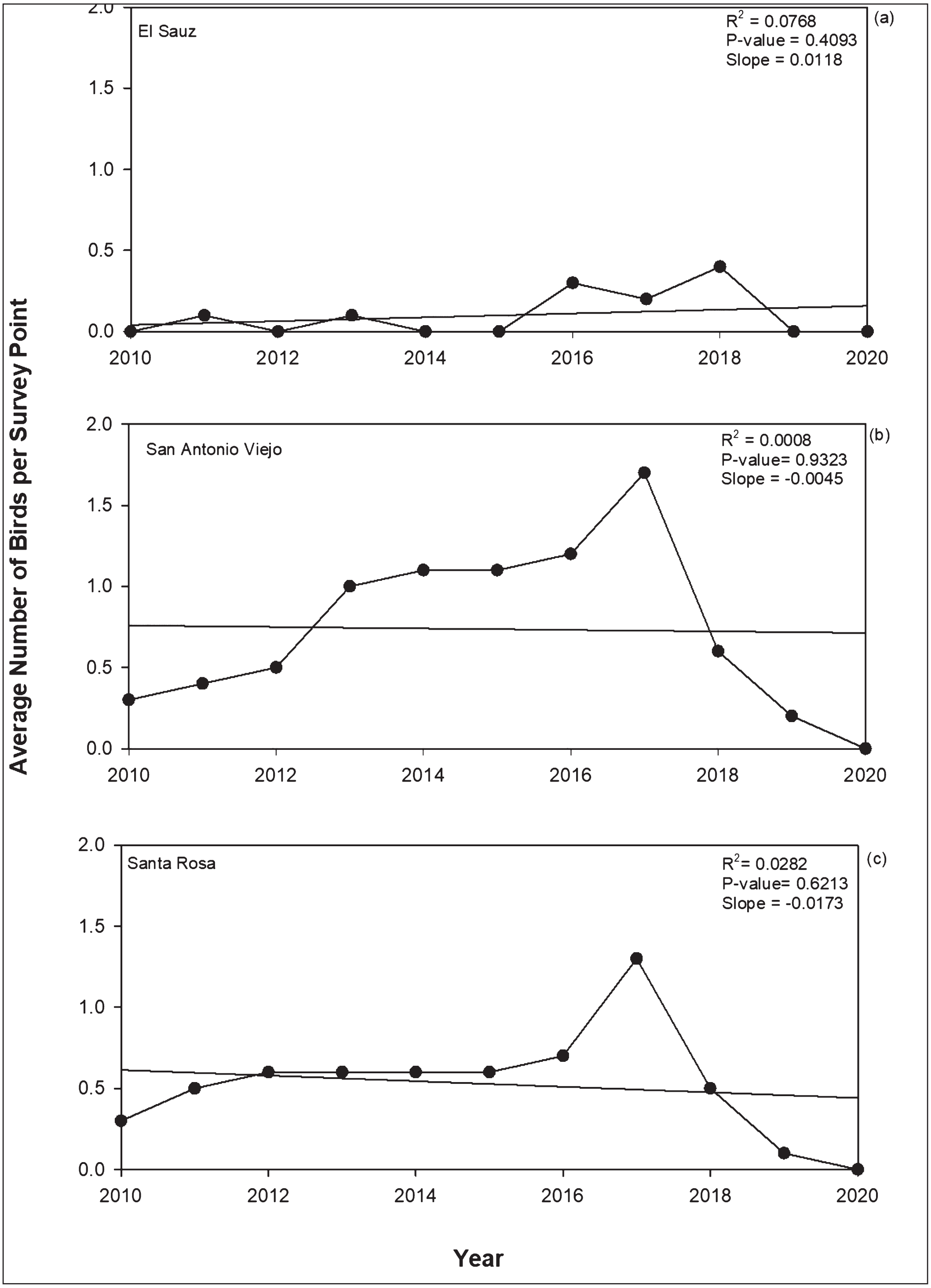

Figure 76. Breeding populations of Painted Bunting on East Foundation ranches from 2010-2020.

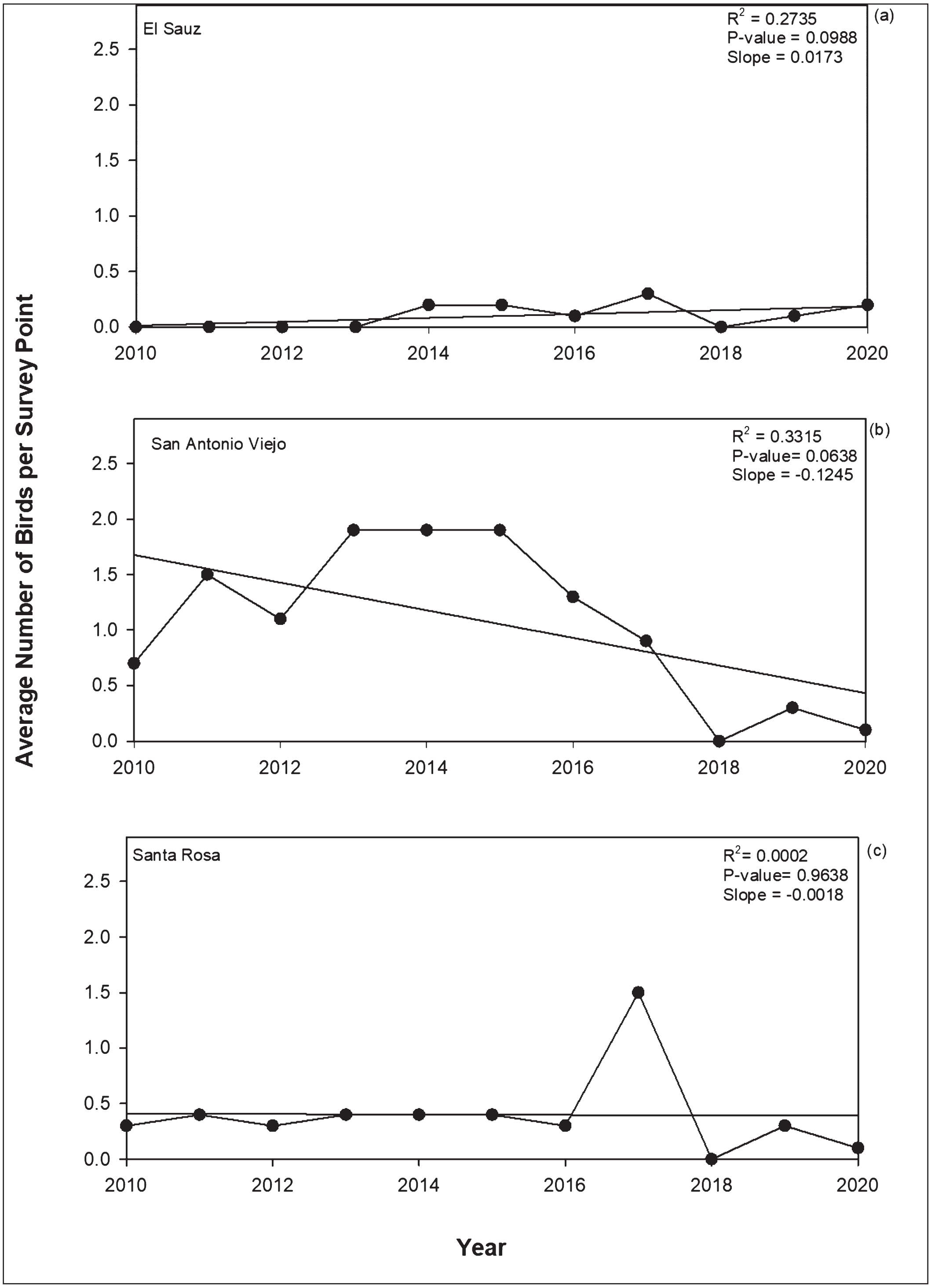

Figure 77. Breeding populations of Pyrrhuloxia on East Foundation ranches from 2010-2020.

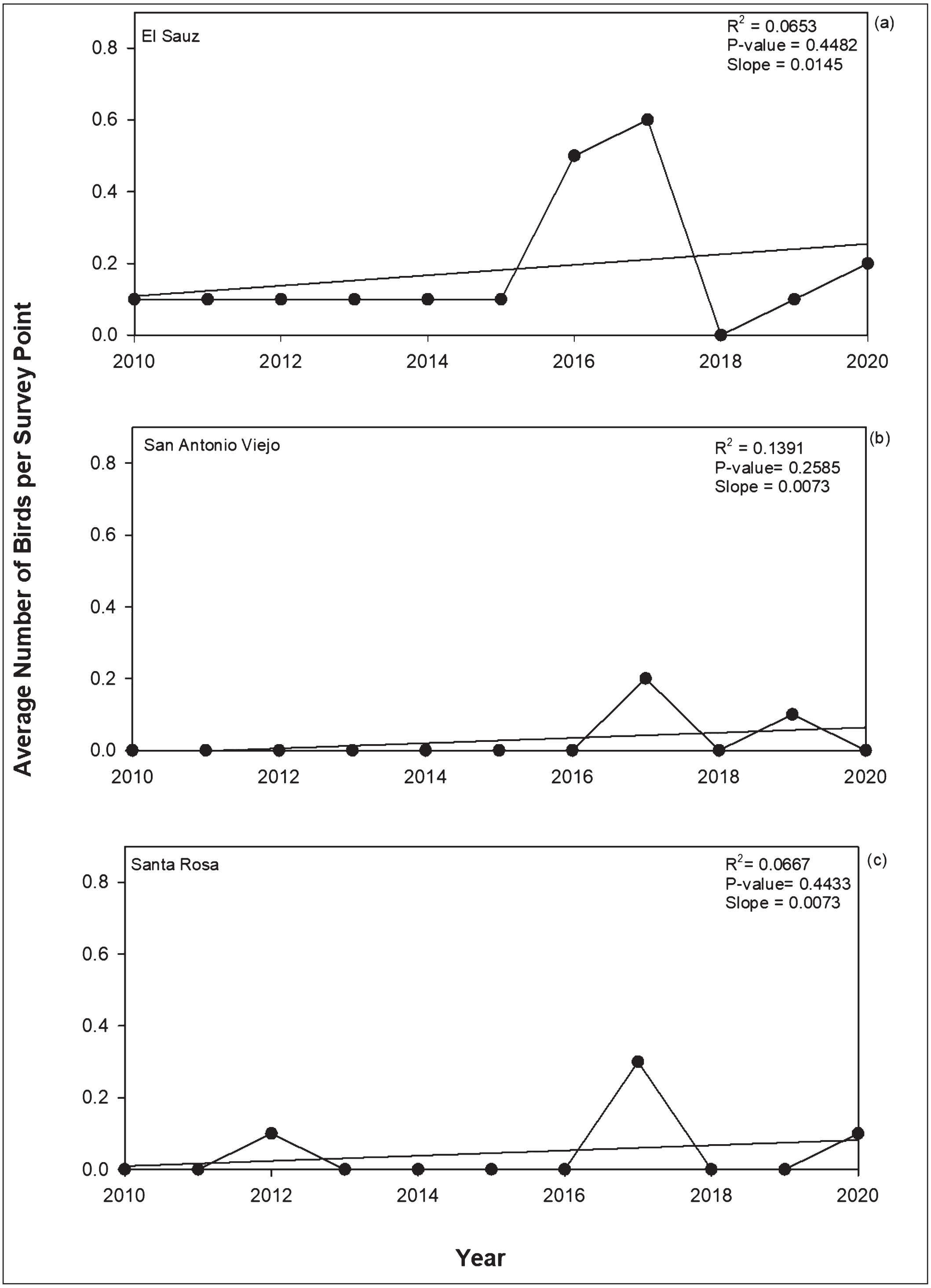

Figure 78. Breeding populations White-tipped Dove on East Foundation ranches from 2010-2020.

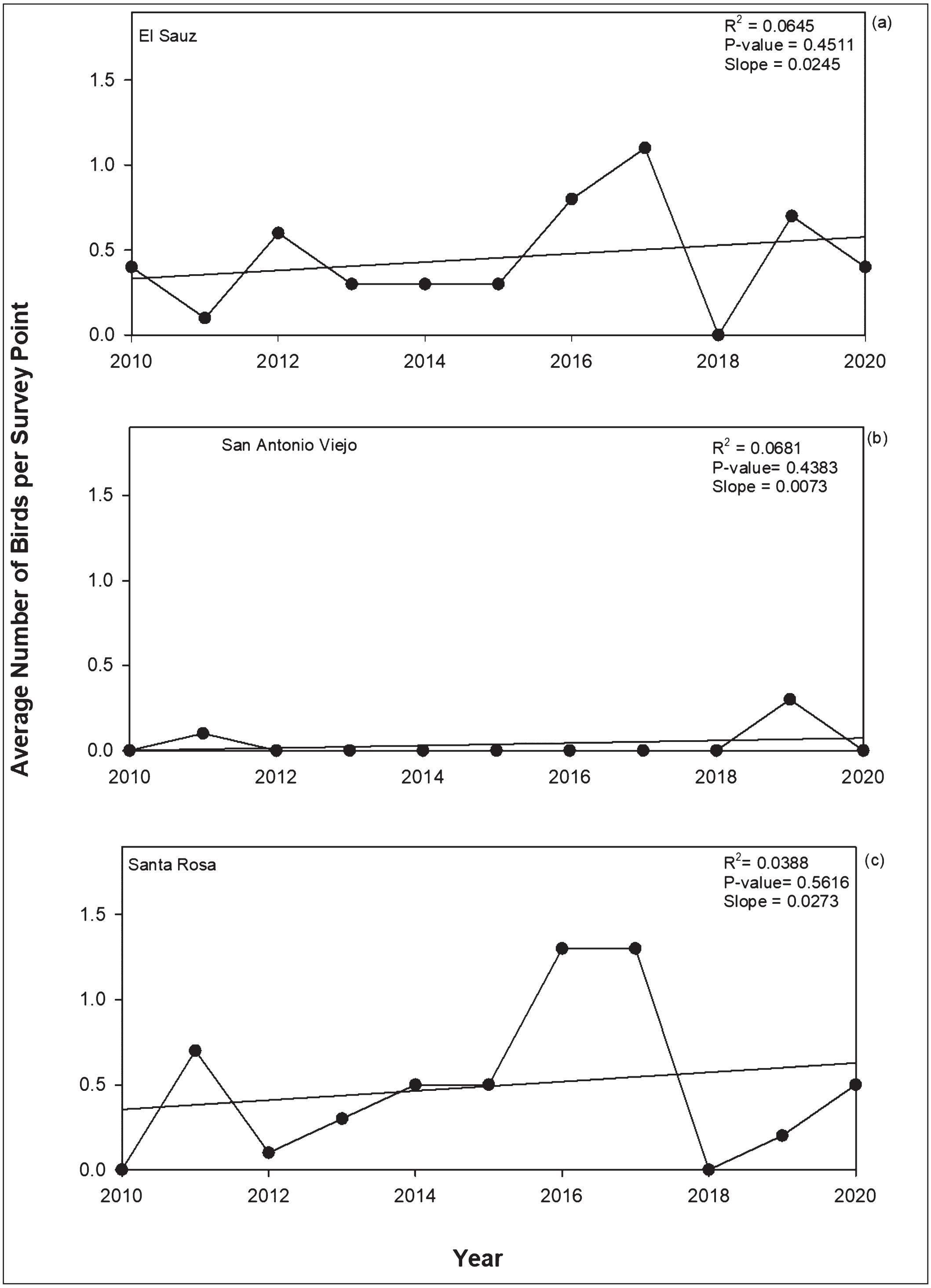

Figure 79. Breeding populations of Wild Turkey on East Foundation ranches from 2010-2020.

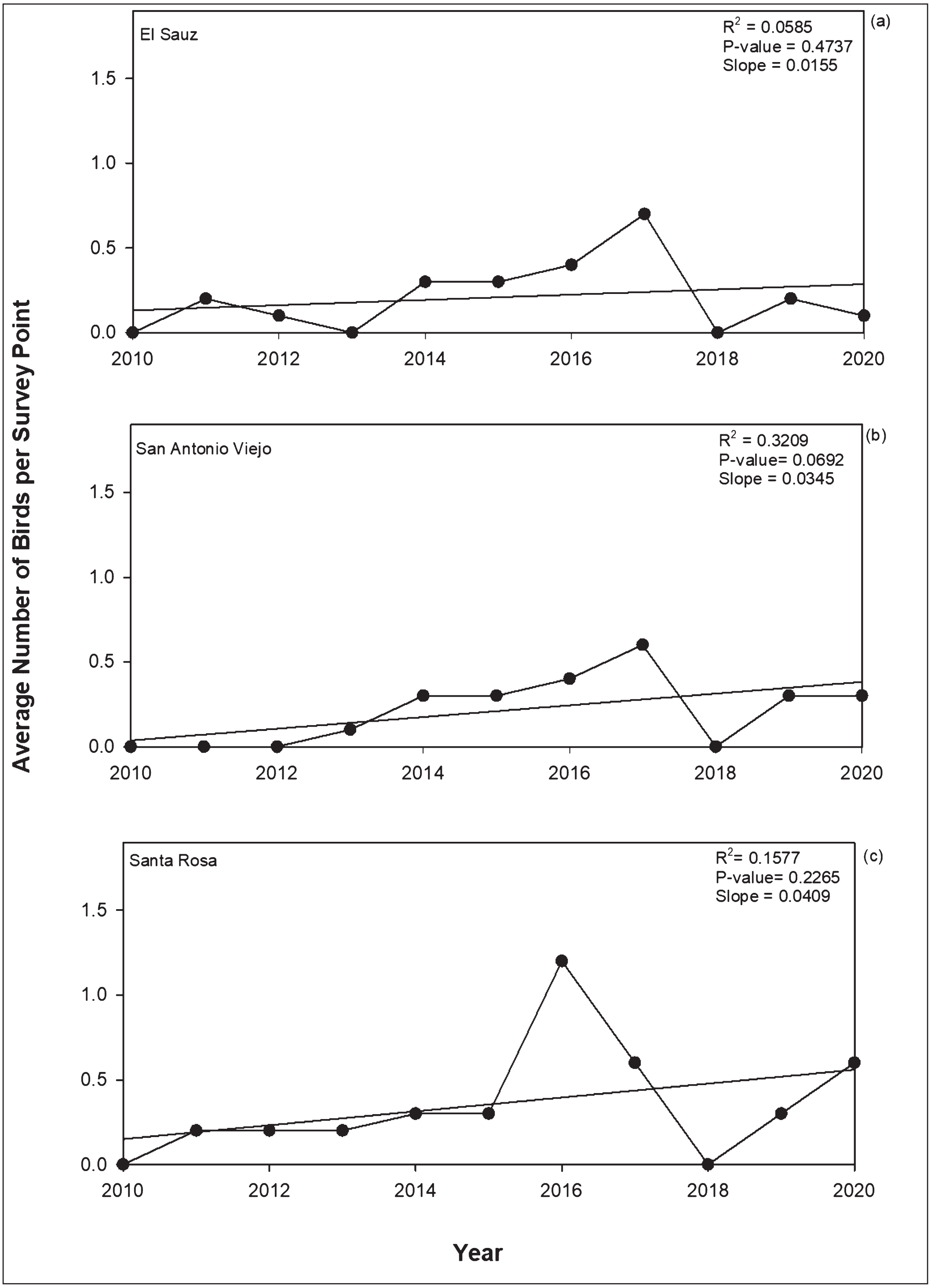

Figure 80. Breeding populations of Green Jay on East Foundation ranches from 2010-2020.

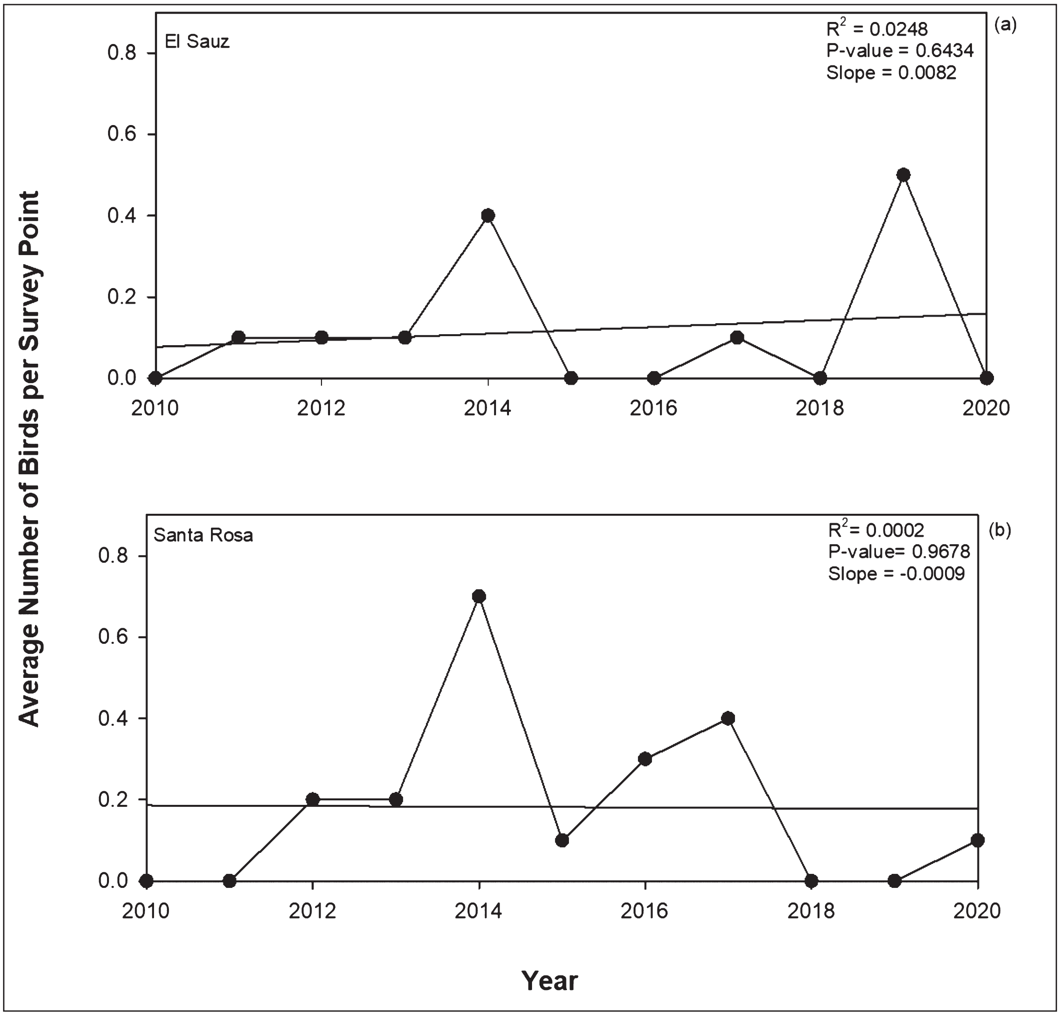

Figure 81. Breeding populations of Black Vulture on East Foundation ranches from 2010-2020.

Ground Foragers.—Black-throated Sparrows (Fig. 59), Bronzed Cowbirds (Fig. 60), Cactus Wrens (Fig. 62), Cassin's Sparrows (Fig. 63), Common Ground Doves (Fig. 64), Curved-billed Thrashers (Fig. 65), Great-tailed Grackles (Fig. 67), Greater Roadrunners (Fig. 68), Lark Sparrows (Fig. 69), Long-billed Thrashers (Fig. 70), Mourning Doves (Fig. 71), Northern Mockingbirds (Fig. 74), Olive Sparrows (Fig. 75), Painted Buntings (Fig. 76), Pyrrhuloxias (Fig. 77), White-tipped Doves (Fig. 78), and Wild Turkeys (Fig. 79), were detected on all three ranches during the breeding season. However, their population changes were not significant during our breeding-bird surveys.

