Point Blue Report

Avian Monitoring of the Chips and Storrie Fire Areas

2013 Annual Report

JUNE 2014

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Cover photo: *Black-backed Woodpecker returning to its nest cavity on the Lassen National Forest. Photo by Brent Campos.*

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EXECUTIVE SUMMARY

In this report we present our 2013 activities and preliminary results of avian monitoring in post-fire habitats of the Chips and Storrie Fires. By comparing data collected in 2013 to data collected before the Chips Fire, we detected an initial response of the avian community where the fire burned through green forest. The spring and summer of 2013 was our single opportunity to collect pre-treatment data for a study on the effects of salvage logging in the Chips Fire. Comparing metrics of avian abundance and richness prior to treatment, our control and impact sample appear to be very close matches and will provide a good foundation for the remainder of the before-after control-impact analysis once the post-treatment data is collected. Lastly, we present results that demonstrate short term declines in shrub nesting birds as a result of Storrie Fire mastication treatments.

2013 Activities

- We resurveyed existing post-fire study plots established in 2009 in the Storrie Fire footprint which re-burned in the Chips Fire (50 point count stations on 10 nest searching transects and 14 other point count stations).
- We established 6 new post-fire study plots in the Chips Fire outside of the Storrie footprint (30 point count stations on 6 nest searching transects).
- We resurveyed most Plumas-Lassen Administrative Study (PLAS) green forest point count stations that burned in the Chips fire (195 point count stations).
- We established and surveyed point count stations in planned salvage units and outside salvage units as controls in the Chips Fire area (110 point count stations).
- We collected vegetation/habitat data at 392 point count stations, 60 nests, and 80 random locations in the Chips Fire footprint.

Post-Fire Habitat Management Recommendations

Recommendations are a culmination of our results, scientific literature, and expert opinion from 15 years of studying birds in the Sierra Nevada. Some of these are hypotheses that should be tested and further refined to ensure they are achieving the desired outcome of sustaining biological diversity in the Sierra Nevada.

General

- Whenever possible restrict activities that depredate breeding bird nests and young to the non-breeding season (August–April).
- Consider post-fire habitat as an important component of the Sierra Nevada ecosystem because it maintains biological diversity.
- Consider the area of a fire that burned in high severity, as opposed to the area of the entire fire, when determining what percentage of the fire area to salvage log.
- Consider the landscape context (watershed, forest, ecosystem) and availability of different habitat types when planning post-fire management actions.
- Approach post-fire management through a climate-smart lens - use the past to inform but plan for the future – find solutions that promote resiliency and foster adaptation.
- Use existing climate predictions of vegetation communities to guide reforestation locations and species mixes.
- Monitor, evaluate, be patient, strategic, and constrained in aiding the recovery of a post-fire landscape..

Snags

- Manage a substantial portion of post-fire areas for large patches (20–300 acres) burned with high severity as wildlife habitat.
- Retain high severity burned habitat in locations with higher densities of medium to larger diameter trees.

- Retain high severity patches in areas where pre-fire snags are abundant as these are the trees most readily used in the first three years after a fire.
- Retain snags in salvaged areas far greater than green forest standards and retain some in dense clumps.
- Snag retention immediately following a fire should aim to achieve a range of snag conditions from heavily decayed to recently dead in order to ensure a longer lasting source of snags for nesting birds.
- When reducing snags in areas more than five years post fire (e.g. Storrie fire), snag retention should favor large pine and Douglas Fir, but decayed snags of all species with broken tops should be retained in recently burned areas.
- Consider that snags in post-fire habitat are still being used by a diverse and abundant avian community well beyond the 5 to 10 year horizon of Black-backed Woodpecker use.
- Retain snags (especially large pine trees that decay slowly) in areas being replanted as they can provide the only source of snags in those forest patches for decades to come.
- Consider retaining smaller snags in heavily salvaged areas to increase snag densities because a large range of snags sizes are used by a number of species for foraging and nesting from as little as 6 inches DBH. Though, most cavity nests were in snags over 15 inches DBH.

Early Successional Habitat

- Manage post-fire areas for diverse and abundant understory plant community including shrubs, grasses, and forbs. Understory plant communities provide a unique and important resource for a number of species in a conifer dominated ecosystem.
- Most shrub patches should be at least 10 acres and shrub cover should average over 50% across the area in order to support area-sensitive species such as Fox Sparrow.

- Retain natural oak regeneration with multiple stems as these dense clumps create valuable understory bird habitat in post-fire areas 5–15 years after the fire.
- When treating shrub habitats ensure some dense patches are retained.
- In highly decadent shrub habitat consider burning or masticating half the area (in patches) in one year and burning the rest in the following years once fuel loads have been reduced.
- Maximize the use of prescribed fire to create and maintain chaparral habitat and consider a natural fire regime interval of 20 years as the targeted re-entry rotation for creating disturbance in these habitat types.

Shaping Future Forest

- Limit replanting of dense stands of conifers in areas with significant oak regeneration and when replanting these areas use conifer plantings in clumps to enhance the future habitat mosaic of a healthy mixed conifer hardwood or pine-hardwood stand.
- Consider managing smaller burned areas (<5000 acres) and substantial portions of larger fires exclusively for post-fire resources for wildlife especially when there have been no other recent fires (within the last 10 years) in the adjoining landscape.
- Retain patches of high burn severity adjacent to intact green forest patches as the juxtaposition of unlike habitats is positively correlated with a number of avian species, including those declining such as Olive-sided Flycatcher, Western Wood-Pewee, and Chipping Sparrow.
- Incorporate fine scale heterogeneity in replanting by clumping trees with unplanted areas interspersed to create fine scale mosaics that will invigorate understory plant communities and natural recruitment of shade intolerant tree species.
- Plant a diversity of tree species where appropriate, as mixed conifer stands generally support greater avian diversity than single species dominated stands in the Sierra Nevada.

- Consider staggering plantings across decades and leaving areas to naturally regenerate in order to promote uneven-aged habitat mosaics at the landscape scale.
- Consider fuels treatments to ensure the fire resiliency of remnant stands of green forest within the fire perimeter as these areas increase avian diversity within the fire and the edges between unlike habitats support a number of species (e.g. Olive-sided Flycatcher).
- Avoid planting conifer species in or adjacent (depends on the size of riparian corridor) to riparian areas to avoid future shading of riparian deciduous vegetation and desiccation.
- Consider replanting riparian tree species (cottonwood, willow, alder, aspen) in riparian conservation areas affected by stand replacing fire where natural regeneration is lacking.

