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

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

Delanie E. Slifka[1,6] April A. T. Conkey[1], Leonard A. Brennan[1], Humberto L. Perotto-Baldivieso[1], Fidel Hernández[1], Janel L. Ortiz[2], Maia L. Lipschutz[3], Andrea Montalvo[5], Tom Langschied[4]

[1] Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Kingsville, TX 78363, USA.
[2]Center for Excellence in Mathematics and Science Teaching and Department of Biological Sciences, California State Polytechnic University-Pomona, Pomona, CA, 91768, USA
[3] Air Force Civil Engineer Center, Beale AFB, CA 95903
[4] 928 Lyndale St, Kingsville, TX, 78363, USA
[5] East Foundation, Hebbronville, TX, 78361, USA

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

[4] E-mail: dslifka14@gmail.com

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

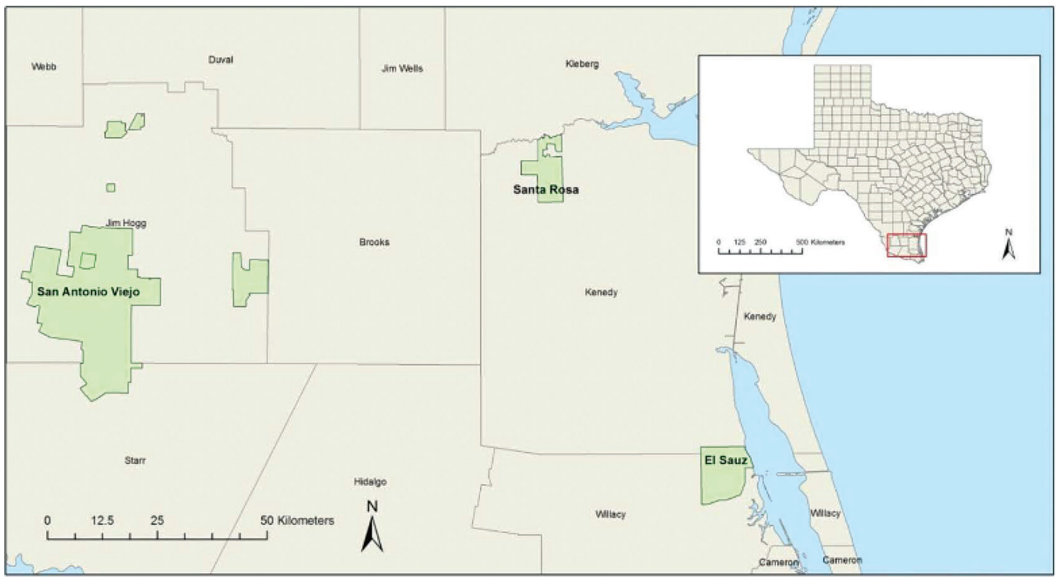

Figure 1. Map of East Foundation Properties

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 ($\alpha = 0.05$), 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

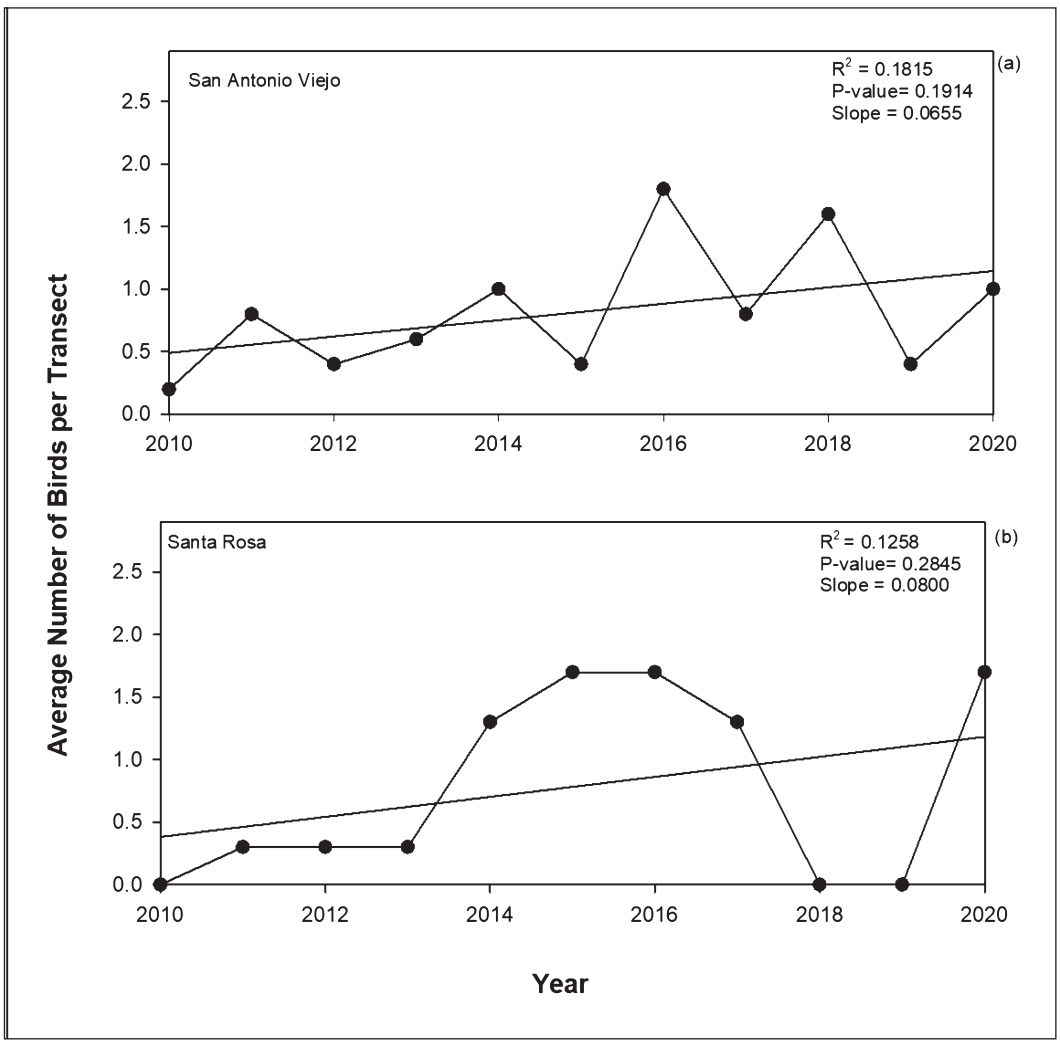

Figure 2. Non-breeding populations of Loggerhead Shrike on East Foundation ranches from 2010-2020.

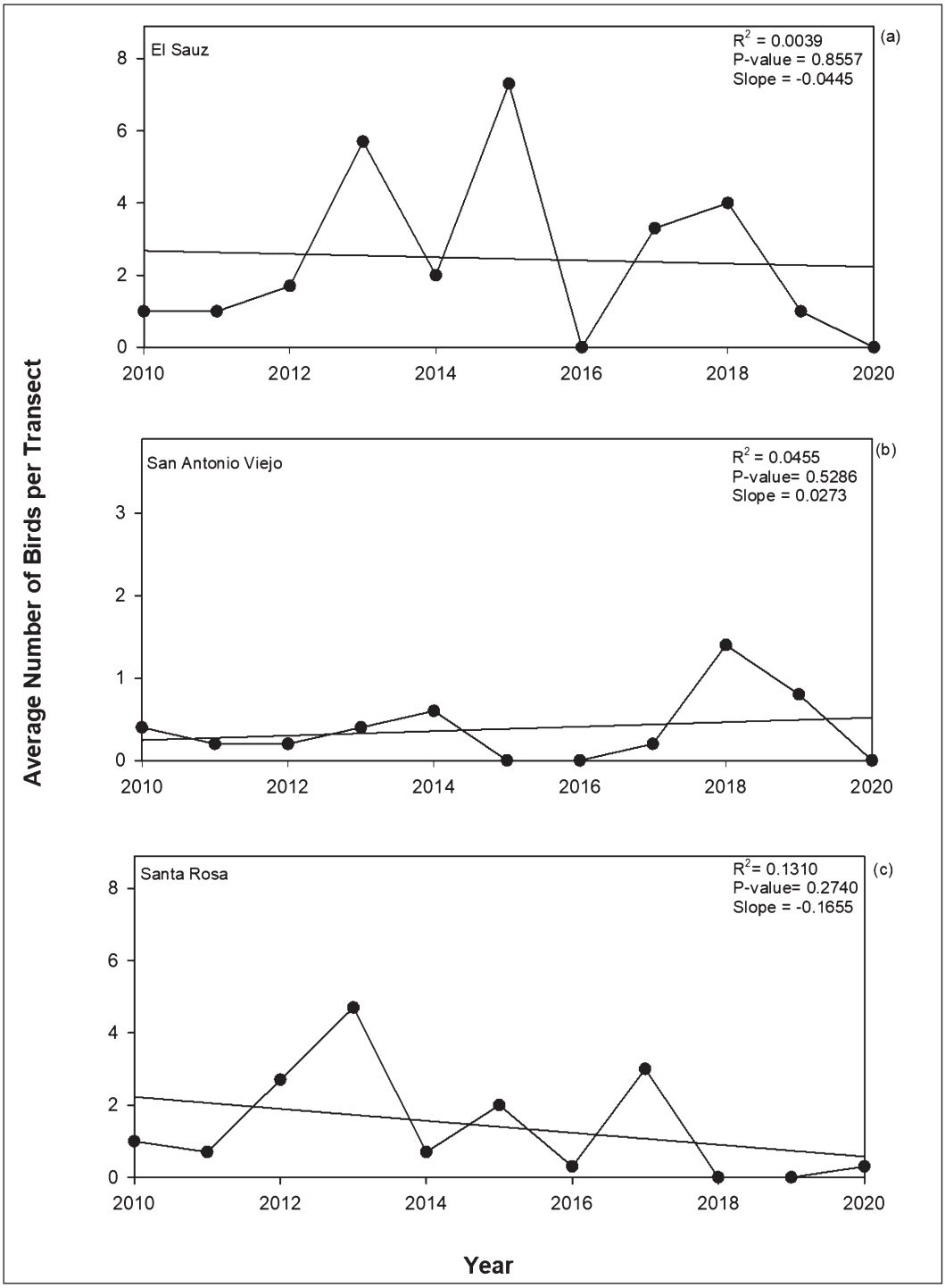

Figure 3. Non-breeding populations of Brown-crested Flycatcher on East Foundation ranches from 2010-2020.

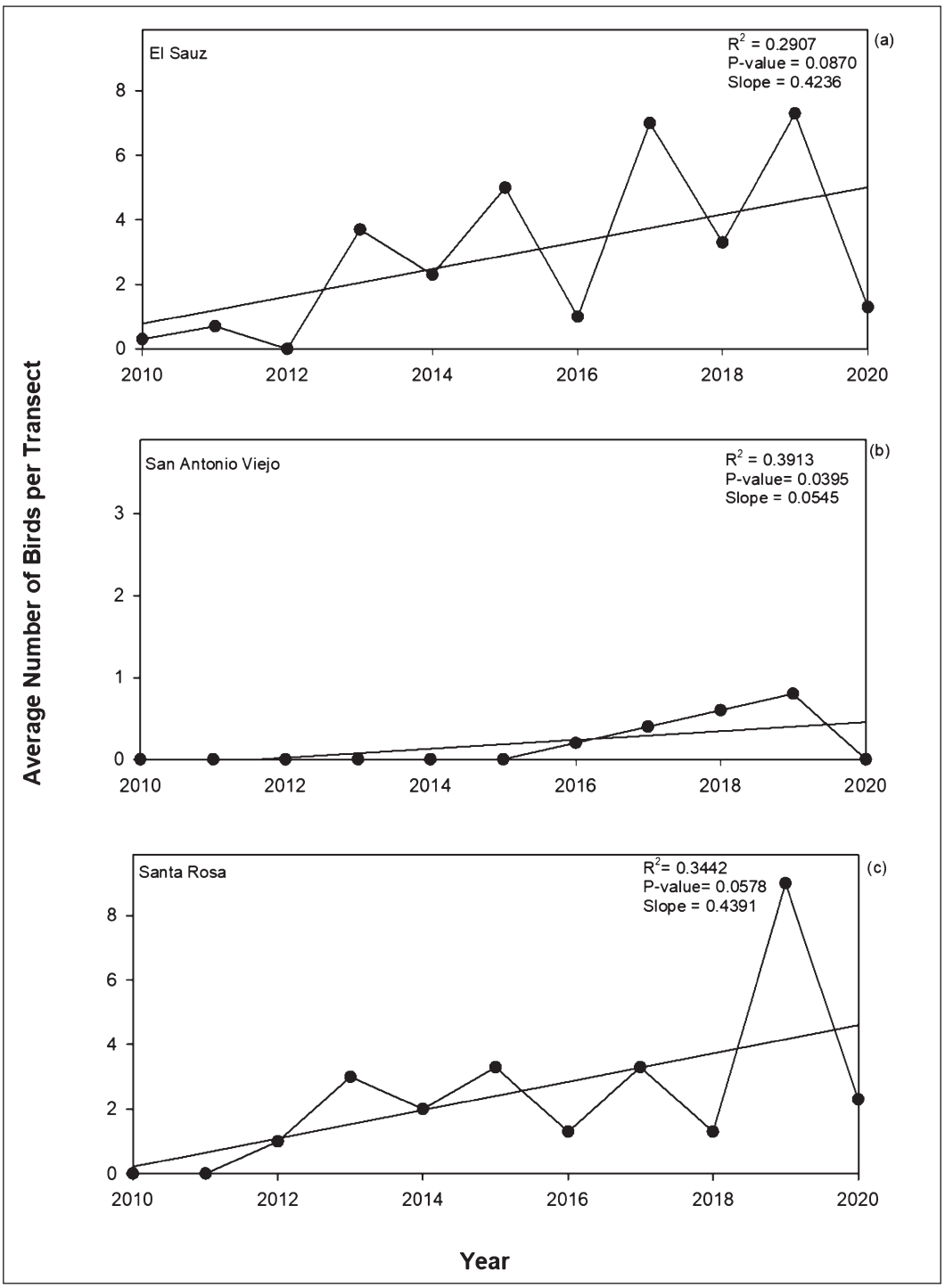

Figure 4. Non-breeding populations of Couch's Kingbird on East Foundation ranches from 2010-2020.

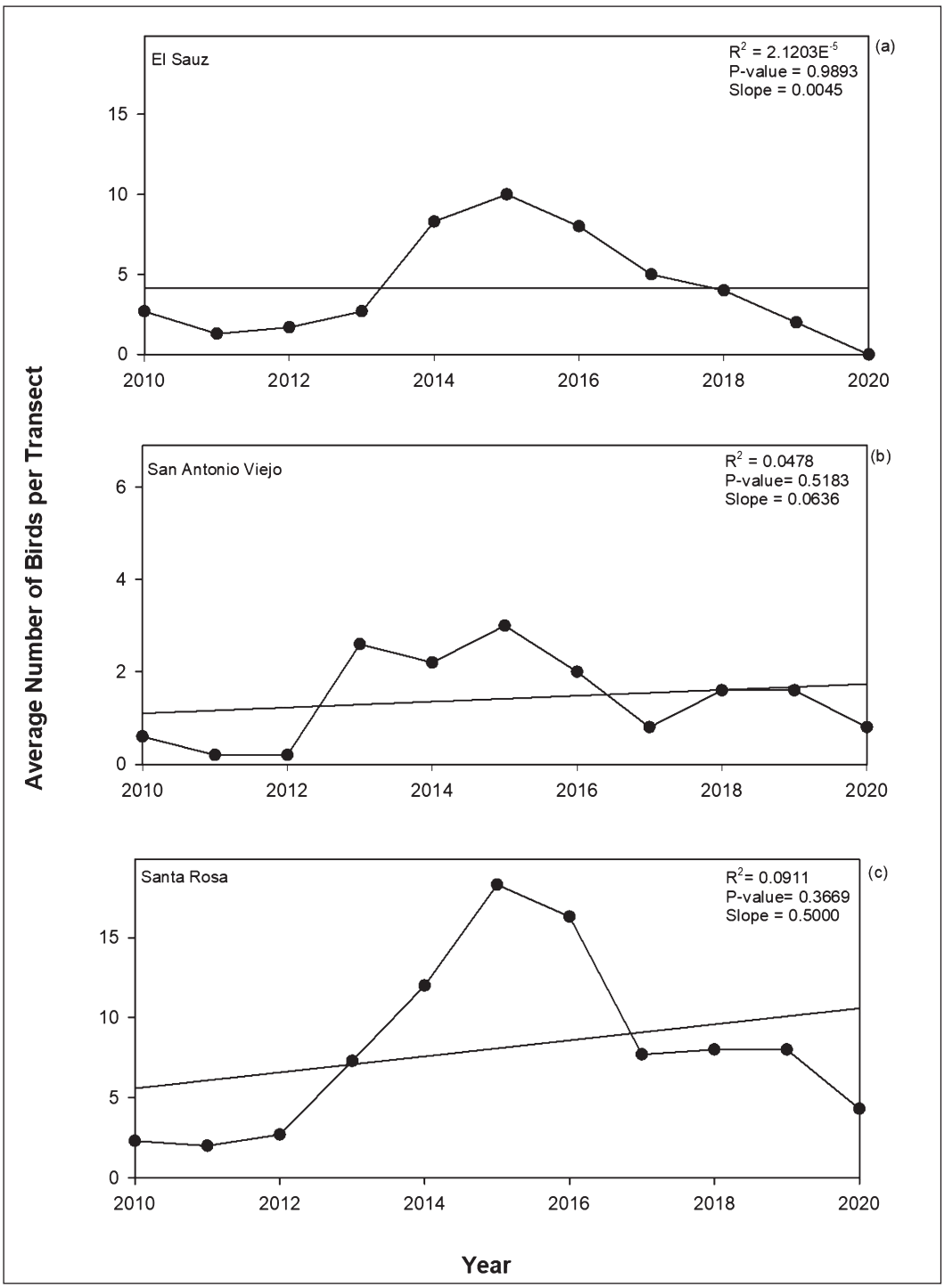

Figure 5. Non-breeding populations of Eastern Phoebe on East Foundation ranches from 2010-2020.

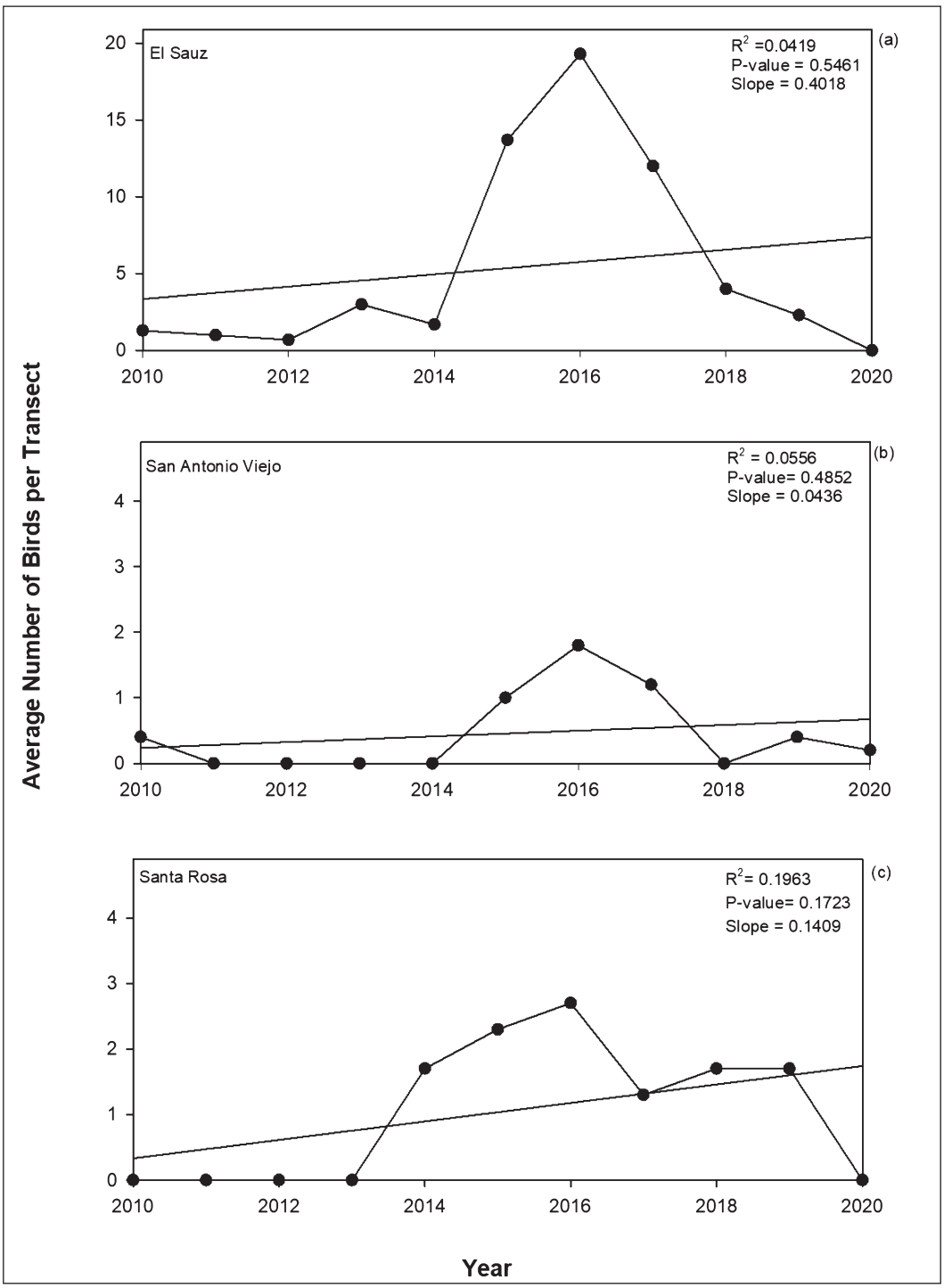

Figure 6. Non-breeding populations of Great Kiskadee on East Foundation ranches from 2010-2020.

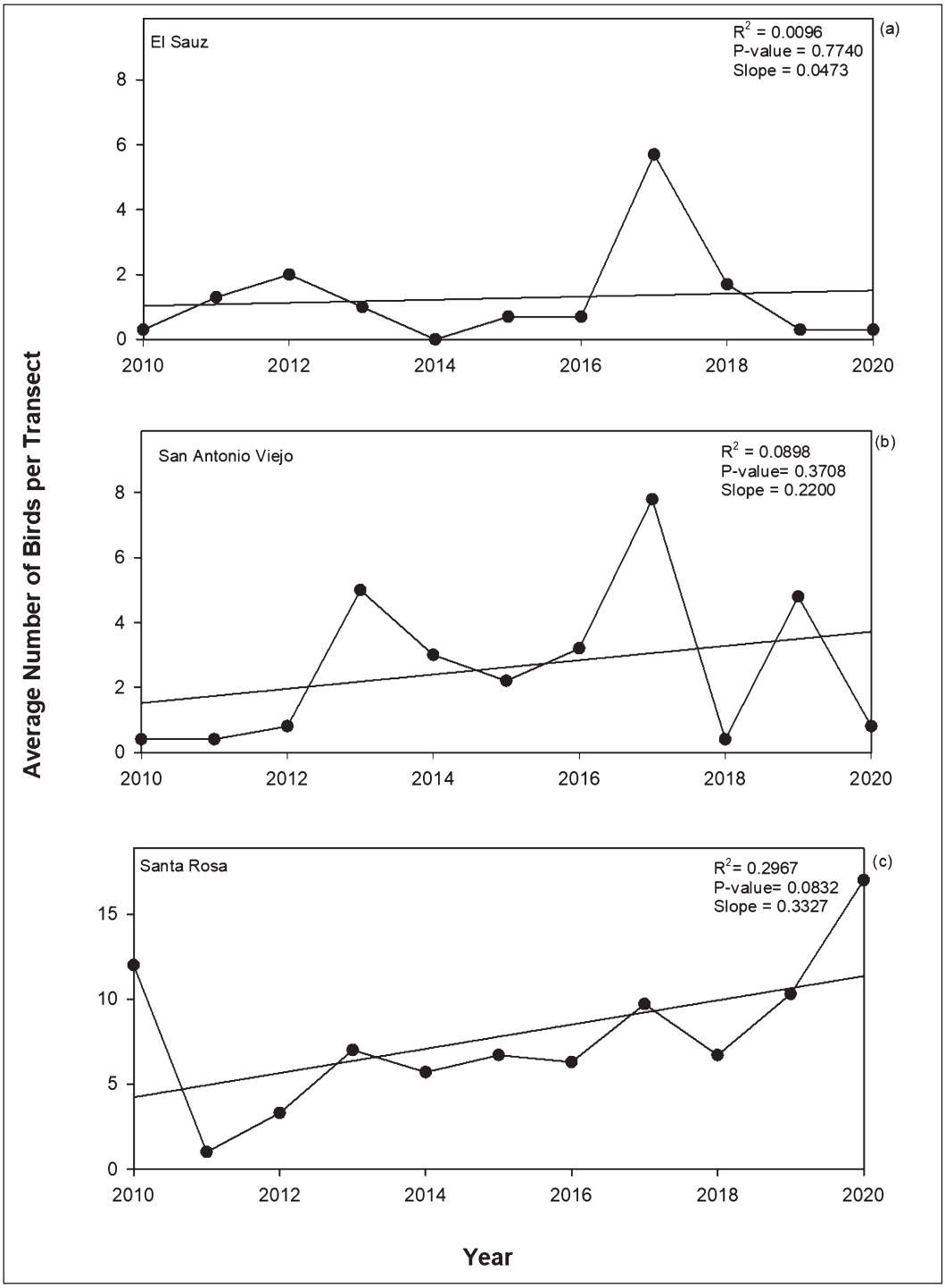

Figure 7. Non-breeding populations of Scissor-tailed Flycatcher on East Foundation ranches from 2010-2020.

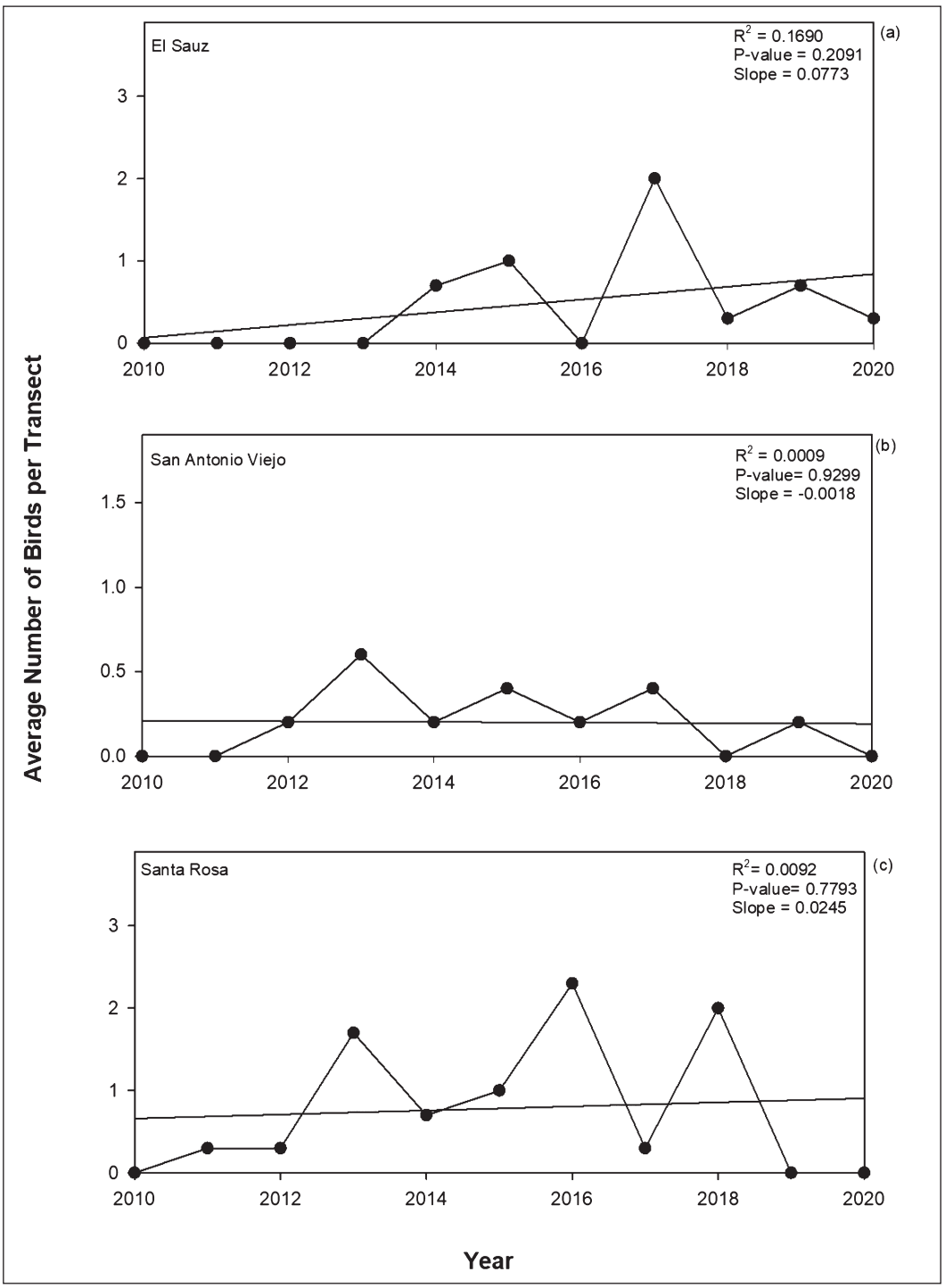

Figure 8. Non-breeding populations of Vermilion Flycatcher on East Foundation ranches from 2010-2020.

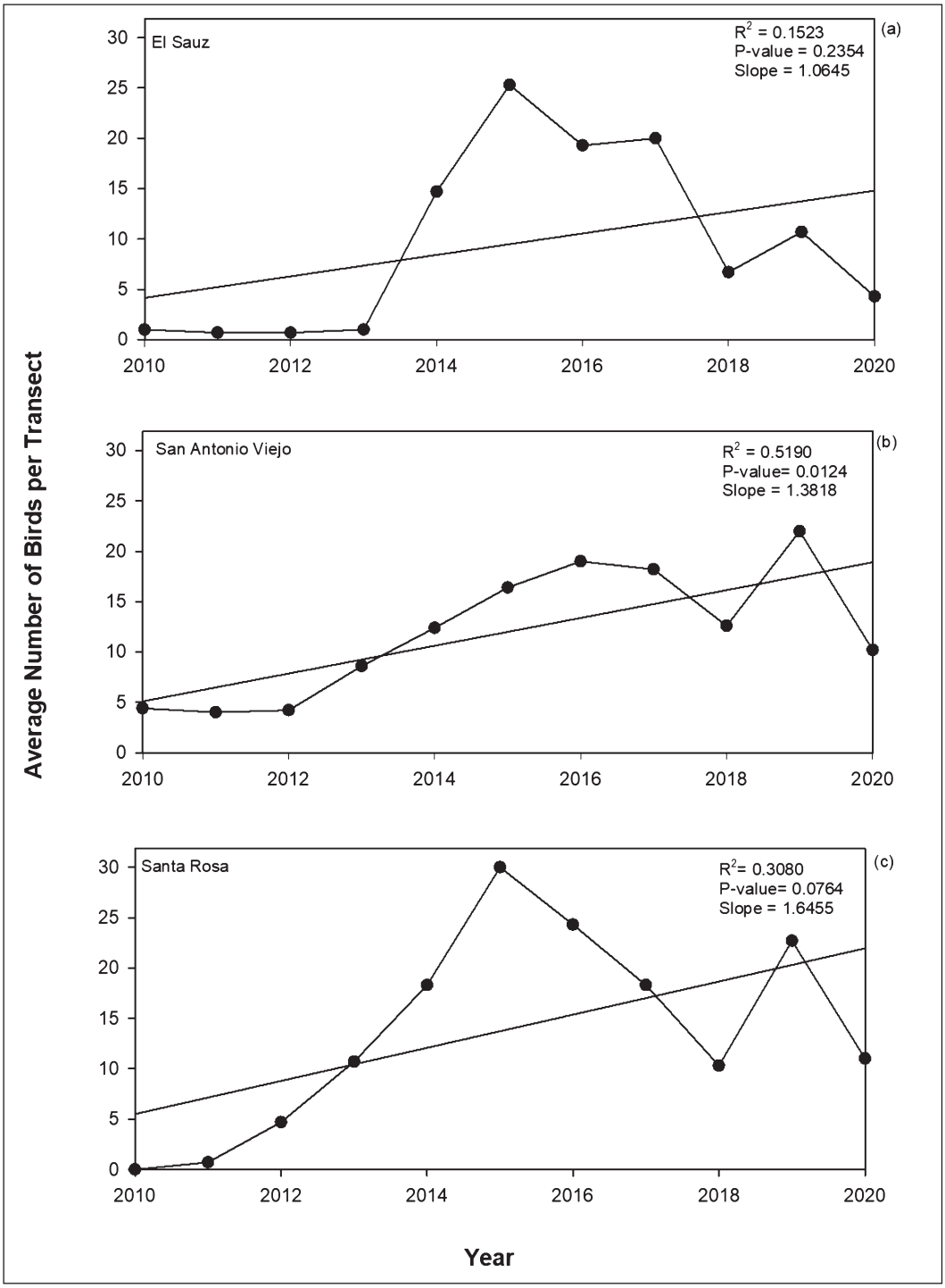

Figure 9. Non-breeding populations of Golden-fronted Woodpecker on East Foundation ranches from 2010-2020.

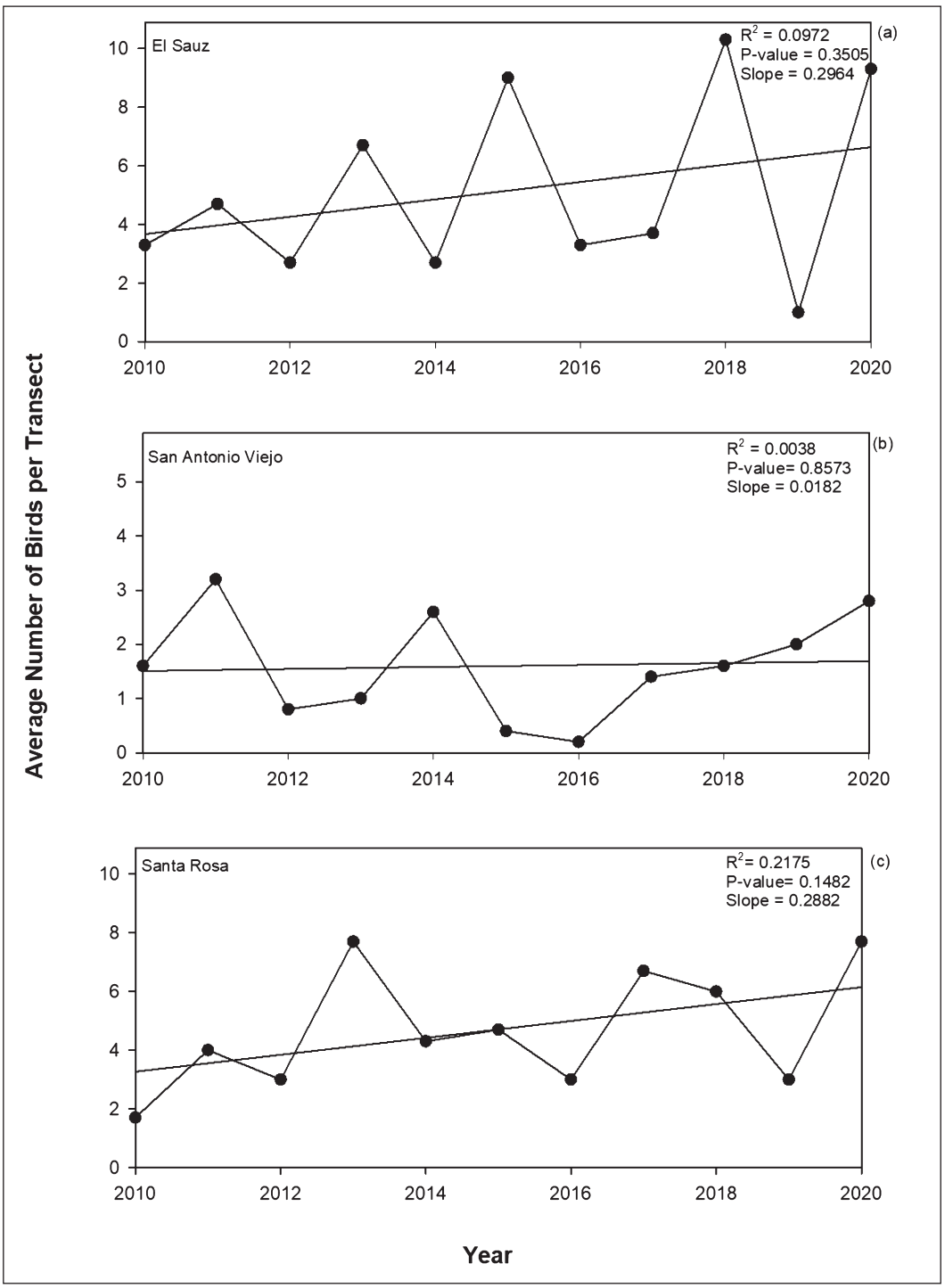

Figure 10. Non-breeding populations of Ladder-backed Woodpecker on East Foundation ranches from 2010-2020.

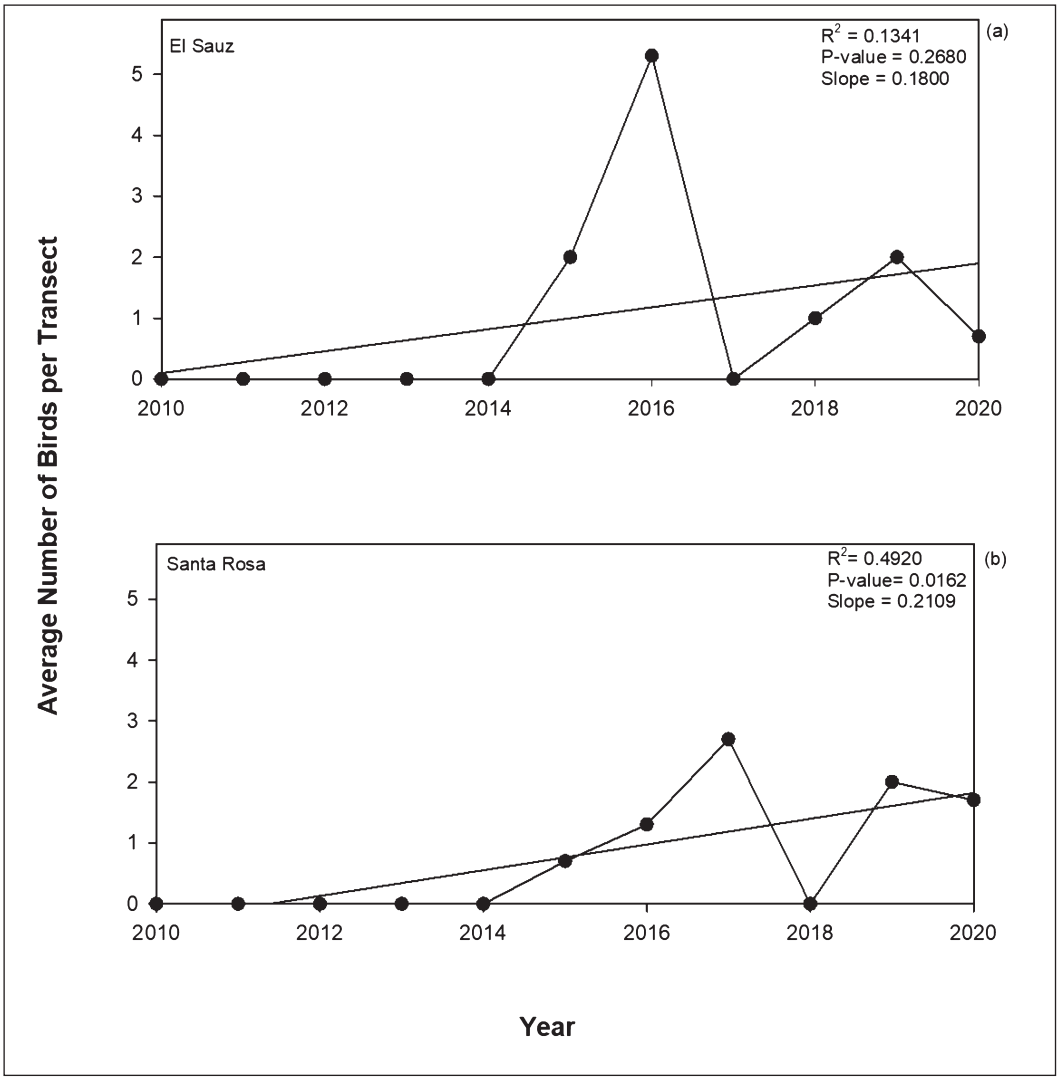

Figure 11. Non-breeding populations of Black-bellied Whistling-Duck on East Foundation ranches from 2010-2020.

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.