Brown-headed Cowbirds (Fig. 61) were detected on all three ranches during the breeding season. Brown-headed Cowbirds were more abundant on El Sauz and Santa Rosa ranches (Figs. 61a and 61c) than on San Antonio Viejo Ranch (Fig. 61b). However, the breeding survey detections on El Sauz Ranch ($P = 0.022$) and San Antonio Viejo Ranch ($P = 0.012$) experienced a decreasing trend, while the detections on Santa Rosa Ranch had no significant trend. Across the state, in the

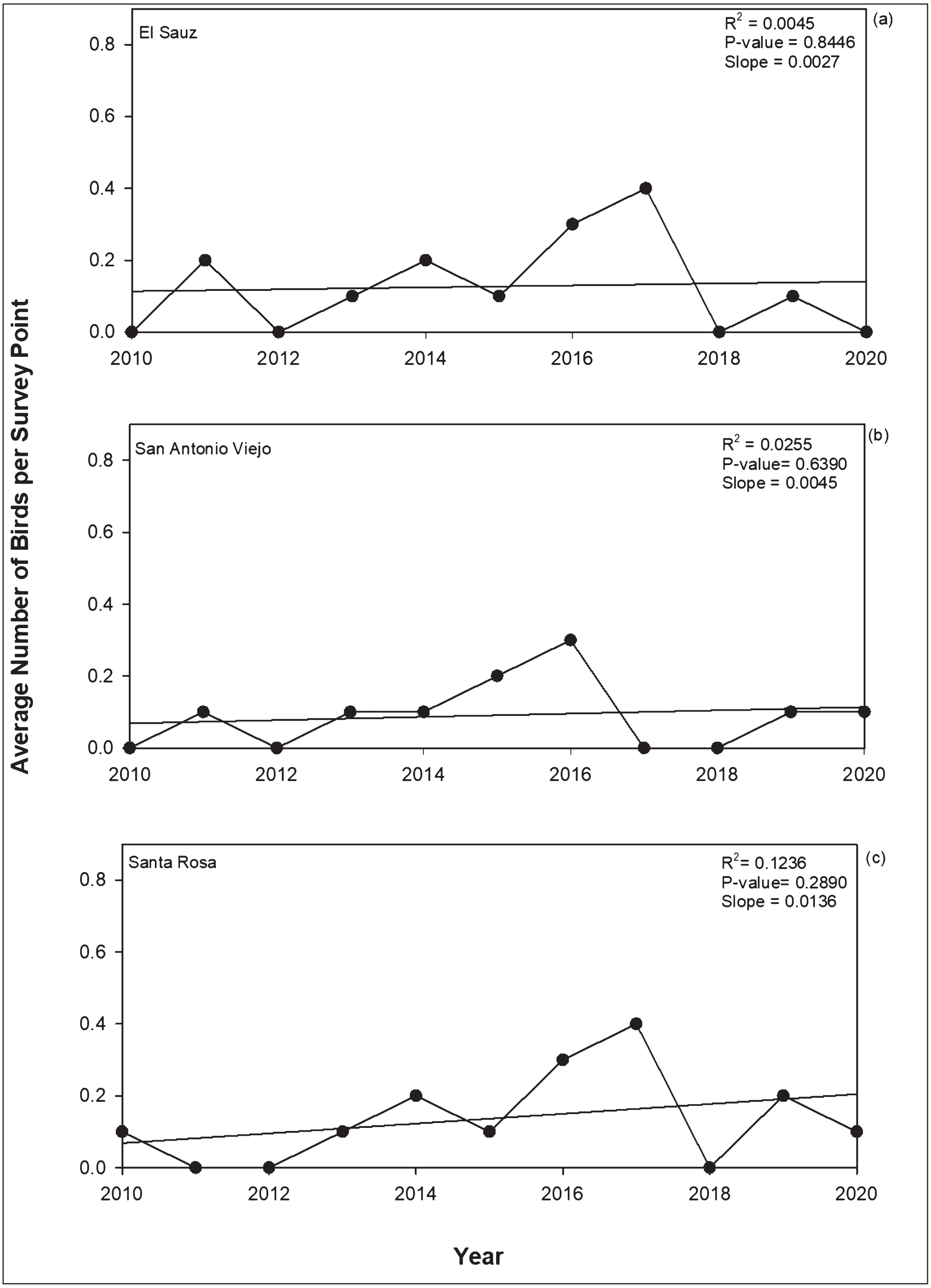

Figure 82. Breeding populations of Crested Caracara on East Foundation ranches from 2010-2020.

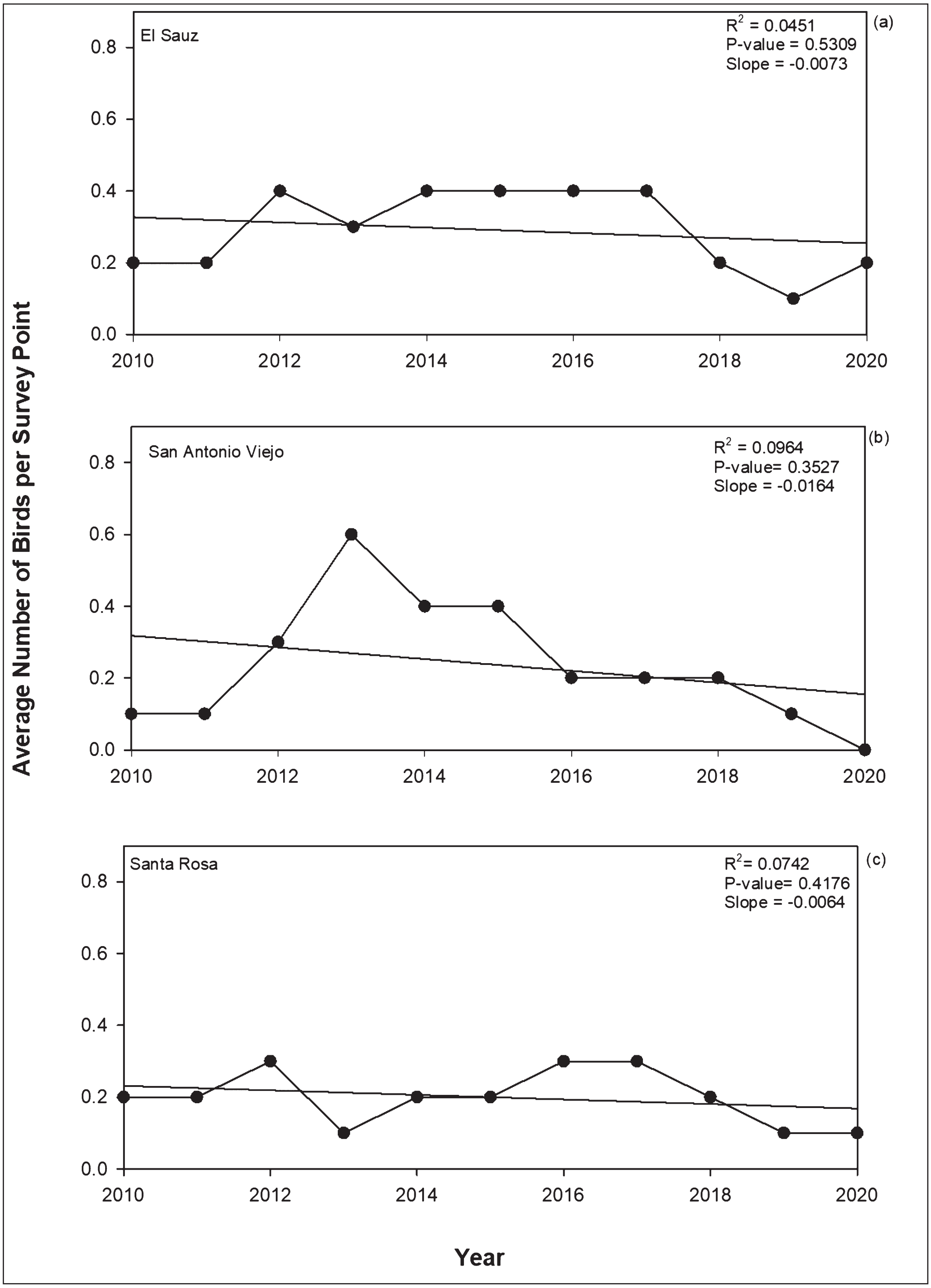

Figure 83. Breeding populations of Turkey Vulture on East Foundation ranches from 2010-2020.

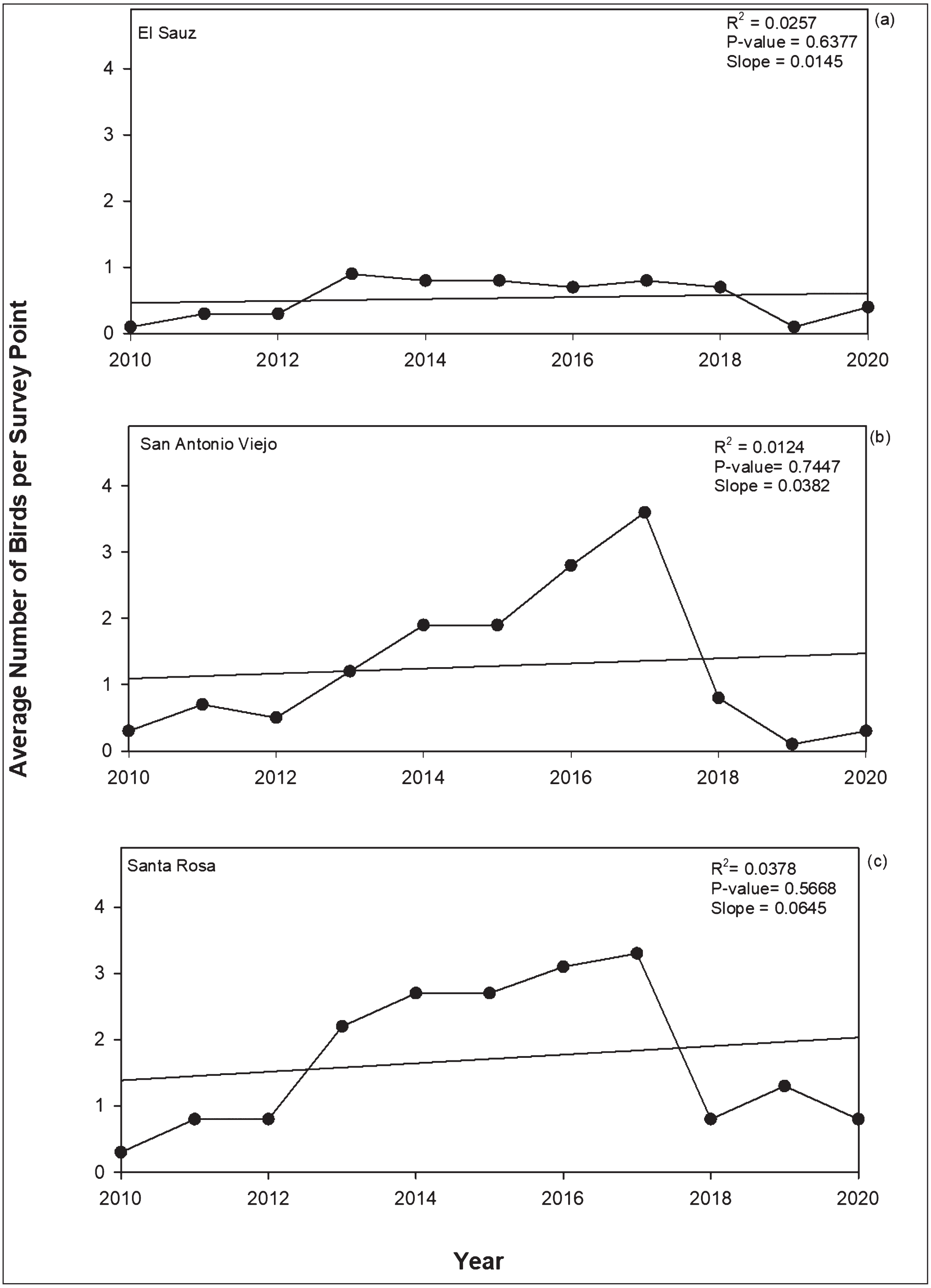

Figure 84. Breeding populations of Bewick's Wren on East Foundation ranches from 2010-2020.

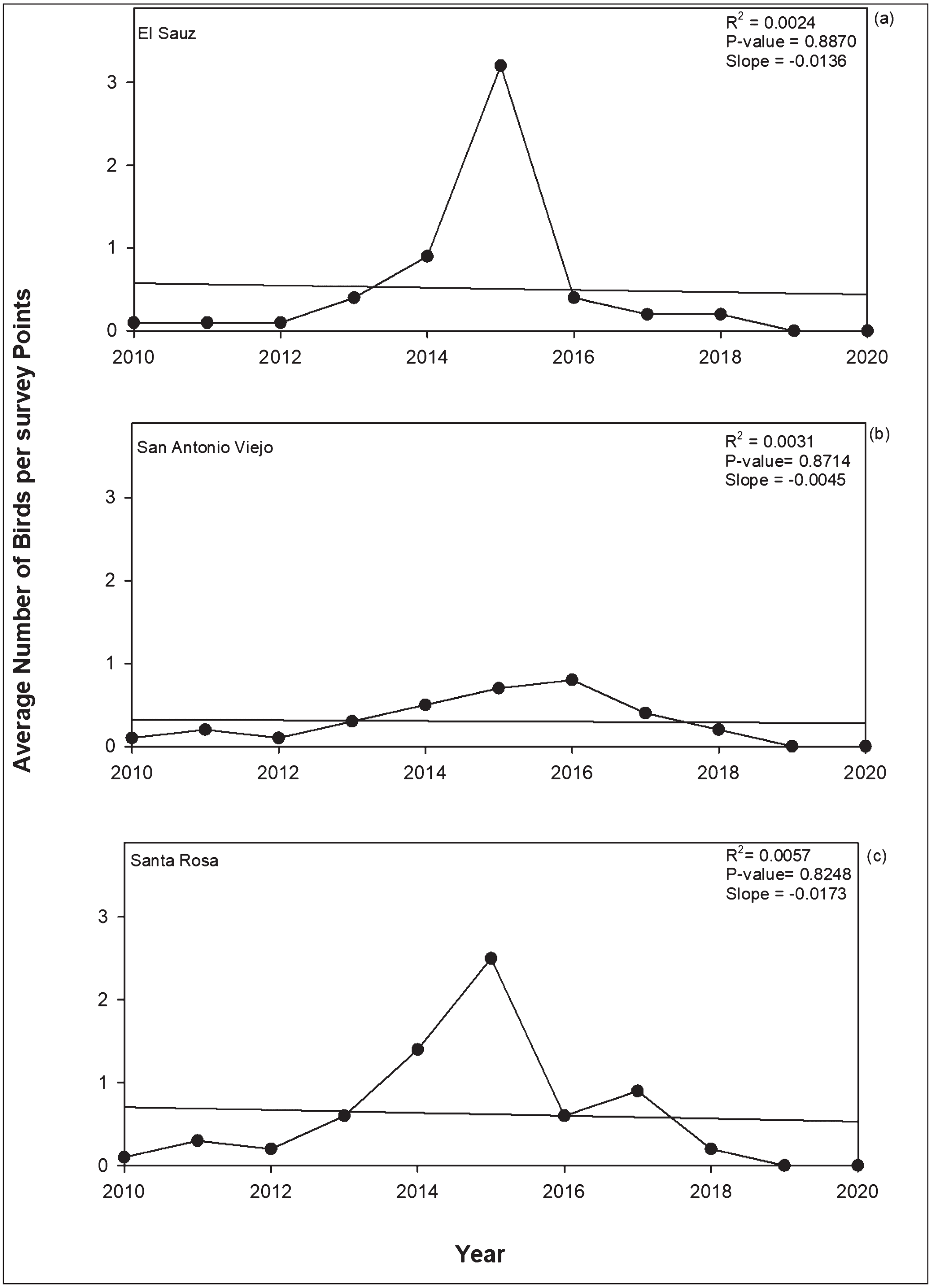

Figure 85. Breeding populations of Black-crested Titmouse on East Foundation ranches from 2010-2020.

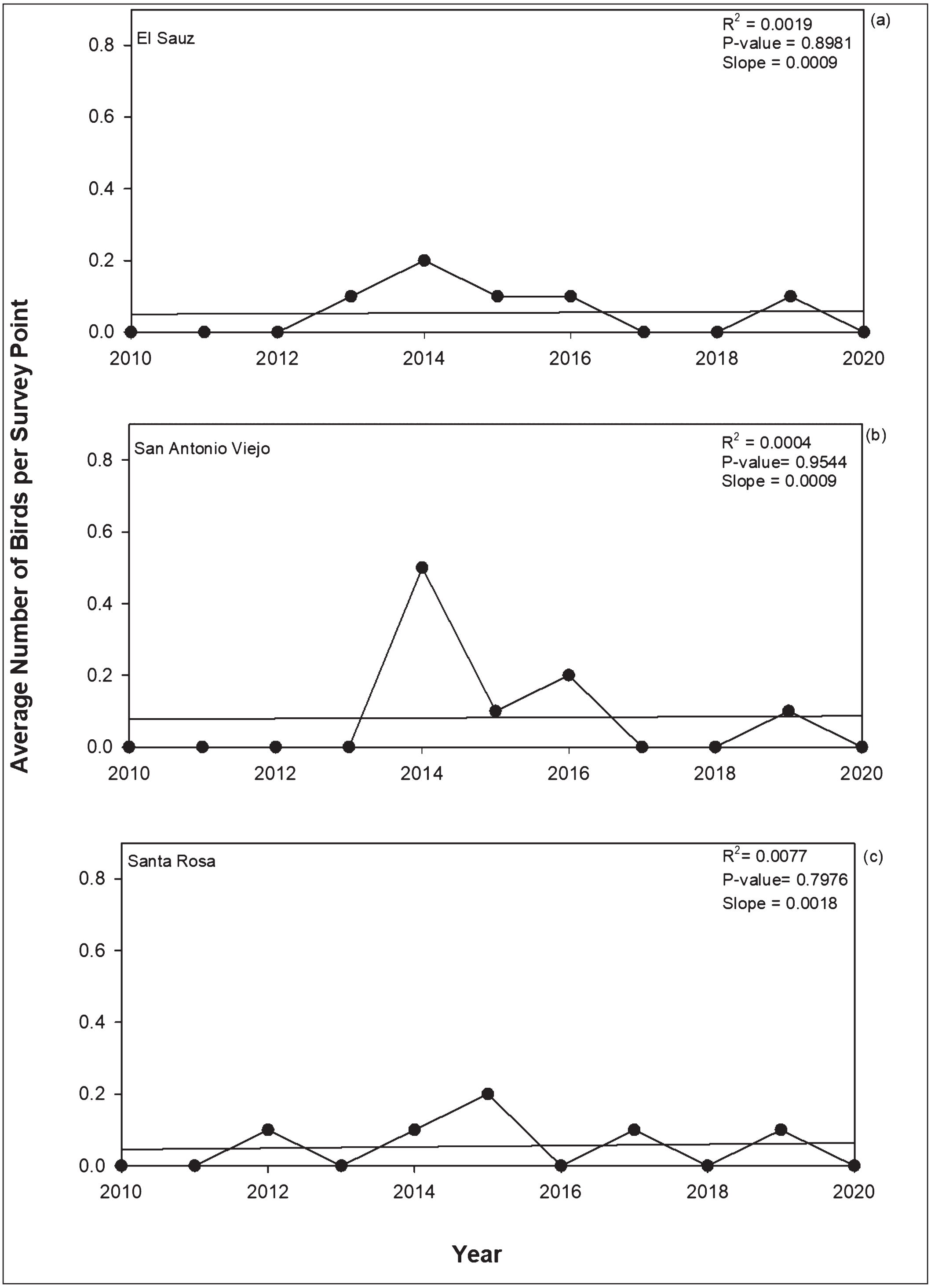

Figure 86. Breeding populations of Blue-gray Gnatcatcher on East Foundation ranches from 2010-2020.

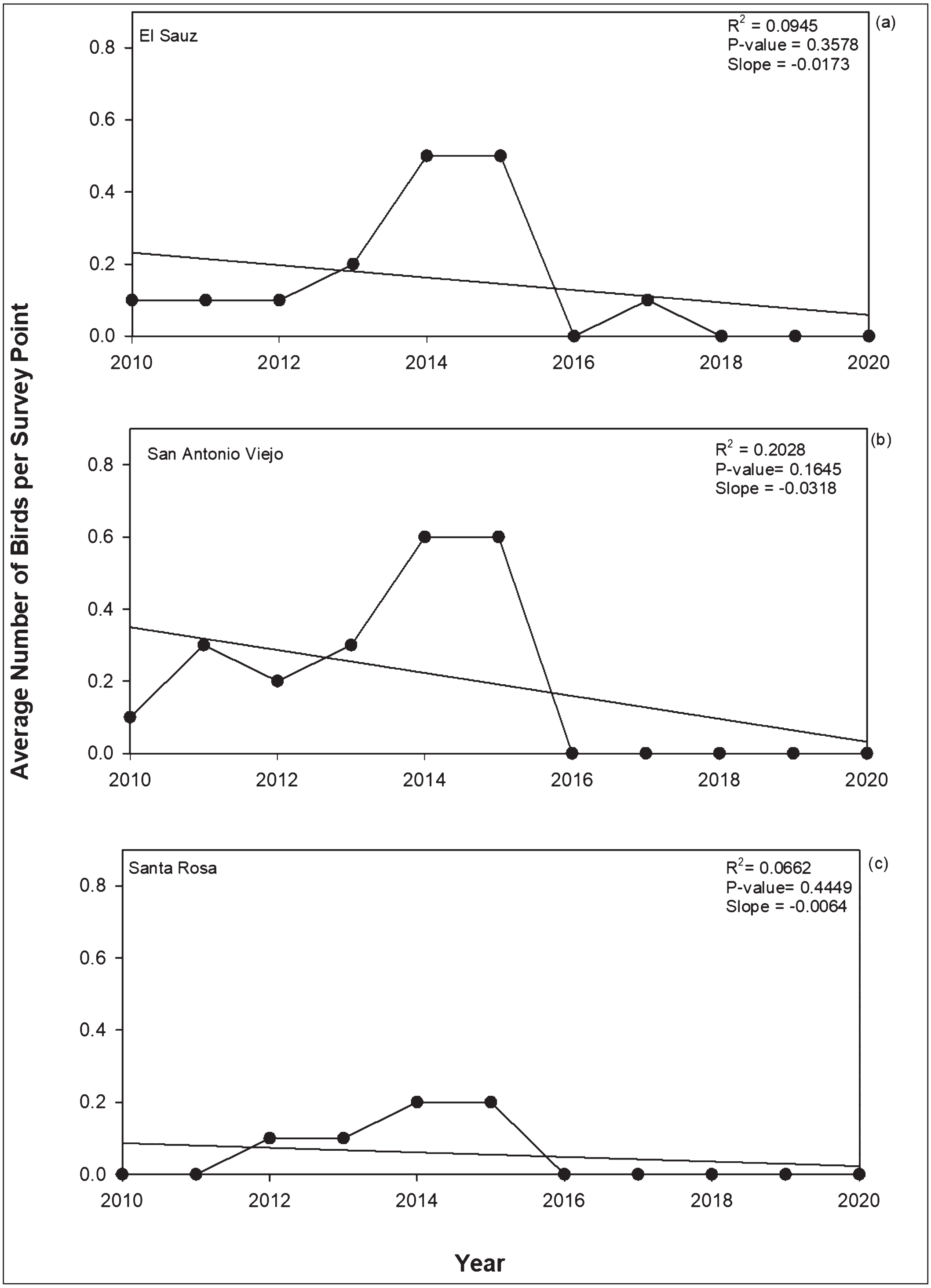

Figure 87. Breeding populations of Verdin on East Foundation ranches from 2010-2020.

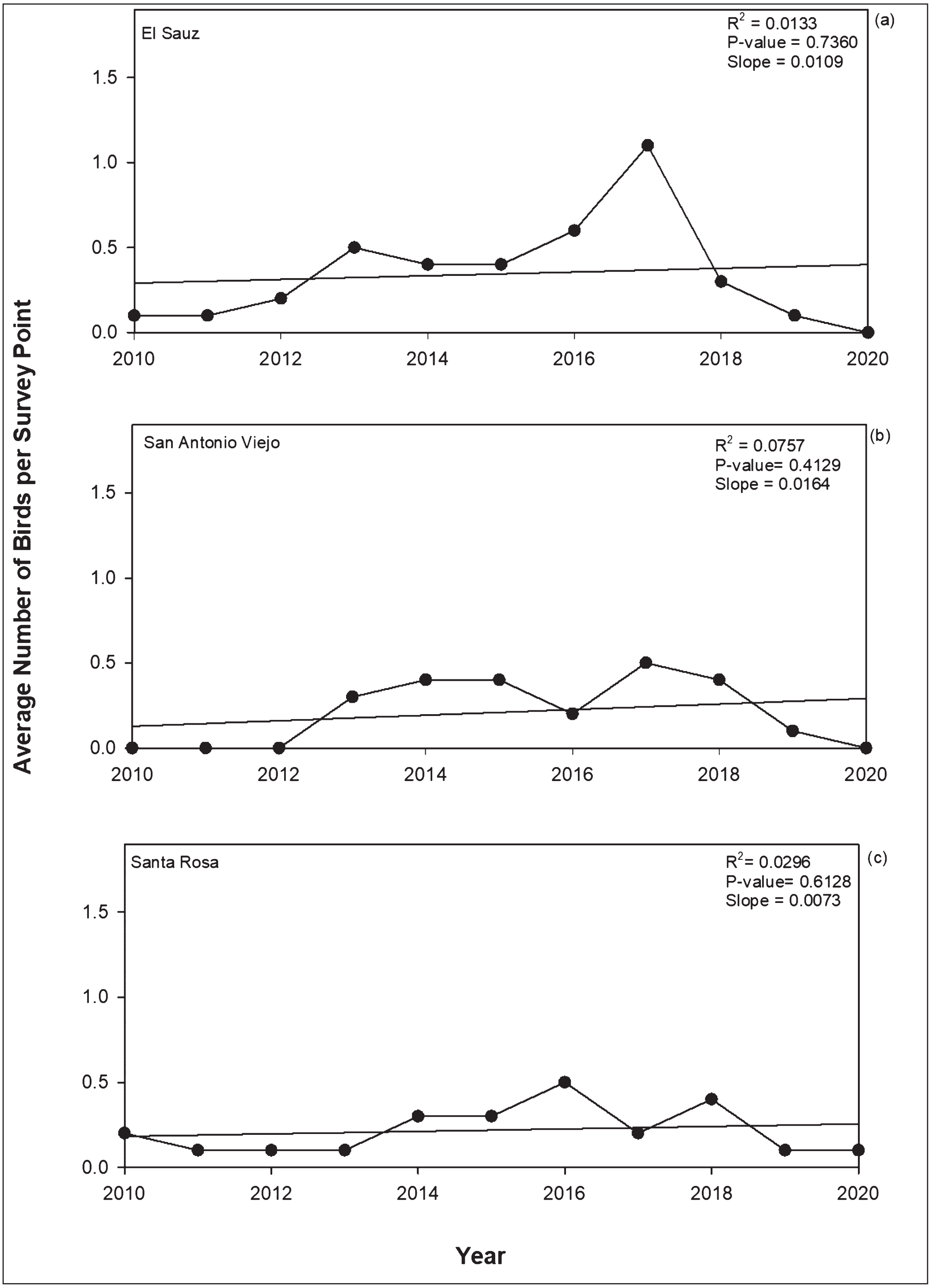

Figure 88. Breeding populations of White-eyed Vireo on East Foundation ranches from 2010-2020.