INTRODUCTION

After over a half century of fire suppression, the area affected by wildfire in the Sierra Nevada is increasing. With the important role of fire as a primary driver of ecosystem form and function, there is a substantial need to understand the value of habitats created by wildfire and how post-fire habitats are used by the unique avian community that occupy them. In the Sierra Nevada, considerable debate surrounds the management of post-fire habitat. Management actions in post-fire habitat will affect the forest composition that will exist there for decades. Thus, it is necessary to carefully consider the species using post-fire habitat under different management prescriptions soon after fire and well into the post-fire time horizon. With an increasing emphasis on ecological restoration to improve ecosystem resilience and the delivery of ecosystem services, there is also a need to use ecological monitoring to minimize tradeoffs, seek complementarities among values, and optimize benefits among objectives (Hutto and Belote 2013).

Until recently there has been little study of bird communities in post-fire areas in the Sierra Nevada. Point Blue (formerly PRBO) Conservation Science has studied bird communities within burned areas since 2009 in the Lassen and Plumas National forests. While we have provided a considerable amount of new information to help guide the management of burned areas, there are still many uncertainties that fuel the ongoing debate over how to manage landscapes following large fires.

The Chips Fire in 2012 afforded several opportunities to greatly expand our knowledge of the effects of fire and post-fire management on Sierra Nevada avian communities. The Chips Fire burned through 75% of our Storrie Fire avian and vegetation monitoring sampling locations. By resurveying these locations we are seizing on a unique opportunity to assess the effects of re-burning on the avian community and vegetation with before and after data. In addition, the Chips Fire burned through a large portion of the Plumas-Lassen Administrative Study (PLAS) area where Point Blue has over 200 avian and vegetation sampling locations, just outside the boundaries of the Storrie Fire, with 4–10 years of pre-burn avian and vegetation data for these sampling locations. By re-surveying these locations we are capitalizing on a very rare opportunity to use data from before and after a fire across a fairly large landscape to understand avian response to this ecosystem driver. Lastly, we are combining these datasets and additional sampling locations targeting post-fire salvage units to conduct one of the first studies on the effects of salvage logging on birds in the Sierra Nevada. In this report we present data and preliminary results from our work to start to answer some of the management questions addressed by our Chips Fire avian monitoring project. In addition, we present results from a small study on the effects of shrub mastication in the on birds.

METHODS

Study Location

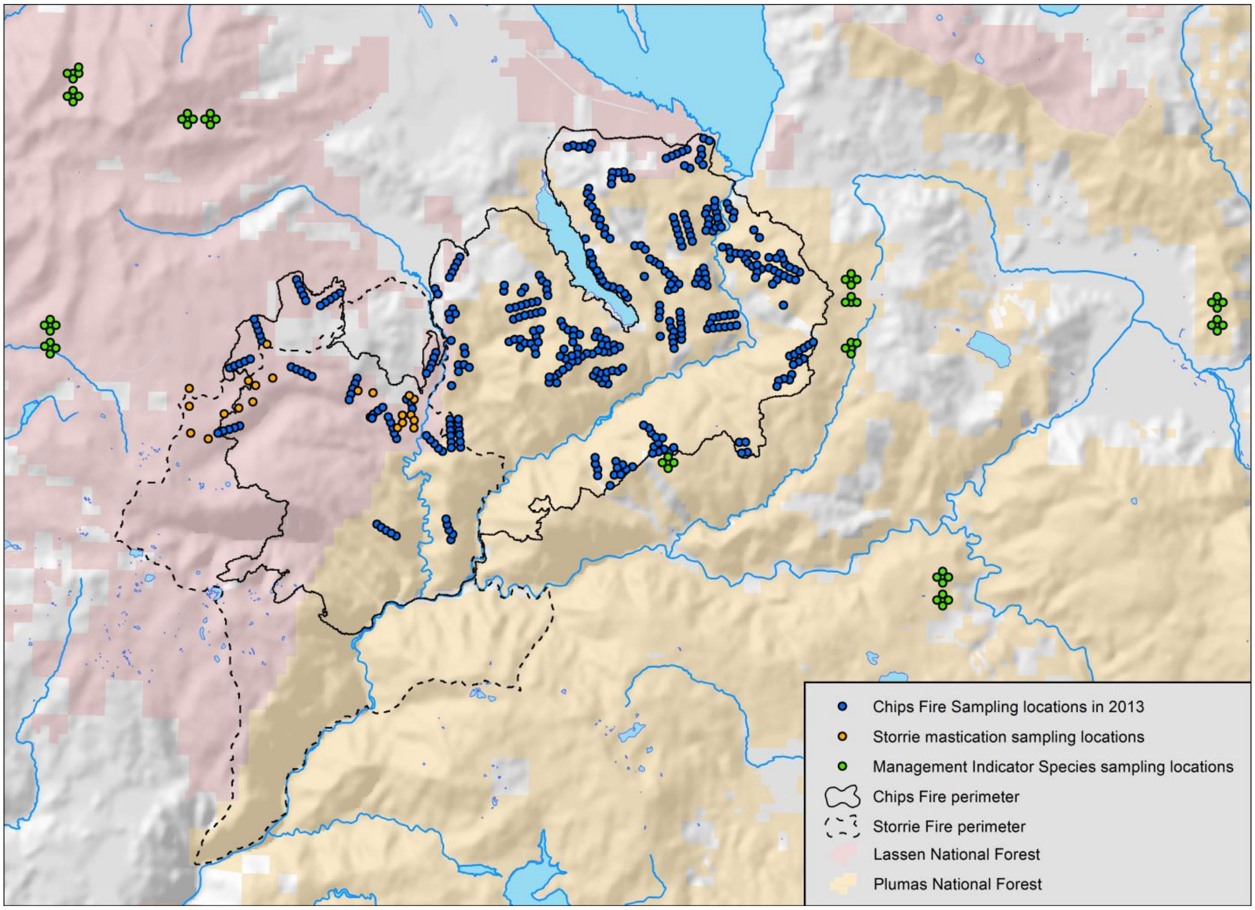
The study area for projects presented in this report includes the Chips Fire and Storrie Fire footprints on the Almanor Ranger District of Lassen National Forest and the Mount Hough Ranger District of Plumas National Forest in the Sierra Nevada Mountains of Northeastern California (Figure 1). The Storrie Fire occurred in the summer of 2000, burning 56,677 acres. The Chips Fire occurred in the summer of 2012 and burned 76,890 acres; many of those acres are within the Storrie Fire footprint. The elevations of sites surveyed ranges from 1287–1941 m ($\bar{x}$ = 1533 m).

Sampling Design

We gathered data across four historic and current projects on the Almanor and Mount Hough Ranger Districts of the Lassen and Plumas National Forests to investigate the effects of timber salvage, shrub mastication, and wildland fire on landbirds. Survey locations were selected using four separate sampling design protocols.

One hundred and ninety-five of 399 avian survey sampling locations in the Chips Fire footprint surveyed in 2013 were originally established between 2002 and 2005 for the PLAS avian community response to fuel treatments study. Site selection for PLAS green forest survey locations followed a random selection protocol, except approximately 25% of transects were systematically established in areas where treatments were planned. The PLAS site selection protocol for the unburned green forest sample is described in detail in the original PLAS study plan and previous annual reports (Stine et al. 2002, Burnett et al. 2009). For the purposes of this study, these sampling locations were used as: (1) impact samples for a BACI analysis of wildland fire, and (2) impact and control samples for a BACI analysis of timber salvage, depending on whether the points fell inside or outside of proposed timber salvage units.

