Point Blue Report

Bird and Bat Inventories in the Storrie and Chips Fire Areas 2015–2016

Final Report to the Lassen National Forest

NOVEMBER 2017

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Conservation science for a healthy planet

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Point Blue Conservation Science

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Cover photos: *Left: A post-fire landscape in the Storrie and Chips fire areas is home to high densities of snag-nesting birds and high bat activity. Credit Point Blue. Top right: Northern Flicker, a cavity nesting bird in the Storrie and Chips fire areas. Credit Tom Grey. Bottom right: Microphones attached to an automated recorder unit to detect bats in the Ridge Project area of the Storrie and Chips Fires.*

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EXECUTIVE SUMMARY

In this report we present our 2015 and 2016 activities and results from bird and bat inventories in and near post-fire habitats of the Storrie and Chips Fires. This is a final report on work completed with analyses that focus primarily on guiding management in the two fires.

We compared the avifauna within the proposed Green Island and Ridge Projects on the Lassen National Forest with several regions in and adjacent to the Chips and Storrie Fires in 2015-16. The Ridge Project area contained abundances of bird species in early seral, post-fire snag, and open forest species guilds that were as high, or higher, than the rest of the Storrie and Chips fire footprints and adjacent unburned areas. Fuels treatment within this project area have the potential to alter a biological community that reflect the unique burn mosaic and forest types within the Storrie and Chips Fires. The Green Island Project area currently has relatively high abundances of open forest and early seral forest bird species, and generally low (but patchily moderate and high) abundance of dense forest species, and very few post-fire snag species. The introduction of prescribed fire to the Green Island Project area would likely result in an avifauna similar to that currently found in the area proposed for fuels reduction treatment of the Ridge project, but likely with fewer post-fire snag species.

We found 102 nests from 8 species of primary and secondary cavity-nesting bird species across 19 nest searching transects in the Storrie and Chips Fires in 2015 and 2016. The communities of cavity nesting birds varied markedly between the Storrie and Chips Fires despite their spatial proximity and even though almost all of the data from the Storrie Fire were from transects that also burned in Chips. This suggests the cavity nesting community in consecutive burns (12 years apart in this case) is unique from those of once-burned areas. Diameter at breast height of nest trees was fairly similar between the fires within each cavity-nesting species, but varied among species. There was, however, within-species variation in the species of trees used for nesting between the fires that may be attributable to differing rates of tree species decay after fire.

We sampled bats in and adjacent to the Storrie and Chips Fires on both Lassen and Plumas National Forests. We detected 91,442 passes from 16 bat species in 2015-2016, including all three bat species of USFS conservation concern known to occur on Lassen and Plumas National Forests: fringed myotis (*Myotis thysanodes*), pallid bat (*Antrozous pallidus*), and Townsend’s big-eared bat (*Corynorhinus townsendii*). The maximum number of passes recorded during a single night was 1517 and the minimum was zero, with a nightly mean and median of 141 and 68 bat passes, respectively. A general pattern of bat seasonality is reflected in our data with peak activity levels occurring in August. Bats were much more active in burned areas than in nearby unburned forest. Five of the 16 species had increased activity in areas of higher burn severity, whereas no species had significantly higher activity levels with decreasing burn severity; we did not detect a change in activity levels in relation to burn severity for any of the three USFS sensitive species. Finally, we detected a difference in activity levels between salvaged and unsalvaged stands that burned at high severity for only two species, including one USFS sensitive species, reflecting increased activity levels in salvaged stands for these two species.

2015 Activities

- We surveyed birds at 102 point count stations established in 2015 in the Green Island and Ridge project areas on Lassen National Forest to provide guidance on restoration activities.
- We surveyed birds at existing post-fire study plots established in 2009 in the Storrie fire footprint (75 point count stations on 15 nest searching transects and 14 other point count stations) on Lassen and Plumas National Forests.
- We surveyed birds at 6 post-fire study plots established in 2013 in the Chips Fire outside of the Storrie fire footprint (30 point count stations on 6 nest searching transects) on Lassen National Forest.
- We surveyed birds at most Plumas-Lassen Administrative Study (PLAS) green forest point count stations that burned in the Chips fire (195 point count stations) on Lassen and Plumas National Forests.
- We surveyed birds at point count stations established in 2013 inside and outside salvage units in the Chips Fire (110 point count stations) on Lassen and Plumas National Forests.
- We surveyed bats at 55 randomly selected point count stations in the Storrie and Chips Fires and adjacent unburned green forest locations on Lassen and Plumas National Forests.

- We collected vegetation/habitat data at 61 nests, 94 random locations, and 500 PC locations in the Storrie and Chips Fires on Lassen and Plumas National Forests.

2016 Activities

- We surveyed birds at 102 point count stations established in 2015 in the Green Island and Ridge project areas on Lassen National Forest to provide guidance on restoration activities.
- We surveyed birds at post-fire study plots established in 2009 in the Storrie fire footprint (40 point count stations on 8 nest searching transects) on Lassen National Forest.
- We surveyed birds at 6 post-fire study plots established in 2013 in the Chips Fire outside of the Storrie fire footprint (30 point count stations on 6 nest searching transects) on Lassen National Forest.
- We surveyed bats at 62 randomly selected point count stations in the Storrie and Chips Fires and adjacent unburned green forest locations on Lassen and Plumas National Forests.
- We collected vegetation/habitat data at 42 nests and 65 random locations on 14 nest searching transects surveyed for birds in 2016 in the Storrie and Chips Fires on Lassen National Forest.
- We assisted the Almanor RD with an analysis that evaluated the potential effects of the initial Rocks and Ridge project proposals on Black-backed Woodpeckers in the Chips Fire.

Post-fire Habitat Management Recommendations

Our recommendations are a culmination of the results from this study, the scientific literature, and expert opinion from 17 years of studying birds in the Sierra Nevada. As with most management actions and techniques, many of our recommendations 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–March).
- Consider post-fire habitat as an important component of the Sierra Nevada ecosystem.
- When determining what percentage of the fire area to salvage log, consider the area of a fire that was forested and burned at high severity, as opposed to the area of the entire fire.
- 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. Using the past to inform while planning 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.
- Be patient, strategic, and constrained in aiding the recovery of a post-fire landscape. Monitor, evaluate, and redefine goals and adjust management activities on the basis of new evidence.

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 by cavity nesting birds in the first three years after a fire.
- Retain snags in salvaged areas at far greater abundances 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. Moonlight and Storrie fire), snag retention should favor large pine and Douglas Fir, but decayed snags with broken tops of all species 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 2 – 8 years they are used by Black-backed Woodpeckers.

- Retain snags in areas being replanted, as they can provide the only source of snags in those forest patches for decades to come.

- Retain smaller snags in heavily salvaged areas to increase snag densities because a large range of snag sizes, from as little as 6 inches DBH, are used by a number of species for foraging and nesting. Though, most cavity nests are in snags over 15 inches DBH.

Early Successional Habitat

- Manage post-fire areas for a diverse and abundant understory plant community including shrubs, grasses, and forbs. Understory plants provide unique and important resources for many 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; 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 montane chaparral habitat and consider a natural fire regime interval of 20 years as the targeted re-entry rotation for creating disturbance in this habitat.

Shaping Future Forest

- In areas with significant oak regeneration, limit replanting of dense stands of conifers. When replanting these areas, use conifer plantings in clumps to enhance the future habitat mosaic of a healthy conifer-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 (<10 years old) fires 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.
- 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 allow 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 stands dominated by single species in the Sierra Nevada.
- Consider staggering plantings across decades, leaving areas to regenerate naturally, 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 and adjacent to the fire perimeter to promote habitat mosaics.
- Avoid planting conifer species in or adjacent 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

With the growing recognition of fire as a primary driver of ecosystem form and function in the Sierra Nevada (North et al. 2009; North 2012), and the increasing severity, extent, and frequency of large wildfires in the last few decades due to past suppression efforts and ongoing climate change (Westerling et al. 2006; Miller & Safford 2012; Steel et al. 2015), there is substantial and urgent need to understand the value of habitats created by wildfire and how post-fire habitats are used by the unique wildlife community that occupy them (e.g. Fontaine et al. 2009). Current knowledge of wildlife response to fire and post-fire management in the Sierra Nevada is based almost entirely upon studies of a limited number of bird and small mammal species (Fontaine & Kennedy 2012). While birds are excellent indicators of ecological processes that can provide important feedback regarding the health of managed fire-prone ecosystems (Alexander et al. 2007), there is increasing interest in the other wildlife taxa, such as bats.

There is one peer-reviewed study on the effects of wildfire on bats in the Sierra Nevada (Buchalski et al. 2013), and very little knowledge to draw from elsewhere in North America (Fisher & Wilkinson 2005; Fontaine & Kennedy 2012). Buchalski et al. (2013) found bat response was categorically neutral to positive one year after wildfire, suggesting bats are resilient to wildfire and that naturally generated early successional habitats are an important landscape component for bats, as has been demonstrated for birds (Smucker et al. 2005; Fontaine et al. 2009; Tingley et al. 2016). Many important knowledge gaps remain about bat response to wildfire, such as the effects of salvage logging, time since fire, and pre-fire forest conditions. Effective management of post-fire areas for bats depends on answers to these questions.

Considerable debate surrounds the management of fire and post-fire landscapes in the Sierra Nevada—the issue is fraught with seemingly disparate and contradictory objectives (e.g. fuels management, public safety, and wildlife habitat) and outcomes of management actions are often uncertain. Furthermore, management actions in post-fire forest ecosystems may affect the physiognomic structure and habitat for decades (Lindenmayer & Noss 2006; Swanson et al. 2010), thus it is necessary to carefully consider the effects of actions and desired conditions well into the post-fire time horizon. Adaptive management coupled with monitoring of outcomes is one of five effective approaches for managing complex ecosystems, especially when results from decisions are uncertain and the system is highly dynamic (DeFries & Nagendra 2017). In this report we present findings from our bird and bat inventories and monitoring in the Storrie and Chips fire areas in an effort to reduce uncertainty of management actions and provide data to feed into the adaptive management of a complex ecosystem.

METHODS

Study Location

The study area for projects discussed in this report includes the footprints the Storrie and Chips Fires on the Mount Hough Ranger District of Plumas National Forest and the Almanor Ranger District of Lassen 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 we surveyed within these fires ranges from 1287–1941 m.

Bird Sampling Designs

In 2015 we added 78 sampling locations in the Ridge Project area on Almanor Ranger District. Site selection occurred in a GIS framework. First we masked out areas in the project boundary that were >30 degrees slope and dissolved the treatment unit boundaries by treatment type. We then manually distributed points within treatment unit boundaries ≥250 m apart and >100 m from the edge, in a way that maximized sampling coverage of points in the surveyable areas of the polygons, while avoiding the few riparian areas in the project area. All points were positioned within the Storrie-Chips overburn area, >100 m from the Chips Fire boundary—a small area of one polygon that was burned only once in the Storrie Fire was avoided. Points were placed irrespective of habitat type (other than riparian) and fire severity, which was fairly homogenous within treatment areas. Forty-one points were placed within the reforestation treatment area and 37 in the fuel reduction treatment area. The points were split into six transects using topography, access roads, and point proximities, with 12–14 points per transect, and a mix of fuels and reforestation points on most transects.

In 2015 we added 24 sampling locations in the Green Island Project area on Almanor Ranger Distract, in addition to the 8 pre-existing sampling locations that fell inside the project boundary. Site selection occurred in a GIS framework. First we masked out areas in the project boundary that were >30 degrees slope. We distributed 24 points on two line-transects >100 m from the project boundary edge. Each transect consisted of 12 points with two transect lines of points spaced 250 m apart. All points fell in white fir, sierra mixed conifer, red fir, and montane chaparral.

Sampling designs for other bird survey locations on Lassen and Plumas National Forest visited in 2015-16 in the Storrie and Chips Fires (Figure 1) have been described in detail in previous reports (see Campos & Burnett 2016).

Passive 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 June.

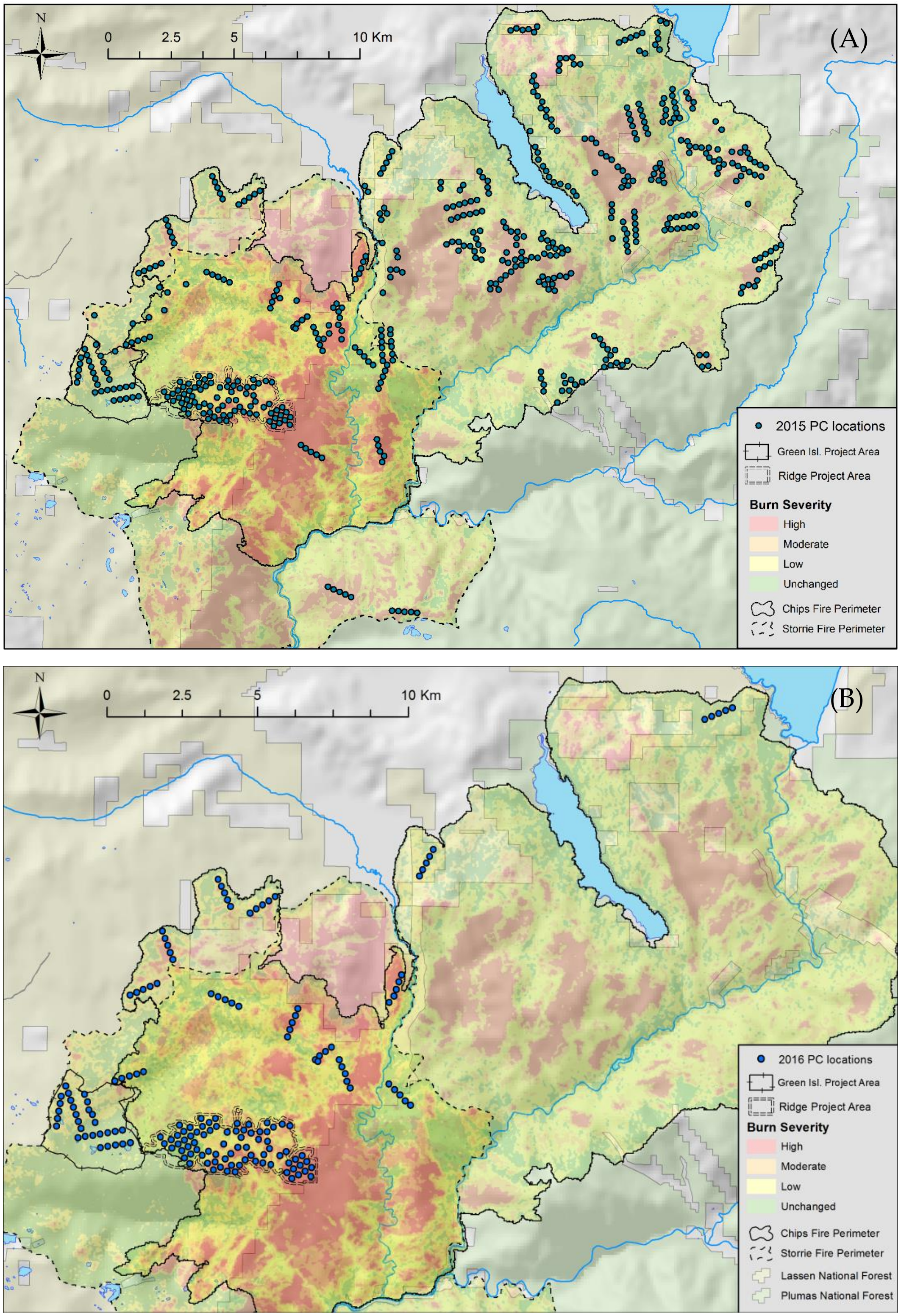
Black-backed Woodpecker Detections

Observers recorded the locations of all Black-backed Woodpeckers they detected in the Storrie and Chips Fires in 2015 and 2016, whether or not during a formal survey. Detections for the Green Island and Ridge projects are presented in the results. Detections for the greater Almanor Ranger District are summarized in Appendix A. It is important to note that the detections are not independent. Detections from multiple visits and multiple observers are included, such that each detection should not be considered a separate Black-backed Woodpecker.

Nest Cavity Surveys

A 20-ha area (200 x 1000-m rectangle) surrounding 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” by Dudley & Saab (2003). In order to focus our attention on species of greatest management interest, we ignored some of the more common cavity-nesters (e.g. chickadees, wrens). Our focal species included both species of bluebird, all woodpeckers, and all cavity-nesting raptors.

Figure 1. Survey locations in the Storrie and Chips Fires in 2015 (A) and 2016 (B). The fire severity layers are transparent, such that both fires' severities are visible in the burn overlap area.



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. We do not present results from the nest monitoring in this report, but they are being incorporated into our cavity nest habitat suitability model analysis and manuscript (see Discussion).

Vegetation and Habitat Surveys

Vegetation data was collected at all point count locations in the Storrie and Chips fire perimeters in 2015. We measured vegetation characteristics within a 50-m 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 visually estimated 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.

