CZU Bird Study

2021 Results

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Final Report
October 2021

KEY FINDINGS

There were fewer individuals and species of birds in the burn compared to unburned areas. Only Lazuli Bunting and Hairy Woodpecker were more abundant in all habitats in the burn. Eleven species were consistently less abundant in all habitats in the burn compared to unburned areas. All eleven of these species prefer habitat with high canopy cover or the presence of an understory, both of which were greatly reduced by the CZU fire.

BACKGROUND

In August 2020, the CZU Lightning Complex fire burned over 86,000 acres in the Santa Cruz Mountains (Calfire Incidents 2021). Most notable about this fire is that old-growth redwood forest was burned at a high and extreme severity, which is unusual for that forest type (Lazzeri-Aerts and Russell 2014). The CZU fire, the largest wildfire on record in the Santa Cruz Mountains, will have profound impacts on breeding bird populations in future years, especially in old-growth redwood forests where forest structure can take hundreds of years to form (Noss 2000). The increased burn severity is becoming a characteristic of fires fueled by climate change and over a century of intensive fire suppression in California (Williams et al. 2019, Taylor et al. 2016). As larger and more destructive wildfires become increasingly frequent in California (Gross et al. 2020), it is imperative we respond with informed land and species management.

Few studies have investigated the impact of fires on birds in the Santa Cruz Mountains. Avian communities have shown responses to controlled burns in grasslands on the Santa Cruz north coast and summit ridge (Burns and Scullen 2013, Rinkert 2015, Scullen 2017), but these grasslands comprise a relatively small area compared to forested habitats. Anecdotal observations indicate some species associated with fire, such as Black-chinned Sparrow (*Spizella atrogularis*) and Purple Martin (*Progne subis*), have established breeding populations following several large fires—Summit Fire 2008, Lockheed Fire 2009, and Loma Fire 2016—in forested areas of the Santa Cruz Mountains (A. Rinkert pers. obs.), but quantification of how the avian community as a whole has responded is lacking. Understanding how birds respond to the CZU fire, especially in forested areas, will help guide effective conservation and natural resource management in an era where fires have an increasingly profound effect in shaping the landscape.

This report summarizes the preliminary results of a three-year study investigating the initial impacts of the CZU fire on breeding birds in the Santa Cruz Mountains. Point-count data was used to quantify the abundance of birds in burned and unburned control areas, and these data along with prefire data from 2002–2004, were compared to determine how bird populations have changed following the CZU fire.

METHODS

Survey Design

Bird presence and abundance was sampled using point-count methodology (see Nur et al. 1999). Point-count survey routes were identified within the CZU burn and nearby unburned areas to serve as treatment and control groups, respectively (Figure 1). Six survey routes were established in the burn, and five routes were established in nearby unburned areas. Land with a uniform habitat type and burn severity, and existing Forest Bird Monitoring Program (FBMP) point-count survey routes were prioritized for sampling in this study. Point-count surveys conducted for the CZU Bird Study generally had the same survey design and followed the same methodology as the FBMP for counting birds.

A total of 195 point-count stations were established (Table 1); 108 (55%) of these stations were also surveyed during the FBMP (2002–2004) (Table 2). Point-count stations were spaced approximately 250 m apart on survey routes, as road and trail conditions allowed. The locations of stations on FBMP routes were not modified in any way, but for new survey routes, an effort was made to site survey stations within a single habitat type and uniform burn severity.

Four major habitat types within the CZU fire area were sampled: old-growth redwood forest, second-growth redwood forest, mixed evergreen forest, and Chalks chaparral. Each of the four habitat types had routes in both burned and unburned areas except for Chalks chaparral. This habitat was only sampled in the burn as the entire Chalks burned during the CZU fire and no adequate control area existed elsewhere.

Survey stations located in old-growth redwood forest were within the habitat delineation by Halbert and Singer (2017); the canopy at these stations was dominated by old-growth Coast redwood (*Sequoia sempervirens*) and Douglas-fir (*Pseudotsuga menziesii*), and tan oak (*Notholithocarpus densiflorus*). The canopy at stations in second-growth redwood forest was dominated by younger Coast redwood, live oaks (*Quercus* sp.) and tan oak. Stations in mixed evergreen forest were primarily between 500–700 m in elevation and the canopy cover was dominated by live oaks (primarily *Quercus agrifolia*, *Q. parvula* var. *shrevei*, and *Q. chrysolepis*), but also included Douglas-fir, tan oak, and Pacific madrone (*Arbutus menziesii*). Common trees and shrubs at stations in Chalks chaparral, which occurs in northwestern Santa Cruz County and southwestern San Mateo County, included manzanita (*Arctostaphylos* sp.), giant chinquapin (*Chrysolepis chrysophylla*), and canyon live oak (*Q. chrysolepis*).

