Monitoring the Effects of Power Fire Reforestation Treatments on the Bird Community

2019 Progress Report to Eldorado National Forest

March 2020

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Herbicide-treated shrub patches in Power Fire (left); Green-tailed Towhee (right). Photo credits (L-R) Alissa Fogg and Gary Woods

Introduction

After nearly a century of successful fire suppression (Calkin et al. 2005), the subsequent densification of Sierra Nevada forests and accumulation of fuels (Sugihara et al. 2006), has led to increasingly large and severe wildfires across the range (Miller and Safford 2012; Steel et al. 2015). With the important role of fire as a primary driver of ecosystem structure and function, there is a substantial need to understand the value of habitats created and altered by wildfire and how post-fire habitats are used by the unique avian community that occupy them. Management actions in post-fire landscapes affect the forest composition and structure that could persist for decades to centuries (Lindemayer and Noss 2006, Swanson et al. 2011). Thus, it is prudent to carefully consider the species using post-fire habitats under different management prescriptions, both in the short- and long-term.

To help inform a science based approach to post-fire habitat management for wildlife, Point Blue partnered with UC Davis to monitor birds in the 2004 Power Fire. From 2014-2016 we characterized the bird community utilizing post-fire habitat and collected baseline data to study the effects of salvage and replanting treatments (Fogg et al. 2015, Fogg et al. 2016, Fogg et al. 2017). We also collected vegetation data to link changes in habitat structure with changes in the avian community. We presented these results to the Amador-Calaveras Consensus Group, a local collaborative group working to restore resilient forests, on field trips and at national conferences.

In January 2017, the Amador Ranger District proposed management actions in the Power Fire to accelerate late-seral forest conditions and promote resilient forest structure and composition (under the Power Fire Reforestation EIS: https://www.fs.usda.gov/project/?project=14704). These actions include clearing vegetation competing with young conifers, applying herbicides to species competing with conifers, replanting conifer seedlings, and re-introducing prescribed fire to areas that burned at low and moderate severity during the 2004 fire. Point Blue participated in workshops to discuss the habitat value of older burned areas and ensure our data was used to help guide reforestation alternatives. We then entered into a new agreement with Eldorado National Forest to monitor the response of the avian community to these treatments. We worked collaboratively with the Amador-Calaveras Consensus Group to identify monitoring questions of interest and how results can continue to feed back into management guidance. This report describes our study's methods, summarizes avian results from the 2018 treatments and identifies next steps for the 2020 field season.

Study Area and Methods

The Power Fire burned 17,005 acres in October 2004 on the Amador Ranger District of the Eldorado National Forest (ENF), located in the central Sierra Nevada Mountains of California. Approximately 13,600 acres of the fire was on the ENF. It was human-ignited and burned predominantly on the south-facing side of the Mokelumne River Canyon. Prefire forest structure and composition was moderate to densely stocked ponderosa pine and Sierra mixed conifer forest. The elevations of avian monitoring locations in Power Fire ranged from 1120 – 2016 m (mean = 1611m; N = 148), roughly matching the elevation range of the entire fire area.

Sampling Design

Survey locations were originally established in 2014 within the Power Fire perimeter (Figure 1). We selected avian sampling stations from a previously established vegetation sampling grid within the fire (Richter and Safford 2016; Welch and Safford 2010). Bird transects were typically comprised of 10 points made up of two parallel five-point sub-transects, placed at a diagonal along the vegetation plot grids making point count locations approximately 283m apart. Any given point in a transect was at least 500m from points in other transects. Transects were limited to Forest Service land, slopes with a maximum of 35 degrees and did not require any major stream crossings. In total, 148 points on 15 transects were surveyed in Power Fire during 2014-2016 field seasons. For 2019, we removed one transect (PW04) due to its remote location and safety concerns (large volume of decaying snags and logs), thus reducing our sample size to 138 points on 14 transects. In 2019, we also could not visit 7 points within PW09 due to proximity to marijuana contamination sites and interaction with bears.