BBS, Brown-headed Cowbird populations had no statistically significant trend (Sauer et al. 2019).

Eastern Meadowlarks (Fig. 66) were not detected on Santa Rosa Ranch but were present on San Antonio Viejo and El Sauz ranches. Cactus Wrens were present on all three ranches but were only documented on our transects on El Sauz Ranch in 2014 (Fig. 66a) and on Santa Rosa Ranch in 2011 and 2020 (Fig. 66c).

Northern Cardinals (Fig 73) and Northern Bobwhites (Fig 72) were the only ground foraging species that showed a statistically significant population trend during the breeding season on our study sites. The population of Northern Cardinals on San Antonio Viejo Ranch experienced an increasing trend ($P = 0.030$), while the population changes on El Sauz and Santa Rosa ranches were not statistically significant. Northern Bobwhites had a similar abundance across all three of the ranches (Figs. 72a, 72b, 72c). However, the population on Santa Rosa Ranch experienced an increasing trend ($P = 0.050$), while the population changes on El Sauz and San Antonio Viejo ranches were not significant.

Breeding Bird Surveys across the state showed no significant population trends for ground foraging species with the exception of the Eastern Meadowlark and Northern Mockingbird. Statewide BBS data analysis indicates declines for the Eastern Meadowlark and Northern Mockingbird (Sauer et al. 2019), but populations of these species in our study showed no significant declines (Figs. 66 and 74, respectively).

The population trend for White-tipped Doves statewide was unclear due to the low number of BBS routes running through their distribution in South Texas (Sauer et al. 2019). The East Foundation ranches are on the northern border of the White-tipped Dove distribution range (Tweit 2007). White-tipped Doves were detected on El Sauz Ranch transects in all years except 2018 (Fig. 78a) but were only detected on San Antonio Viejo Ranch in 2017 and 2019 (Fig. 78b), and on Santa Rosa Ranch in 2012 and 2017 (Fig. 78c). There were no significant trends in the detection numbers of our surveys.

Mid-Sized Foliage Gleaners.—Green Jays (Fig. 80) were detected on all three ranches during the breeding season. Their population changes were not significant during our breeding bird surveys. Likewise, there were no significant trends for this species for the state BBS (Sauer et al. 2019).

Scavengers.— Crested Caracaras (Fig. 82) were detected on all three ranches during the breeding season. Crested Caracaras had a similar abundance across all three of the ranches (Figs. 82a, 82b, 82c) and there were no statistically significant trends in our survey detections. Across the state, in the BBS, Crested Caracara populations have been experiencing an increasing trend and their range may be expanding (Sauer et al. 2019).

Black Vultures (Fig. 81) were only detected on El Sauz and Santa Rosa ranches during the breeding season. Conversely, Turkey Vultures (Fig. 83) were detected on all three ranches. However, neither species experienced a significant change in their detections on our breeding surveys. Likewise, across the state, both species' populations have remained stable (Sauer et al. 2019).

Small Foliage Gleaners.—Bewick's Wrens (Fig. 84) were detected on all three ranches during the breeding season. Bewick's Wrens were slightly more abundant on San Antonio Viejo and Santa Rosa ranches (Figs. 84b and 84c) than on El Sauz Ranch (Fig. 84a). Despite having no statistically significant trend, the populations on San Antonio Viejo and Santa Rosa ranches experienced a peak in 2017 and then decreased for the rest of the study period. Across the state, in the BBS, Bewick's Wren populations have been increasing (Sauer et al. 2019). The Texas Breeding Bird Atlas listed them as probable in the regions surrounding the Santa Rosa and El Sauz ranches (Tweit 2006), which we have now confirmed their presence.

White-eyed Vireos (Fig. 88) are not well documented in the study region during the breeding season (Tweit n.d.), however, we detected them on all three ranches during the months of May and June. White-eyed Vireos were slightly more abundant on El Sauz Ranch (Fig. 88a) than on San Antonio Viejo and Santa Rosa ranches (Figs. 88b and 88c), but there were no statistically significant trends. Similar to Bewick's Wren, White-eyed Vireos on El Sauz Ranch experienced a peak in 2017 and then decreased for the rest of the study period. Detections on the other two ranches remained stable throughout the study period. Across the state, in the BBS, White-eyed Vireo populations have been increasing (Sauer et al. 2019).

Black-crested Titmice (Fig. 85), Blue-gray Gnatcatchers (Fig. 86), and Verdins (Fig.87) were detected on all three ranches during the breeding season. However, their population changes were not significant during our breeding bird surveys.

The hypothesis that the state and local trends would be different was correct for Brown-crested Flycatchers, Scissor-tailed Flycatchers, Eastern Meadowlarks, Northern Bobwhites, Northern Mockingbirds, Brown-headed Cowbirds, Crested Caracaras, Bewick's Wrens, and White-eyed Vireos. Brown-crested Flycatchers and Brown-headed Cowbirds were experiencing a decreasing trend on the East Foundation while their populations remained stable in the statewide BBS. Although their preferred habitat is present on the ranches, Brown-crested Flycatchers were detected in relatively small numbers during the breeding season surveys. The decreasing trend may be a result of a small sample size or a factor of misidentification (as this species is easily confused with Ash-throated and Great-crested Flycatcher). Scissor-tailed Flycatchers, Eastern Meadowlark, and Northern Mockingbird populations remained stable on our transects while their populations decreased in the statewide BBS. Northern Bobwhites experienced an increasing trend on one of the ranches while their populations in the statewide BBS remained stable. Scissor-tailed Flycatchers and Eastern Meadowlarks are particularly impacted by loss of their native grassland habitats due to their status as a grassland obligate species (Correll et al. 2019 and Rosenberg et al. 2019), but the East Foundation properties constitute a relatively undisturbed large habitat where these species may thrive. Crested Caracaras, Bewick's Wrens, and White-eyed Vireos remained stable on our survey sites but in the statewide BBS their populations were increasing. For all other breeding bird species, the hypothesis was not supported, and there were no differences between the state and local trends.

Breeding Bird Abundance and Precipitation Correlations

Precipitation did not appear to have a significant effect on most bird species on the East Foundation ranches during the May and June breeding bird surveys. Six species recorded during the breeding bird survey had a significant relationship between their abundance and annual precipitation on one of the three East Foundation ranches (Table 2). Of these species, Black-throated Sparrow and White-eyed Vireo abundance increased with increasing precipitation, and 4 species (Black Vulture, Brown-crested Flycatcher, Common Ground Dove, and Scissor-tailed Flycatcher) had a significant negative relationship with precipitation (Table 2). However, it seems unlikely that these species would have a significant negative relationship with precipitation since the same pattern was not present in the non-breeding survey results. It is likely that these are spurious correlations.

DISCUSSION

This 10-year survey helps to fill the knowledge gap on bird populations on the ranch lands of South Texas. We recorded 207 bird species on 3 East Foundation properties. Most of the 51 species that were analyzed had stable or increasing population trends. Precipitation did not appear to have a significant effect on most bird species on our transects during this study.

A subset of this data was reported by Lipschutz (2016) in an earlier study and, although the statistical analyses were slightly different, the results can be used as a comparison to test the idea that survey time periods of different lengths may yield different abundance trends for the same location. Lipschutz (2016) analyzed the 2010 to 2015 non-breeding bird surveys and the 2008 to 2015 breeding bird surveys. Our analyses included 5 additional years and covered 2010 to 2020 for both surveys (we omitted data from 2008 to 2009 due to changes in survey points). A majority of the bird species that were analyzed individually in Lipschutz 2016 were reported as stable or increasing abundance. Similarly for the 10-year study period, 99% of the 51 species analyzed from the non-breeding bird surveys and 94% of 36 species analyzed from the breeding bird surveys had stable or increasing population trends. Yet, there may be some bias towards species with increasing or stable populations because of the criteria that a species had to be detected "frequent enough" to run statistical analyses.

For the 10-year study, 20% of the non-breeding bird species had significant increases in abundance (7 species on El Sauz Ranch, 8 species on San Antonio Viejo Ranch, and 15 species on Santa Rosa Ranch), and 2% of species on the breeding bird

Table 2. Rainfall correlation coefficients for breeding species on East Foundation ranches.

	El Sauz		San Antonio Viejo		Santa Rosa	
	Correlation Coefficient	P-Value	Correlation Coefficient	P-Value	Correlation Coefficient	P-Value
Bewick's Wren	.0460	0.894	0.100	0.769	0.244	0.470
Black Vulture	−0.696*	0.017	0.192	0.572	−0.055	0.872
Black-bellied Whistling-Duck	−0.105	0.758	--	--	−0.256	0.447
Black-crested Titmouse	0.082	0.810	0.119	0.728	0.237	0.483
Black-throated Sparrow	0.458	0.157	−0.214	0.527	0.639*	0.034
Blue-gray Gnatcatcher	0.051	0.882	0.149	0.661	0.257	0.445
Bronzed Cowbird	0.100	0.770	0.293	0.382	−0.398	0.225
Brown-crested Flycatcher	−0.703*	0.016	−0.622*	0.041	−0.709*	0.015
Brown-headed Cowbird	−0.636*	0.036	−0.483	0.133	−0.374	0.257
Cactus Wren	0.051	0.882	0.137	0.689	−0.256	0.447
Cassin's Sparrow	0.132	0.698	0.209	0.537	0.162	0.635
Common Ground Dove	−0.319	0.339	−0.269	0.424	−0.743**	0.009
Couch's Kingbird	−0.323	0.332	0.387	0.239	0.138	0.687
Crested Caracara	−0.273	0.417	−0.014	0.968	0.334	0.315
Curve-billed Thrasher	0.232	0.493	0.290	0.388	0.178	0.600
Eastern Meadowlark	−0.219	0.518	0.020	0.954	--	--
Golden-fronted Woodpecker	0.397	0.226	−0.301	0.369	0.005	0.989
Great-tailed Grackle	−0.119	0.728	0.055	0.872	0.233	0.490
Greater Roadrunner	0.444	0.171	0.331	0.320	0.333	0.316
Green Jay	−0.014	0.968	0.387	0.240	0.348	0.295
Killdeer	−0.075	0.827	0.337	0.311	0.013	0.969
Ladder-backed Woodpecker	−0.317	0.343	−0.240	0.478	−0.348	0.295
Lark Sparrow	−0.05	0.883	0.091	0.790	−0.141	0.679
Long-billed Thrasher	−0.306	0.360	−0.148	0.664	−0.244	0.470
Mourning Dove	−0.220	0.515	0.246	0.466	0.078	0.821
Northern Bobwhite	0.073	0.831	0.118	0.729	0.251	0.457
Northern Cardinal	0.064	0.852	0.137	0.689	0.087	0.800
Northern Mockingbird	0.109	0.749	−0.237	0.483	0.041	0.905
Olive Sparrow	−0.105	0.758	0.037	0.913	−0.434	0.183
Painted Bunting	0.0650	0.850	0.036	0.915	0.023	0.947
Pyrrhuloxia	0.020	0.556	−0.339	0.307	−0.164	0.631

Table 2. *Continued.*

	El Sauz		San Antonio Viejo		Santa Rosa	
	Correlation Coefficient	P-Value	Correlation Coefficient	P-Value	Correlation Coefficient	P-Value
Scissor-tailed Flycatcher	−0.691*	0.019	−0.212	0.532	−0.460	0.154
Turkey Vulture	−0.223	0.510	−0.196	0.563	0.267	0.427
Verdin	−0.477	0.138	−0.314	0.347	−0.057	0.867
Vermillion Flycatcher	0.300	0.370	−0.121	0.724	0.422	0.196
White-eyed Vireo	−0.050	0.883	0.228	0.500	0.604*	0.049
White-tipped Dove	0.051	0.881	0.279	0.406	−0.153	0.653
Wild Turkey	−0.064	0.852	−0.254	0.451	0.082	0.810

-- denotes zero individuals of that species were observed on that property.
* denotes significance at $P \leq 0.05$ level
** denotes significance at $P \leq 0.01$ level

surveys had significant increases in abundance (zero species on El Sauz Ranch, Northern Cardinal on San Antonio Viejo Ranch, and Northern Bobwhite on Santa Rosa Ranch). Lipschutz (2016) did not report statistical trends for individual species on the non-breeding transects, so we are not able to make a comparison. However, she did report that Bewick's Wren, Mourning Dove, and Northern Mockingbird significantly increased in abundance on all breeding bird surveys on all 3 East Foundation properties. This differed for our 10-year analysis; these 3 species' populations remained stable. In addition, Lipschutz (2016) reported significant increases in the following populations: Northern Bobwhite (El Sauz and San Antonio Viejo ranches), White-eyed Vireo (El Sauz and Santa Rosa ranches), Painted Bunting (San Antonio Viejo Ranch), Northern Cardinal (Santa Rosa Ranch), Red-winged Blackbird (Santa Rosa Ranch), White-eyed Vireo (Santa Rosa Ranch), and 5 species on both San Antonio Viejo and Santa Rosa ranches (Brown-crested Flycatcher, Black-crested Titmouse, Lark Sparrow, and Scissor-tailed Flycatcher). None of these increasing trends were verified in the 10-year analysis. All the listed species had stable breeding population numbers in the 10-year study except the following two species. Northern Bobwhite had an increasing population trend on Santa Rosa Ranch, and Brown-crested Flycatcher had a decreasing trend on El Sauz and Santa Rosa ranches. The 2016 study also reported significant declines in Botteri's Sparrow (El Sauz Ranch), Olive Sparrow (Santa Rosa Ranch), and White-eyed Vireo (San Antonio Viejo Ranch) (Lipschutz 2016). These were also not verified in the 10-year analysis. Declines in Brown-headed Cowbirds (El Sauz and San Antonio Viejo ranches) and an increasing trend in Northern Cardinal numbers (San Antonio Viejo Ranch) were identified in the 10-year study but not in Lipschutz 2016.

Many of these species have been documented to be in decline in Texas and in other parts of their ranges. For example, Rosenberg et al. 2019 found that since 1970 approximately 74% of grassland breeding birds and 57% of arid land breeding bird species were in decline across North America. As mentioned before, only 36 of the species found on our breeding bird surveys were abundant enough to establish trends. Of those species, Cassin's Sparrow, Eastern Meadowlark, Lark Sparrow, and Scissor-tailed Flycatcher were classified as grassland breeding species and experiencing a decline across North America (Rosenberg et al. 2019). Cassin's Sparrow is listed as a grassland breeder and its population across the continent is thought to be declining (Rosenberg et al 2019). In our 10-year study, the Cassin's Sparrow population on El Sauz Ranch was the only group that had a significant decreasing trend on the non-breeding bird transects. But the population trend for Cassin's Sparrow was stable for the breeding months of May and June over the 10-year period. Both non-breeding and breeding populations of Eastern Meadowlark and Scissor-tailed Flycatcher on our transects were stable. Lark Sparrows significantly increased in abundance on the non-breeding transects on all 3 East Foundation properties, but their breeding survey populations remained stable. Vegetation monitoring and preventing brush encroachment are important factors that ranches in the region should consider to maintain healthy grasslands for a diverse group of grassland birds.

Of the 36 breeding bird species that were abundant enough to establish trends on our transects, 17 were classified as arid land breeding bird species according to Rosenberg et al. 2019. From 1970 to 2019 Black-crested Titmouse, Bewick's Wren, Black-throated Sparrow, Bronzed Cowbird, Ladder-backed Woodpecker, and Verdin populations across the United States have remained stable (Rosenberg et al. 2019) and their populations were stable in our 10-year study. Brown-crested Flycatcher, Couch's Kingbird, Crested Caracara, Greater Roadrunner, Green Jay, Long-billed Thrasher, Olive Sparrow, and Vermillion Flycatcher populations across the United States have been increasing (Rosenberg et al. 2019). Only a few arid land species found on our transects, Common Ground Dove, Curve-billed Thrasher, and Harris's Hawk, have been experiencing a decreasing trend across the United States (Rosenberg et al. 2019). The abundance was stable for these species on our transects but Harris's Hawk abundance increased on San Antonio Viejo Ranch. These arid land species were more likely to be documented on San Antonio Viejo Ranch, which is further west than the other 2 properties and has more arid conditions and arid adapted vegetation.

For this study only the Texas BBS data from 2010 to 2019 was used to compare against the data gathered from our transects on the East Foundation ranches. This smaller amount of data, in many cases, and different landscape scales (regional vs. State) has led to the appearance of different trends from the North American BBS. Shorter studies can fail to capture the full amount of variation that a longer study may capture. In this case, our 10-year study supplies much less information than the 50-year national BBS. However, 10 years may be a long enough time to account for the population variation brought on by drought, hurricanes, and other extreme weather patterns. Due to funding, it is uncommon to have data sets that span 10 years or more which makes them vital even if they are limited in their own way. In South Texas specifically, there are fewer BBS routes, which means some species that thrive primarily in South Texas have no BBS trend or a trend that is less accurate. It will be important that going forward the USGS and private ranches, like the East Foundation, work together to create a more accurate representation of bird population trends in areas dominated by private ranchlands. Often these ranches provide a more contiguous and less degraded landscape which allows many of these bird populations to thrive.

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LATE-WINTER PATTERNS OF WATERFOWL HABITAT ON TEXAS PRAIRIE WETLANDS PROJECTS IN THE TEXAS MID-COAST

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ABSTRACT.—The Texas Prairie Wetlands Project (TPWP) was established in 1991 by partners of the Gulf Coast Joint Venture (GCJV) to provide cost-share assistance to private landowners for restoring and enhancing seasonal wetlands in agricultural landscapes along the Texas coast. We classified remotely sensed imagery from winters 2003–04 and 2005–06 in the Texas Mid-Coast (TMC), where TPWP delivery has been greatest, to evaluate temporal patterns of late-winter waterfowl habitat on TPWP and generate multiple metrics of program performance. Across years, TPWP sites in the TMC provided 1,199–2,818 ha of winter waterfowl habitat, accounting for 16.2–21.1% of the total winter waterfowl habitat classified in the TMC. Project performance, measured as percent of total TPWP area inundated during winter, varied from 12.4% during a dry winter (2005–06) to 40.9% in a wet winter (2003–04). We documented evidence of declining waterfowl habitat on TPWP immediately after the close of the duck hunting season at rates equal to or greater than declines across the larger landscape, suggesting that efforts to encourage retention of water on TPWP beyond the duck season are warranted to achieve maximum program benefits for wintering waterfowl along the Texas coast.

The Texas Mid-Coast (TMC), extending from Galveston Bay to Corpus Christi Bay and ranging inland 80–170 km through the historic coastal prairie region (Fig. 1), is an area of continental significance to North American waterfowl populations, annually providing resource needs for 1.5–3.0 million wintering ducks and geese (Stutzenbaker and Weller 1989, Texas Parks and Wildlife Department, unpublished data). The Gulf Cost Joint Venture (GCJV), a partnership of federal and state agencies, private industry, and non-profit bird habitat conservation organizations, has established mid-winter population objectives of 1,670,600 ducks and 707,500 geese for their TMC Initiative Area (TMCIA) (Lancaster et al. 2021). Within the TMCIA, priority waterfowl habitats include coastal marshes, seagrass meadows, and palustrine, agriculture-based wetlands in inland regions. Among these, agriculture-based waterfowl habitats are considered of greatest importance, as they are expected to provide 71% of dietary energy needs for wintering waterfowl within the TMCIA (Lancaster et al. 2021).

Agricultural and urban land uses are largely responsible for historical drainage and conversions of natural, palustrine wetlands within the TMC (Hakkenberg et al. 2019). However, loss of these wetlands and the waterfowl food resources they provided have largely been offset by those available in ricelands on the TMC landscape. Existing waterfowl foraging habitats in inland regions of the TMC occur primarily as idled or harvested rice fields (Hobaugh et al. 1989). Post-harvest waste rice and naturally occurring moist-soil seeds within these fields provide substantial food resources for waterfowl when fields are shallowly flooded during autumn and winter (Marty et al. 2020). Shallow flooding may occur either from precipitation or post-harvest water management designed to help control weeds, expedite rice straw decomposition, or provide habitat for wetland-dependent wildlife. Unfortunately, planted rice area in the TMCIA has

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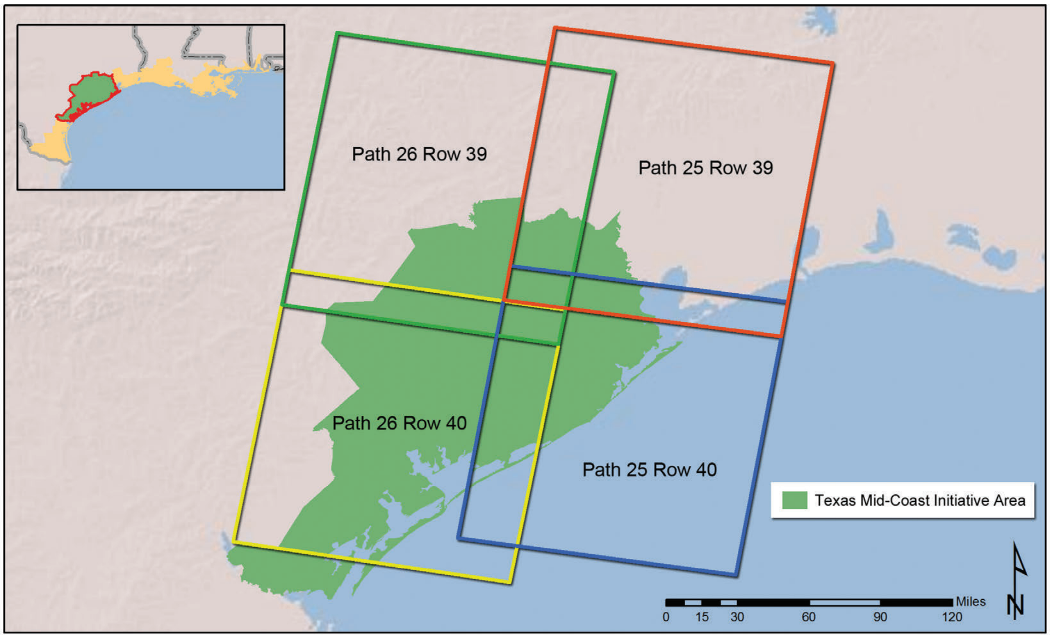

Figure 1. Areal coverage of Landsat scenes considered for analysis of waterfowl habitat abundance in the Gulf Coast Joint Venture Texas Mid-Coast Initiative Area during winters 2003–04 and 2005–06.

declined by approximately 69% since 1975 (U.S. Department of Agriculture 2020), driven largely by rising agricultural production costs, depressed rice prices, urban and industrial expansion, and competition for limited water supplies (Baldwin et al. 2011). Recent landscape-scale assessments of waterfowl habitat abundance during winter in the TMCIA suggest current levels of habitat are insufficient to satisfy dietary energy needs of GCJV waterfowl population objectives (Lancaster et al. 2021). Without implementation of ambitious and successful wetlands conservation efforts, these and future declines in rice production threaten to significantly reduce the capacity of the TMCIA to support winter waterfowl populations.