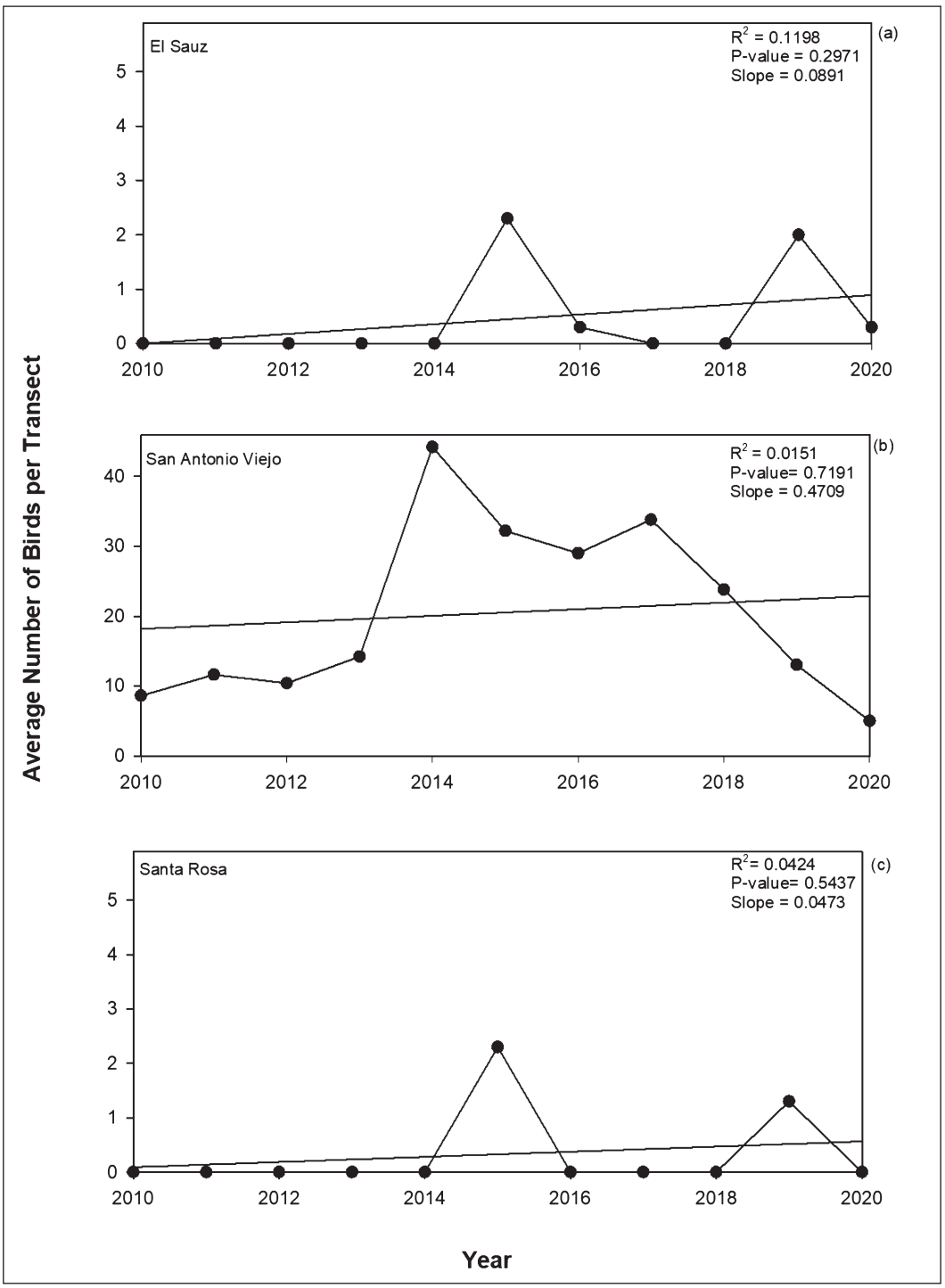

Figure 12. Non-breeding populations of Black-throated Sparrow on East Foundation ranches from 2010-2020.

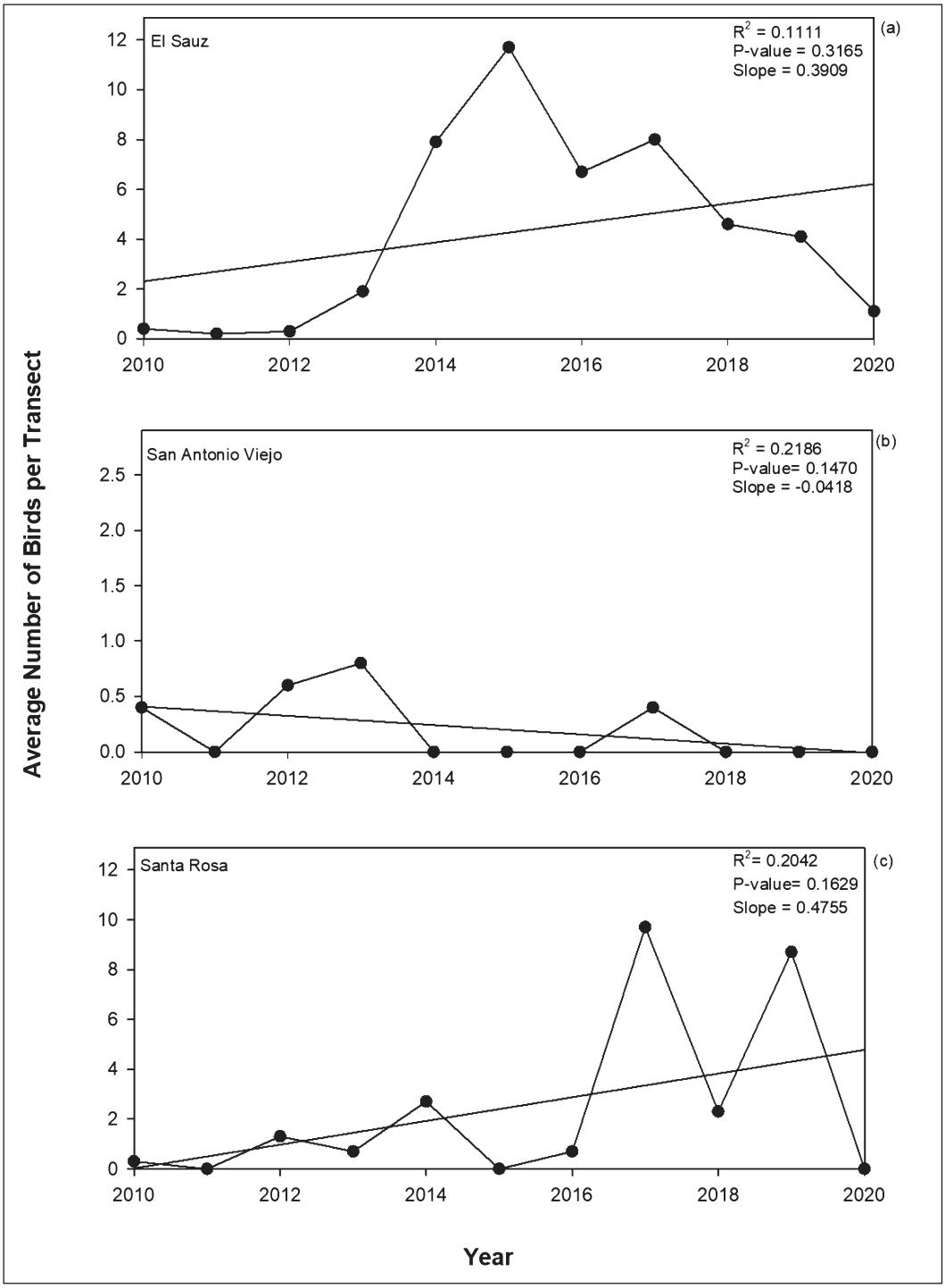

Figure 13. Non-breeding populations of Bronzed Cowbird on East Foundation ranches from 2010-2020.

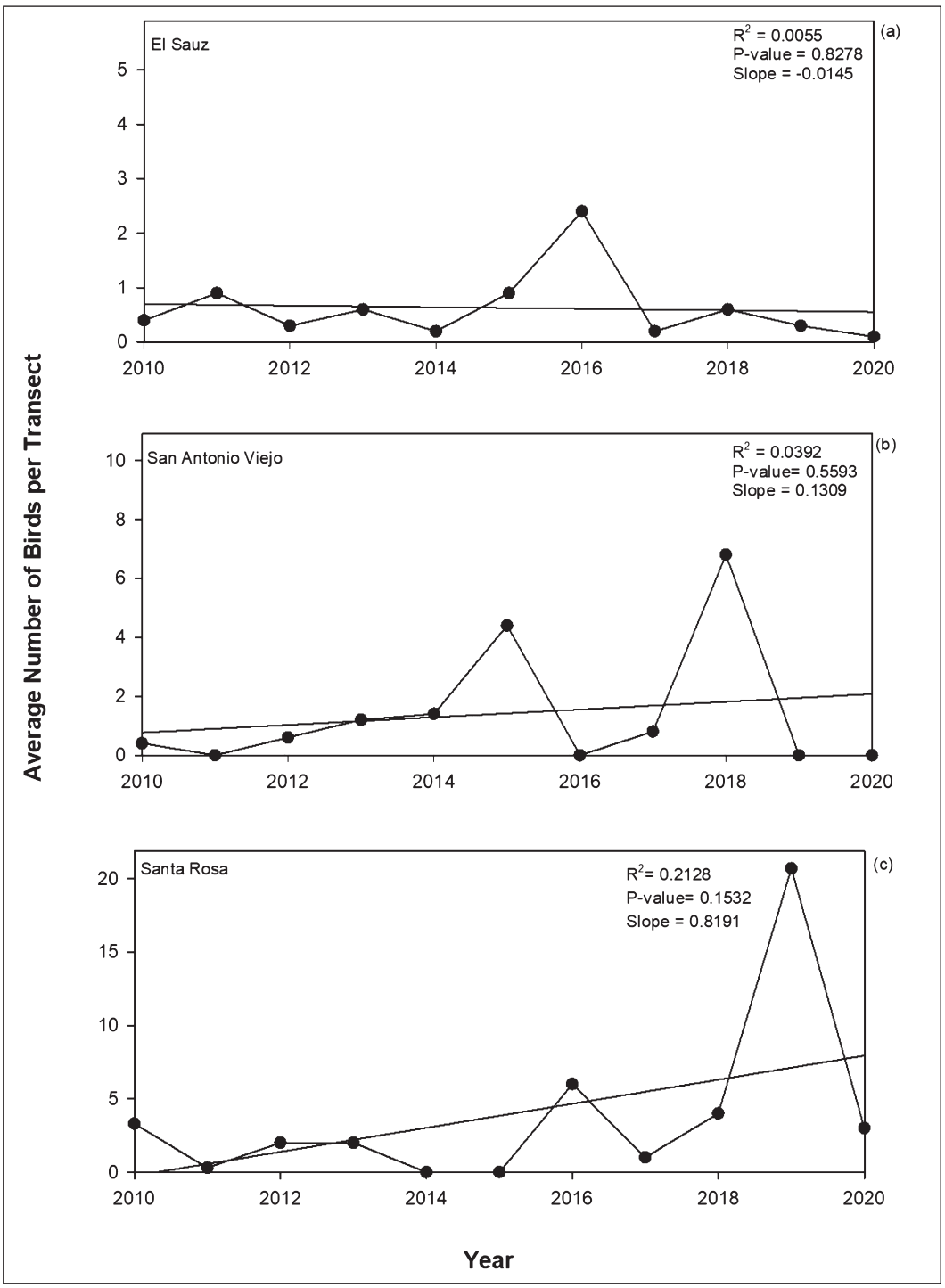

Figure 14. Non-breeding populations of Brown-headed Cowbird on East Foundation ranches from 2010-2020.

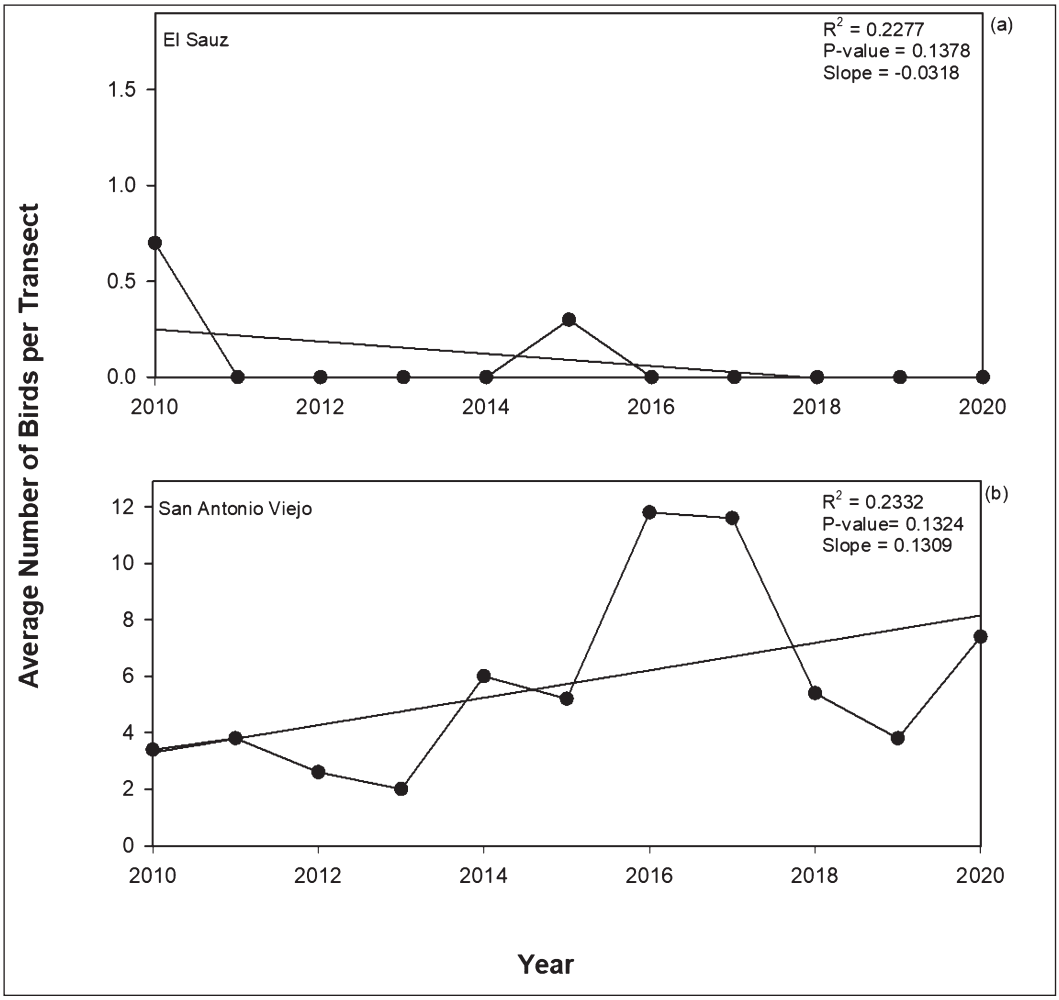

Figure 15. Non-breeding populations of Cactus Wren on East Foundation ranches from 2010-2020.

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

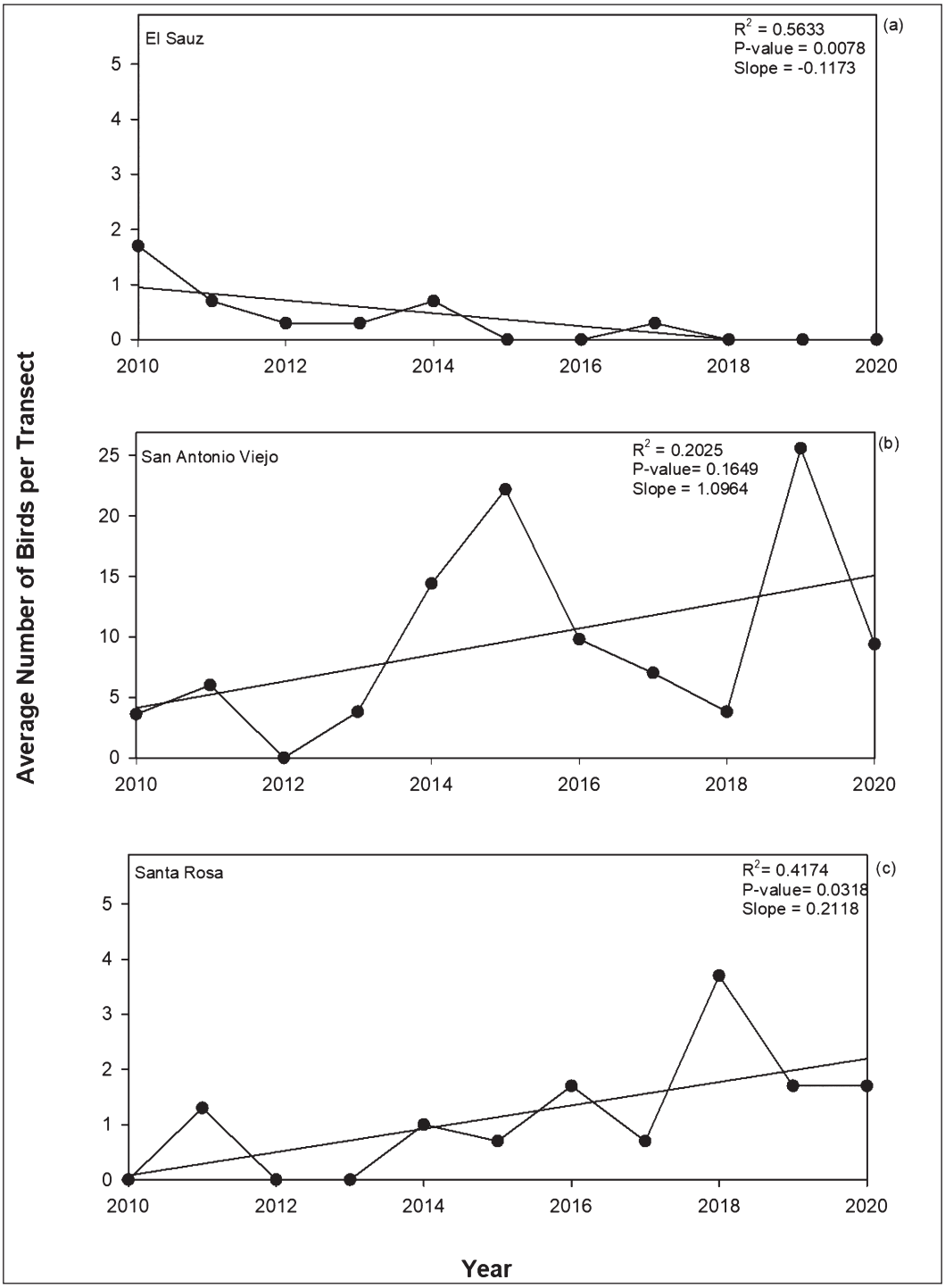

Figure 14. Non-breeding populations of Brown-headed Cowbird on East Foundation ranches from 2010-2020.

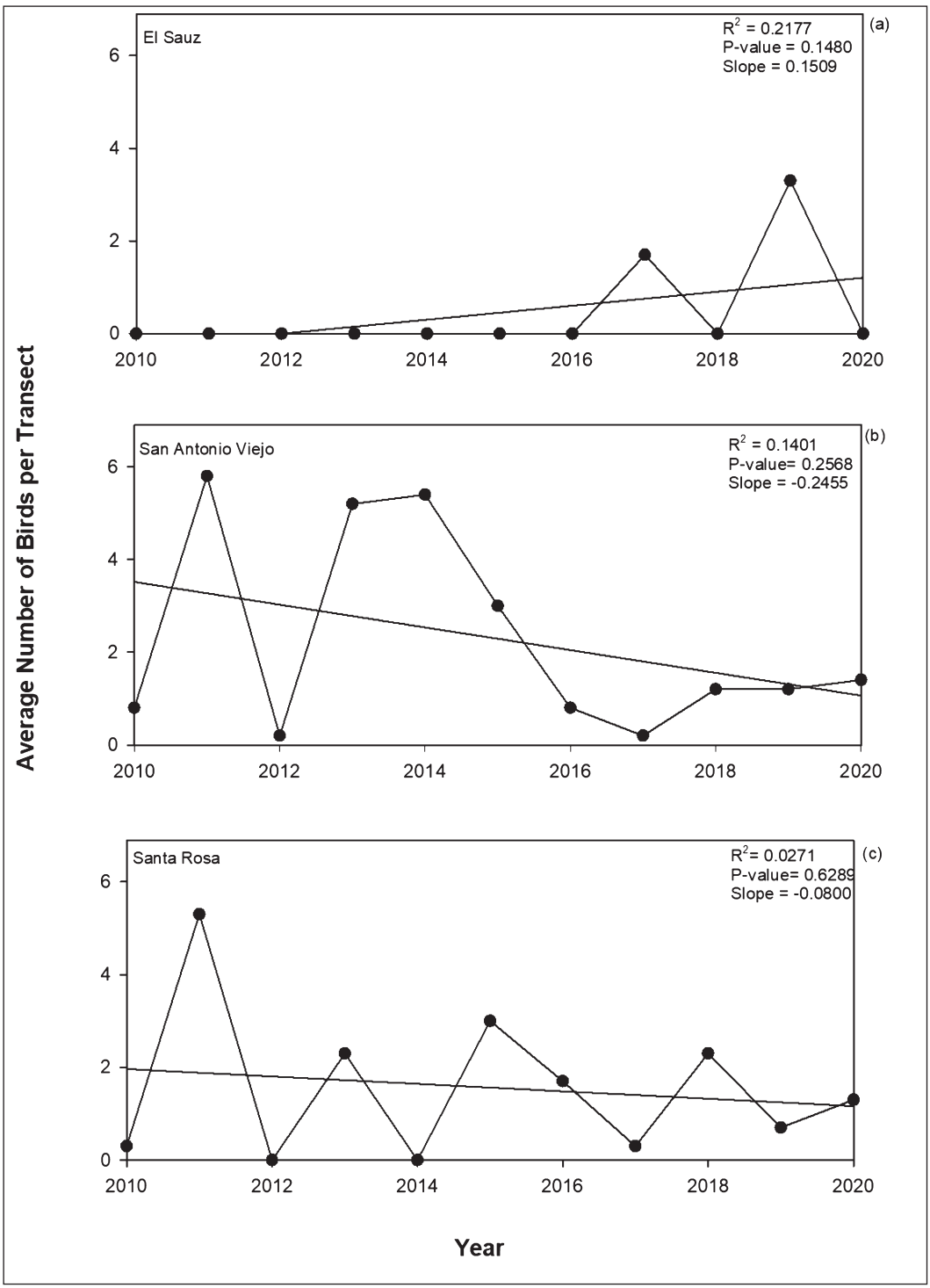

Figure 17. Non-breeding populations of Clay-colored Sparrow on East Foundation ranches from 2010-2020.

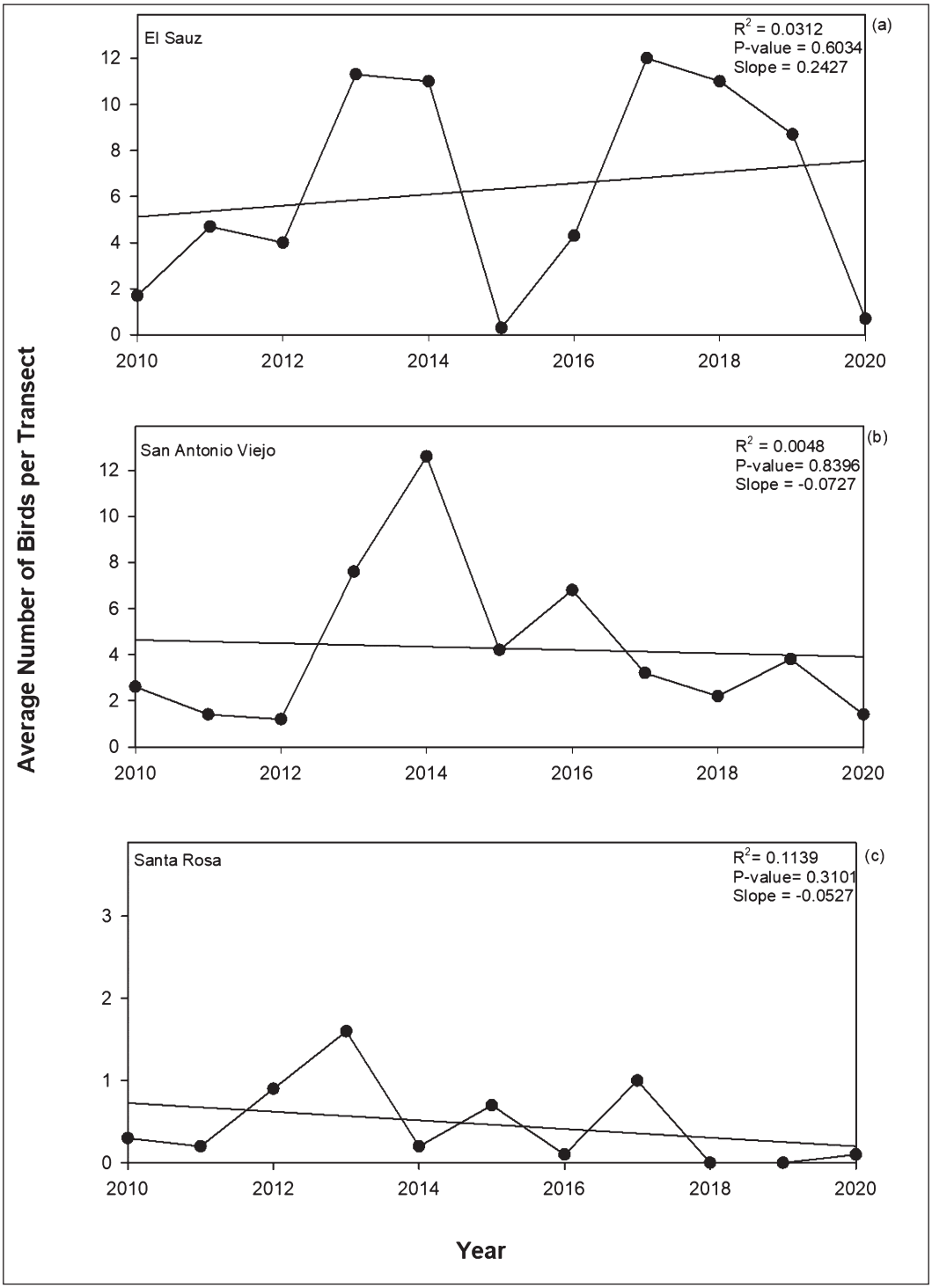

Figure 18. Non-breeding populations of Common Ground Dove on East Foundation ranches from 2010-2020.

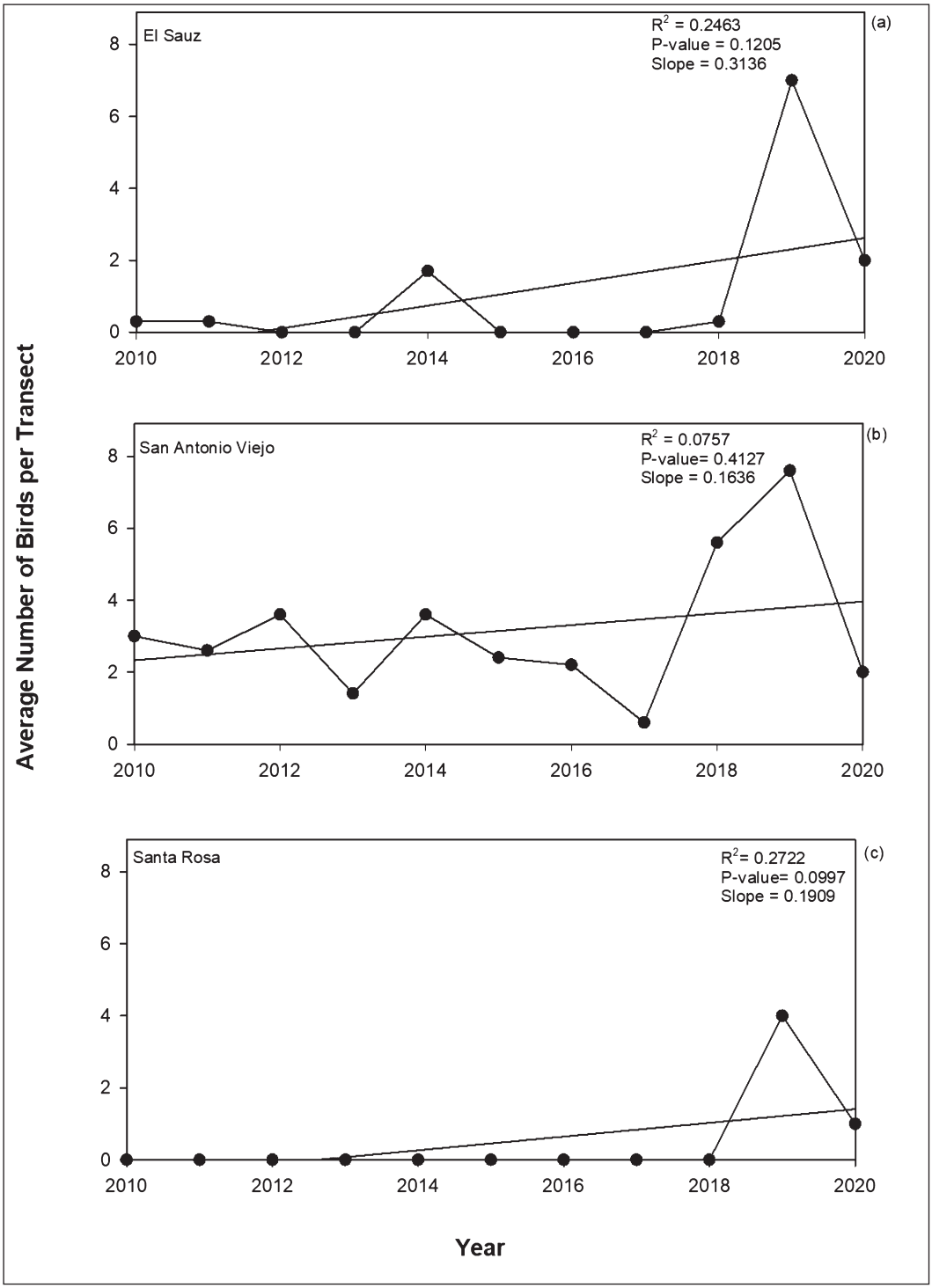

Figure 19. Non-breeding populations of Curve-billed Thrasher on East Foundation ranches from 2010-2020.

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.

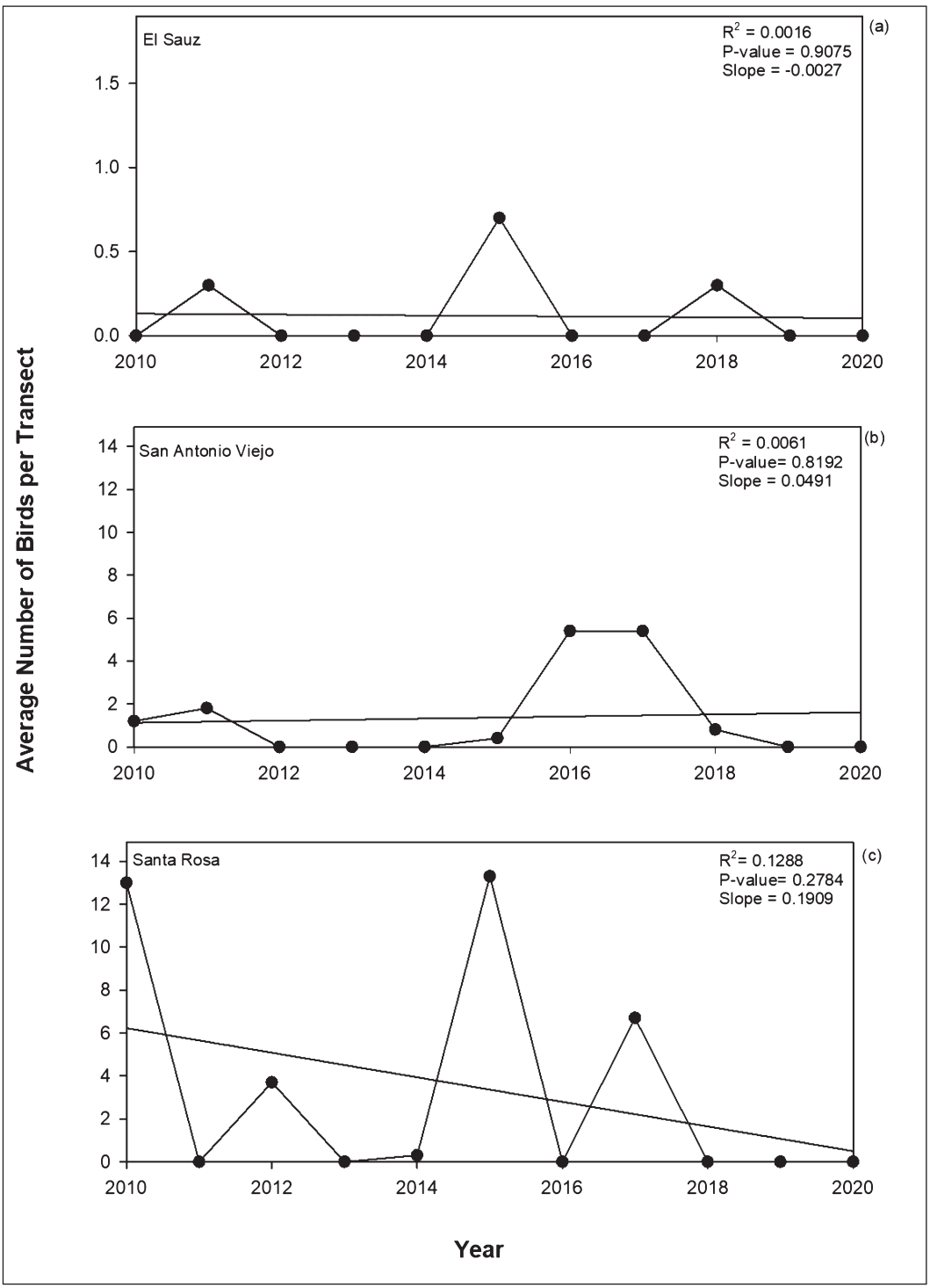

Figure 20. Non-breeding populations of Eastern Meadowlark on East Foundation ranches from 2010-2020.

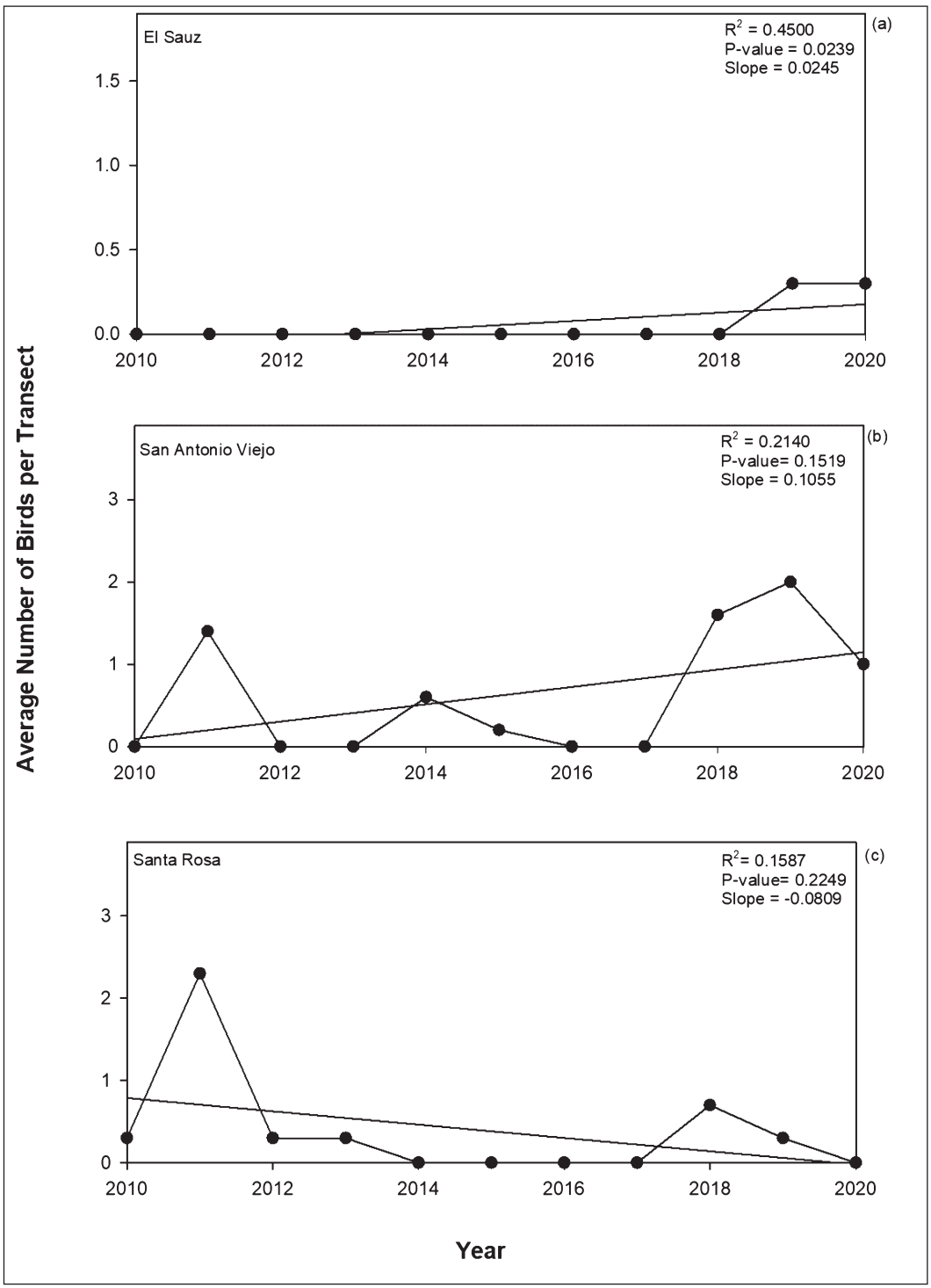

Figure 21. Non-breeding populations of Field Sparrow on East Foundation ranches from 2010-2020.

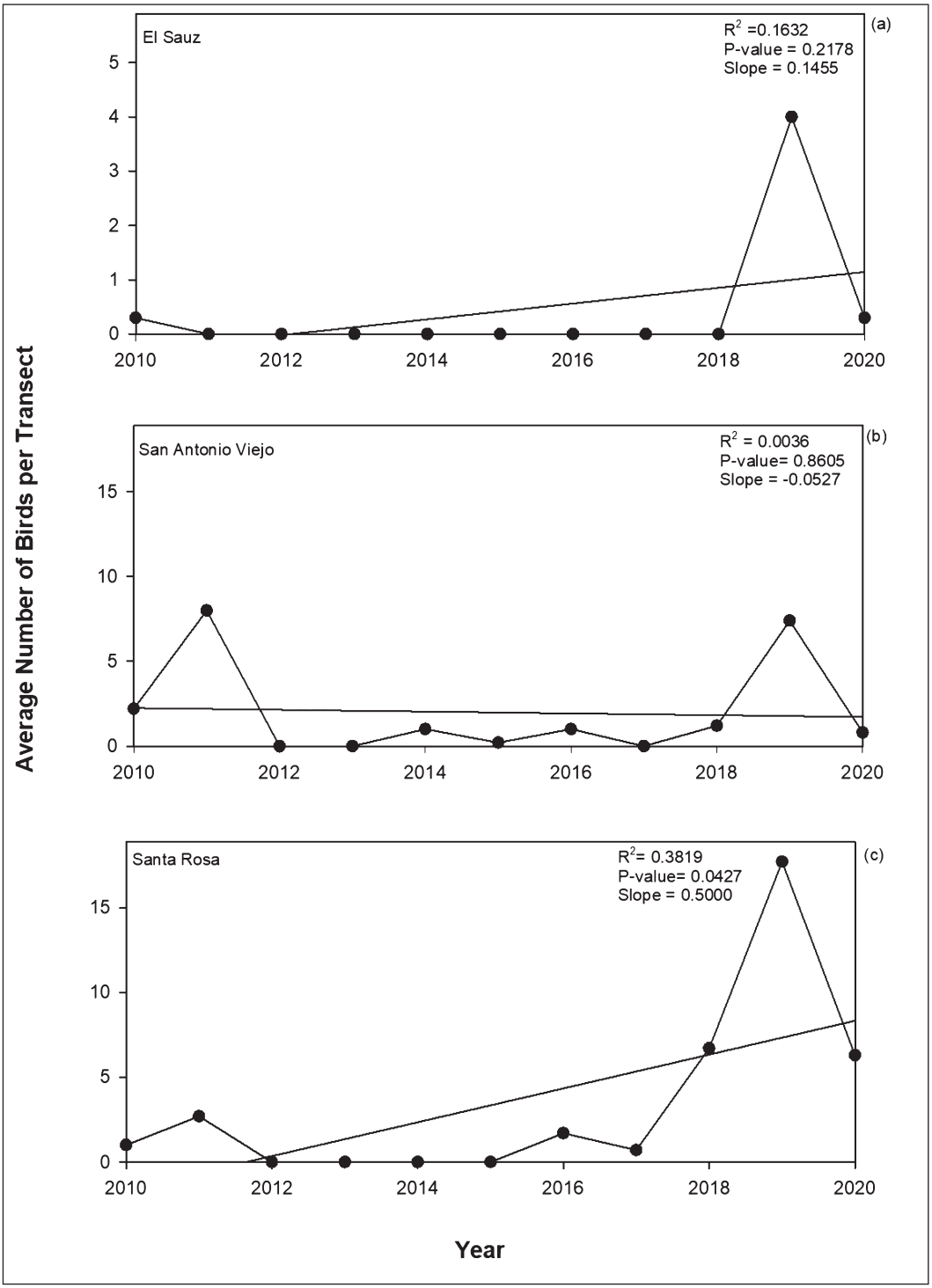

Figure 22. Non-breeding populations of Grasshopper Sparrow on East Foundation ranches from 2010-2020.