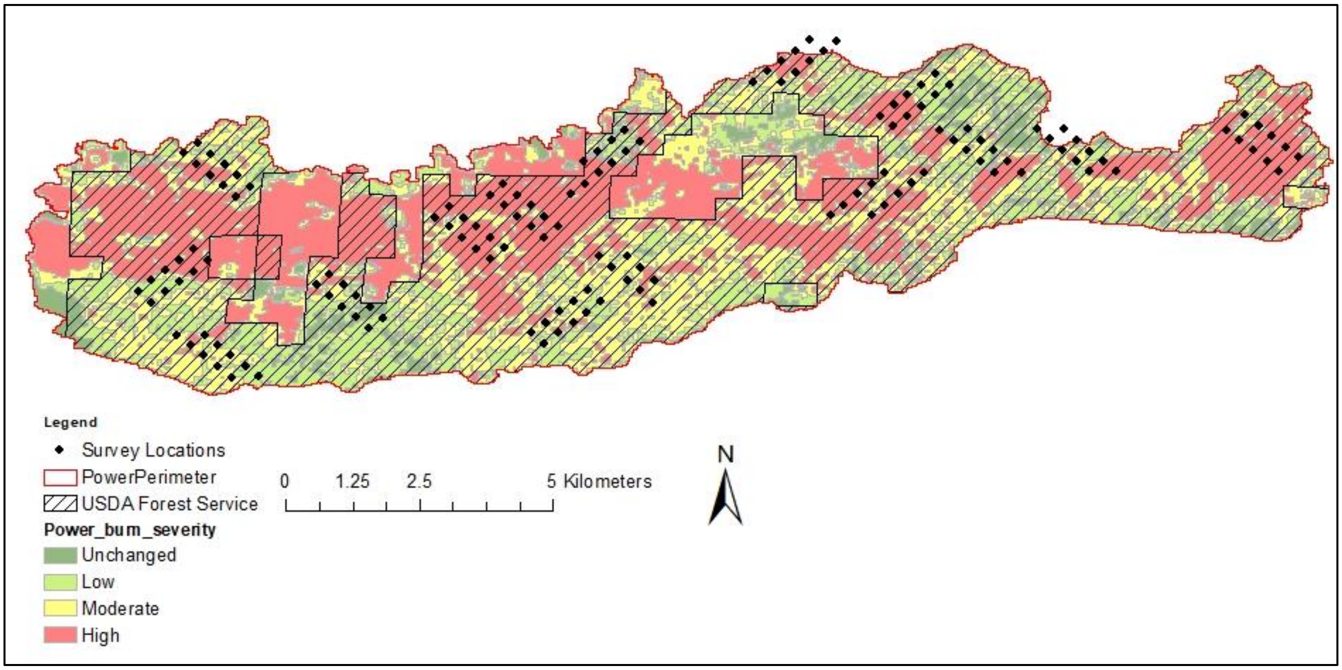

Figure 1. Avian survey locations overlaid on a burn severity map for the Power Fire.

Reforestation Treatments

The Power Fire Reforestation project sought to reforest areas that burned at moderate and high severity and had low amounts of conifer regeneration, including plantations established post-fire and those areas with naturally-occurring regeneration. Treatments included manual herbicide spraying to control competing vegetation (shrubs, grasses, bear clover (*Chamaebatia foliolosa*); clearing deerbrush (*Ceanothus integerrimus*) with chainsaws (material was left on the ground) and mastication using heavy machinery and then replanting with conifer seedlings (Figure 2). Prescribed fire was utilized in areas that burned at low to moderate severity using drip torch and aerial ignition; these areas were not replanted following treatments. We evaluated our sample size for different treatments using the Region 5 Forest Activity Tracking System (FACTS) database (available online at http://www.fs.usda.gov/detail/r5/landmanagement/gis) and through ground-truthing surveys where a technician estimated area treated within 50m of the survey point center and type of treatment, defined as % of the plot that had dead or removed shrubs. In areas dominated by deerbrush, the chainsaw treatments took place during summer-fall 2018 (N = 14 points with 10-100% of the area treated within 50m). Herbicide-only treatments, primarily in whitethorn ceanothus (*Ceanothus cordulatus*) and bear clover-dominated areas, took place at N = 13 points with 20-100% of the area within 50m treated.