In response to observed declines of waterfowl habitat in the TMCIA, conservation partners of the GCJV developed and implemented habitat conservation programs to address resource needs of waterfowl populations. One such program is the Texas Prairie Wetlands Project (TPWP)—a partnership among the GCJV, Ducks Unlimited, Inc., US Department of Agriculture Natural Resources Conservation Service, Texas Parks and Wildlife Department, and US Fish and Wildlife Service. The TPWP was created in 1991 to restore, enhance, and create seasonal wetlands within the historical coastal prairie region of the Texas Gulf Coast. Conservation activities of the TPWP generally target wetland restoration on fields formerly in rice production or enhancement of waterfowl food resources on lands currently in rice production. Indeed, the TPWP was conceived as and remains a key program to help offset losses in waterfowl carrying capacity and achieve GCJV waterfowl habitat objectives along the Texas coast.

Texas Prairie Wetland Project activities are administered via 10–15-year Wetland Development Agreements (WDA) signed by cooperating landowners and partner agencies. Wetland Development Agreements describe allowable activities and set forth management and performance expectations for each TPWP site. Compliance monitoring is conducted annually on a sample of TPWP sites to ensure projects are functioning as expected and being managed consistent with WDA specifications. Observations during compliance monitoring visits and general familiarity of TPWP partner staff with project sites generated anecdotal evidence that some cooperating landowners may be removing water from TPWP sites immediately prior to or following the close of Texas' annual duck hunting season. Although such activity may not violate TPWP WDAs, if widespread, this practice could reduce abundance of foraging habitat in the TMCIA at a time when waterfowl are assimilating nutrient reserves in preparation for northward migration and breeding (Miller 1986, Moorman et al. 1992, Ballard et al. 2006).

We used GIS and Landsat imagery from winters 2003–04 and 2005–06 to quantify waterfowl foraging habitat abundance on TPWP sites within the TMCIA during and after annual duck hunting seasons, as well as to evaluate performance of the TPWP. Our specific objectives were to 1) quantify the change in waterfowl foraging habitat on TPWP sites in the TMC between periods before and after close of the duck hunting season, 2) quantify the change in waterfowl foraging habitat in the TMC landscape not on TPWP sites between periods before and after close of the duck hunting season, 3) assess the relative contribution of waterfowl habitat on TPWP sites to the total waterfowl foraging habitat in the TMCIA before and after close of the duck hunting season, and 4) measure hydrologic performance of TPWP sites in providing waterfowl habitat during winter. For these analyses, we defined waterfowl foraging habitat as non-permanent, palustrine wetlands, and we used the spatial extent of observed inundation to estimate the area of available habitat.

METHODS

Study Area.—We selected the GCJV TMCIA as our study region (29° 18' N, 95° 50' W; Fig. 1), including the counties of Aransas, Austin, Brazoria, Calhoun, Colorado, Fort Bend, Galveston, Harris, Jackson, Lavaca, Matagorda, Refugio, San Patricio, Victoria, Waller, and Wharton. The region includes estuarine coastal marsh and large marine bay systems adjacent to the Gulf of Mexico coastline, with inland landscapes dominated by agriculture (sorghum, cotton, rice, corn), pasture, and multiple sprawling commercial and residential centers (e.g., Houston, Victoria). Climate of the region varies from semi-arid (80.5 cm mean annual rainfall) at the southern end to subtropical humid in the north (143.4 cm mean annual rainfall). The Texas Mid-Coast supports the largest concentration of Northern Pintails (*Anas acuta*) along the Gulf Coast, and previous research suggested potential fitness consequences to this species as a result of limited abundance of waterfowl foraging habitat during winter (Ballard et al. 2004, 2006; Anderson 2008; Gulf Coast Joint Venture, unpublished data). Moreover, this region is a priority delivery area for the TPWP. Within the TMCIA, we limited our analyses to Landsat scenes Path 25 Row 39, and Path 25 Row 40, Path 26 Row 39, and Path 26 Row 40, because these scenes collectively encompass 97% of the TMCIA (Fig. 1).

Image Classification.—We examined availability of Landsat imagery corresponding to the TMCIA region during 2002–2009, and selected imagery based on their suitability for analysis as determined by extent of cloud cover and temporal proximity of image collection date to the closing date of the Texas duck hunting season. We sought cloud-free imagery collected on dates immediately preceding and following the close of the Texas duck hunting season because changes in waterfowl habitat between these periods would be the most relevant for assessing whether landowners were intentionally removing water from TPWP sites following close of the duck hunting season.

We used ERDAS Imagine and ArcGIS to conduct an unsupervised classification of selected Landsat images and quantify surface water as a measure of waterfowl habitat abundance. We preprocessed suitable Landsat images by applying a permanent water and coastal marsh exclusion mask (hereinafter referred to as "exclusion mask") to isolate our analysis to sources of detectable surface water most likely to represent non-permanent, palustrine wetlands providing waterfowl foraging habitat. Our exclusion mask included permanent water bodies, forested wetlands, and permanently flooded palustrine and estuarine emergent marsh as identified by National Wetlands Inventory (NWI) and National Hydrography Dataset (NHD) (Fig. 2). Application of this mask reduced spectral variation in each scene, and thereby increased the accuracy of resulting classifications. We obtained spatial data layers depicting TPWP project locations and boundaries from Ducks Unlimited Inc., Southern Regional Office, Ridgeland, Mississippi. We overlaid TPWP boundaries on our exclusion mask to identify sites that may have inadvertently been included in our mask. We removed from our mask all TPWP sites that fell within the masked area, thus making them available for classification.

We applied to each masked Landsat scene a Tasseled Cap transformation that used weighted sums of the 6 Landsat spectral bands to derive

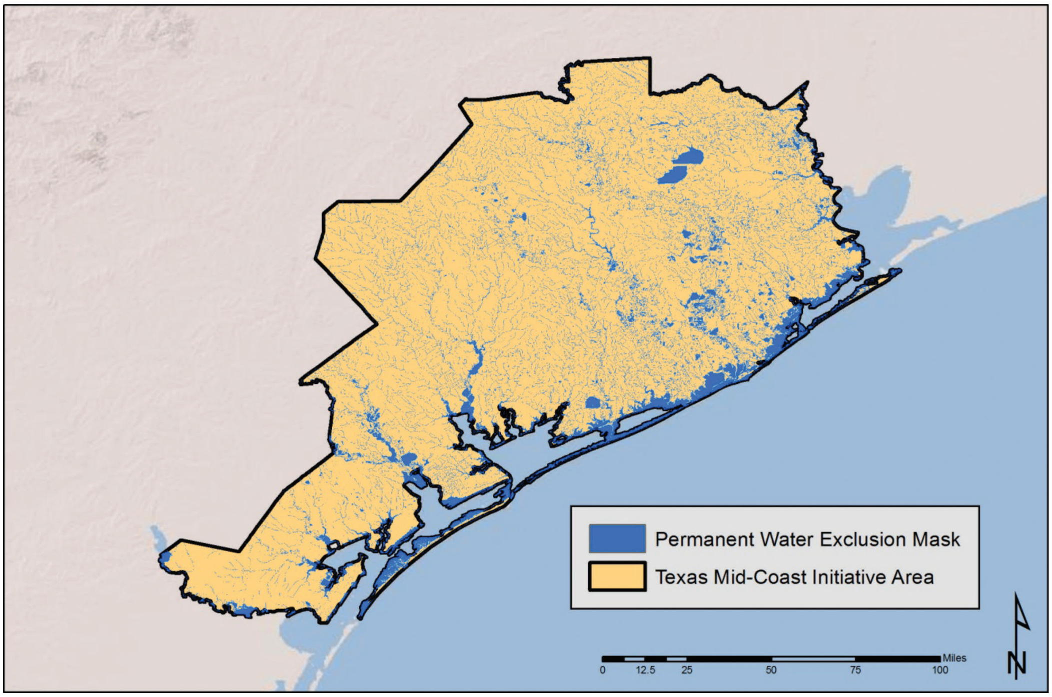

Figure 2. Permanent water and coastal marsh exclusion mask used in isolating geospatial analysis on sources of detectable surface water most likely to reflect non-permanent, palustrine wetlands providing waterfowl foraging habitat in the Gulf Coast Joint Venture Texas Mid-Coast Initiative Area.

a series of components that corresponded to Brightness, Greenness, and Wetness. We developed an 8-band input image for our unsupervised classification by stacking the Tasseled Cap Wetness band (TCW), a Band 5/Band 2 ratio (both of which serve as indices of moisture), and the 6 Landsat spectral bands. We performed an unsupervised classification on each 8-band Landsat scene. Our classification consisted of 100 clusters, with 25 iterations, at a 97% threshold. We manually edited clusters and "busted" confused clusters into smaller clusters, iteratively classifying each pixel as either water or non-water. We performed a final series of pixel edits to further improve the accuracy of our classification.

We calculated and applied an adjustment factor to our water classifications to account for "non-inclusion" and "misalignment" errors in our exclusion mask that could inflate estimates of waterfowl foraging habitat abundance as defined in this analysis (Gulf Coast Joint Venture, unpublished report). Procedures by which mask error parameters were calculated and applied are described in Appendix A. We used corrected values for analyses and calculation of summary statistics. To assess whether persistence of waterfowl habitat following close of the duck season was greater on TPWP sites than the broader landscape, we calculated the percent change in waterfowl habitat abundance between periods during and after the duck hunting season on TPWP and non-TPWP sites (i.e., total habitat on landscape less habitat on TPWP sites). We calculated waterfowl habitat abundance on TPWP sites as a percentage of waterfowl habitat on the entire TMC landscape to assess relative importance of the TPWP in providing habitat in our study area.

We assessed hydrologic performance of TPWP sites using 3 metrics. First, we calculated total percent inundation across all evaluated TPWP sites using total hectares inundated and total hectares enrolled. Second, we calculated mean percent inundation across individual TPWP sites (i.e., hectares inundated/hectares of basin averaged across all TPWP sites) within each year and time period of interest. Lastly, we calculated the percentage of TPWP sites that contained detectable water during each year and time period of interest. Measures of variation were not calculated for the first and third metrics, because our analysis encompassed all waterfowl habitat in the study area and produced a true population measure rather than a sample-based estimate.

RESULTS

Limited availability of cloud-free imagery precluded analysis of waterfowl habitat abundance across all desired Landsat scenes on ideal dates (i.e., immediately proximal to close of the duck hunting season) or during consecutive years. Our examination of available Landsat imagery identified winters 2003–04 and 2005–06 as the most suitable for addressing our objectives during the time period of interest. During winter 2003–04, cloud-free imagery was available for only Landsat scenes Path 26 Row 39 and Path 26 Row 40 in the target time periods (Table 1). Thus, we limited our analysis for winter 2003–04 to these Landsat scenes, which collectively encompassed 79% of the TMCIA. We used Landsat images collected on 19 December 2003 and 21 February 2004 to quantify landscape conditions before (i.e., during-season)

Table 1. Landsat scenes and image collection dates used in analysis of waterfowl habitat abundance in the Gulf Coast Joint Venture Texas Mid-Coast Initiative Area during winters 2003–04 and 2005–06.

Year	Time period	Landsat scene	Image collection date
2003–04			
	During season	Path 26 Rows 39 and 40	19-Dec-2003
	Post season	Path 26 Rows 39 and 40	21-Feb-2004
2005–06			
	During season	Path 25 Row 40	18-Jan-2006
		Path 26 Rows 39 and 40	25-Jan-2006
	Post season	Path 25 Row 40	3-Feb-2006
		Path 26 Rows 39 and 40	14-Mar-2006

Table 2. Waterfowl habitat abundance (ha) in the Gulf Coast Joint Venture Texas Mid-Coast Initiative Area during and after Texas duck hunting seasons in winters 2003–04 and 2005–06. Waterfowl habitat was classified according to whether it occurred on Texas Prairie Wetlands Project sites (i.e., TPWP habitat vs. Non-TPWP habitat).

Year[a]	Time period	TPWP habitat	Non-TPWP habitat	Total habitat	TPWP habitat as % of total habitat
2003–04	During season	2,745	12,801	15,546	17.7
	Post season	2,818	14,444	17,262	16.2
	Percent change	2.7%	13.7%		
2005–06	During season	2,188	8,171	10,359	21.1
	Post season	1,199	4,699	5,898	20.3
	Percent change	–45.2%	–42.5%		

[a] Landsat scenes and collection dates of imagery used in analysis differed between years:
2003–04 During season: 19 Dec 2003 for Path 26 Rows 39 & 40
2003–04 Post season: 21 Feb 2004 for Path 26 Rows 39 & 40
2005–06 During season: 18 Jan 2006 for Path 25 Row 40; 25 Jan 2006 for Path 26 Rows 39 & 40
2005–06 Post season: 3 Feb 2006 for Path 25 Row 40; 14 Mar 2006 for Path 26 Rows 39 & 40

and after close of the duck season (i.e., post-season), respectively, for winter 2003–04. Within these scenes and time periods, 416 TPWP sites were available for analysis (Table 2).

Cloud-free imagery was available for 3 of the 4 desired Landsat scenes during target time periods of winter 2005–06 (Table 1). We used Landsat images collected on 18 January 2006 for Path 25 Row 40 and 25 January 2006 for Path 26 Row 39 and Path 26 Row 40 to quantify waterfowl habitat in the during-season time period. These scenes collectively encompassed 94% of the TMCIA. We used images collected on 3 February 2006 for Path 25 Row 40 and 14 March 2006 for Path 26 Row 39 and Path 26 Row 40 to quantify habitat in the post-season time period. Within these scenes and time periods, 522 TPWP sites were available for analysis (Table 2).

We examined 2 climatological indices to ascertain relative moisture conditions during our winters of study—Palmer's Drought Severity Index (PDSI) and Palmer's Z-index (National Climate Data Center 2011). The PDSI measures long-term, drought-inducing patterns of precipitation and temperature, while Palmer's Z-index measures short-term precipitation anomalies and drought conditions on a monthly scale (Heim 2002). We examined Palmer's Z-index to ensure relationships between observed waterfowl habitat abundance and long-term drought conditions were not confounded by significant, short-term precipitation events that may not be reflected in the PDSI. Both indices suggested moisture conditions were above average during winter 2003–04 but significantly below average during winter 2005–06 (Figs. 3 and 4).

Inconsistent availability of cloud-free imagery between study years also precluded area-based comparisons of waterfowl habitat abundance between years. Thus, we assessed changes in waterfowl habitat abundance between the during-season and post-season time periods for each year separately and calculated the percent change in habitat abundance between these periods to enable comparisons between years. Our metrics of total percent and mean percent inundation revealed similar results and patterns across all time periods and years. Thus, we report and focus primarily on total percent inundation metrics.

During the wet winter of 2003–04, waterfowl habitat abundance increased on TPWP and non-TPWP sites between the during-season and post-season time periods (Table 2). However, the

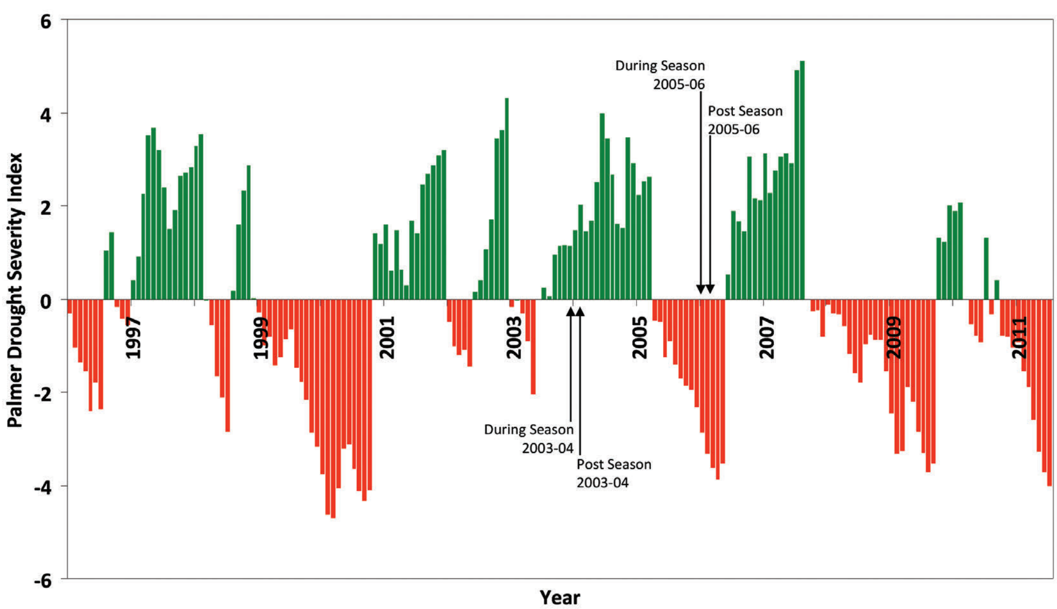

Figure 3. Monthly Palmer Drought Severity Index values, January 1996–July 2011, for the Upper and Mid-Coast of Texas (i.e., Texas Climatic Division No. 8). Values >0 indicate moisture conditions wetter than normal, while values <0 indicate moisture conditions drier than normal. Periods corresponding to collection dates for Landsat imagery used to quantify waterfowl habitat abundance in the Texas Mid-Coast Initiative Area during winters 2003–04 and 2005–06 indicated by vertical arrows.

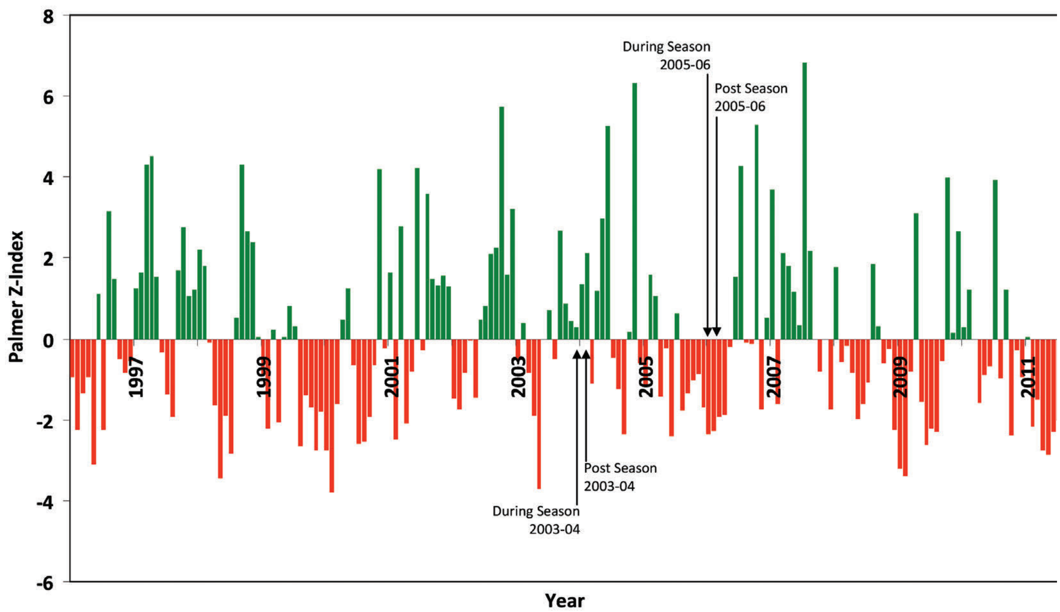

Figure 4. Monthly Palmer Z-index values, January 1996–July 2011, for the Upper and Mid-Coast of Texas (i.e., Texas Climatic Division No. 8). Values >0 indicate moisture conditions wetter than normal, while values <0 indicate moisture conditions drier than normal. Periods corresponding to collection dates for Landsat imagery used to quantify waterfowl habitat abundance in the Texas Mid-Coast Initiative Area during winters 2003–04 and 2005–06 indicated by vertical arrows.

proportional increase in waterfowl habitat was greater on non-TPWP sites than TPWP sites (13.7% vs. 2.7%; Table 2). During the dry winter of 2005–06, waterfowl habitat abundance decreased substantially (–45.2% and –42.5%) on both TPWP and non-TPWP sites between during-season and post-season time periods, although the decrease was somewhat greater on TPWP sites. Waterfowl habitat on TPWP sites accounted for a greater percentage of the total waterfowl habitat available on the TMC landscape during 2005–06 than 2003–04 (Table 2). The percentage of total waterfowl habitat accounted for by TPWP sites was roughly similar between during-season and post-season time periods in both winters (Table 2).

Based on all metrics, hydrologic performance of TPWP sites was greater during the wet winter of 2003–04 than the dry winter of 2005–06 (Table 3). The greatest changes in performance between during-season and post-season time periods occurred in winter 2005–06, when total percent inundation decreased by approximately 45% (i.e., (22.5–12.4%)/22.5%) and percent of TPWP sites with water decreased by 33% (i.e., (56.3–37.5%)/56.3%). However, an examination of scene-specific metrics during the post-season period of 2005–06 revealed percent inundation for sites classified from February 3 imagery to be 3.5 times greater than those classified from March 14 imagery (i.e., 32% vs. 9%). Performance changed only marginally between during-season and post-season time periods in winter 2003–04 (Table 3). Percent inundation varied considerably among individual TPWP sites during both years, ranging from 0 to near 100.0 during each year and time period (Fig. 5).

DISCUSSION

The greater proportional increase in waterfowl habitat abundance on non-TPWP sites than TPWP sites between during-season and post-season periods in winter 2003–04 was noteworthy. Climatological data suggested relative moisture conditions increased between during-season and post-season periods in winter 2003–04, which was likely responsible for increases in habitat on non-TPWP. A possible explanation for greater proportional increase on non-TPWP sites in response to this precipitation is that TPWP sites containing water may have already been at maximum flooding

Table 3. Hydrologic performance metrics for the Texas Prairie Wetlands Project (TPWP) in the Gulf Coast Joint Venture Texas Mid-Coast Initiative Area during and after the Texas duck hunting season in winters 2003–04 and 2005–06. Performance measured as percent inundation of cumulative TPWP area (ha), mean percent inundation across TPWP sites, and percent of TPWP sites containing detectable water.

					Project performance		
Year[a]	Time period	TPWP sites (n)	TPWP habitat area	TPWP project area	Total % inundated[b]	Mean % inundated[c]	% of sites with water[d]
2003–04	During season	416	2,745	6,885	39.9	40.0	78.1
	Post season	416	2,818	6,885	40.9	40.9	72.1
2005–06	During season	522	2,188	9,706	22.5	23.2	56.3
	Post season	522	1,199	9,706	12.4	11.8	37.5

[a] Landsat scenes and collection dates of imagery used in analysis differed between years:
2003–04 During season: 19 Dec 2003 for Path 26 Rows 39 & 40
2003–04 Post season: 21 Feb 2004 for Path 26 Rows 39 & 40
2005–06 During season: 18 Jan 2006 for Path 25 Row 40; 25 Jan 2006 for Path 26 Rows 39 & 40
2005–06 Post season: 3 Feb 2006 for Path 25 Row 40; 14 Mar 2006 for Path 26 Rows 39 & 40

[b] Calculated by dividing total waterfowl habitat area on TPWP sites by total project area across all TPWP sites.

[c] Calculated by generating percent inundation for each TPWP site and averaging across all sites.

[d] Calculated by dividing number of TPWP sites on which water was detected by total number of sites available for analysis.

capacity during the hunting season and therefore could not hold additional water. However, during winter 2003–04, we detected water on 8% (i.e., (78.1–72.1%)/78.1%) fewer TPWP sites in the post-season than during-season time period. Thus, the observed increase in waterfowl habitat on TPWP sites between during-season and post-season time periods was attributable to fewer wetlands, suggesting that indeed water was removed from some TPWP sites while others increased in inundation levels.

Hydrologic performance of TPWP sites was greater and less variable during the wet winter of 2003–04. Performance declined significantly between during-season and post-season periods in winter 2005–06. Although performance declines during 2005–06 were likely driven by persistence of long-term drought, it is also possible that some TPWP sites were actively dewatered between during-season and post-season periods in preparation for spring cultivation, especially those classified from imagery collected on March 14 (i.e., 45 days after the close of the duck season). Proportional decline in waterfowl habitat on TPWP sites between these periods in 2005–06 was marginally greater than that observed for sites not enrolled in the TPWP (–45.2% vs. –42.5%). Although this difference is minor, the weight of evidence suggests that retention of water on TPWP sites between during-season and post-season periods is no greater than that on the broader landscape. Although additional analyses would be required to definitively identify the source of waterfowl habitat declines on TPWP sites during these winters, efforts to encourage retention of water on TPWP sites beyond the duck season appears warranted.