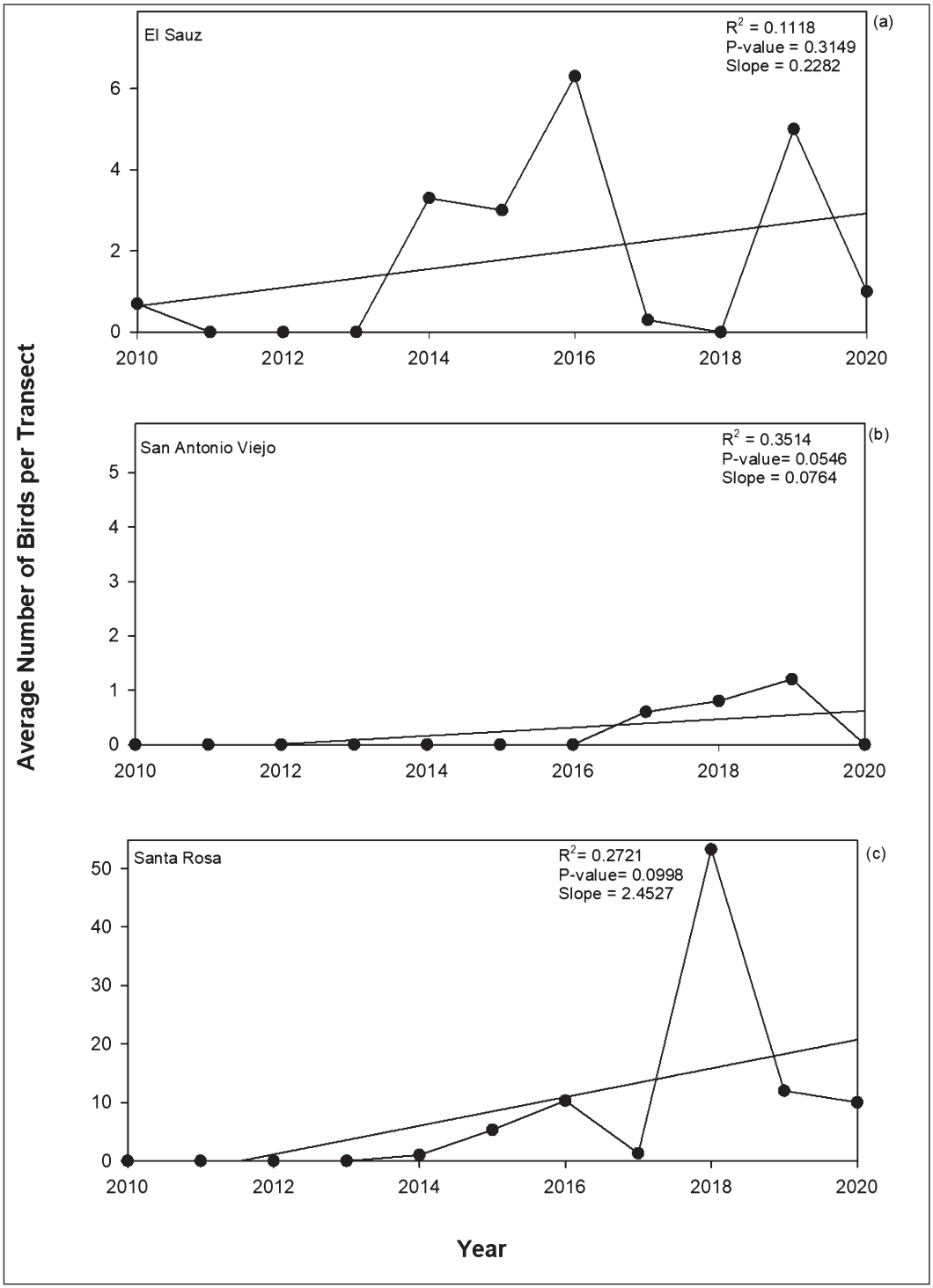

Figure 23. Non-breeding populations of Great-tailed Grackle on East Foundation ranches from 2010-2020.

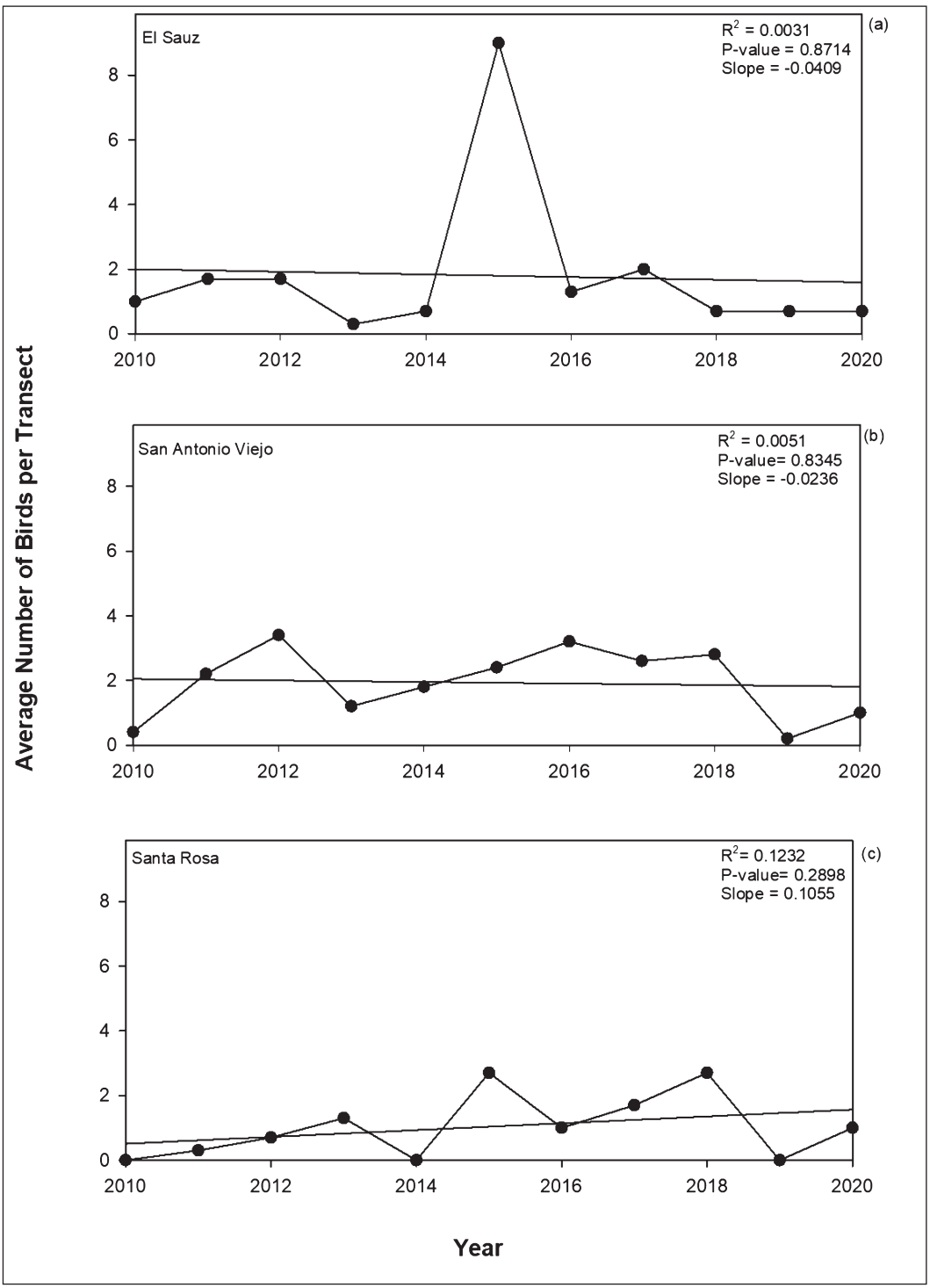

Figure 24. Non-breeding populations of Greater Roadrunner populations on East Foundation ranches from 2010-2020.

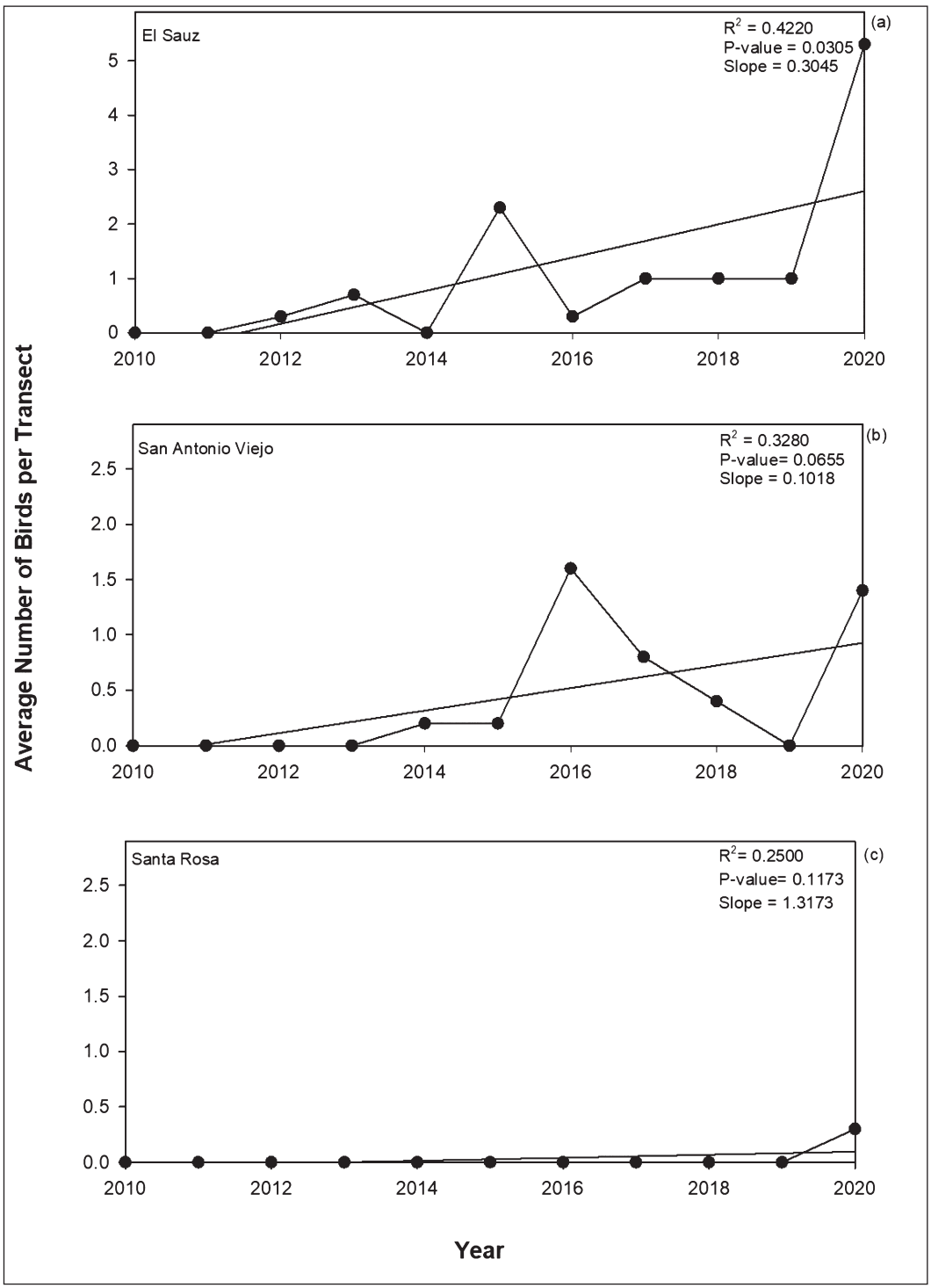

Figure 25. Non-breeding populations of Killdeer on East Foundation ranches from 2010-2020.

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; $P = 0.004$).

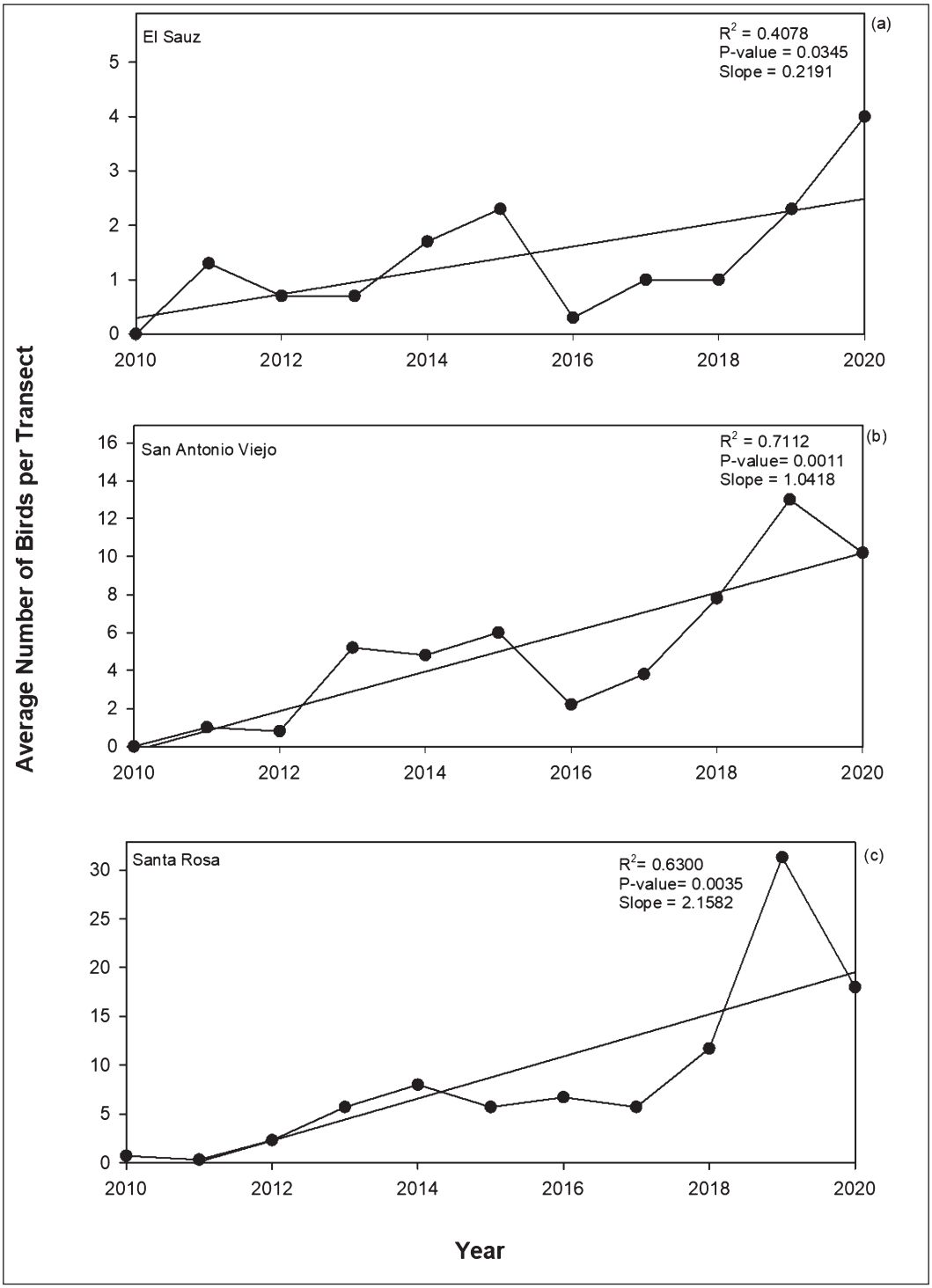

Figure 26. Non-breeding populations of Lark Sparrow on East Foundation ranches from 2010-2020.

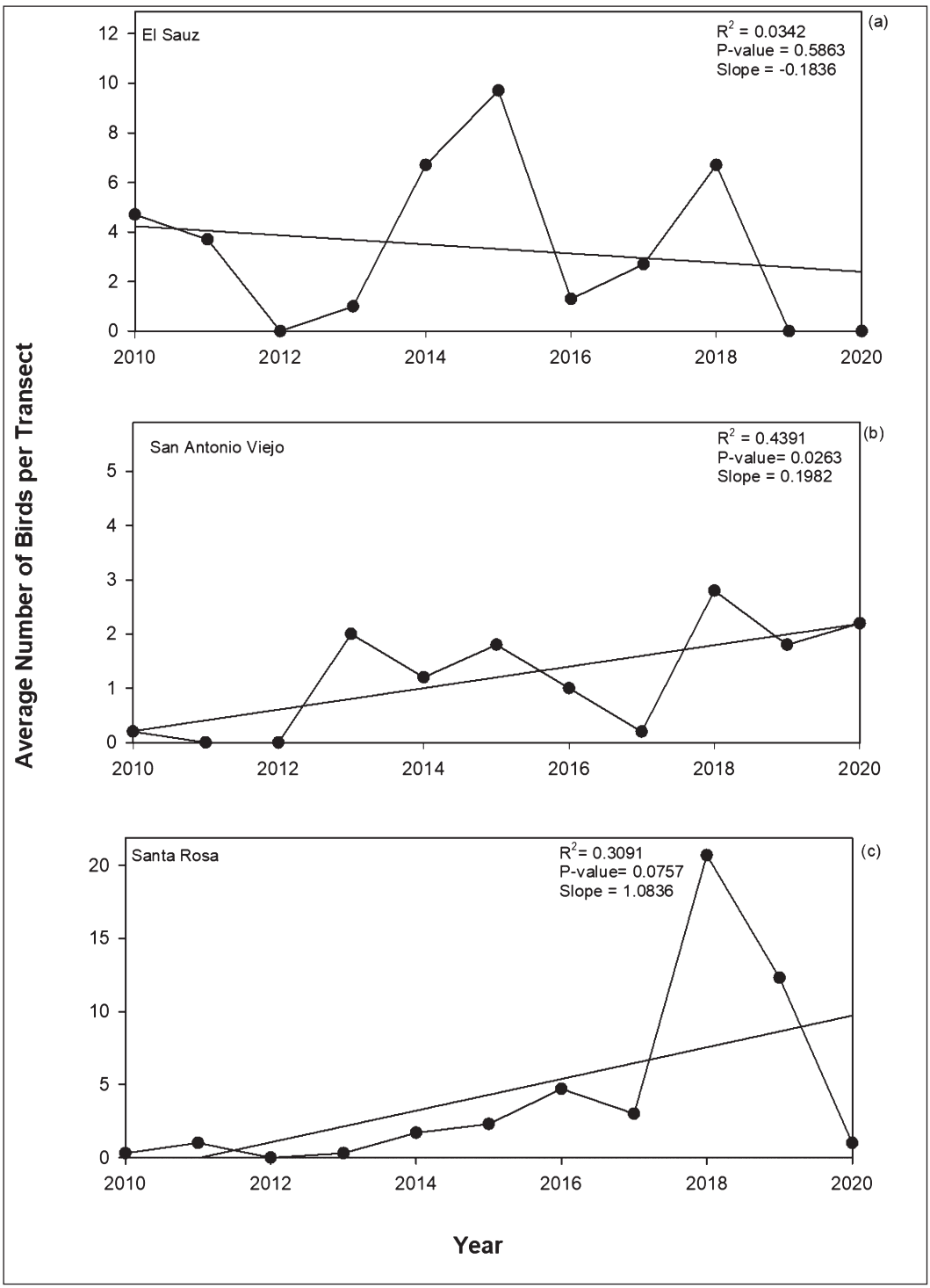

Figure 27. Non-breeding populations of Lincoln's Sparrow on East Foundation ranches from 2010-2020.

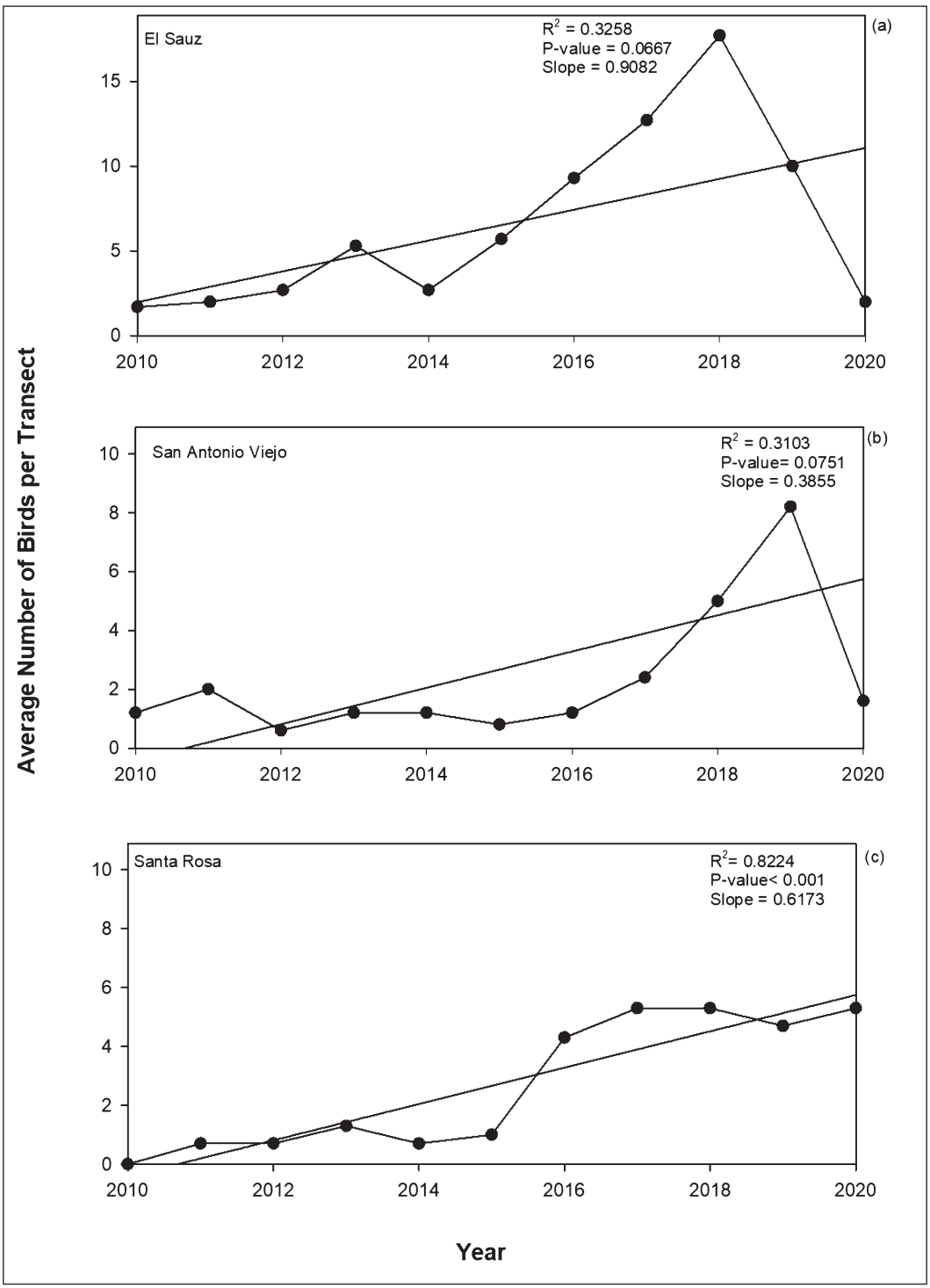

Figure 28. Non-breeding populations of Long-billed Thrasher on East Foundation ranches from 2010-2020.

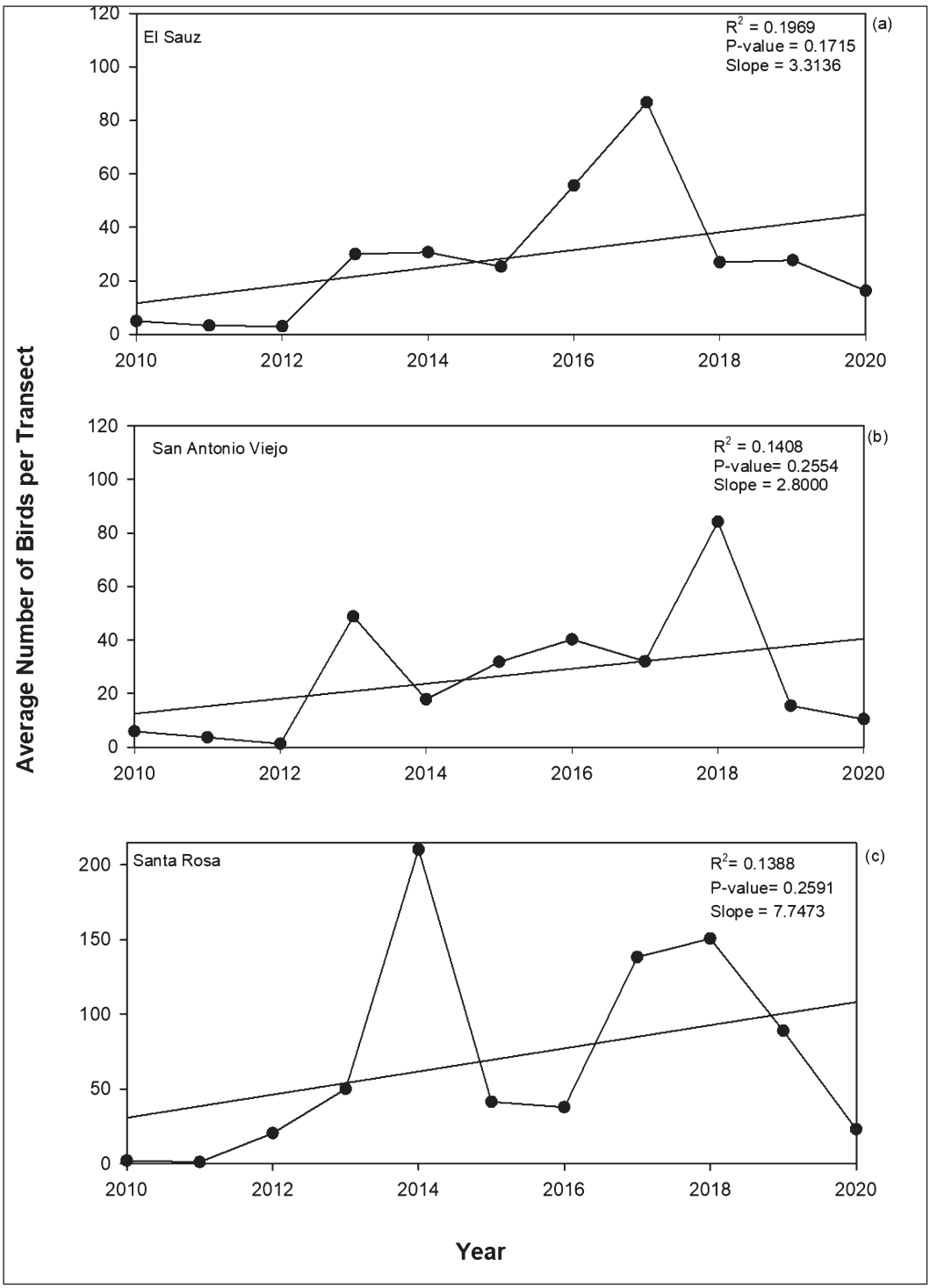

Figure 29. Non-breeding populations of Mourning Dove on East Foundation ranches from 2010-2020.

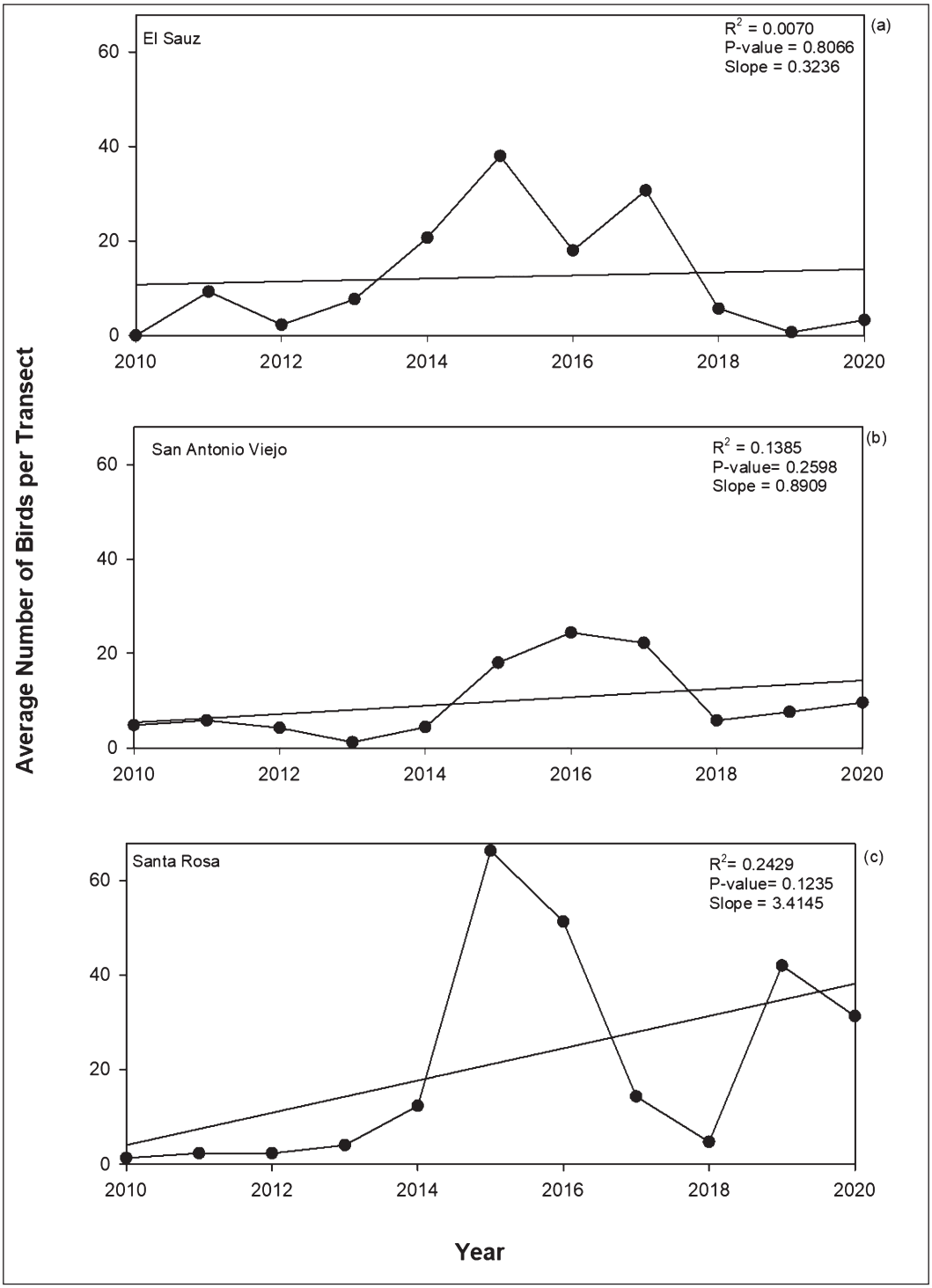

Figure 30. Non-breeding populations of Northern Bobwhite on East Foundation ranches from 2010-2020.

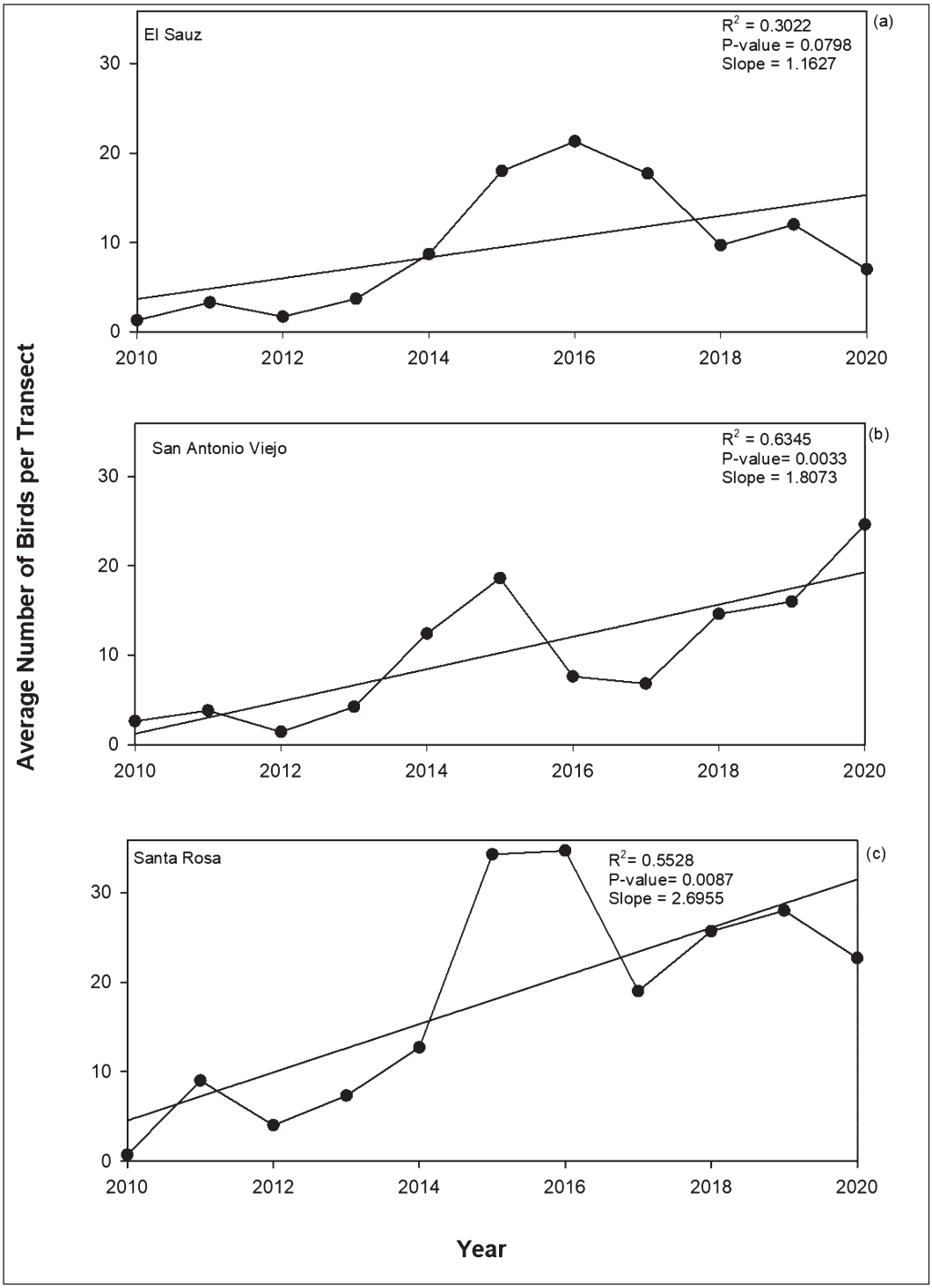

Figure 31. Non-breeding populations of Northern Cardinal on East Foundation ranches from 2010-2020.

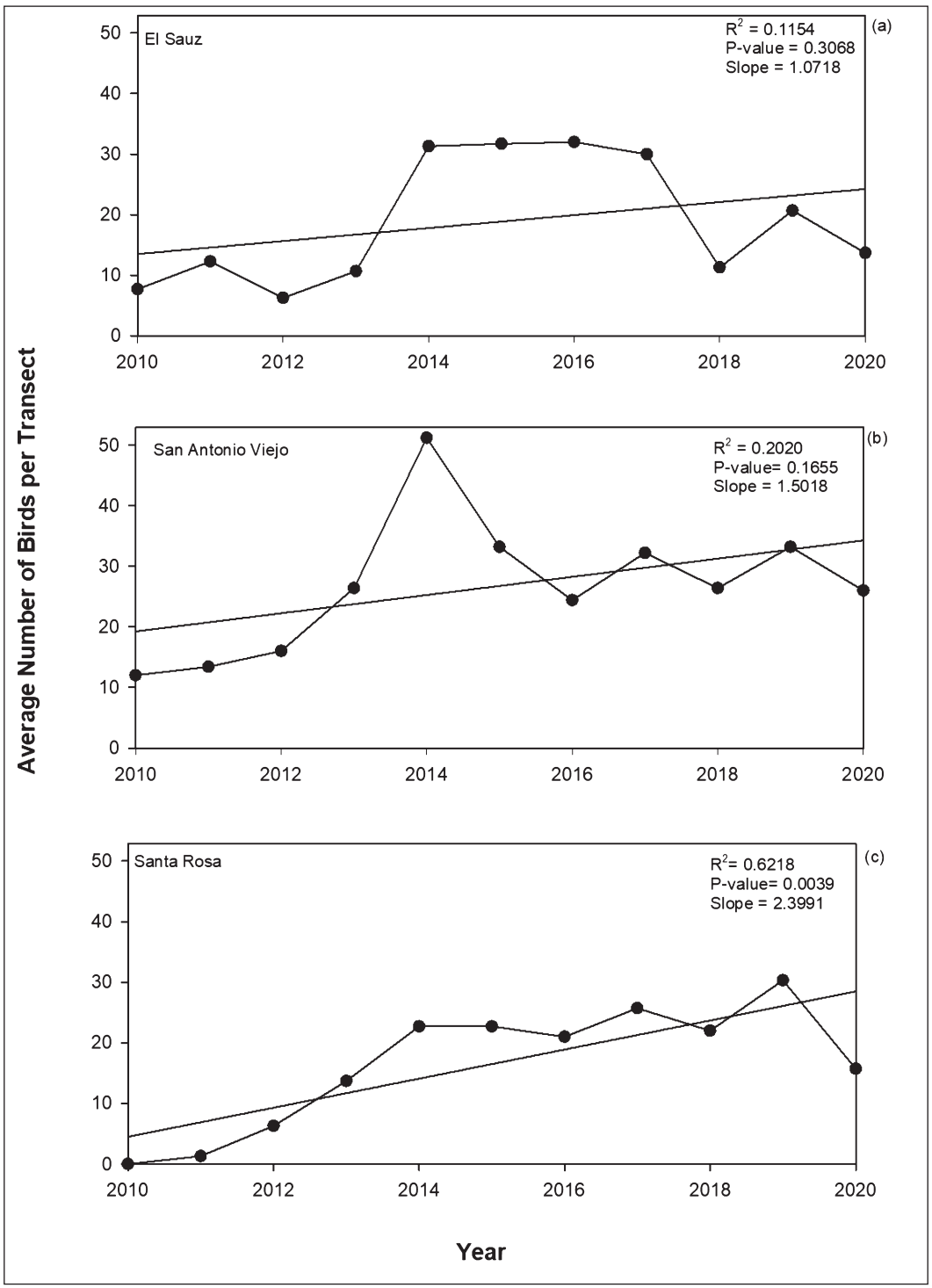

Figure 32. Non-breeding populations of Northern Mockingbird on East Foundation ranches from 2010-2020.

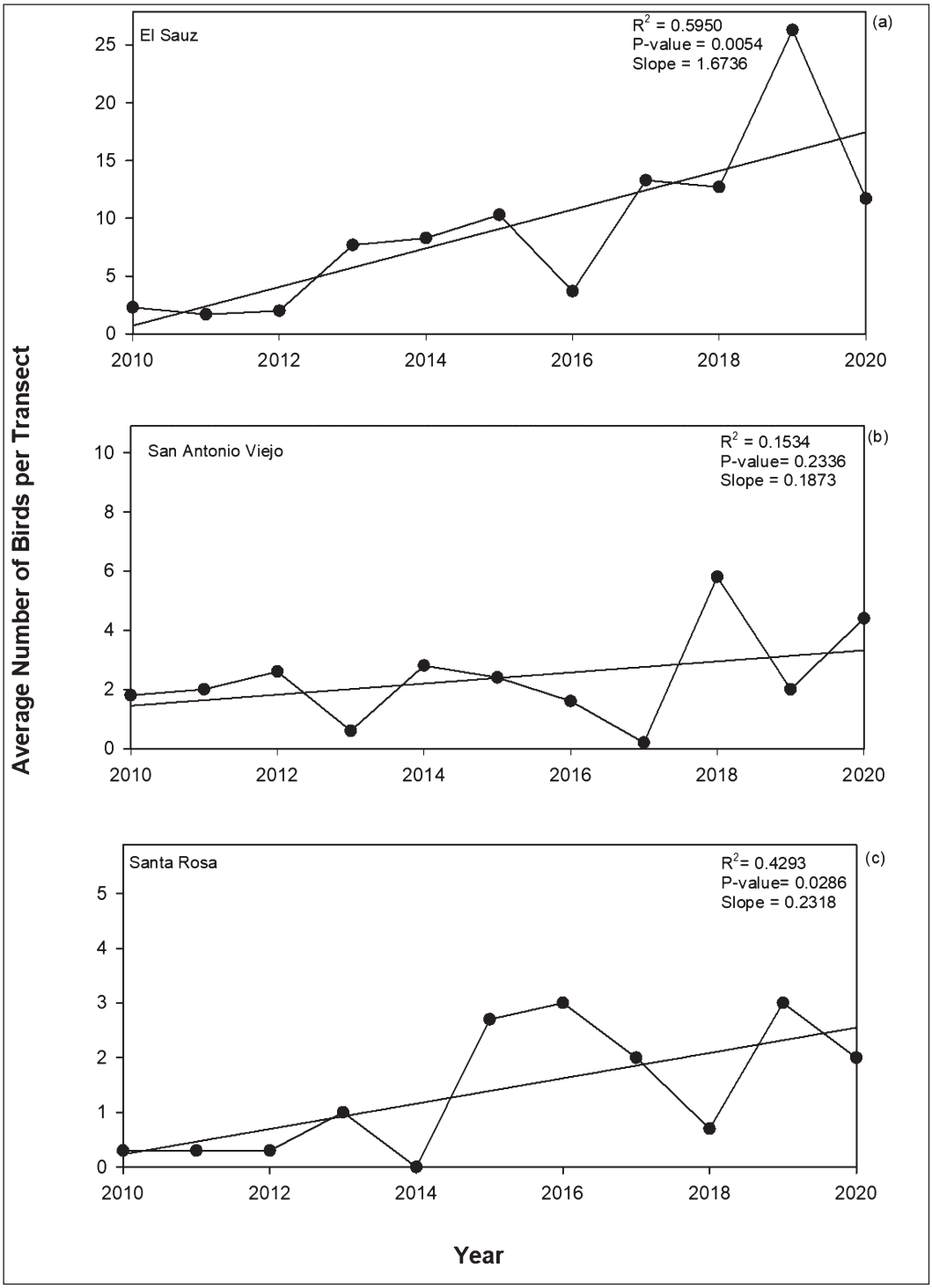

Figure 33. Non-breeding populations of Olive Sparrow populations on East Foundation ranches from 2010-2020.