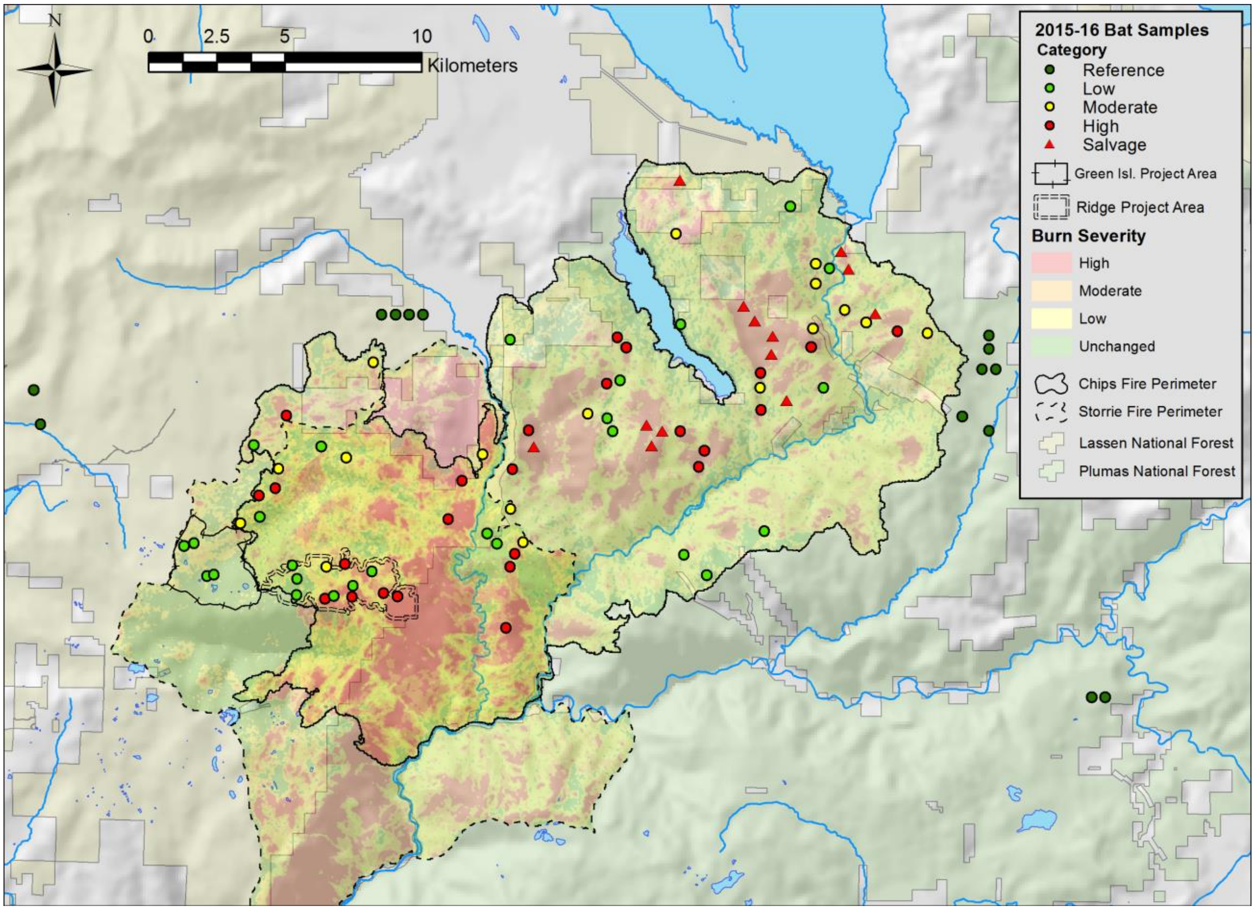
Habitat data was collected at all nests confirmed as active in 2015 and 2016, as well as random locations on each nest searching plot. At all active nests, a variety of characteristics of both the nest tree and the cavity were recorded: diameter at breast height (DBH), tree height, tree species, tree decay class, scorch height on tree, cavity height, orientation of the cavity opening, aspect, and slope. 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. We sampled five random locations on each 20 ha nest plot in each year. Observers navigated to within 10 m of a random location and chose the closest tree or snag ≥12 cm DBH. All tree characteristics recorded at active nest trees were also recorded for these random trees. The data from random trees were used as a sample of available habitat to compare to the trees with confirmed active nests. To estimate the density of snags at used (nest) and available (random) locations, we recorded the DBH, species, height, and decay class of all snags ≥23 cm DBH on 11.3-m-radius plots (snag plots) centered on the nest or random tree.

Bat Sampling

We used 7 automated recording units (ARUs; SM3BAT, Wildlife Acoustics, Maynard, Maryland, USA) paired with an ultrasonic microphone (SMM-A1 & SMM-U1, Wildlife Acoustics, Maynard, Maryland, USA) to sample bats at 95 locations inside and near the Storrie and Chips Fires, including 12 locations in the Ridge Project and 4 locations Green Island Project. Of the 95 locations, 28 were in the Storrie-Chips overlap area, 49 were in Chips only, 4 were in Storrie only, and 14 were in unburned green forest areas within 10 km of fire perimeters on Lassen and Plumas National Forests (Figure 2). Sampling in the Green Island and Ridge project areas was conducted by randomly selecting point count locations from the 8 newly established avian point count transects. No more than one point was sampled per transect per year and new points were selected in the second sampling year, resulting in a total of 12 ARU sampling locations in the Ridge and 4 in Green Island projects. Outside of these project areas, ARU sampling locations were also randomly selected from our existing and actively sampled avian point count locations, with sampling locations stratified by fire history and treatment rather than by transect. All point count sampling locations that were active in 2015 were stratified into the following five categories based on the following criteria:

- Unburned green forest: sampling locations within 10 km of either fire perimeter and within the elevation range of either fire
- Low severity: burned at low severity in either Chips or Storrie only; or low severity in both fires
- Moderate severity: burned at moderate severity in either Chips or Storrie only; or low severity in Storrie and moderate severity in Chips; or moderate severity in Storrie and low severity in Chips; or moderate severity in both Chips and Storrie
- High severity unsalvaged: burned at high severity in either or both Storrie or Chips
- High severity salvaged: within the Chips Fire perimeter only, burned at high severity and >70% of the area within a 100-m radius of the survey point treated by tractor or helicopter according to the R5 Forest Activities spatial data

Figure 2. Locations where automated recorder units were deployed in the Storrie and Chips Fire areas to sample the calls of bats.



Burn severity was classified at the 30-m pixel scale according to the composite burn index in USFS spatial data layers. Points in the non-salvage categories had to have less than 1% of the area within 100 m treated to be eligible for selection. We ranked all points within each of these categories with a random prioritization number. All ranked points were ≥500 m apart. Locations were sampled in order of priority within each category. In rare cases where a sampling location could not be reached because of logistics or other constraints, the point was dropped and the next highest priority location was sampled. We ended up with data from 26 unique locations burned in low severity areas, 17 in moderate severity, 25 in unsalvaged high severity areas, 13 in salvaged high severity areas, and 14 in unburned green forest.

All ARUs were deployed from early May to early September of 2015 and 2016. ARUs recorded ultrasonic sound wavelengths every other night to sample bat species. Recordings started 30 minutes prior to sunset and ended 30 minutes after sunrise. We targeted each deployment for 5–6 nights of ultrasonic recording for each sampling location (the approximate battery life) before being moved to a different sampling location. Because of logistical constraints and hardware failure, ARU deployments ranged from 3–9 nights (mean 5.5 nights) of active ultrasonic recording.

Analysis: Bird Abundance in the Green Island and Ridge Project Areas

We used passive point count data collected inside and outside of the Green Island and Ridge project areas in 2015 and 2016 to evaluate the abundance of 33 bird species in four habitat guilds in relation to the project areas. Based on our local knowledge and published information about the habitat associations, these species are closely aligned with four broad forest conditions in the Sierra Nevada: post-fire snags, early seral understory, mid- to late-seral open canopy forest, and mid- to late-seral dense forest. The guilds represent four structural forest conditions that are created by fire or lack of fire: (1) snags created by a very recent fire, (2) early successional conditions created by regenerating vegetation following stand-replacing or frequent fire, (3) open and mature conditions created by frequent low to moderate severity fire, and (4) dense and mature conditions created by primarily long-term fire absence. There are 7 species in the post-fire snags guild, 9 species in the early seral understory guild, 9 species in the open forest guild, and 9 species in the dense forest guild. These species include year-round residents, short-distance migrants, and Neotropical migrants.

The mature dense forest (MDF) guild is 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*), and Hammond's Flycatcher (*Empidonax hammondii*). The open mature forest (OMF) 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*), Yellow-rumped Warbler (*Setophaga coronata*), Chipping Sparrow (*Spizella passerina*), Black-headed Grosbeak (*Pheucticus melanocephalus*), and Western Tanager (*Piranga ludoviciana*). The early seral forest (ESF) guild is comprised of species that use herbaceous and shrub habitats and included: Mountain Quail (*Oreortyx pictus*), Dusky Flycatcher (*Empidonax oberholseri*), 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 post-fire snag (PFS) guild is comprised of species that use fire-killed trees: Lewis' Woodpecker, Hairy Woodpecker (*Picoides villosus*), Black-backed Woodpecker (*Picoides arcticus*), White-headed Woodpecker (*Picoides albolarvatus*), Northern Flicker (*Colaptes auratus*), House Wren (*Troglodytes aedon*), and Mountain Bluebird (*Sialia currucoides*).

We tested whether the abundance of birds within each of these guilds was equal among seven areas in the Storrie-Chips study area: (1) the Green Island Project area; the Ridge Project areas of proposed (2) reforestation and (3) fuels treatments; (4) areas of the Storrie Fire that did not reburn in the Chips Fire; (5) areas of the Storrie Fire that did reburn in the Chips Fire; (6) areas of Chips Fire that were not in the Storrie Fire; and (7) nearby unburned green forest. We restricted the analysis to points with less than 1% of the area within 100-m of the sampling location experiencing salvage treatments according to the USFS Region 5 Forest Activities geospatial dataset. Black-backed Woodpecker was analyzed both as part of the post-fire snag forest guild and alone in a separate model because of management concern for this species in burned forest.

To evaluate the abundance of the post-fire avian guilds and Black-backed Woodpeckers among the seven areas, we built generalized linear mixed models with Poisson error and logarithmic link function using the package lme4 version 1.1-9 (Bates et al. 2015), in program R x64 version 3.2.2. Our sample unit was a single point count visit and the dependent variable was the count of all individuals of each species in a guild; or, in the case of Black-backed Woodpeckers, simply the count of all individuals. The names of the point count station and the transect each point count station was apart of, were included as random effects to account for repeated measures on each point and transect. The year of the survey (2015 or 2016) was included as a categorical fixed effect to account for variation in abundance between the two years. The primary parameter of interest was a categorical fixed effect with a factor level for each of the seven areas of the Storrie-Chips study area. Unburned green forest was used as the reference category for the fixed effect of area. All coefficient estimates are relative to this reference area.

We used a likelihood ratio test to compare this model to one without the categorical fixed effect of area. We interpreted a P value < 0.05 as a rejection of the null hypothesis that the species were equally abundant among the seven areas. If area was significant, using the glht function in the package multcomp version 1.4-1 (Hothorn et al. 2008), we ran Tukey multiple comparisons to test for differences in the mean estimates of bird abundance among the seven areas.

Analysis: Bats

Each bat pass (i.e. detection) from the ultrasonic data was automatically classified using SonoBat software version 3.2.1 Western US edition. The software classifies recordings to species when possible. Low quality or ambiguous recordings are classified as unknown species or to a broader taxonomic grouping (e.g., as broad as a suite of species with high-frequency calls). Classifications are made by comparing call characteristics of recorded bat passes against a library of known bat calls from all California bat species. We then used SonoBat to calculate an estimated likelihood of presence for each survey night at each sampling location for each of the 17 species known to the SonoBat classifier (Table 1). This SonoBat likelihood estimate is based on the number of classified species and their known overlap and ambiguity of classification. The likelihood estimate is a probabilistic estimate and does not convey certainty. Trained observers manually vetted the detection/non-detection of each USFS bat species of special concern—*Antrozous pallidus, Corynorhinus townsendii, Myotis thysanodes*—for all survey nights with an estimated likelihood of presence > 0.

We used the number of classified passes in a night as an index of bat activity and observed species richness as an index of bat diversity. We modeled the number of passes and species richness from all sampling nights in the Storrie and Chips fire perimeters as a function of fire severity, elevation, salvage logging, Julian day, and year. For species richness we built generalized linear mixed models with Poisson error and logarithmic link function using the package lme4 version 1.1-9 (Bates et al. 2015), in program R x64 version 3.2.2 (R Core Team 2015). We modeled bat activity in the same way, but used a negative binomial error structure. The unique name of the sampling location was included as a random effect to account for repeated measures over nights and years. The year of the survey (2015 or 2016) was included as a categorical fixed effect to account for variation in abundance between the two years. We used the Relative difference Normalized Burn Ratio (RdNBR) for the Storrie and Chips Fires as measures of fire burn severity (Miller & Thode 2007; Miller et al. 2009). For sampling locations that did not burn in the Storrie Fire, the Storrie Fire RdNBR was set to 0. The models we report here have a linear term for Storrie Fire burn severity and a linear term for Chip Fire burn severity. Quadratic and interaction terms for each of the burn severity variables were also considered, but were discarded during a model selection process using a likelihood ratio test. Salvage logging was treated as a binary variable in accordance with the sampling stratification described above. Julian day was included as a numeric variable.

Table 1. Bat species known to the classifier in SonoBat version 3.2.1 Western US edition.

Species Name	Common Name	Code
*Antrozous pallidus**	pallid bat	ANPA
*Corynorhinus townsendii**	Townsend's big-eared bat	COTO
Eptesicus fuscus	big brown bat	EPFU
Euderma maculatum	spotted bat	EUMA
Eumops perotis	western mastiff bat	EUPE
Lasiurus blossevillii	western red bat	LABL
Lasiurus cinereus	hoary bat	LACI
Lasionycteris noctivagans	silver-haired bat	LANO
Myotis californicus	California myotis	MYCA
Myotis ciliolabrum	western small-footed myotis	MYCI
Myotis evotis	long-eared myotis	MYEV
Myotis lucifugus	little brown bat	MYLU
*Myotis thysanodes**	fringed myotis	MYTH
Myotis volans	long-legged myotis	MYVO
Myotis yumanensis	Yuma myotis	MYYU
Parastrellus hesperus	western pipistrelle	PAHE
Tadarida brasiliensis	Mexican free-tailed bat	TABR

*USFS Region 5 species of special concern

RESULTS

Bird Abundance in the Green Island and Ridge Project Areas

The abundance of the four bird guilds and Black-backed Woodpecker varied among the seven areas of the Storrie and Chips study area ($P < 0.001$, Figure 3). Relative to other areas inside and adjacent to the Storrie and Chips fire perimeters, the Green Island

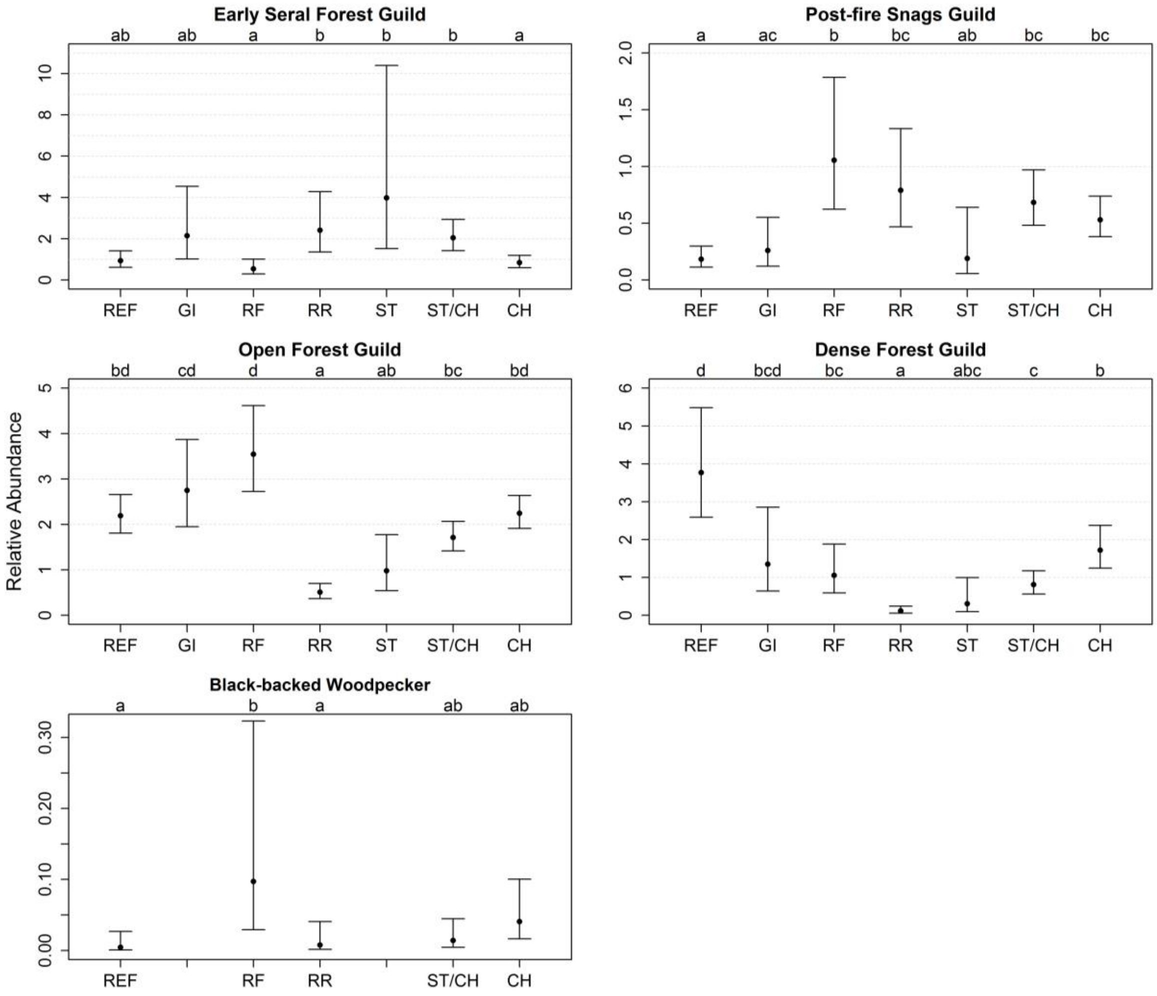
Project area had a moderately high abundance of early seral forest species, a low abundance of post-fire snag species, a moderately high abundance of open forest, and a moderate abundance of dense forest species. No Black-backed Woodpeckers were detected on passive point counts in the Green Island Project area, hence they are not represented in the Green Island Project area in this analysis. The fuels reduction treatment area within the Ridge Project was characterized by a very low abundance of early seral species, a moderate abundance of dense forest species, and a high abundance of open forest and snag species, including high abundances of Black-backed Woodpeckers. The reforestation treatment areas within the Ridge Project were characterized by high abundances of early seral and post-fire snag species, but very low abundances of open and dense forest species, and few Black-backed Woodpeckers despite having high abundances of other post-fire snag species.

