



Bird Community Monitoring for Bandelier National Monument

2012 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2014/621



ON THE COVER

Yellow-rumped warbler (*Setophaga coronada*)
Photograph by Nigel

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1 Introduction and background

The National Park Service Inventory and Monitoring Program was designed to determine the current status and monitor long-term trends in the condition of park natural resources, providing park managers with a strong scientific foundation for making decisions and working with other agencies and the public for the protection of park ecosystems. The goal of bird community monitoring is to provide status and trends data on bird communities in several predominant habitats where integrated upland or riparian vegetation monitoring is also occurring.

For Bandelier National Monument (BAND), Southern Colorado Plateau Network (SCPN) and park staff selected the Mixed Conifer ecological site as an important ecosystem for vegetation and bird community monitoring. At the initiation of bird monitoring, in 2008, this ecological site represented large areas of the monument. Then, in June, 2011, the Las Conchas Fire burned over 156,000 acres of the park. All of the major watersheds within the park were heavily impacted, and much of the park's mixed conifer forest was burned. This large-scale disturbance resulted in long-lasting changes in forest structure and composition. Continued monitoring of the mixed conifer bird community required that we modify the original sampling frame. We assessed burn severity for each of the original 100 monitoring plots and identified 48 plots with no evidence of fire or with low canopy burn severity, exhibiting little to no changes in vegetation structure. These plots now comprise the BAND mixed conifer sampling frame for bird community monitoring.

In 2012, through a Colorado Plateau Cooperative Ecosystems Studies Unit agreement with SCPN, we continued monitoring the upland bird community of the target mixed conifer habitat in BAND, which was initially monitored in 2008 and then monitored again in 2009. In this report, we document monitoring activities of the 2012 field season and summarize the data that were collected.

2 Methods

2.1 Sampling frame

A sampling frame is the area within which we locate our monitoring sites, and hence, the area to which statistical inferences can be made based on monitoring data. The sampling frames for vegetation and bird community monitoring were generally derived from maps of ecological sites (see Appendix A of DeCoster et al. 2012). Ecological sites are landscape divisions with characteristic soils, hydrology, plant communities, and disturbance regimes and responses, and are based on soil survey data (Butler et al. 2003). When we developed the sampling frame, a soil survey update had recently been completed for the monument (Hibner 2000), but ecological site data were not updated. So, in 2007, as the integrated upland protocol was being developed (DeCoster et al. 2012), SCPN created initial soil-based sampling frames that consisted of those soil units most strongly correlated with the occurrence of mixed conifer vegetation. Then, the initial soil-based draft sampling frame was overlapped with a draft vegetation map (published as Muldavin et al. 2010), and we identified soils that were well correlated with mixed conifer vegetation. These comprised the Mixed Conifer ecological site, which is henceforth referred to as mixed conifer habitat.