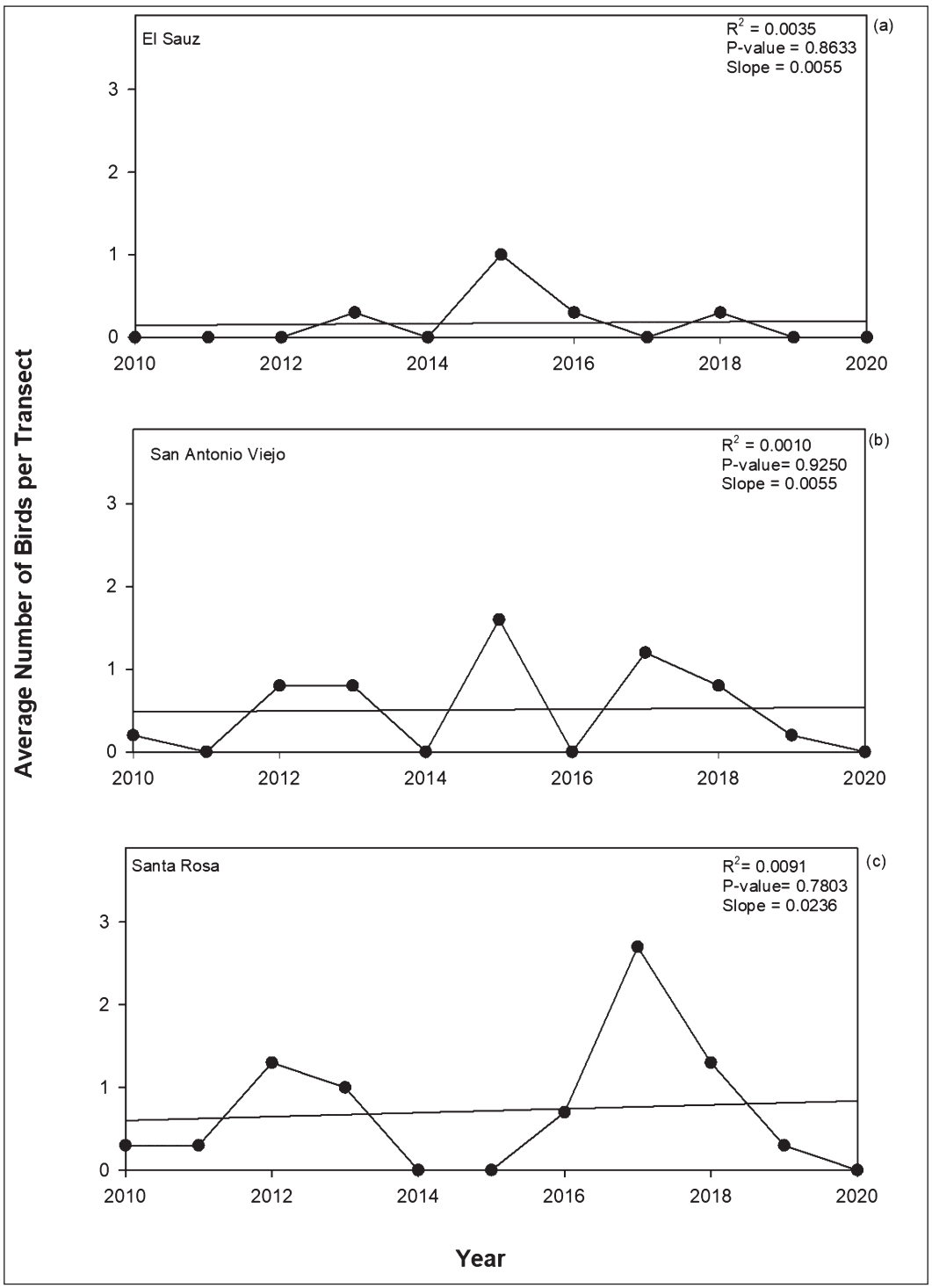

Figure 34. Non-breeding populations of Painted Bunting populations on East Foundation ranches from 2010-2020.

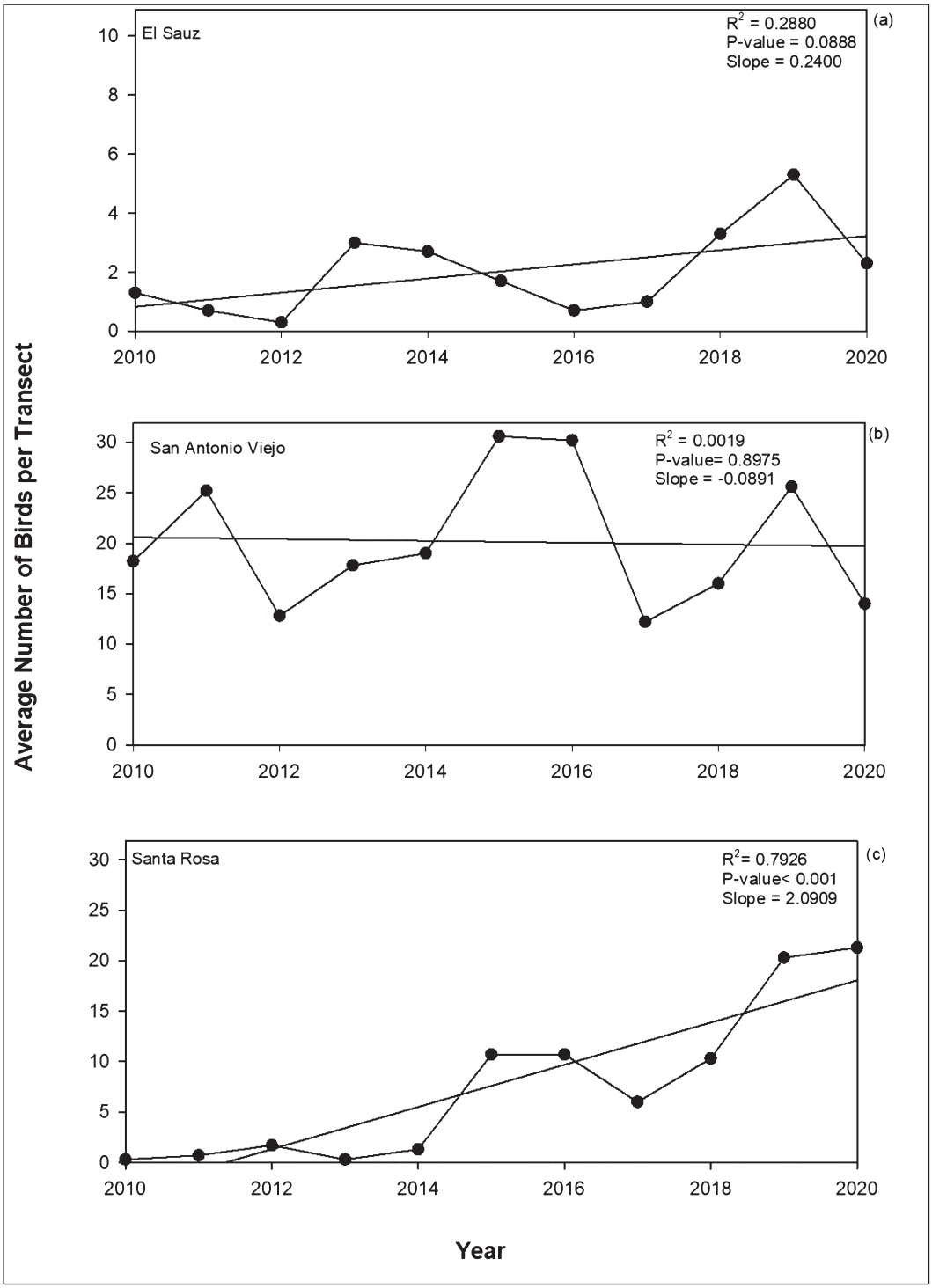

Figure 35. Non-breeding populations of Pyrrhuloxia on East Foundation ranches from 2010-2020.

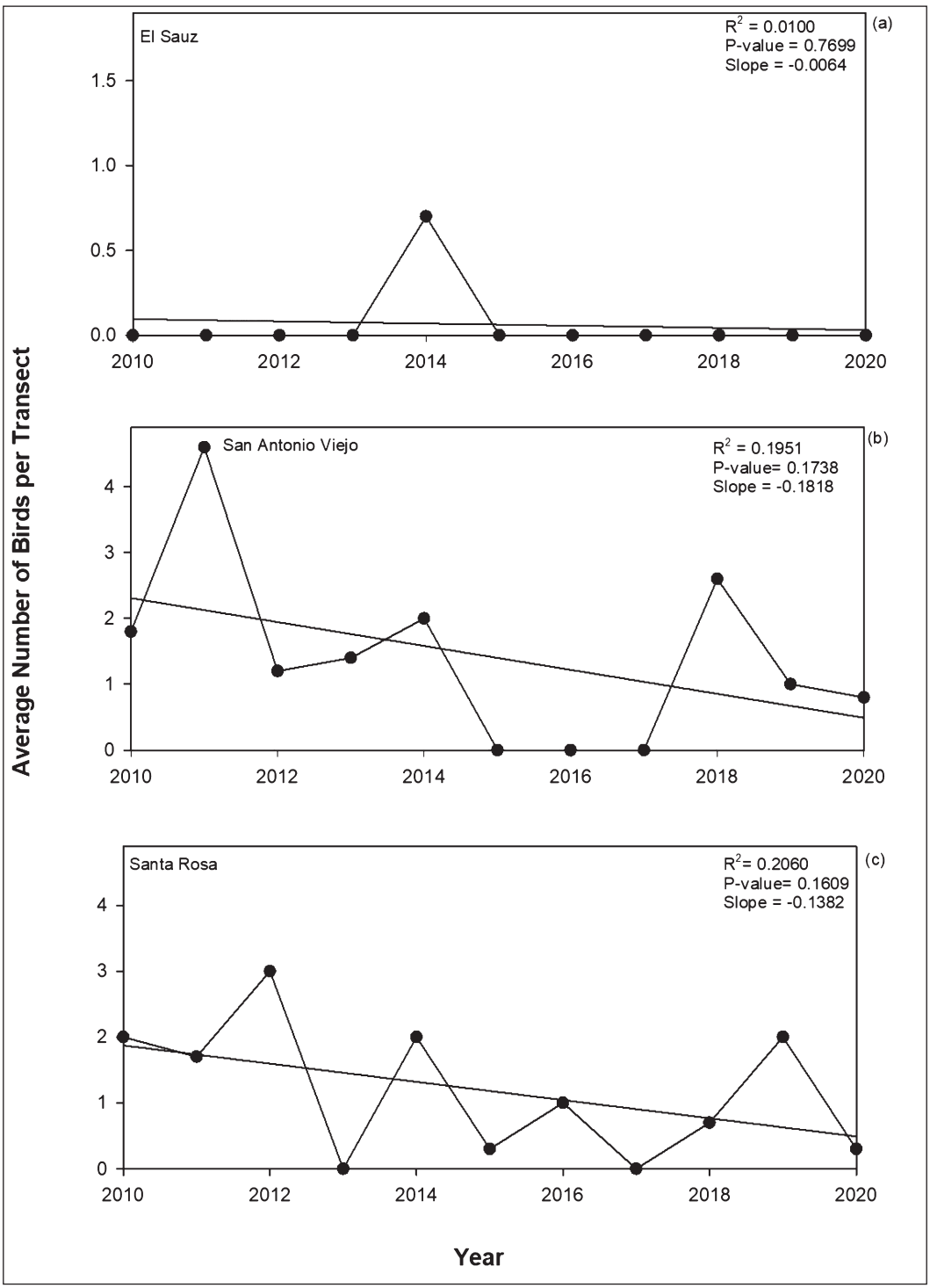

Figure 36. Non-breeding populations of Vesper Sparrow on East Foundation ranches from 2010-2020.

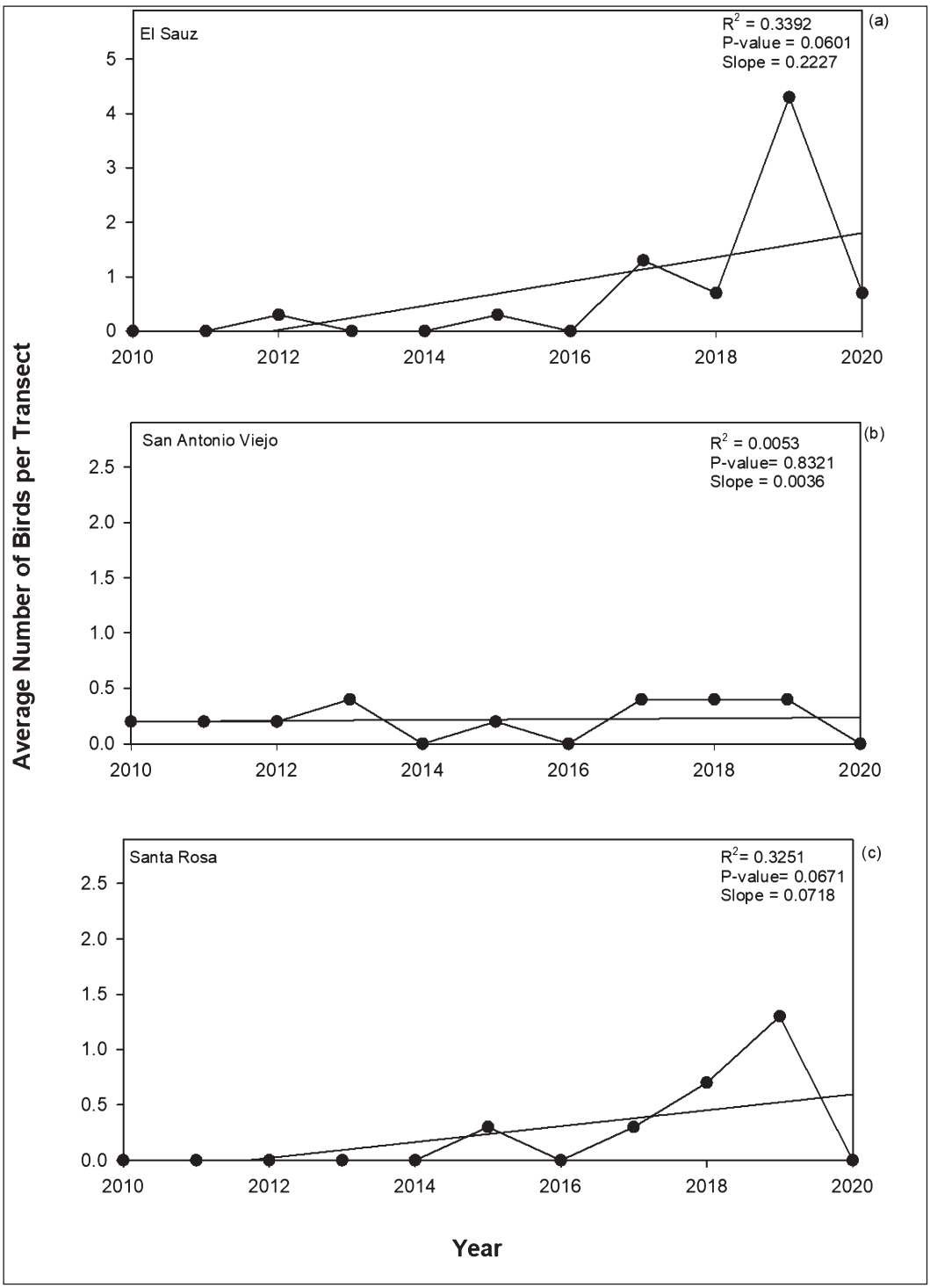

Figure 37. Non-breeding populations of White-tipped Dove on East Foundation ranches from 2010-2020.

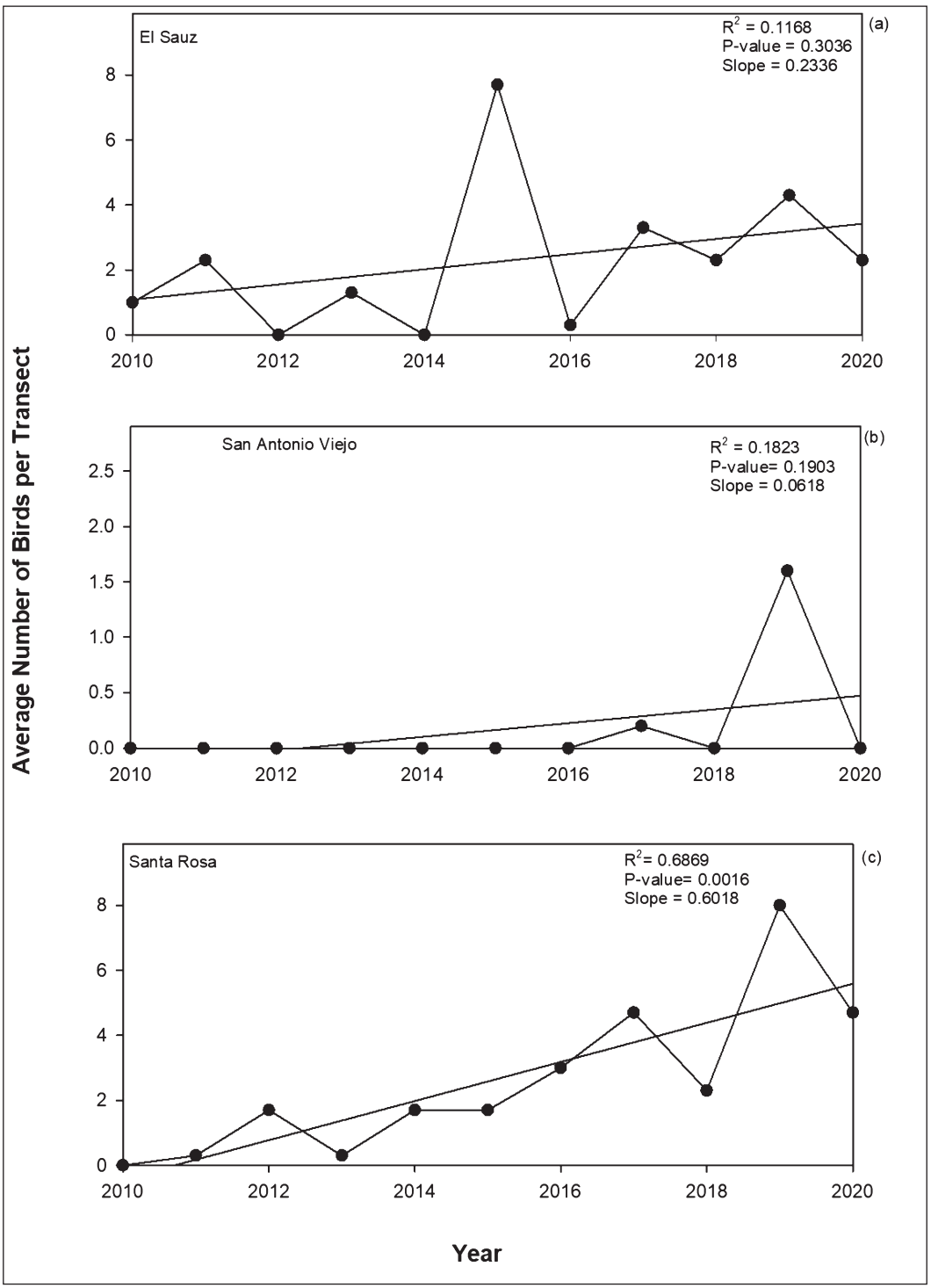

Figure 38. Non-breeding populations of Wild Turkey on East Foundation ranches from 2010-2020.

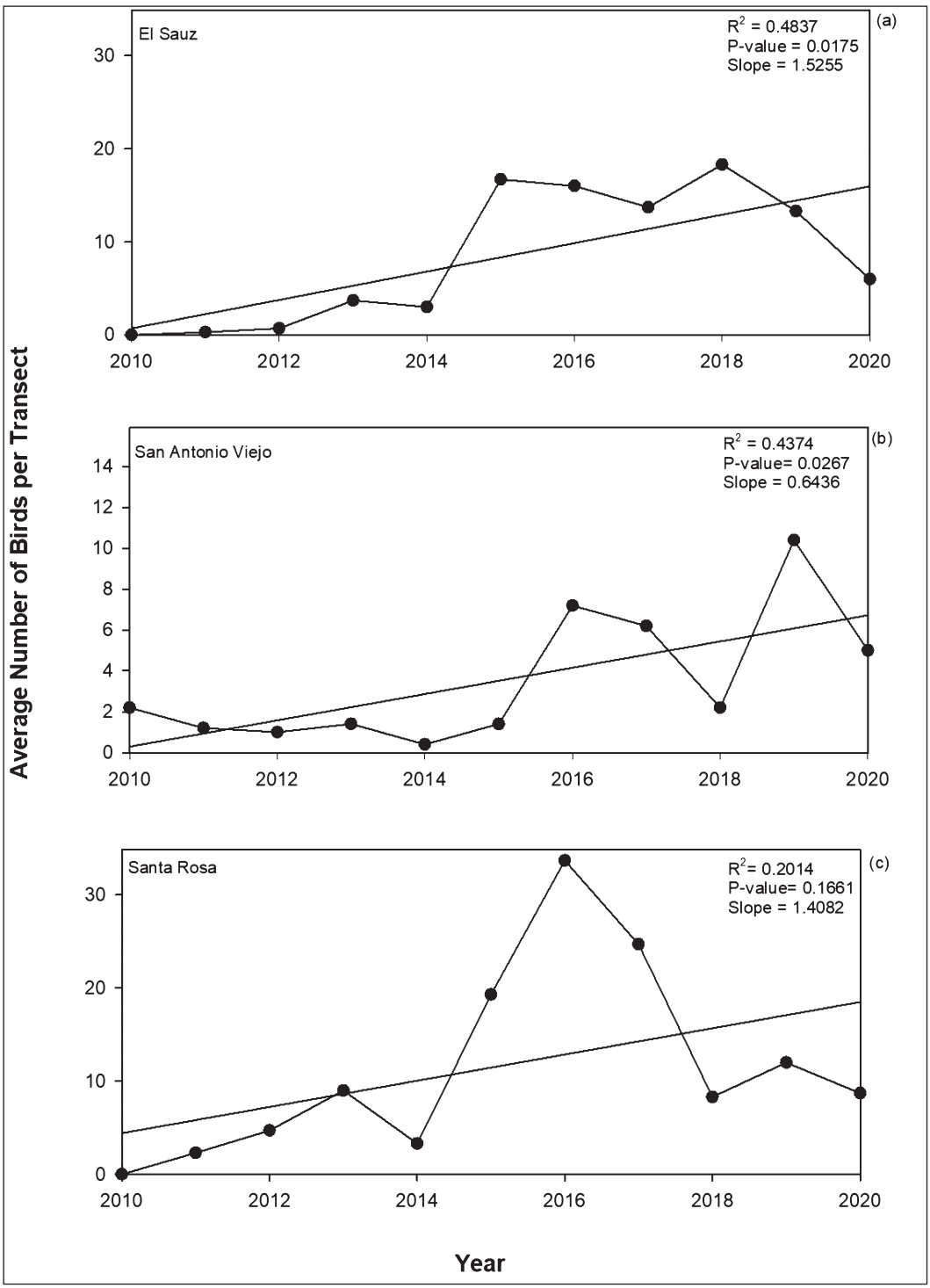

Figure 39. Non-breeding populations of Green Jay on East Foundation ranches from 2010-2020.

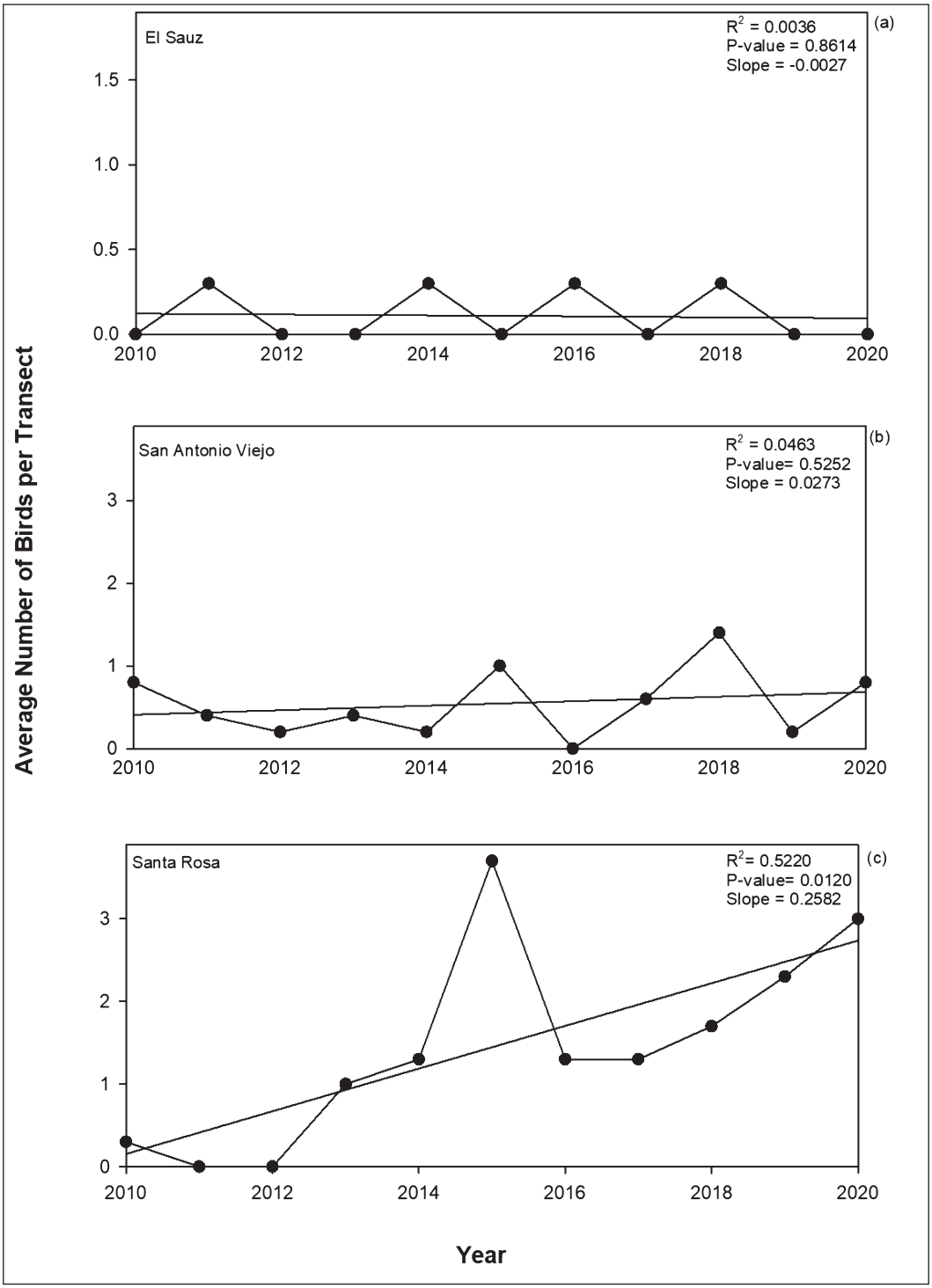

Figure 40. Non-breeding populations of American Kestrel on East Foundation ranches from 2010-2020.

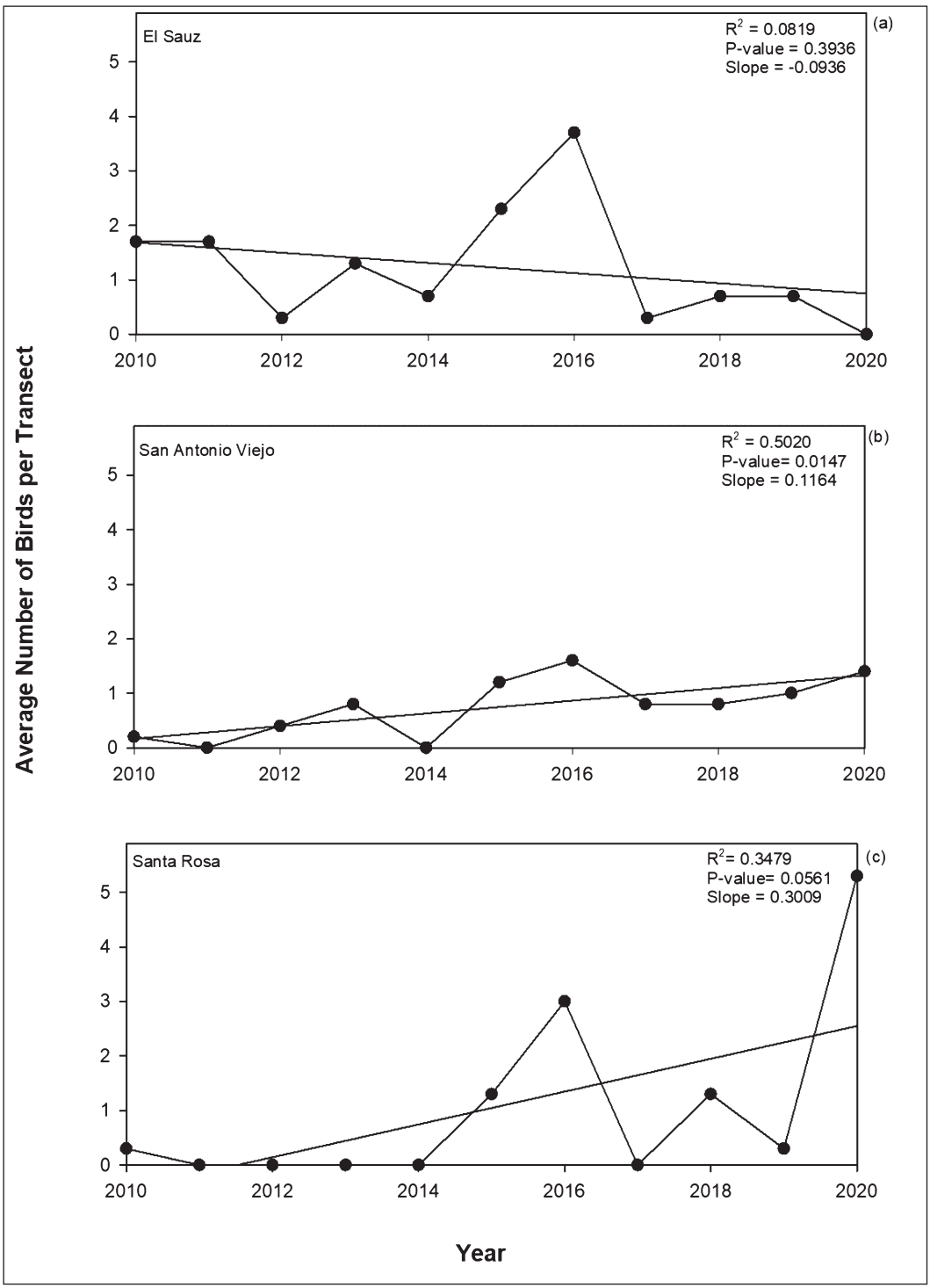

Figure 41. Non-breeding populations of Harris's Hawk on East Foundation ranches from 2010-2020.

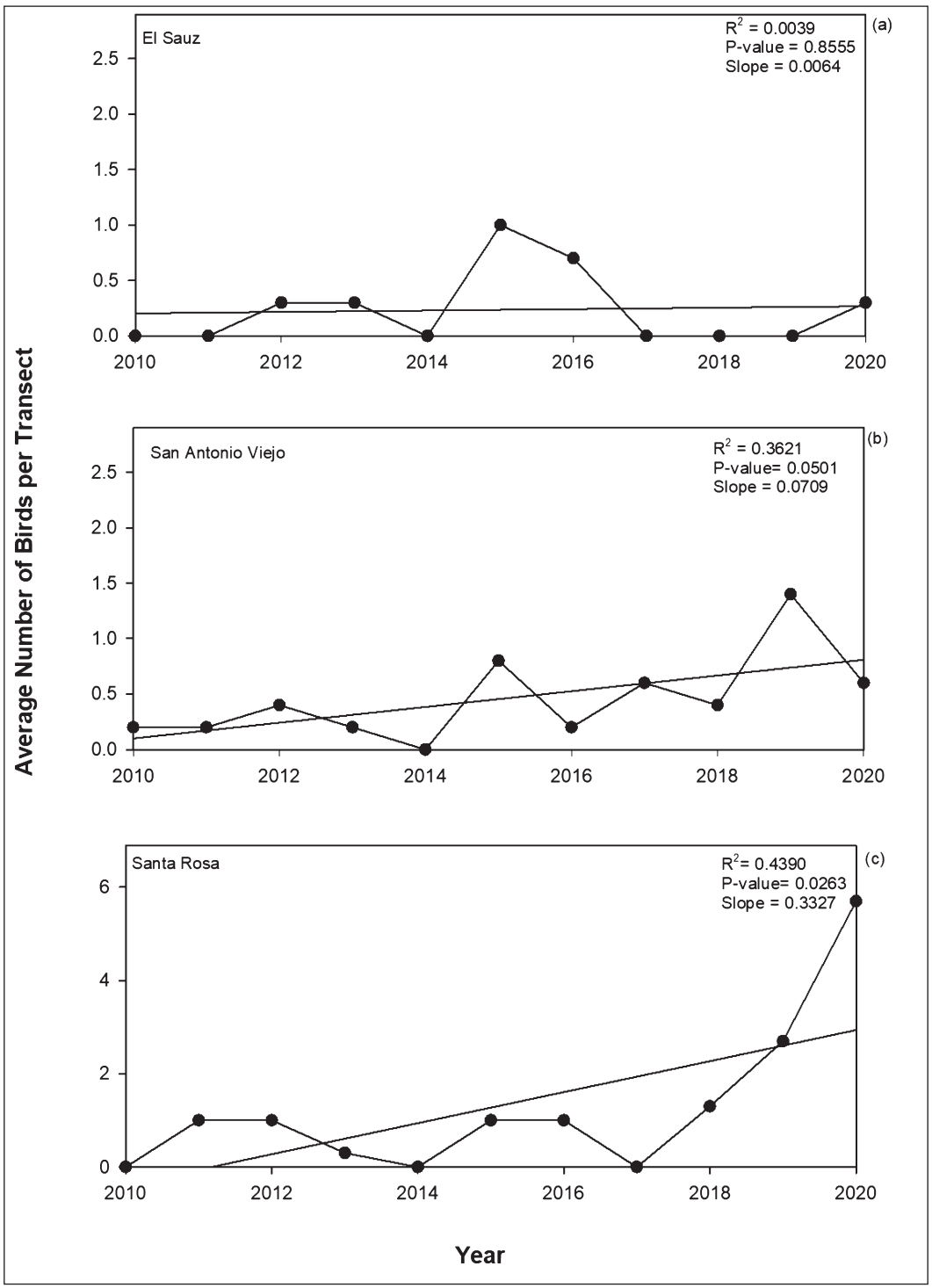

Figure 42. Non-breeding populations of Red-tailed Hawk on East Foundation ranches from 2010-2020.

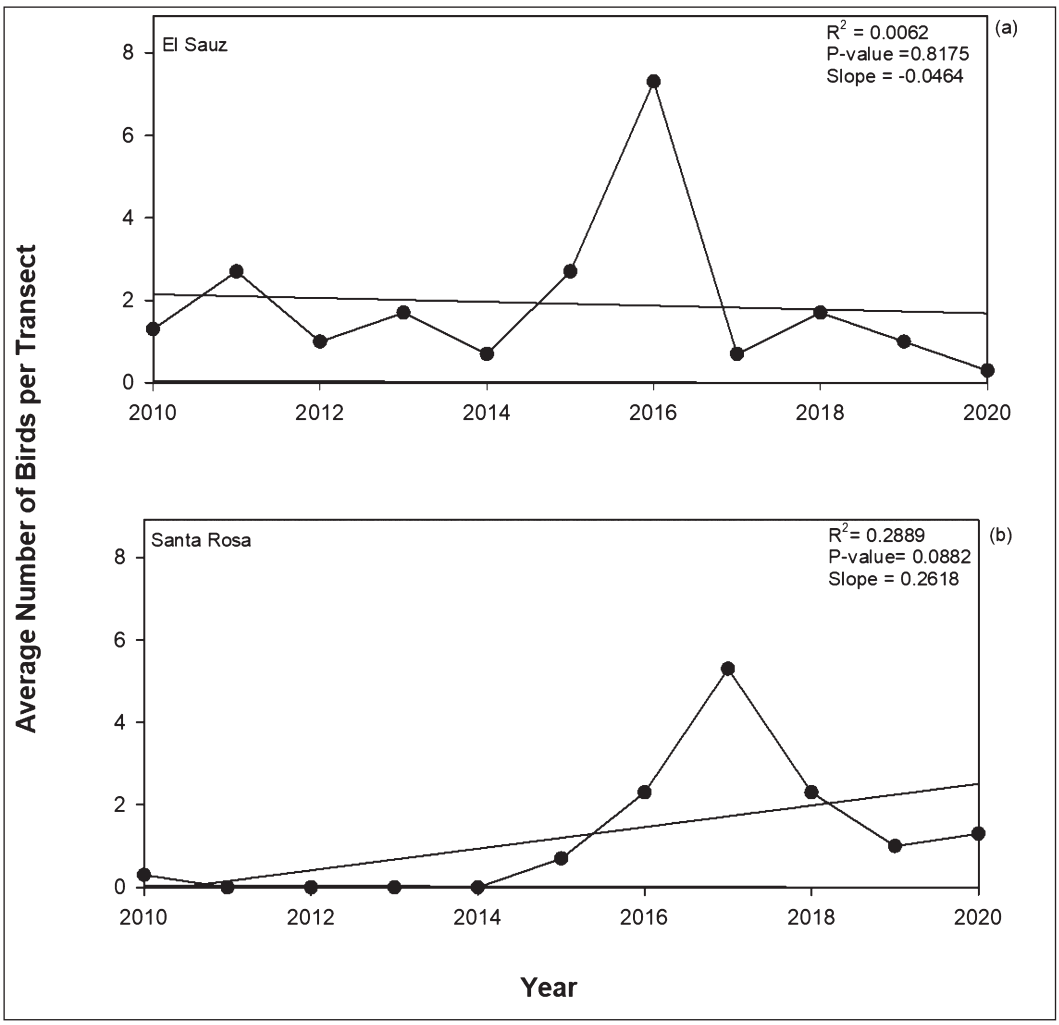

Figure 43. Non-breeding populations of Black Vulture on East Foundation ranches from 2010-2020.

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 ($P < 0.001$).

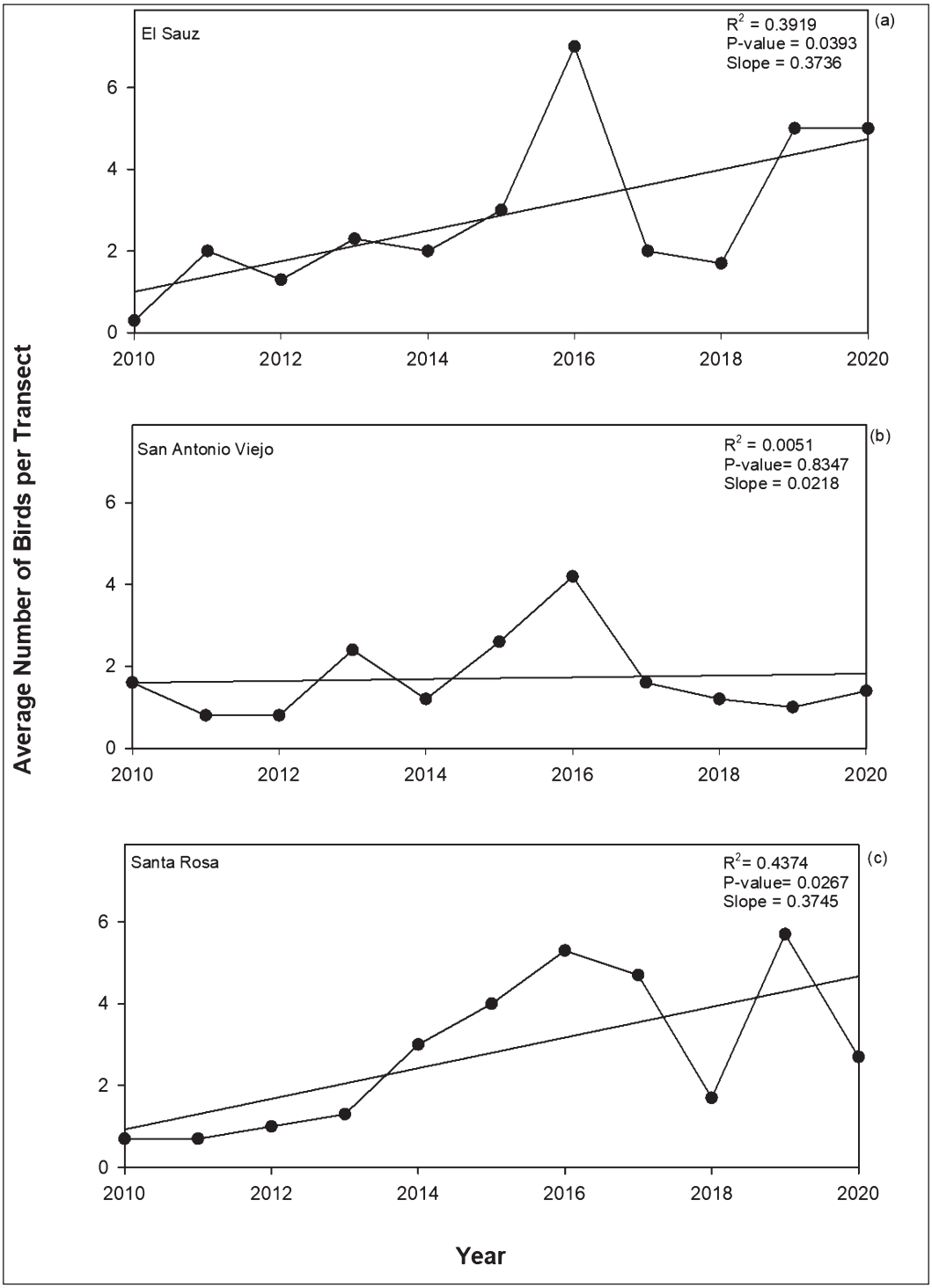

Figure 44. Non-breeding populations of Crested Caracara on East Foundation ranches from 2010-2020.