During 2003–04, a maximum of 78% of TPWP sites contained water, yet only 40% of the enrolled area was inundated. Observed precipitation levels during this winter were greater than normal; thus, it is uncertain to what extent performance of TPWP sites would increase during even wetter winters. Our results for the percent of TPWP area inundated during winter 2003–04 were similar to those from an earlier study of the hydrologic performance of a similar private land wetland conservation program in the Mississippi Alluvial Valley (Holden et al. 2006). Using methods similar to ours, Holden et al. (2006) reported inundation of only 42% of area enrolled in a Ducks Unlimited private land program during February 2001. Climatological records suggested precipitation

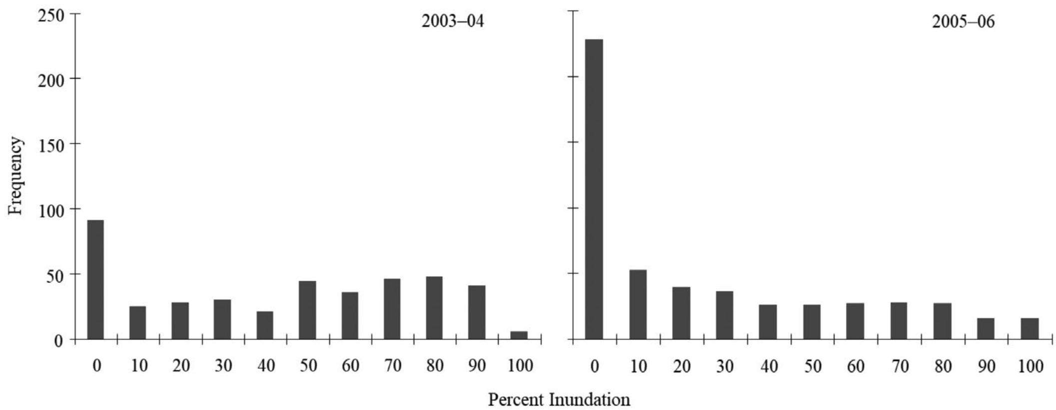

Figure 5. Frequency histograms of percent inundation for individual Texas Prairie Wetlands Project sites in the Gulf Coast Joint Venture Texas Mid-Coast Initiative Area during the Texas duck hunting seasons in winters 2003–04 and 2005–06.

levels during winter 2000–01 were near to slightly above normal. Collectively, these data suggest private land wetland conservation programs for providing wintering waterfowl foraging habitat, as currently designed and implemented, may be challenged to achieve area inundation levels much greater than 40–45%. Detailed investigations of inundation patterns among individual TPWP sites should be considered for their potential to elucidate determinants of flooding extent and help inform future modifications to private land wetland conservation programs.

Classification of Landsat imagery spanning the period 1994–2002 revealed that waterfowl habitat abundance during mid-late winter in agricultural landscapes of the TMC varied in relation to seasonal precipitation levels but was on average 66% (range: 23–89%) below GCJV habitat objectives (i.e., 47,435 ha) under all precipitation scenarios examined (Lancaster et al. 2021). Our analysis estimated 10,359 ha of waterfowl foraging habitat available during the hunting season of 2005–06, which was the drier of the two winters examined. Although direct comparisons between these values should be made with caution because of slight differences in methodology, both revealed significant habitat deficits in the TMCIA under all precipitation scenarios. Ongoing work by the GCJV to complete a comprehensive assessment of historical (mid-1980s to present) waterfowl habitat abundance and implement an operational habitat monitoring protocol will bolster our understanding of annual variation in waterfowl abundance and its relation to objectives.

Challenges to overcoming the persistent habitat deficits on the TMC are substantial. Harvested and idled rice fields are the primary source of foraging habitat for wintering waterfowl in agricultural regions of the TMC yet planted rice area in the TMCIA has declined by approximately 62% since 1975 (US Department of Agriculture National Agricultural Statistics Service). Competition for limited water supplies, land development pressures, as well as higher production costs and low rice prices may lead to additional declines in rice agriculture within this region (Baldwin et al. 2011). Moreover, Texas coastal wetlands are likely to face continued threats from saltwater intrusion, shoreline erosion, and altered hydrology, potentially leading to additional losses of valuable habitats for wintering waterfowl (Tremblay and Calnan 2009, Tremblay and Calnan 2010). Consequently, it seems likely that wetland conservation programs aimed at providing critical resource needs of waterfowl will become increasingly important for supporting wintering waterfowl on the Texas coast.

Despite total TPWP project area being only 6,885 and 9,706 ha within the Landsat scenes available for analysis during 2003–04 and 2005–06, respectively, waterfowl habitat detected on TPWP sites accounted for 16–21% of total waterfowl habitat available within agricultural landscapes of the TMC. Furthermore, waterfowl habitat available on TPWP sites accounted for a larger percentage of total habitat available during the dry winter of 2005–06 when the benefits of active wetland management are expected to be elevated. Collectively, these results suggest partner investments in the TPWP have indeed provided meaningful landscape-level impacts on foraging habitat for wintering waterfowl in agricultural regions of the TMC.

MANAGEMENT IMPLICATIONS

Availability of foraging habitat is considered the greatest potential limiting factor for waterfowl during non-breeding periods (Williams et al. 2014), and habitat should be most constraining during years of below average precipitation or otherwise severe winters. Ballard et al. (2006) documented declining body condition of Northern Pintails during winter in coastal Texas, with lower nutrient reserves and poorer condition indices during what they classified as a "dry winter" when compared to a "wet winter." Other studies have demonstrated effects of within-season variation in habitat conditions on Mallard body mass (Veon et al. 2023) and cross-seasonal effects of habitat conditions on subsequent recruitment (Raveling and Heitmeyer 1989, Osnas et al 2016). This study revealed late-winter declines in winter waterfowl habitat associated with a signature conservation program of the GCJV. Conservation partners could bolster the beneficial effects of this program and help mitigate effects of existing habitat deficits in the TMC by encouraging or incentivizing participating landowners to retain water on TPWP sites later into winter and spring as waterfowl build nutrient reserves in preparation for spring migration and nesting.

ACKNOWLEDGEMENTS

This work was supported by the Gulf Coast Joint Venture Management Board, Migratory Bird Program of the U.S. Fish and Wildlife Service Southwest Region, and Ducks Unlimited, Inc., Southern Region. We thank the organizational partners of the Texas Prairie Wetlands Project, including the Gulf Coast Joint Venture, Ducks Unlimited, Inc., US Department of Agriculture Natural Resources Conservation Service, Texas Parks and Wildlife Department, and US Fish and Wildlife Service for their support of science-based wetland conservation and over 4 decades of personnel, financial, and intellectual investments in the program. We thank S. J. DeMaso, N. M. Enwright, and W. G. Vermillion for earlier review and insight on project development and interpretation of analyses. Lastly, we extend special thanks to cooperating landowners for their interest and commitment to wetlands conservation and management.

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APPENDIX A

Procedures for Calculating and Applying Permanent Water and Coastal Marsh Exclusion Mask Error Parameters to Waterfowl Habitat Classifications on the Texas Mid-Coast

We calculated parameters to account for errors in our permanent water and coastal marsh exclusion mask (hereinafter "exclusion mask") that could inflate our estimates of waterfowl habitat abundance. We identified two types of errors in our exclusion mask: errors of misalignment and errors of non-inclusion (Fig. A.1). We further considered two sources of misalignment error: 1) errors resulting from omission of water pixels along perimeters of permanent or estuarine water bodies and streams/rivers that should have been included in the exclusion mask and 2) errors resulting from the inclusion of non-water pixels that lie along perimeters of permanent or estuarine water bodies and streams/rivers that should not have been included in the exclusion mask. Errors of non-inclusion stem from water pixels (permanent water) that have arisen on the landscape since the NWI and NHD data was collected, that should have been included in the exclusion mask.

We estimated both sources of error for our analysis of waterfowl habitat in the TMCIA. We accomplished this by applying our exclusion mask to 2004 imagery collected through the National Agricultural Imagery Program, randomly sampling 30 quarter-quadrangles within the TMCIA, and used the variance from this initial sampling in the following equation to determine a final sample size:

$$n = \frac{z^2 N V_x^2}{z^2 V_x^2 + (N-1)\varepsilon^2}$$

n = sample size
N = Population size
V_x^2 = relative variance
ε = tolerable error (.25 selected)

We performed a threshold classification on the near-infrared band for each masked, sample quad to extract water pixels. We accomplished this by identifying a threshold value for water in each sample quad and classifying any pixel with a value above that value as non-water and every pixel below that value as water. We edited the resulting classifications to characterize each pixel as waterfowl habitat, misalignment error, or non-inclusion error. We combined the two sources of

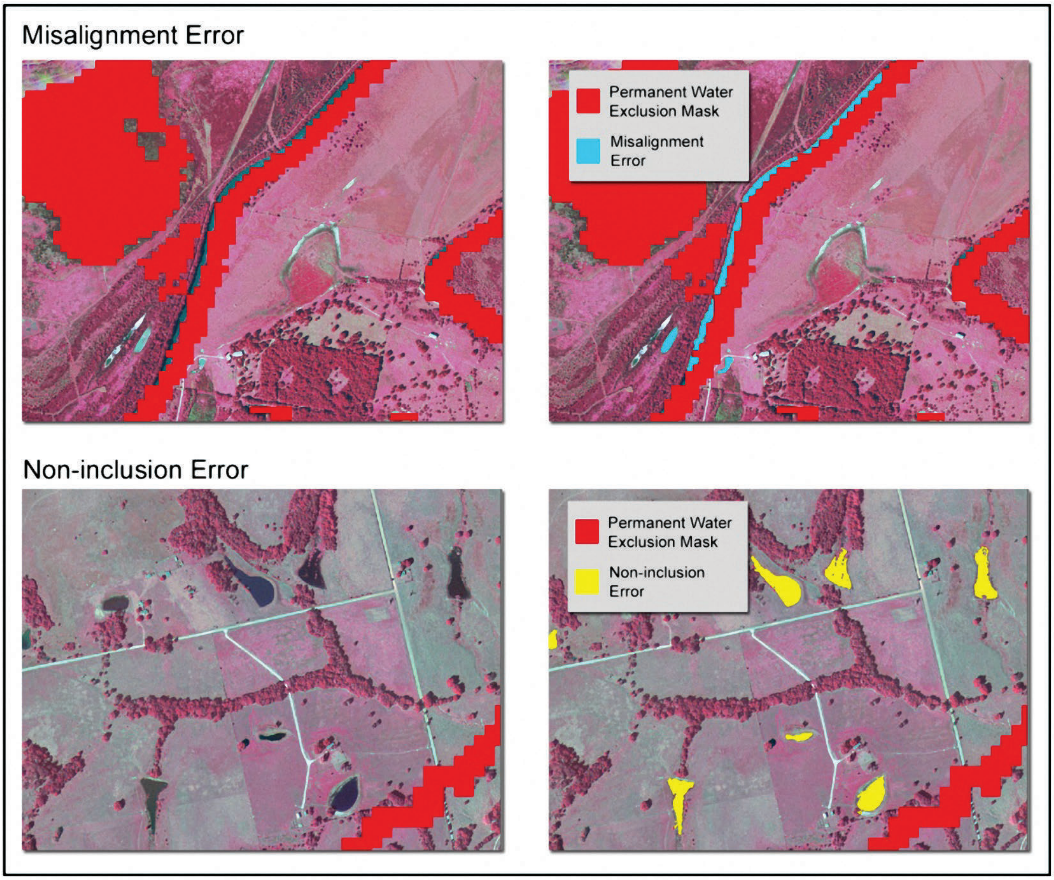

Figure A.1. Graphic depiction of two sources of error that occur in the Gulf Coast Joint Venture permanent water and coastal marsh exclusion mask and for which error estimates were calculated to adjust final estimates of waterfowl habitat abundance in the Texas Mid-Coast Initiative Area.

error and recoded waterfowl habitat pixels to zero, resulting in an error classification for each sample quad.

We calculated combined error estimates for each Landsat scene by intersecting each water classification with the error classifications. We then summarized for each sample quad the amount of classified water that intersected the error classification and considered these our initiative area-specific estimates of error for each sampled quad. Because sample quads were intersected by our exclusion mask and JV boundary, the area available for water classification differed among sample quads. Some quads were intersected extensively and in irregular patterns by our exclusion mask. In some instances, this resulted in relatively small areas available for water classification but a high potential for misalignment error to occur along the points of intersection. We used a weighted mean to calculate error rates, expressed as hectares of error per hectare of quad available for classification, to account for the potential for quads with small areas available for sampling to disproportionately influence our results. We used area available for water classification within a quad as the weighting factor. We then multiplied our error rates by the area of the initiative area outside the exclusion mask to derive our estimate of total error water within an initiative area. We subtracted this value from the total hectares of water estimated from the unsupervised classifications to account for errors in the exclusion mask.

SHORT COMMUNICATIONS

THE ERRONEOUS ASSUMPTION OF CAROLINA PARAKEETS AT BROWNWOOD, TEXAS

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The summer of 1885 in the Lower Rio Grande Valley was characterized by an unusual event. Travelers arriving at Brownsville from Tamaulipas during late August reported flocks of 100 or more parrots near the border (Casto 2010). By the first week of September, the parrots had crossed the border and were seen near Lake Tio Cano between the present-day communities of La Feria and Santa Rosa (Anon. 1885a). The presence of parrots and an unusual numbers of crows caused some of the local residents to be seized by a sense of dread. This feeling of imminent danger is described in the following dispatch from Brownsville, Texas, published in the *El Paso Times* (Anon. 1885b).

"Large parrots, whose natural habitation is the southern part of Mexico and counties on the south of the Gulf, have made their appearance here in vast numbers, an event that has never occurred before. Crows, which seldom come here have also appeared in large numbers in the valley. These unusual visitations have filled the minds of the superstitious portion of our population with dread, many believing that they are but the forerunners of some pestilence."

The parrots remained in the Lower Rio Grande Valley until at least the first week in October when they were seen in the live oak country above Brownsville (Anon. 1885c, Casto 2010). They presumably returned to Mexico later in October since there are no further reports of them being seen in Texas.

ORIGIN OF THE ERRONEOUS ASSUMPTION

The occurrence of parrots in the Lower Rio Grande Valley would have soon become a footnote in history had it not been for Edwin C. Davis (Fig. 1) an egg collector and publisher of the Sunny South Oologist at Gainesville, Texas (Casto 1991). Davis had obviously read the newspaper reports of parrots at Brownsville, an event he wished to share with the readers of his journal. To achieve this goal, he published the following note in the March 1886 issue of the *Sunny South Oologist* (Davis 1886).

"Hundreds of bright colored parrots were seen near Brownwood, Texas, last summer (supposed to have come from Central America), something which has never happened before. There were also a great many more crows than usual. Many of the superstitious people of the place consider it to be an omen of bad luck."

Even the casual reader can see that Davis' note is an abridgement of the 1885 article published in the *El Paso Times*. Davis' error in substituting Brownwood [Brown County] for Brownsville, however unintentional it might have been, led ornithologists of a later generation to believe that some type of parrot had actually been seen at Brownwood. They were, however, skeptical that the birds were from Central America and instead assumed, without further evidence, that they must have been Carolina Parakeets. This erroneous assumption eventually found its way into the literature and has been perpetuated until the present time as described in the following paragraph.

Arthur Cleveland Bent, an associate in ornithology at the Harvard Museum of Comparative Zoology and author of *Life Histories of North American Birds*, noted without comment that Carolina Parakeets had been recorded at Brownwood, Texas (Bent 1940). Daniel Mckinley (1964), an ornithologist at the State University of New York, described Davis' article in the *Sunny South Oologist* as a "chatty

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Figure 1. Edwin Carlisle Davis (1864-1943), egg collector and publisher of the *Sunny South Oologist*. Photograph from *Davis' Standard Collectors Directory* privately published at Gainesville, Texas, in 1895.

note" which he reproduced verbatim while noting that Brown County is in north-central Texas. Harry Oberholser, who spent years studying the bird life of Texas and compiling an exhaustive gazetteer of locations where birds had been reported, accepted the Brownwood location as valid (Oberholser 1974, Vol, 1, p. 430). Roger Tory Peterson (1963) followed earlier authors in stating that the Carolina Parakeet ranged into central Texas thus accepting the report without mentioning Brownwood by name. The belief that Carolina Parakeets were irregular nonbreeding summer wanderers as far west as Brown County can still be found in The *TOS Handbook of Texas Birds* (Lockwood and Freeman 2014).

The mistake made by E. C. Davis of substituting "Brownwood" for Brownsville led the eminent ornithologist A. C. Bent to assume without evidence that it was Carolina Parakeets rather than parrots from Mexico that were seen at Brownwood. Later authors followed Bent's lead in perpetuating this erroneous assumption. It can, however, now be concluded with certainty that neither Carolina Parakeets nor parrots from Mexico visited Brownwood, Texas, during the summer of 1885.

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THE IVORY-BILLED WOODPECKER IN COOKE COUNTY, TEXAS

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The sightings of the Ivory-billed Woodpecker (IBWO) by Joshua Gorham during 1849 and 1851 represent the only reports of this species in Cooke County, Texas. This paper relates events in the life of Joshua Gorham and the interpretation of his sight records by George Ragsdale (1877-1879), Edwin Hasbrouck (1891), Harry Oberholser (1974), James Tanner (1942) and Clifford Shackelford (1998).

SIGHTINGS BY JOSHUA GORHAM

Joshua Gorham was born on 7 June 1824 in Scott County, Kentucky. He apparently had no formal education since his legal documents are signed with his mark (an X). Although educationally handicapped, Gorham had a well-developed sense of curiosity and he would often bring natural history specimens that he had found to Gainesville to show his friends. In his elderly years, "Uncle Josh", as he was affectionately called, was recognized as an authority on the early history of Cooke County. He was, in addition, a respected veteran of the war with Mexico, the "Indian War" of the 1850s and the Civil War.

Gorham came to Texas in 1845 and settled where the city of Dallas is now located. He perhaps came with the hope of receiving a headright certificate in the land grant of William S. Peters, an impresario headquartered in Louisville, Kentucky. He was not successful in his attempt to receive a certificate, and in February 1847, he enlisted for 12 months in Bell's Regiment of Texas Mounted Volunteers during the war with Mexico. In February 1848, he re-enlisted for another 12 months of service under the same command.

Gorham was discharged from military service on 1 February 1849 and was married later that year to Lucinda Worley from Indiana. In early November 1850, he was granted a headright of 320 acres in Cooke County about 7-8 miles southeast of Gainesville. In that same month, his son, John Thornton Gorham, was born in the family home on Scott Creek which traversed the southern quarter of Gorham's property (Anon. 1925). Scott Creek was a small tributary of Wolf Creek a tributary of Isle du Bois Creek which empties into the Elm Creek Branch of the Trinity River (Gray 1919, West 1920-1940).

Gorham's sightings of the IBWO during 1849 and 1851 were made, according to Oberholser (1974), about 7-1/2 miles southeast of Gainesville at or near the location of Gorham's headright on Scott Creek. How Oberholser obtained this information is problematic since Ragsdale died in 1895 and Gorham in 1896 whereas Oberholser did not arrive in Texas until 1900. It is possible that the presumed location of Gorham's sightings, i.e., his headright on Scott Creek, was obtained by Oberholser from Joshua's son, John Thornton 'Thornt" Gorham (1850-1925), a prominent farmer and business man in Gainesville (Anon. 1925).

RAGSDALE AND GORHAM

George Henry Ragsdale (1846-1895) moved in 1867 from Tennessee to a small farm owned by his parents in Cooke County. Ragsdale first worked on the family farm but in 1870 was elected county surveyor and, in this capacity, he was often in the uninhabited sections of the county. In 1875 he published his first article on birds and a few years later began to collect and sell birds' eggs and skins, as well as other specimens of natural history. He eventually published numerous short articles on birds, as well as on geology and other topics of natural history. He was a careful worker and well-thought of by other naturalists, as well as the citizens of Cooke County who respectfully referred to him as "Professor Ragsdale" (Casto 1980).

Ragsdale and Joshua Gorham shared a common interest in natural history. The various specimens that Gorham brought to the office of the Gainesville

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Daily Hesperian (Anon. 1891a,b,c; 1892a,b; 1894a) were generally referred to Ragsdale for identification, e.g., a large tooth and bone found by Gorham in the bed of Elm Creek were determined by Ragsdale to be those of a Columbian mammoth (Ragsdale 1889). Ragsdale also had in his collection a "flint implement" collected on Uncle Josh's property (Anon. 1894b).

Knowing of Gorham's knowledge of local history, Ragsdale would have undoubtedly asked him about bird life during the early days of Cooke County. This inquiry probably took place between 1875 when Ragsdale first began to seriously study birds and 1877 when he started his list of Cooke County birds (Fig. 1). The dialogue between Ragsdale and Gorham regarding the IBWO probably began with the fact that both men were well-acquainted with the Pileated Woodpecker. Gorham may have off-handedly mentioned that in the early days there was another large woodpecker with a distinct vocalization that was not nearly as abundant as the Pileated. After further discussion, Ragsdale must have been convinced that the birds seen by Gorham nearly 25 years earlier were IBWOs which by the 1870s had been extirpated from Cooke County.

RAGSDALE'S COLLECTION OF PAPERS

Oberholser identified George Ragsdale as a person from whom he had received "particularly valuable encouragement and information" while researching for his book *The Bird Life of Texas* (Acknowledgments, p. xvii). Since Ragsdale died five years before Oberholser arrived in Texas, it is likely that this assistance came from the examination of Ragsdale's papers which were in possession of his daughter Elizabeth 'Miss Bess' Ragsdale.

The Ragsdale papers consist of his correspondence with other naturalists and scientific institutions, as well as his field books, miscellaneous notes and unpublished manuscripts. Following Ragsdale's death these materials passed to his daughter "Miss Bess" who zealously guarded them until her death in 1984. The Ragsdale papers were then temporarily stored in the Morton Museum in Gainesville before being donated to the Briscoe Center for American History at the University of Texas in Austin where they are presently located.

Contained within the Ragsdale Collection is a list of the birds of Cooke and adjoining counties based on observations made during the years 1877, 1878 and 1879. Included in this list is the IBWO which was said to be extinct, i.e., extirpated, at that time (Fig. 1). Ragsdale's claim that the IBWO was no longer present in 1877 suggests that the extinction event occurred at a much earlier date. How Oberholser obtained his information regarding Gorham's sightings remains unknown since a search of the Ragsdale papers did not reveal any items relating to either Joshua Gorham or his sightings of the IBWO.

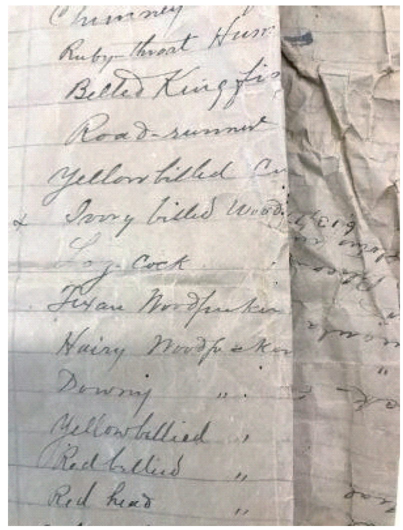

Figure 1. Ragsdale's list of birds of Cooke County based on observations made in 1877, 1878 and 1879 (G. H. Ragsdale Collection, Briscoe Center for American History, Box 2.325/ V46). The annotation for the IBWO, which cannot be seen in this photograph because of the fold in the paper, reads "now extinct in Cooke County." Ragsdale revised his list in 1880, and again listed the IBWO but without mention of its status.

HASBROUCK'S 1891 STATUS REPORT

Edwin Marble Hasbrouck (1866-1956, Fig. 2) worked for the United States Geological Survey during 1887-1889 in Texas where he collected over a hundred specimens of birds that are now in the National Museum of Natural History and various other museums in the United States (*fide* VertNet). In October 1888 he received a letter from Robert Ridgway, curator of birds at the National Museum inquiring about the IBWO in Texas (Ridgway 1888). Hasbrouck responded that he could "learn nothing about it [the IBWO], it seemingly being unknown. I think it is here however, as its cousin C. pileatus [Pileated Woodpecker] is quite common" (Hasbrouck 1888).

Hasbrouck, in his status report, cites Ragsdale as his source for the presence of the IBWO during the "early settlement" of Cooke County, i.e. the 1840s and 1850s, noting that this information was obtained via "Epistle" (Hasbrouck 1891, pp. 182 & 185). However, no correspondence between Hasbrouck and Ragsdale was found during a search of the Ragsdale Papers at the Briscoe Center for American History.

Hasbrouck worked for many years after returning from Texas as a volunteer in the ornithology department of the National Museum of Natural History while also maintaining a medical practice in Washington, D. C. The location of his personal papers and correspondence, if still in existence, is unknown.

Figure 2. Edwin M. Hasbrouck was a medical doctor and volunteer worker in the Ornithology Department of the National Museum of Natural History. Photograph from Hasbrouck (1900).

THE REPORT OF JAMES TANNER

James Tanner is credited with the most extensive study of the IBWO ever made (Tanner 1942). However, he notes only a single record of the IBWO in Cooke County which is dated about 1875 and attributed to Ragsdale as reported by Hasbrouck (1891). A problem arises in that the date 1875 is not found in Hasbrouck's paper. In addition, Tanner was either unaware of the sightings of Joshua Gorham or he did not consider them to be valid. The compilation of Texas records by Clifford Shackelford (1998) parallels Tanner's report with the added detail that Gorham's sighting were made in the "Red River bottoms." The IBWO most likely occurred during the early days in the "bottoms" of the Red River which form the northern boundary of Cooke County. However, Gorham's observations were reported to have been made at or near his homestead on Scott Creek which is in the drainage of the Trinity River.