Mastication occurred using a dozer to push vegetation into piles; this was followed by replanting conifers at most areas (N = 12 points with 5-100% of the area within 50m treated). Prescribed burning took place at N= 4 points with a range of fire effects from extensive small-diameter tree mortality to no noticeable effects.

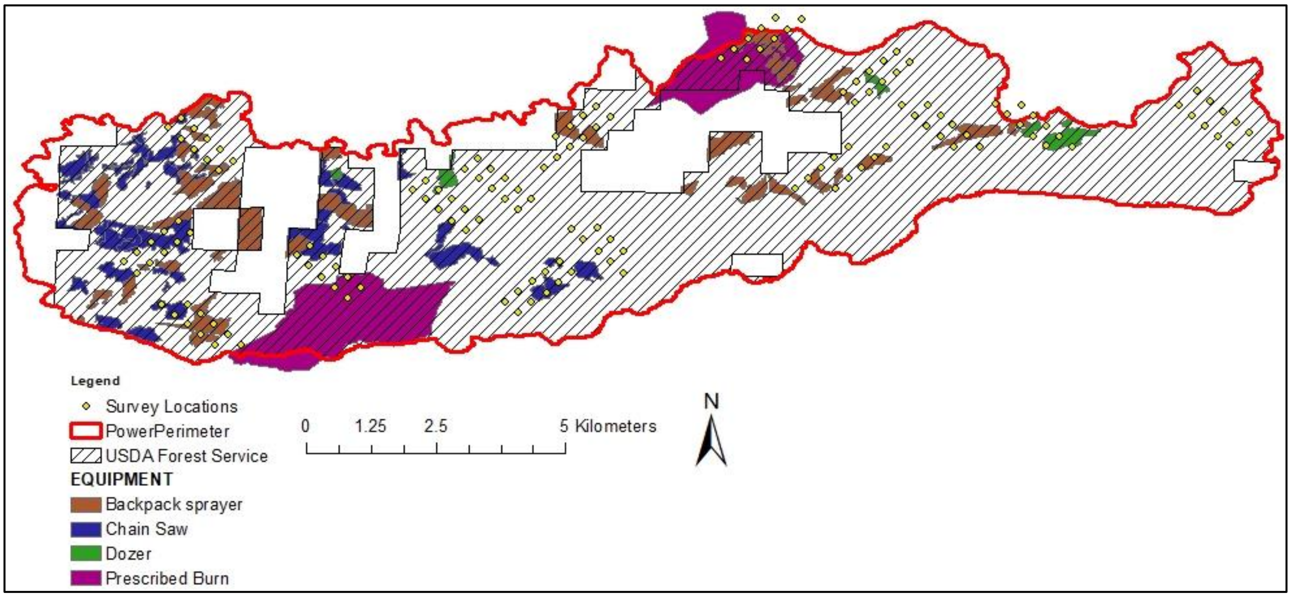

Figure 2. Avian sample locations within the Power Fire area and 2018 reforestation and prescribed fire treatments. The backpack sprayer treatment was herbicide applied to competing vegetation. Chain Saw treatment was the manual cutting of deerbrush and leaving it on the ground. Dozer treatment was clearing of the majority vegetation using a dozer, and replanting with conifer seedlings. The Prescribed Burn took place in April 2018; all other treatments took place during spring, summer and fall 2018. At a small number of points, our field crews documented treatments which were not accounted for in the FACTS layer or did not take place and thus are not accounted for in this figure.

Survey Protocols

Experienced observers conducted standardized five-minute exact-distance point counts at each point count station (Ralph et al. 1995). With the aid of rangefinders, surveyors estimated the exact distance to each individual bird. The initial detection cue (song, visual, or call) for each individual was also recorded. Counts began around local sunrise, were completed within four hours, and did not occur in inclement weather. Surveyors received two weeks of training to identify birds and estimate distances and passed a double-observer field test. The majority of transects were visited twice during the peak of the breeding season from mid-May through the end of June during 2014-2016, but were only visited once in 2019 due to timing of ongoing herbicide treatments.