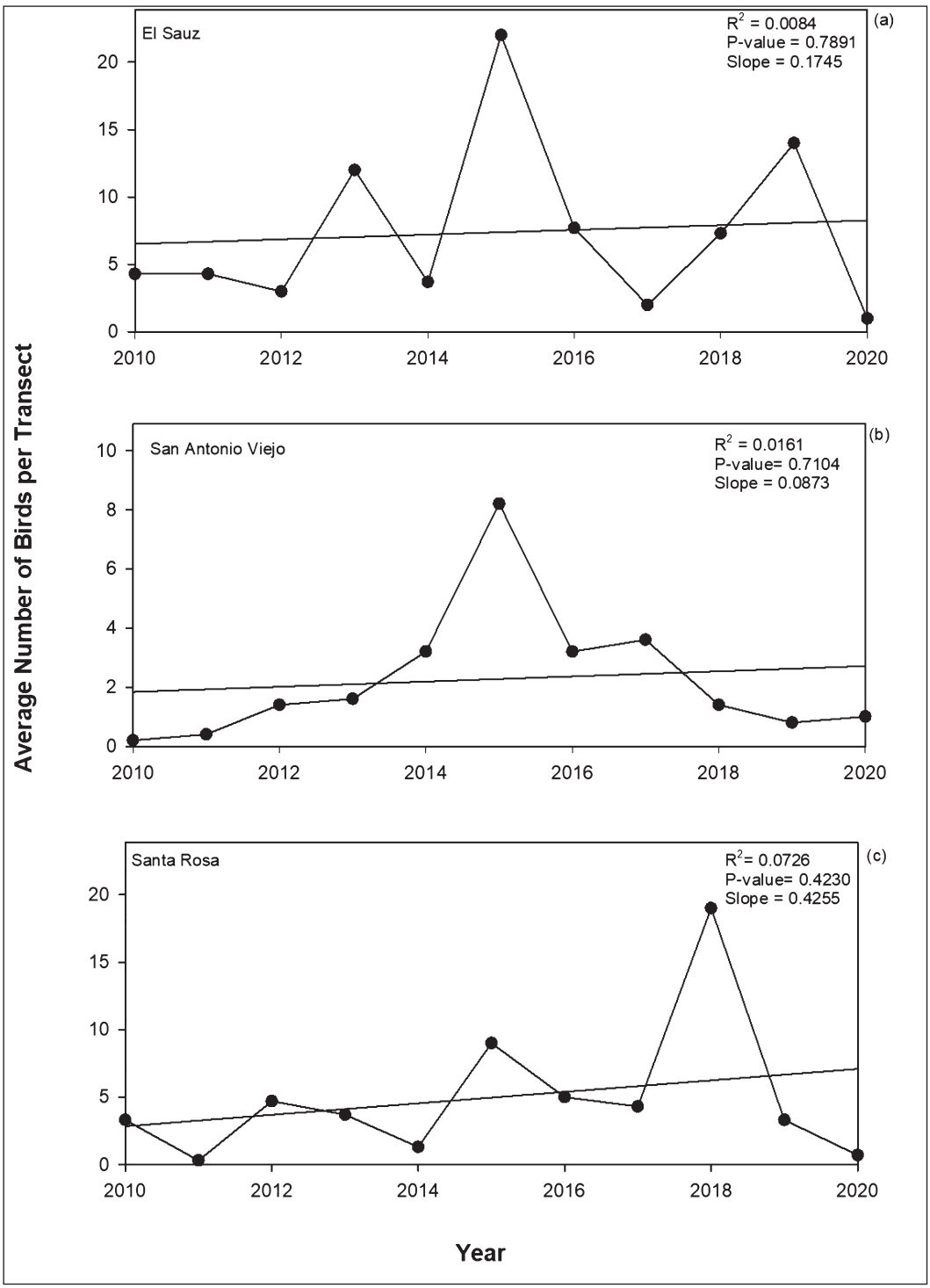

Figure 45. Non-breeding populations of Turkey Vulture on East Foundation ranches from 2010-2020.

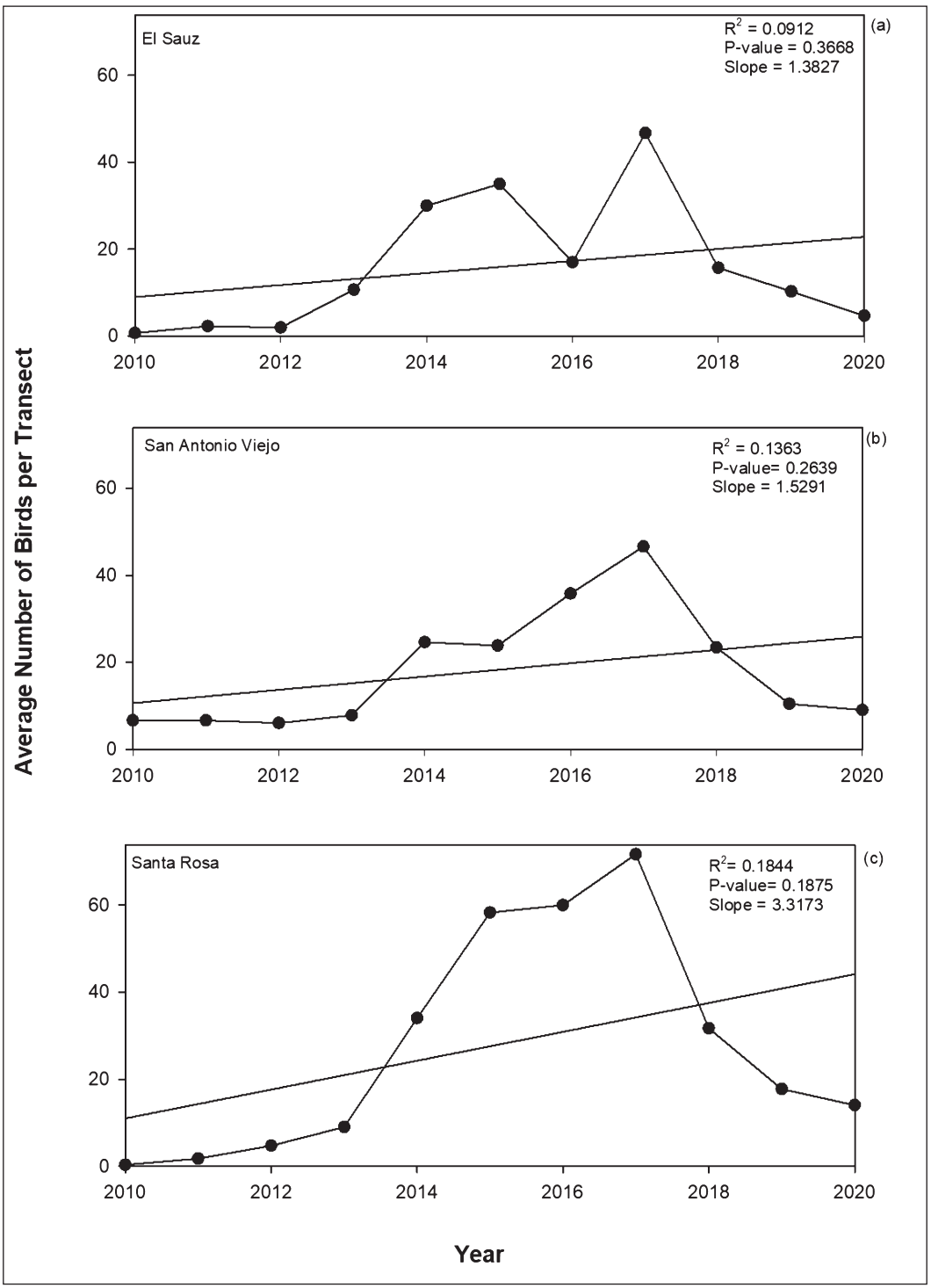

Figure 46. Non-breeding populations of Bewick's Wren on East Foundation ranches from 2010-2020.

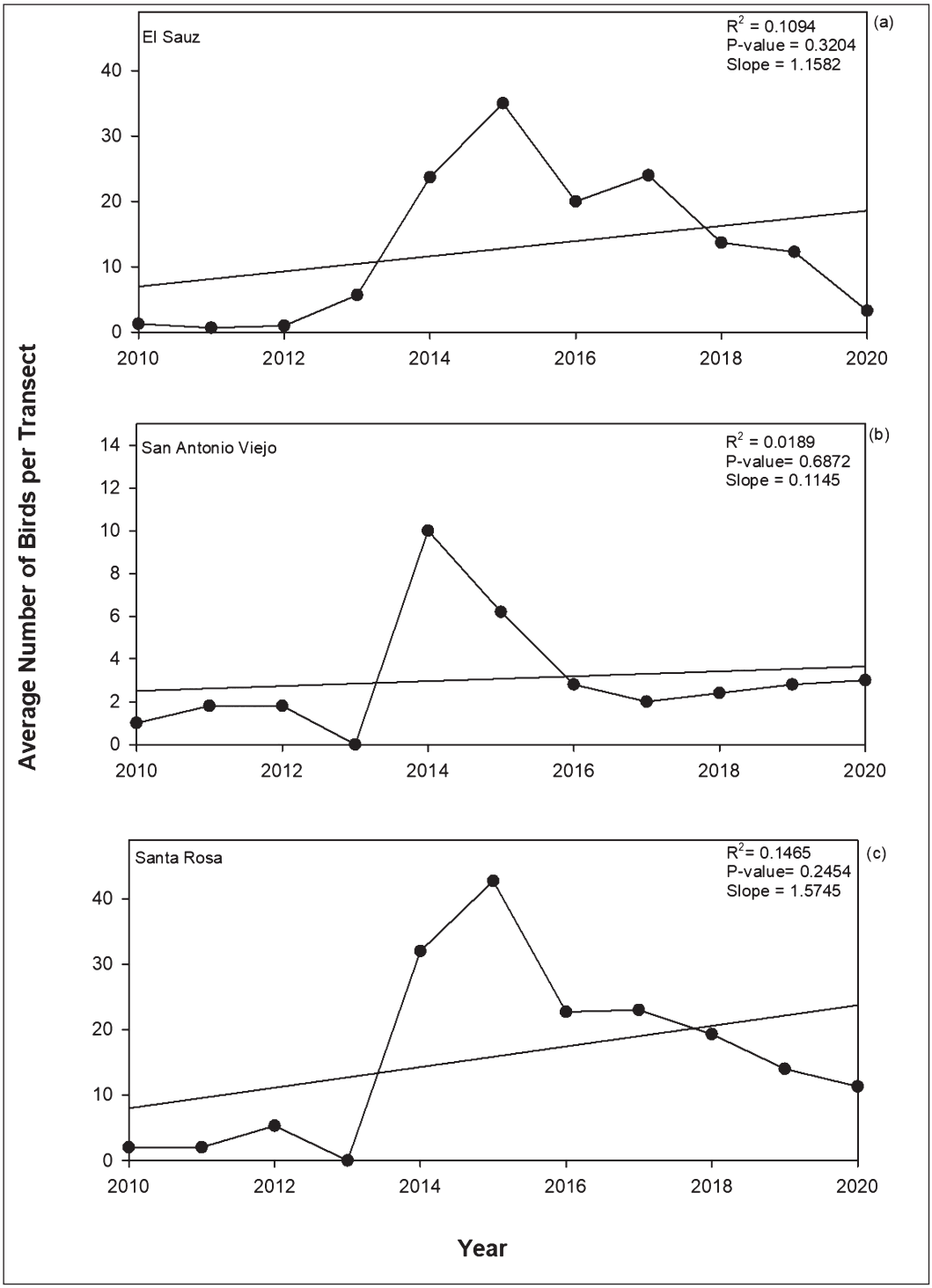

Figure 47. Non-breeding populations of Black-crested Titmouse on East Foundation ranches from 2010-2020.

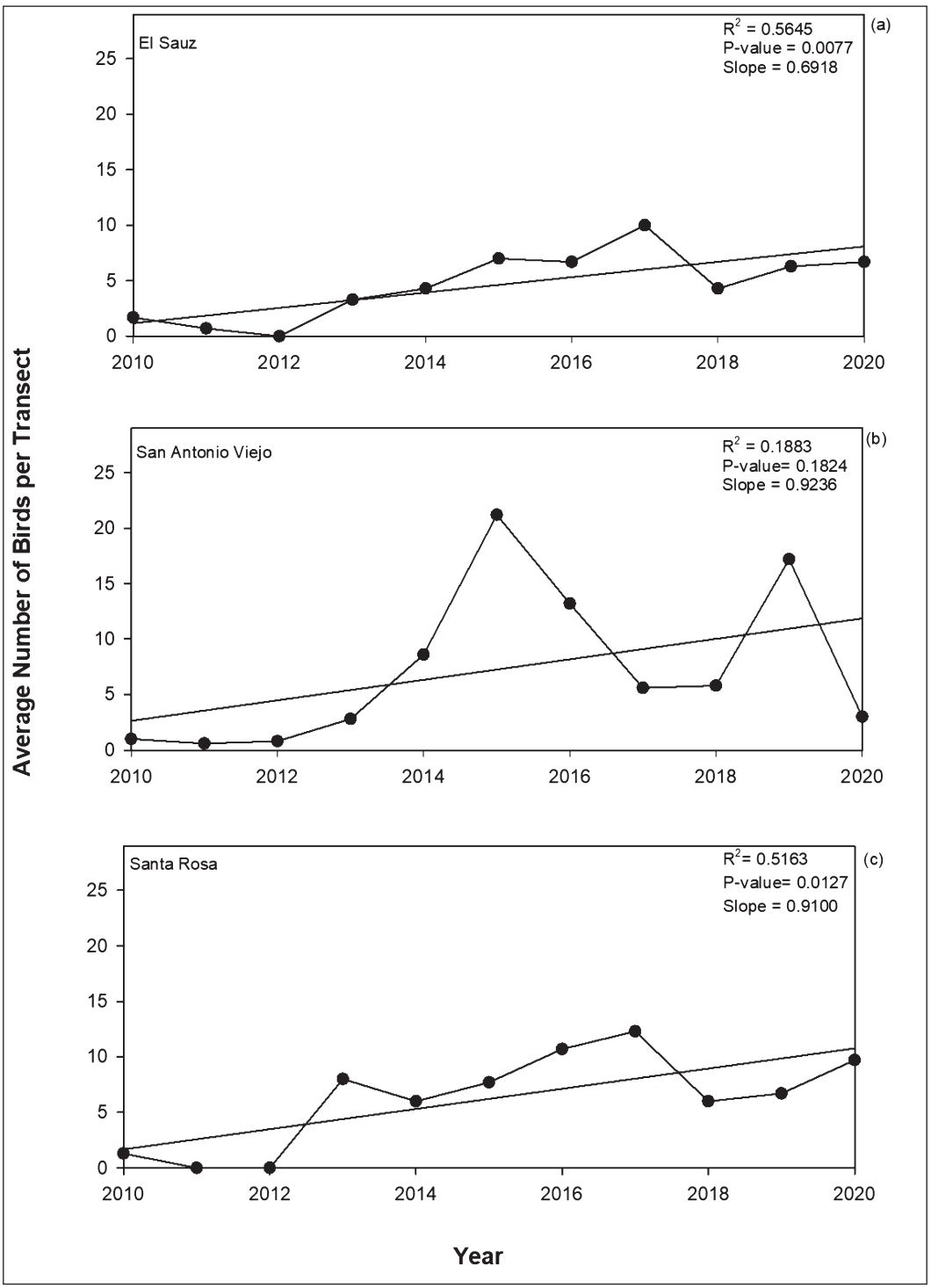

Figure 48. Non-breeding populations of Blue-gray Gnatcatcher on East Foundation ranches from 2010-2020.

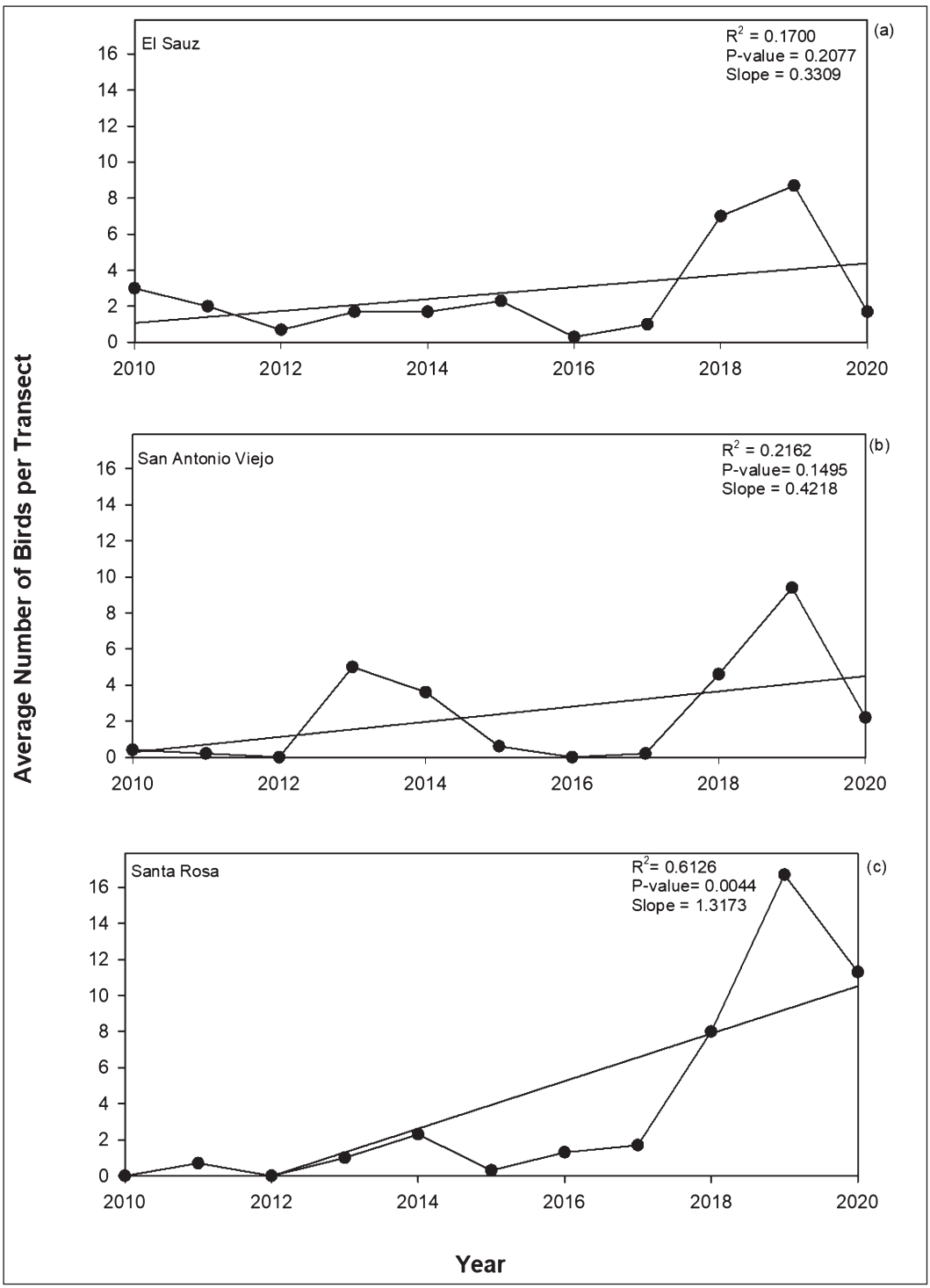

Figure 49. Non-breeding populations of House Wren on East Foundation ranches from 2010-2020.

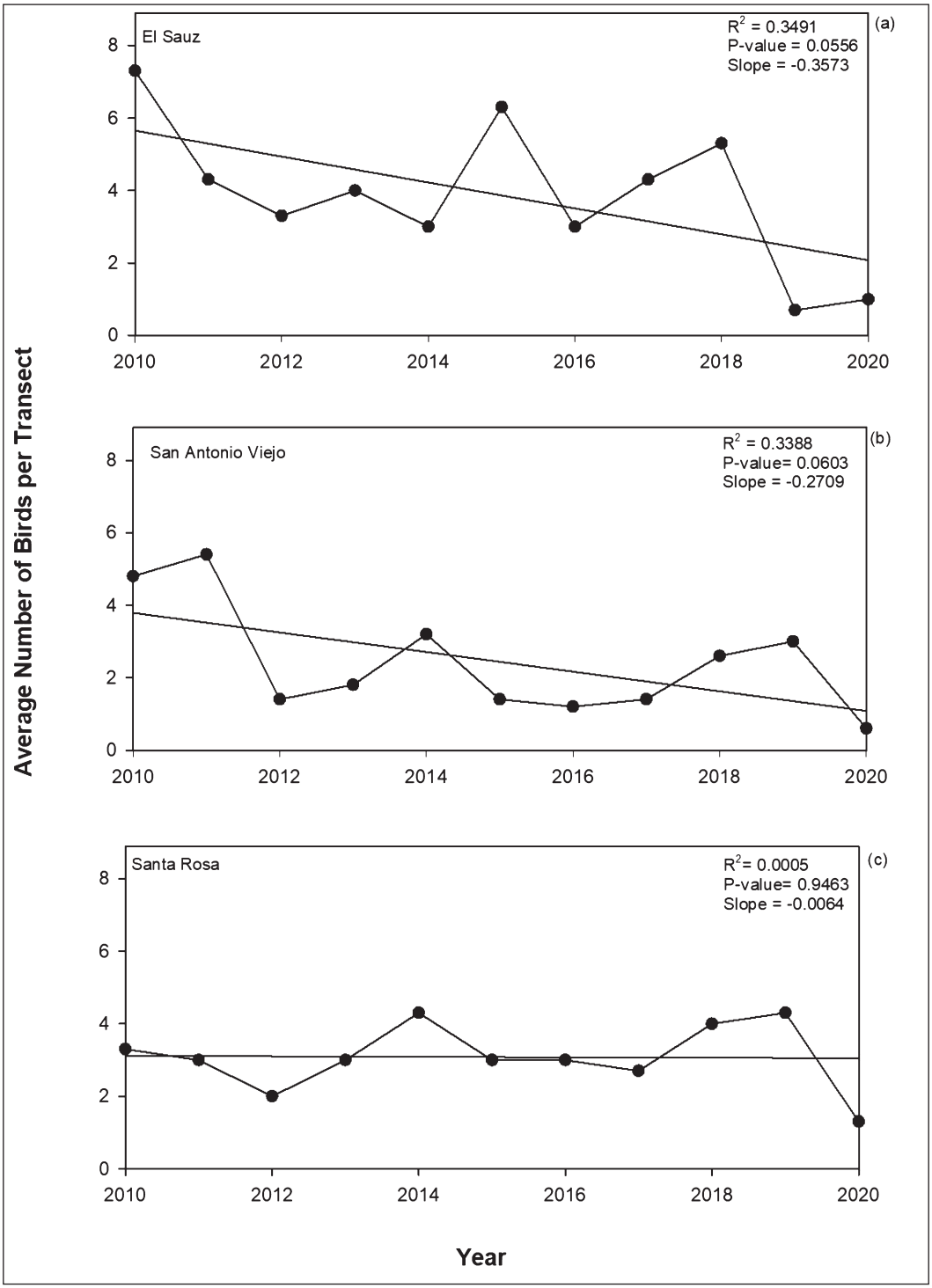

Figure 50. Non-breeding populations of Orange-crowned Warbler on East Foundation ranches from 2010-2020.

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.

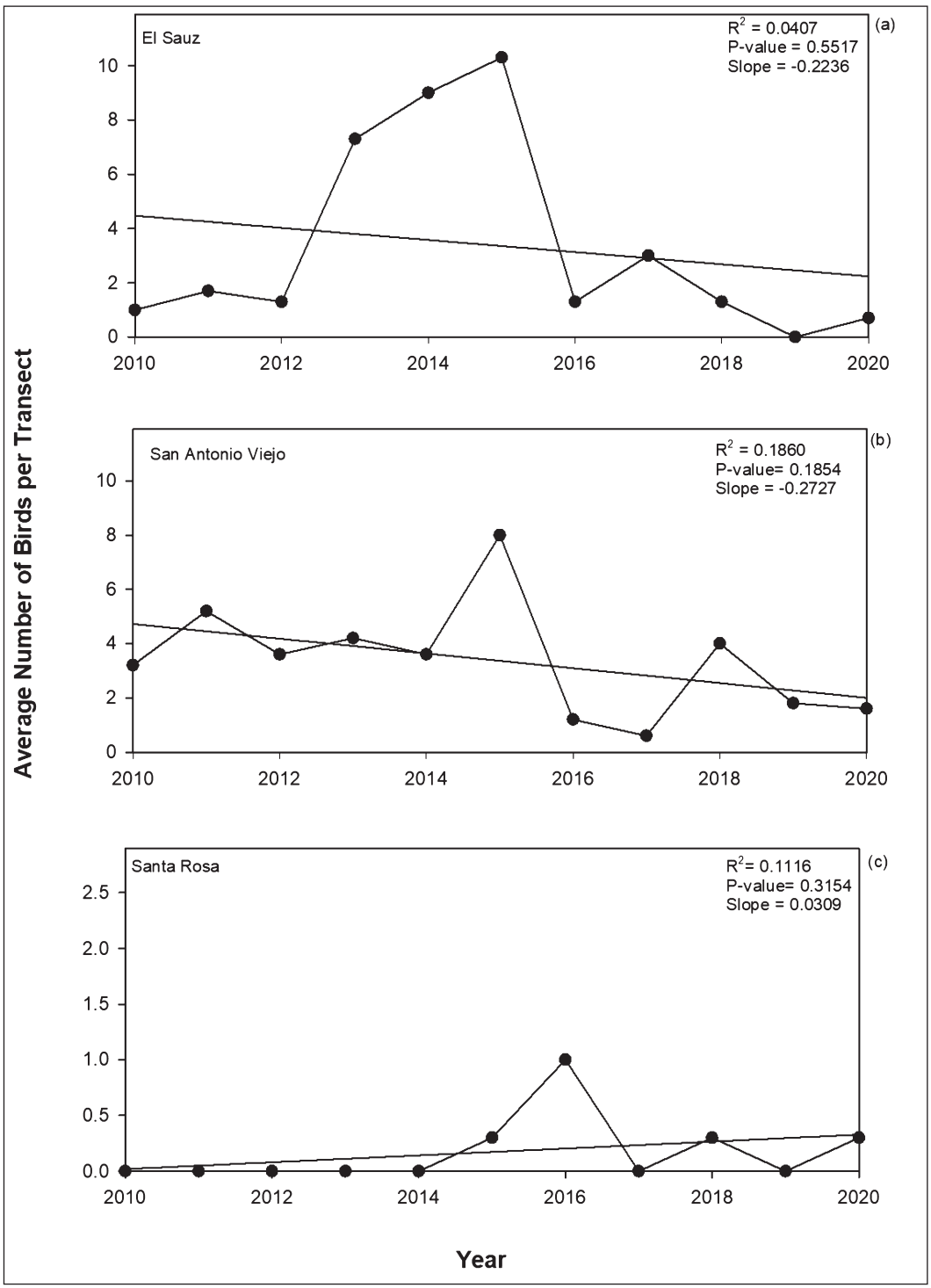

Figure 51. Non-breeding populations of Verdin on East Foundation ranches from 2010-2020.

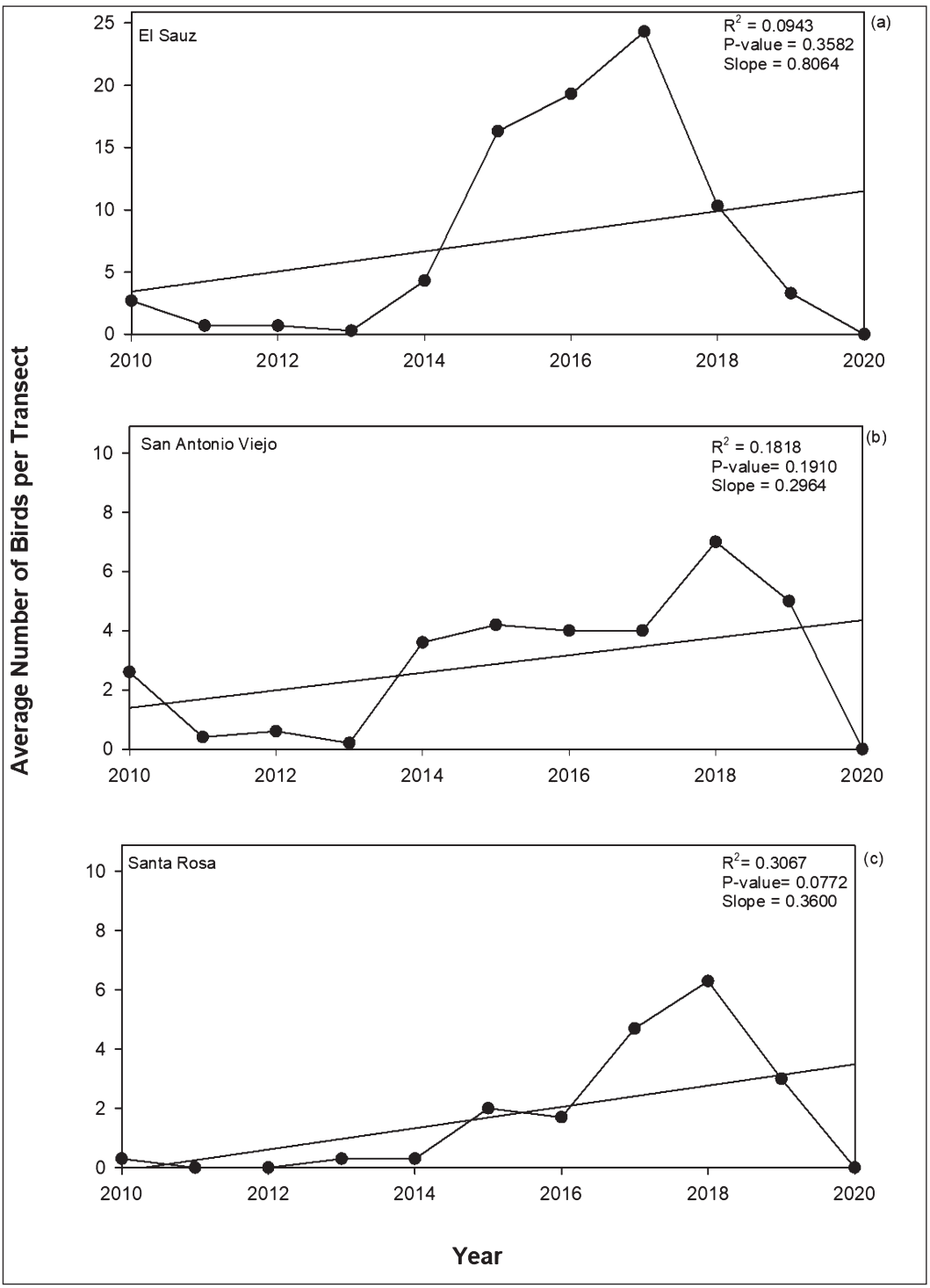

Figure 52. Non-breeding populations of White-eyed Vireo on East Foundation ranches from 2010-2020.

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

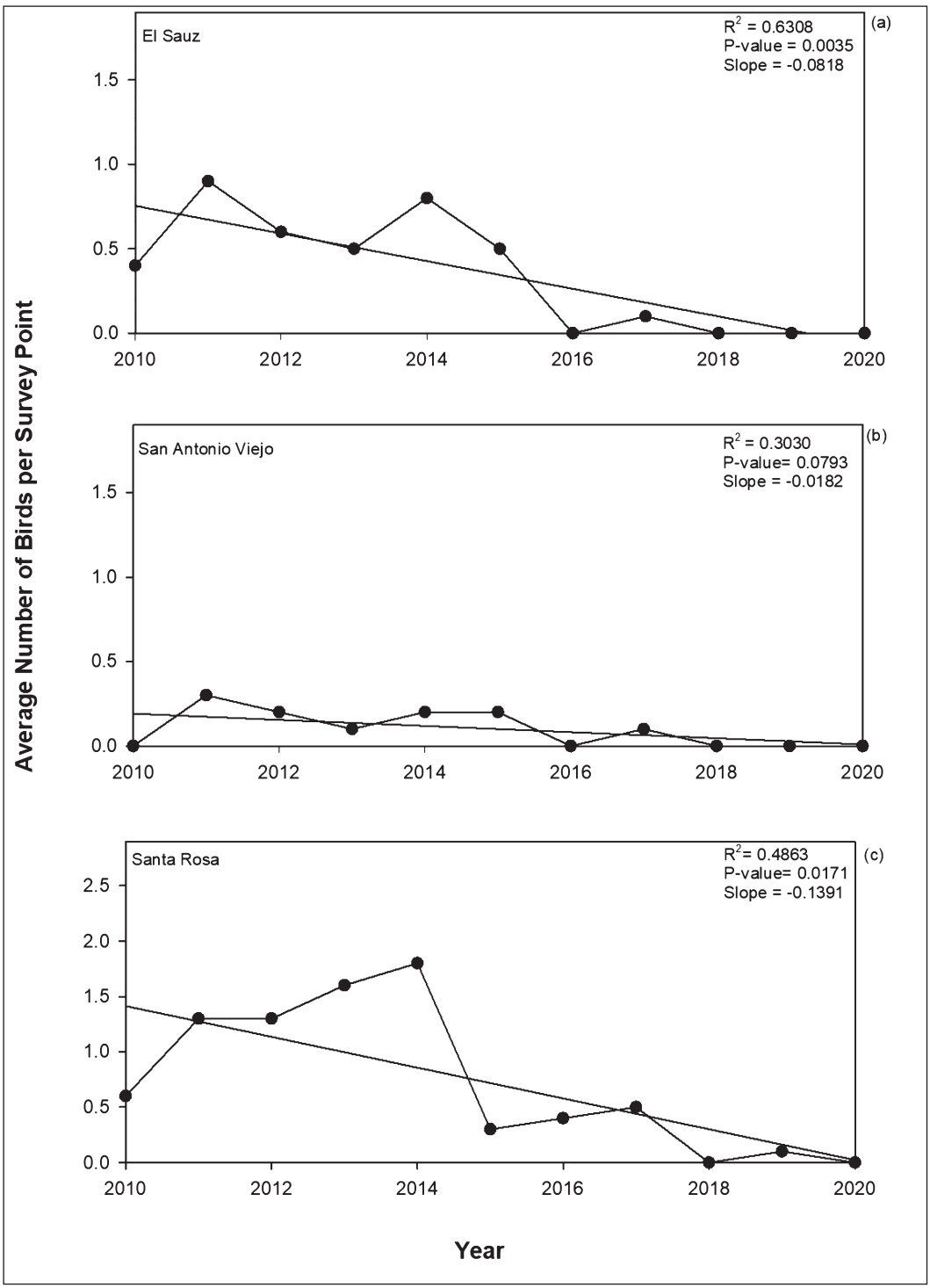

Figure 53. Breeding populations of Brown-crested Flycatcher on East Foundation ranches from 2010-2020.

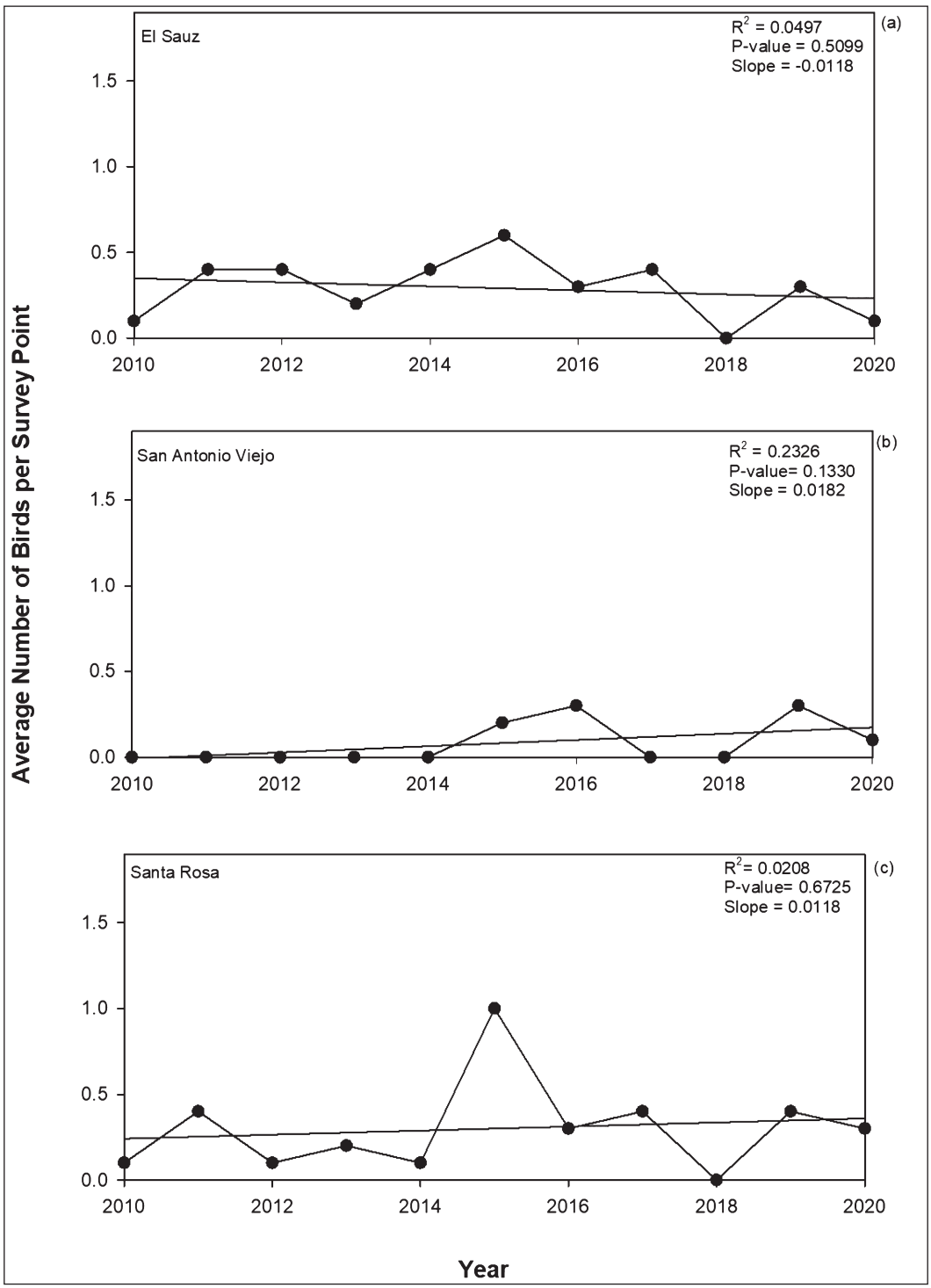

Figure 54. Breeding populations of Couch's Kingbird on East Foundation ranches from 2010-2020.

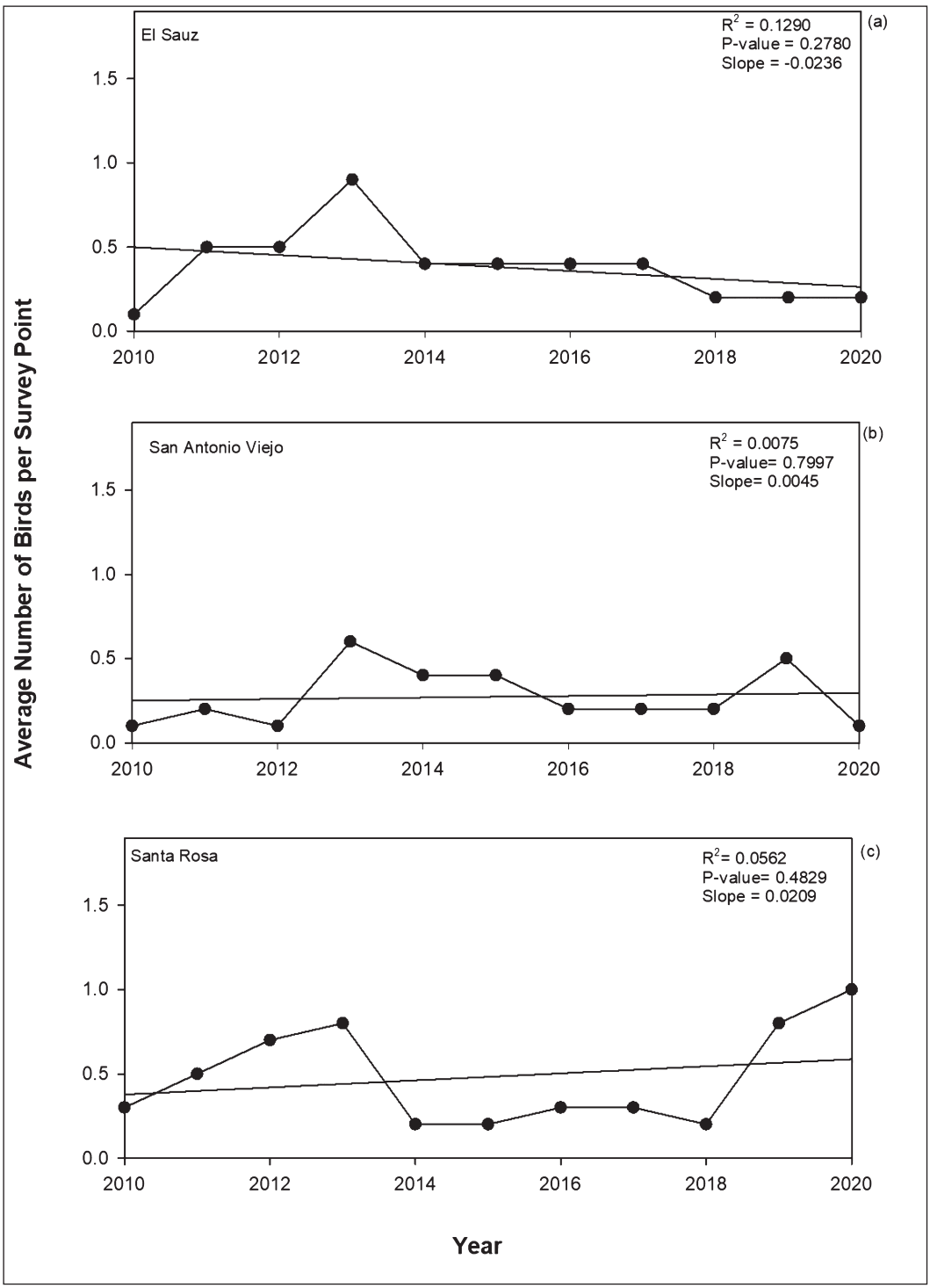

Figure 55. Breeding populations of Scissor-tailed Flycatcher on East Foundation ranches from 2010-2020.