CONCLUSIONS

The sight records attributed to Joshua Gorham represent the only reports of the IBWO in Cooke County, Texas. The IBWO was never collected in Cooke County although it was probably present in both the Trinity River drainage and the Red River bottoms prior to the influx of settlers in the years before the Civil War (see Appendix 1.). George Ragsdale was convinced that "Uncle Josh" had definitely seen the IBWO in Cooke County, and later published reports can be traced back to Ragsdale. However, the dates and location of Gorham's sightings, which Ragsdale obtained orally, cannot be verified since no written record of these events has been found in the Ragsdale collection of papers.

ACKNOWLEDGMENTS

Thanks are extended to Cliff Shackelford and Chuck Hunter for stimulating my interest in the Ivory-billed Woodpecker and providing constructive comments on an early draft of this paper. I also thank Deborah Shapiro of the Smithsonian Institution Archives for copies of the letters between Robert Ridgway and Edwin Hasbrouck.

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APPENDIX 1. CHRONOLOGY OF EVENTS IN THE HISTORY OF THE IBWO IN COOKE COUNTY TEXAS

1824 – Joshua Gorham is born in Scott County, Kentucky.

1845 – Joshua Gorham arrives in Texas.

1846-1847 – Joshua Gorham serves in the United States-Mexican War.

1848 – Cooke County is created.

1849 – Cooke County is organized. The IBWO is reported to have been seen by Joshua Gorham 7-1/2 miles southeast of Gainesville (Oberholser 1974).

1850 – The federal census reports the population of Cooke County to be 220 persons. Joshua Gorham is living on his 320 acre headright on Scott Creek circa 7-8 miles southeast of Gainesville.

1851 – The IBW0 is reported to have been seen by Joshua Gorham 7-1/2 miles southeast of Gainesville (Oberholser 1974).

1854 – Gorham serves from 24 December 1854 until 23 March 1855 in the Indian Campaign.

1860 – The population of Cooke County is 3,760.

1862-1863 – Joshua Gorham serves as a private in the Civil War.

1867 – George Henry Ragsdale and his family arrive in Cooke County where they settle on a small farm about three miles south of Gainesville (Casto 1980).

1870 – The population of Cooke County is 5,315. Ragsdale is elected surveyor of Cooke County.

1875 – Ragsdale publishes his first articles on the birds of Cooke County and begins his career as an authority on the natural history of Cooke County (Casto 1980).

1877 – Ragsdale begins a list of the birds of Cooke County which is continued through 1878 and 1879. The IBWO is included in the completed list with the annotation that it was extinct in Cooke County. No date is given for when this extinction [extirpation] occurred.

1880 – The population of Cooke County is 20,391. Ragsdale revises his 1877-1878-1879 list and again lists the IBWO but without comment as to its status.

1888 – E. M. Hasbrouck writes to Robert Ridgway that the IBWO is seemingly unknown in Texas although he believes it to be present.

1891 – E. M. Hasbrouck (1891) cites Ragsdale that the IBWO was present in Cooke County during "earlier times."

1895 – Ragsdale dies and is buried in Fairview Cemetery in Gainesville.

1896 – Joshua Gorham dies and is buried in Osburn Cemetery eight miles south of Gainesville.

1900 – Harry Oberholser arrives in Texas.

1942 – James Tanner publishes his study on the IBWO.

1956 – E. M. Hasbrouck dies and is buried in Arlington National Cemetery.

1984 – Elizabeth 'Miss Bess' Ragsdale, daughter of George Ragsdale and the guardian of his papers, dies and is buried in Fairview Cemetery.

2013 – A Texas historical person marker commemorating the life of George H. Ragsdale as an outstanding naturalist is placed near Ragsdale's grave in Fairview Cemetery.

TEXAS BIRD RECORDS COMMITTEE REPORT FOR 2022

ERIC CARPENTER

674 Goodnight Trail, Dripping Springs, Texas 78620

The Texas Bird Records Committee (hereafter "TBRC" or "committee") of the Texas Ornithological Society requests and reviews documentation on any record of a TBRC Review List species (see TBRC web page at http://www.texasbirdrecordscommittee.org). Annual reports of the committee's activities have appeared in the Bulletin of the Texas Ornithological Society since 1984. For more information about the Texas Ornithological Society or the TBRC, please visit www.texasbirds.org. The committee reached a final decision on 121 records during 2022: 106 records of 51 species were accepted and 15 records of 11 species were not accepted, an acceptance rate of 87.6% for this report. A total of 224 observers submitted documentation (to the TBRC or to other entities) that was reviewed by the committee during 2022.

The TBRC accepted 6 first state records in 2022: Red-vented Bulbul (established exotic), Scaly-breasted Munia (established exotic), Bat Falcon, Small-billed Elaenia, Trindade Petrel, and Wedge-tailed Shearwater. These additions plus the addition of Chihuahuan Meadowlark (split from Eastern Meadowlark) bring the official Texas State List to 664 species in good standing. This total does not include the 5 species on the Presumptive Species List, nor the 2 species on the Supplemental List.

In addition to the review of previously undocumented species, any committee member may request that a record of any species be reviewed. The committee requests written descriptions as well as photographs, video, and audio recordings if available. Information concerning a Review List species may be submitted to the committee secretary, Eric Carpenter, 674 Goodnight Trail, Dripping Springs, Texas 78620 (email: ecarpe@gmail.com). Guidelines for preparing rare bird documentation can be found in Dittmann and Lasley (1992) *How To Document Rare Birds*. Online submission forms can be found at https://www.texasbirdrecordscommittee.org/home/forms.

The records in this report are arranged taxonomically following the AOS Check-list of North American Birds (AOU 1998) through the 63rd supplement (Chesser et al. 2022). A number in parentheses after the species name represents the total number of accepted records in Texas for that species at the end of 2022. Species added to the Review List because of population declines or dwindling occurrence in recent years do not have the total number of accepted records denoted as there are many documented records that were not subjected to review (e.g. Brown Jay, Pinyon Jay, Tamaulipas Crow, and Evening Grosbeak). All observers who submitted written documentation or photographs/recordings of accepted records are acknowledged by initials. If known, the initials of those who discovered a particular bird are in boldface but only if the discoverer(s) submitted supporting documentation. The TBRC file number of each accepted record will follow the observers' initials. If photographs or video recordings are on file with the TBRC, the Texas Photo Record File (TPRF) (Texas A&M University) number is also given. Specimen records are denoted with an asterisk (*) followed by the institution where the specimen is housed and the catalog number. The information in each account is usually based on the information provided in the original submitted documentation; however, in some cases this information has been supplemented with a full range of dates the bird was present if that information was made available to the TBRC. All locations in italics are counties. Please note that the county designations of offshore records are used only as a reference to the nearest point of land.

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TBRC Membership – Members of the TBRC during 2022 who participated in decisions listed in this report were: Tony Frank, Chair; Keith Arnold, Academician; Eric Carpenter, (non-voting) Secretary; Sheridan Coffey, Greg Cook, Mel Cooksey, Steve Glover, Mary Gustafson, Jesse Huth, Arman Moreno, Chris Runk, and Willie Sekula.

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Additional Abbreviations – **AOS** = American Ornithologists' Society; **AOU** = American Ornithologists' Union; **BBNP** = Big Bend National Park; **GMNP** – Guadalupe Mountains National Park; **NP** = National Park; **NWR** = National Wildlife Refuge; **SHS** = State Historic Site; **SNA** = State Natural Area; **SP** = State Park; **WMA** = Wildlife Management Area.

ACCEPTED RECORDS

Brant (*Branta bernicla*) (38). One at Plainview, *Hale* on 21 November – 8 December 2021 (**NP**, DS, ML, JM, SL, MA, BD; 2021-113; TPRF 3935). One at Lubbock, *Lubbock* on 27 December 2021 (**AH**; 2022-06; TPRF 3929). One at Plainview, *Hale* on 11 January – 3 February 2022 (**NP**, ML, MW; 2022-18; TPRF 3940). One at Lubbock, *Lubbock* on 21 January – 9 February 2022 (**JC**, JeM, BS, JB; 2022-23; TPRF 3944).

Trumpeter Swan (*Cygnus buccinator*) (15). One southwest of Stinnett, *Hutchinson* on 20 January 2022 (**TW**, BP; 2022-19; TPRF 3943).

Eurasian Wigeon (*Mareca penelope*) (64). One at Balmorhea Lake, *Reeves* on 14 November 2021 – 27 January 2022 (**GC**, CB, BF, SF; 2021-115; TPRF 3934). One at west El Paso, *El Paso* on 13-17 April 2022 (**MH**, OJ, SR; 2022-32; TPRF 3951).

Harlequin Duck (*Histrionicus histrionicus*) (3). Two at Port Aransas jetty, *Nueces* on 19 February – 23 March 2022 (**TD**, SC, MR, JM, EC, RP, AS; 2022-24; TPRF 3946).

American Flamingo (*Phoenicopterus ruber*) (11). One at South Padre Is., *Willacy* on 16 September 2021 (**CRR**; 2021-99; TPRF 3908). One at west side of Laguna Atascosa NWR, *Cameron* on 10-24 October 2021 (**KB**, JM, DC, MM, CT; 2021-106; TPRF 3916). One at Norias Division, King Ranch, *Kenedy* on 17-21 November 2021 (**MOB**, JH, AW, JS; 2022-12; TPRF 3924).

Mexican Violetear (*Colibri thalassinus*) (100). One at west Austin, *Travis* on 2-4 June 2022 (**BN**; 2022-50; TPRF 3961). One southwest of Concan, *Uvalde* on 6-7 July 2022 (**JHT**; 2022-81; TPRF 3995).

Costa's Hummingbird (*Calypte costae*) (49). One west of Fort Davis, *Jeff Davis* on 7 July – 17 September 2021 (**CO**, EC, JM, BaP, ME, MaE; 2021-82; TPRF 3902).

Limpkin (*Aramus guarauna*) (29). One at Bear Creek Park, *Harris* on 28-29 April 2022 (**JiH**, AC; 2022-45; TPRF 3954). One at Lewisville, *Denton* on 17-24 May 2022 (**BeS**, EW, CW; 2022-41; TPRF 3958). One at Cullinan Park, Sugarland, *Fort Bend* on 23 May – 2 September 2022 (**KP**, HJ, AR, RM; 2022-53; TPRF 3964). One at Barton Creek, *Travis* on 24 May – 25 August 2022 (**WM**, VOB, RF, JeS, EC, CH; 2022-47; TPRF 3965). One at Village Creek Drying Beds, Arlington, *Tarrant* on 5-6 June 2022 (EW, SS, JA; 2022-39; TPRF 3966). One to two at San Bernard NWR, *Brazoria* on 8 June – 20 August 2022 (**DH**, RW, SH, BL; 2022-51; TPRF 3967). One at Tyrrell Park, Beaumont, *Jefferson* on 12 June 2022 (**DN**; 2022-52; TPRF 3963). One at Richland Creek WMA, *Navarro/Freestone* on 17 June – 6 August 2022 (**AF**, EW, AbF, MR; 2022-54; TPRF 3968). One at Village Creek Historical, Arlington, *Tarrant* on 20 June – 8 July 2022 (**JR**, EW, TF; 2022-56; TPRF 3969). One at Lake McClellan, *Gray* on 21-27 June 2022 (**JaM**, BP, DoS, SuS; 2022-60; TPRF 3970). One to two at Caddo Lake, *Harrison* on 22 June – 3 August 2022 (**MiL**, DN; 2022-62; TPRF 3971). One at El Franco Lee Park, Houston, *Harris* on 9 July 2022 (**MC**; 2022-102; TPRF 3972). One at Ft Worth Nature Center, *Tarrant* on 23 July – 27 August 2022 (**TC**; 2022-103; TPRF 3973). One northeast of Village Creek, Arlington, *Tarrant* on 30 July – 12 August 2022 (**TC**, TF; 2022-104; TPRF 3974). One south of College Station, *Brazos* on 1-27 August 2022 (**ChB**, BE, BrS; 2022-105; TPRF 3975). One at Joe Pool Lake, *Tarrant* on 5-12 August 2022 (**TF**; 2022-106; TPRF 3976). One at Armand Bayou, *Harris* on 8 August 2022 (**GS**; 2022-107; TPRF 3977). One to two southeast of College Station, *Brazos* on 14-24 August 2022 (**BW**, RN; 2022-108; TPRF 3978). One at The Woodlands, Montgomery on 15-19 August 2022 (**PM**, GM, TM; 2022-109; TPRF 3979). One at Lake Madison, *Madison* on 18-20 August 2022 (**GP**, BrN; 2022-110; TPRF 3980). One at Kickerillo-Mischer Preserve, *Harris* on 23 August 2022 (**KeB**; 2022-111; TPRF 3981). One at White Rock Creek, *Dallas* on 6-16 September 2022 (**SW**; 2022-112; TPRF 3982). With the rapid increase in Limpkin records plus documented and successful breeding at two locations (2021-53 and 2021-100; see 2021 Annual Report), the TBRC removed Limpkin from the Review List on 17 Sep 2022.

Northern Jacana (*Jacana spinosa*) (45). One at Laughlin AFB, *Val Verde* on 19 September 2022 (**BNo**; 2022-79; TPRF 4002).

Curlew Sandpiper (*Calidris ferruginea*) (13). One at Hagerman NWR, *Grayson* on 22 August 2021 (**CP**, WaM, MiC; 2021-93; TPRF 3904).

Purple Sandpiper (*Calidris maritima*) (30). One at South Padre Is. jetty, *Cameron* on 18 January – 17 March 2022 (**MaW**, JG, BM; 2022-17; TPRF 3942).

Red Phalarope (*Phalaropus fulicarius*) (54). One at Horizon City, *El Paso* on 22 September – 2 October 2021 (**MH**, JM, JoG, RH; 2021-101; TPRF 3912). One at Richland Creek WMA, *Freestone* on 5 November 2021 (**GK**, CA; 2022-08; TPRF 3920).

Long-tailed Jaeger (*Stercorarius longicaudus*) (29). One at San Jose Is., *Aransas* on 23 August 2021 (**AO**; 2021-92; TPRF 3905).

Short-billed Gull (*Larus brachyrhynchus*) (48). One at Keystone Heritage Park, El Paso, *El Paso* on 5 December 2021 – 2 January 2022 (**MiW**, CL, MG, JoM, OJ, JoG, JK; 2021-116; TPRF 3936). One at White Rock Lake, *Dallas* on 12 December 2021 (**SSc**; 2022-07; TPRF 3927).

Kelp Gull (*Larus dominicanus*) (6). One at Brownsville Landfill, *Cameron* on 20-21 April 2022 (**AL**, CM, MBS; 2022-33; TPRF 3953).

Brown Noddy (*Anous stolidus*) (26). One at Port Aransas jetty, *Nueces* on 21 May 2022 (**PW**; 2022-37; TPRF 3959). One ~7 miles offshore from Matagorda Is., *Matagorda* on 17 July 2022 (**VH**; 2022-80; TPRF 3997).

Arctic Tern (*Sterna paradisaea*) (11). One at South Padre Is., *Cameron* on 5 October 2021 (**JG**; 2021-103; TPRF 3914). One at Twin Buttes Reservoir, *Tom Green* on 4 June 2022 (**CD**; 2022-49; TPRF 3989).

Elegant Tern (*Thalasseus elegans*) (12). One at Twin Buttes Reservoir, *Tom Green* on 3 June 2022 (**KT**; 2022-42; TPRF 3987).

Leach's Storm-Petrel (*Hydrobates leucorhoa*) (43). One offshore, 40 miles southeast of Port Aransas, *Nueces* on 22 July 2021 (**JM**; 2021-87; TPRF 3910). Two offshore from South Padre Is., *Cameron* on 14 August 2021 (**JeS**, JeH, TJA; 2022-26; TPRF 3919). One ~140 miles southeast of Galveston Is., *Galveston* on 2 June 2022 (**JeS**; 2022-59; TPRF 3985).

Trindade Petrel (*Pterodroma arminjoniana*) (1). One at Port Aransas jetty, *Nueces* on 22 February 2022 (**SkC**; 2022-28; TPRF 3947). This represents the first documented record for Texas.

Wedge-tailed Shearwater (*Ardenna pacifica*) (1). One at Cox/Lavaca Bay, *Calhoun* on 15 June 2022 (**JL**; 2022-55; TPRF 3991). This represents the first documented record for Texas.

Sooty Shearwater (*Ardenna grisea*) (22). One at San Jose Island, *Aransas* on 14 June 2022 (**AlW**, AO; 2022-61; TPRF 3990).

Sooty/Short-tailed Shearwater (*Ardenna grisea/Ardenna tenuirostris*) (1). One at Matagorda Nature Park jetty, *Matagorda* on 14 March 2022 (**BE**; 2022-30).

Great Shearwater (*Ardenna gravis*) (34). One ~140 miles east of South Padre Is., *Cameron* on 6 November 2021 (**JM**; 2021-108; TPRF 3921). One ~60 miles southeast of Port Aransas, *Nueces* on 10 September 2022 (**JeS**, RR; 2022-71; TPRF 4001). One at South Padre Is., *Cameron* on 24 September 2022 (**EF**; 2022-72; TPRF 4003).

Manx Shearwater (*Puffinus puffinus*) (14). One at Mustang Is., *Nueces* on 29 August 2021 (AO; 2021-119; TPRF 3911). One ~94 miles south-southeast of Brazos River mouth, *Brazoria* on 3 June 2022 (**JOB**, JeS, EC; 2022-40; TPRF 3988). One ~77 miles southeast of Sargent Beach, *Matagorda* on 3 June 2022 (**JOB**, JeS; 2022-58; TPRF 3986). One at Port Aransas, *Nueces* on 19 August 2022 (**AO**; 2022-78; TPRF 4000).

Red-footed Booby (*Sula sula*) (9). One 148 miles southeast (offshore) from the Brazos River mouth, *Brazoria* on 25 July 2020 (**ZS**; 2022-21; TPRF 3918). One at Leonabelle Turnbull Birding Center, Port Aransas, *Nueces* on 17 November 2021 (**LH**, LS, MaR, JeR; 2021-110; TPRF 3923).

Snail Kite (*Rostrhamus sociabilis*) (5). One at Flag Pond, Lake Somerville, *Lee* on 23 July – 1 August 2022 (**AN**, SC, WE, DaS, PS, EW, SL, RP, PG, MeC, HH, JeS, EC; 2022-65; TPRF 3998).

Short-tailed Hawk (*Buteo brachyurus*) (68). One at Chisos Mtns., BBNP, *Brewster* on 24 June 2021 (**SJ**; 2022-14; TPRF 3909). One at Bentsen-Rio Grande Valley SP, *Hidalgo* on 4 September 2021 (**RR**; 2021-96; TPRF 3907). One at South Llano River SP, *Kimble* on 15 May 2022 (**JeB**; 2022-46; TPRF 3957). One east of Pipe Creek, *Bandera* on 3 June 2022 (**TR**; 2022-48; TPRF 3962). One at Franklin Mountains, *El Paso* on 23 June 2022 (**CeM**, ML; 2022-63; TPRF 3993). One at National Butterfly Center, south of Mission, *Hidalgo* on 13 July 2022 (**TH**; 2022-68; TPRF 3996).

Snowy Owl (*Bubo scandiacus*) (14). One south of Spearman, *Hansford* on 11 December 2021 (**BB**; 2022-02; TPRF 3926).

Northern Saw-whet Owl (*Aegolius acadicus*) (37). One at Davis Mountains Preserve, *Jeff Davis* on 25 May 2022 (**RK**; 2022-38; TPRF 3960).

Bat Falcon (*Falco rufigularis*) (1). One at Santa Ana NWR, *Hidalgo* on 8 December 2021 – 10 March 2022 (**RG**, JoM, IM, ToF, PF, SC, JoH, EW, RP, PI, MeC, PG, JiB, AnW, KM; 2021-117; TPRF 3928). This represents the first documented record for Texas.

Rose-throated Becard (*Pachyramphus aglaiae*) (83). One at Salineno, *Starr* on 24 January – 13 February 2021 (**TK**, WS, WB; 2022-83; TPRF 3983). One at Salineno, *Starr* on 7 February 2022 (**TrC**, TL; 2022-22; TPRF 3945).

Small-billed Elaenia (*Elaenia parvirostris*) (1). One at Mustang Is., *Nueces* on 17 May 2021 (**AO**; 2021-122; TPRF 3930). This represents the first documented record for Texas.

Dusky-capped Flycatcher (Lawrence's) (*Myiarchus tuberculifer lawrenceii*) (32). One at Laguna Atascosa NWR, *Cameron* on 21 December 2021 – 19 January 2022 (**KaM**, EJ, GW, LK, AD, ChW, JiS, AB; 2022-03; TPRF 3938). One south of Olmito, *Cameron* on 13 March 2022 (**MK**; 2022-43; TPRF 3950).

Sulphur-bellied Flycatcher (*Myiodynastes luteiventris*) (37). One at Sabine Woods, *Jefferson* on 7-18 October 2021 (**SM**, JM, SL, JoH, DM; 2021-105; TPRF 3915). One at Alamito Creek, *Presidio* on 30 June 2022 (**CR**, MiG; 2022-70; TPRF 3994).

Piratic Flycatcher (*Legatus leucophaius*) (8). One at Resaca de la Palma SP, *Cameron* on 29 August 2021 (**MEs**; 2021-95; TPRF 3906).

Thick-billed Kingbird (*Tyrannus crassirostris*) (20). One at Terlingua, *Brewster* on 28 July 2021 (**MF**; 2021-88; TPRF 3903).

Gray Kingbird (*Tyrannus dominicensis*) (18). One at South Padre Is., *Cameron* on 7 May 2022 (**MEs**; 2022-35; TPRF 3956).

Fork-tailed Flycatcher (*Tyrannus savana*) (56). One at South Padre Is., *Cameron* on 4 October 2021 (**JMo**; 2021-104; TPRF 3913). One at San Benito Wetlands, Cameron on 14 November – 18 December 2021 (**MaM**, RP, JM, TD, PK, TeD, JJD; 2021-114; TPRF 3922). One at Friendship Park, Granger Lake, *Williamson* on 31 December 2021 – 2 February 2022 (**BA**, RK, TiF, JoH, RP, RiK; 2022-01; TPRF 3939). One northeast of Rosharon, *Brazoria* on 14 August 2022 (**KR**; 2022-66; TPRF 3999).

Greater Pewee (*Contopus pertinax*) (38). One at Bear Creek Park, *Harris* on 20 October 2021 – 30 January 2022 (**JiH**, JM, JoH, ToF, PF, OJ, DoS, SuS, KK; 2021-107; TPRF 3931). One at Memorial Park, El Paso, *El Paso* on 4 October 2022 (**SR**; 2022-73; TPRF 4004).

Pacific-slope Flycatcher (*Empidonax difficilis*) (13). One at Cullinan Park, *Sugarland*, Fort Bend on 12-26 March 2022 (DL, BiS, MS, DV, CT; 2022-31; TPRF 3949).

Red-vented Bulbul (*Pycnonotus cafer*). The TBRC voted to add this to the state list as an established exotic primarily in around Houston, Harris (**MA**, DB; 2021-120).

Rufous-backed Robin (*Turdus rufopalliatus*) (29). One at El Paso, *El Paso* on 10 October 2021 (**JoG**; 2022-10; TPRF 3917).

Varied Thrush (*Ixoreus naevius*) (53). One at Pine Springs, GMNP, *Culberson* on 3-4 November 2021 (**DeM**, LW; 2022-09).

Scaly-breasted Munia (*Lonchura punctulata*). The TBRC voted to add this to the state list as an established exotic primarily in around Houston, Harris (**MA**, DB; 2021-121).

Common Redpoll (*Acanthis flammea*) (19). One at Lake Granbury, *Hood* on 17 January – 21 February 2022 (**MB**; 2022-16; TPRF 3941).

Dark-eyed (White-winged) Junco (*Junco hyemalis aikeni*) (8). One west of Fort Davis, *Jeff Davis* on 9-11 December 2021 (**StC, DD**; 2021-118; TPRF 3925).

Golden-crowned Sparrow (*Zonotrichia atricapilla*) (50). One at Pine Springs, GMNP, *Culberson* on 3 March – 26 April 2022 (**WiS**, MM, CG, BS, GG; 2022-29; TPRF 3948). One at Chisos Basin, BBNP, *Brewster* on 28-29 April 2022 (**CBe**, CN, RiN; 2022-44; TPRF 3955).

Golden-crowned Warbler (*Basileuterus culicivorus*) (32). One at Valley Nature Center, Weslaco, *Hidalgo* on 11 November 2021 – 31 March 2022 (**ShF, DI**, RP, SL, BiS, ZW, CaO, KeM; 2021-109; TPRF 3932).

Flame-colored Tanager (*Piranga bidentata*) (17). One at San Antonio, *Bexar* on 17 December 2021 – 8 January 2022 (**BT**, DMi, TB, LC; 2022-04; TPRF 3937).