Survey Methodology

Surveys were conducted between May 27 and June 19, 2021 by Alex Rinkert. Surveys began between local sunrise and up to 15 minutes afterward, and lasted up to four hours after sunrise. For FBMP routes where only some of the stations were surveyed during the CZU Bird Study, an effort was made to visit those stations at the approximate time they were visited during the FBMP.

Surveys were not conducted in inclement weather defined by moderate precipitation or winds stronger than Beaufort 2.

A visit to each point-count station consisted of a 5-minute count of all birds detected by sight or sound. Each individual bird was recorded as being within or beyond 50 m, and whether it was initially detected within the first three minutes or in the last two minutes of the 5-minute count. Birds only detected while flying over the station were counted separately, with the exception of aerial species such as swallows, swifts, raptors, and hummingbirds. Dependent young were also counted separately. No method of attracting birds was used during surveys. Travel between point-count stations was either by vehicle or on foot, depending on access conditions.

Statistical Analysis

Prefire data from the Forest Bird Monitoring Program submitted to eBird.org (Sullivan et al. 2009) was obtained from the Global Biodiversity Information Facility (GBIF.org 2021) through an "Occurrence" download of all avian observations in Santa Cruz County, CA between the years 2002–2004. This dataset was filtered to only include the FBMP station names. Duplicate records shared with individual observer accounts in eBird were excluded so that only FBMP account checklists remained. Any incidental observations not associated with a complete FBMP survey were also excluded. The dataset was further subsetted to only include data from FBMP stations that were resurveyed for the CZU Bird Study.

The average number of individuals and average number of species at a station were compared between prefire, control, and burn areas in each of the four habitat types. A Kruskal-Wallis test was used to determine globally significant differences among all groups, and a Wilcoxon rank sum test determined pairwise significance between groups; only the pairwise p-value is reported in the preliminary results below. A Bonferroni-Holm correction was applied to p-values in post-hoc testing.

For species that were consistently more abundant or less abundant in all of the habitats they were detected, their average abundance across all habitats they were detected in was compared between burn and control areas using a Wilcoxon rank sum test. This analysis was only conducted on species that were detected in more than one habitat. When comparisons were made between burn and control areas, the FBMP prefire data was used in lieu of control data for Chalks chaparral. All statistical analyses were performed in R (R Core Team 2019, version 3.6.1).

PRELIMINARY RESULTS

The results in this report are preliminary and subject to change with further analysis.

Total Birds

The average number of birds at stations in the burn was less than in control areas in old-growth redwood (p=0.002), second-growth redwood (p=0.002), mixed evergreen forest habitats (p=0.002), and Chalks chaparral (p<0.001) (Table 3, Figure 2a). The average percentage decrease of birds at stations in the burn compared to control areas was about the same in the three forested habitats (range=-20.6–28.4%), while the decrease in Chalks chaparral after the burn was considerably more (-62.4%).

Total Species

As with the average number of birds, the average number of species in the burn was less than in control areas in old-growth redwood (p=0.016), second-growth redwood (p<0.001), mixed evergreen forest (p=0.002), and Chalks chaparral (p<0.001) (Table 4, Figure 2b). The average percentage decrease of species at stations in the burn in the three forested habitats (range=-18.0–30.8%) and Chalks chaparral (-49.0%) was similar to the decrease in total number of birds at stations in those habitats.

Abundance

Fifteen species were consistently less abundant in the burn compared to control areas in all habitats they were detected, while only three species were more abundant in the burn (Table 5). The two species—Lazuli Bunting and Hairy Woodpecker—that were significantly more abundant in the burn than in control areas are known to prefer habitats affected by fire (Salt and Wilk 1966, Semenchuck 1992, Greene et al. 2020; Figure 3).