Figure 1. Survey locations for data presented in this report.



In 2009, we started collecting data to monitor four USFS Management Indicator Species (MIS) across the Sierra Nevada management region. We used data gathered from these sampling locations as the control sample in our BACI analysis of wildland fire. Details on the sampling design for this project are described in Roberts et al. (2011).

Also in 2009, we established two transects within mastication units on the Almanor Ranger District that were within the footprint of the Storrie Fire. We used a site selection protocol where GIS layers of mastication unit boundaries were used to place points in a way that would maximize the points a person could sample in one morning while covering the majority of treatment units in the project. At the time, we did not establish adjacent reference points for these transects. Data from these sampling locations gathered in 2009 and 2012 that were treated in 2010 and 2011 serve as our impact sample for a BACI analysis of shrub mastication. As control samples for this BACI analysis of shrub mastication, we use data collected from sampling locations in the Storrie Fire in 2009 and 2012. Transects used in the control sample were established using post-fire-specific sampling design protocols described in detail in previous reports (Burnett et al. 2012).

In 2013, we added 110 sampling locations in the Chips Fire to monitor the effects of timber salvage operations. We used a site selection protocol where GIS layers of salvage unit boundaries were used to place points in a way that would maximize the points a person could sample in one morning while covering the majority of treatment units in the fire. Both impact and control points were established to increase the size of our samples in forest that burned at moderate and high severities.

Also in 2013, we added 30 sampling locations on six transects on the Chips Fire in Almanor Ranger District to monitor the habitat selection of cavity nesting birds. Our protocol for selecting these locations mirrored that used to select sampling locations for post-fire monitoring in the Storrie Fire. These sampling locations were also used as part of our control sample in our BACI analysis of timber salvage, as all points fell outside of proposed timber salvage units.

Salvage and Mastication Treatments

Mastication is the mechanical shredding of shrubs that sometimes uproots them but often leaves plants alive below ground to regenerate. The primary objective of mastication treatments was to reduce shrub competition with planted conifers and reduce the risk of future loss of planted conifers during wildfire. The residual woody material produced by mastication operations was left in place within stands. Prescribed fire was not used. No shrub removal occurred in control stands. Mastication treatments were implemented between 2010 and 2011. As a result, the time since treatment varies slightly among treated points. Up to 25% residual shrub cover was retained in some of the units.

Salvage logging is the felling and removal of trees damaged by a natural disturbance, such as fire or insect outbreak. Salvage logging on Forest Service land in the Chips Fire started in 2013, before and during our field season. Salvage treatments were primarily conducted by tractor-based logging systems, though a small proportion of units were helicopter logged and a few used a skyline system. Because salvage treatments spanned two different National Forests, treatments varied. The vast majority followed a prescription that retained 13% of each unit in untreated leave islands where all snags were left standing. In the remaining matrix very few merchantable trees were left standing. For a few treatments, the standard 4 of the largest trees per acre were retained as well as a number of smaller non-merchantable trees.

Point Count Surveys

Surveyors conducted standardized five-minute exact-distance point counts (Ralph et al. 1995) at each point count station. 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 three weeks of training to identify birds and estimate distances and passed a double-observer field test. All transects were visited twice during the peak of the breeding season from mid May through the first week of July.

Nest Cavity Surveys

A 20 ha area (200 x 1000 m rectangle) surrounding the nest cavity point count transects was surveyed for nests of cavity-nesting birds following the protocol outlined in "A field protocol to monitor cavity-nesting birds" (Dudley and Saab 2003). In order to focus our attention on species of interest we ignored some of the more common cavity-nesters. Our focal species included both species of bluebird, all woodpeckers, and all cavity-nesting raptors.

After the point count surveys were completed on all five point count locations, the nest survey was conducted for between two and four hours depending on the habitat, terrain and time spent waiting to confirm a cavity's status. All nest surveys were completed by noon. The primary search method for finding nests was bird behavior, though, once an individual of the focal species was located, observers often conducted a systematic search of snags in the vicinity. Once a potential nest was found, it was observed from a distance for up to 20 minutes to confirm the cavity was an active nest. If that cavity was confirmed active, a variety of characteristics of both the nest tree and the cavity were recorded. These characteristics included diameter at breast height (DBH), tree height, tree species, cavity height, tree decay class, and the orientation of the cavity opening. For tree decay, we used a qualitative scale of decay ranging from one to eight, with one being a live, intact tree and eight being a severely decayed stump. If the observer was unable to confirm the cavity as active, its location was recorded to aid nest searchers during the second visit to each transect.

Black-backed Woodpecker Detections

We recorded the locations of all black-backed woodpecker detections in the Chips Fire footprint in 2013. This data is summarized in Appendix A. The detections presented in Appendix A are not independent because they are from two point count visits and multiple observers, such that each detection should not be considered a separate Black-backed Woodpecker.

Vegetation/Habitat Surveys

We collected vegetation data at 392 of the 399 point count survey locations in the Chips Fire footprint following a relevé protocol. This data will be used in future analyses to inform models of habitat selection, habitat suitability, detection probability, and avian abundance.

Analysis: General Procedures with Point Count Data

We restricted the analysis of our point count data to a subset of the species encountered. We excluded: (1) all birds >100 m from the observer, (2) species flying over the sampling locations but not actively using the habitat, (3) species that do not breed in the study area, and (4) those species that are not adequately sampled using the point count method (e.g., waterfowl, raptors, waders; Appendix B). A number of our analyses are further restricted to different suites of species whose habitat requirements we believe represent different spatial attributes, habitat characteristics, and management regimes representative of a healthy system. For all analyses we used naïve point count detections uncorrected for detection probability, thus our abundance metrics represent indices rather than true densities (Johnson 2008). The indices of bird abundance herein are defined as the mean number of individuals detected per point per visit in one year. The indices of bird species richness herein are defined as the mean number of species detected per point per visit in one year.

Analysis: Unburned to Burned Forest

We used data collected inside and outside of the Chips Fire footprint in 2010, 2011, and 2013 in a before-after control-impact analysis to evaluate the ecological effects of the Chips Fire in the year following the fire. We identified 32 bird species to evaluate the ecological effects of the Chips Fire. We began with 81 species that are adequately sampled using our standardized point count method (Ralph et al. 1995) and detected in sufficient numbers to allow for meaningful statistical analysis (Nur et al. 1999). Based on our local knowledge and published information about the habitat associations of these species, we selected the species mostly closely aligned with three broad forest conditions in the Sierra Nevada: early-seral, mid to late-seral open canopy forest, and mid to late-seral mature to dense forest. The guilds represent three structural forest conditions that are created by fire or lack of fire: early successional conditions created by stand-replacing or frequent fire, open and mature conditions created by frequent low to moderate severity fire, and dense and mature conditions created by primarily long-term fire exclusion. We selected a total of 11 species in the early-seral guild, 11 species in the open forest guild, and 10 species in the mature dense forest guild. The open forest and early-seral guilds shared two species (listed below). The species selected included year-round residents, short-distance migrants, and Neotropical migrants.