Crimson-collared Grosbeak (*Rhodothraupis celaeno*) (61). One at Quinta Mazatlan, *Hidalgo* on

12 November 2021 – 29 January 2022 (**MaM**, LT, JW, ED, CyB; 2022-05; TPRF 3933).

Blue Bunting (*Cyanocompsa parellina*) (65). One ~10 miles north of Rio Grande City, *Starr* on 27 March 2021 (**MBE**; 2022-82; TPRF 3984). One at Estero Llano Grande SP, *Hidalgo* on 17-21 April 2022 (**JaA**, DO; 2022-34; TPRF 3952).

NOT ACCEPTED

A number of factors may contribute to a record being denied acceptance. It is quite uncommon for a record to not be accepted due to a bird being obviously misidentified. More commonly, a record is not accepted because the material submitted was incomplete, insufficient, superficial, or just too vague to properly document the reported occurrence while eliminating all other similar species. Also, written documentation or descriptions prepared entirely from memory weeks, months, or years after a sighting are seldom voted on favorably. It is important that the simple act of not accepting a particular record should by no means indicate that the TBRC or any of its members feel the record did not occur as reported. The non-acceptance of any record simply reflects the opinion of the TBRC that the documentation, as submitted, did not meet the rigorous standards appropriate for adding data to the formal historical record. The TBRC makes every effort to be as fair and objective as possible regarding each record. If the committee is unsure about any particular record, it prefers to err on the conservative side and not accept a good record rather than validate a bad one. All records, whether accepted or not, remain on file and can be re-submitted to the committee if additional substantive material is presented.

Mute Swan (*Cygnus olor*). The TBRC voted against adding this to the state list as an established exotic (2022-20).

Ruddy Ground Dove (*Columbina talpacoti*). Two at El Paso, *El Paso* on 29 May 2021 (2022-15).

Limpkin (*Aramus guarauna*). One at The Woodlands, *Montgomery* on 3 July 2021 (2021-81). One at North Padre Is., *Kleberg* on 1 October 2021 (2021-102).

Elegant Tern (*Thalasseus elegans*). One at Rollover Pass, *Galveston* on 19 July 2022 (2022-64).

Leach's Storm-Petrel (*Hydrobates leucorhoa*). One 18 miles southeast of San Jose Is., *Aransas* on 27 June 2021 (2021-75). One offshore from Port Aransas, *Nueces* on 26 July 2021 (2022-25). One ~20 miles southeast of Mustang Island, *Nueces* on 21 June 2022 (2022-57; TPRF 3992).

Red-footed Booby (*Sula sula*). One 142 miles south-southeast of Matagorda Island, *Matagorda* on 5 September 2021 (2021-97).

Short-tailed Hawk (*Buteo brachyurus*). One at Hazel Bazemore Park, Calallen, *Nueces* on 14 September 2021 (2021-98).

Rose-throated Becard (*Pachyramphus aglaiae*). One at Bentsen-Rio Grande Valley SP, *Hidalgo* on 11 April 2021 (2021-68).

Fork-tailed Flycatcher (*Tyrannus savana*). One at Crystal Beach, *Galveston* on 14 April 2021 (2021-67).

Pacific-slope Flycatcher (*Empidonax difficilis*). One at Brazos Bend SP, *Fort Bend* on 27 September 2020 (2021-57). One at Sabine Woods, *Jefferson* on 19 September 2021 (2022-11).

Tamaulipas Crow (*Corvus imparatus*). One at Brownsville Landfill, *Cameron* on 27 October 2021 (2022-13).

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IN MEMORIAM
PAUL AUSTIN JOHNSGARD, 1931–2021

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Paul A. Johnsgard, July 2006 (photo by Linda R. Brown)

Ornithology lost a giant on May 28, 2021, with the passing of Paul A. Johnsgard in Lincoln, Nebraska. The author of more books on birds and natural history than any other person living or dead (by a factor of 2), Paul was also key in initially publicizing the spectacular spring migration of Sandhill Cranes in Nebraska's Platte River Valley that well over 2 million people have enjoyed over the past 50 years. Very few ornithologists have had as large a collective impact on science, education, and conservation as Paul Johnsgard achieved in his remarkable almost 90-year life. He was an Elective Member (1970) and Fellow (1981) of the American Ornithological Society.

Paul Austin Johnsgard was born June 28, 1931 in Fargo, North Dakota and spent his childhood in the nearby small town of Christine. His interest in the outdoors started as a small child by walking along railroad tracks collecting wildflowers for his mother. He credited a mounted Redwinged Blackbird in a glass dome case in his first-grade classroom for kindling his obsession with birds, and he was profoundly influenced by his first-grade teacher, Ms. Evelyn Bilstead, who encouraged the shy, scrawny, nearsighted

6-year-old to follow his dreams wherever they might lead him. The gift of a copy of F. H. Kortright's *Duck, Geese, and Swans of North America* when he was 13 hooked him for the rest of his life on waterfowl and led to much of his later original research on this group of birds. Paul's prolific book production might have been predicted in high school when he enrolled in a typing class, which required special permission because at that time only girls were allowed to take typing! Paul later said it was a wonder he even developed an interest in biology, because his high school biology classes were taught by a coach who knew no biology, and when Paul enrolled at the local community college (North Dakota State School of Science, 1949–1951), the same coach had been hired to teach biology there as well. It was not the last time that Paul would have major issues with football coaches!

Upon transferring to North Dakota State University to complete his undergraduate degree, Paul fell under the influence of the Cornell-trained J. Frank Cassel, who encouraged Paul's ornithological interests. Cassel made Paul aware of a $25 scholarship available to students desiring to do research over the summer, which Paul received, and for the scholarship, Cassel suggested Paul do a bibliographic survey of the waterfowl of North

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Dakota. Paul created a card file summarizing what was known of each species and later expanded it to include all the birds of North Dakota, illustrating it with his own line drawings. When the work was published as a 16-page booklet by a local printer, the basic outline of how he would later produce scores of similar but far more substantive books was born.

Enrolling at Washington State University to do a Master's degree under Charles Yocom, Paul was quickly advisor-less when Yocom left for another university within 2 weeks of Paul's arrival. It was a trying time in which Paul tried to make do with a committee composed of a botanist, a mammologist, and a wildlife biologist, and he came perilously close to switching permanently to botany. But he also was able to interact with Don Farner, James King, Jared Verner, and Alan Wilson who were also at Washington State, and they may have helped him stay in ornithology. During that time, he met and in 1956 married Lois Lampe, a plant ecologist, and they remained married until his death.

Paul's Master's degree was an ecological study of a sand dune region of Washington called the Potholes. This research first led him to observing and describing waterfowl courtship behavior, which was to figure prominently in his later PhD work. When Paul published some of his initial waterfowl observations in *The Condor*, he received a somewhat nasty letter from Charles Sibley of Cornell, castigating him for not being aware of Konrad Lorenz's recent paper on duck courtship (published in a Germanlanguage journal). But Sibley also extended an invitation to Paul to join him at Cornell for his PhD, a school the everfrugal Paul was interested in but had rejected applying to for his Masters because of the $25 application fee!

Paul's actual PhD research at Cornell was a comparative study of the evolutionary relationships of the North American mallard-like ducks using observations of courtship behavior. Sibley gave him free rein as long as the research looked at species relationships, and Paul found Cornell to be the most stimulating intellectual environment he was ever in. He completed his PhD in about 3 years.

While engaged in his waterfowl research, Paul worked one summer as Sibley's research technician. Sibley was demanding and tyrannical, and students quaked at his temper and treated him like a god. (Paul could never bring himself to call him anything to his face except "Dr. Sibley" to the day Sibley died, even though they stayed relatively close long after Paul left Cornell.) At the time, Sibley was experimenting, without success, in using blood proteins as a taxonomic tool, and was about to give up entirely on molecular analyses of avian taxonomy. However, being a voracious reader of the literature, Paul encountered a paper by Robert McCabe and H. F. Deutsch in *The Wilson Bulletin* (1952) that reported interspecific differences in egg-white proteins of gamebirds. That approach seemed promising to Paul, but he dared not risk Sibley's wrath by suggesting something that differed from the strict protocols he had been assigned by the master. So, Paul surreptitiously began replicating the McCabe and Deutsch work with captive birds at Cornell. When Paul was completely sure of the results, he worked up the nerve to take them to Sibley, who immediately appreciated their significance. This later led to Sibley's well-known DNA–DNA hybridization work that shook the avian taxonomic tree to its very roots. Paul always seemed slightly bemused by the seminal role he had in Sibley's influential research.

Paul crossed Sibley again when Paul sought a postdoc at the Wildfowl Trust in England, then at its peak with the largest collection of captive waterfowl ever assembled. Sibley wanted to apply for funding for the Trust work with Paul designated as his assistant. Paul rejected that idea, not wanting to be under Sibley's continued control, so he applied to the National Science Foundation on his own, receiving support for two years in which he continued his comparative behavioral studies of ducks and geese. This led to Paul's first major book, *Handbook of Waterfowl Behavior* (1965), which was the first comprehensive comparative survey of behavior for any group of birds.

Paul was always refreshingly oblivious to academic formalities. At the 1959 International Ethological Congress in Cambridge (UK), on one evening Paul encountered a packed dining hall where he observed Sibley sitting at a table with others that was slightly elevated. Seeing a vacant chair next to Sibley, a naïve Paul sat down only to encounter an incredulous stare from Sibley who informed Paul that one had to be invited to sit at High Table! Embarrassed, Paul quickly started to leave, only to have the others there laugh and tell him to sit down. The High Table diners who wanted him to stay included later Nobel laureates Konrad Lorenz and Niko Tinbergen, and Lorenz became Paul's friend and helped him secure a Guggenheim Fellowship.

While still at the Wildfowl Trust in the fall of 1959, Paul learned from Sibley that a job for an ornithologist was open at the University of Nebraska-Lincoln (UNL), with Sibley commenting that "Nebraska would not be a bad place from which to look for another job." All Paul knew about Nebraska is that it was second only to North Dakota for prime waterfowl habitat and duck production, so he applied sight unseen. He was offered and accepted the job as an instructor without an interview or visit. Paul was promoted to assistant professor with tenure after only 1 year as an instructor. Within 6 years, Paul had become a full professor; he always believed his was the shortest time it had ever taken anyone to go from instructor to full professor at UNL. During his subsequent ~40 years at UNL, Paul received the university's three highest honors: the Distinguished Teaching Award, the Outstanding Research and Creativity Award, and an Honorary Doctor of Science, a rare trifecta among biologists at UNL. He taught introductory zoology, ornithology, ecology, and animal behavior to more than 7,000 students during his teaching career and supervised 12 PhD and 13 MS degrees.

Paul's arrival in Lincoln began his lifelong love affair with Nebraska. He explored all corners of the state but was particularly fond of the Nebraska Sandhills and the Platte River Valley. One of his early explorations in spring 1962 first took him to the Platte after he heard rumors of Sandhill Cranes in the area. At the time, the spectacular 600,000-crane migration each spring along the Platte was not well known except to locals, and certainly wasn't a multimillion-dollar tourist attraction as it is today. When Paul and his class reached Elm Creek and turned south toward the river, he was astounded to see thousands of cranes in nearby cornfields. That trip fixated him on cranes, and later he was to write multiple books and consult on a film about them, and he became a dedicated popularizer of the Platte River crane phenomenon. Sandhill Cranes were his favorite bird, and he became more closely associated with them than any other single person. Probably not a spring went by in the next 50 years that he did not venture out to see them, usually multiple times, and his last trip was just a few weeks before his death.

Paul's arrival in Nebraska also started his prolific writing career that continued unabated until a few days before his death. Depending on how revisions and collected essays are counted, he wrote 105 books. Originally his interest was in writing encyclopedic monographs of particular groups (e.g., waterfowl, cranes, cormorants, bustards, sandgrouse, pheasants, quail, brood parasites, owls). Although he traveled, often internationally, to collect data or secure photographs for these books, some people (including likely envious colleagues in his own department) criticized his monographs as having no original work. Nonetheless, his books summarized a vast amount of material on select species, and virtually all serious scientists beginning research on these species in the late 20th century (in the pre-Birds of the World Online era) would consult a Johnsgard book as a starting point.

Paul usually had multiple book projects going simultaneously, sometimes 7 or 8 at once. He compulsively worked on his books, often being one of the few people in the biology building on weekends, holidays, or evenings. Only football Saturdays deterred him from coming into his office, and he was an outspoken critic of Nebraska football, dismayed by the diversion of university resources into it. He feuded with legendary Nebraska coach Bob Devaney, and it was fitting that when the Omaha and Lincoln newspapers published their lists of the 100 most influential Nebraskans of the 20th century, Paul was right there alongside Devaney. Paul's 100+ books occupy about seven feet of bookshelf space, include over 20,000 pages of text, and contain at least 2.75 million words. Many of his books were illustrated by his own line drawings or photographs.

As Paul traveled more in Nebraska and elsewhere, he became increasingly concerned with preservation of threatened habitats and considered it important to make people aware of the natural history surrounding them. This led to a series of books targeted for a general audience, including some quite lyrical ones on cranes, Snow Geese, the Sandhills, the Platte River, the Niobrara River, the Grand Tetons and Yellowstone, prairie birds, and the natural history of Nebraska. Particularly after his retirement from UNL in 2001, he worked increasingly in conservation and outreach, often collaborating with the crane sanctuaries along the Platte or local Audubon societies to preach the importance of preserving natural environments. He detested the irrigation industry for the way they drain the Ogallala Aquifer and divert water from his beloved Platte River. His conservation work was recognized by the American Ornithologists' Union in 2012 with the Ralph W. Schreiber Conservation Award, and he received countless other awards throughout his career for both conservation and his books.

As a personal reflection, I first met Paul in July 1981 when I visited UNL's Cedar Point Biological Station in western Nebraska to scout it as a possible site for Cliff Swallow research. Paul was teaching ornithology there and took an immediate interest in my work. He encouraged me endlessly in the early years of my research and kindled my lifelong love for Nebraska. We had a close friendship for 40 years even though I was never formally associated with him or UNL. My experience with him was not unique, and he nurtured many young biologists from both UNL and elsewhere. I will miss my friend's dry wit, cheerfulness, and the twinkle in his eye, as will countless others he touched during his enormously influential life.

Paul is survived by his wife Lois, son Scott, daughters Ann and Karin, six grandchildren, and four great-grandchildren.

I have drawn heavily for this memorial from an essay about his life that Paul first published in 2010 and later updated (https://digitalcommons.unl.edu/zeabook/30/); a relatively complete curriculum vita is also included there. I thank Scott Johnsgard, Karin Johnsgard, and Valerie O'Brien for their comments and/or suggestions.

NOTEWORTHY RESIGHTING OF BANDED INCA DOVE

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A small non-migratory dove of Mexico, northern Central America, and the southwestern United States, the Inca Dove *Columbina inca* has extended its range both north and south over the past 100 years (Mueller 2020). Occurring in Texas (except for eastern panhandle), the species was first recorded in Laredo, TX in 1866 (Phillips 1968), and in 1890 in San Antonio, where it was common in 1904 (Oberholser 1974). Continued northward expansion in Texas; the species is now common in Lubbock and breeding in Wichita Falls (Mueller 2020).

From 2010 to 2016 Inca Doves were banded in San Antonio as part of a long-term study on the species' longevity and social behavior (Eitniear 2018). On 3 October 2010 an email arrived from personnel at the Welder Wildlife Foundation in Sinton, Texas. Attached to the email was an image of a color banded adult Inca Dove (also with a USFWS band). The band number was not recorded but the author was only individual color banding Inca doves (Banding Lab pers. comm.). The distance from San Antonio (29º 30'42 N, 98º 28'18 W) to Welder Wildlife Foundation (28º2'5"N 97º30'32"W) is 219 Km se. Fig.1.

While only a single sighting the distance travelled provides limited evidence that the low 35% annual survival of the species as stated by Mueller et al (2021) may actually be the result of emigration. This consideration was mentioned by the author in his statement that *"Our survival estimate is an apparent survival rate estimate, which would be biased low in the event of permanent movement away from the trapping site during the study as the model cannot distinguish permanent emigrants from mortalities* (Mueller et al. 2021)".

In Texas, movement by Inca Doves into new regions has been thought to occur mostly in winter

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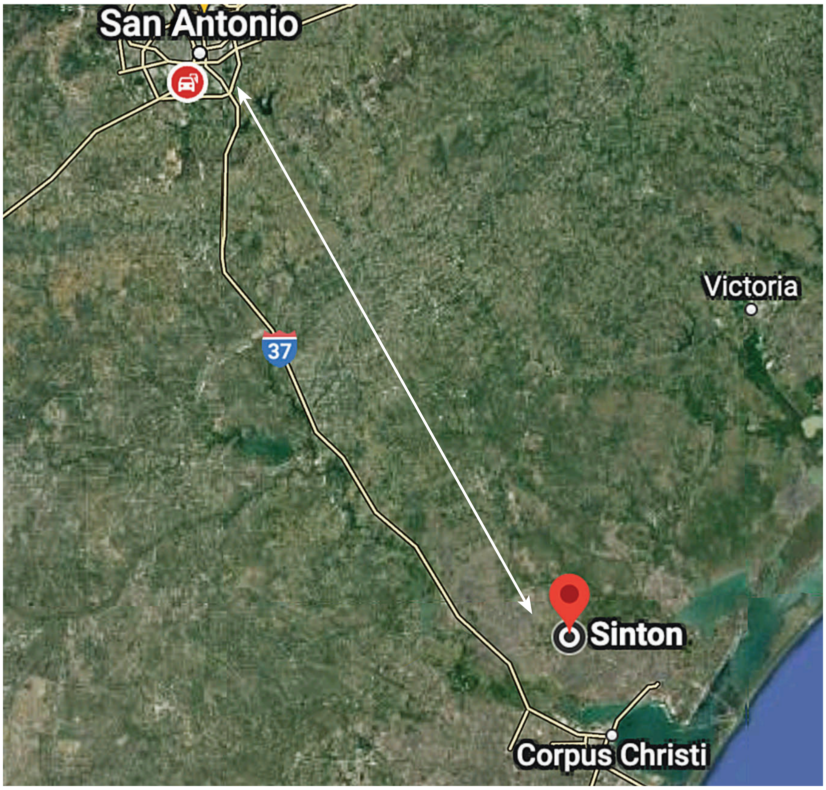

Figure 1. Distance from San Antonio to Sinton, Texas (210 Kms.SE).

(Quay 1982), or during the colder months (Simmons 1925, Oberholser 1974). This view apparently stems from the circumstance that reported geographic range extensions have been based upon doves observed or collected in the winter (Lowery 1974, Oberholser 1974). The current observation supports this theory and suggest that the Inca Dove may be more nomadic than the literature indicates (Johnston 1960)

ACKNOWLEDGMENTS

Inca Doves in this study were captured and banded under Texas permit #SPR-0893-626 and Federal Bird Banding permit #22614. The paper benefited greatly by the comments of Kent Rylander.

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SPECIMEN RECORDS OF SOOTY SHEARWATER (*ARDENNA GRISEA*) FROM THE GULF OF MEXICO, WITH COMMENTS ON TEMPORAL FREQUENCY

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The Sooty Shearwater (*Ardenna grisea*) is a globally wide-ranging seabird found in major marine systems across the world, from temperate to tropical latitudes. It is absent from the Indian Ocean, several regions dominated by island chains, and some gulfs (Carboneras 2023). Despite being largely absent from the Gulf of Mexico (Carboneras 2023), occasional transitional individuals or extralimital dispersers are very rarely found in that region (Lockwood and Freeman 2014).

With the establishment of community science avian monitoring initiatives such as eBird (Sullivan et al. 2009), documentation of Texas bird distribution has increased dramatically in the 21st century. However, where possible, it is helpful to have voucher specimens for these records as physical, incontrovertible evidence of their occurrence. Data associated with museum study skins are invaluable, as they provide information that is unavailable with most internet monitoring initiatives.

Herein we document the first specimens of Sooty Shearwater from the Texas portion of the Gulf of Mexico, representing the northwestern portions of that body of water. These records provide important additions to our knowledge of these rare oceanic birds along the Texas coast (Brooks and Arnold 2003). Additionally, we address temporal frequency of occurrence (by month, and decade) in the Texas Gulf by pooling the specimen data with eBird records (Carboneras 2023), and discuss biological data of these specimens, especially as it may relate to their health and fitness.

Table 1 provides a list of six Sooty Shearwater specimens from Nueces County (Pt. Aransas, Mustang Island; all housed at Texas A&M's Biodiversity Research and Teaching Collections - TCWC), and one additional specimen approximately 85 km to the northeast from Matagorda Beach (Matagorda County; HMNS 4330; Fig. 1).

A total of 17 records were obtained when we pooled the specimen (n = 7) with eBird (n = 10) records (Table 1). Sooty Shearwaters are found along the Texas coast throughout the year, with peaks during June, July and September (Fig. 2). Similar to our results, Lockwood and Freeman (2014) suggested peaks from May – September using a smaller sample size; however they also suggest absence during Spring (February – April), whereas we noted overall presence throughout the year.

The earliest record was a specimen from South Pier in Port Aransas (Nueces Co.), salvaged 19 June 1952 by H.H. Hildebrand (TCWC 9081). Then a gap of 40 years interrupts until the next specimen salvaged 10 June 1993 by A.F. Amos from Mustang Island (Nueces Co.; TCWC 13000). The remaining group of 16 specimens were all salvaged over the most recent three decades (1993 – 2023) in even numbers (mean = 4, range = 3-5/decade; Fig. 3).

The reason for the 40-year gap between the first and next 16 specimens is unknown. It is likely not an artifact of increased numbers of birdwatchers logging records into eBird, as additional specimens were also not salvaged during this four decade pause. It is possible that irregular patterns of distribution and dispersal are becoming more prevalent in recent years with the compounding effects of environmental catastrophes, including global warming and freezing, El Niño events, floods, tropical storms and hurricanes (McSweeny and Brooks 2022).

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Table 1. Sooty Shearwater (*Ardenna grisea*) data from Texas for seven museum specimens and ten eBird observations.

Specimen Data						
Date	Locality	Tx County	Catalog #	Gender / Reproductive data	Fat content	Grams
Jun 19 1952	Pt. Aransas S. Pier	Nueces	TCWC 9081			
Jun 10 1993	Mustang Island	Nueces	TCWC 13000	female; ovary: 13x6, no ova visable		474
Oct 10 1993	Mustang Island	Nueces	TCWC 13001	male; testes 3x2, black		597
Sep 16 1995	San Jose Island	Nueces	TCWC 13352			
Jun 18 2007	Pt. Aransas	Nueces	TCWC 14625	male; testes 4x3 mm	Trace	400
Jul 28 2009	Pt. Aransas County Park	Nueces	TCWC 15557	female; ovary 10x4 mm, granular	Moderate	595
Apr 27 2022	Matagorda Beach	Matagorda	HMNS 4330	male; sub-adult (skull 80% ossified)	Emaciated	485

eBird Data		
Date	Locality	Tx County
Dec 26 1990	Pelican Island, Seawolf Park	Galveston
Jul 23 1994	offshore from Matagorda	Matagorda
Sep 19 2009	offshore from S. Padre Island	Cameron
Jul 7 2012	Padre Island NS	Kenedy
Sep 6 2013	San Jose Island N. Jetty	Aransas
Mar 8 2014	Matagorda Bay Nature Park Jetty	Matagorda
Jul 10 2016	1 Mi. S. Horace Caldwell Pier, Mustang Island	Nueces
Jul 18 2021	Galveston Jetties	Galveston
Mar 14 2022	Matagorda Bay Nature Park Jetty	Matagorda
Jan 1 2023	S. Padre Island	Cameron

Of the five museum specimens with gender data, three were males (testes = 3 × 2 [October] – 4 × 3 mm [June]) and two were females (ovaries = 10 × 4 mm [July] – 13 × 6 mm [June]; Table 1). The three birds with data for fat content ranged from emaciated to moderate fat levels, with mean mass

Figure 1. Sooty Shearwater specimen HMNS 4330 from Matagorda Beach (Matagorda County, Tx).

510 g (r = 400-597 g, N = 5; Table 1). Considering mean mass of 100 healthy specimens was 787 g, and the mass range was 666-978 g (Dunning 2008), it is likely that the Texas specimens were all in poor health, as their weight was significantly less ($X^2 = 29.93$, $P < 0.00001$).

Specific cause of death is unknown for the majority of these specimens, but several of the specimens were found dead on the beach. Specimen HMNS 4330 is a male with primarily pebbles in his crop, along with a 3 x 8 mm blue plastic shard. This specimen presented with a 6.2 × 2.4 cm laceration on the right ventral side of his abdomen, which likely was the ultimate cause of death; whether the piece of plastic attributed to the death of this young individual is unknown.

ACKNOWLEDGMENTS

Kind thanks to the individuals who salvaged the specimens for the Biodiversity Research and Teaching Collections, especially Tony Amos, over the years, and to Dana Simon for providing the salvaged specimen to HMNS. We thank John Berner and the eBird team for providing eBird data for Sooty Shearwater specimens from Texas. This is publication number 1676 of the Biodiversity Research and Teaching Collections, at Texas A&M University.