Vegetation data was collected at a sample of the point count locations during July 2019, and at all locations during 2014-2016. We measured vegetation characteristics within a 50m radius plot centered at each point count station following a modified version of the relevé protocol, outlined in Ralph et al. (1993). On these plots, we measured shrub cover, live tree cover, herbaceous cover, as well as the relative cover of each species in the shrub and tree layers. We also measured basal area of live trees and snags using a 10-factor basal area key at five fixed locations in each plot. In 2019, we completed vegetation surveys at 89 of 138 total points in our sampling frame, focusing on control locations and those which have completed treatments. We plan to finish vegetation data collection in 2020, targeting those points which received herbicide treatments in 2019.

Analysis – 2019 data
To examine the preliminary effects of reforestation treatments, we used a before-after control-impact (BACI) analysis utilizing 2016 data as the pre-treatment sample and 2019 as the post-treatment sample. We decided to only use 2016 data because it is the most recent pre-treatment data available and in other data we have observed a large increase in avian abundance during the drought years of 2014 and 2015 (Roberts et al. 2019). We focused our analysis on a subset of species which primarily utilize the shrubs for forage and cover. We calculated the per-point maximum abundance (highest from first or second survey visit) within 50m of for the following 10 species tied to early seral forest (ESF) conditions: Mountain Quail, Dusky Flycatcher, House Wren, Fox Sparrow, Spotted Towhee, Green-tailed Towhee, Nashville Warbler, Yellow Warbler, MacGillivray's Warbler and Lazuli Bunting (see Appendix A for scientific names). We hypothesize treatments such as chainsaw clearing, herbicide and dozer mastication will disproportionately affect this community because they rely heavily on shrubs for cover and food resources and those conditions were being directly modified. We summed the per-point maximum abundance of all ESF species (total individuals of ESF birds per point) and species richness (maximum number of ESF species per point from any visit within the same year) as response variables.

We included in our analysis a set of control locations that burned at moderate or high severity and received no treatment within 100m of the point center determined using ground-truthed surveys (N = 44 points). A number of the treatment and control plots had ben salvaged logged and/or replanted with conifers following the fire, but not all. Only 20% of control locations had been affected by salvage or replanting while 50% of dozer, 57% of chainsaw and 77% of herbicide points had been previously salvaged and/or replanted. If possible, we will control for these effects in the final analysis. With multiple treatment groups, we used two-way ANOVA with variables for time (before and after) and treatment (chainsaw, herbicide, dozer and control) and an interaction between time and treatment. If time or treatment were significant, we used Tukey multiple comparisons to test for differences among the treated and control samples before and after treatments took place. Significant differences were evaluated at $P < 0.05$.

In addition to examining treatment effects, we report the average abundance of each species detected within 50m of the observer and those species we detected beyond 50m. For the early seral forest bird community, we compare 2014-2016 abundance data with 2019 (including all survey locations within the Power Fire) and use linear regression to estimate annual trends. For all analyses we used naïve point count detections uncorrected for detection probability, thus abundance metrics herein represent indices rather than true densities (Johnson 2008).

Results & Discussion

At all Power Fire locations, we detected a total of 69 species in 2019 (in comparison, we detected 94 species over the course of 4 years of monitoring). Nashville Warbler was the most abundant species (0.36 individuals per point), followed by House Wren (0.31), Fox Sparrow (0.28) and MacGillivray's Warbler (0.24; see Appendix A for a complete list of all species detected).

Reforestation Treatments

We evaluated the time*treatment interaction term for all reforestation treatment effects and found these were non-significant for ESF abundance and ESF species richness (Table 1). However, the main effects of time and treatment were significant for ESF species richness (Table 1). Tukey HSD tests comparing the main effects showed that chainsaw treatments had marginally higher ESF species richness pre-treatment compared to control locations ($P = 0.06$; Table 2, Figure 3) but these were similar in 2019 after treatments took place ($P = 0.87$), suggesting the chainsaw treatments may be associated with a decline in ESF species richness.