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-

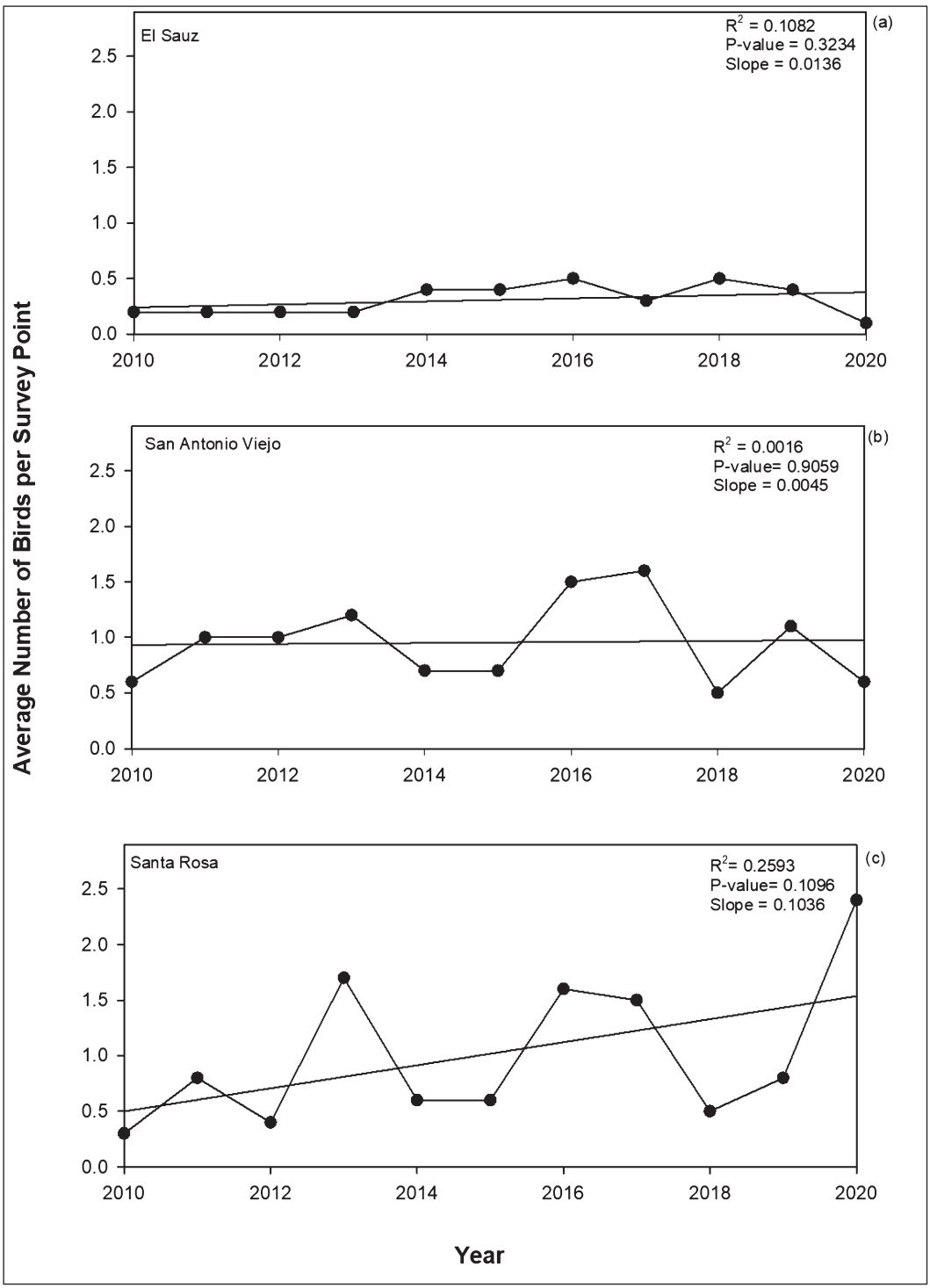

Figure 56. Breeding populations of Golden-fronted Woodpecker on East Foundation ranches from 2010-2020.

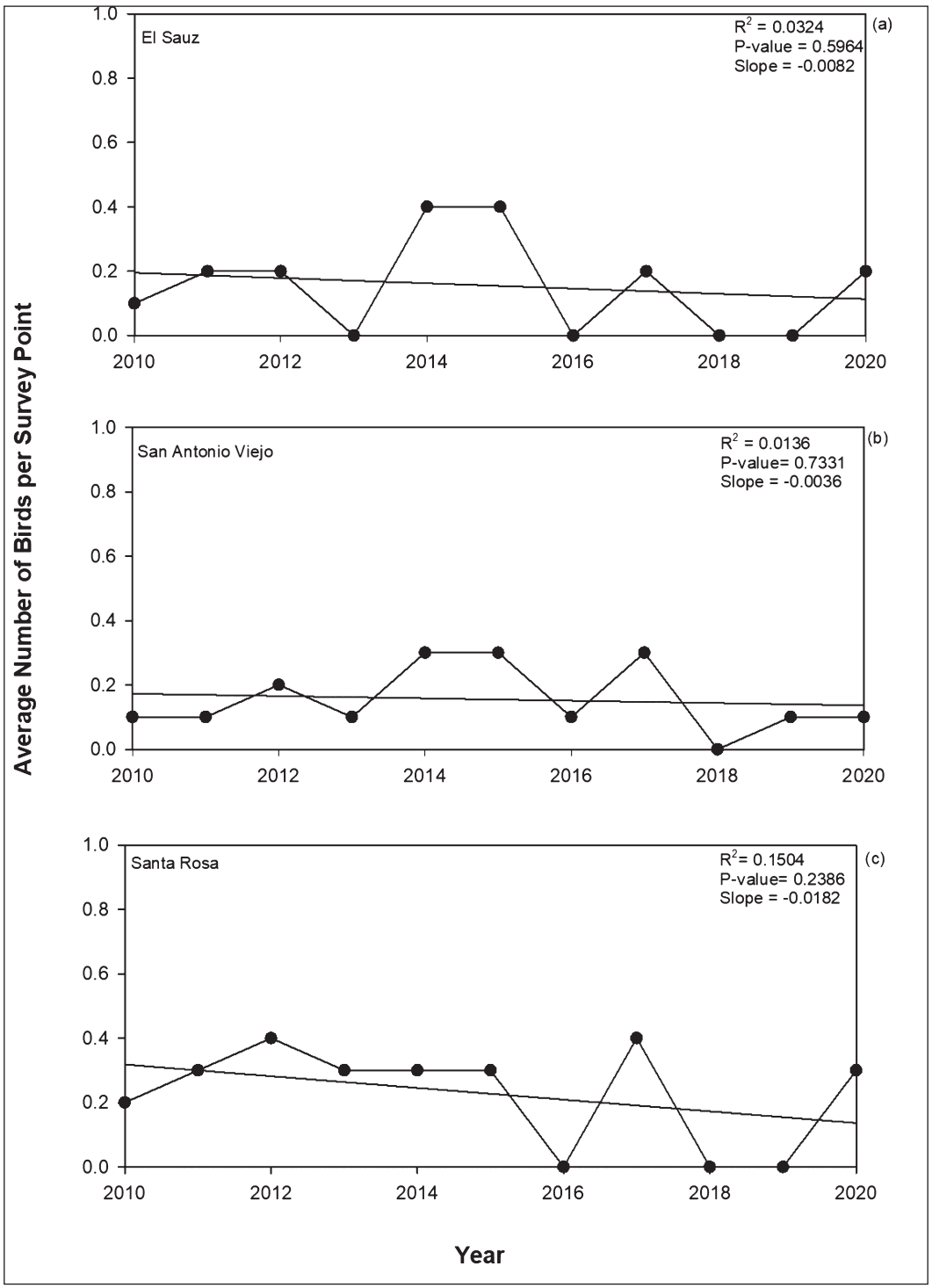

Figure 57. Breeding populations of Ladder-backed Woodpecker on East Foundation ranches from 2010-2020.

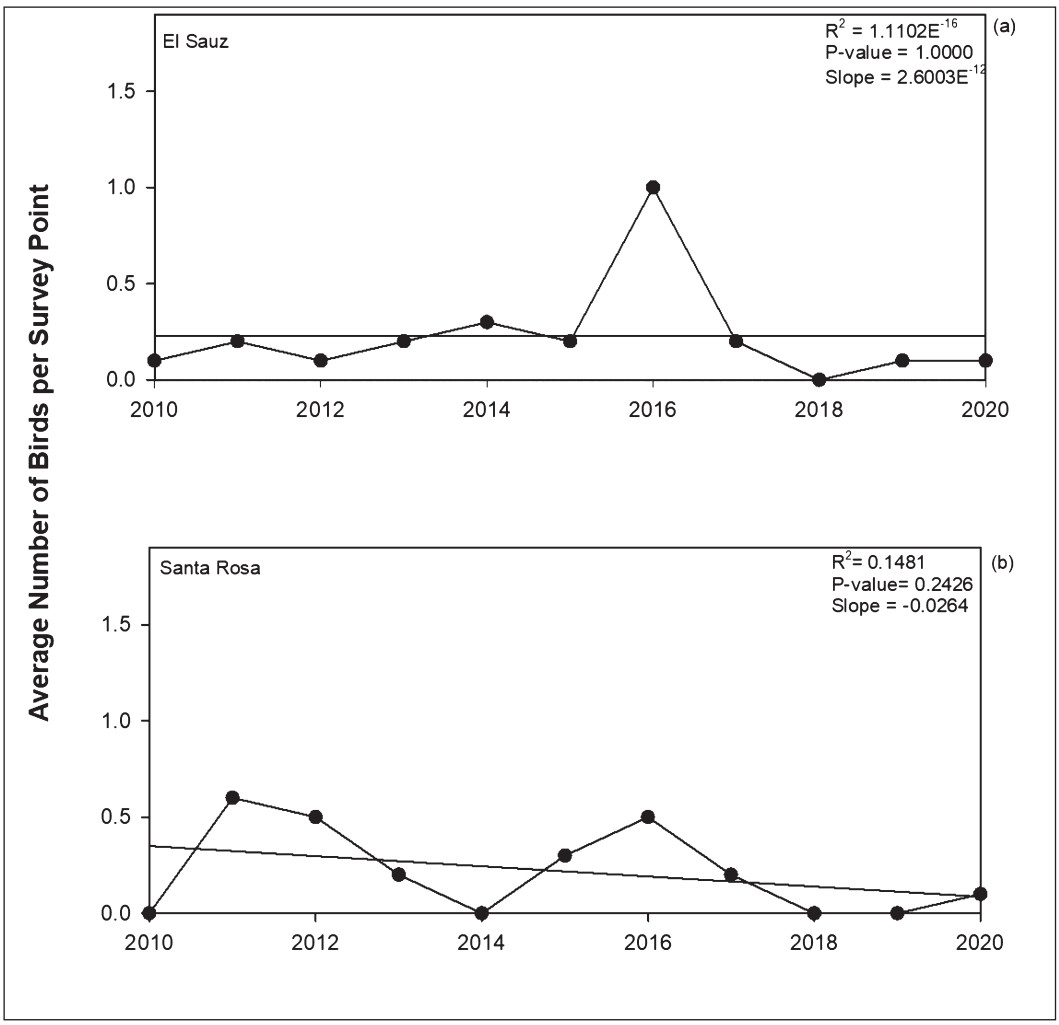

Figure 58. Breeding populations of Black-bellied Whistling-Duck on East Foundation ranches from 2010-2020.

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

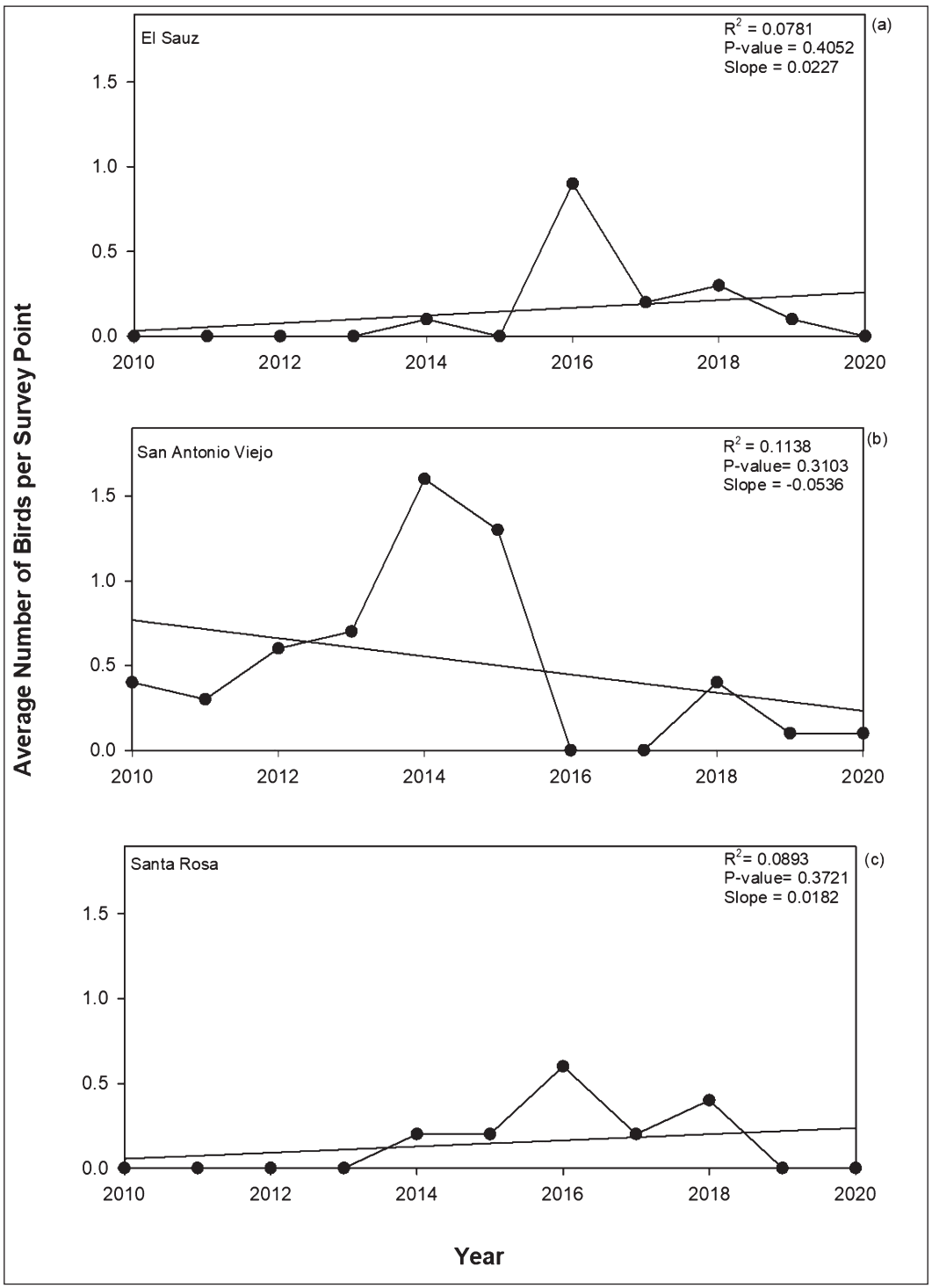

Figure 59. Breeding populations of Black-throated Sparrow on East Foundation ranches from 2010-2020.

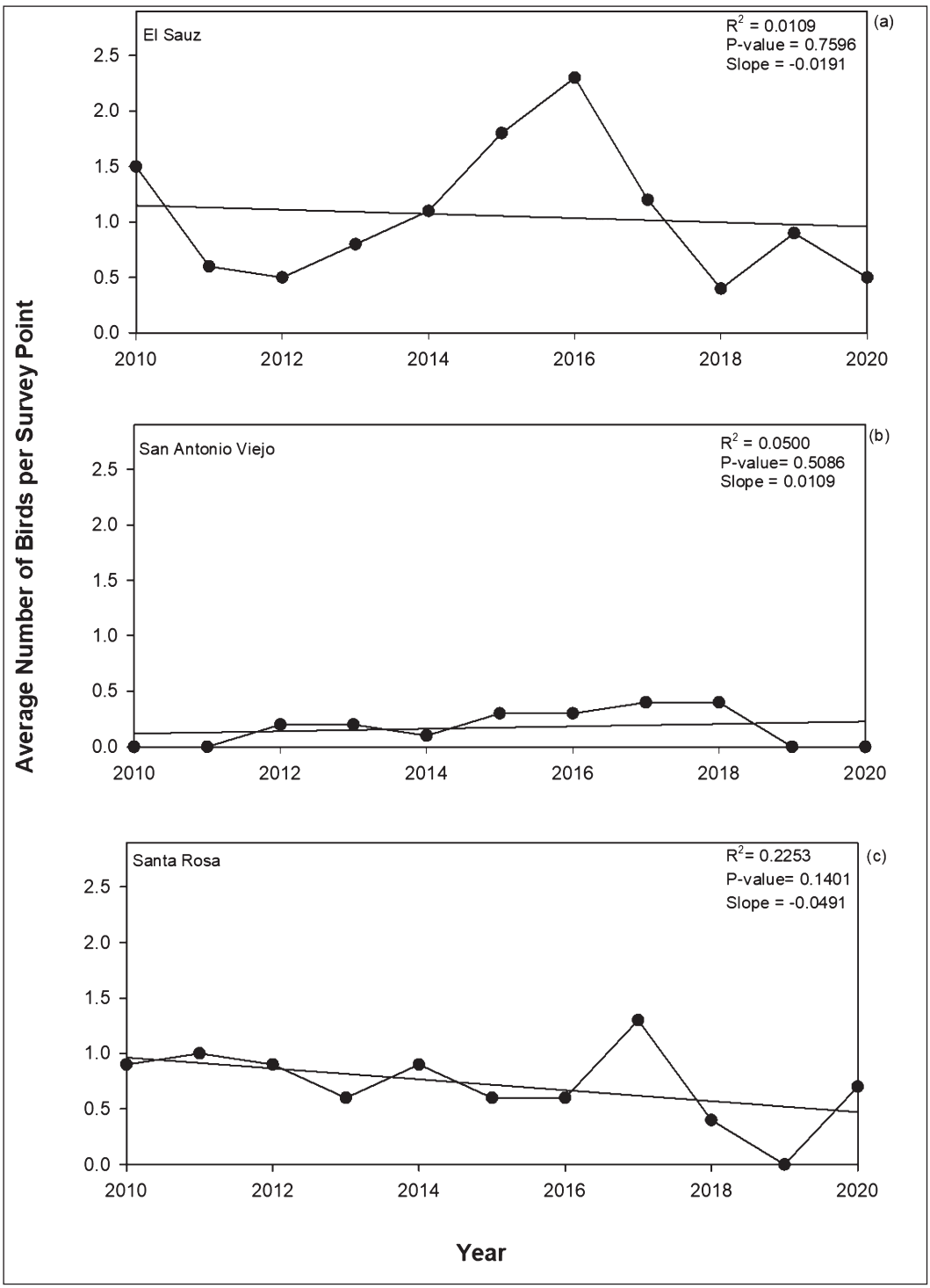

Figure 60. Breeding populations of Bronzed Cowbird on East Foundation ranches from 2010-2020.

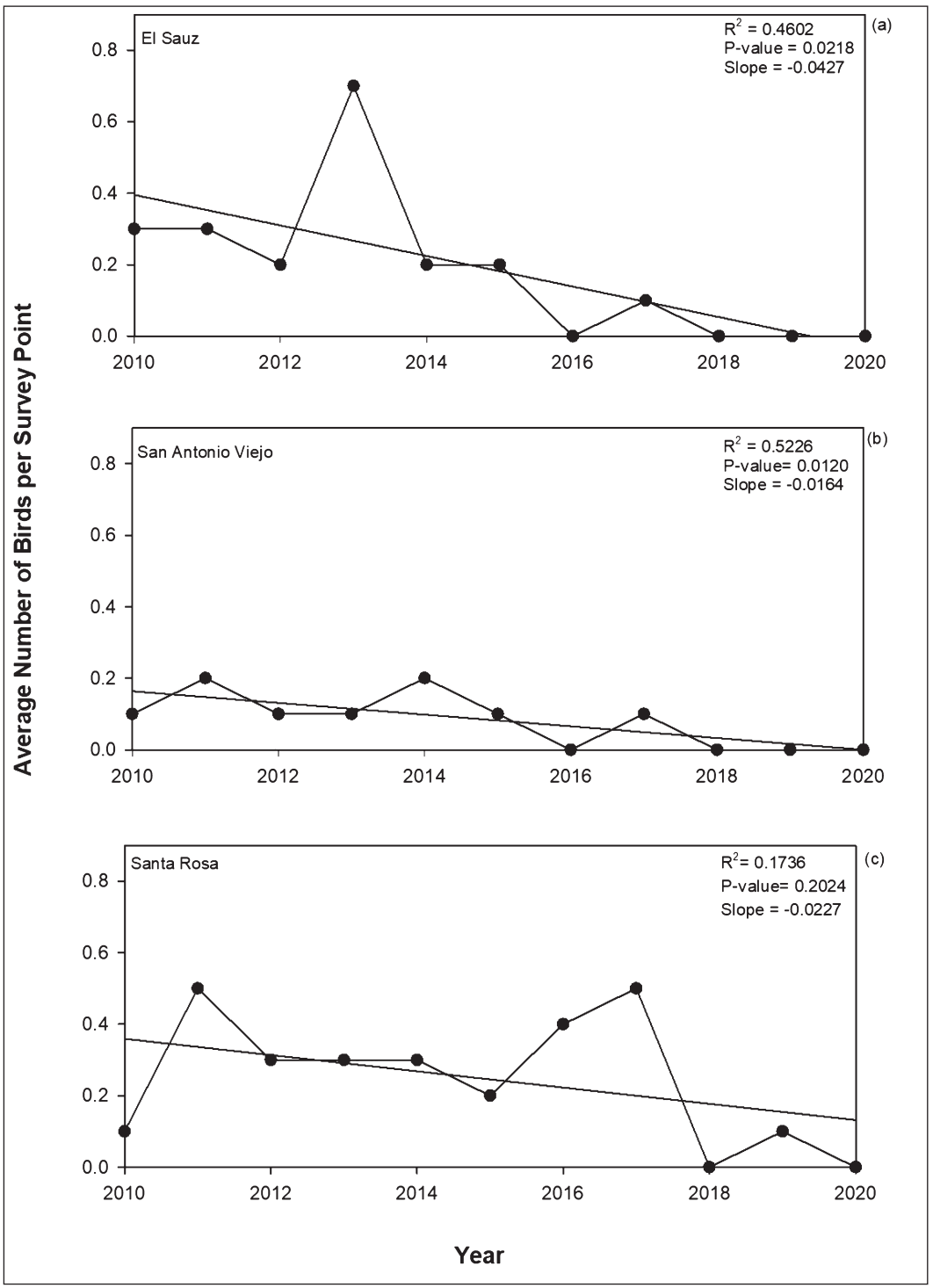

Figure 61. Breeding populations of Brown-headed Cowbird on East Foundation ranches from 2010-2020.

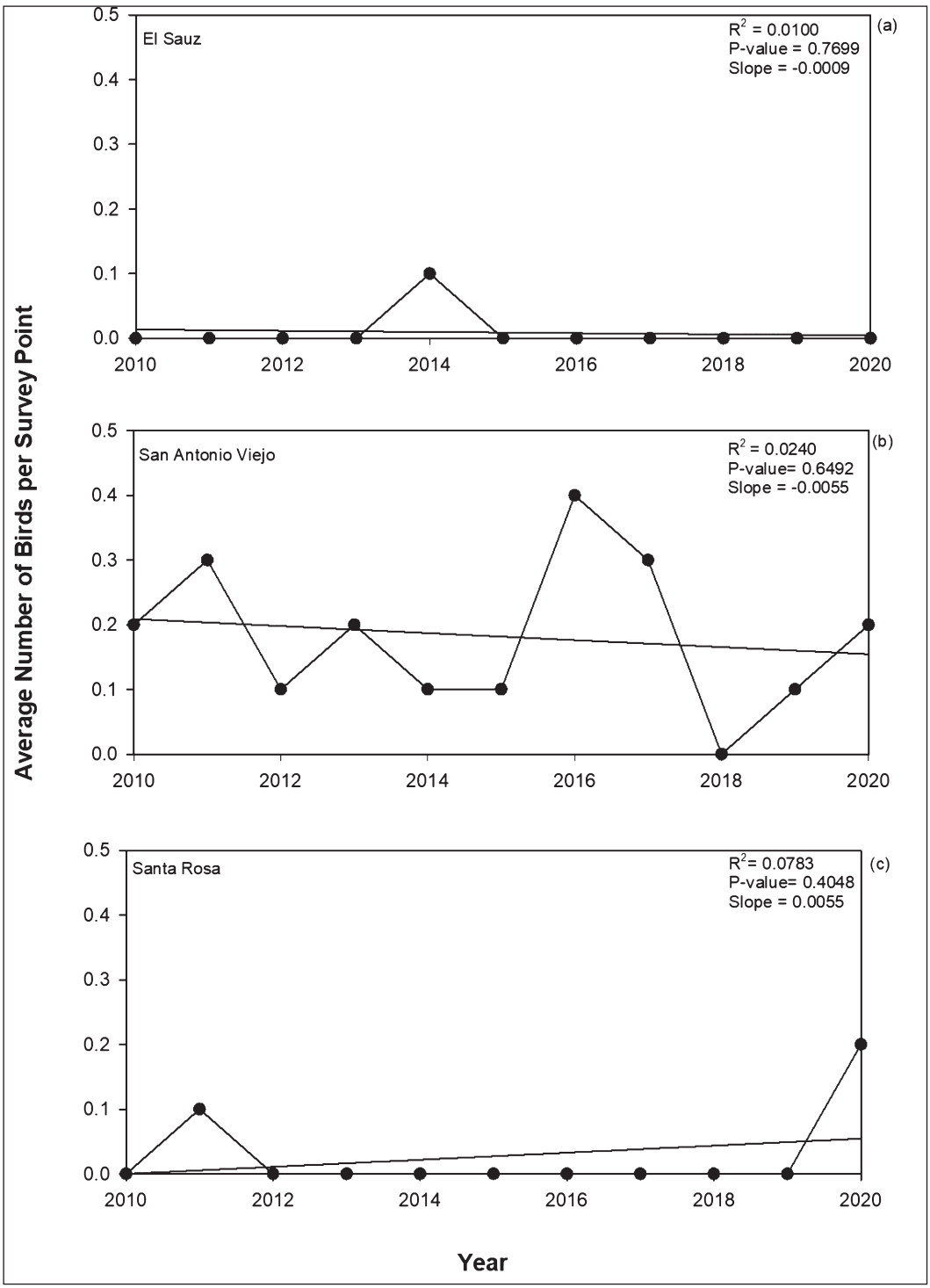

Figure 62. Breeding populations of Cactus Wren on East Foundation ranches from 2010-2020.

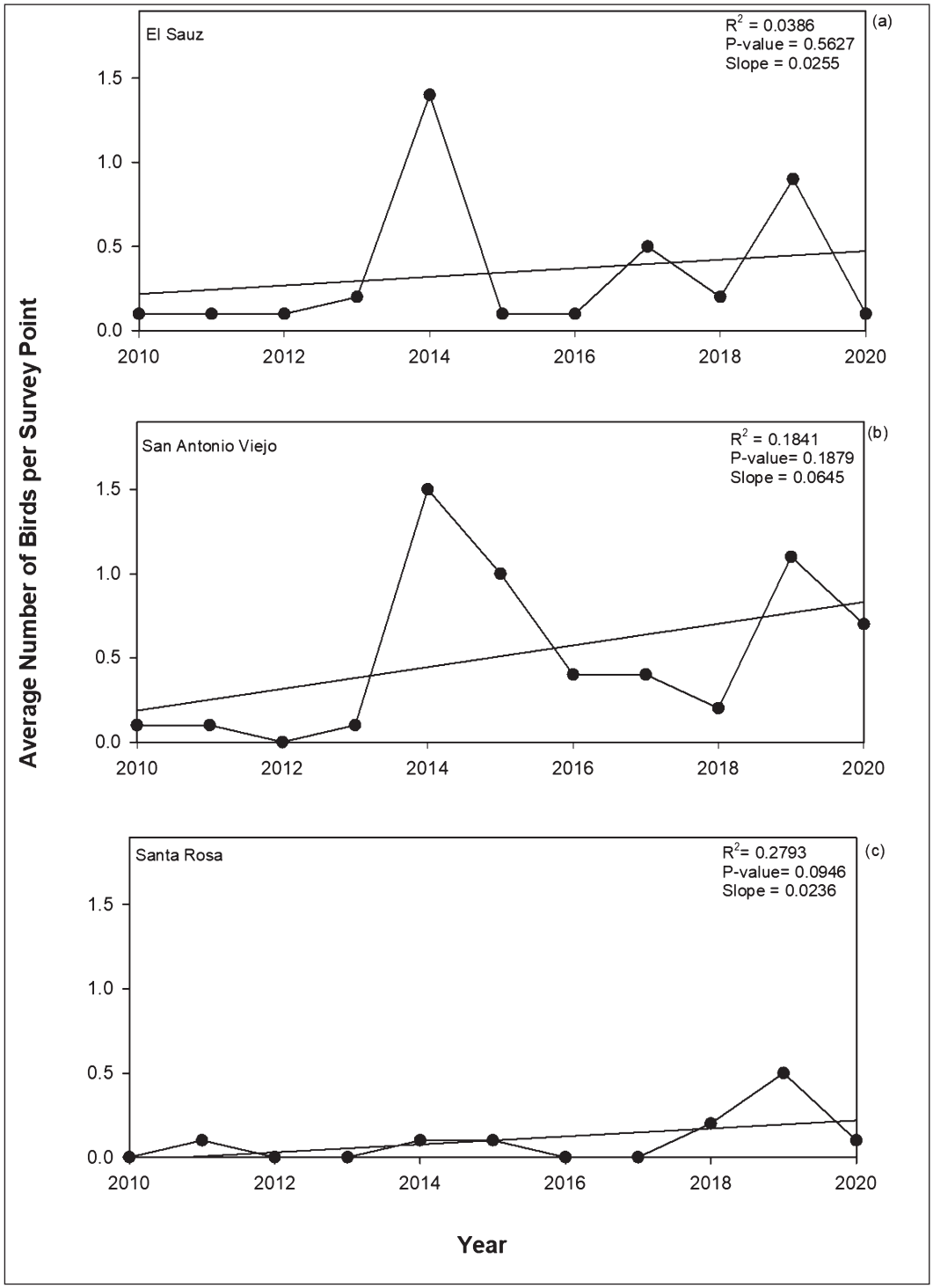

Figure 63. Breeding populations of Cassin's Sparrow on East Foundation ranches from 2010-2020.

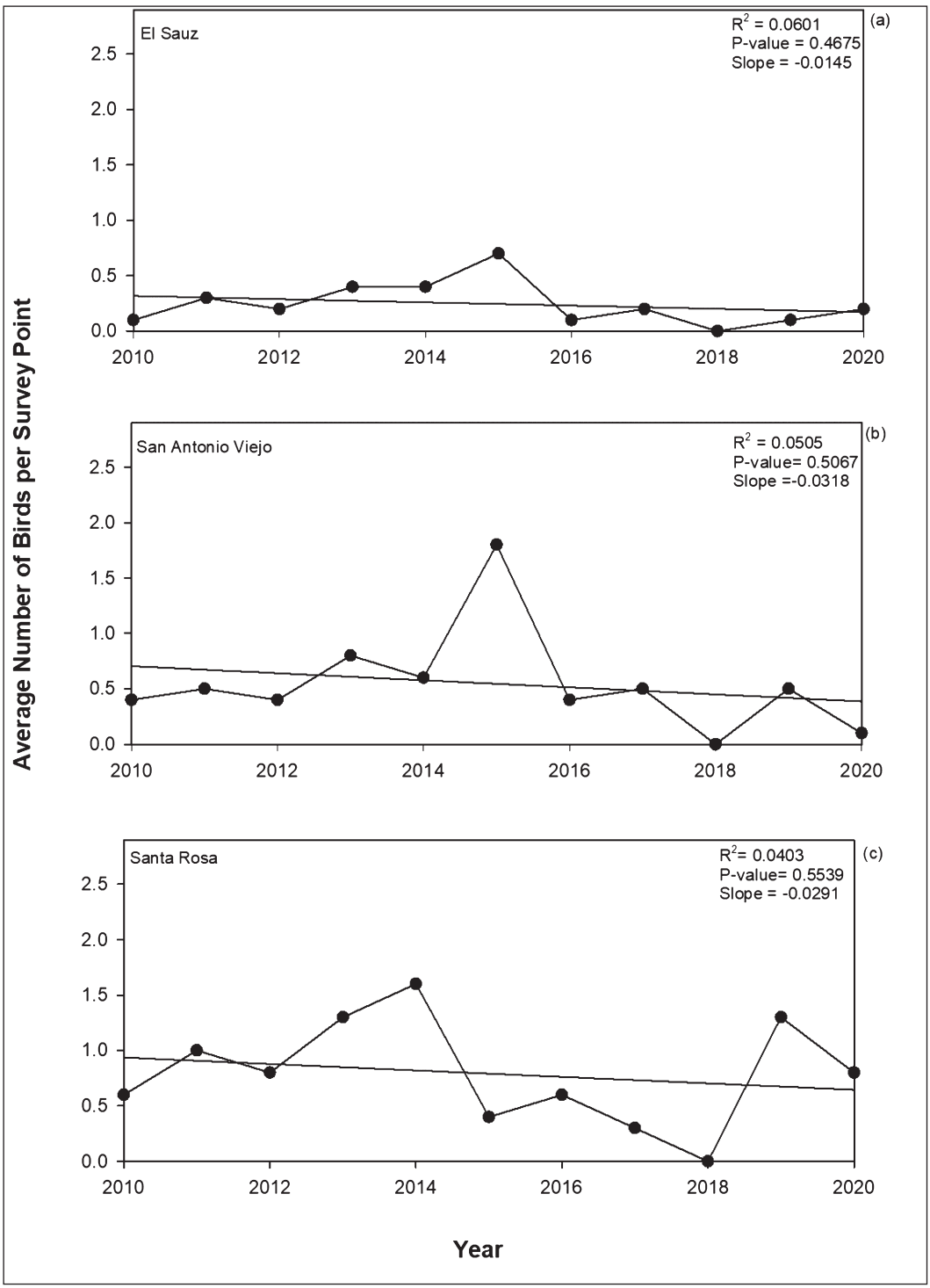

Figure 64. Breeding populations of Common Ground Dove on East Foundation ranches from 2010-2020.

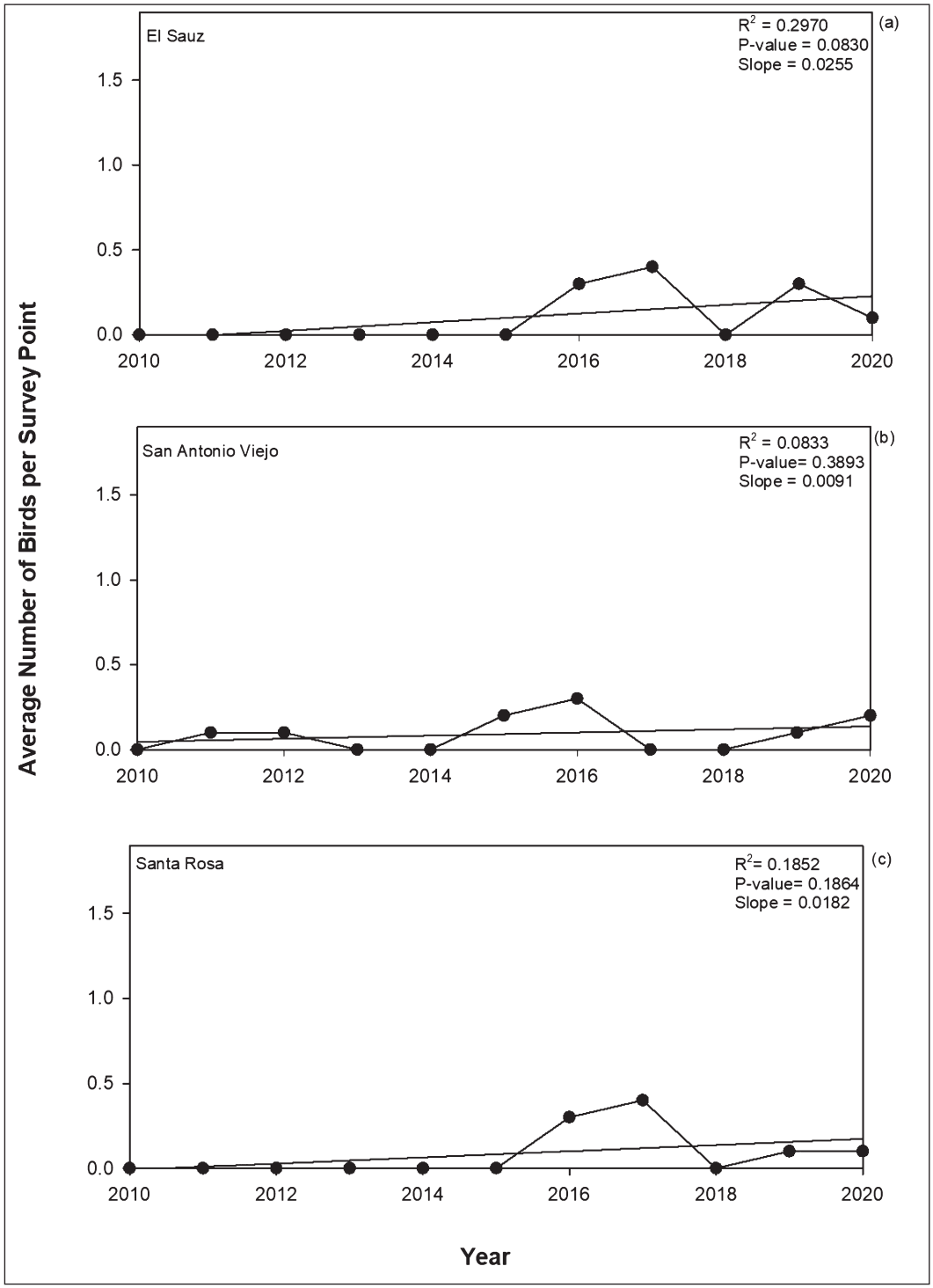

Figure 65. Breeding populations of Curve-billed Thrasher on East Foundation ranches from 2010-2020.

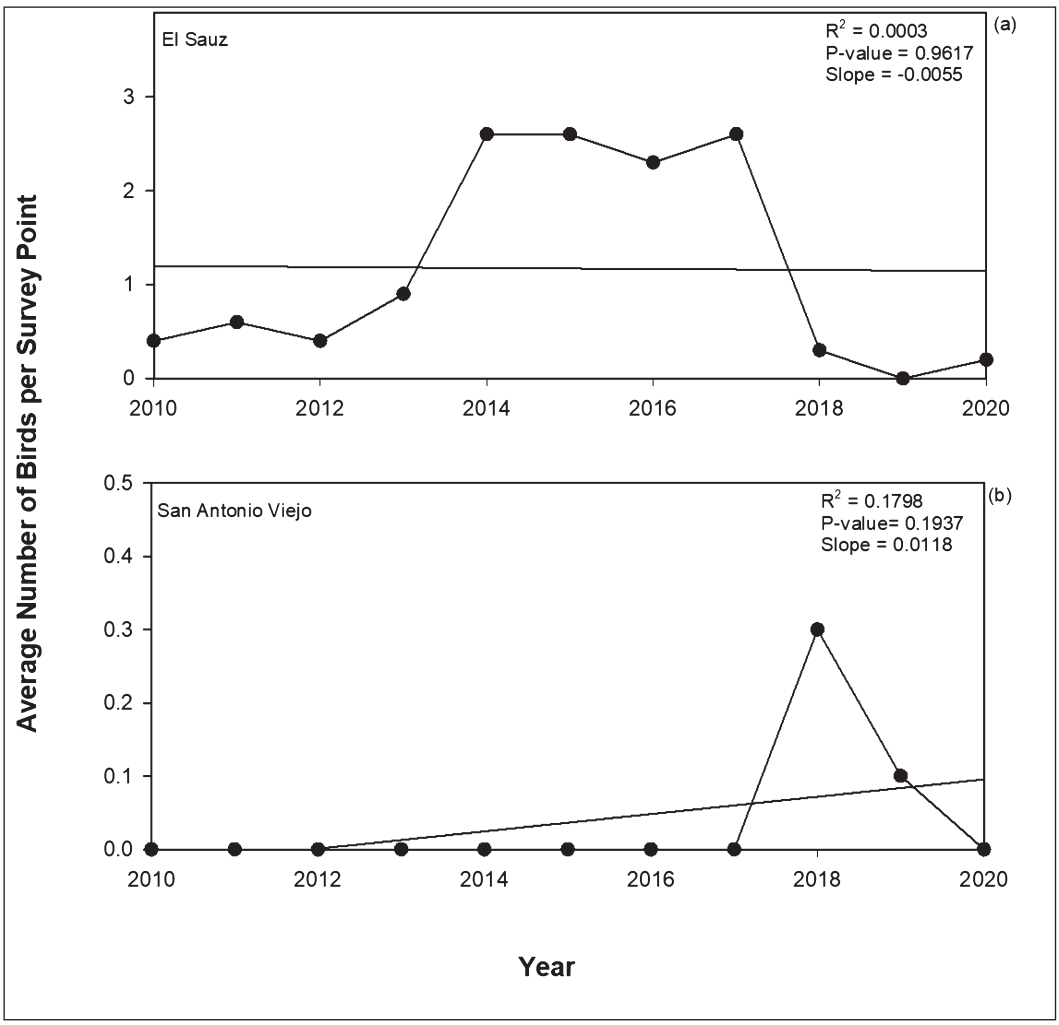

Figure 66. Breeding populations of Eastern Meadowlark on East Foundation ranches from 2010-2020.

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).