The mature dense forest guild was comprised of: Pileated Woodpecker (*Dryocopus pileatus*), Cassin's Vireo (*Vireo cassinii*), Golden-crowned Kinglet (*Regulus satrapa*), Pacific Wren (*Troglodytes hiemalis*), Hermit Thrush (Catharus guttatus), Hermit Warbler (*Setophaga occidentalis*), Red-breasted Nuthatch (*Sitta canadensis*), Western Flycatcher (*Empidonax difficilis & occidentalis*), Hammond's Flycatcher (*Empidonax hammondii*), and Brown Creeper (*Certhia americana*). The early-seral guild was comprised of species that use shrub habitats and fire killed trees and included: Mountain Quail (*Oreortyx pictus*), Hairy Woodpecker (*Picoides villosus*), Dusky Flycatcher (*Empidonax oberholseri*), Western and Mountain Bluebirds (*Sialia currucoides & mexicana*), Spotted Towhee (*Pipilo maculatus*), Green-tailed Towhee (*Pipilo chlorurus*), Fox Sparrow (*Passerella iliaca*), Chipping Sparrow (*Spizella passerina*),Yellow Warbler (*Setophaga petechia*), MacGillivray's Warbler (*Geothlypis tolmiei*), and Lazuli Bunting (*Passerina amoena*). Finally, the open canopy forest species are those that occur along forest edges and openings and/or utilize shade intolerant resources from the sub-canopy to the forest floor and included: Western Wood-Pewee (*Contopus occidentalis*), Olive-sided Flycatcher

(*Contopus cooperi*), Warbling Vireo (*Vireo gilvus*), American Robin (*Turdus migratorius*), Nashville Warbler (*Oreothlypis ruficapilla*), Black-throated Gray Warbler (*Setophaga nigricens*) Yellow-rumped Warbler (*Setophaga coronata*), MacGillivray's Warbler, Chipping Sparrow, Black-headed Grosbeak (*Pheucticus melanocephalus*), and Western Tanager (*Piranga ludoviciana*).

We tested whether the change in abundance and richness of these habitat guilds from before to after the Chips Fire was equal among three 'treatment' categories using t-tests. The three treatments were unburned, low severity burn, and high severity burn. The unburned forest sample was comprised of point count data from our Management Indicator Species project collected outside of the Chips Fire perimeter that did not burn in the Rich or Storrie Fires. The 'low severity' and 'high severity' burn samples were comprised of points in the Chips Fire footprint that were classified as unchanged or low and moderate or high fire severities, respectively, using the Composite Burn Index thresholds from Miller and Thode (2007), and were unburned before the Chips Fire. We averaged data collected among 2010 and 2011 surveys into a single before-fire time period. Data collected in 2013 served as our post-fire sample. Only point count locations with data from all three years (2010, 2011, and 2013) were used in this analysis.

Analysis: Salvage Logging Pre-treatment Avian Indices

We tested for differences in bird abundance and richness in pre-treatment data collected in 2013 in control and impact salvage logging areas. Pooling sampling locations established before the Chips Fire, and sampling locations established to boost sample sizes in control and impact areas, before the start of the 2013 field season, we had 104 points in areas expected to be salvaged and 188 points in areas not expected to be salvaged. By the end of the 2013 field season, 17 points classified as control had ≥10% salvage logging impact within 100-m radius of the point count and were reclassified as impact (for the purpose of this preliminary analysis only). For this analysis of pre-treatment condition, we removed all points with >10% impact of salvage logging within a 100-m radius of the point count station in order to facilitate our pre-treatment evaluation of similarity in our sample. In future analysis of the effects of the salvage treatments we may include those sampling locations for which we only have post-treatment data. Because sample sizes were not equal between control and impact points within each burn severity, we randomly selected an equally sized sample of control and impact points within each burn severity from the pool of sampling locations surveyed in the Chips Fire in 2013. The resultant sample for each burn severity corresponded to the smallest pre-treatment sample size of the control and impact samples. We used a t-test evaluate differences in the means of total bird abundance and species richness between the control and impact samples. Samples from all three burn severities were pooled for analysis.

Analysis: Avian Indices Before and After Mastication

We used data collected in the Storrie Fire footprint in 2009 and 2012, prior to the Chips Fire, in a before-after control-impact analysis to evaluate the effects of mastication on the avian community. We identified 17 bird species in two guilds to include in the analysis: 9 species in a shrub nesting guild and 8 species in cavity nesting guild. The shrub nesting guild was comprised of species that use shrub habitats for nesting: Dusky Flycatcher, Spotted Towhee, Green-tailed Towhee, Fox Sparrow, Chipping Sparrow, Nashville Warbler, Yellow Warbler (*Setophaga petechia*), MacGillivray's Warbler, and Lazuli Bunting. The cavity nesting guild was comprised of species that use fire-killed trees for nesting: Northern Flicker (*Colaptes auratus*), Hairy Woodpecker, Black-backed Woodpecker (*Picoides arcticus*), White-headed Woodpecker (*Picoides albolarvatus*), Tree Swallow (*Tachycineta bicolor*), Western and Mountain Bluebirds, and House Wren (*Troglodytes aedon*). Because mastication treatment units were generally small, we removed from the analysis all birds >50 m from the observer to ensure our sample best represented masticated areas. We used t-tests to evaluate whether the change in abundance and richness of these species guilds before and after mastication at impacted points was equal relative to the change at control points.

Data Management and Access: Sierra Nevada Avian Monitoring Information Network

All avian data from this project is stored in the California Avian Data Center and can be accessed through the Sierra Nevada Avian Monitoring Information Network web portal (http://data.prbo.org/apps/snamin). At this website, species lists, interactive maps of study locations, as well as calculations of richness, density, and occupancy can be generated as selected by the user. Study site locations can also be downloaded in various formats for use in GPS, GIS, or online mapping applications as well. Non-avian data (e.g., site narratives, vegetation) are stored on Point Blue's server.