It is important to note that this analysis compares areas of differing scales which affects the interpretation of the results. For example, there are localities within the Chips Fire that burned once and are equivalent in size as the Ridge Project fuels reduction treatment area that support higher densities of Black-backed Woodpeckers than their predicted abundance in Ridge Project fuels reduction treatment area; but the mean density in the Chips Fire area is lower because it is averaged over a larger extent that includes areas of low Black-backed Woodpecker density.

Black-backed Woodpecker Presence in Ridge and Green Island Project Areas

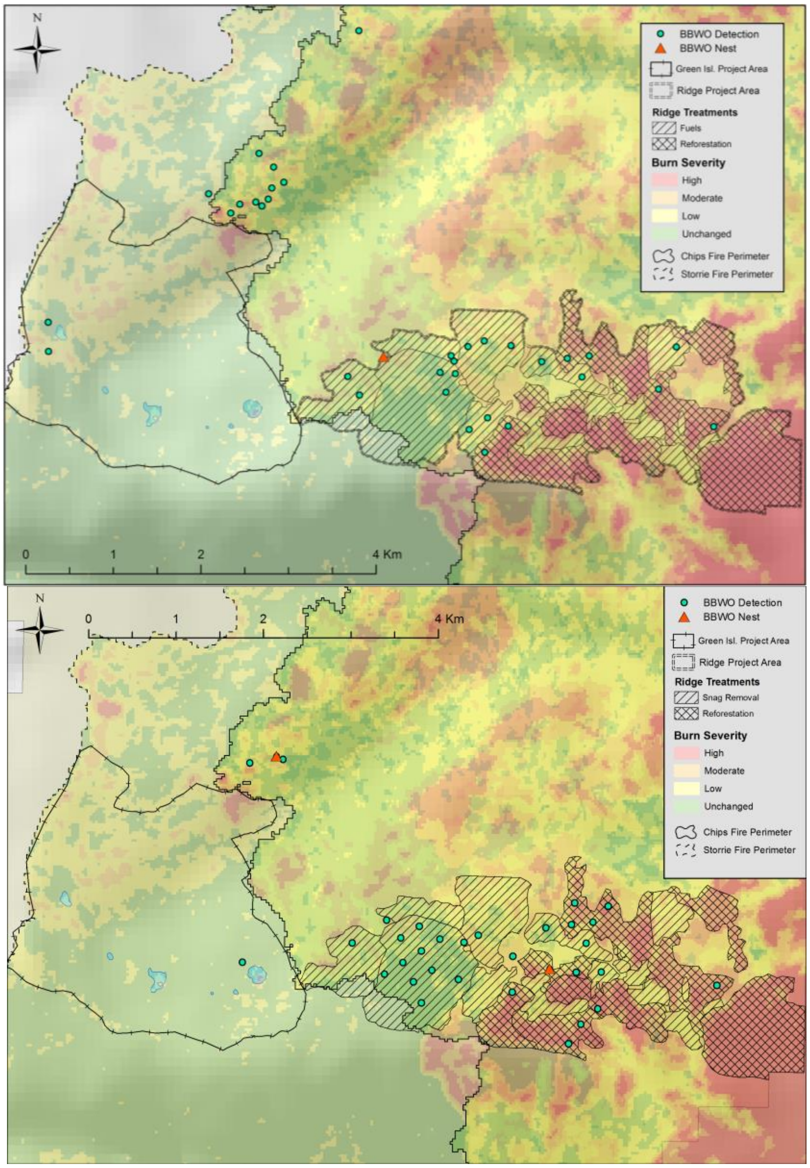
Black-backed Woodpeckers were detected in most areas of the Ridge Project that we sampled, except for areas that burned at high severity in both fires that were at least ca. 50 m from pixels classified as moderate or low severity in the Storrie Fire. In 2015 and 2016 respectively, we had 23 and 32 detections of Black-backed Woodpecker in the Ridge project, and 2 and 1 detections in Green Island (Figure 4). Thirty-eight of the 55 detections in Ridge were found in the fuels reduction treatment areas. All but 3 of these detections were in or directly adjacent to pixels classified as low or moderate severity burn in the Chips Fire. Seventeen of the 55 detections in Ridge were in the reforestation treatment areas. Three of these detections occurred in pixels classified as high severity burn in both the Storrie and Chips, but all 3 were within about 50 m of pixels classified as moderate severity in the Storrie Fire.

Figure 3. Relative bird abundance (individuals/point) in seven regions of the Storrie and Chips Fire area in 2015 and 2016. Points are mean estimates with 95% confidence intervals (vertical bars). Letters above each area indicate groupings based on Tukey pairwise comparisons. REF = unburned reference; GI = Green Island; RF = Ridge fuels reduction treatment areas; RR = Ridge reforestation treatment areas; ST = Storrie Fire burned once only; ST/CH = Storrie Fire reburned in Chips Fire; CH = Chips Fire burned once only. See text for guild definitions.



The Black-backed Woodpecker detections in the Green Island project area in 2015 were approximately 2.2 km from the Chips Fire perimeter and 2.6 km from the nearest other Black-backed Woodpecker detection in the Storrie-Chips overlap area. In 2016, our solo Black-backed Woodpecker detection in the Green Island project area was 1.2 km from the nearest Black-backed Woodpecker detection in the Storrie-Chips burn overlap area. Based on the proximity of the detections in Green Island to the nearest detections in the Chips Fire, the detections may represent single territories in each year that spanned into the Green Island Project area from the Chips Fire.

Figure 4. Map of Black-backed Woodpecker locations detected during field work in the Ridge and Green Island project areas in 2015 (top) and 2016 (bottom).



Nest Cavity Inventory

We found 102 nests from 8 species of primary and secondary cavity nesting bird species across 19 nest searching transects in the Storrie and Chips Fires in 2015 and 2016 (Table 2). Sample sizes of active nests reflected communities of cavity nesting birds that varied markedly between the Storrie and Chips Fires despite their spatial proximity and even though all but 5 of the nests in the Storrie Fire were on transects that also burned in the Chips Fire. American Kestrel, Red-breasted Sapsuckers, and Western Bluebirds were only found in the Storrie Fire, whereas Black-backed Woodpeckers were almost absent from our nest searching transects in the Storrie Fire and abundant in the Chips Fire.

We collected vegetation and habitat data at the 102 nests and an additional 159 random locations on the same 19 transects. The Storrie Fire had much lower snag densities than the Chips Fire, but the DBH of the available snags was similar among the two burned areas (Table 3). The DBH of nests trees was also fairly similar between the fires within a species, but varied among species. Black-backed Woodpeckers used the smallest trees on average and Northern Flickers and Western Bluebirds the largest. Species that used larger nest trees tended to use areas with lower snag densities within an 11.3-m radius, whereas species that used smaller nest trees used areas with higher snag densities.

Table 2. Tree characteristics for nest trees and random trees in the Storrie and Chips Fires in 2015 and 2016. All but 9 random trees and 5 nest trees from the Storrie Fire were located inside the Storrie-Chips burn overlap area (see Figure 1). Fir snags include red fir (*Abies magnifica*), white fir (*Abies concolor*), and Douglas fir (*Pseudotsuga menziesii*).

Species	Fire	Sample Size	Nest Tree DBH	Proportion Pine Nest Tree	Proportion Fir Nest Tree
Random Location	Chips	55	41.6 (19)	0.16	0.78
	Storrie	104	41.4 (25.7)	0.17	0.53
American Kestrel	Chips	0	-	-	-
	Storrie	4	67.2 (5.6)	0.25	0.75
Black-backed Woodpecker	Chips	13	38.2 (14)	0.15	0.85
	Storrie	1	58 (NA)	1.00	0.00
Hairy Woodpecker	Chips	12	49.8 (14.7)	0.25	0.75
	Storrie	8	47.1 (17.3)	0.00	0.63
Mountain Bluebird	Chips	7	58.6 (19.5)	0.43	0.57
	Storrie	3	50 (10.5)	0.00	1.00
Northern Flicker	Chips	7	70.7 (29.7)	0.00	1.00
	Storrie	13	60.3 (16)	0.15	0.85
Red-breasted Sapsucker	Chips	0	-	-	-
	Storrie	1	45 (NA)	0.00	1.00
Western Bluebird	Chips	0	-	-	-
	Storrie	8	72.1 (33.7)	0.25	0.50
White-headed Woodpecker	Chips	13	46.1 (18.4)	0.46	0.54
	Storrie	12	58.2 (32.9)	0.25	0.50

Table 3. Snag characteristics in a plot of 11.3-m radius surrounding nest trees and random trees in the Storrie and Chips Fires. All but 9 random plots and 5 nest plots from the Storrie Fire were located inside the Storrie-Chips burn overlap area (see Figure 1). Fir snags include red fir (*Abies magnifica*), white fir (*Abies concolor*), and Douglas fir (*Pseudotsuga menziesii*).

Species	Fire	Sample Size	Mean Snag DBH	Snags >23 cm	Snags 23-38 cm	Snags 39-50 cm	Snags >51 cm	Proportion Pine Snags	Proportion Fir Snags
Random Location	Chips	55	46.1 (15.6)	7.3 (6.5)	3.8 (3.7)	1.6 (1.7)	1.9 (2.5)	0.1 (0.2)	0.7 (0.4)
	Storrie	104	47.3 (20.1)	2.6 (2.8)	1.1 (1.5)	0.8 (1.3)	0.7 (1.3)	0.1 (0.2)	0.5 (0.5)
American Kestrel	Chips	0	-	-	-	-	-	-	-
	Storrie	4	57.6 (10.6)	4.8 (3.8)	0 (0)	2.5 (2.6)	2.2 (1.5)	0.3 (0.5)	0.5 (0.4)
Black-backed Woodpecker	Chips	13	42.5 (5.2)	20.4 (6.2)	10.2 (3.5)	5 (2.7)	5.2 (2.6)	0.1 (0.2)	0.9 (0.2)
	Storrie	1	50.1 (NA)	11 (NA)	5 (NA)	2 (NA)	4 (NA)	0.1 (NA)	0.6 (NA)
Hairy Woodpecker	Chips	12	46.7 (11.7)	16.1 (10.5)	7.8 (5.5)	4.2 (3.1)	4.1 (2.9)	0.2 (0.3)	0.8 (0.3)
	Storrie	8	45 (10.2)	8.9 (5.2)	4.2 (3.9)	2.6 (2.4)	2 (1.9)	0 (0.1)	0.6 (0.4)
Mountain Bluebird	Chips	7	47.5 (16)	11.3 (9.8)	5.7 (4.9)	3.3 (2.9)	2.3 (3)	0.2 (0.4)	0.8 (0.4)
	Storrie	3	44.8 (9.5)	5.7 (3.1)	2.3 (2.1)	2 (1.7)	1.3 (0.6)	0 (0)	1 (0)
Northern Flicker	Chips	7	58.8 (32.2)	8.9 (8.3)	5.4 (6)	1.7 (2)	1.7 (1.4)	0.1 (0.1)	0.9 (0.1)
	Storrie	13	49.3 (15.7)	6.1 (5.7)	2.3 (2.4)	2.2 (2.5)	1.6 (1.9)	0.1 (0.2)	0.8 (0.3)
Red-breasted Sapsucker	Chips	0	-	-	-	-	-	-	-
	Storrie	1	39.8 (NA)	27 (NA)	14 (NA)	7 (NA)	6 (NA)	0 (NA)	0.7 (NA)
Western Bluebird	Chips	0	-	-	-	-	-	-	-
	Storrie	8	55.2 (34.5)	4.5 (3.2)	2.1 (1.7)	1.1 (1)	1.2 (1.2)	0.1 (0.2)	0.4 (0.4)
White-headed Woodpecker	Chips	13	47 (8.7)	11.8 (7.5)	5.4 (3.8)	2.8 (3.2)	3.7 (2.3)	0.3 (0.4)	0.7 (0.4)
	Storrie	12	60.8 (30.6)	5.2 (5.2)	2.5 (3.9)	1.3 (1.2)	1.4 (1.6)	0.3 (0.4)	0.6 (0.4)

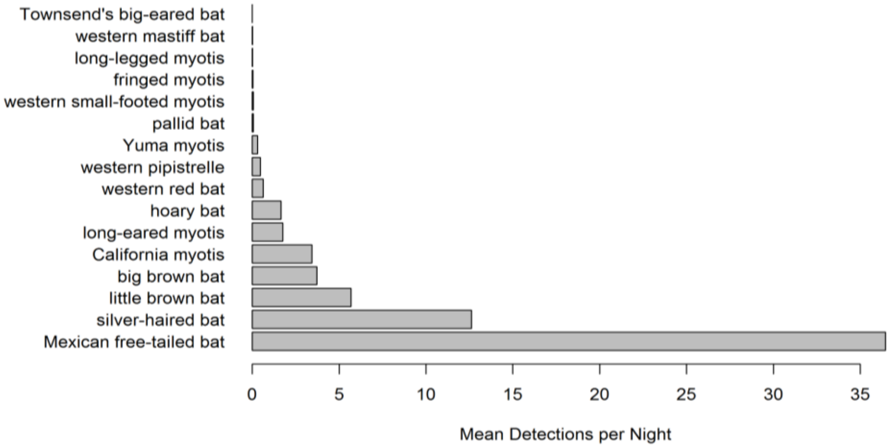
Bats

Species Inventory & Activity Levels

During 649 survey nights in 2015 and 2016 within the Storrie and Chips Fires and nearby unburned forest, we detected a total of 91,442 passes, including recordings of 16 of the 17 bat species known to occur in the Sierra Nevada as classified by SonoBat (Table 1). All 16 species were detected during both survey years. The number of species observed during any given survey night ranged from 0 to 11 with a mean of 4.0 species per night. Mexican free-tailed bats registered the most detections per night on average (36.5) followed by silver-haired bat (12.6) and little brown bat (5.7; Figure 5). Nine of the species were detected fewer than once per survey on average. The species detected across the largest number of sampling locations in the study region were the Mexican free-tailed bat, silver-haired bat, long-eared myotis, little brown bat, California myotis, which were all recorded at >88% of sampling locations. The Lassen and Plumas

National Forests hosts three Forest Service sensitive species: fringed myotis, pallid bat, and Townsend's big-eared bat. In 2015, fringed myotis, pallid bat, and Towsend's big-eared bat were recorded at 22 (40%), 25 (46%), and 9 (16%) survey locations, respectively, according to manually-verified classifications (Figure 6). In 2016, fringed myotis, pallid bat, and Towsend's big-eared bat were recorded at 15 (24%), 20 (32%), and 5 (8%) survey locations, respectively, according to manually-verified classifications (Figure 6). Townsend's big-eared bat was only detected through our manual data classification process for the three bat species of special concern bat.

Figure 5. Mean detections per night for bat species detected in the Storrie and Chips fire study area in 2015-16.



Nightly bat activity varied widely among survey nights, between years, and among seasons. The maximum number of passes recorded during a single night was 1517 and the minimum was zero, with a nightly mean and median of 141 and 68 bat passes, respectively. The distribution of passes per night appears to follow a log-normal or negative binomial distribution where most surveys recorded relatively few bat passes, but a few surveys recorded much higher activity levels. Nightly bat activity was higher on average in 2015 (174 passes/night) than 2016 (108 passes/night; P=0.001), though this pattern was not consistent across species, and was likely driven by large decreases in passes of Mexican free-tailed and silver-haired bats, the two most abundant species (Figure 7). The number of passes also varied greatly over time within our survey season (Figure 8). With some variation among species, Sierra Nevada bats generally arrive at their summer grounds during the spring, females will give birth during June and July, juveniles will be able to fly approximately a month later, and individuals migrate to winter habitats or hibernate beginning in the fall (Richardson 2011). This general pattern of bat seasonality is reflected in our data with peak activity levels occurring in August when juveniles typically become active foragers. Activity levels were similar in 2015 compared to 2016 prior to mid-June, but diverged thereafter (Figure 8).

Figure 6. Survey locations where sensitive bat species were detected at least once during 2015-2016 surveys.

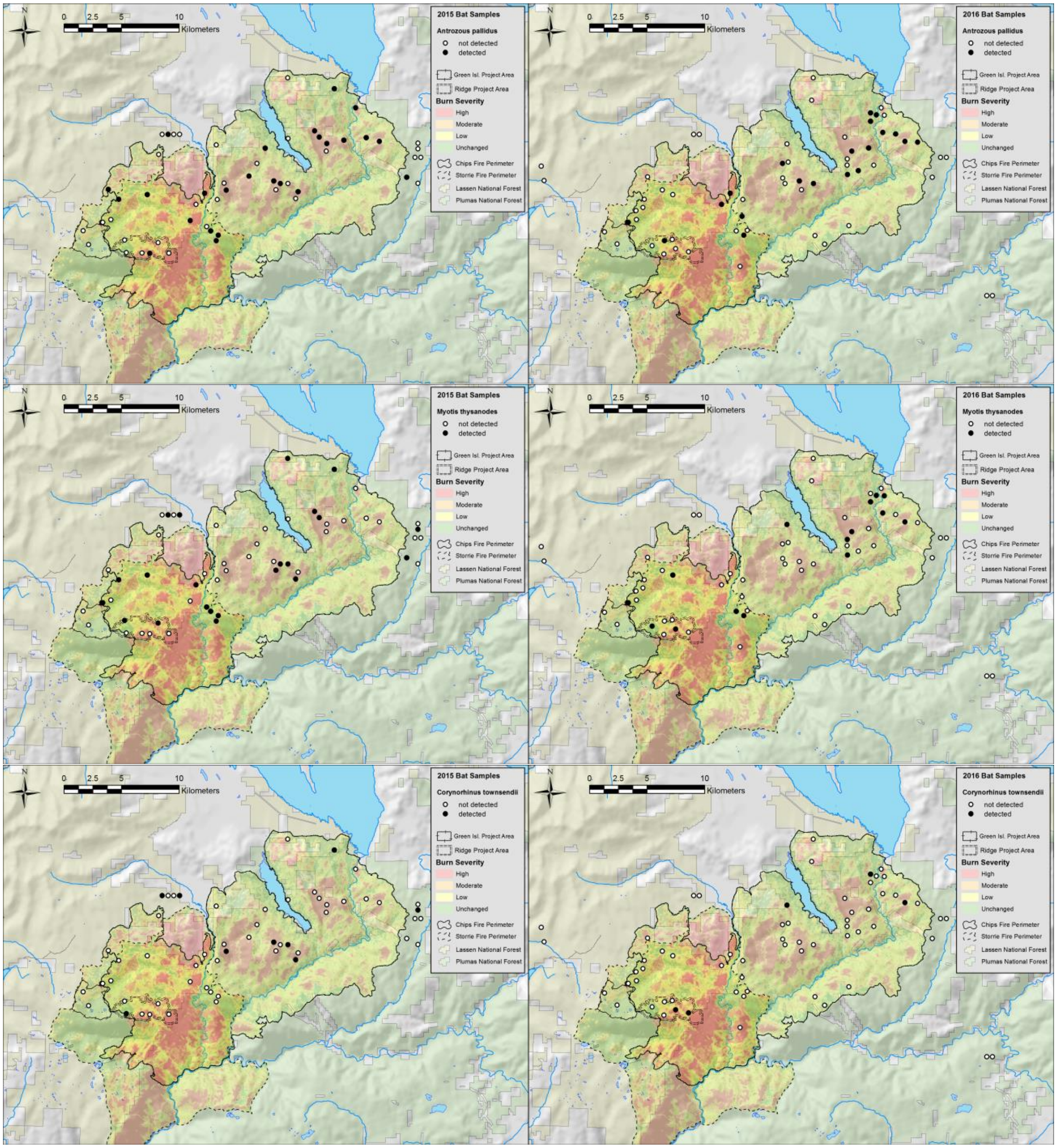


Figure 7. Mean observations per night in 2015 and 2016 for common bat species (top panel) and uncommon bat species (bottom panel).