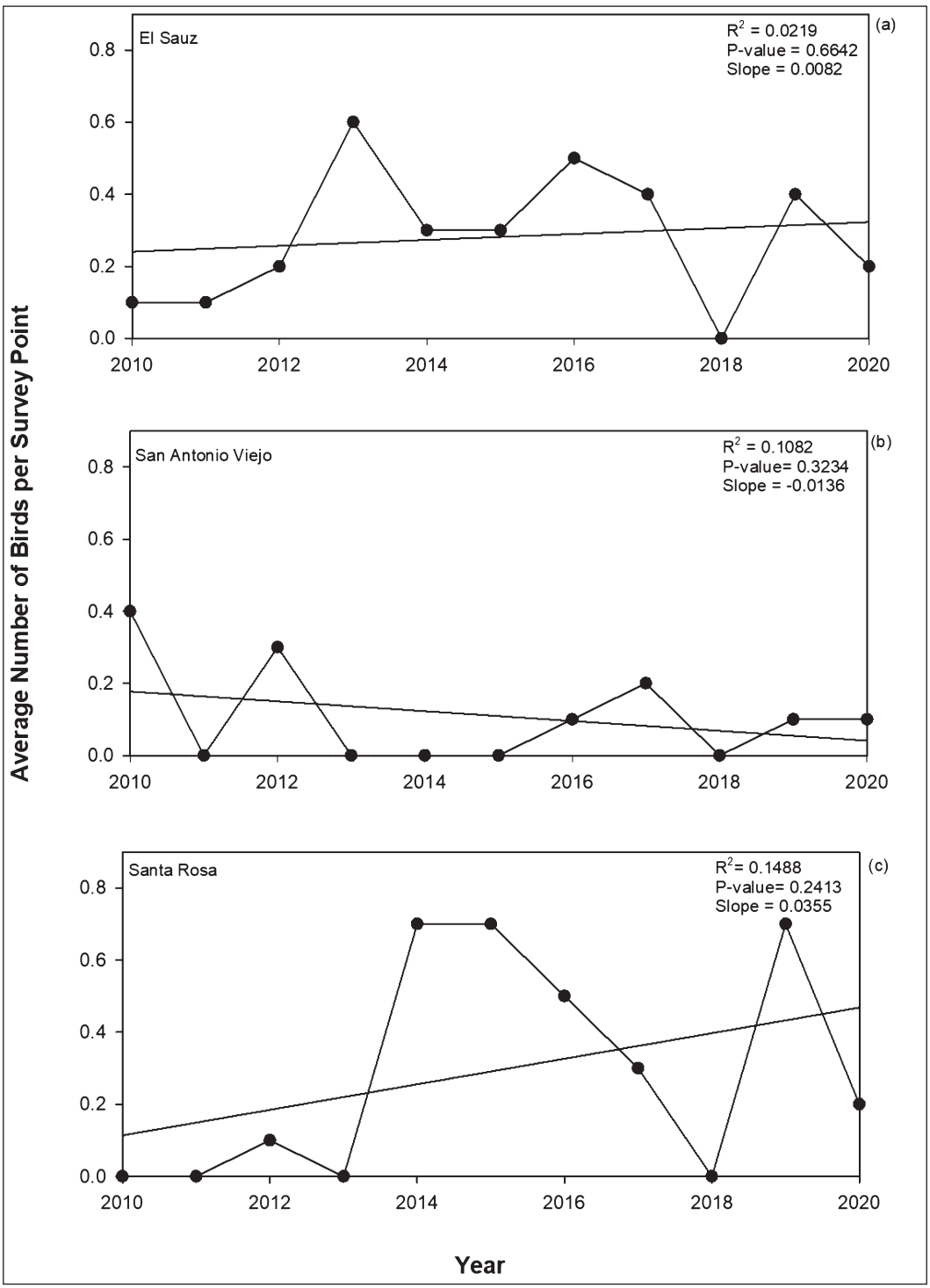

Figure 67. Breeding populations of Great-tailed Grackle

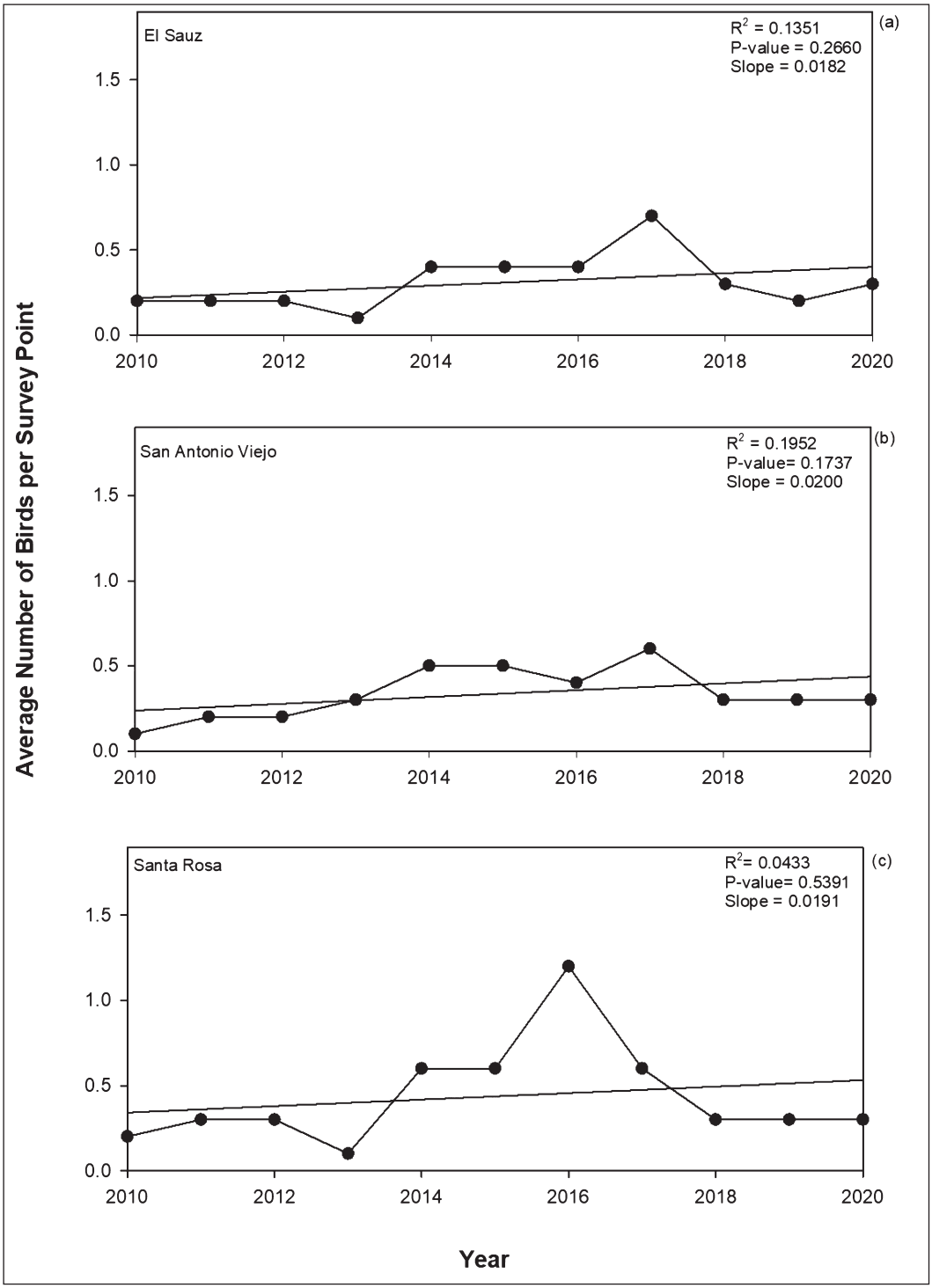

Figure 68. Breeding populations of Greater Roadrunner on East Foundation ranches from 2010-2020.

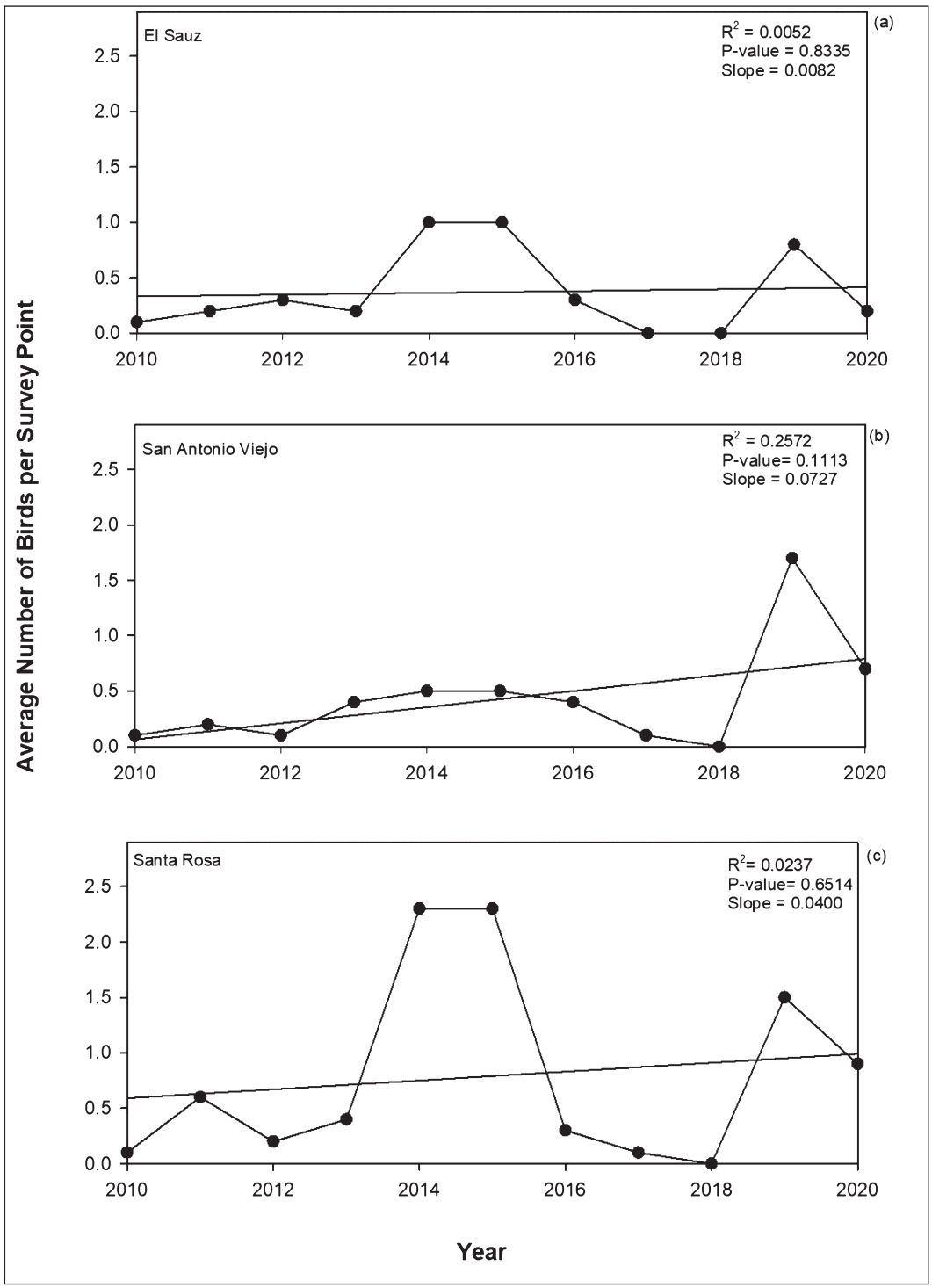

Figure 69. Breeding populations of Lark Sparrow on East Foundation ranches from 2010-2020.

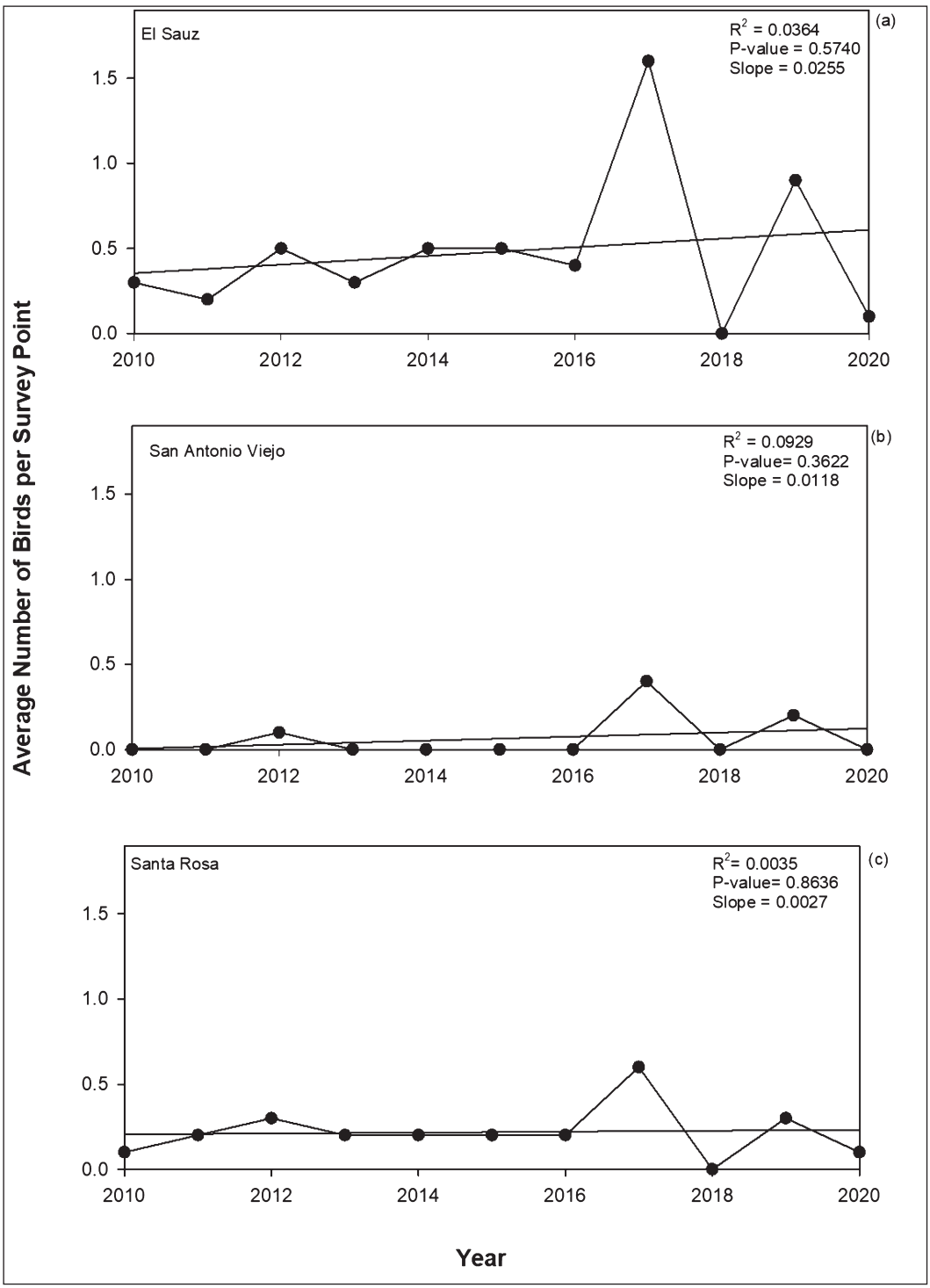

Figure 70. Breeding populations of Long-billed Thrasher on East Foundation ranches from 2010-2020.

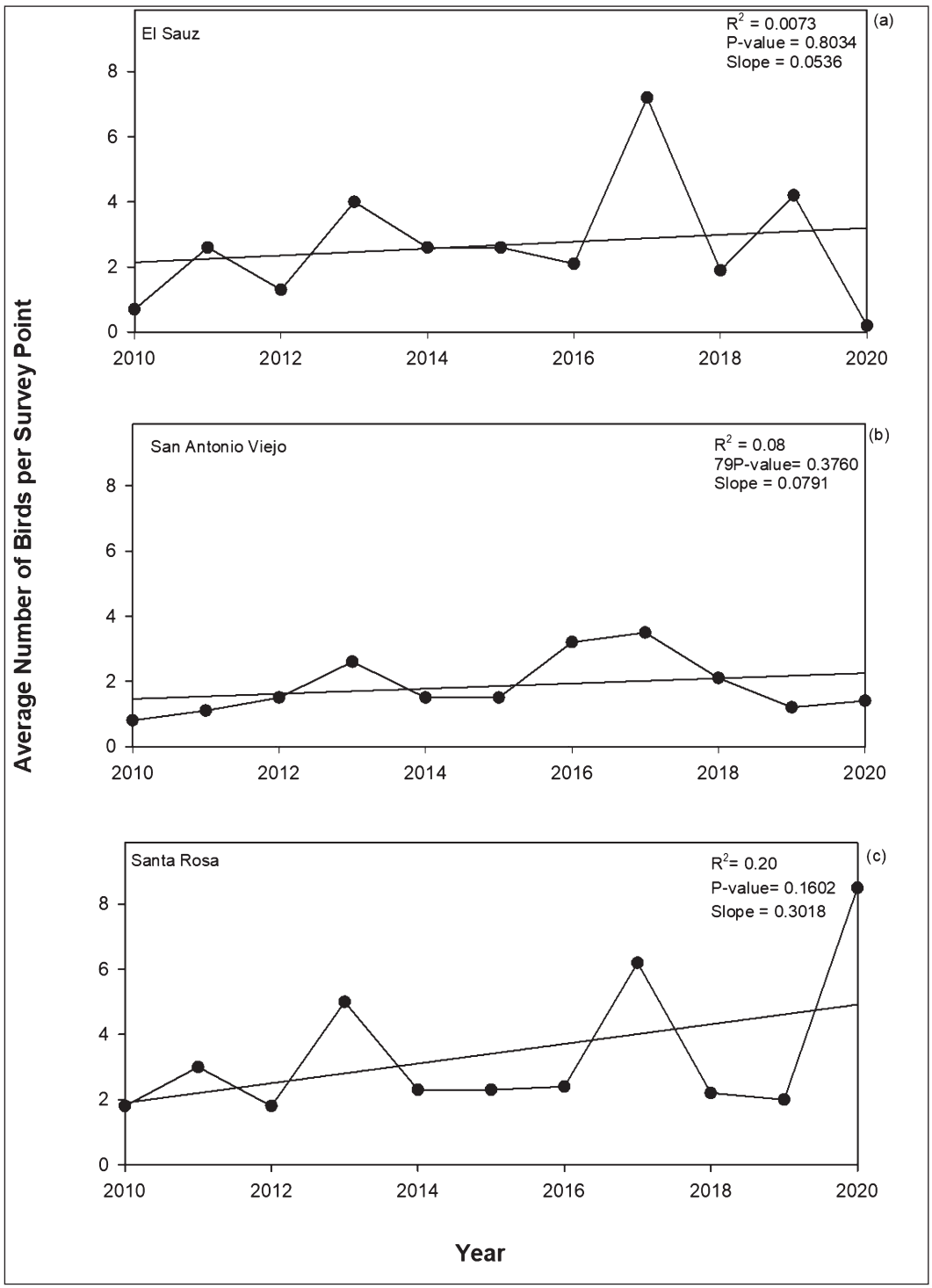

Figure 71. Breeding populations of Mourning Dove on East Foundation ranches from 2010-2020.

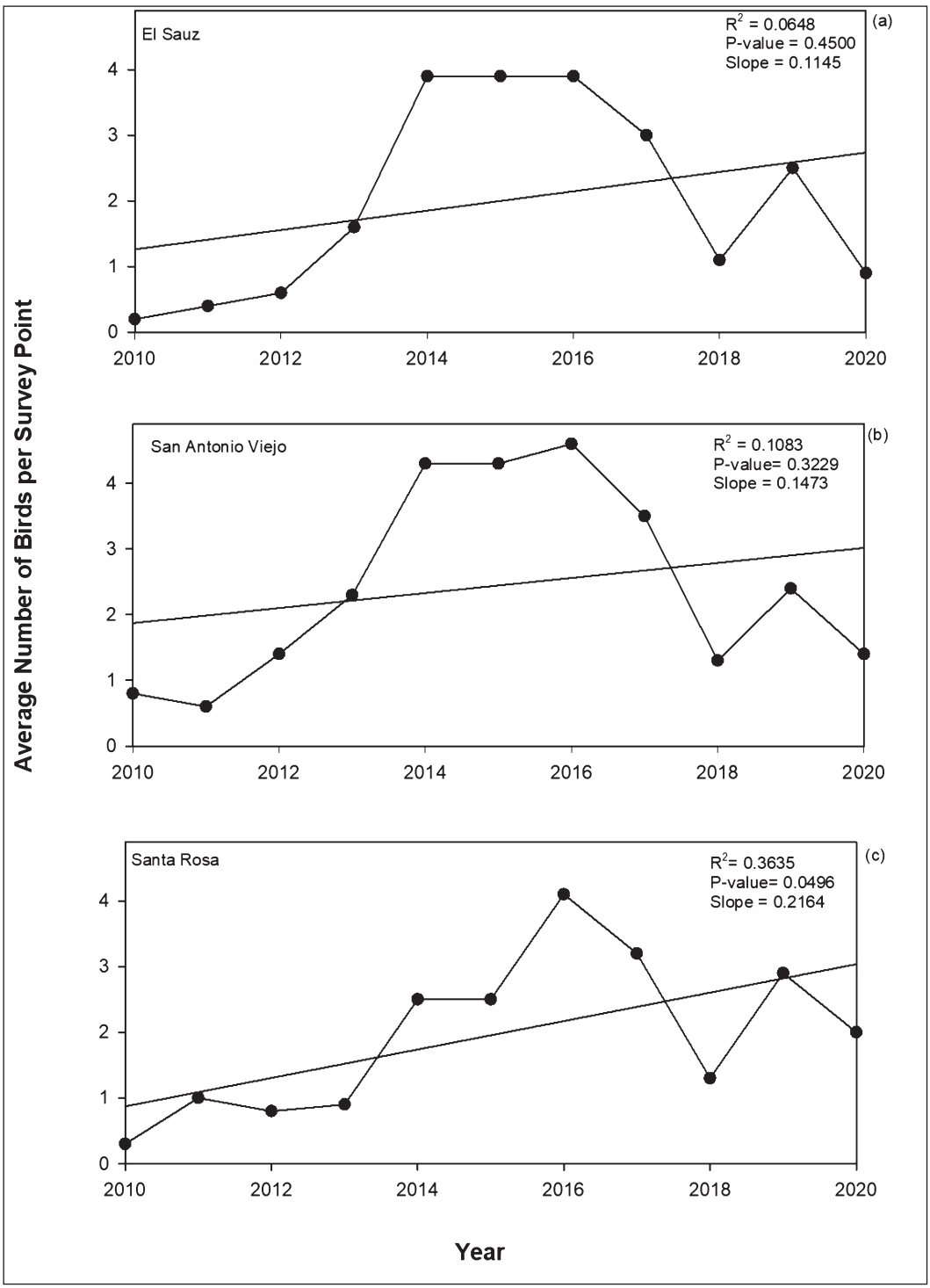

Figure 72. Breeding populations of Northern Bobwhite on East Foundation ranches from 2010-2020.

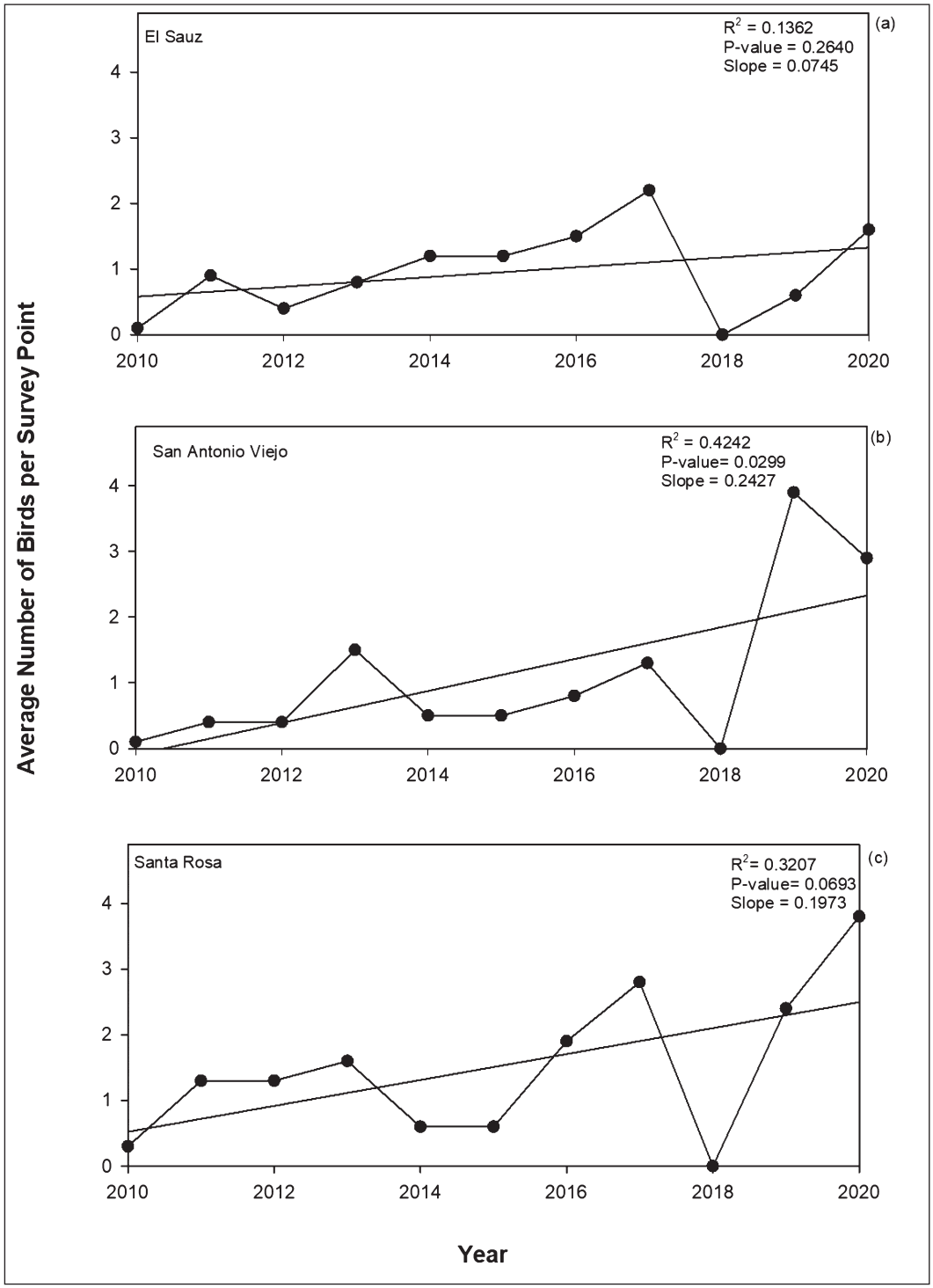

Figure 73. Breeding populations of Northern Cardinal on East Foundation ranches from 2010-2020.

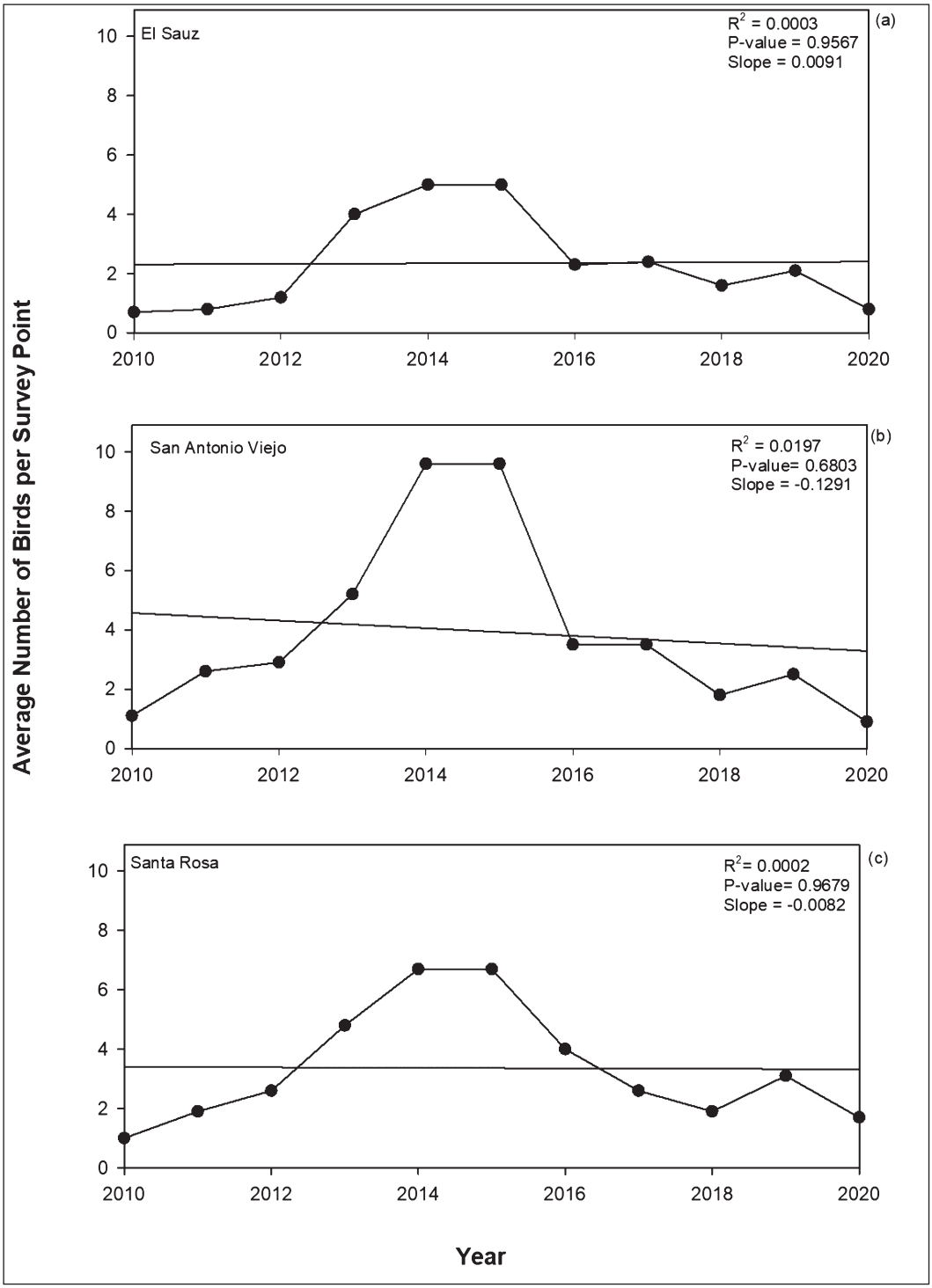

Figure 74. Breeding populations of Northern Mockingbird on East Foundation ranches from 2010-2020.

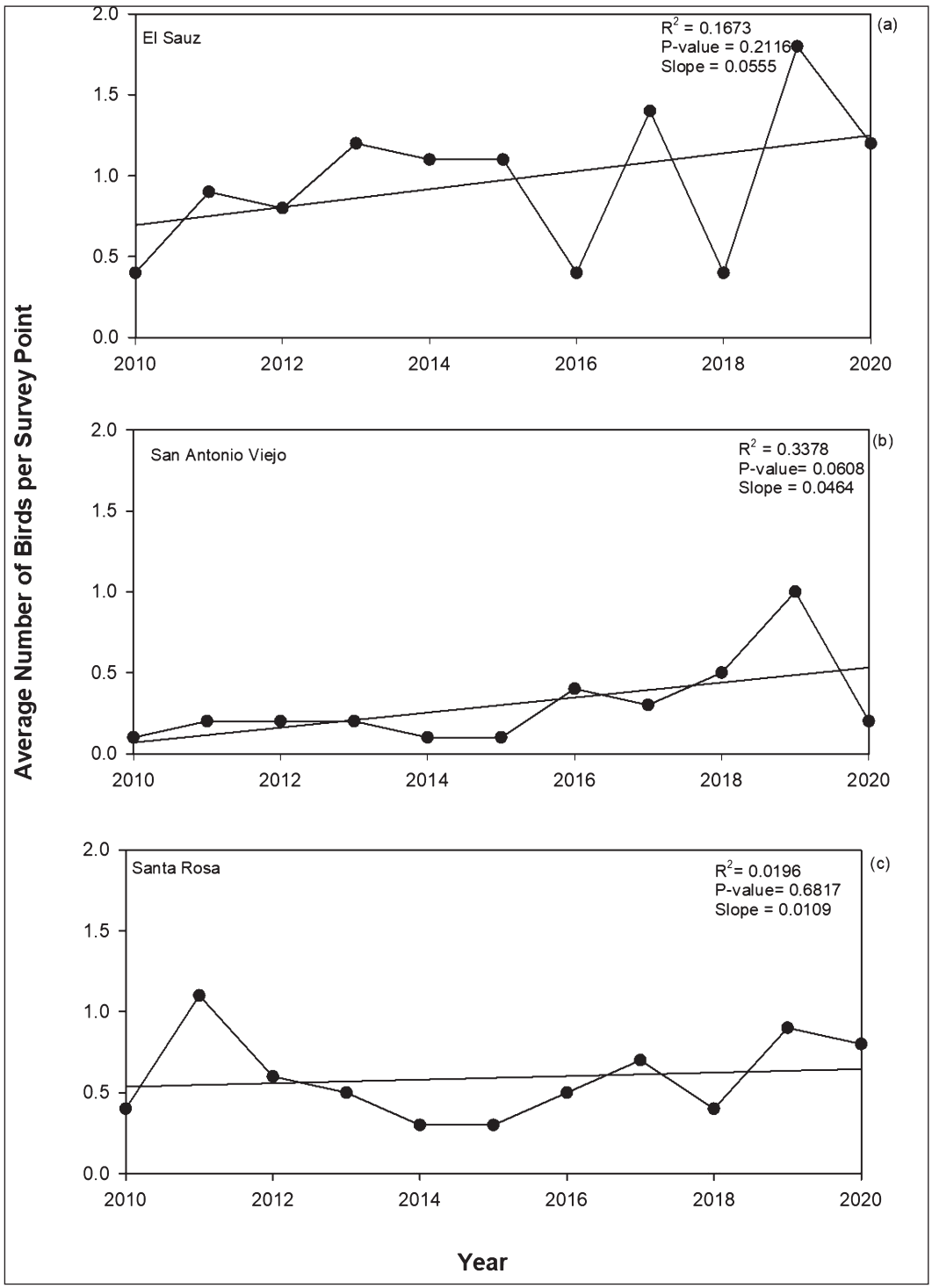

Figure 75. Breeding populations of Olive Sparrow on East Foundation ranches from 2010-2020.

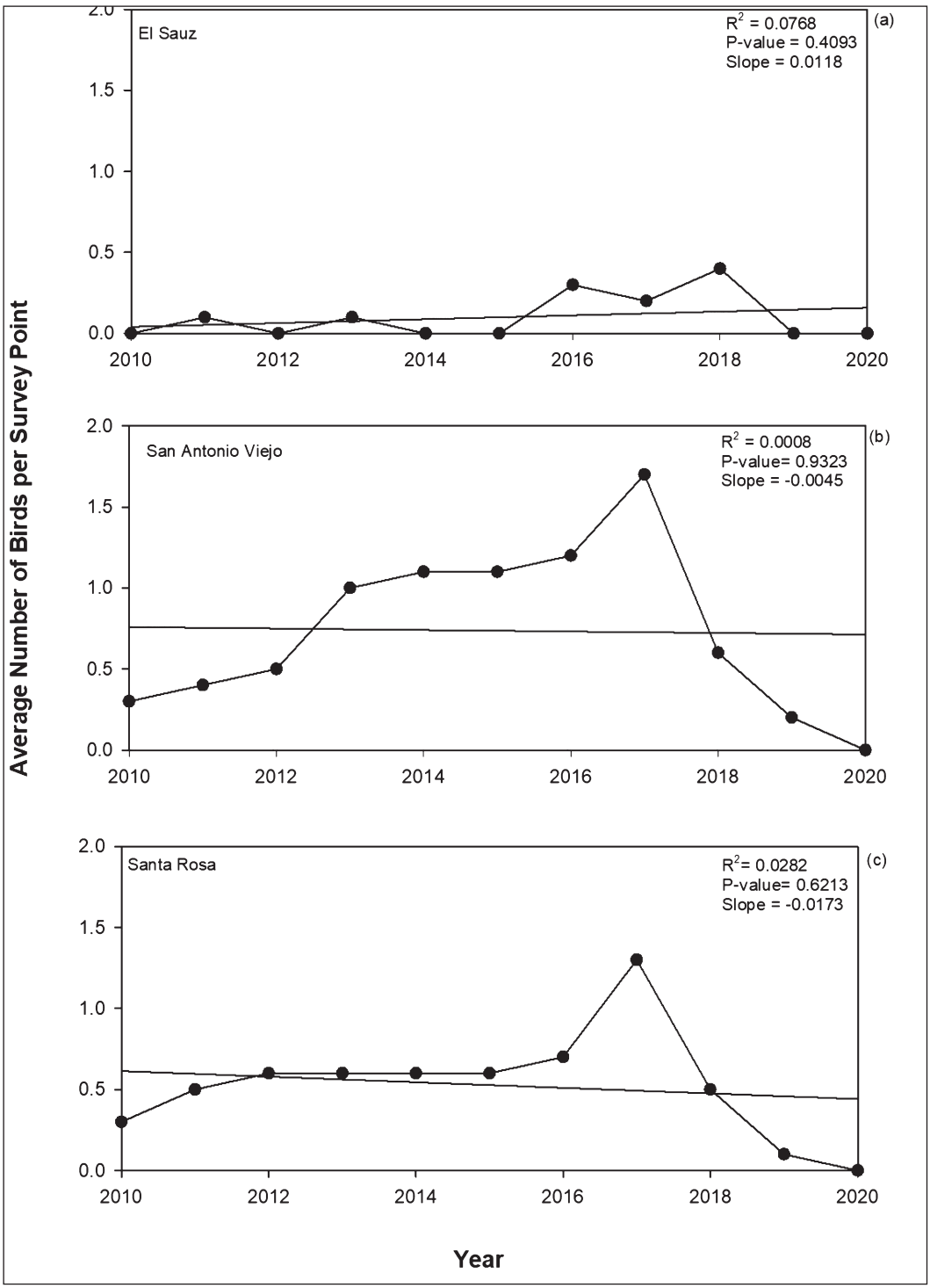

Figure 76. Breeding populations of Painted Bunting on East Foundation ranches from 2010-2020.

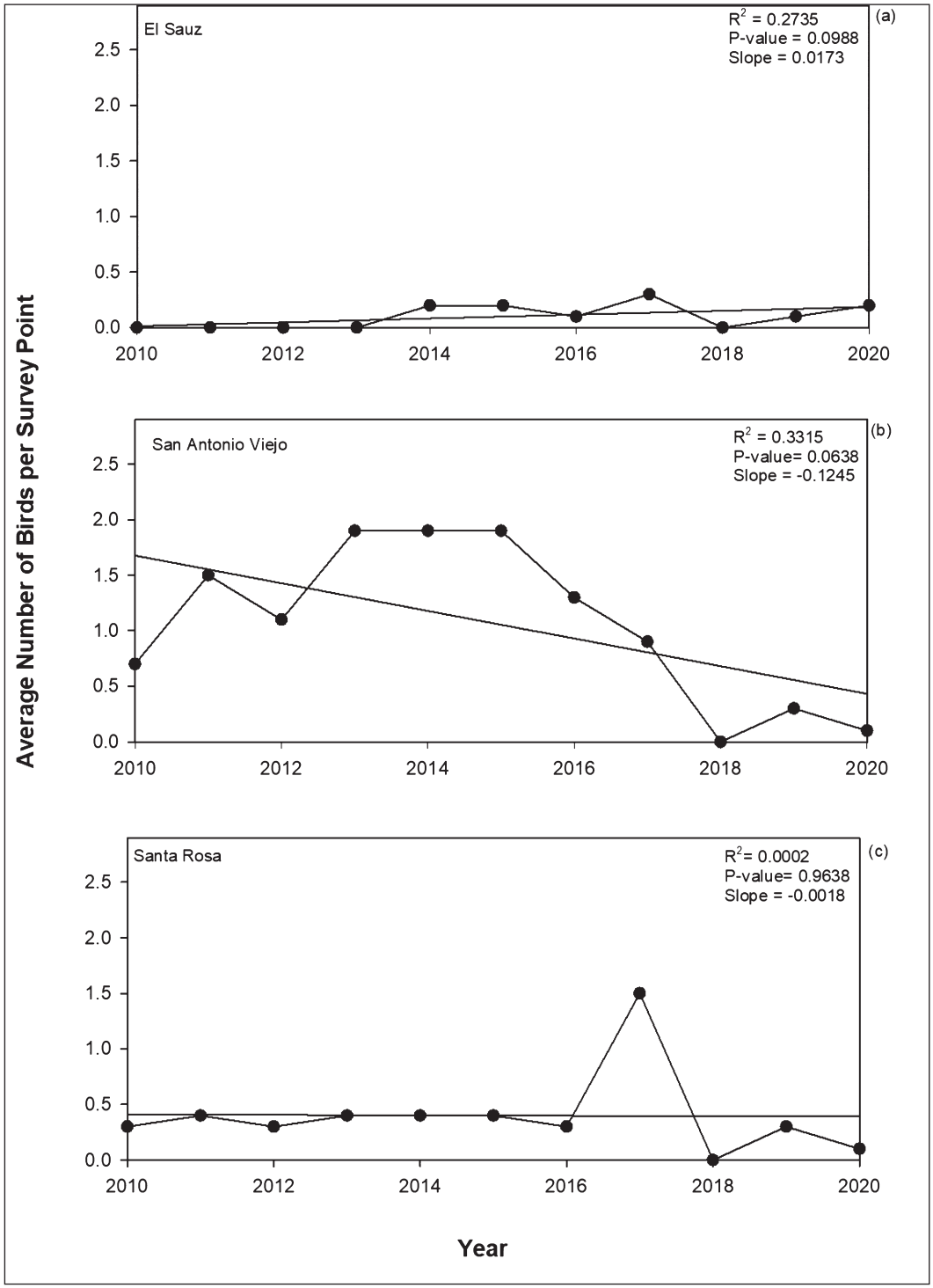

Figure 77. Breeding populations of Pyrrhuloxia on East Foundation ranches from 2010-2020.

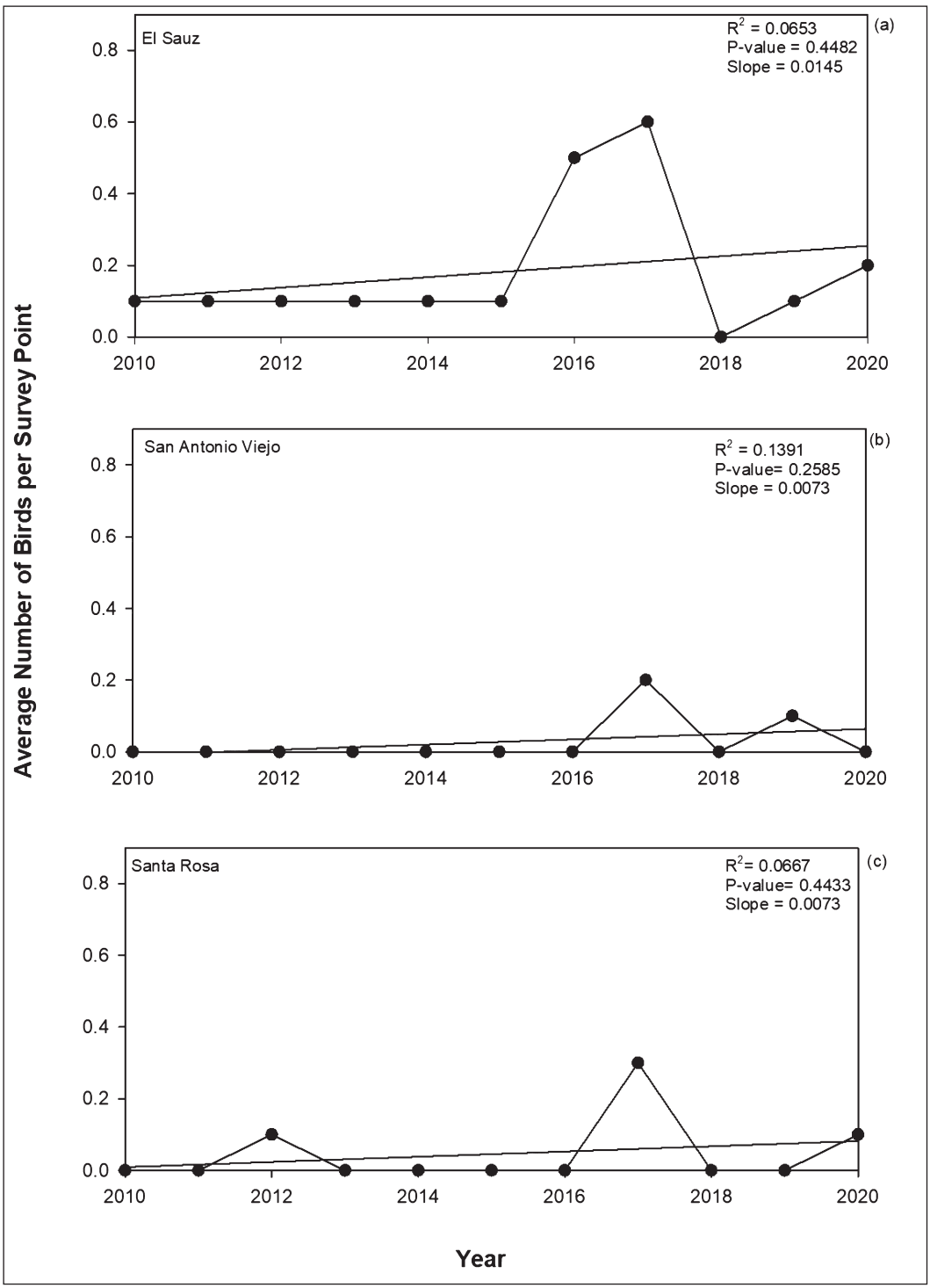

Figure 78. Breeding populations White-tipped Dove on East Foundation ranches from 2010-2020.