RESULTS

Unburned to Burned Forest

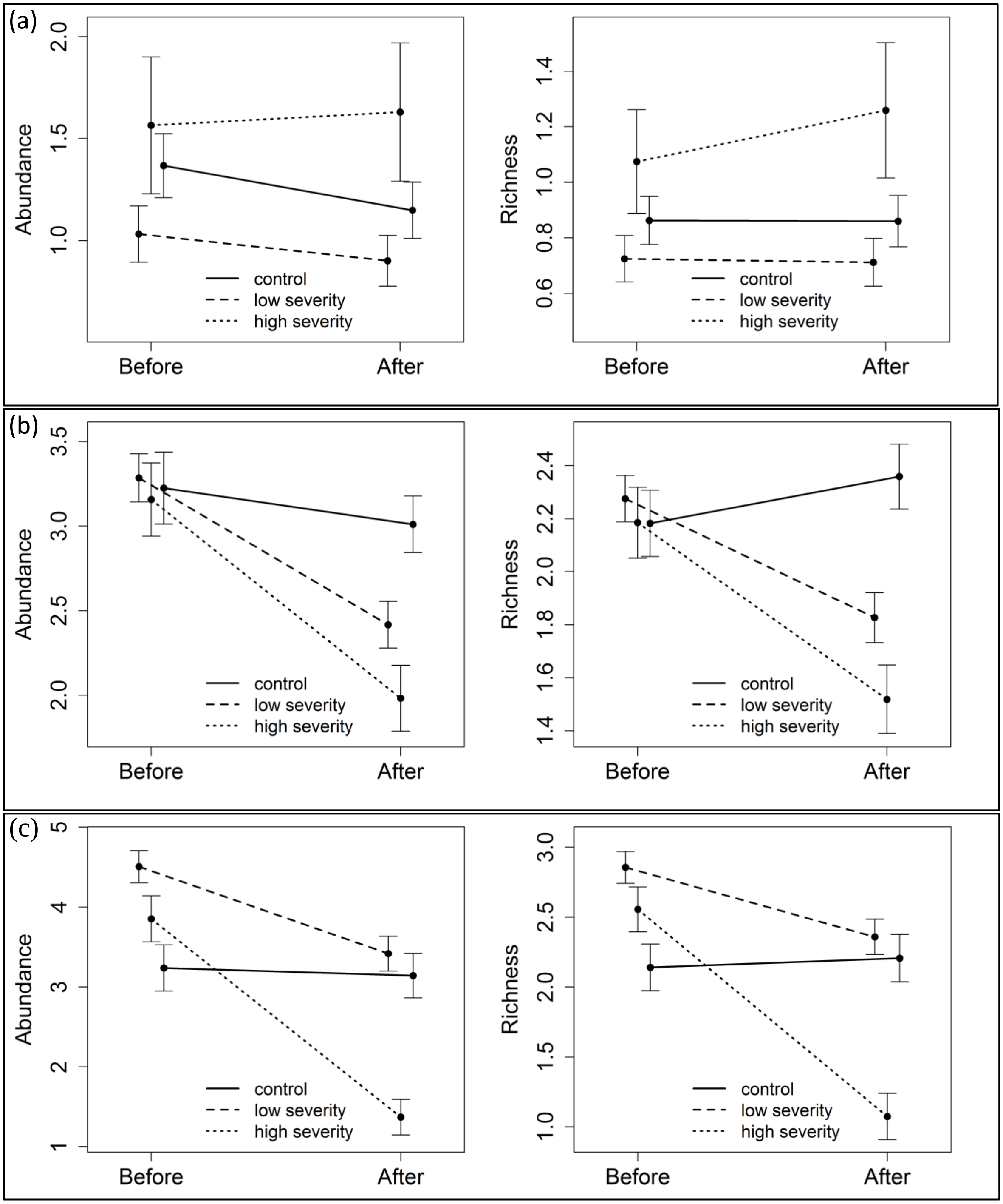
The impact of the fire on birds varied among burn severities and species guilds. The abundance and richness of early successional species did not change at sampling locations that were subject to low and high severity fire compared to unburned control points (Table 1, Figure 2a). Conversely, the abundance and richness of open and edge forest species declined markedly in areas affected by both low and high severity fire compared to control points, but we did not detect difference between low and high fire severity (Table 1, Figure 2b). The abundance and richness of mature and dense forest species also declined following both low and high severity fire compared to control points, and declines were steeper in high severity compared to low severity (Table 1, Figure 2c).

Table 1. Indices of avian abundance and species richness for three species guilds before and one year after the Chips Fire. Burn severity was based on the Composite Burn Index with Low = CBI <1.25 and High = >1.25 (moderate to high).

			Mean Species Abuncance (± 1 SE)		unburned vs. low			unburned vs. high			low vs. high		
Species Guild	Burn Severity	Sample Size	Before	After	*t*	*df*	*P*	*t*	*df*	*P*	*t*	*df*	*P*
early success-ional	unburned	69	1.37 (0.16)	1.15 (0.14)									
	low	78	1.03 (0.14)	0.90 (0.13)	-0.56	145	0.578	-1.23	94	0.224	-1.13	103	0.263
	high	27	1.57 (0.34)	1.63 (0.34)									
open and edge	unburned	69	3.26 (0.21)	3.01 (0.17)									
	low	78	3.28 (0.14)	2.42 (0.14)	2.139	145	0.034	2.149	94	0.034	0.943	103	0.348
	high	27	3.16 (0.22)	1.98 (0.20)									
mature and dense	unburned	69	3.24 (0.29)	3.14 (0.28)									
	low	78	4.51 (0.20)	3.42 (0.22)	3.47	145	<0.001	5.829	94	<0.001	4.093	103	<0.001
	high	27	3.85 (0.29)	1.37 (0.22)									

			Mean Species Richness (± 1 SE)		unburned vs. low			unburned vs. high			low vs. high		
Species Guild	Burn Severity	Sample Size	Before	After	*t*	*df*	*P*	*t*	*df*	*P*	*t*	*df*	*P*
early success-ional	unburned	69	0.86 (0.09)	0.86 (0.09)									
	low	78	0.72 (0.08)	0.71 (0.09)	0.095	145	0.924	-1.09	94	0.278	-1.44	103	0.157
	high	27	1.07 (0.19)	1.26 (0.24)									
open and edge	unburned	69	2.18 (0.13)	2.36 (0.12)									
	low	78	2.28 (0.09)	1.83 (0.09)	2.989	145	0.003	2.783	94	0.007	0.982	103	0.329
	high	27	2.19 (0.13)	1.52 (0.13)									
mature and dense	unburned	69	2.14 (0.17)	2.21 (0.17)									
	low	78	2.86 (0.11)	2.36 (0.13)	3.383	145	<0.001	6.658	94	<0.001	4.811	103	<0.001
	high	27	2.56 (0.16)	1.07 (0.17)									

Figure 2. The change in abundance and richness (± 1 SE) of (a) early successional, (b) open and edge, and (c) mature dense forest species guilds, from before and one year after the Chips Fire, at point count sampling locations in low and high fire severities relative to nearby unburned control points.



Pre-Salvage Logging

We detected no difference in total bird abundance or species richness between the salvage control and impact samples in 2013, prior to treatment being implemented (Table 2).

Table 2. Indices of total avian abundance and species richness in the Chips Fire before salvage logging. Data for all burn severities were pooled for analysis.