All eleven species that were significantly less abundant in the burn are known to prefer high canopy cover or dense understory; both of these vegetation components were greatly reduced following the CZU fire. Three species preferring high canopy cover that were significantly less abundant in the burn include Chestnut-backed Chickadee, Steller's Jay, and Brown Creeper (Brennan et al. 1999, Bousman 2007a, Poulin et al. 2020); eight species preferring a dense understory or shrub component that were consistently less abundant in the burn include Wrentit, Bewick's Wren, Pacific Wren, Hermit Thrush, Spotted Towhee, Orange-crowned Warbler, Lesser Goldfinch, and California Scrub-Jay (Geupel and Ballard 2020, Bartos Smith and Greenlaw 2020, Gilbert et al. 2020, Bousman 2007b–f; Figure 4).

Prefire Comparisons

The average number of birds was higher during prefire surveys (2002–2004) compared to surveys in current control areas at stations in old-growth redwood (p<0.001) and mixed evergreen forest (p=0.001), but not second-growth redwood (p=0.217). Similarly, the average number of species was higher during prefire surveys than in current control areas in old-growth redwood (p<0.001) and mixed evergreen forest (p=0.017), but not second-growth redwood (p=0.653). These apparent declines in total number of birds and species are reflected to some extent in data from two Breeding Bird Survey routes and regional Christmas Bird County data (Pardieck et al. 2020, National Audubon Society 2020). These declines may have been exacerbated by the extreme drought conditions in 2021 compared to abnormally dry to no drought conditions in 2002–2004 (Fuchs 2021).

ACKNOWLEDGEMENTS

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TABLES

Table 1. Stations surveyed as part of the CZU Bird Study.

Habitat	Total Stations		
	Control	*CZU Burn*	*Total*
Old-growth redwood	31	35	**66**
Second-growth redwood	42	24	**66**
Mixed evergreen forest	22	21	**43**
Chalks chaparral	0	20	**20**
Total	**95**	**100**	**195**

Table 2. Stations with prefire data from the Forest Bird Monitoring Program 2002–2004.

Habitat	Stations with Prefire Data		
	Control	*CZU Burn*	*Total*
Old-growth redwood	0	31	**31**
Second-growth redwood	33	11	**44**
Mixed evergreen forest	13	0	**13**
Chalks chaparral	0	20	**20**
Total	**46**	**62**	**108**

Table 3. Average number of birds per station in 2021.

Habitat	Birds per Station (mean ± SE)		
	Prefire	*Control*	*CZU Burn*
Old-growth redwood	20.3 ± 1.1	11.2 ± 0.5	8.9 ± 0.5
Second-growth redwood	13.8 ± 0.7	12.8 ± 0.9	9.2 ± 0.7
Mixed evergreen forest	17 ± 1.3	11.5 ± 0.6	8.4 ± 0.7
Chalks chaparral	13.8 ± 0.9	-	5.2 ± 0.4

Table 4. Average number of species per station in 2021.

Habitat	Species per Station (mean ± SE)		
	Prefire	*Control*	*CZU Burn*
Old-growth redwood	10.9 ± 0.4	7.8 ± 0.4	6.4 ± 0.3
Second-growth redwood	9.2 ± 0.5	8.9 ± 0.4	6.1 ± 0.4
Mixed evergreen forest	10.8 ± 0.6	8.7 ± 0.5	6.1 ± 0.5
Chalks chaparral	8.7 ± 0.4	-	4.5 ± 0.3

**Table 5.** Differences in abundance between burn and control areas for selected species.

Species	Average Difference in Abundance per Station					Difference between Burn and Control	
	Redwood Old-growth	Redwood Second-growth	Mixed evergreen forest	Chalks	Average Difference[1]	Significance[2]	Result[3]
Lazuli Bunting	1.2	1.3	0.6	0.5	**0.9**	p<0.001	***
Hairy Woodpecker	0.3	0.1	0.2	0.4	**0.3**	p=0.002	**
Turkey Vulture	0.1	-	-	0.1	**0.1**	p=0.130	NS
Chestnut-backed Chickadee	-0.9	-1.6	-0.7	-0.7	**-1.0**	p<0.001	***
Wrentit	-0.1	-0.1	-0.2	-2.2	**-0.7**	p<0.001	***
Steller's Jay	-0.7	-0.5	-0.3	-1.0	**-0.6**	p<0.001	***
Bewick's Wren	-	-	-0.1	-1.0	**-0.6**	p<0.001	***
Pacific Wren	-1.1	-0.2	-0.1	-	**-0.5**	p<0.001	***
Hermit Thrush	-0.5	-0.6	-0.3	-0.4	**-0.5**	p<0.001	***
Spotted Towhee	-0.2	-0.4	-0.1	-0.7	**-0.4**	p<0.001	***
Orange-crowned Warbler	-	-0.3	-0.2	-	**-0.3**	p<0.001	***
Brown Creeper	-0.3	-0.3	-0.1	-0.1	**-0.2**	p<0.001	***
Lesser Goldfinch	-	-0.1	-0.3	-0.1	**-0.2**	p=0.007	**
Anna's Hummingbird	-	-0.1	-	-0.2	**-0.2**	p=0.146	NS
California Scrub-Jay	-	-0.1	-0.1	-0.2	**-0.1**	p=0.012	*
American Crow	-0.1	-0.1	-	-	**-0.1**	p=0.061	NS
Golden-crowned Kinglet	-0.1	-	-	-0.1	**-0.1**	p=0.061	NS
Pine Siskin	-	-0.1	-	-0.1	**-0.1**	p=0.479	NS