ESF abundance and species richness was similar at dozer points before and after treatments, and declined slightly at herbicide points, similar to what occurred at control locations (Table 2, Figure 3). The herbicide treatments resulted in fairly widespread shrub mortality where whitethorn or bear clover were the dominant species, however visual observations show the shrub structure was still present in 2019. We may expect herbicide treatments to affect food availability (i.e., dead shrubs no longer produce seeds nor may they host insect species that birds consume), but this effect could be delayed. In the Freds Fire, we documented a weak negative herbicide effect where treatments took place 1-4 years before surveys (Fogg et al. 2016). We would also expect dozer mastication treatments to cause a decline in ESF abundance and richness similar to what we documented in the Storrie Fire in the northern Sierra (Campos and Burnett 2014), however treatments took place 1-2 years before surveys, thus we may see a delayed effect once seed bank densities decline and philopatric species (i.e., tendency to return to the same site for nesting) have sufficient time to abandon no longer suitable habitat. The short term effects of these treatments may take one or more years to fully manifest.

Table 1. Results from two-way ANOVA evaluating the effects of reforestation treatments on the early seral forest (ESF) species abundance and richness.

		ESF Abundance		ESF Richness	
	df	F	P-value	F	P-value
Time	1	1.99	0.12	3.23	0.02
Treatment	3	3.10	0.08	4.62	0.03
Time*Treatment	3	0.38	0.77	0.46	0.71

Table 2. Mean abundance and richness of early seral forest (ESF) species before and after reforestation treatments.

		Abundance	Richness
Treatment	Time	Mean (SE)	Mean (SE)
Chainsaw	before	4.14 (0.57)	3.21 (0.41)
	after	2.79 (0.42)	2.14 (0.27)
Herbicide	before	2.77 (0.79)	2.31 (0.60)
	after	2.38 (0.69)	1.77 (0.43)
Dozer	before	2.67 (0.56)	2.25 (0.35)
	after	2.42 (0.84)	1.92 (0.63)
Control	before	2.57 (0.33)	1.86 (0.21)
	after	2.07 (0.27)	1.52 (0.18)

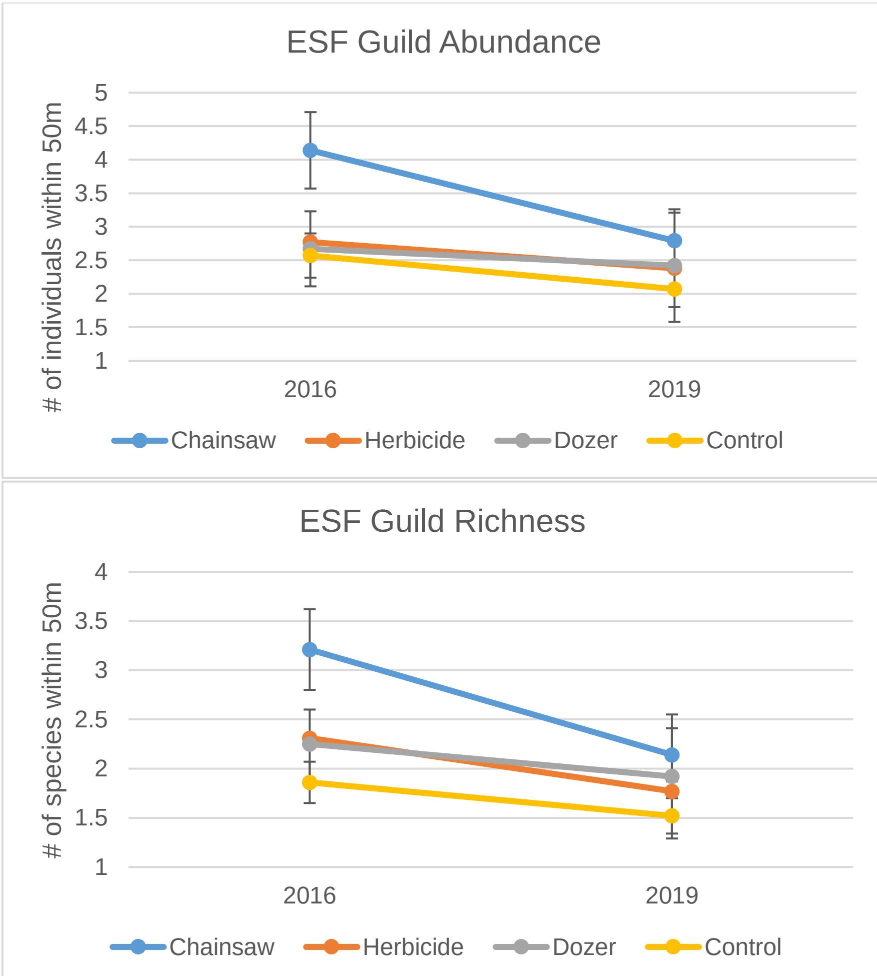

Figure 3. Early seral forest (ESF) bird abundance and richness (± 1 SE) at locations where chainsaw, herbicide and dozer treatments took place, in comparison to control locations.