Treatment	Burn Severity	Sample Size: After 2013 treatments	Sample Size: Analysis#	Mean abundance (± 1 SE)	*t*	*df*	*P*	Mean spp. richness (± 1 SE)	*t*	*df*	*P*
	low	91	21								
control	moderate	27	19	7.09 (0.23)				5.56 (0.32)			
	high	53	53		-0.08	184	0.94		0.142	184	0.89
	low	23	21								
impact	moderate	24	19	7.13 (0.22)				5.52 (0.31)			
	high	74	53								

#: pre-treatment data through both point-count visits

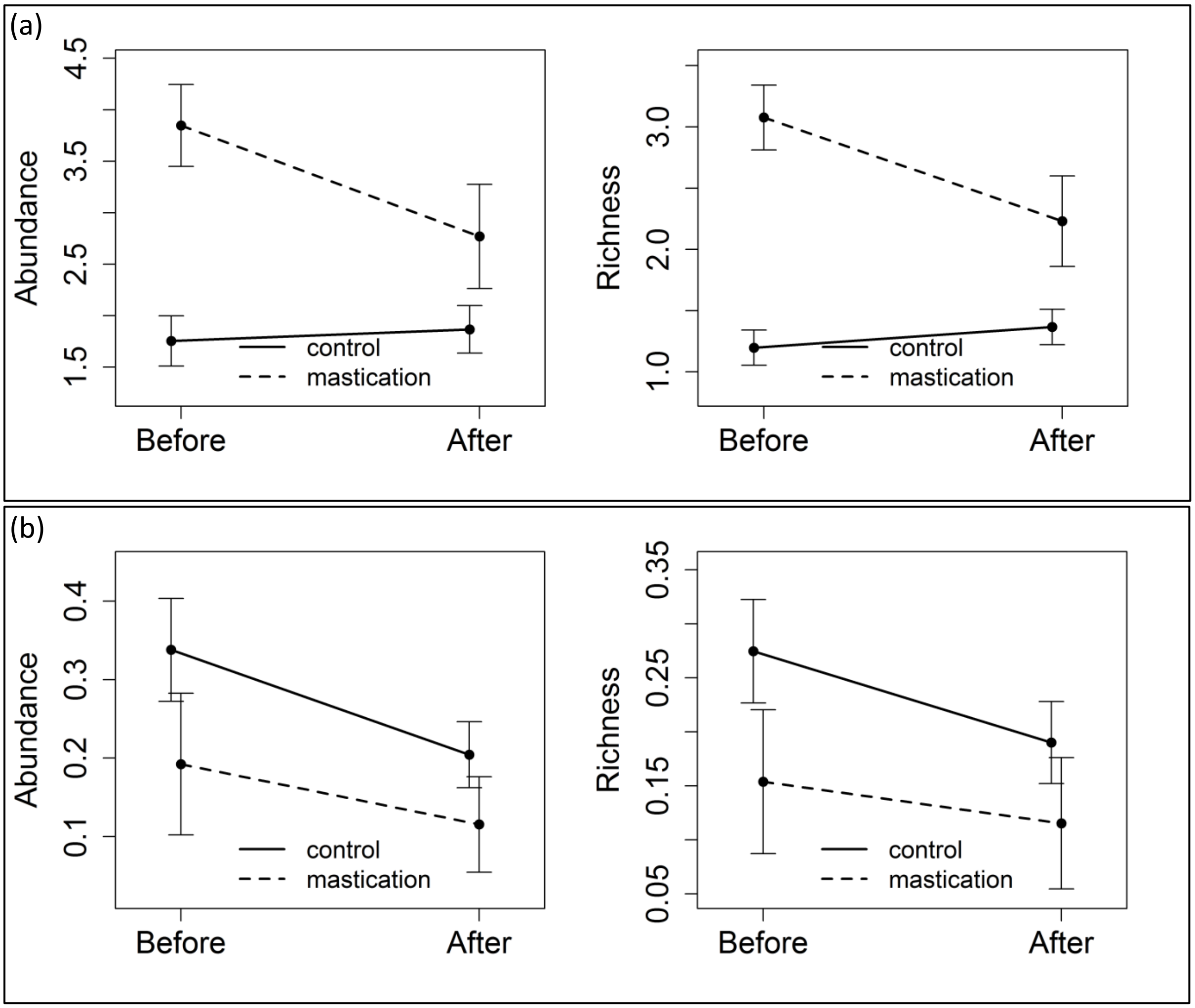
Mastication

The abundance and richness of shrub nesting birds in areas impacted by shrub mastication declined relative to control stands (Table 3, Figure 3a). However, we detected no change in the abundance or richness of cavity nesting birds in masticated areas relative to control stands (Table 3, Figure 3b).

Table 3. Avian response to shrub mastication following the Storrie Fire.

Nesting Guild	Treatment	Sample Size	Mean abundance (± 1 SE): Before	Mean abundance (± 1 SE): After	*t*	*df*	*P*	Mean specis richness (± 1 SE): Before	Mean specis richness (± 1 SE): After	*t*	*df*	*P*
shrub	control	71	1.76 (0.24)	1.87 (0.23)	2.167	82	0.033	1.20 (0.14)	1.37 (0.14)	3.141	82	0.002
	impact	13	3.85 (0.40)	2.76 (0.51)				3.08 (0.27)	2.23 (0.37)			
cavity	control	71	0.34 (0.07)	0.20 (0.04)	-0.36	82	0.719	0.28 (0.05)	0.19 (0.04)	-0.4	82	0.694
	impact	13	0.19 (0.09)	0.12 (0.06)				0.15 (0.07)	0.12 (0.06)			

Figure 3. The change in abundance and richness (± 1 SE) of (a) shrub nesting and (b) cavity nesting species at point count sampling locations before and after mastication treatments in the Storrie Fire (pre Chips Fire) relative to nearby unmasticated control points.



Nest Searching

We found 61 nests of six cavity nesting species in the Chips Fire in 2013 (Table 4). All but one of these nests were found during nest searching surveys; one Black-backed Woodpecker nest was found during point count surveys on a non-nest searching transect (see Appendix A).

Table 4. Cavity nests, by species, found while nest searching in the Chips Fire in 2013.

Species	Nests Found
Northern Flicker	7
Hairy Woodpecker	13
White-headed Woodpecker	25
Black-backed Woodpecker	10
Red-breasted Sapsucker	4
Western Bluebird	2

DISCUSSION

As average fire severity and fire size increases in the Sierra Nevada, post-fire habitat management activities will likely affect an increasing amount of land in the region. Birds are excellent indicators of ecological processes that can provide important feedback regarding the health of managed fire-prone ecosystems (Alexander et al. 2007). As exemplified by our results, there is a differential response to ecosystem drivers (e.g. fire) and management (e.g. shrub mastication) among bird species that yields information about the ecology of the sampled areas. After biological interpretation of these data, the information can be applied to future management actions in an adaptive management framework (Burnett 2011).