1: Average difference in abundance per station for all habitats between the burn and control areas. Prefire survey data was used in lieu of control data for Chalks chaparral.
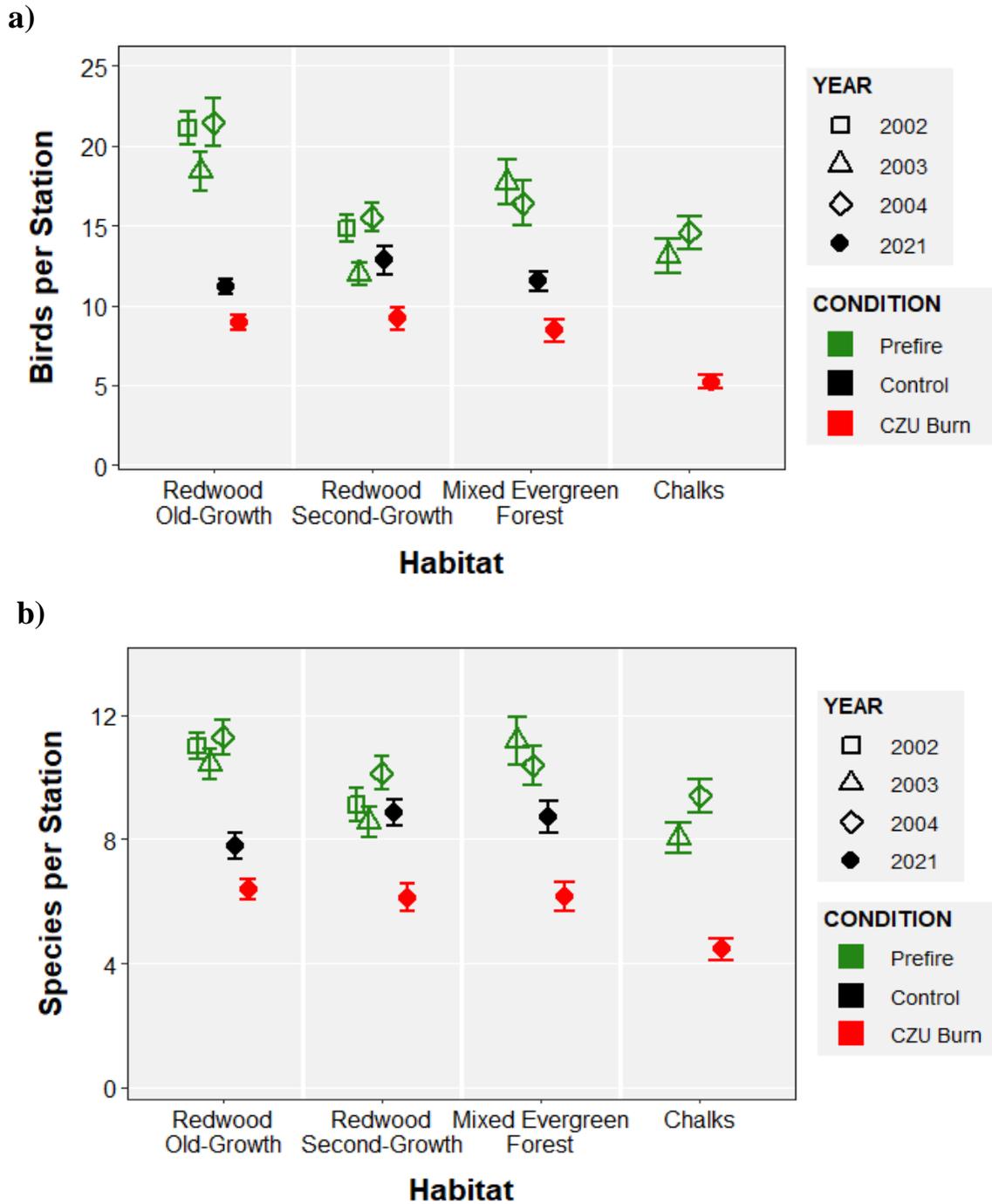
2: Significance values from a Wilcoxon rank sum test comparing average abundance between burn and control areas.