Bird Trends

Six of the ten ESF species showed a significant decline from 2014 to 2019 in the Power Fire area (all *P*-values < 0.001; Figure 4, Table 3). Declining species and percent decline per year include: House Wren (8%), Fox Sparrow (9%), Spotted Towhee (10%), Green-tailed Towhee (7%) and Lazuli Bunting (10%). The remaining species (Mountain Quail, Dusky Flycatcher, Nashville Warbler, MacGillivray's Warbler and Yellow Warbler) had non-significant trends. No species showed an increasing trend. Recent work from the northern Sierra show several of these species reach peak abundance 13-15 years post-fire (e.g., House Wren, Spotted and Green-tailed towhees; Taillie et al. 2018), thus the declining trend is surprising to see during the same post-fire period in the Power Fire. However, the majority of these negative trends appear to be driven by high abundances in 2014 and 2015, with 2016 numbers similar to 2019. The historic drought in California appears to have resulted in increased abundance of many species in the Sierra (Roberts et al. 2019, Saracco et al. 2019). Thus, the declines may be at least in part attributable to this regional effect of the drought and not necessarily attributable to treatments. Nonetheless, the relatively large declines in a number of shrub associated species in the Power fire during a period post-fire where we would expect them to be stable if not increasing is of note, considering the targeted removal of shrub habitat in the fire.