The Chips Fire resulted in substantial and immediate changes to the avian community outside of areas that were burned in the Storrie Fire. These changes were primarily a result of declines in the abundance of species within the mature dense forest guild. Interestingly, the species associated with open forest and edge also declined in both high and low severity burned areas. We expected these species would have no initial response, or even increase, following low severity fire. The early successional guild was the least abundant guild before the fire and did not change following the fire. This is likely the result of the habitat attributes (e.g. shrub cover) that most of the species use being scarce before the fire and not having sufficient time to colonize the recently burned landscape. We expect the early successional guild will realize the greatest increases in the next 5–10 years, as seen in other fire areas (Smucker et al. 2005, Burnett et al. 2012).

Before the Chips Fire, this landscape was dominated by mature dense and open forest associated species. In the year following the fire the three guilds were much more equally represented on the landscape, suggesting the fire had positive effects on increasing landscape heterogeneity. In future years we will evaluate individual species response to fire and consider separating snag forest associates from early seral shrub associates to provide a more detailed evaluation of the changes in the avian community following a large fire. We will also consider species linear vs. categorical fire severity effects.

The 2013 field season was our single opportunity to collect pre-treatment data for a study on the effects of salvage logging in the Chips Fire. Comparing metrics of avian abundance and richness in our treatment and control samples, our control and impact sample are closely matched and should provide a good foundation for the remainder of the before-after control-impact analysis once the post-treatment data is collected in subsequent field seasons. In future years we will evaluate both guild level responses and those of individual species to salvage logging treatments. By combining this data with those from several other recent fires we will be able to provide the first quantitative evaluation of the effects of salvage logging on the avian community of the Sierra Nevada.

Differences in the abundance and richness of shrub and cavity-nesting species guilds in masticated areas were consistent with expectations given the change in vegetation structure following shrub mastication. These results corroborate the sensitivity of shrub-nesting species to reduced shrub cover characteristic of post-fire habitat conditions (Seavy et al. 2008). All of the masticated sites in this small-scale study were salvage logged 8–9 years prior to mastication treatments. It is possible that the results for cavity nesting species could differ in areas with higher snag retention given the affinity of some cavity nesting species for open ground (i.e. bluebirds). Our pre-mastication indices illustrate that areas that are salvage logged can still provide future habitat for both shrub and cavity nesting wildlife if legacy structures are retained and plantation management (i.e. shrub abatement) is minimized. However, it should be noted that the majority of these plantations were lost in the Chips Fire despite (or potentially because) they were masticated immediately before the fire (Bradley et al. 2006).

Looking Forward

These data and data we are continuing to collect in the Chips Fire will be applied to many upcoming products. The analyses in this report are preliminary and will be expanded upon and finalized in coming years. Three or four major products are planned. Firstly, a more detailed evaluation of the changes in the avian community following a large fire. This will be accomplished with a BACI analysis of individual species responses to fire that considers finer categories of fire severity in a longer time series. Secondly, by combining this data with those from several other recent fires in the Sierra Nevada, we will be able to provide the first quantitative evaluation of the effects of salvage logging on the avian community of this region. We will analyze the response of guilds and those of individual species to salvage logging treatments in a BACI framework. Thirdly, we will evaluate the effects of two moderate to high intensity burns in close succession on individual bird species and species guilds. Lastly, using the data collected at nest searching transects in the Chips, Storrie, Cub and Moonlight Fires, we will evaluate the local as well as landscape level habitat associations for primary and secondary cavity nesting birds in the Northern Sierra Nevada.

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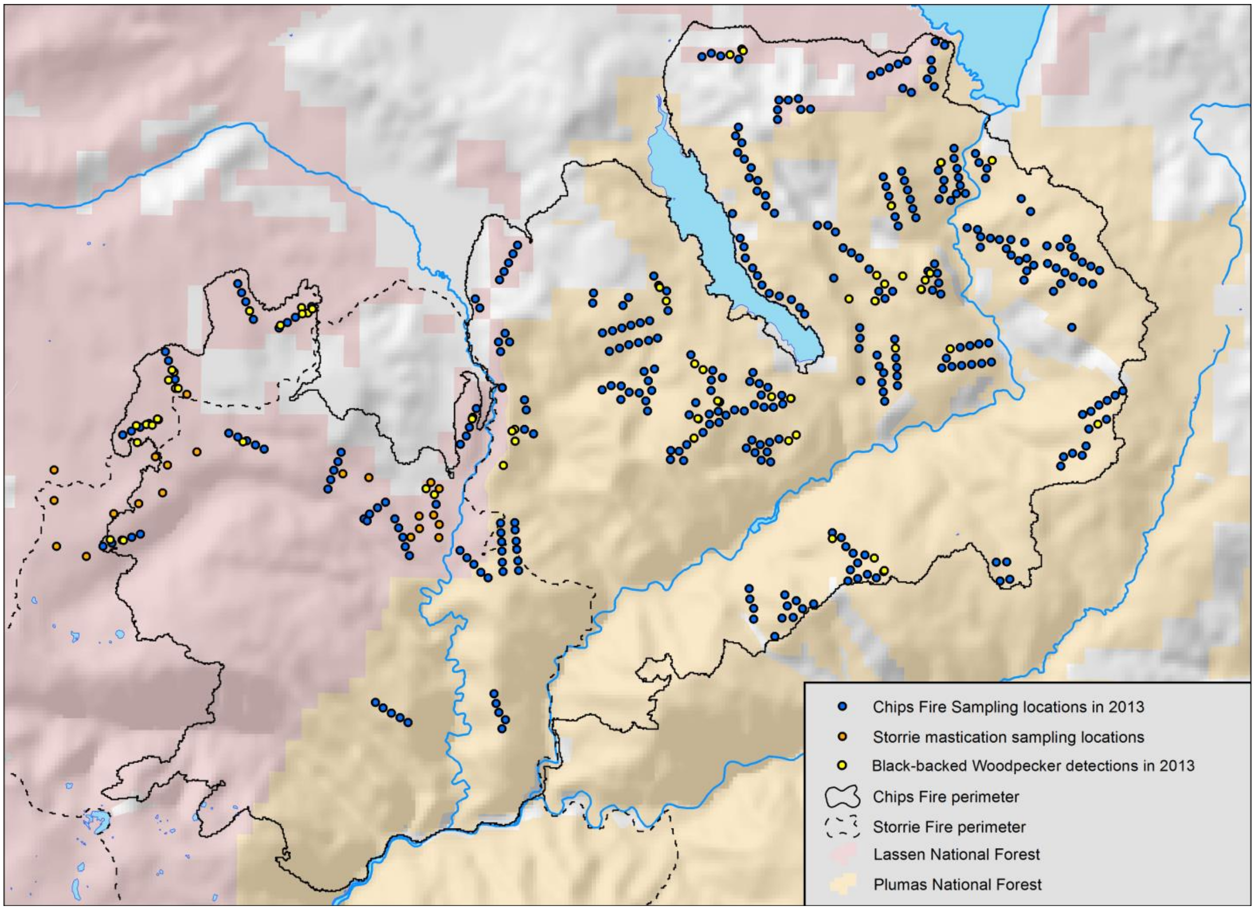
APPENDICES

Appendix A. Black-backed woodpecker detections in the Chips Fire perimeter during the 2013 field season.