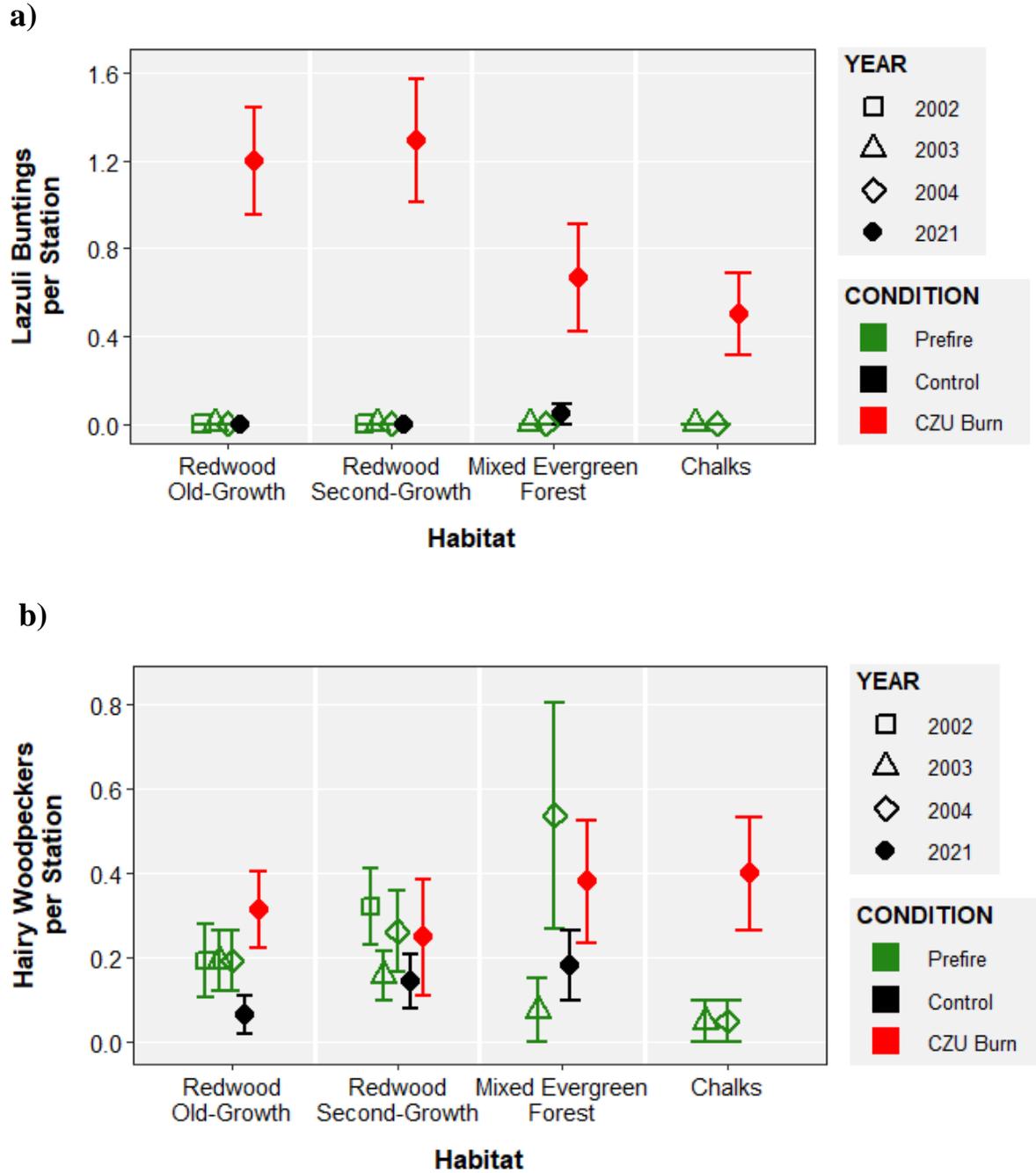**3:** * p<0.05, ** p<0.01, *** p<0.001, NS = no significant difference.