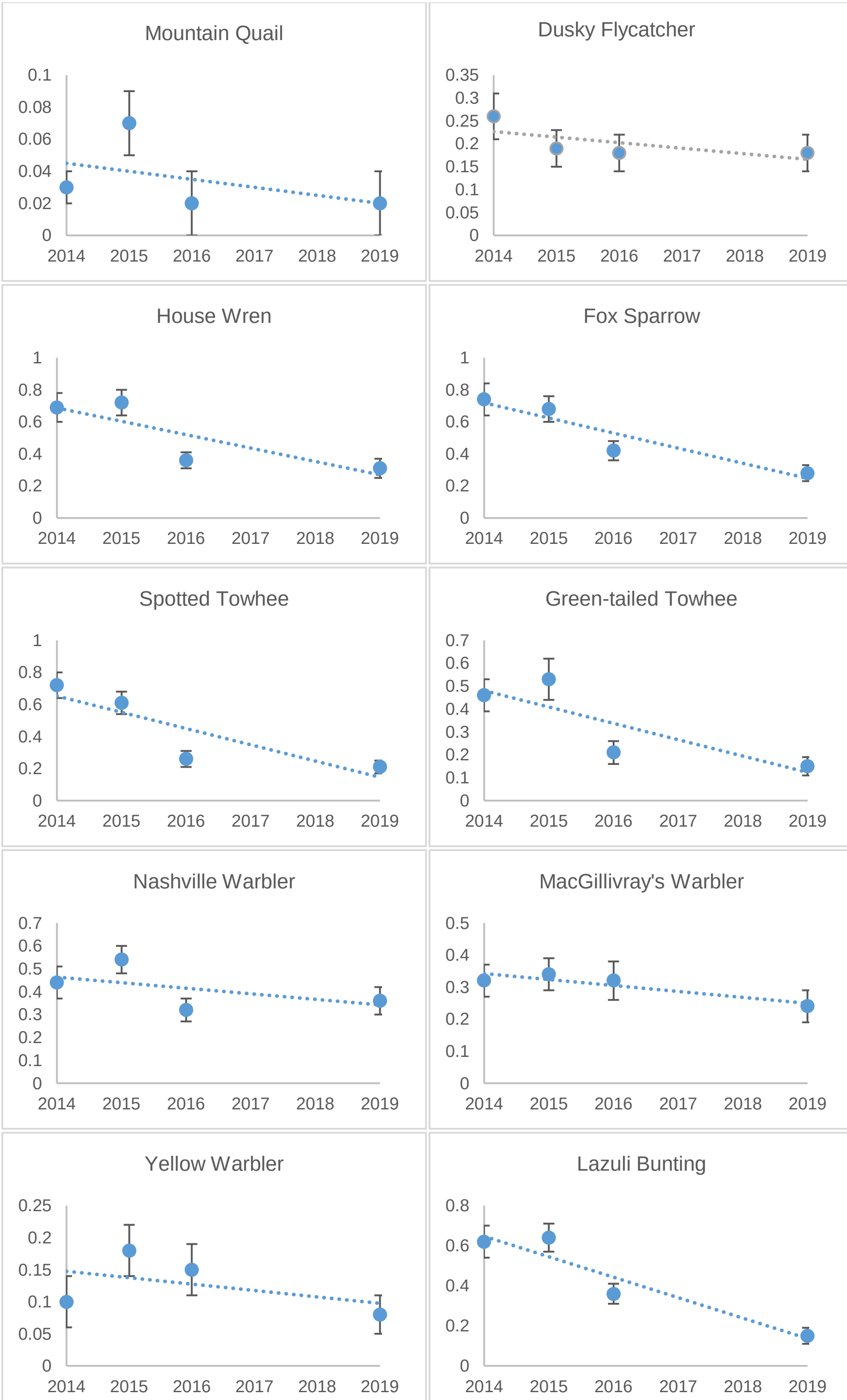

Figure 4. Trends in early seral forest bird abundance (± 1 SE) from 2014-2016 and 2019. Abundance is calculated as number of individuals within 50m of the observer.

Table 3. Trend estimates for early seral forest species during 2014-2019. Model coefficient for year, standard error (SE) and *P*-value for trend estimates are shown.

Species	Year	SE	*P*-value
Mountain Quail	0.00	0.01	0.38
Dusky Flycatcher	-0.01	0.01	0.30
House Wren	-0.08	0.02	<0.001
Fox Sparrow	-0.09	0.02	<0.001
Spotted Towhee	-0.10	0.02	<0.001
Green-tailed Towhee	-0.07	0.02	<0.001
Nashville Warbler	-0.03	0.02	0.13
MacGillivray's Warbler	-0.02	0.01	0.18
Yellow Warbler	-0.01	0.01	0.30
Lazuli Bunting	-0.10	0.02	<0.001

Future Directions

During the 2020 field season, we will prioritize re-surveying all of the point count stations identified as treated or control in this report as well as any areas treated in 2019 following our survey period. While the chainsaw and dozer treatments have largely been completed, we expect to add 30 herbicide-treated points; approximately half of which are targeted applications to deerbrush in the chainsaw-released areas which has already been cut and left on site via chainsaw, with the remainder applications in herbicide-only areas dominated by whitethorn ceanothus and bear clover. Our priority is to visit each point twice (to help control for sampling variation) and will work closely with the Amador Ranger District herbicide team to avoid running into their operations which is scheduled for April-May 2020 but may now be delayed due to heavy snowfall in March. Vegetation surveys will be finished at all locations (N=49 points). We will also help lead the Power Fire field symposium and present results from 2019 monitoring for reforestation effects and highlight the post-fire bird community. During fall-winter 2020, we will complete the final analysis and deliver a final report to the Amador Ranger District by March 31, 2021. Findings will be presented to the Eldorado National Forest and the Amador-Calaveras Consensus Group general and monitoring work groups.

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Appendix A. Average number of birds per point (within 50m of the observer) in the Power Fire during 2019, in order from highest to lowest abundance. Early seral forest species names are bolded.