Appendix A (continued). Black-backed woodpecker detections in the Chips Fire perimeter during the 2013 field season.

Observer	Date	Number of Individuals	Easting	Northing	Transect	Nearest Point	During Cavity Survey	Cavity ID
DJL	5/17/2013	1	657893	4440290	CS07	11	no	
DJL	5/19/2013	1	650449	4439274	CS09	14	no	
DJL	5/19/2013	1	650731	4439901	CS09	13	no	
DJL	5/19/2013	2	650715	4440197	CS09	10	no	
DJL	5/20/2013	1	648503	4438614	CS11	1	no	
DJL	5/24/2013	1	660020	4444208	SENW	1	no	
DJL	5/24/2013	2	659812	4444428	CS05	7	no	
EJB	5/24/2013	1	659130	4443799	CS06	7	no	
DJL	5/25/2013	2	662507	446987	CS03	4	no	
EJB	5/25/2013	2	645339	4442985	CH04	1	yes	CH04C13
EJB	5/25/2013	2	645178	4443119	CH04	2	yes	CH04E13
EJB	5/25/2013	2	645200	4442963	CH04	3	yes	
EJB	5/25/2013	1	644653	4442653	CH04	5	yes	
BJL	5/26/2013	1	641097	4439545	CH01	3	no	
BJL	5/26/2013	1	641617	4440149	CH01	5	no	
BJL	5/26/2013	3	641312	4440012	CH01	4	yes	
EJB	5/26/2013	2	656187	4450071	CS02	1	no	
EJB	5/26/2013	2	655889	4449919	CS02	3	no	
RLS	5/26/2013	2	642027	4440956	CH02	1	no	
RLS	5/26/2013	2	641972	4441374	CH02	3	yes	
RLS	5/26/2013	2	659993	4437228	PL22B	C	no	
PJT	5/26/2013	1	643794	4439655	ST06	2	yes	
BJL	5/28/2013	1	660960	4444108	CS04	1	no	
PJT	5/28/2013	1	660130	4446208	OHC1	3	no	
PJT	5/28/2013	1	655370	4440627	CS08	11	no	
BJL	5/29/2013	1	655289	4440125	CAR1	9	no	
DJL	5/29/2013	1	657729	4441220	BVR2	8	no	
EJB	5/30/2013	2	658906	4437685	CAR2	12	no	
EJB	5/30/2013	1	660253	4436914	CAR2	2	no	
BRC	6/2/2013	1	661056	4444338	CS04	2	no	
DJL	6/4/2013	2	640830	4437048	ST15	3	yes	ST15A13
EJB	6/6/2013	1	657706	4440140	CS07	10	no	
DJL	6/8/2013	1	660351	4442584	224	11	no	
BJL	6/8/2013	2	659795	4443767	CS05	8	no	
DJL	6/10/2013	1	649618	4440425	ST10	2	yes	
BRC	6/10/2013	2	648719	4438468	CS11	2	no	
PJT	6/11/2013	1	643850	4442990	CH03	4	yes	CH03D13
BRC	6/11/2013	1	645448	4443091	CH04	1	yes	

Appendix A (continued). Black-backed woodpecker detections in the Chips Fire perimeter during the 2013 field season.

Observer	Date	Number of individuals	Easting	Northing	Transect	Nearest Point	During Cavity Survey	Cavity ID
PJT	6/13/2013	2	642099	4440962	CH02	1	yes	CH02I13
PJT	6/13/2013	2	641920	4441421	CH02	3	yes	CH02D13
PJT	6/13/2013	2	641846	4441164	CH02	4	yes	CH02G13
EJB	6/13/2013	2	641465	4440003	CH01	4	yes	CH01A13
EJB	6/13/2013	2	641060	4439982	CH01	3	yes	CH01B13
EJB	6/13/2013	1	641587	4440166	CH01	5	yes	
PJT	6/16/2013	2	662661	4447444	CS03	3	no	
EJB	6/16/2013	2	650648	4440156	CS09	10	no	
EJB	6/17/2013	2	640489	4437050	ST15	4	yes	
BJL	6/19/2013	1	661172	4444522	CS04	3	no	CS04A13
BJL	6/19/2013	2	660481	4444428	SENW	2	no	
BRC	6/19/2013	1	661752	4442612	SEN1	11	no	
EJB	6/22/2013	1	665580	4440818	222	11	no	
DJL	6/26/2013	1	655248	4442017	CS08	2	no	
DJL	6/26/2013	1	655461	4441872	CS08	3	no	
DJL	6/26/2013	1	655862	4441093	CS08	8	no	
BJL	6/26/2013	1	656223	4450030	CS02	1	no	
EJB	6/26/2013	1	657240	4441248	BVR2	6	no	
BJL	6/26/2013	1	656223	4450030	CS02	1	no	
BRC	6/30/2013	1	654289	4443934	CS10	6	no	
BRC	6/30/2013	2	654470	4443592	CS10	8	no	
BRC	7/8/2013	1	661358	4447353	223	1	no	

Appendix B. List of species excluded from all analyses, unless otherwise noted.

American Bittern	Long-billed Curlew	Townsend's Warbler
American Coot	Mallard	Tree Swallow
American Kestrel	Northern Goshawk	Turkey Vulture
American White Pelican	Northern Harrier	Vaux's Swift
Bald Eagle	Northern Pintail	Violet-green Swallow
Bank Swallow	Northern Pygmy-Owl	Virginia Rail
Barn Swallow	Northern Rough-winged Swallow	Western Grebe
Black-crowned Night-Heron	Northern Shoveler	White-faced Ibis
Brown-headed Cowbird	Orange-crowned Warbler	Willet
Bufflehead	Osprey	Wilson's Phalarope
Canada Goose	Pied-billed Grebe	Wilson's Snipe
California Gull	Peregrine Falcon	Wood Duck
Cinnamon Teal	Prairie Falcon	Unid. Blackbird
Cliff Swallow	Ring-billed Gull	Unid. Empidonax Flycatcher
Cooper's Hawk	Red-shouldered Hawk	Unid. Finch
Double-crested Cormorant	Red-tailed Hawk	Unid. Tyrant Flycatcher
Eurasian Collared-Dove	Ruddy Duck	Unid. Hawk
European Starling	Rufous Hummingbird	Unid. Hummingbird
Forster's Tern	Sandhill Crane	Unid. Rail
Gadwall	Sora	Unid. Sapsucker
Great Blue Heron	Spotted Sandpiper	Unid. Sparrow
Great Egret	Sharp-shinned Hawk	Unid. Woodpecker
Green-winged Teal	Swainson's Hawk	Unid. Bird