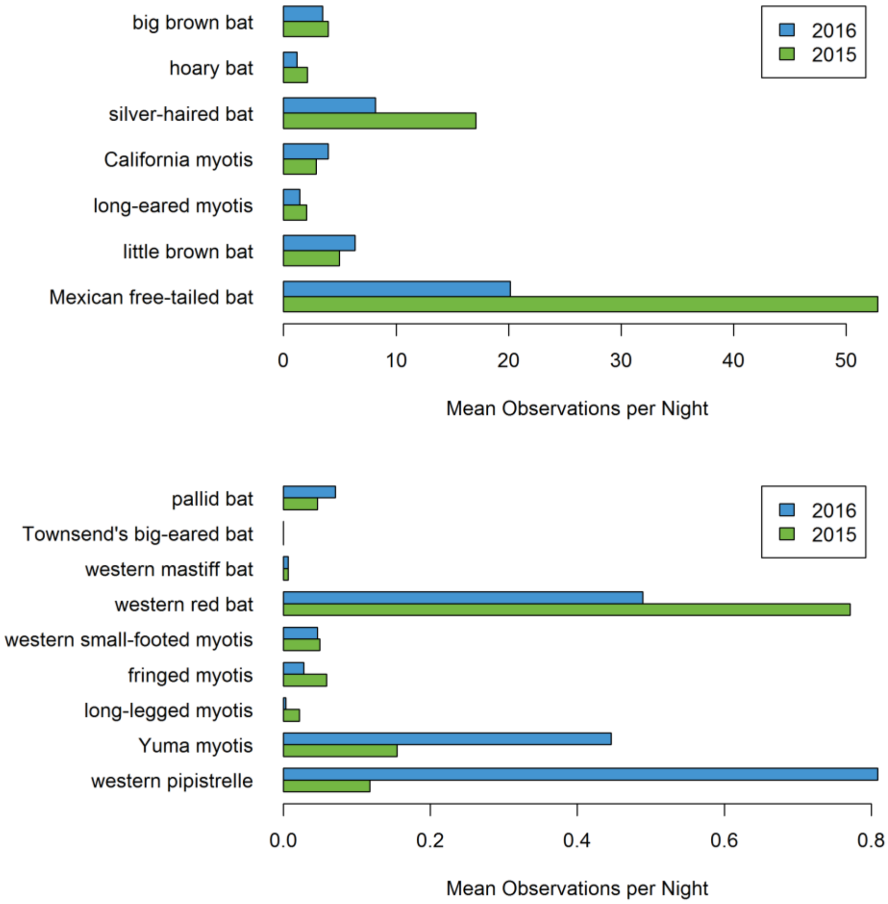
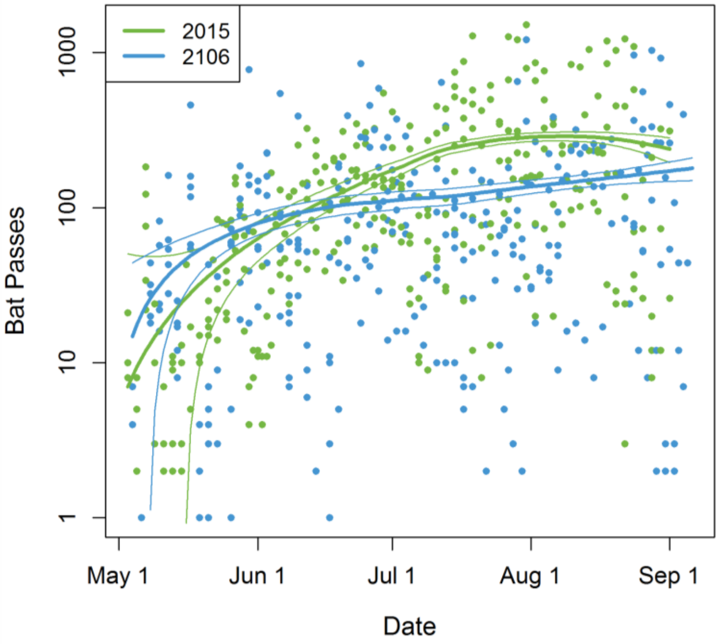


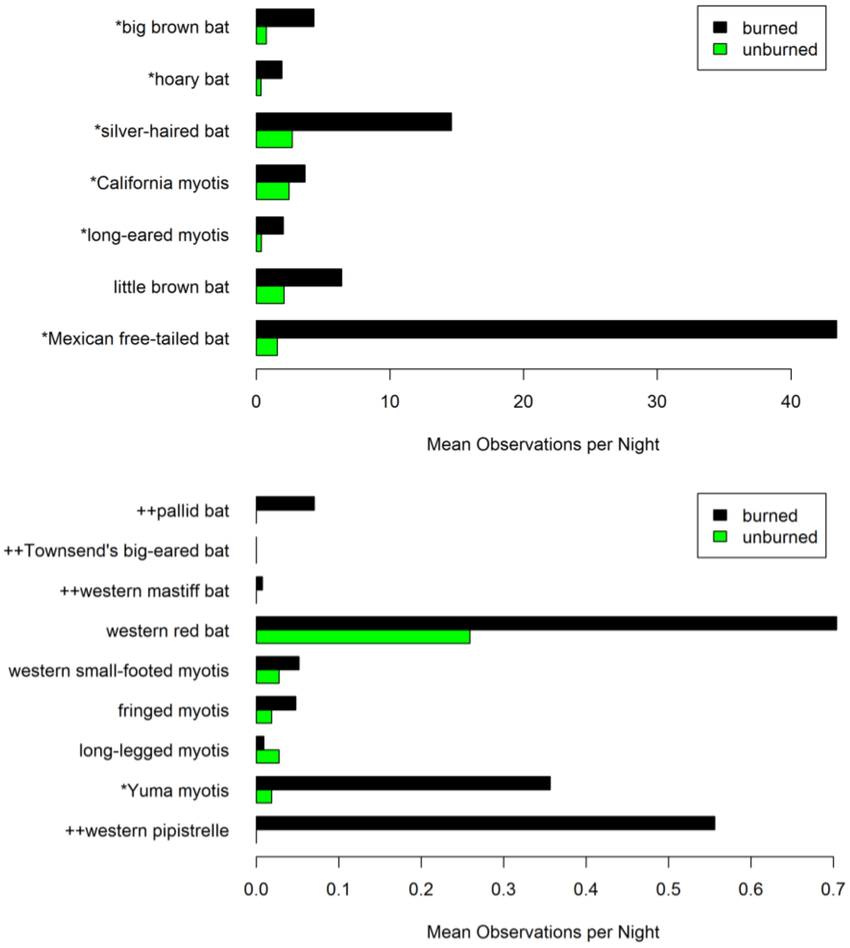
Figure 8. Bat passes by date of survey in 2015 and 2016.



Burned vs. Unburned Areas

We compared species richness and individual species activity levels between sampling locations within the Storrie and Chips burned areas (81 locations and 541 survey nights) and those outside of the burn perimeters (14 locations and 108 survey nights; Figure 9). Significantly more species were detected during an average night at locations within the burned areas (mean = 4.3) than at locations in the unburned forest (mean = 2.2; $P < 0.001$; Table B1). All but one species had a higher mean nightly detection rate inside of the burn perimeters, but the difference was only significant for seven species (Figure 9; Table B2).

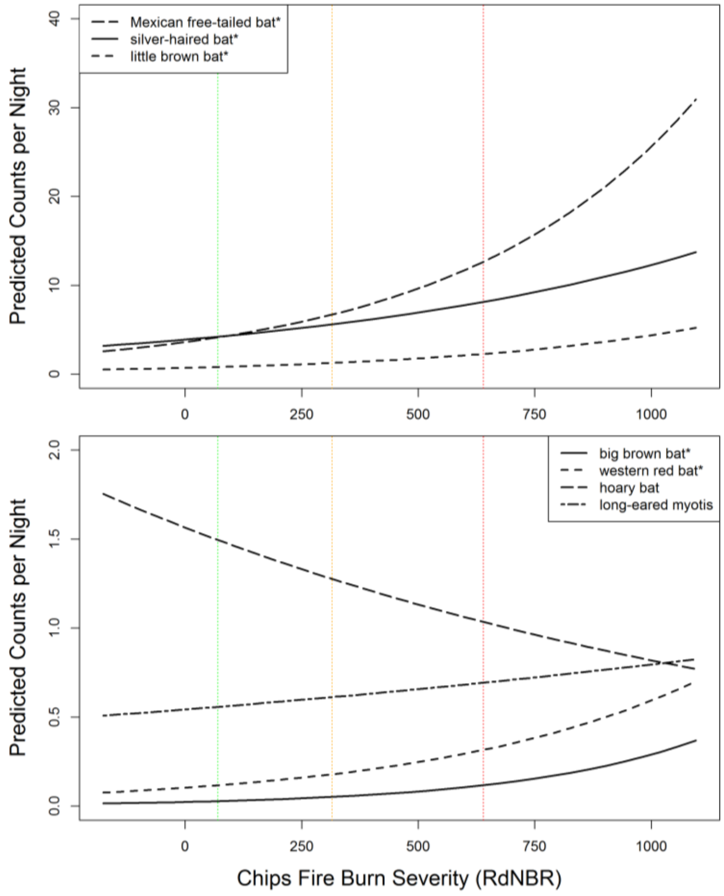
Figure 9. Bat passes inside and outside of the Storrie Fire and Chips Fire perimeters in 2015-2016 for common species (top panel) and rare species (bottom panel). * = statistically significant difference. ++ = no auto-classified detections in one or both sampling categories.



Burn Severity Effects

We investigated species richness and individual species activity levels across the burn severity gradient in the Storrie and Chips Fires (76 locations and 508 survey nights). In contrast to the change in species richness inside and outside the burned areas, species richness did not change significantly over the gradient in burn severity within the Chips or Storrie Fires (P > 0.05; Table B3). However, individual species models provide evidence that the composition of the bat community does change with burn severity. Nightly activity levels of pallid bat, western red bat, and hoary bat increased with higher levels of burn severity in the Chips Fire, and Mexican free-tailed bat and silver-haired bat had higher activity levels with increasing burn severity in the Storrie and Chips fires (Figure 10, Table B4). Negative relationships with burn severity were not significant in either fire (Table B4).

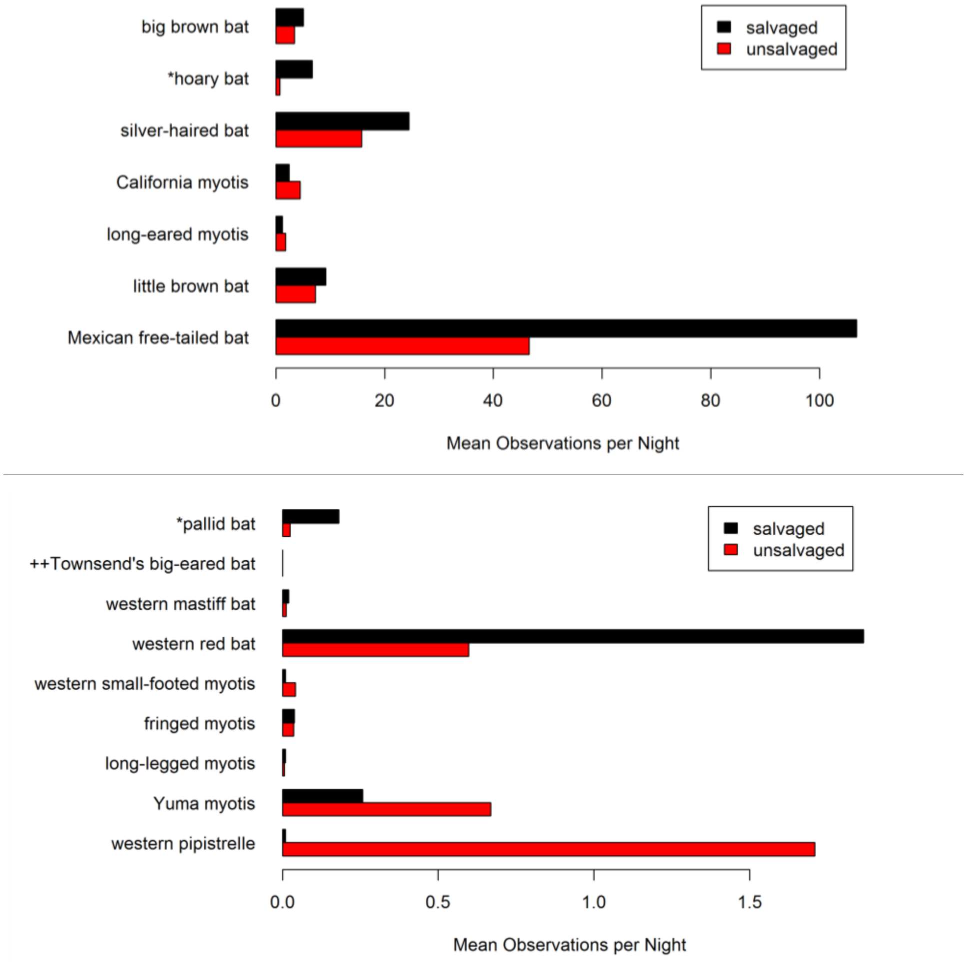
Figure 10. Bat activity in relation to burn severity (RdNBR) in the Chips Fire in 2015-2016 for three common species (top panel) and four rare species (bottom panel). Vertical green, orange, and red dotted lines indicate thresholds for low, moderate, and high severity fire, respectively.* = statistically significant relationship.



Salvage Logging Effects

We compared species richness and individual species activity levels between sampling locations in salvaged (13 locations and 105 survey nights) versus unsalvaged (25 locations and 169 survey nights) stands burned at high severity in the Storrie and Chips fires. We did not detect an effect of salvage logging on species richness or overall bat activity (P > 0.05; Table B5). At the species level, we only detected a significant effect of salvage logging for two species—hoary bat and pallid bat—which were more active in salvage logged areas (Figure 11, Table B6).

Figure 11. Bat passes inside and outside of salvage-logged areas of the Chips Fire in 2015-2016 for common species (top panel) and rare species (bottom panel). * = statistically significant difference. ++ = no auto-classified detections in one or both sampling categories.



DISCUSSION

Wildfire is a dominant driver of forest structure and composition and ecosystem function in the Sierra Nevada (Sugihara et al. 2006) and has strong implications for species diversity and the geographic distributions for many taxa (Kelly & Brotons 2017). Knowledge of the role of fire in providing habitat is increasing for well-studied species (Fontaine & Kennedy 2012), but still lacking for understudied taxa such as bats (but see Buchalski et al. 2013; Steel and Safford 2017). As average fire severity, fire size, and overall annual burned area increases in the Sierra Nevada due to an era of fire suppression and ongoing climate change (Westerling et al. 2006; Miller & Safford 2012), post-fire habitat management activities will also likely affect an increasing amount of land in the region. Those post-fire management activities may in turn influence the abundance and distribution of wildlife (e.g. Saab et al. 2007; Lee & Bond 2015), adding another layer of complexity to the management of the Sierra Nevada ecosystem. Our inventory and monitoring activities in the Storrie and Chips Fires in 2015 and 2016 in relation to proposed and implemented post-fire management activities help to fill knowledge gaps for wildlife managers in this system and the larger region. Here we provide context to our results, and use our findings and knowledge from previous years of post-fire monitoring to provide recommendations to improve proposed restoration activities in these two fire areas.

Management Implications for the Ridge Project Area

The Ridge Project area contained abundances of bird species in the early seral, post-fire snag, and open forest guilds that were as high, or higher, than the other areas of the Storrie and Chips fire footprints and adjacent unburned areas. However, there were important differences in the abundance of these guilds between the fuel reduction and reforestation treatments that both reflected and conflicted with the purpose and need for action for the proposed treatments.

The fuel reduction treatments in the proposed action for the Ridge Project were intended to reduce hazardous surface and ladder fuels to improve the health and resilience of remnant forest stands and protect them from future high-severity fire effects. Most of the area proposed for fuel reduction treatment burned at low to moderate severity in the Chips Fire after burning at low to moderate severity 12 years prior in the Storrie. The draft proposed treatment called for concentrations of snags and down wood to be removed within the zone designated around the remnant conifer stands.