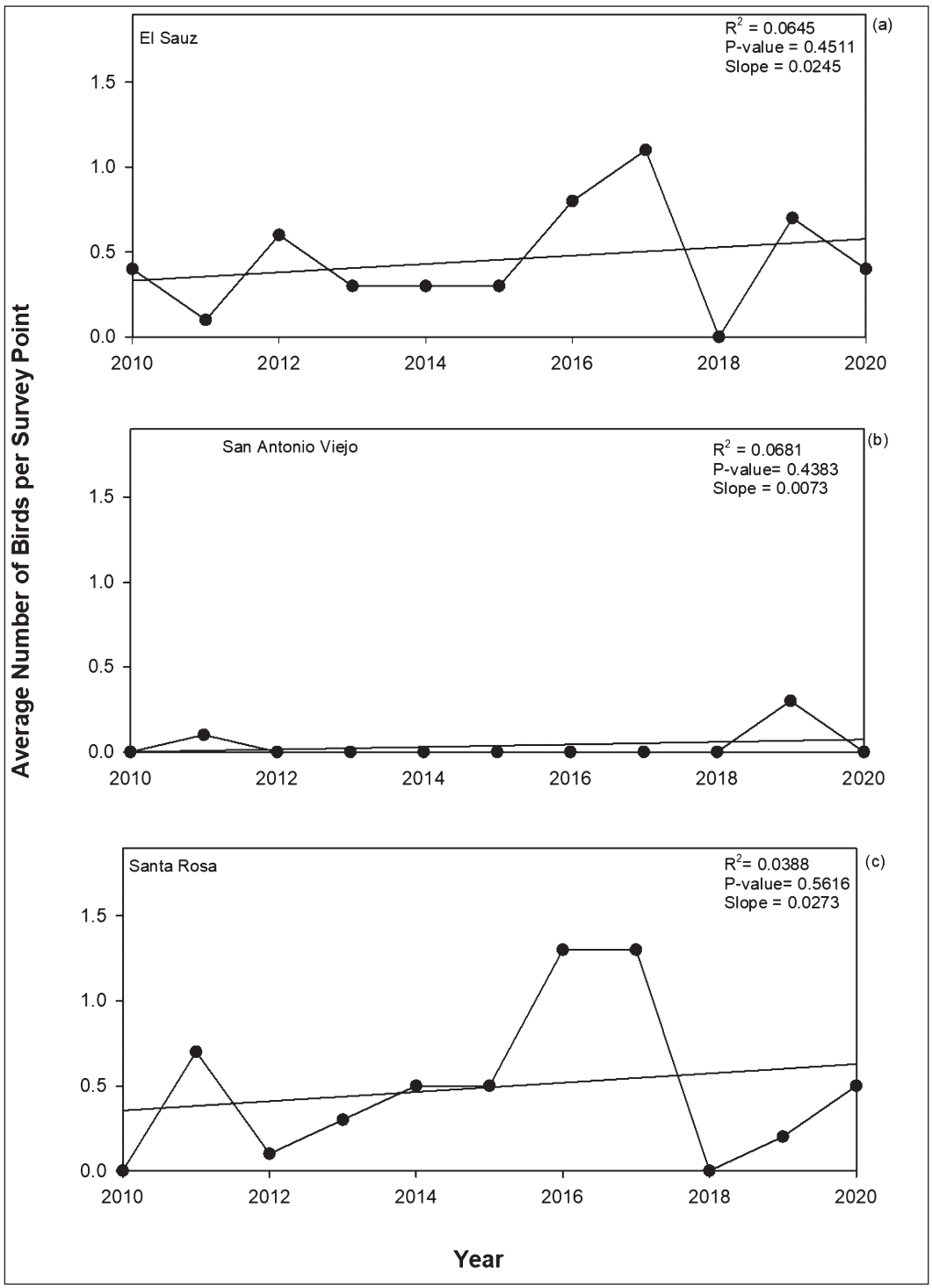

Figure 79. Breeding populations of Wild Turkey on East Foundation ranches from 2010-2020.

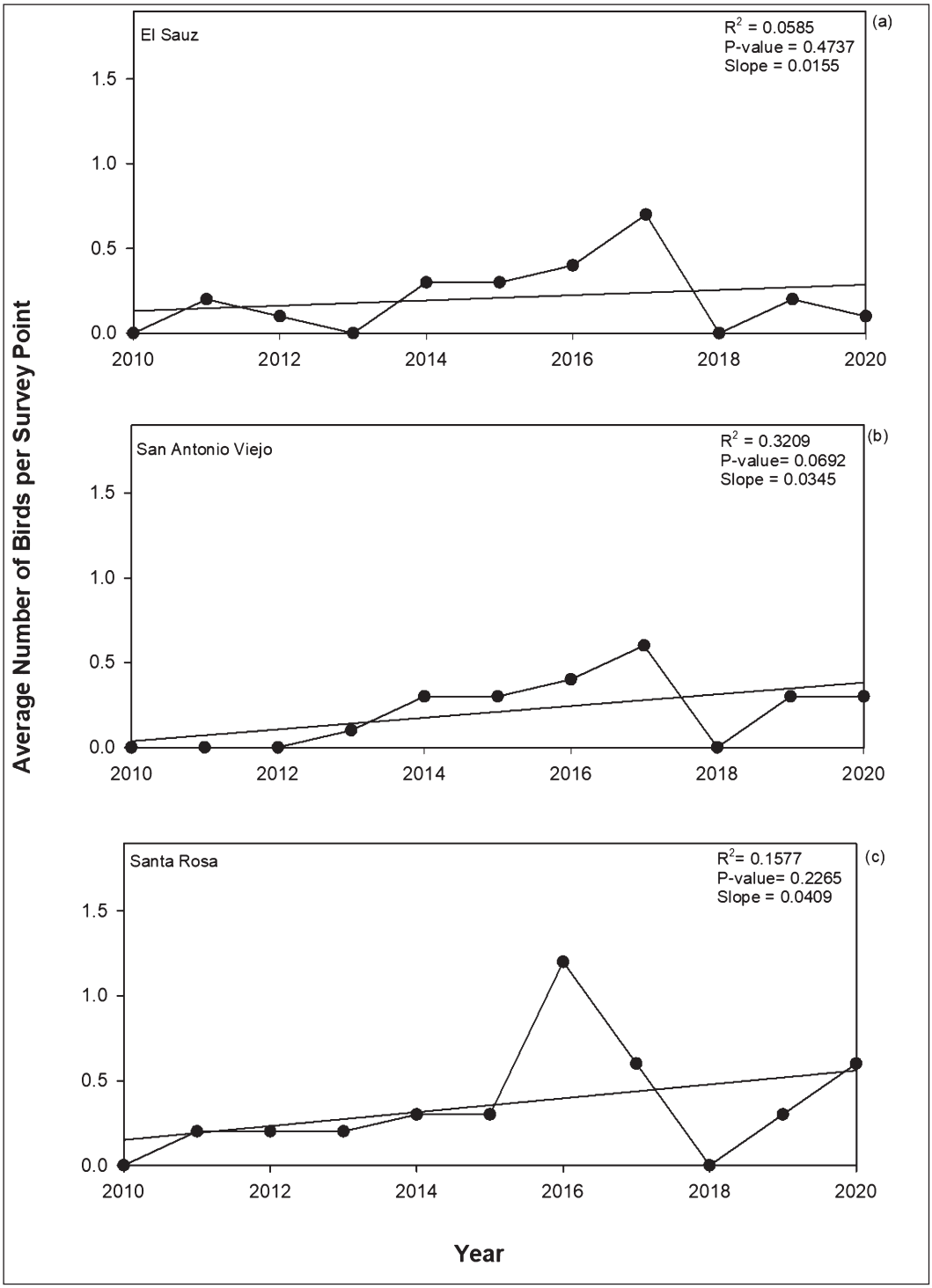

Figure 80. Breeding populations of Green Jay on East Foundation ranches from 2010-2020.

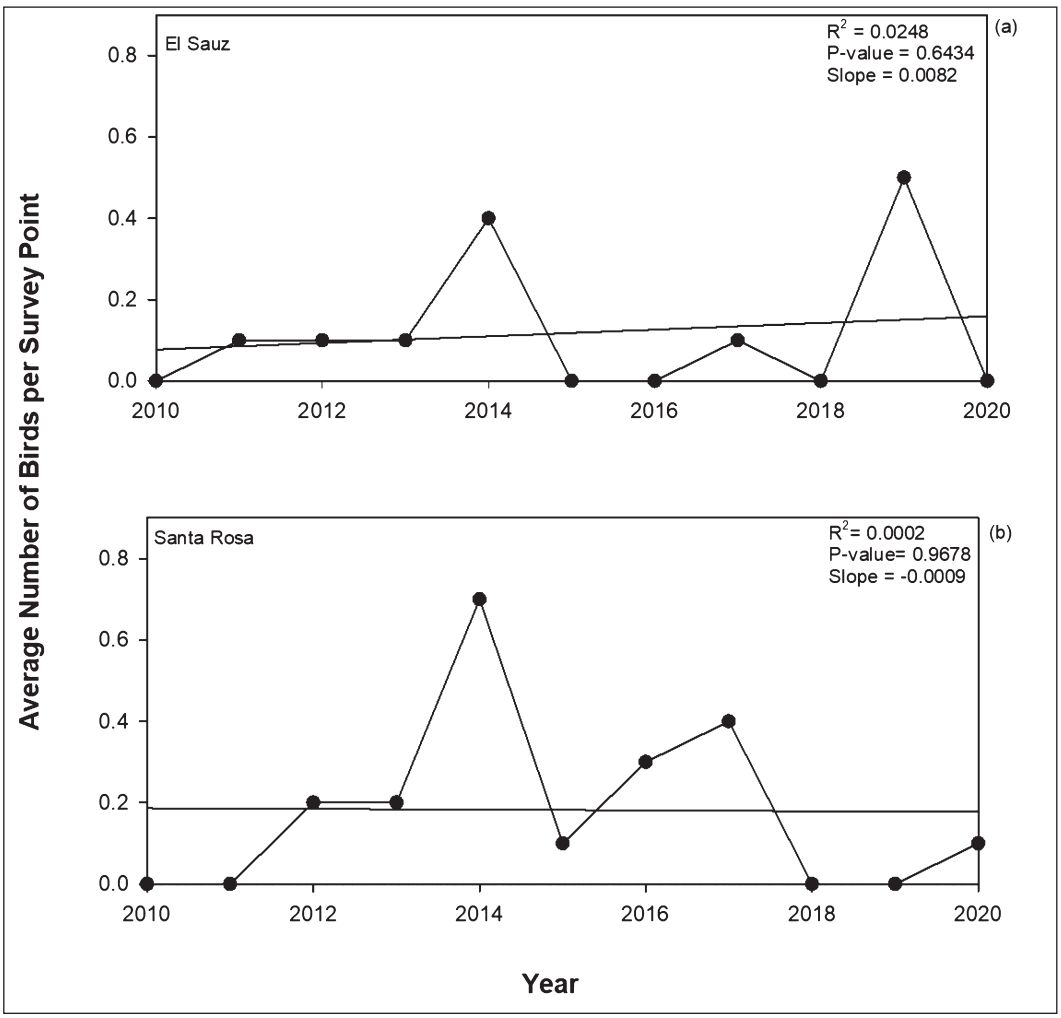

Figure 81. Breeding populations of Black Vulture on East Foundation ranches from 2010-2020.

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

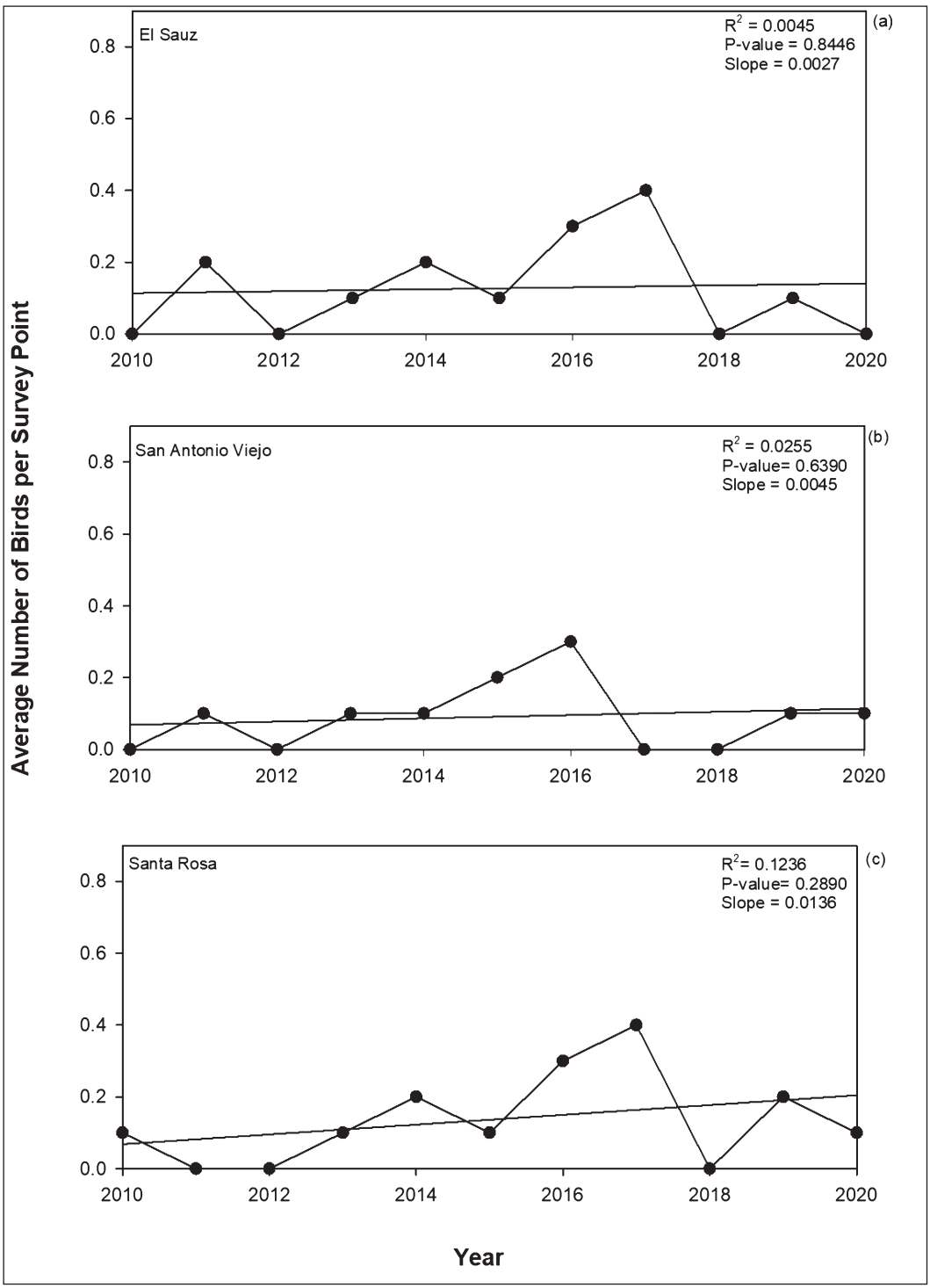

Figure 82. Breeding populations of Crested Caracara on East Foundation ranches from 2010-2020.

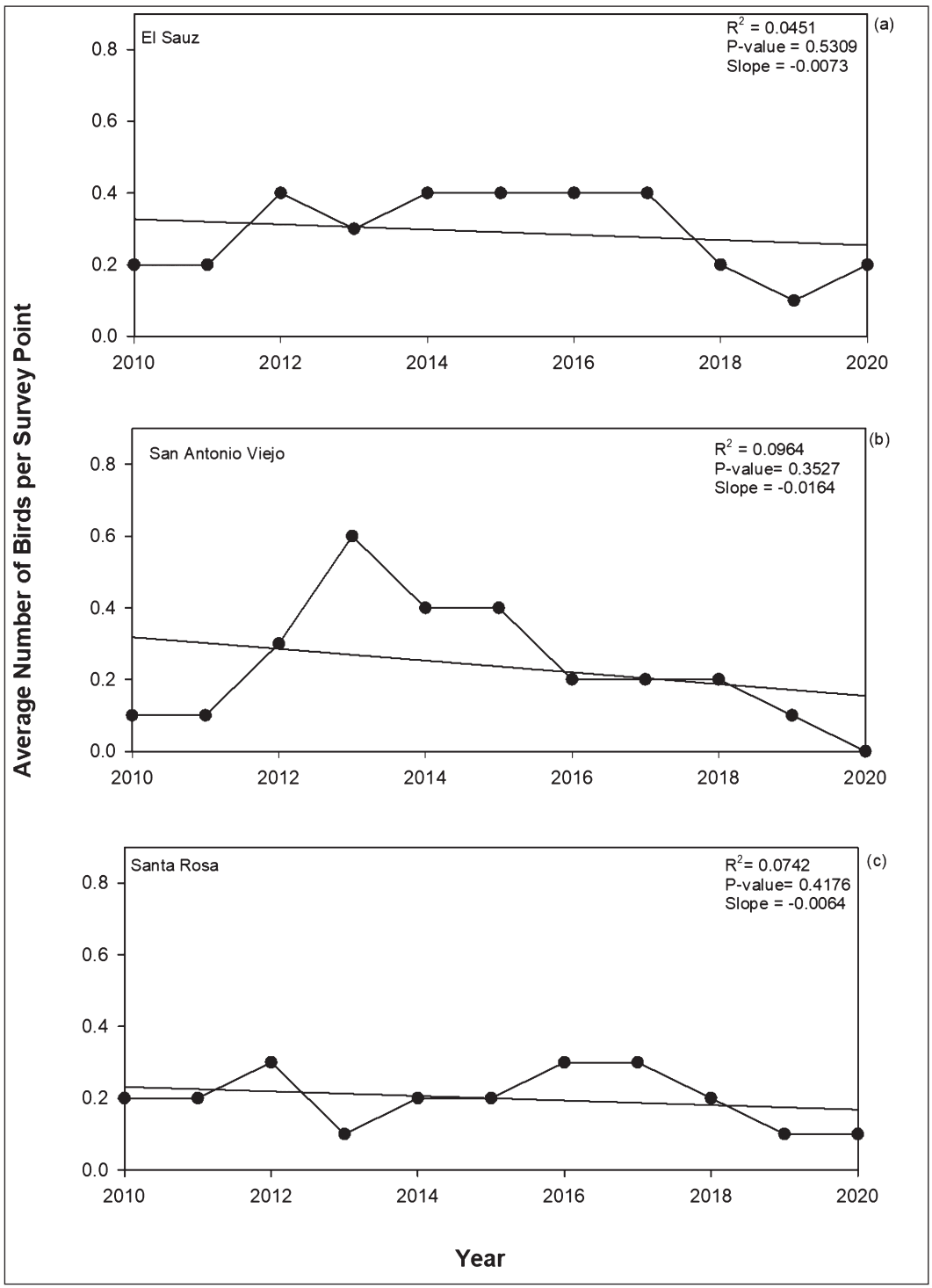

Figure 83. Breeding populations of Turkey Vulture on East Foundation ranches from 2010-2020.

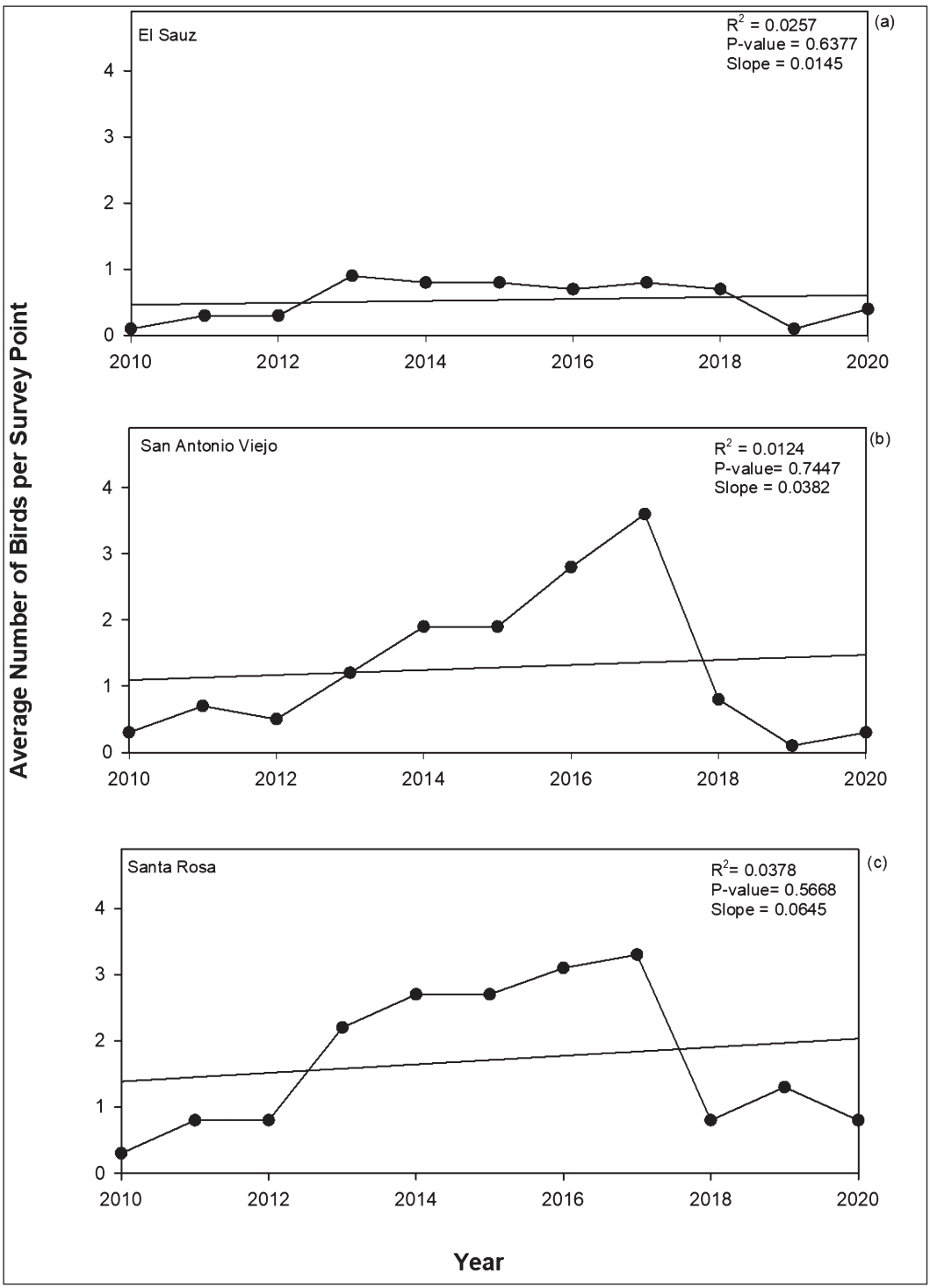

Figure 84. Breeding populations of Bewick's Wren on East Foundation ranches from 2010-2020.

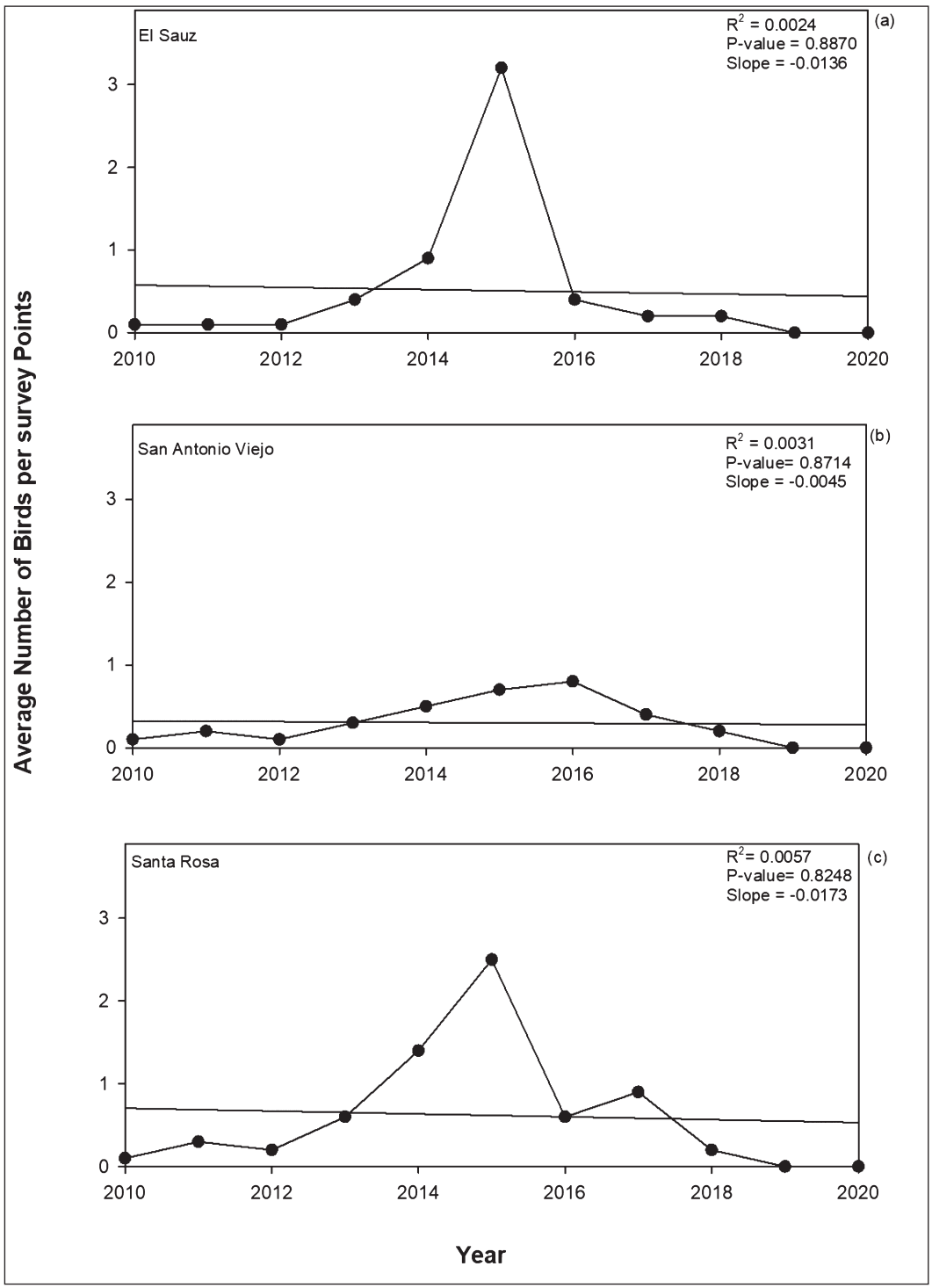

Figure 85. Breeding populations of Black-crested Titmouse on East Foundation ranches from 2010-2020.

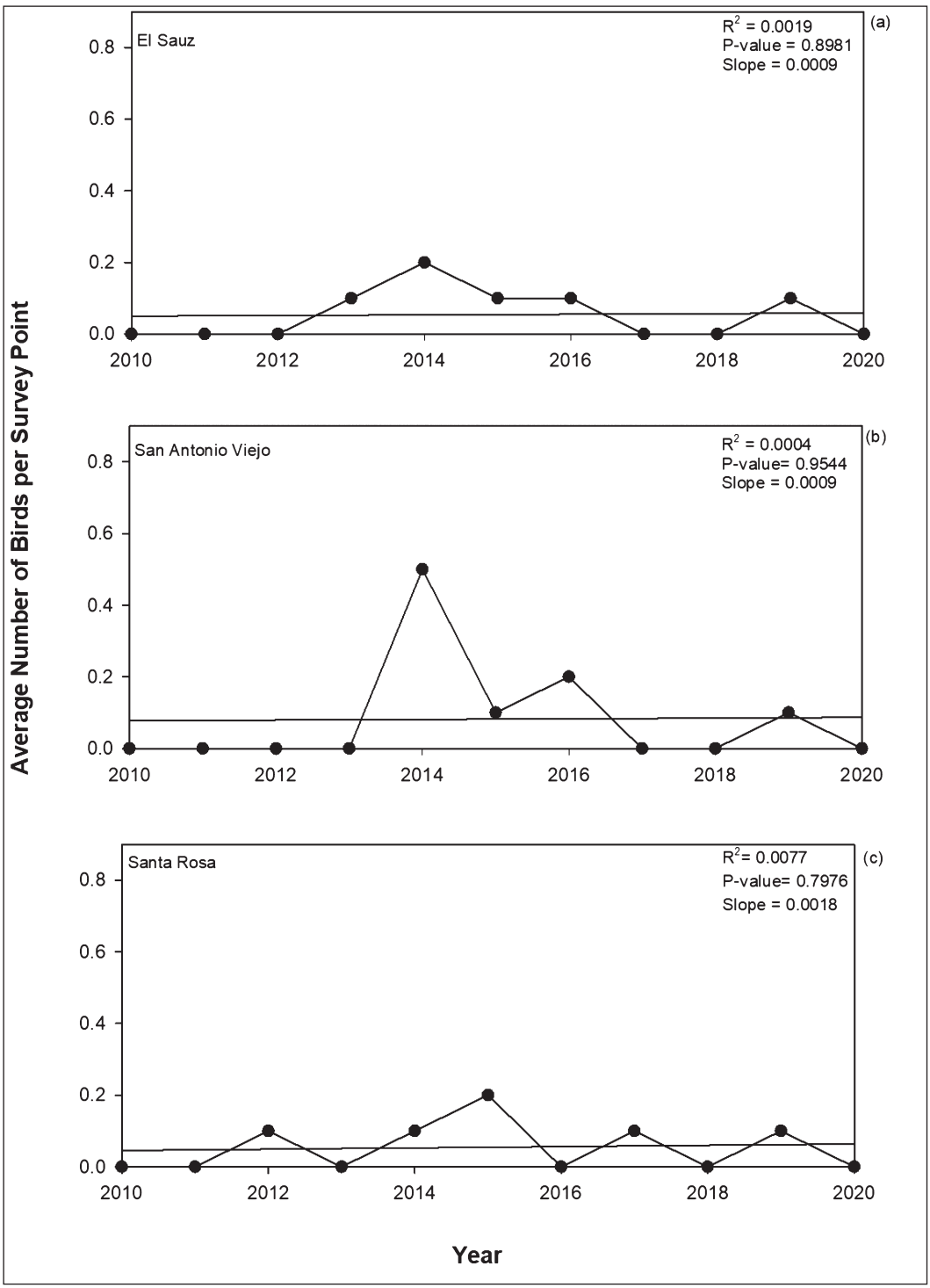

Figure 86. Breeding populations of Blue-gray Gnatcatcher on East Foundation ranches from 2010-2020.

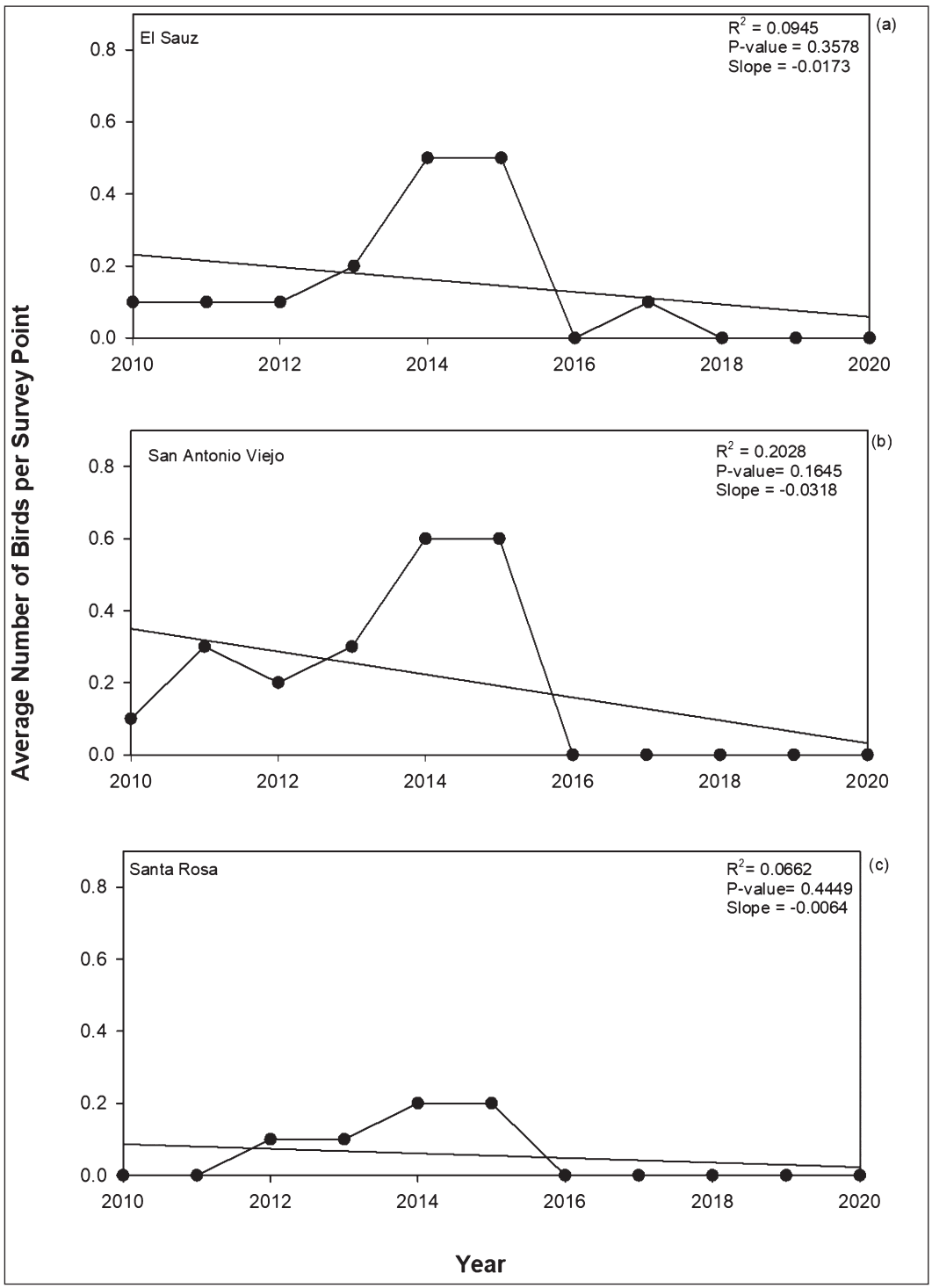

Figure 87. Breeding populations of Verdin on East Foundation ranches from 2010-2020.

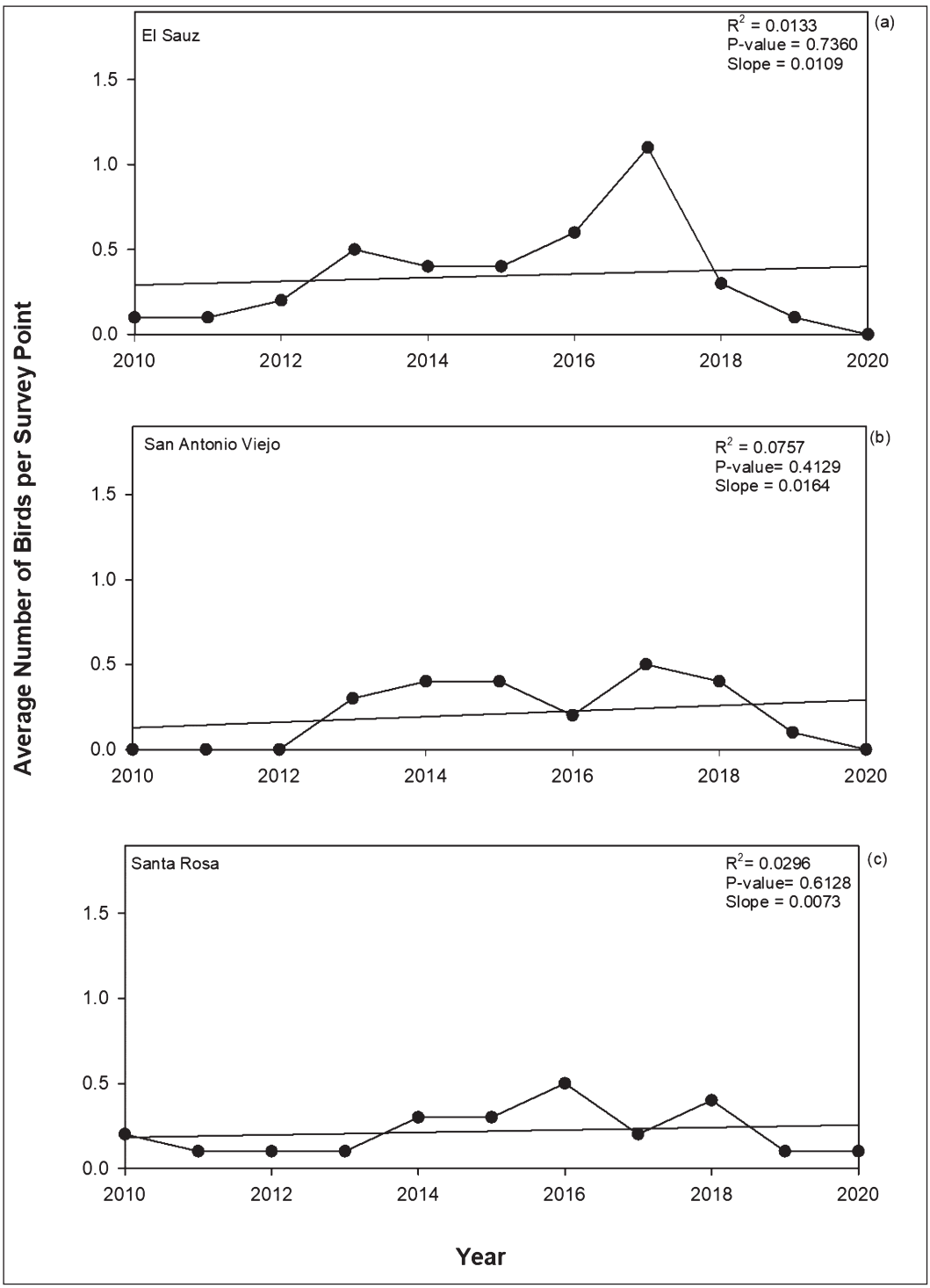

Figure 88. Breeding populations of White-eyed Vireo on East Foundation ranches from 2010-2020.

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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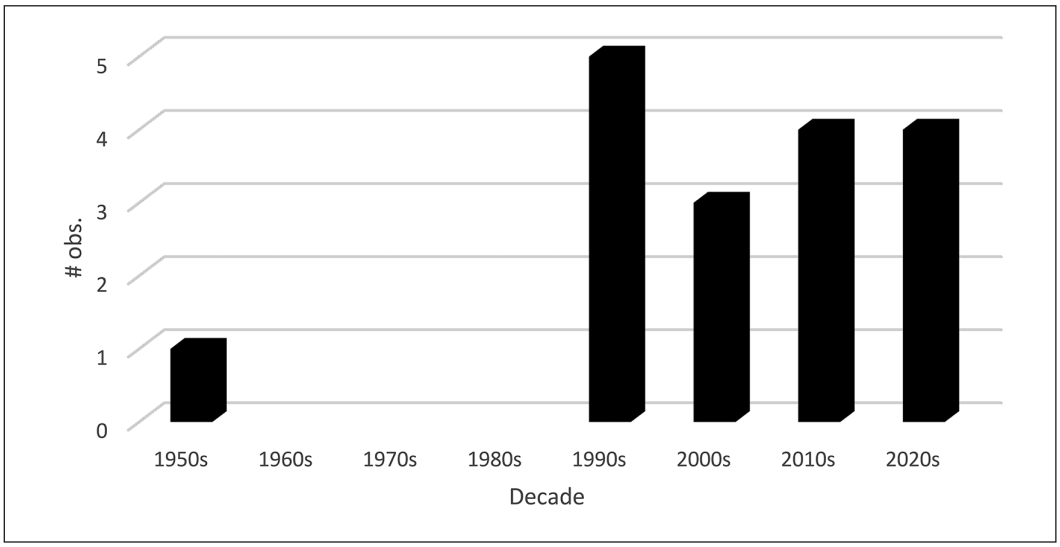

Figure 3. Sooty Shearwater occurrence from Texas waters by decade using museum specimens and eBird data.

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The Texas Mid-Coast supports the largest concentration of Northern Pintails (*Anas acuta*) along the Gulf Coast. Photo Clyde Robinson

Jack Clinton Eitniear, Editor, E-mail: jclintoneitniear@gmail.com
Kent Rylander, Associate Editor, E-mail : kent.rylander@mac.com

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