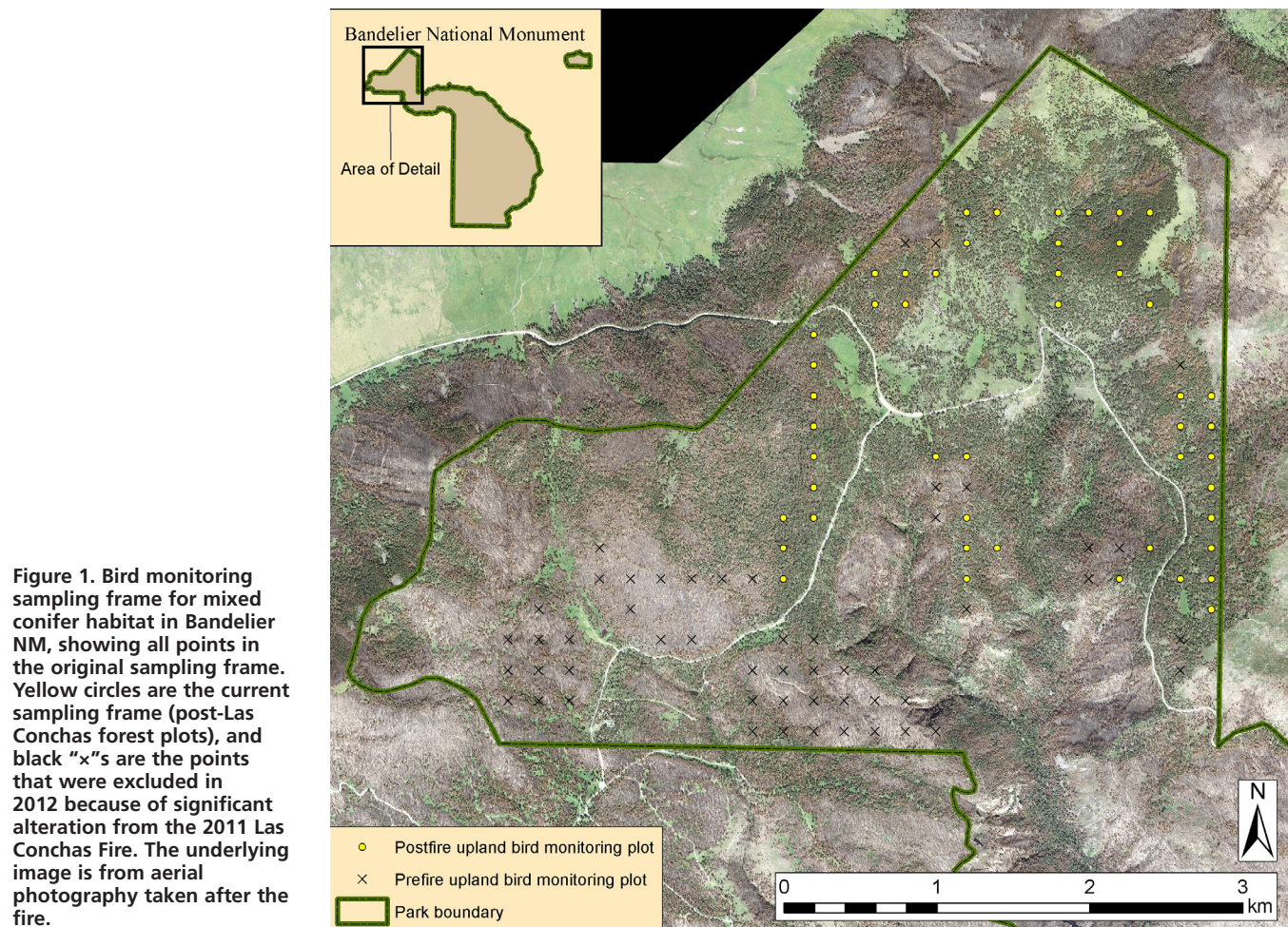
To complete the mixed conifer bird community monitoring sampling frame, we modified the maps of the sampling frame using Geographical Information System (GIS) technology to eliminate

- areas that were not within the habitat (roads, buildings, and infrastructure)
- areas that were expected to differ substantially from the norm for the target habitat, such as areas that have experienced fire of moderate to high burn severity, because these areas would have increased ecological variation, making it more difficult to detect trends
- areas with slopes $\geq 30\%$ to prevent erosion from occurring as a result of the field work

We created a set of spatially distributed sampling plots in a simple grid sampling design. BAND park staff first reviewed the sampling plots and rejected those plots that landed in the proximity of archeological sites. Next, in

the initial year of bird community monitoring (2008), the bird monitoring crew evaluated the accessibility of each plot in the field and rejected those that were inaccessible. Sites were rejected as inaccessible if (1) they required greater than 2 hours travelling time (by car and foot) from the Juniper Campground, and (2) they did not constitute a group of 9 to 10 plots that could be accessed and sampled within a single morning. The crew then assessed each sampling plot to ensure that it (1) fell within the target habitat, (2) had a slope of less than 30%, and (3) did not contain a major disturbance. Any plots that did not meet these criteria were rejected. Because of these limitations, only a relatively small area was available for sampling at BAND, and all logistically feasible plots were sampled (i.e., a “census approach” was taken; see Appendix A of Holmes et al., in review). We selected 100 sampling plots in the mixed conifer habitat (Figure 1) and rejected 145. The mixed conifer habitat at BAND was monitored in 2008 and 2009 using this original sampling frame.

Then, in June, 2011, the Las Conchas Fire occurred. The major watersheds within the park were heavily impacted, and much of the park’s mixed conifer habitat was burned. This large-scale disturbance resulted in long-lasting changes in forest structure and composition. Continued monitoring of the mixed conifer bird community required that we modify the original sampling frame. First, our original bird monitoring plots were overlaid on a soil burn severity map developed in 2011 by the Department of the Interior National Interagency Burned Area Emergency Response Team (DOI BAER 2011) and each plot was classified by soil burn severity. Second, we assessed vegetation burn severity using high resolution aerial photography showing each plot before and after the fire. We classified 44 plots as having high or moderate vegetation burn severity; 56 plots were classified as unchanged or with minimal structural change. Third, we made field visits to the 56 plots classified as unchanged or having low burn severity to further assess vegetation burn severity and accessibility. From this assessment we identified 48 bird monitoring plots where the majority of the plot was assessed as having low to low-moderate burn severity. We hereafter refer to these as “post-Las Conchas forest” plots and they now comprise the revised BAND mixed conifer sampling frame for bird community monitoring (Figure 1).