The proposed fuel reduction treatments overlap some of the highest abundances of Black-backed Woodpeckers in the Storrie and Chips fire areas. Black-backed Woodpeckers are often thought to be mostly associated with high-severity fire areas (Hanson & North 2008; Hutto 2008), which is scarce in the proposed fuel reduction treatment areas. But other evidence suggests that Black-backed Woodpeckers in the Sierra Nevada may require, or at least be more tolerant of, more heterogeneous burn severities than has been suggested for regions outside of the Sierra Nevada (Saracco et al. 2011). The elevation range of this project area and the red fir forest type are selected by Black-backed Woodpeckers (Saracco et al. 2011; Fogg et al. 2014), which likely contributes to the high observed abundances. Because the project proposal did not specify treatment prescriptions, it is difficult to gauge how much material would be removed and how much Black-backed Woodpecker habitat would be affected. As stated in the purpose and need for action, most of the fuel that is targeted for removal is in the form of recently killed standing dead timber. Black-backed Woodpeckers have been shown to be sensitive to silvicultural treatments that retain even high snag densities (Saab et al. 2007), so the potential for this project to negatively impact Black-backed Woodpecker habitat suitability could be substantial if implemented within 8-10 years of the Chips fire.

Species in the open mature forest guild also reached their highest abundance in these proposed fuel reduction treatment areas, relative to other areas of the Storrie and Chips fire footprint and adjacent unburned forest. This suggests that the area proposed for fuel treatment is providing suitable open forest habitat structure, as might be expected after repeated low- to moderate-severity burning (Coppoletta et al. 2016).

A potential approach to reduce the negative impacts to post-fire associated birds would be to limit the fuel reduction treatments to the portions of the proposed treatment area that were classified as 0% canopy cover change (unchanged burn severity) in both the Chips and Storrie fires, the small portion of the project area outside of the Chips Fire perimeter, and other areas outside the fire perimeters but adjacent to it. These areas likely require the most fuel management and also pose the lowest potential for negative impacts on the Black-backed Woodpecker population.

The reforestation treatments in the Ridge Project are intended to reestablish native conifer cover by minimizing competition from brush and other vegetation, and accelerate long-term establishment of conifer stands. According to the draft purpose and need for action, site preparation would take place in a 1- to 2-acre area at locations selected for founder stands and include: (a) for safety, the felling of snags in adjacent to the planting unit felled for safety, except those identified as wildlife habitat, and (b) pile and burn downed woody material and live brush within planting units.

As proposed, the reforestation treatments should have a low impact on the avifauna, but there is room for improvement in placement of founder stands. Despite the relatively high densities of early seral forest bird species in the reforestation treatment area, because of the small proposed extent of the founder stands (≤10% of the treatment area), we expect few impacts to those species. The abundance of post-fire snag species was also high throughout the proposed treatment area, whereas Black-backed Woodpeckers were primarily found in areas that did not burn at high severity in Storrie Fire. To reduce impacts to Black-backed Woodpeckers and other species in the post-fire snag guild, we recommend that founder stands be placed primarily in areas that burned in high severity in the Storrie Fire, as these areas have the fewest snags. To avoid the need to fell large numbers of snags adjacent to the founder stands for safety, founder stands can be placed and sized in a manner such that the edge of the stand planting area is ≥30 m away from areas that burned at moderate severity or lower in the Storrie Fire and high severity in the Chips Fire. Furthermore, to reduce impacts to the cavity nesting species (Western and Mountain Bluebirds and Northern Flicker) that are more likely to use areas burned twice at moderate and high severities, avoid felling of snags >50 cm (20 in) DBH which these species target as nest trees.

Management Implications for the Green Island Project Area

The Green Island Project proposed a prescribed burn to reduce fuel loading and increase resiliency of the forest when faced with future wildfire. Based on the expectation of a low severity prescribed burn with a few moderate or high severity patches, using the bird data we can make some inferences about the potential effects of the project if implemented.

Much like the fuels reduction treatment area of the Ridge Project, after Storrie Fire the Green Island Project area was classified as an unchanged and low-severity burn with small amount of moderate severity. The Green Island Project area currently has relatively high abundances of open forest and early seral forest bird species, and generally low abundance (but patches of moderately high abundance) of dense forest species and very few post-fire snag species. The introduction of prescribed fire would likely result in a modestly more open forest condition with a few more snags, but a significant reduction in surface fuels (Coppoletta et al. 2016). Post-fire snag species would likely respond positively – especially Black-backed Woodpeckers given the relatively high elevation of the project area – as would open forest species (Russell et al. 2009; but see Rota et al. 2014).

The presence of Black-backed Woodpeckers in the Green Island Project area this year was unexpected, but not unprecedented. By 10 years post-fire, Black-backed Woodpecker occupancy is extremely low in the Sierra Nevada (Saracco et al. 2011). In 2015, the Storrie Fire was in its 15th year post-fire, so the likelihood of Black-backed Woodpecker use of the Green Island Project areas was very low. However, Black-backed Woodpeckers nesting in the perimeters of recent fires (e.g. the Chips Fire) do occasionally incorporate large amounts of unburned forest in their home range, and have been tracked as far as 5.4 km from the fire perimeter (Tingley et al. 2014). Black-backed Woodpeckers also occupy territories and nest in unburned green forest in the Sierra Nevada and southern Cascades, well away from recent fires (Fogg et al. 2014), so the Black-backed Woodpeckers detected in the Green Island Project area may occupy the area independent of the Chips Fire.

Bats

Acoustic Monitoring Considerations

During the 2015-16 monitoring seasons, automated recording units detected 91,442 bat passes in total. Of these detections, 43,408 passes (47.5%) were confidently classified by the SonoBat software, meaning a slight majority of individual passes were not identified to the species level. The classification process is intentionally conservative to avoid misclassifications and false-positive detections. From a statistical and modeling perspective, false-positives are more problematic than false-negatives because they can lead to biased effects estimates when modeling species relationships with environmental variables (Clement et al. 2014). In our 2015 annual report (Campos & Burnett 2016), we presented an analysis that compared a manual review of all automatically classified species presences from a subset of survey nights from the

Storrie, Chips, and Power Fires to elucidate the advantages and drawbacks of this automated classification approach. For those survey nights reviewed, we found high agreement among classified recordings for most species, meaning false-positive rates were low. However, in many cases a human observer confirmed the presence of a bat species when the software discarded the recording due to poor quality or ambiguity. As a result, the estimates of species richness and bat activity presented in this report should be interpreted as quite conservative, with true values likely exceeding those observed. Likewise, effects estimates should be considered relative rather than absolute. For example, we show that Mexican free-tailed bat activity increases from less than five passes per night to approximately 30 passes per night across the range of burn severity in the Chips Fire. It is likely that the actual nightly pass rate of Mexican free-tailed bats is higher than what was observed over the spectrum of burn severity, but the modeled proportional change remains a good estimate of the effect of burn severity.

In addition to low classification rates among recorded passes, a species may be present but not detected at all. For example, pallid bat often hunts using auditory cues to find its prey without emitting echolocation calls (Reid 2006), and the echolocation calls of Townsend's big-eared bats are relatively quiet (Lacki et al. 2007a), meaning individuals must fly closer to microphones than other species to be detected. Imperfect detection is a common problem when surveying mobile and inconspicuous wildlife. For some applications, detection rates can be statistically accounted for using occupancy models (MacKenzie et al. 2003). The analyses presented in this report do not account for this type of detectability. For this reason, comparisons of activity across species should be made with caution. Furthermore, because we do not expect acoustic detection to vary markedly across habitat types, the relative relationships with habitat we presented are likely robust.

Management Considerations

Our results suggest that the bat community in the Storrie and Chips Fires responded positively to fire over to the full range of burn severities. The same conclusion was recently reached from bat inventory and monitoring activities in the Power Fire on the Eldorado National Forest (Steel & Safford 2017). Only one other study on bats in a post-fire landscape exists from the Sierra Nevada region. In that study, Buchalski et al. (2013) found that bat activity in burned areas was either equivalent or higher than in unburned stands for all bat groups that they measured. These findings from post-fire landscapes in mixed-conifer forests of the Sierra suggest that bats are resilient to mixed severity fire at the landscape-scale and that many species are more active in burned areas, including areas that burn at the highest severity.

The suitability of forest ecosystems for bat species can be characterized by the abundance of roost sites, the amount of clutter, availability of prey, and availability of water (Lacki et al. 2007b), where clutter is roughly defined as the difficulty of negotiating vegetation structure while foraging, and is related to vegetation density and structural complexity. Wildfire and forest management influence habitat suitability for bats through changes in forest vegetation which may affect roost site availability, prey availability, and navigation potential.

Bats use a variety of structures for roosting in forested ecosystems, including relatively permanent natural features such as rocky outcroppings, cliffs or caves, and human infrastructure such as bridges, buildings or mines. Additionally, 13 of the 16 bat species detected, including the three forest service sensitive species, are known to roost in live trees or snags at some point during their lifecycle. These include the pallid bat, Townsend’s big-eared bat, spotted bat, silver-haired bat, western red bat, hoary bat, California myotis, long-eared myotis, fringed myotis, long-legged myotis, and Yuma myotis (Lacki et al. 2007b). Some species, including the hoary bat, will roost in the foliage of live trees, while many others will use features of snags such as cavities, crevices, exfoliating bark, and abandoned woodpecker holes, or defects of living trees. Roost trees tend to be tall, large in diameter, and located in stands with an open canopy, high density of snags (Kalcounis-Rüppell et al. 2005), and near water and riparian areas (Brigham et al. 1997b).

High-severity fire creates high snag densities, and effectively high densities of potential roosting sites for many species. Salvage logging operations that remove large-diameter snags may reduce the availability of high quality roosting sites. In the Chips Fire, we observed higher activity of hoary and pallid bats in salvaged than unsalvaged high severity areas, but otherwise no effects of salvage logging were evident. The lack of effects suggest that the bat community in this area may be resilient to the extent of, and prescriptions used in, salvage logging on Forest Service lands in the Chips Fire. These treatment areas were relatively small and the majority retained 10–20% of the unit in snag leave islands, so caution against extrapolating these results to far larger continuous salvage blocks without substantial snag retention. Management activities that promote the persistence, and future creation of large diameter live trees and snags would benefit many forest bat species that use live and dead trees as roosts (Barclay & Kurta 2007). Long-term management strategies that promote mature and multi-aged forests, at the stand and landscape-scale, would ensure roosting sites are continuously available into the future.

Fires may improve foraging habitat for some species in forests by reducing the amount of vegetation in the forest canopy and understory, which can obstruct flyways and interfere with echolocation. Bat species vary in size and wing morphology, characteristics that affect flight speed and maneuverability. Small-bodied bats with low wing-loading (body mass / wing area) are able to hunt effectively in cluttered environments such as dense, closed-canopy forests, while large bats with high wing-loading are observed foraging more often in open forests or clearings (Lacki et al. 2007a). Previous studies have found several species of bats avoid foraging in denser forests with more “clutter” (Brigham et al. 1997a; Erickson & West 2003). Thus, we might expect some species in the Sierra Nevada to be excluded from very dense forests, which is supported by the observed elevated rates of species richness and activity levels of some species within the Storrie and Chips fires compared to the more cluttered surrounding green forest. We also observed compositional changes in the bat community along the gradient of burn severity, with some large-bodied species preferring the more open habitats created by high severity fire, while species richness remained unchanged across the same burn severity gradient (Figure 10). This indicates the bat community is adapted to an ecosystem whose structure was historically driven by heterogeneous burn severities.

Fires may also improve foraging habitat by increasing prey availability. Fires are known to increase the abundance of terrestrial and aquatic insect prey (Swengel 2001; Lacki et al. 2009; Malison & Baxter 2010), which increases foraging opportunities for bats. However, the structural characteristics of a forest after a fire may be more important than prey density (Armitage & Ober 2012).

Owing to a century of fire suppression, much of the area of mixed conifer forest in the Sierra Nevada supports stands that are denser than they were historically (McKelvey & Johnston 1992; Taylor 2000). The open forests found in low and moderate severity areas of the Storrie and Chips fires are thus relatively rare on the landscape, and are likely rather valuable for the bat community. Similarly, the forest clearings created in high-severity burns are important foraging areas, with potentially roost areas, for some species. Managing post-fire areas for long-term habitat heterogeneity through the retention of large snags and promoting the maintenance of open stands where reforestation efforts are implemented, would most benefit the bat community of the Storrie and Chips Fires.

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APPENDICES

Appendix A. Black-backed Woodpecker Detections

Figure A1. Maps of Black-backed Woodpecker locations detected during field work in and near the Storrie and Chips Fires in 2015 (A) and 2016 (B).

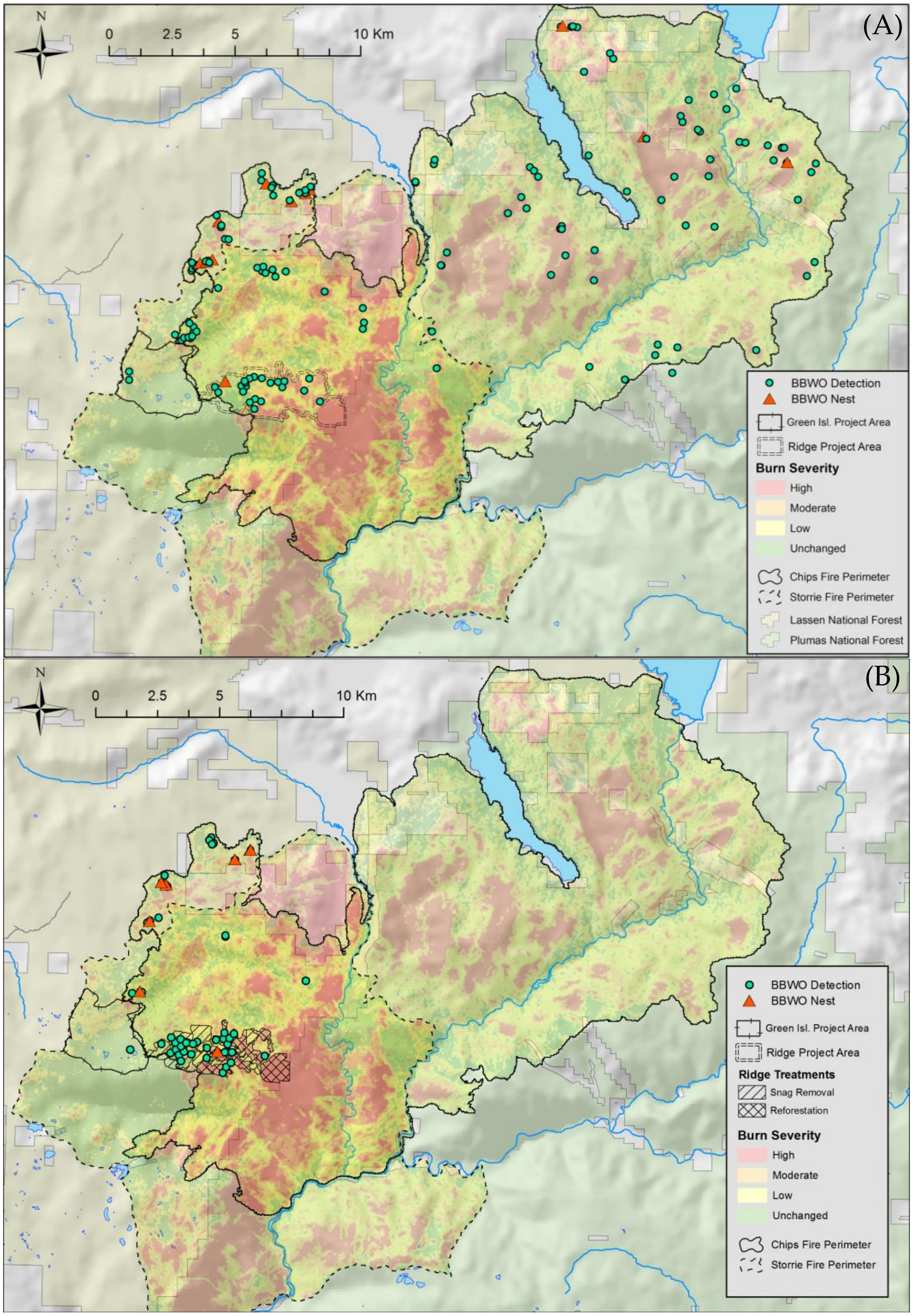


Table A1. Detections of Black-backed Woodpecker on Lassen National Forest during field work in and near the Storrie and Chips Fires 2015. Observers: BJL = Brent J. Leyerle, CLS = Carine L. Squibb, DJL = Daniel J. Lipp, EEI = Eric-Evan Irvin, JEM = Jeffrey E. Moker, JML = Joseph M. Leibrecht, LMO = Lauren Morgan-Outhisack, WCW = Wendy C. Willis, WMH = Wyatt M. Hersey.