FIGURES
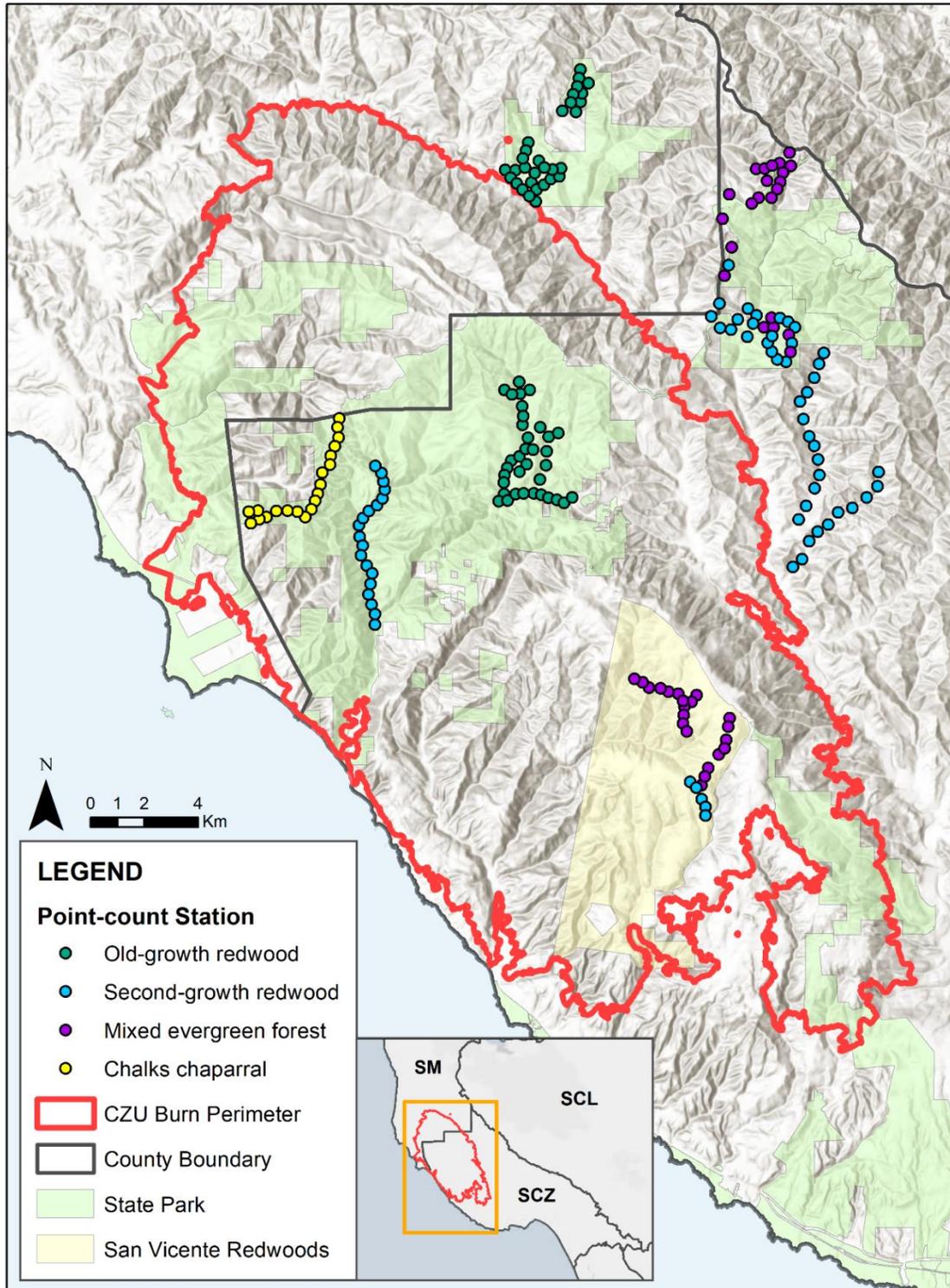
Figure 1. Point-count stations surveyed in 2021 as part of the CZU Bird Study.

a)

b)