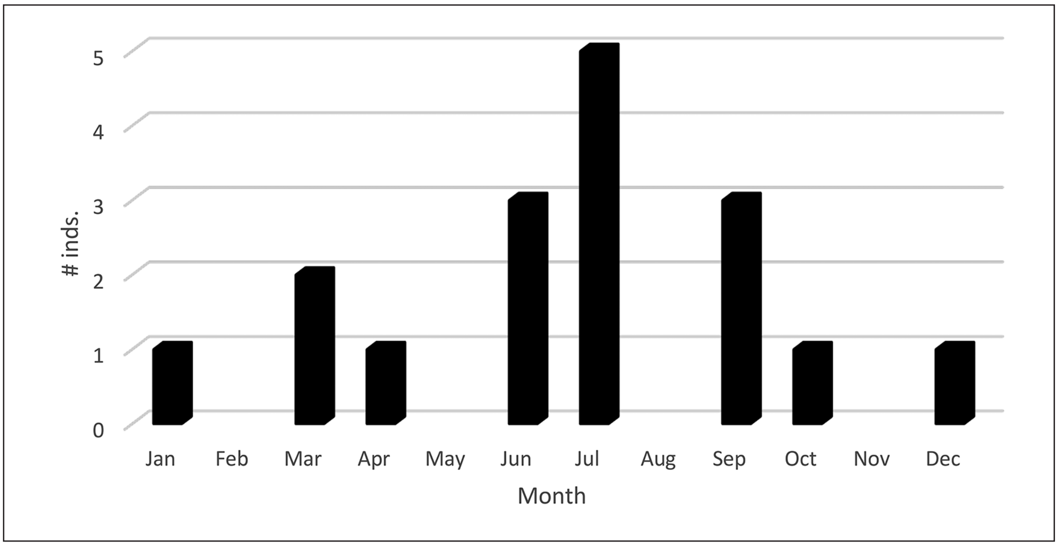

Figure 2. Monthly occurrence of Sooty Shearwaters from Texas using museum specimens and eBird data.

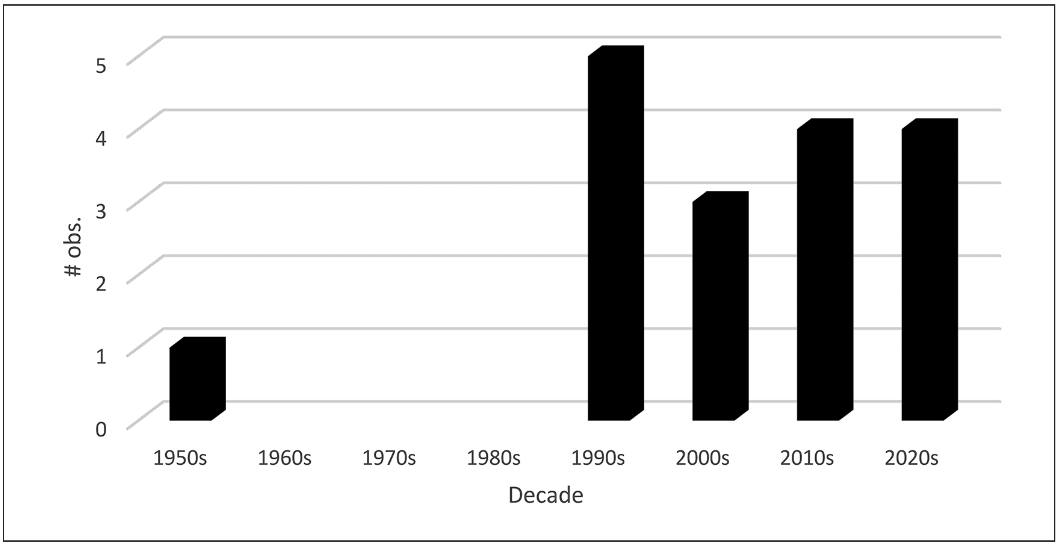

Figure 3. Sooty Shearwater occurrence from Texas waters by decade using museum specimens and eBird data.

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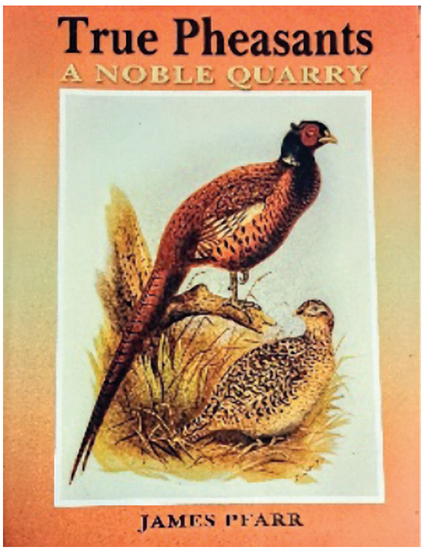
BOOK REVIEWS

TRUE PHEASANTS A NOBLE QUARRY

James Pfarr, Hancock House Publishers, 2012, 248 pages

Reviewer Ron Johnson



The group of pheasants commonly called True or Ringnecks, found in the genus *Phasianus*, are native to Asia but have been introduced to numerous countries around the world including the United States. *True Pheasants A Noble Quarry* is the most extensive, complete thesis on this extensive and not well understood genus which consists of two species and 33 subspecies. James Pfarr has traveled, domestically and internationally, to museums looking at skin preparations, taking detailed photos of each. His photographs of these skins, and live birds (mostly captive), are used as comparisons to differentiate the species and subspecies. Supplementing the photographs is the marvelous art work of nineteenth century masters Josef Wolf and Major Henry Jones, plus paintings by Josef Wolter.

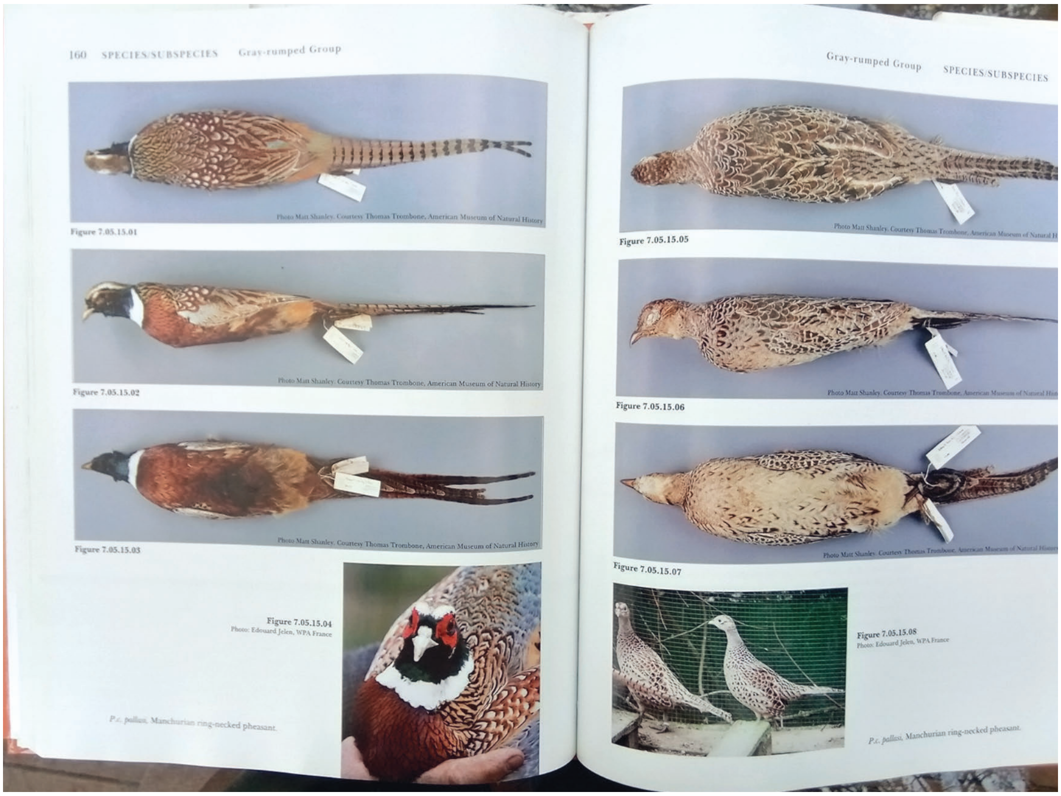
Phasianus are the most widely distributed of the Phasianidae, giving rise to the question "Why are there so many subspecies?" Museum skins are "natural time stamps," providing critical data for locality, dates of collection, and preserved specimen types, which can be used to collaborate field work and provide a base comparison for genetic research. This book identifies, describes, and gives location of each taxon to provide a phenotypic standard and identification, with discussions of geographic variability and barriers, ability for adaptation, variation vs. subspecies, and genetic continuity.

The focus of the book is identification—dividing the thirty *Phasianus colchicus* subspecies into five characteristic groups—Black-necked, Kirghiz, White-winged, Olive-rumped, and Grey-rumped. Each subspecies is given a chapter outlining traits of both cock and hen in straight forward bullet point identifiers, multiple museum skin photographs, plus range and integration with others, if known. This format, along with the live photos and paintings, allow the reader to clearly see the delineation and traits between subspecies. Having comparable taxa photographed together to show similar characteristics or differences would have aided the reader into seeing the subtleties between subspecies.

Defining valid subspecies is especially important today because, collectively *P. colchicus* is listed by IUCN as species of least concern - ignoring that some individual subspecies are from volatile areas where habitat destruction is rampant with increasing human populations, making them vulnerable.

Included is a chapter, written by Ralph G. Somes Jr. with permission from *Poultry Breeding and Genetics*, concerning the mutations and variations of the genus. The chapter also covers a synopsis of blood, tissue and egg protein research.

Additionally, there are chapters on Stockmanship, Facilities (captive management), Breeding, and Game Farms and Hunting Preserves. These chapters cover the logistics and management utilized by natural resource agencies and private hunting clubs to enhance populations making the *Phasianus* a



Sample plates from the book.

“Noble Quarry” and one of the most sought-after hunting species in the United States.

Listed in the Appendix are 16 beautiful color plates by Major Henry Jones (1838-1921), depicting *Phasianus* males and females in their natural habitat. Jones was an extremely accomplished bird artist, with the Zoological Society of London having over 1200 of his paintings.

True Pheasants A Noble Quarry ends with a list of Related Reading and Resources, a Bibliography, and an Index of Common Names. The book is well organized, written, and illustrated for those who have an interest in the taxonomy, geographic locations, and descriptions of the genus *Phasianus*. It has become the standard for phenotypic bird studies.

BULLETIN OF THE TEXAS ORNITHOLOGICAL SOCIETY GUIDELINES FOR AUTHORS

SUBMISSION

For initial submission, e-mail one copy of the manuscript and photographs/illustrations[1] to jclintoneitniear@gmail.com or mail to Jack C. Eitniear, 218 Conway Drive, San Antonio, Texas 78209-1716. If you do not have access to the internet mail a DVD or CD containing a word processor version (MS WORD 2015 preferred or Apache Open Office 4.1) of the manuscript with all figures and tables, as separate documents

Submission Categories.—Manuscripts may be submitted as a Major Article or Short Communication. Major Articles generally are longer papers that are >5,000 character count including literature cited and figure captions, and excluding tables, figures, and spaces between characters. Manuscripts <5,000 characters in length including literature cited and figure captions, and excluding tables, figures, and spaces between characters will be considered Short Communications. Major articles must include an Abstract. The Editor may move a paper from one category to another at his discretion.

Multi-authored Submissions.—All authors should have contributed in a significant manner to designing and performing the research, writing the manuscript, and reading and approving the manuscript prior to submission.

Non-U.S. Submissions.—Authors whose native language is not English should ensure that colleagues fluent in English have critically reviewed their manuscript before submission.

GENERAL INSTRUCTIONS

(Carefully read and follow these instructions before submitting your manuscript. Papers that do not conform to these guidelines will be returned.)

Prepare manuscripts on 8.5 X 11 inch format with 1-inch margins. Double-space all text, including literature cited, figure captions, and tables. Insert page numbers top right beginning on the second page. Use a font size of at least 11 point. Consult a recent issue of the journal for correct format and style as you prepare your manuscript.

Write in the active voice whenever possible. Use U.S. English and spelling. Use *italics* instead of underlining (i. e., scientific names, third-level headings, and standard statistical symbols). Use Roman typeface (**not boldface**) throughout the manuscript.

Common and scientific names of bird species that occur in North and Middle America should follow the AOU *Check-list of North American Birds* (1998, 7th ed., and its supplements. Reference http://www.americanornithology.org/content/checklist-north-and-middle-american-birds. Names for other bird species should follow an appropriate standard (cite standard used). Use subspecific identification and list taxonomic authorities only when relevant. Give the scientific name at first mention of a species in the abstract and in the body of the paper. Capitalize common names of birds except when referred to as a group (i. e., Northern Cardinal, Golden-cheeked and Yellow warblers, vireos). Do not italicize family names.

The common names of other organisms are lower case except for proper names (i. e., yellow pine, Ashe juniper, Texas kangaroo rat).

Cite each figure and table in the text. Sequence tables and figures in the order cited. Use “figure” only outside of parentheses; otherwise, use “Fig.” if singular, “Figs.” if plural (i. e., Fig. 1, Figs. 2–3). To cite figures or tables from another work, write figure, fig., or table in lowercase (i. e., figure 2 in Jones 1980; Jones 1980:fig. 2; Jones 1987: table 5).

Use the following abbreviations: d (day), wk (week), mon (month), yr (year), sec (second), min (minute), h (hour); report temperature as °C (i. e., 15° C). In text months should be abbreviated (Jan, Feb, Mar, Apr, etc.) in figures and tables. Define and write out acronyms and abbreviations the first time they appear in text; abbreviate thereafter: “Second-year (SY) birds . . . We found SY birds in large numbers.”

Present all measurements in metric units. Use continental dating (i. e., 15 August 2007), the 24-hour clock (i. e., 0500, 1230), and local standard time. Specify time as Standard Time (i. e., CST for Central

[1]Due to file restrictions by most e-mail systems we ask that you contact the editor regarding the best means to provide graphic support.

Standard Time) at first reference to time of day. **Study site location(s) should be identified by latitude and longitude.** Present latitude and longitude with one space between each element (i. e., 28° 07' N, 114° 31'W). If latitude and longitude are not available indicate the distance and direction from the nearest permanent location. Abbreviate and capitalize direction (i. e., north = N, southwest = SW, or 5 km W Abilene, Taylor County [but Taylor and Bexar counties]). Also capitalize regions such as South Texas or Southwest United States.

Numbers.—The conventions presented here revise what has often been called the "Scientific Number Style (SNS)". The SNS generally used words for 1-digit whole numbers (i.e., 9 = nine) and numerals for larger numbers (i.e., ten = 10), a distinction that may be confusing and arbitrary. The revised SNS treats numbers more consistently by extending the use of numerals to most single-digit whole numbers that were previously expressed as words. This style allows all quantities to be expressed in a single manner, and because numerals have greater visual distinctiveness than words, it increases the profile of quantities in running text. The objective of emphasizing quantity with numerals is further facilitated by the use of words for numbers appearing in a context that is only secondarily quantitative, i.e., when a number's quantitative function has been subordinated to an essentially nonquantitative meaning or the number is used idiomatically. In these cases, use words to express numbers (i.e., the sixty-four-dollar question). However, the numbers zero and one present additional challenges. For these numbers, applying consistent logic (numerals for quantities and words otherwise) often increases tedium in making decisions about correct usage and creates an inconsistent appearance, primarily because "one" has a variety of functions and readers might not quickly grasp the logic. For example, "one" can be used in ways in which quantity is irrelevant: as a personal pronoun or synonym for "you" (i.e., "one must never forget that") or as an indefinite pronoun ("this one is preferred"). The usage of the numeral in these cases would possibly be confusing to a reader. "Zero" and "one" are also used in ways that are more like figures of speech than precise quantifications (i.e., "in one or both of the ….", "in any one year", "a zero-tolerance policy"). In addition the numeral"1" can be easily confused with the letters "l" and "I", particularly in running text, and the value"0" can be confused with the letter "O" or "o" used to designate a variable. Therefore simplicity and consistent appearance have been given priority for these 2 numbers.

Cardinal Numbers.—quantitative elements in scientific writing are of paramount importance because they lead the way to the findings. Use numerals rather than words to express whole and decimal numbers in text tables and figures. This practice increases their visibility and distinctiveness and emphasizes their enumerative function.

2 hypotheses   5 birds   65 trees   0.5 mm   5 times   8 samples Also use numerals to designate mathematical relationships.

6:1   at 200X magnification   5-fold not five-fold

Use words in to represent numbers in 4 categories of exceptions:

(1) If a number begins a sentence, title, or heading, spell out the number or reword the sentence so the number appears elsewhere in the sentence.

Five eggs were in the nest, but the typical clutch size is 12. The nest contained 5 eggs, but the typical clutch size is 12.

(2) When 2 numbers are adjacent, spell out the first number and leave the second as a numeral or reword the sentence.

The sample area was divided into four 5 ha plots.

I divided my sample area into 4 plots containing 5 ha.

(3) For most general uses, spell out zero and one.

one of the species   was one of the most important   on the one hand values approaching zero   one peak at 12-14 m, the other at 25-28 m.

However, express the whole numbers zero and one as numerals when they are directly connected to a unit of measure or a calculated value.

1 week   1 m   a mean of 0   1-digit numbers   when $z = 0$

Similarly, express zero and one as numerals when part of a series or closely linked to other numbers.

1 of 4 species   between 0 and 5   of these, 4 samples were…1 sample was… and 8 samples

(4) When a number is used idiomatically or within a figure of speech.

the one and only reason   a thousand and one possibilities   comparing one to the other the two of them   one or two of these   an extra week or two of growth.

Ordinal Numbers

Ordinal numbers usually convey rank order, not quantity. Rather than expressing how many, ordinals often describe what, which, or sequence. Ordinals are more prose oriented than quantitative within the text and it is less important to express ordinal numbers as numerals.

(1) Spell out single-digit ordinals used as adjectives or adverbs.

the third chick hatched   first discovered   a third washings   for the seventh time

(2) The numeric form of 2-digit ordinals is less confusing, so express larger ordinals as numerals.

the 20th century   for a 15th time   the 10th replication   the 50th flock

(3) Express single digit ordinals numerically if in a series linked with double-digit ordinals.

The 5th, 6th, 10th, and 20th hypotheses were tested or We tested hypotheses 5, 6, 10, and 20

Zeros before Decimals.

For numbers less than 1.0, always use an initial zero before the decimal point.

0.05 not .05   P = 0.05 not P = .05

Numbers Combined with Units of Measure

(1) Use a single space to separate a number and a subsequent alphabetic symbol

235 g   1240 h   8 mm

(2) Generally close up a number and a non alphabetic symbol whether it precedes or follows the number. 45° for angles   45 °C for temperature   ±9   35±   <5 but P < 0.001

(3) Geographic coordinate designation for latitude and longitude have a space between each unit. 35º 44' 77" N

(4) If the number and associated symbol or unit start a sentence, spell out the number and associated factor. Twenty-five percent of nests

Numeric Ranges, Dimensions, Series, and Placement of Units

(1) When expressing a range of numbers in text, use the word to or through to connect the numbers. Alternatively, an en dash, which means to may be us3ed but only between 2 numbers that are not interrupted by words, mathematical operators, or symbols.

Yielded −0.3 to +1.2 differences not −0.3−+1.2 differences 5 July to 20 July or 5-20 July not 5 July-20 July 1-12 m not 1 m – 12 m

(2) When the word from precedes a range, do not substitute the en dash for to. From 3 to 4 nests not from 3-4 nests

(3) The en dash represents only the word "to", when between precedes a range, use "and" between the numbers.

between 5 and 18 March not between 5-18 March

(4) When the range includes numbers of several digits, do not omit the leading digits from the second number in the range.

between 2001 and 2012 not between 2001 and 12 nor 2001-12   1587-1612 m not 1587-12 m

(5) A range of numbers and the accompanying unit can be expressed with a single unit symbol after the second number of the range, except when the symbol must be closed up to the number (i.e., percent symbol) or the unit symbol may be presented with both numbers of the range.

5 to 12 cm or 5 cm to 12 cm   5 to 10 °C or 5 °C to 10 °C   20% to 30% or 20-30% not 20 to 30%

(6) If a range begins a sentence, spell out the first number and present the second as a numeral; however if a nonalphabetic symbol (%), write out both units.

Twelve to 15 ha not twelve to fifteen ha   Ten percent to 20 percent of samples not Ten percent to 20% of samples

(7) To prevent misunderstanding, avoid using "by" before a range; this may imply an amount change from an original value, rather than a range of values. growth increased 0.5 to 0.8 g/d (a range) or growth increased 0.5-0.8 g/d not growth increased by 0.5-0.8 g/d

(8) To prevent a wrong conclusion by a reader, do not express 2 numbers preceded by words like "increase", "decrease", or "change". A range may be intended but the reader may conclude the first value as an initial value and the second as a new value.

increased from 2 cm/wk to 5 cm/ wk (Was the increase 2-5 cm or was the increase 3 cm?)
When changes are from one range to a new range, en dashes within each range is a better statement.
increased from 10-20 m to 15-30 m

(9) For dimensions, use a mathematical symbol (not a lower case “x”) or the word “by” to separate the measurements.
5 X 10 X 20 cm 5 cm X 10 cm X 20 cm 5 by 10 by 20 cm

(10) For a series of numbers, present the unit after the last numeral only, except if the unit symbol must be set close to the number.
5, 8, 12, and 20 m diameters of 6 and 8 mm 12%, 15%, and 25% categories of <2, 2-4, and > 6 km

Descriptive Statistics

Variables are often reported in the text: the units and variability term should be unambiguous.
mean (SD) = 20% (2) or Mean of 20% (SD 2) mean of 32 m (SD 5.3) not mean of 32 ± 5.3 m
mean of 5 g (SD ± 0.33) mean (SE) = 25 m (0.24)

MANUSCRIPT

Assemble a manuscript for Major Articles in this sequence: title page, abstract, text (introduction, methods, results, and discussion), acknowledgments, literature cited, tables, figure captions, and figures. Short Communications need not be subdivided into sections (optional).

Title Page.—Put title in all caps for a Major Article and a Short Communication. Follow with author name(s) with the first letter of the first name, middle initial and last name as a cap and all other letters in lower case.

Addresses of author(s) should be in italics and arranged from first to last at the time of the study. The current address (if different from above) of each author (first to last), any special essential information (i. e., deceased), and the corresponding author and e-mail address should be in a footnote. Use two-letter postal codes (i. e., TX) for U.S. states and Canadian provinces. Spell out countries except USA. Consult a recent issue if in doubt.

Abstract.—Heading should be caps, indented, and followed by a period, three dashes, and the first sentence of the abstract (ABSTRACT.—Text . . .). Only Major Articles have an abstract.

Text.—Text, except for headings, should be left justified. Indent each paragraph with a 0.5-inch tab. Text should began immediately after the abstract.

Up to three levels of headings may be used. First level: centered, all caps (includes METHODS, RESULTS, DISCUSSION, ACKNOWLEDGMENTS, and LITERATURE CITED). There is no heading for the Introduction. Second level: flush left, indent, capitalize initial letter of significant words and italicize all words. Third level: flush left, indent, capitalize the initial letter of each word, followed by a period, three dashes, and then the text. *Keep headings to a minimum*. Major Articles typically contain all first-level headings. Short Communications may or may not have these headings, depending on the topic and length of paper. Typical headings under Methods may include “Study Area” and “Statistical Analyses.” Consult a recent issue for examples.

METHOD—First level
Study Species, Locations, and Recordings—Second level
Study Species, Locations, and Recordings—Third level

Each reference cited in text must be listed in Literature Cited section and vice versa. The exception is unpublished materials, which occur only in the text. Cite literature in text as follows:

- One author: Jones (1989) or (Smith 1989).
- Two authors: Jones and Smith (1989) or (Jones and Smith 1989)
- Three or more authors: Smith et al. (1989) or (Smith et al. 1989)

- Manuscripts accepted for publication but not published: Smith (in press), (Jones in press) or Jones (1998) if date known. "In Press" citations must be accepted for publication, with the name of journal or publisher included.
- Unpublished materials, including those in preparation, submitted, and in review:
  (1) By submitting author(s) use initials: (JTB unpubl. data), JTB (pers. obs.),
  (2) By non-submitting author(s): (J. T. Jones unpubl. data), (J. T. Jones and J. C. Smith pers. obs.), or J. T. Jones (pers. comm.). Do not use (J. T. Jones et al. unpubl. data); cite as (J. T. Jones unpubl. data).
- Within parentheses, order citations by date: (Jones 1989, Smith 1992, Franklin et al. 1996), (Franklin 1980; Jones 1983, 1990; Smith and Black 1984), (Delgado 1988a, b, c; Smith 2000).
- When citing a direct quote, insert the page number of the quote after the year: (Beck 1983:77).

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