Observer	Date	Near Transect	Near Site	Qty Adults	Easting	Northing	Nest	Observer Activity
LMO	8/12/2015	213	2	1	664342	4444724	N	Veg survey
CLS	6/15/2015	213	2	2	664357	4444751	Y	Point count
DJL	5/16/2015	213	6	1	665324	4444383	N	Point count
DJL	5/16/2015	213	7	1	665493	4444738	N	Point count
WCW	6/8/2015	214	2	1	650451	4437552	N	Point count
WMH	7/10/2015	222	11	1	665580	4440818	N	Veg survey
DJL	7/24/2015	223	1	1	661357	4447353	N	Veg survey
DJL	7/21/2015	223	8	1	661872	4446784	N	Veg survey
JML	6/8/2015	223	8	1	661872	4446784	N	Point count
JML	6/5/2015	224	9	1	660399	4442101	N	Point count
WMH	6/1/2015	314	6	2	663371	4437238	N	Point count
DJL	5/13/2015	BVR1	1	1	658015	4443374	N	Point count
DJL	7/17/2015	BVR1	9	1	656444	4444761	N	ARU deployment
LMO	8/14/2015	BVR2	12	2	656809	4441001	N	Veg survey
DJL	6/1/2015	BVR3	1	1	656158	4448081	N	Point count
DJL	6/3/2015	BVR3	1	1	656158	4448081	N	Point count
DJL	6/9/2015	CAR1	10	1	655111	4439954	N	Point count
LMO	7/28/2015	CAR2	6	1	659356	4436903	N	Veg survey
WMH	6/1/2015	CAR2	9	1	659446	4437326	N	Point count
CLS	7/27/2015	CAR3	2	1	658188	4435892	N	Veg survey
LMO	7/27/2015	CAR3	12	1	656754	4436356	N	Veg survey
JML	7/16/2015	CH01	1	1	640803	4439656	N	Veg survey
WMH	5/19/2015	CH01	1	1	640839	4439740	N	Nest survey
EEI	6/9/2015	CH01	2	1	640940	4439832	N	Point count
JML	7/16/2015	CH01	2	1	640938	4439837	N	Veg survey
JML	7/16/2015	CH01	2	1	640913	4439910	N	Veg survey
JML	7/16/2015	CH01	3	2	641124	4439928	N	Veg survey
EEI	6/9/2015	CH01	3	1	641161	4439936	N	Nest survey
WMH	5/19/2015	CH01	3	2	641133	4439989	Y	Nest survey
WMH	5/19/2015	CH01	4	2	641472	4440073	N	Nest survey
EEI	6/9/2015	CH01	4	1	641385	4440041	Y	Nest survey
JML	7/16/2015	CH01	4	1	641357	4440048	N	Veg survey
WMH	5/19/2015	CH01	5	2	641623	4440131	Y	Nest survey
JML	7/30/2015	CH01	R1	1	641500	4440012	N	Veg survey
JML	7/30/2015	CH01	R2	1	640817	4439983	N	Veg survey
EEI	5/19/2015	CH02	1	2	642099	4440962	N	Point count
JEM	6/15/2015	CH02	1	2	642099	4440962	N	Nest survey

Observer	Date	Near Transect	Near Site	Qty Adults	Easting	Northing	Nest	Observer Activity
EEI	5/19/2015	CH02	3	1	641920	4441421	N	Point count
EEI	5/19/2015	CH02	4	2	641829	4441656	Y	Nest survey
JEM	6/15/2015	CH02	4	1	641829	4441656	Y	Point count
EEI	5/19/2015	CH02	5	1	641736	4441888	N	Point count
JML	7/30/2015	CH02	R3	2	641941	4441498	N	Veg survey
JEM	6/8/2015	CH03	1	2	643478	4443625	N	Point count
JML	7/28/2015	CH03	2	1	643464	4443341	N	Veg survey
LMO	5/20/2015	CH03	3	1	643919	4443162	N	Nest survey
LMO	5/20/2015	CH03	3	1	643665	4443223	Y	Nest survey
LMO	5/20/2015	CH03	4	1	643879	4443067	N	Nest survey
LMO	5/20/2015	CH03	5	1	643960	4442755	N	Point count
JEM	5/20/2015	CH04	1	2	645392	4443053	Y	Nest survey
DJL	6/30/2015	CH04	1	1	645431	4443156	N	Veg survey
JEM	5/20/2015	CH04	2	2	645242	4442892	Y	Nest survey
LMO	7/1/2015	CH04	2	1	645242	4442892	N	Veg survey
LMO	7/15/2015	CH04	2	1	645232	4443008	N	Veg survey
JEM	5/20/2015	CH04	3	1	644992	4442903	N	Incidental
LMO	6/8/2015	CH04	4	1	644985	4442891	N	Point count
JEM	5/20/2015	CH04	5	2	644692	4442551	Y	Nest survey
LMO	6/8/2015	CH04	5	2	644614	4442586	N	Point count
WMH	6/13/2015	CH06	4	1	650305	4444211	N	Nest survey
JML	7/27/2015	CH06	R3	1	650333	4444386	N	Veg survey
LMO	5/13/2015	CS01	13	1	657163	4448853	N	Point count
LMO	5/13/2015	CS01	14	1	657305	4448637	N	Incidental
BJL	6/9/2015	CS02	3	1	655823	4449840	N	Incidental
CLS	6/9/2015	CS02	4	1	655588	4449852	N	Incidental
JEM	5/13/2015	CS02	4	1	655650	4449874	N	Incidental
JEM	5/13/2015	CS02	6	1	655174	4449844	N	Point count
CLS	6/9/2015	CS02	6	2	655243	4449885	Y	Point count
EEI	5/17/2015	CS03	1	1	662232	4447611	N	Point count
WMH	6/15/2015	CS03	1	1	662232	4447611	N	Point count
DJL	7/15/2015	CS03	7	1	664125	4445319	N	Veg survey
WMH	6/15/2015	CS03	7	1	664217	4445319	N	Point count
WMH	6/15/2015	CS03	9	1	663556	4445392	N	Point count
EEI	5/17/2015	CS03	12	1	664829	4443268	N	Point count
DJL	6/6/2015	CS04	4	1	661283	4444767	N	Point count
DJL	6/6/2015	CS04	8	2	661247	4444089	N	Point count
EEI	5/13/2015	CS05	2	1	658618	4445589	Y	Point count
DJL	7/7/2015	CS05	3	1	658720	4445498	N	Veg survey
CLS	5/13/2015	CS06	7	1	659403	4443080	N	Point count
JML	7/15/2015	CS07	3	1	656822	4439799	N	Veg survey

Observer	Date	Near Transect	Near Site	Qty Adults	Easting	Northing	Nest	Observer Activity
JML	6/9/2015	CS08	3	1	655478	4441797	N	Point count
JML	6/9/2015	CS08	3	1	655412	4441805	N	Point count
JML	6/9/2015	CS08	3	3	655460	4441872	N	Point count
JML	6/9/2015	CS08	3	1	655474	4441916	N	Point count
WMH	7/13/2015	CS08	9	1	655657	4440753	N	Veg survey
LMO	6/29/2015	CS09	1	1	649599	4443453	N	Point count
DJL	6/29/2015	CS09	1	2	649593	4443485	N	Incidental
JML	7/13/2015	CS09	9	1	650937	4440711	N	Veg survey
JEM	5/14/2015	CS09	10	1	650744	4440196	N	Point count
DJL	6/4/2015	CS09	10	1	650715	4440197	N	Point count
WMH	6/9/2015	CS10	5	3	654127	4444215	N	Veg survey
LMO	7/9/2015	CS10	6	2	654294	4444078	N	Point count
WMH	6/9/2015	CS10	7	1	654466	4443848	N	Point count
WMH	6/9/2015	CS10	8	1	655474	4441916	N	Point count
WMH	6/9/2015	CS10	9	1	655478	4441797	N	Point count
DJL	7/14/2015	CS12	1	1	665292	4440253	N	Veg survey
EEI	5/21/2015	CS12	2	1	665292	4440253	N	Point count
JML	6/15/2015	GRN1	1	2	638465	4435233	N	Point count
BJL	5/25/2015	GRN1	2	1	638451	4435565	N	Playback
LMO	5/19/2015	LA08B	W	1	644556	4439747	N	Point count
LMO	5/19/2015	LA08C	E	1	644027	4439804	N	Point count
LMO	5/19/2015	LA08C	W	1	643615	4439732	N	Point count
BJL	5/13/2015	MSQ2	2	1	653824	4443013	N	Point count
DJL	7/20/2015	MSQ2	8	1	653312	4442358	N	Veg survey
DJL	7/20/2015	MSQ2	11	1	654049	4442577	N	Veg survey
EEI	5/16/2015	OHC1	3	1	660137	4446212	N	Point count
EEI	5/16/2015	OHC1	4	1	660054	4446452	N	Point count
EEI	5/16/2015	OHC1	7	2	660357	4447093	N	Point count
WMH	5/16/2015	OHC1	12	1	660836	4445855	N	Incidental
CLS	6/8/2015	OHC1	12	1	660844	4445857	N	Point count
EEI	5/16/2015	OHC1	12	1	660759	4445924	N	Point count
EEI	6/15/2015	OHC2	2	1	662430	4445496	N	Point count
CLS	5/15/2015	OHC2	3	2	662667	4445468	N	Point count
EEI	6/15/2015	OHC2	10	1	663812	4444810	N	Point count
CLS	5/18/2015	PL22A	C	1	660058	4436222	N	Playback
EEI	6/1/2015	PL22B	E	1	660237	4437239	N	Point count
WMH	6/3/2015	RDG1	1	1	641891	4435059	N	Point count
BJL	6/17/2015	RDG1	1	1	641892	4435059	N	Playback
BJL	6/17/2015	RDG1	2	2	642031	4434853	N	Point count
BJL	6/3/2015	RDG1	12	2	642291	4435299	Y	Incidental
BJL	6/3/2015	RDG2	3	1	643118	4435133	N	Incidental

Observer	Date	Near Transect	Near Site	Qty Adults	Easting	Northing	Nest	Observer Activity
CLS	6/17/2015	RDG2	3	1	642944	4435140	N	Point count
JML	6/3/2015	RDG2	4	1	643018	4434917	N	Point count
JML	6/3/2015	RDG2	7	1	643742	4435473	N	Playback
CLS	6/17/2015	RDG2	9	1	643435	4435516	N	Point count
CLS	6/17/2015	RDG2	11	2	643253	4435444	N	Point count
JML	6/3/2015	RDG2	12	1	643099	4435274	N	Point count
CLS	6/17/2015	RDG2	12	1	643063	4435335	N	Point count
EEI	6/17/2015	RDG3	1	2	643740	4434555	N	Point count
EEI	6/17/2015	RDG3	2	3	643503	4434642	N	Point count
JML	6/4/2015	RDG3	3	1	643296	4434502	N	Point count
JML	6/4/2015	RDG3	4	1	643483	4434248	N	Point count
BJL	6/3/2015	RDG4	11	1	645444	4435033	N	Playback
EEI	6/16/2015	RDG5	1	2	644099	4435302	N	Point count
EEI	6/16/2015	RDG5	2	1	644391	4435348	N	Playback
BJL	6/4/2015	RDG5	4	1	644638	4435385	N	Playback
EEI	6/16/2015	RDG5	5	1	644565	4435142	N	Point count
EEI	6/16/2015	RDG5	10	3	645630	4435519	N	Point count
BJL	6/16/2015	RDG6	2	1	646087	4434627	N	Playback
EEI	8/6/2015	SEN1	1	1	661550	4442089	N	Veg survey
EEI	5/13/2015	SENW	4	2	659882	4444025	N	Point count
DJL	7/13/2015	ST01	3	1	646129	4439002	N	Veg survey
DJL	8/5/2015	ST02	R4	1	650684	4436098	N	Veg survey
LMO	6/15/2015	ST06	1	1	643419	4439860	N	Nest survey
LMO	6/15/2015	ST06	2	1	643658	4439911	N	Nest survey
LMO	6/15/2015	ST06	3	2	643753	4439663	N	Nest survey
LMO	5/19/2015	ST06	4	1	644153	4439530	N	Incidental
LMO	5/15/2015	ST11	4	1	647697	4437570	N	Nest survey
BJL	5/8/2015	ST11	5	1	647733	4437821	N	Incidental
EEI	6/6/2015	ST13	5	1	647665	4438390	N	Point count
JEM	6/16/2015	ST15	2	2	640954	4437178	N	Point count
BJL	5/27/2015	ST15	4	1	640494	4436877	N	Nest survey
JML	5/27/2015	ST15	5	1	640234	4437089	N	Incidental
BJL	5/27/2015	ST15	5	2	640966	4437417	N	Point count
DJL	7/30/2015	ST15	R1	1	640847	4436969	N	Veg survey
DJL	7/30/2015	ST15	R2	1	640593	4436981	N	Veg survey
DJL	7/30/2015	ST15	R3	1	640775	4437011	N	Veg survey
DJL	7/30/2015	ST15	R4	1	641088	4437248	N	Veg survey
DJL	7/30/2015	ST15	R5	1	640916	4437050	N	Veg survey
DJL	7/16/2015	STMW	3	2	640794	4437567	N	ARU deployment
WMH	6/15/2015	STMW	9	1	642235	4440952	N	Point count
DJL	7/28/2015	STMW	11	1	641889	4439002	N	ARU deployment

Table A2. Detections of Black-backed Woodpecker on Lassen National Forest during field work in and near the Storrie and Chips Fires 2016. Observers: BJL = Brent J. Leyerle, CMS = Christa M. Seidl, WMH = Wyatt M. Hersey.

Observer	Date	Near Transect	Near Site	Qty Adults	Easting	Northing	Nest	Observer Activity
WMH	6/9/2016	CH01	CH0103	2	641161	4439936	N	Point count
BJL	5/24/2016	CH01	CH0104	2	641280	4440011	N	Nest survey
WMH	6/9/2016	CH01	CH0104	2	641260	4439998	Y	Nest survey
WMH	6/9/2016	CH01	CH0105	1	641617	4440149	N	Point count
WMH	5/24/2016	CH02	CH0203	2	641920	4441421	N	Point count
BJL	6/9/2016	CH02	CH0203	1	641870	4441437	N	Nest survey
WMH	5/24/2016	CH02	CH0203	1	641871	4441502	Y	Nest survey
BJL	6/9/2016	CH02	CH0204	1	641674	4441591	Y	Nest survey
BJL	6/9/2016	CH02	CH0205	1	641808	4441860	N	Nest survey
WMH	5/23/2016	CH03	CH0302	1	643636	4443447	N	Point count
WMH	5/23/2016	CH03	CH0302	1	643564	4443347	N	Nest survey
WMH	5/23/2016	CH03	CH0303	1	643745	4443223	N	Point count
WMH	5/23/2016	CH03	CH0303	1	643673	4443185	N	Nest survey
BJL	5/23/2016	CH04	CH0402	2	645227	4443015	Y	Point Count
BJL	5/23/2016	CH04	CH0402	2	645236	4443000	Y	Nest survey
WMH	6/8/2016	CH04	CH0405	2	644614	4442583	N	Point count
BJL	5/23/2016	CH04	CH0405	1	644614	4442583	N	Point count
WMH	6/8/2016	CH04	CH0405	2	644611	4442601	Y	Nest survey
BJL	6/25/2016	GRN2	GRN209	2	640643	4434795	N	Playback
WMH	6/30/2016	RDG1	RDG101	2	641891	4435059	N	Playback
WMH	6/30/2016	RDG1	RDG103	1	642271	4434713	N	Point count
WMH	6/30/2016	RDG1	RDG104	1	642478	4434853	N	Playback
WMH	6/30/2016	RDG1	RDG105	1	642604	4434637	N	Point count
WMH	6/30/2016	RDG1	RDG106	1	642702	4434401	N	Playback
WMH	6/30/2016	RDG1	RDG109	2	643116	4434682	N	Playback
WMH	6/30/2016	RDG1	RDG110	1	642811	4434777	N	Point count
BJL	6/16/2016	RDG1	RDG110	2	642811	4434777	N	Playback
BJL	6/16/2016	RDG1	RDG111	1	642685	4434993	N	Point count
WMH	6/30/2016	RDG1	RDG112	1	642445	4435133	N	Point count
BJL	6/16/2016	RDG1	RDG112	2	642445	4435133	N	Playback
BJL	6/15/2016	RDG2	RDG201	1	642277	4435332	N	Incidental
BJL	6/30/2016	RDG2	RDG202	1	642652	4435273	N	Point count
BJL	6/30/2016	RDG2	RDG203	1	642892	4435133	N	Playback
CMS	6/16/2016	RDG2	RDG203	2	642892	4435133	N	Point count
CMS	6/16/2016	RDG2	RDG205	1	643328	4435193	N	Playback
BJL	6/14/2016	RDG2	RDG205	2	643167	4435105	N	Incidental
BJL	6/28/2016	RDG3	RDG301	1	643740	4434555	N	Playback
CMS	6/14/2016	RDG3	RDG309	1	644401	4433989	N	Playback

Observer	Date	Near Transect	Near Site	Qty Adults	Easting	Northing	Nest	Observer Activity
CMS	6/14/2016	RDG3	RDG310	1	644535	4434217	N	Point count
BJL	6/14/2016	RDG4	RDG401	2	644157	4434837	Y	Incidental
BJL	8/8/2016	RDG4	RDG401	1	643733	4434964	N	ARU deployment
WMH	6/28/2016	RDG4	RDG402	2	644462	4434808	N	Playback
WMH	6/28/2016	RDG4	RDG403	1	644751	4434818	N	Point count
CMS	6/15/2016	RDG4	RDG405	1	644722	4434400	N	Playback
BJL	6/29/2016	RDG5	RDG501	3	644099	4435302	N	Playback
CMS	6/15/2016	RDG5	RDG502	1	644391	4435348	N	Playback
BJL	6/29/2016	RDG5	RDG503	2	644418	4435596	N	Point count
BJL	6/29/2016	RDG5	RDG504	2	644638	4435385	N	Playback
CMS	6/15/2016	RDG5	RDG505	2	644565	4435142	N	Point count
BJL	6/29/2016	RDG5	RDG507	1	644803	4435573	N	Point count
WMH	6/29/2016	RDG6	RDG602	1	646075	4434712	N	Point count
BJL	6/10/2016	ST06	ST0605	1	644341	4439484	N	Point count
BJL	6/10/2016	ST06	ST0605	1	644331	4439523	N	Nest survey
WMH	5/22/2016	ST11	ST1105	1	647633	4437804	N	Nest survey
WMH	6/13/2016	ST15	ST1502	1	641031	4437127	N	Point count
WMH	6/13/2016	ST15	ST1502	1	640954	4437161	Y	Nest survey
BJL	5/27/2016	ST15	ST1503	1	640651	4437074	N	Nest survey

Appendix B. Bat Modeling Effects Tables

Table B1. Parameter estimates from a model investigating the effect of burned areas on bat species activity in the Storrie and Chips Fires in 2015-16. Estimates should be interpreted as the expected change from outside of a burn perimeter to a comparison level of the average locations within the Chips and Storrie fire perimeters. Estimate and measures of uncertainty are on the log scale. Elevation and year are included to control for these effects which were pronounced for some species.