Common Name	Scientific Name	2019
Nashville Warbler	***Oreothlypis ruficapilla***	**0.36**
House Wren	***Troglodytes aedon***	**0.31**
Fox Sparrow	***Passerella iliaca***	**0.28**
MacGillivray's Warbler	***Geothlypis tolmiei***	**0.24**
Red-breasted Nuthatch	*Sitta canadensis*	0.21
Golden-crowned Kinglet	*Regulus satrapa*	0.21
Spotted Towhee	***Pipilo maculatus***	**0.21**
Dusky Flycatcher	***Empidonax oberholseri***	**0.18**
Green-tailed Towhee	***Pipilo chlorurus***	**0.15**
Lazuli Bunting	***Passerina amoena***	**0.15**
Black-headed Grosbeak	*Pheucticus melanocephalus*	0.15
Brown Creeper	*Certhia americana*	0.14
Dark-eyed Junco	*Junco hyemalis*	0.14
Cassin’s Vireo	*Vireo cassinii*	0.11
Warbling Vireo	*Vireo gilvus*	0.11
Mountain Chickadee	*Poecile gambeli*	0.11
Hermit Warbler	*Setophaga occidentalis*	0.11
Yellow-rumped Warbler	*Setophaga coronate*	0.11
Steller’s Jay	*Cyanocitta stelleri*	0.10
Western Wood-Pewee	*Contopus sordidulus*	0.08
Western Tanager	*Piranga ludoviciana*	0.08
Yellow Warbler	***Setophaga petechia***	**0.07**
Hairy Woodpecker	*Picoides villosus*	0.06
White-headed Woodpecker	*Picoides albolarvatus*	0.05
Western Bluebird	*Sialia Mexicana*	0.05
American Robin	*Turdus migratorius*	0.05
Olive-sided Flycatcher	*Contopus cooperi*	0.04
Bewick’s Wren	*Thrymanes bewickii*	0.03
Black-throated Gray Warbler	*Setophaga nigrescens*	0.03
Chipping Sparrow	*Spizella passerine*	0.03
Mountain Quail	***Oreortyx pictus***	**0.02**
Anna’s Hummingbird	*Calypte anna*	0.02
Pileated Woodpecker	*Dryocopus pileatus*	0.02
Northern Flicker	*Colaptes auratus*	0.02
Red-breasted Sapsucker	*Sphyrapicus ruber*	0.02
Hammond’s Flycatcher	*Empidonax hammondii*	0.02
Pacific-slope Flycatcher	*Empidonax difficilis*	0.02
Bushtit	*Psaltriparus minimus*	0.02
White-breasted Nuthatch	*Sitta carolinensis*	0.02
Townsend's Solitaire	*Myadestes townsendi*	0.02
Orange-crowned Warbler	*Oreothlypis celata*	0.02
House Finch	*Haemorhous mexicanus*	0.02
Purple Finch	*Haemorhous purpureus*	0.02
Calliope Hummingbird	*Selasphorus calliope*	0.01
Hutton’s Vireo	*Vireo huttoni*	0.01

Common Name	*Scientific Name*	2019 Abundance
Wrentit	*Chamaea fasciata*	0.01
Song Sparrow	*Melospiza melodia*	0.01
Brown-headed Cowbird	*Molothrus ater*	0.01
Pine Siskin	*Spinus pinus*	0.01
Cassin's Finch	*Haemorhous cassinii*	0.01
California Quail	*Callipepla californica*	>50m
Sooty Grouse	*Dendragapus fuliginosus*	>50m
Red-tailed Hawk	*Buteo jamaicensis*	>50m
American Kestrel	*Falco sparverius*	>50m
Northern Pygmy-Owl	*Glaucidium gnoma*	>50m
Common Nighthawk	*Chordeiles minor*	>50m
Acorn Woodpecker	*Melanerpes formicivorus*	>50m
Lewis' Woodpecker	*Melanerpes lewis*	>50m
Downy Woodpecker	*Picoides pubescens*	>50m
Black Phoebe	*Sayornis nigricans*	>50m
Common Raven	*Corvus corax*	>50m
Canyon Wren	*Catherpes mexicanus*	>50m
Pacific Wren	*Troglodytes pacificus*	>50m
Swainson's Thrush	*Catharus ustulatus*	>50m
Cedar Waxwing	*Bombycilla cedrorum*	>50m
Wilson's Warbler	*Cardellina pusilla*	>50m
Brewer's Blackbird	*Euphagus cyanocephalus*	>50m
Red Crossbill	*Loxia curvirostra*	>50m
Evening Grosbeak	*Coccothraustes vespertinus*	>50m

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