Figure 2. The number of **a)** birds and **b)** species in four habitats affected by the CZU fire. The mean and standard error are shown.

a)

b)

Figure 3. Abundance of **a)** Lazuli Bunting and **b)** Hairy Woodpecker in four habitats affected by the CZU fire. The mean and standard error are shown.

a)

b)
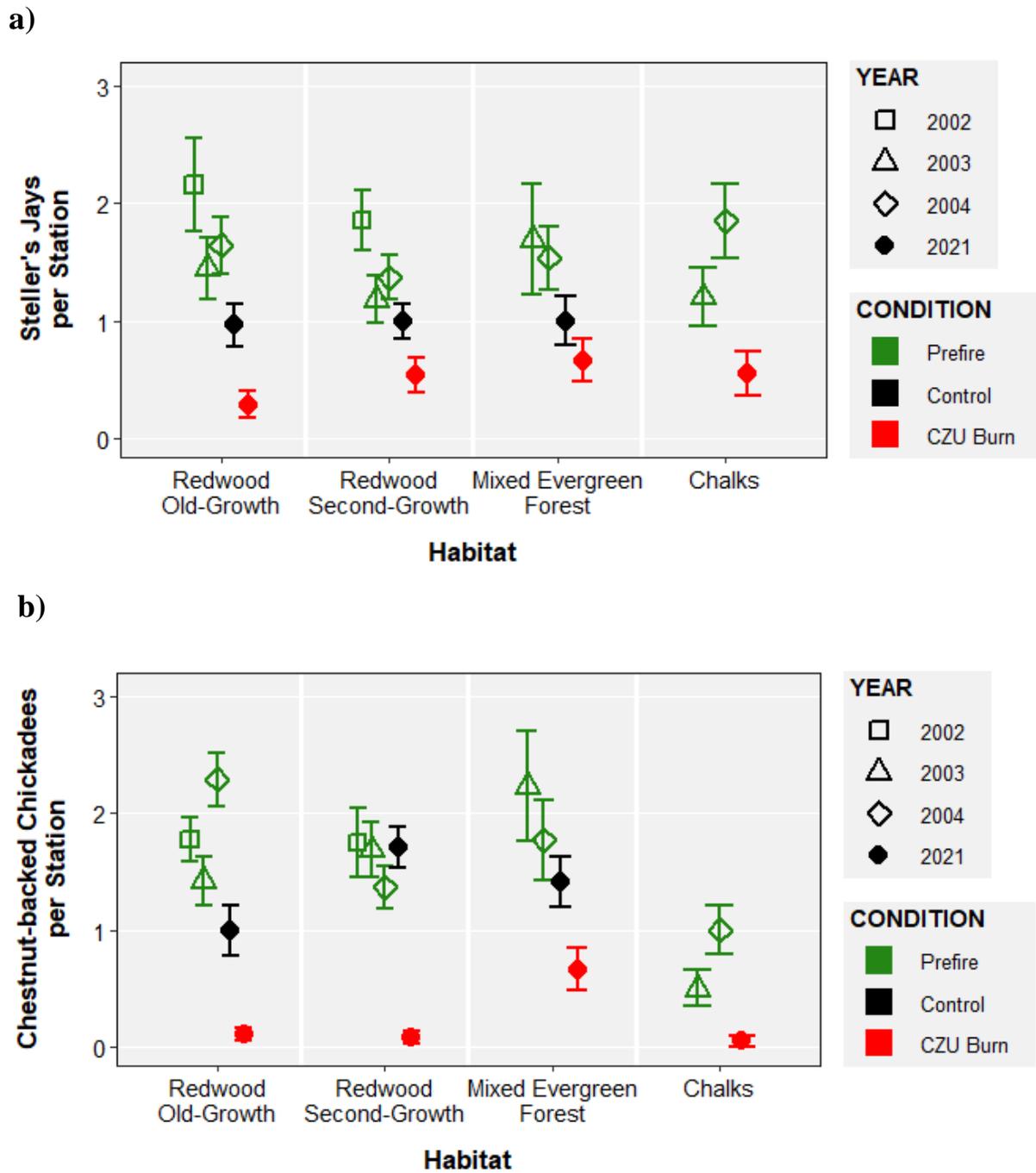
Figure 4. Abundance of **a)** Steller's Jay and **b)** Chestnut-backed Chickadee in four habitats affected by the CZU fire. The mean and standard error are shown.