Variable	Estimate	Lower 95 CI	Upper 95 CI	SE	Z	P
Intercept	0.745	0.495	0.996	0.128	5.824	0.000
Burned (binary)	0.720	0.455	0.984	0.135	5.328	0.000
Elevation	0.065	-0.021	0.150	0.044	1.477	0.140
Year	-0.114	-0.222	-0.007	0.055	-2.088	0.037

Table B2. Parameter estimates from negative binomial models investigating the effect of burned areas on bat species activity in the Storrie and Chips Fires in 2015-16. Estimates should be interpreted as the expected change from outside of a burn perimeter to a comparison level of the average locations within the Chips and Storrie fire perimeters. Estimate and measures of uncertainty are on the log scale. Elevation and year are included to control for these effects which were pronounced for some species. Pallid bat, big brown bat, and western pipistrelle could not be modeled because they were only detected inside the burn perimeters, not outside of them.

Variable	Species	Estimate	Lower 95 CI	Upper 95 CI	SE	Z	P
Intercept	western mastiff bat	-1.798	-3.112	-0.485	0.670	-2.683	0.007
Burned (binary)		1.477	0.103	2.852	0.701	2.107	0.035
Elevation		0.968	0.505	1.432	0.237	4.094	0.000
Year		-0.194	-0.791	0.403	0.304	-0.636	0.525
Intercept	western red bat	-3.195	-4.833	-1.556	0.836	-3.821	0.000
Burned (binary)		1.002	-0.637	2.642	0.836	1.198	0.231
Elevation		0.076	-0.491	0.644	0.290	0.264	0.792
Year		-0.601	-1.277	0.074	0.345	-1.745	0.081
Intercept	hoary bat	-2.606	-3.982	-1.230	0.702	-3.711	0.000
Burned (binary)		1.894	0.495	3.294	0.714	2.653	0.008
Elevation		-0.294	-0.738	0.151	0.227	-1.295	0.195
Year		-1.030	-1.565	-0.496	0.273	-3.781	0.000
Intercept	silver-haired bat	-0.545	-1.400	0.310	0.436	-1.250	0.211
Burned (binary)		2.876	1.976	3.775	0.459	6.265	0.000
Elevation		0.198	-0.081	0.478	0.143	1.390	0.164
Year		-0.800	-1.137	-0.463	0.172	-4.650	0.000
Intercept	California myotis	-0.284	-1.037	0.468	0.384	-0.741	0.459
Burned (binary)		0.881	0.092	1.671	0.403	2.188	0.029
Elevation		0.094	-0.164	0.351	0.131	0.712	0.477
Year		0.212	-0.102	0.525	0.160	1.324	0.186
Intercept	western small-footed myotis	-5.340	-7.994	-2.686	1.354	-3.944	0.000
Burned (binary)		0.104	-2.064	2.273	1.106	0.094	0.925
Elevation		-0.028	-0.775	0.719	0.381	-0.074	0.941
Year		-0.130	-1.346	1.085	0.620	-0.210	0.834
Intercept	long-eared myotis	-1.051	-1.743	-0.359	0.353	-2.978	0.003
Burned (binary)		1.303	0.575	2.031	0.372	3.506	0.000
Elevation		0.385	0.156	0.615	0.117	3.288	0.001
Year		-0.437	-0.738	-0.137	0.153	-2.852	0.004
Intercept	little brown	-0.134	-1.091	0.823	0.488	-0.275	0.783

Variable	Species	Estimate	Lower 95 CI	Upper 95 CI	SE	Z	P
Burned (binary)	bat	0.898	-0.121	1.917	0.520	1.727	0.084
Elevation		0.058	-0.283	0.399	0.174	0.335	0.738
Year		-0.192	-0.518	0.133	0.166	-1.158	0.247
Intercept	fringed myotis	-5.035	-7.285	-2.785	1.148	-4.386	0.000
Burned (binary)		1.041	-1.018	3.100	1.051	0.991	0.322
Elevation		-0.044	-0.664	0.577	0.316	-0.138	0.891
Year		-0.579	-1.619	0.461	0.530	-1.091	0.275
Intercept	long-legged myotis	-8.624	-13.899	-3.349	2.692	-3.204	0.001
Burned (binary)		-0.226	-4.581	4.130	2.222	-0.102	0.919
Intercept	Yuma myotis	-5.355	-7.421	-3.288	1.054	-5.079	0.000
Burned (binary)		2.402	0.378	4.425	1.032	2.327	0.020
Elevation		-0.401	-0.943	0.141	0.277	-1.450	0.147
Year		0.028	-0.725	0.782	0.384	0.074	0.941
Intercept	Mexican free-tailed bat	-0.110	-1.030	0.810	0.469	-0.234	0.815
Burned (binary)		2.811	1.834	3.788	0.499	5.638	0.000
Elevation		0.291	-0.029	0.610	0.163	1.783	0.075
Year		-0.773	-1.149	-0.396	0.192	-4.022	0.000

Table B3. Parameter estimates from a Poisson model investigating the effect of burn severity on bat species richness in the Storrie and Chips Fires in 2015-16. Estimates should be interpreted as the expected change from 0% to 100% canopy mortality within the burn perimeters of the Chips and Storrie Fires. Estimate and measures of uncertainty are on the log scale.

Variable	Estimate	SE	Z	P
Intercept	1.45	0.06	25.02	0.000
Storrie Fire Burn Severity	0.49	0.04	1.18	0.239
Chips Fire Burn Severity	0.08	0.06	1.32	0.187
Elevation	0.12	0.05	2.58	0.010
Year	-0.05	0.06	-0.87	0.385

Table B4. Parameter estimates from negative binomial models investigating the effect of burn severity on bat species activity in the Storrie and Chips Fires in 2015-16. Estimates should be interpreted as the expected change from 0% to 100% canopy mortality within the burn perimeters of the Chips and Storrie Fires. Estimate and measures of uncertainty are on the log scale. Elevation and year are included to control for these effects which were pronounced for some species.

Variable	Species	Estimate	Lower 95 CI	Upper 95 CI	SE	Z	P
Intercept	pallid bat	-4.04	-5.34	-2.74	0.66	-6.10	0.000
Storrie Fire Burn Severity		0.00	-0.59	0.60	0.30	0.01	0.993
Chips Fire Burn Severity		0.85	0.01	1.69	0.43	1.99	0.047
Elevation		-0.21	-0.88	0.45	0.34	-0.63	0.532
Year		0.37	-0.63	1.38	0.51	0.73	0.465
Intercept	big brown bat	-0.28	-0.96	0.40	0.35	-0.81	0.415
Storrie Fire Burn Severity		0.34	-0.12	0.81	0.23	1.47	0.142
Chips Fire Burn Severity		0.15	-0.53	0.83	0.35	0.42	0.672
Elevation		1.15	0.62	1.69	0.27	4.21	0.000
Year		-0.13	-0.78	0.52	0.33	-0.40	0.687
Intercept	western mastiff bat	-5.66	-7.82	-3.51	1.10	-5.14	0.000
Storrie Fire Burn Severity		0.40	-0.39	1.20	0.41	0.99	0.320
Chips Fire Burn Severity		1.17	-0.54	2.88	0.87	1.34	0.180
Elevation		0.08	-1.06	1.23	0.58	0.14	0.885

Variable	Species	Estimate	Lower 95 CI	Upper 95 CI	SE	Z	P
Year		0.10	-1.89	2.09	1.02	0.09	0.924
Intercept	western red bat	-2.33	-3.19	-1.48	0.43	-5.37	0.000
Storrie Fire Burn Severity		-0.14	-0.68	0.39	0.27	-0.52	0.600
Chips Fire Burn Severity		0.97	0.22	1.72	0.38	2.53	0.012
Elevation		0.36	-0.25	0.97	0.31	1.14	0.254
Year		-0.34	-1.07	0.38	0.37	-0.93	0.355
Intercept	hoary bat	-1.05	-1.73	-0.38	0.34	-3.06	0.002
Storrie Fire Burn Severity		0.22	-0.21	0.65	0.22	0.99	0.321
Chips Fire Burn Severity		0.67	0.05	1.30	0.32	2.11	0.035
Elevation		-0.37	-0.90	0.15	0.27	-1.38	0.167
Year		-0.89	-1.45	-0.33	0.29	-3.11	0.002
Intercept	silver-haired bat	2.20	1.86	2.54	0.17	12.73	0.000
Storrie Fire Burn Severity		0.29	0.05	0.53	0.12	2.34	0.019
Chips Fire Burn Severity		0.44	0.11	0.78	0.17	2.57	0.010
Elevation		0.36	0.09	0.63	0.14	2.63	0.008
Year		-0.57	-0.91	-0.23	0.17	-3.27	0.001
Intercept	California myotis	0.70	0.37	1.03	0.17	4.15	0.000
Storrie Fire Burn Severity		0.18	-0.05	0.42	0.12	1.56	0.119
Chips Fire Burn Severity		0.07	-0.26	0.40	0.17	0.41	0.685
Elevation		0.23	-0.03	0.49	0.13	1.74	0.082
Year		0.25	-0.07	0.57	0.16	1.52	0.129
Intercept	western small-footed myotis	-4.87	-6.83	-2.90	1.00	-4.85	0.000
Storrie Fire Burn Severity		0.42	-0.26	1.10	0.35	1.21	0.227
Chips Fire Burn Severity		-0.72	-1.84	0.39	0.57	-1.28	0.202
Elevation		-0.08	-0.93	0.77	0.43	-0.18	0.853
Year		-0.25	-1.60	1.11	0.69	-0.36	0.720
Intercept	long-eared myotis	0.41	0.09	0.72	0.16	2.49	0.013
Storrie Fire Burn Severity		0.14	-0.10	0.37	0.12	1.16	0.248
Chips Fire Burn Severity		-0.25	-0.58	0.08	0.17	-1.49	0.135
Elevation		0.52	0.26	0.77	0.13	3.94	0.000
Year		-0.44	-0.76	-0.12	0.16	-2.71	0.007
Intercept	little brown bat	0.68	0.24	1.12	0.22	3.05	0.002
Storrie Fire Burn Severity		-0.34	-0.68	0.00	0.17	-1.95	0.051
Chips Fire Burn Severity		0.70	0.23	1.17	0.24	2.91	0.004
Elevation		0.38	0.01	0.75	0.19	2.02	0.044
Year		-0.16	-0.50	0.19	0.18	-0.90	0.366
Intercept	fringed myotis	-3.73	-4.94	-2.51	0.62	-6.02	0.000
Storrie Fire Burn Severity		-0.03	-0.62	0.57	0.30	-0.09	0.929
Chips Fire Burn Severity		-0.20	-1.02	0.62	0.42	-0.48	0.633
Elevation		-0.07	-0.73	0.60	0.34	-0.19	0.848
Year		-0.43	-1.50	0.63	0.55	-0.80	0.426
Intercept	long-legged myotis	-0.93	-7.13	5.28	3.16	-0.29	0.770
Storrie Fire Burn Severity		-0.06	-12.21	12.09	6.20	-0.01	0.993
Chips Fire Burn Severity		0.12	-1.78	2.02	0.97	0.12	0.903
Elevation		0.01	-1.33	1.34	0.68	0.01	0.994
Year		-0.07	-2.86	2.73	1.43	-0.05	0.963
Intercept	Yuma myotis	-3.07	-4.01	-2.14	0.48	-6.42	0.000
Storrie Fire Burn Severity		-0.57	-1.22	0.09	0.33	-1.69	0.091
Chips Fire Burn Severity		0.54	-0.25	1.34	0.40	1.34	0.180
Elevation		-0.09	-0.71	0.52	0.32	-0.30	0.764
Year		0.04	-0.75	0.82	0.40	0.09	0.926
Intercept	western	-9.14	-12.64	-5.64	1.79	-5.12	0.000

Variable	Species	Estimate	Lower 95 CI	Upper 95 CI	SE	Z	P
Storrie Fire Burn Severity	pipistrelle	0.46	-0.77	1.69	0.63	0.73	0.466
Chips Fire Burn Severity		-0.67	-2.78	1.44	1.07	-0.62	0.533
Elevation		-0.06	-1.63	1.52	0.80	-0.07	0.943
Year		1.15	-0.22	2.53	0.70	1.64	0.101
Intercept	Mexican free-tailed bat	2.59	2.17	3.01	0.21	12.07	0.000
Storrie Fire Burn Severity		0.35	0.05	0.65	0.15	2.27	0.023
Chips Fire Burn Severity		0.75	0.32	1.18	0.22	3.44	0.001
Elevation		0.57	0.23	0.91	0.17	3.32	0.001
Year		-0.71	-1.10	-0.31	0.20	-3.51	0.000

Table B5. Parameter estimates from a Poisson model investigating the effect of salvage logging on bat species activity in the Storrie and Chips Fires in 2015-16. Estimates should be interpreted as the expected change from a reference level of no salvage logging within 100 m of the sampling location to a comparison level of ≥70% of the area with 100 m within a salvage logging management unit. Estimate and measures of uncertainty are on the log scale. Elevation and year are included to control for these effects which were pronounced for some species.

Variable	Estimate	Lower 95 CI	Upper 95 CI	SE	Z	P
Intercept	1.544	1.386	1.703	0.081	19.062	0.000
Salvage (binary)	-0.083	-0.313	0.147	0.117	-0.709	0.478
Elevation	0.050	-0.070	0.170	0.061	0.811	0.418
Year	-0.043	-0.184	0.098	0.072	-0.604	0.546

Table B6. Parameter estimates from negative binomial models investigating the effect of salvage logging on bat species activity in the Storrie and Chips Fires in 2015-16. Estimates should be interpreted as the expected change from a reference level of no salvage logging within 100 m of the sampling location to a comparison level of ≥70% of the area with 100 m within a salvage logging management unit. Estimate and measures of uncertainty are on the log scale. Elevation and year are included to control for these effects which were pronounced for some species.

Variable	Species	Estimate	Lower 95 CI	Upper 95 CI	SE	Z	P
Intercept	pallid bat	-4.763	-6.419	-3.107	0.845	-5.637	0.000
Salvaged (binary)		2.281	0.831	3.732	0.740	3.083	0.002
Elevation		-0.998	-2.142	0.145	0.583	-1.711	0.087
Year		0.738	-0.495	1.970	0.629	1.173	0.241
Intercept	big brown bat	-0.029	-1.219	1.160	0.607	-0.048	0.961
Salvaged (binary)		-0.256	-2.037	1.524	0.908	-0.282	0.778
Elevation		0.705	-0.229	1.639	0.477	1.480	0.139
Year		-0.612	-1.631	0.406	0.519	-1.179	0.239
Intercept	western mastiff bat	0.000	-1.782	1.782	0.909	0.000	1.000
Salvaged (binary)		0.000	-1.964	1.964	1.002	0.000	1.000
Intercept	western red bat	-1.570	-2.662	-0.478	0.557	-2.818	0.005
Salvaged (binary)		1.201	-0.297	2.698	0.764	1.572	0.116
Elevation		0.476	-0.370	1.322	0.432	1.102	0.270
Year		-0.594	-1.480	0.293	0.452	-1.312	0.190
Intercept	hoary bat	-0.891	-1.753	-0.028	0.440	-2.023	0.043
Salvaged (binary)		2.076	0.968	3.184	0.565	3.672	0.000
Elevation		-0.098	-0.735	0.540	0.325	-0.300	0.764
Year		-0.952	-1.622	-0.281	0.342	-2.783	0.005
Intercept	silver-haired	2.694	2.188	3.200	0.258	10.440	0.000

Variable	Species	Estimate	Lower 95 CI	Upper 95 CI	SE	Z	P
Salvaged (binary)	bat	0.353	-0.360	1.066	0.364	0.970	0.332
Elevation		0.229	-0.162	0.620	0.199	1.147	0.251
Year		-0.815	-1.263	-0.367	0.229	-3.564	0.000
Intercept	California myotis	0.683	0.158	1.207	0.268	2.549	0.011
Salvaged (binary)		-0.485	-1.271	0.301	0.401	-1.209	0.227
Elevation		-0.013	-0.412	0.386	0.204	-0.063	0.950
Year		0.431	0.025	0.838	0.207	2.081	0.037
Intercept	western small-footed myotis	-3.577	-5.620	-1.535	1.042	-3.433	0.001
Salvaged (binary)		-1.620	-4.249	1.010	1.342	-1.207	0.227
Elevation		-0.043	-1.212	1.126	0.597	-0.072	0.943
Year		-1.484	-3.750	0.782	1.156	-1.284	0.199
Intercept	long-eared myotis	0.015	-0.551	0.581	0.289	0.052	0.958
Salvaged (binary)		-0.522	-1.374	0.330	0.435	-1.201	0.230
Elevation		0.281	-0.145	0.707	0.218	1.291	0.197
Year		0.006	-0.463	0.475	0.239	0.024	0.981
Intercept	little brown bat	1.063	0.436	1.689	0.320	3.325	0.001
Salvaged (binary)		0.658	-0.316	1.631	0.497	1.323	0.186
Elevation		0.032	-0.472	0.535	0.257	0.124	0.901
Year		-0.363	-0.785	0.058	0.215	-1.689	0.091
Intercept	fringed myotis	-3.079	-4.165	-1.994	0.554	-5.560	0.000
Salvaged (binary)		0.093	-1.207	1.393	0.663	0.140	0.888
Elevation		-0.371	-1.261	0.518	0.454	-0.818	0.413
Year		-1.260	-2.824	0.304	0.798	-1.579	0.114
Intercept	long-legged myotis	-9.729	-16.619	-2.840	3.515	-2.768	0.006
Salvaged (binary)		0.496	-5.752	6.744	3.189	0.156	0.876
Intercept	Yuma myotis	-2.924	-4.226	-1.623	0.664	-4.404	0.000
Salvaged (binary)		0.429	-1.151	2.008	0.806	0.532	0.595
Elevation		-0.389	-1.296	0.517	0.462	-0.842	0.400
Year		0.272	-0.677	1.221	0.484	0.562	0.574
Intercept	western pipistrelle	-10.853	-15.902	-5.804	2.576	-4.213	0.000
Salvaged (binary)		-0.981	-7.646	5.683	3.400	-0.289	0.773
Elevation		-0.475	-3.550	2.601	1.569	-0.302	0.762
Year		1.984	0.828	3.140	0.590	3.364	0.001
Intercept	Mexican free-tailed bat	3.399	2.727	4.070	0.343	9.921	0.000
Salvaged (binary)		0.516	-0.495	1.526	0.516	1.001	0.317
Elevation		0.630	0.107	1.153	0.267	2.361	0.018
Year		-1.011	-1.584	-0.438	0.292	-3.457	0.001

Appendix C. Automated Recording Unit Deployment and Extraction Protocol

Instructions

Equipment setup (see cartoon example below):

1. Setup microphone and cable approx. 3m above the ground using a pole or stick. Microphone should be angled approx. 45° from horizontal out into the open away from any reflective surfaces (e.g., tree trunk, rocks, water) and clutter (e.g., branches). **If site was visited in previous year, try and deploy ARU and microphone in the same location using last year's datasheet.**
2. Secure pole/branch. For example, by strapping to a tree trunk and pushing one end into the ground or driving a piece of rebar into the ground and slipping pole over.
3. Secure detector to a tree or bush using chain and lock.
4. Connect microphone cables to detector. **Ultrasonic mic must be attached to the top plug and acoustic to the second from top.** This should be done before starting the recording program.

Program detector:

1. Load either Alt2_Bat.PGM or Alt2_Owl.PGM (see schedule)
2. Set fire prefix to match the point ID (e.g., RMS18_6)
3. Set lat & long for point.
4. Sunset/Sunrise type should be Sunset/Sunrise, not civil or astronomic
5. Time zone should be UTC-08:00 (Standard time; one hour later than daylight time during the summer)
6. Press start program. After screen goes to sleep press the info button and check battery and memory card status. Full batteries should be around 6 volts for internal and 13 volts for external batteries. 4 and 10 volts indicate near empty batteries respectively. Also **make sure the unit is detecting U1 mic in channel 0 and A1 mic in channel 1.**

Deployment information

Project - Name of the project (e.g., CSFIRE or PLAS)

Forest - The National Forest that the point lies within.

Date - Date of deployment

Initials - The three-letter initials of all individuals deploying the ARU

Point - Unique code of point or location (e.g., RMS18_6)

Latitude - Latitude of point; be sure this matches what is programmed into the ARU.

Longitude - Longitude of point; be sure this matches what is programmed into the ARU.

ARU - The ARU number

Recording schedule - Name of the programmed recording schedule (E.g., Alt2_Bat)

Microphone # - The number of the acoustic and ultrasonic microphone used

Battery status - The current charge of the batteries (e.g, 6.2 volts)

Memory card stats - The number of gigabytes used and total for each of the card slots; write NA if a slot is empty [e.g., a) 2/32, b) 0/32, c) NA, d) NA]

Microphone Location (match previous year's location if applicable and possible)

Distance from point - When standing on point center, how many meters away is the microphone being deployed (often the ARU will not be directly on the center if a tree or other object is needed to secure microphone and ARU).

Bearing from point - When standing on point center, the bearing to the microphones.

Mic height - To tenth of a meter, the height of the microphone

Mic bearing - The direction that the microphone is pointed.

Canopy cover w/in 15m radius - The percentage of live cover above the microphone within a 15m radius.

Description of airspace sampled - Qualitative description of the habitat type, openness and anything else that would affect detectability or recording quality in the airspace surrounding the microphone (think of a sphere or half-dome of open air around the microphone). Also note what the microphones are attached to (e.g., “pole attached to a ~12” PIPO, mics 1m below branches”).

Photos - Take photos from the microphone position in all four magnetic cardinal directions and one photo of the setup capturing the area around the microphones. Write on the corner of a piece of paper the point number and direction of the photo. Hold this photo label up in the corner of the photo at arm’s length away from the camera when taking each photo. Check the box once photos have been taken. When you return from the field, upload the photos to a work computer and rename them as in the following format: point name_direction.photo file type. For example: RMS18_6_E.jpeg

Management Actions – Describe any observed management within 50 and 100 meters of the microphone. We are especially interested in anything that affects habitat structure such as recent logging, mastication, plantings, spraying etc… Also note the percent treated within the 50 and 100 radii circles.

Extraction data

Date; Initials; Memory card status; Battery status – Same as above

Signs of disturbance – if there is any apparent alteration of the deployment setup due to weather, wildlife or humans that may affect recording describe and photograph.

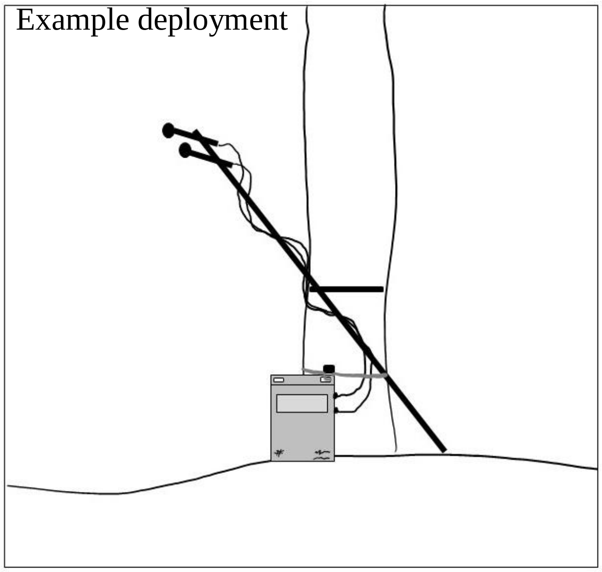
Recordings uploaded to hard drive – **IMPORTANT to upload all data before clearing cards and redeploying monitors.** Check box when completed.

Entered – Indicate that data has been entered and the date when this was completed.

Deployment Gear Checklist

- Detectors
- Memory cards (with recording programs)
- Field computer
- D Batteries (or 12-volt with accessories)
- Microphones and cables
- Attachment chain, combination lock, straps & velcro strips
- Mist-net poles
- Rebar
- Datasheets and this protocol
- Camera
- GPS & batteries
- Compass
- Schedule and full list of sampling locations

Example deployment



Appendix D. Evaluating the effects of the Rocks and Ridge projects on Black-backed Woodpeckers in the Chips Fire Area

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The Rocks and Ridge projects in the Storrie/Chips fire area both had the potential to alter existing Black-backed Woodpecker (BBWO) habitat. To inform treatment unit locations, we used several sources of information to inform management for Black-backed Woodpecker in the Chips fire area on the Lassen National Forest. We employed a model that predicts density of the species based on remotely sensed data (Tingley et al. 2016) and data from Point Blue's point count and nest monitoring efforts in the Chips fire from 2013 – 2016. The LNF worked with Point Blue to implement the model and validate the model outputs in areas where they had collected field data on BBWO nests and presence. This model weighed the relative value of stands in the Rocks project area to BBWO density. This information was used to reduce potential effects to BBWO by choosing stands for reforestation treatments that were predicted to have lower BBWO density relative to other stands in the project area. In addition, nesting data from Point Blue was used during the Rocks project planning to avoid areas with known BBWO nests. An earlier version of this summary was used to inform the planning phases of both the Rocks and Ridge projects in regards to potential effects to BBWO.

In order to understand the cumulative impacts of forest management on BBWO in the Chips fire we considered the predicted impacts of all known treatments since the fire burned in 2012. We calculated the percentage of the entire population affected by various burned forest treatments occurring on the Lassen National Forest, Plumas National Forest, and private lands. We used final project prescriptions and treatment unit boundaries from projects on the Lassen National Forest. We gathered treatment data from the Forest Activities Tracking database for the Plumas National Forest and used treatment description to decipher whether or not the treatment affected snag densities. For private land we assumed all suitable BBWO habitat was removed in post-fire salvage (the magnitude of snag removal was verified by 2014 aerial photographs).

The density of BBWO pairs relative to the entire fire is an important consideration because it takes into account the proportion of woodpeckers in past and future treatment areas relative to the average BBWO density within the Chips fire footprint. The model predicts the density of BBWO in pockets of the Rocks project area to be some of the highest densities in the Chips fire. For example, the predicted density of BBWO is 2.6 times higher in the snag treatment areas in Rocks than the average density for the entire fire (Table 1). The effects on the BBWO Chips fire population are presented below in Table 1 in the "% of

Chips BBWO Population" column. Considering all past treatments combined, the potential Chips BBWO population has been reduced by approximately 30.5% prior to the Ridge or Rocks projects being considered. The Rocks project snag treatments would reduce it by an additional 1.4%. The Ridge project would have negligible effects on the amount of BBWO habitat in the fire area. Overall, the cumulative reduction would be around 31.96% according to the density model predictions (Table 1).

Though the model predicts relatively high densities of BBWO in the Rocks and Ridge project areas, the model may be under predicting densities in the Rocks and Ridge project areas. Extensive sampling in the Chips fire by Point Blue suggests both the Rocks and Ridge project areas have the highest BBWO densities in the fire area and among the highest reported for the species in the Sierra Nevada (Campos and Burnett 2016 & Point Blue unpublished data). In one area of the Rocks project Point Blue documented 3 nesting BBWO within a 20 ha (49 acre) area, among the highest nesting densities reported for this species. Based on evaluation of the model outputs, conversations with Morgan Tingley, and Point Blue data, the model may be under-valuing pre-fire canopy cover and forest type in predicting densities within the Chips fire area. Since BBWO appear to have higher densities in burned fir forests and 90% of the fire is classified as Sierra Mixed Conifer, the higher elevation fir habitat in the Ridge and Rocks areas are fairly unique within the Chips footprint. Though the model may be under predicting densities in the Rocks and Ridge project area, besides removing unsuitable habitat (pre-fire chaparral, mixed conifer pine, hardwoods), we made no changes to the model predictions and the information presented herein is based on the model outputs.

We considered the effects of Rocks treatments on BBWO at two scales: the burned portion of the Rocks Project area and the entire Chips fire area. The model predicts that past treatments affected 16.48% of the breeding pairs occurring in the burned portion of the Rocks project area. The proposed action would reduce Rocks BBWO density by an additional 1.5% (17.98% total past and proposed) of the Rocks BBWO pairs affected. In comparison, the original Rocks project concept would have resulted in a total reduction of 26.33% of the Rocks BBWO pairs; once all treatments past and proposed were considered.

We considered the combined predicted effects of the Rocks and Ridge projects on the Chips fire area BBWO population (Table 2). The original project concepts for these two projects combined were predicted to reduce the BBWO pairs in the Chips fire area by an additional 4.6% for a total of 35.10% from all past and proposed projects combined. The proposed actions for Ridge and Rocks are predicted to reduce pairs by 1.43%, resulting in a total Chips fire area reduction of 31.9% from all projects past and proposed. But, since we suspect the model is under-predicting BBWO density in these higher elevation fir habitats, a higher percentage of the Chips fire population may have been or will be affected by past and future actions in the Rocks & Ridge project areas.

A group of scientists working on BBWO in the Sierra Nevada recommended not affecting more than 25% of the BBWO territories in a given fire to maintain population viability of this rare species (recommendation as presented to the Rim Fire workshop teams by The Institute for Bird Populations, Point Blue, Morgan Tingley, etc.). However, Region 5 has not officially adopted or mandated this threshold for BBWO populations. At present, the model predicts the Chips fire BBWO population has been reduced by 30.5% with the combination of post fire snag treatments on private lands and within the Lassen and Plumas National Forests. This assumes that all previous treatments rendered the habitat unsuitable for the species within those units. If some of those areas still support the species, the percent reduced would be lower by some unknown amount. We know that BBWO are strongly associated with very high snag densities (Seavy et al. 2013, Tingley et al. 2014, Tingley et al. 2016) in the Sierra Nevada. We also know that salvage logging treatments, even those that retain as much as 50% of the snags, can significantly reduce densities of BBWO (Saab et al. 2007). Thus, without ground collected data on densities in these salvage logged areas, we believe our assumption of the previous logged areas supporting a negligible proportion of the Chips fire population is warranted.

The Rocks project area appears unique in respect to the burned mosaic and forest type. The Chips fire appears to have burned within the natural range of variability for white and red fir forest types (<30% high severity in the Rocks project area), based on review of remotely sensed GIS layers (downloaded from USDA Forest Service Region 5 GIS Clearinghouse). Mallek et al. (2013) estimated an 88% reduction in the area of red fir forest that burned at high severity between 1984 and 2009 compared to pre-European estimates, suggesting a deficit of this habitat on the landscape. The Rocks and Ridge project areas burned in a patchy mosaic. These areas of mixed low, moderate, and high severity now support a diverse avian community (Campos and Burnett 2016). The mosaic of high and low severity habitat also seems to be important for BBWO. As time since fire increases, BBWO increasingly use the forest surrounding burned patches as beetle resources in the fire killed trees decline (Dudley and Saab 2007).

Table 1. Effects to the Chips BBWO population of past actions that occurred after the Chips fire. All values derived from the BBWO density model predictions (Tingley et al. 2016).

	Predicted BBWO Density			Area	
	Density of BBWO **RELATIVE** to Chips fire	% of Chips BBWO Population	% of Rocks BBWO Population	% of Chips Fire	Acres
Area					
Chips Fire	1.00	100%		100.00%	76,333
Rocks Project	1.35	7.61%	100%	5.65%	4,310
Past Treatments					
Lassen	0.94	1.25%	16.48%	1.33%	1,015
Plumas	2.16	11.90%		5.50%	4,196
Private land	1.28	17.34%		13.60%	10,378
Total Past		**30.49%**		20.43%	15,589

Table 2. Effects to the Chips BBWO population of future actions that occurred after the Chips fire. Initial values are those from the original potential treatment areas and final values are those in the proposed action. All values derived from the BBWO density model predictions (Tingley et al. 2016).

	Predicted BBWO Density						**Area**	
	Initial BBWO Density **RELATIVE** to Chips fire	Final BBWO Density **RELATIVE** to Chips fire	Initial % of Chips BBWO Population	Final % of Chips BBWO Population	Initial % of Rocks BBWO Population	Final % of Rocks BBWO Population	% of Chips Fire	Final Acres
Proposed treatments								
Ridge Project treatments	1.93	0.74	2.60%	0.06%			0.08%	64
Rocks Project Burned Forest Snag Treatments	3.92	2.64	2.00%	1.37%	26.33%	17.99%	0.51%	390
Total proposed treatments			**4.61%**	**1.43%**			**0.59%**	**454**
Total all projects (proposed + future)			**35.10%**	**31.92%**			**21.02%**	**16,043**

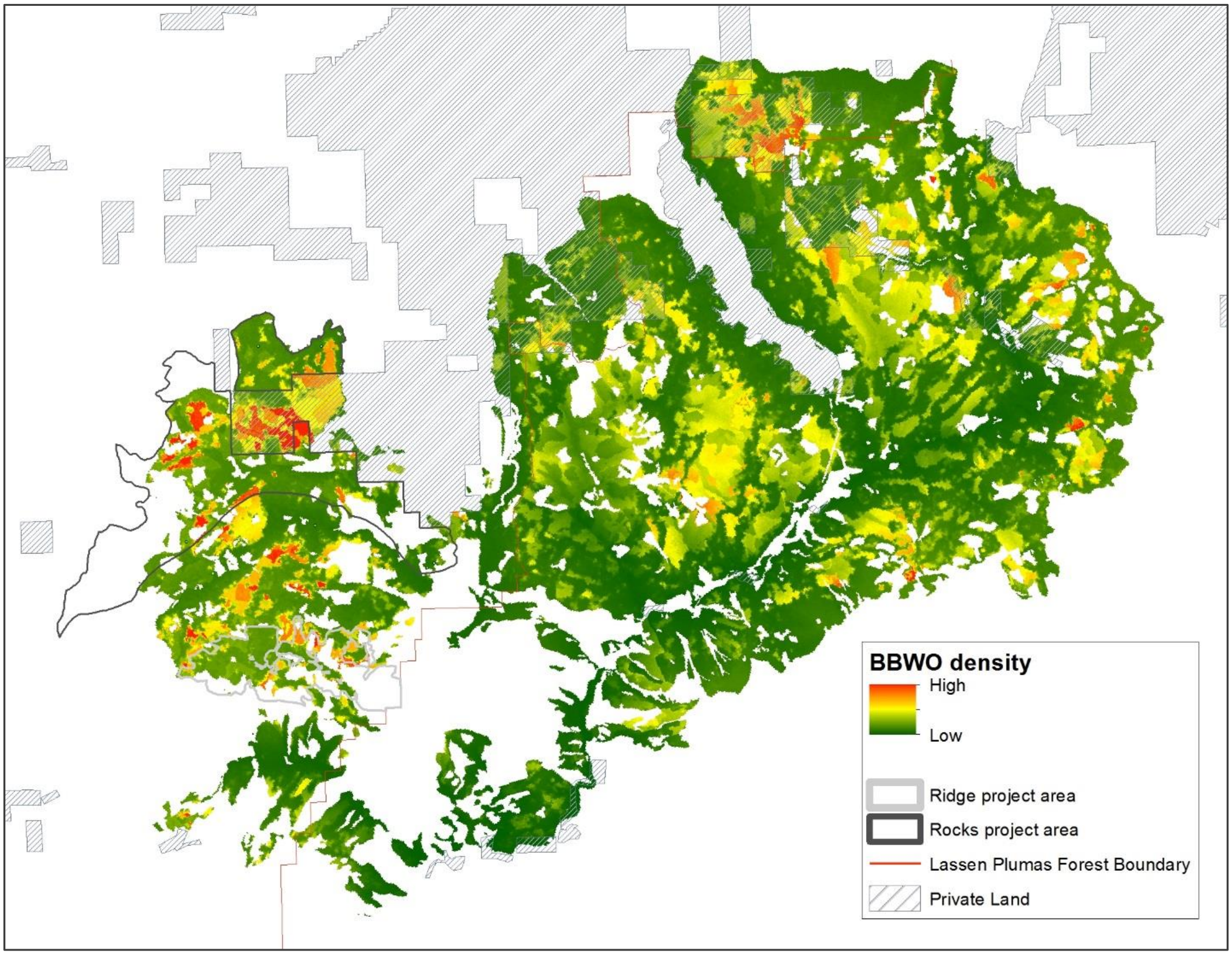

Figure 1. Predicted black backed woodpecker population density in the chips fire prior to Rocks management actions from Tingley Model.

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