2.2 Field methods

In order to approach our target sample size of 150 to 200 Variable Circular Plot (VCP) counts each sampling year (Holmes 2007), we conducted bird sampling at the 48 permanent sampling plots (Figure 1) over the course of 3 survey periods, for a total of 144 counts in 2012 (Table 1). We provide a brief description of the field methods here. A more detailed description can be found in Holmes et al. (in review).

Table 1. Survey periods, dates, and sampling effort (number of plots sampled) for bird community monitoring in mixed conifer habitat at Bandelier NM in 2012.

Survey period	Dates (2012)	Number of VCP counts
1	19 May–22 May	48
2	13 June–15 June	48
3	16 June–18 June	48
Total		144

At each sampling plot, we conducted a VCP count, noting all birds seen or heard during an 8-minute sampling period, regardless of the distance from the observer. We recorded (1) the species, (2) method of detection, (3) gender (if known), and (4) distance from the sampling plot center to the individual bird. Distances were estimated to the nearest meter using a laser range finder. During a single morning, one technician conducted approximately 10 VCP counts.

We characterized burn severity from the Las Conchas Fire at each 50 m radius macroplot centered on a VCP sampling plot. Using a modified Braun-Blanquet cover class scale, we made ocular estimates of the percentage of the macroplot's canopy and understory in each of 4 burn severity classes (low, low-medium, medium-high, and high). We also recorded burn heterogeneity (low, medium, or high) across the macroplot.

We conducted habitat sampling on macroplots and in 4 subplots within the macroplot. First, for the macroplot, we estimated and recorded the area occupied by vegetation and other land-use types, if present. For the 4 subplots, we recorded tree and snag density and basal area, canopy closure, and foliar vegetation cover by functional group (e.g., forbs, shrubs). We measured basal area using a Cruz-All (a type of angle gauge), and canopy closure using a spherical densiometer. Ocular estimates of foliar cover were made using a modified Braun-Blanquet cover class scale.

2.3 Data summary

2.3.1 Variable Circular Plot count data

We summarized the following data for the target mixed conifer habitat at BAND. The sample unit for bird data is the VCP.

- Observed species richness (unadjusted for detectability) is the number of species detected within a given area and specified time.
- Mean number of individuals detected for each species is reported as the average number of individuals detected per 8-minute VCP count. To calculate mean number of individuals detected for each species in mixed conifer habitat with a simple grid sampling design, the data for all plots are averaged across the 3 survey periods, and a mean number of individuals detected and standard deviation are calculated for the target habitat. Detectability-based density estimates are not reported here, but they will be derived for multi-year trend reports.
- Frequency is the proportion of plots in which each species was detected. To calculate species frequency, we calculated the proportion of plots in the target habitat in which the species was detected. For example, if a Cordilleran flycatcher was detected on 26 of the 48 plots in the target habitat, during one, two, or all visits to that plot, the proportion of plots occupied in the target habitat would be 0.54 (54%).

2.3.2 Habitat data

For BAND, habitat data were collected within a circular 0.8 ha macroplot which contained 4 subplots and was centered on each bird sampling plot. Data were summarized at 2 levels: the macroplot and the target habitat. The means and standard deviations for the target habitat were calculated from the macroplot data.

Following the Las Conchas Fire, only unburned and low burn severity plots, which we call post-Las Conchas forest plots, were retained within the mixed conifer sampling frame. To characterize the postfire status of these plots, 3 additional, field-based burn metrics were employed.

Canopy burn severity. We classified burn severity of the canopy into 4 severity classes as shown in Table 2. For each burn severity class we calculated

- mean percent cover and standard deviation, by calculating the mean cover in each burn severity class across macroplots (using the cover class midpoints)
- frequency, by reporting the number of macroplots where a specific burn severity type had been recorded, as a proportion of the total number of macroplots

Understory burn severity. We classified burn severity of the understory into 4 severity classes as shown in Table 2. For each burn severity class we calculated

- mean percent cover and standard deviation, by calculating the mean cover in each burn severity class across macroplots (using the cover class midpoints)
- frequency by reporting the number of macroplots where a specific burn severity type had been recorded, as a proportion of the total number of macroplots

Table 2. Canopy and understory burn severity classes in post-Las Conchas forest plots in mixed conifer habitat at Bandelier NM.

Burn severity class	Canopy burn severity	Understory burn severity
Low	0 to <25% scorched canopy	Most foliage and twigs remain intact, small organic material on ground is scorched but not entirely consumed; mineral soil rarely exposed.
Low-Medium	25–75% scorched canopy and needle consumption	Majority of shrub/herbaceous layer, woody debris is scorched to partially burned; most fine organic materials are partially burned; mineral soil intermittently exposed.
Medium-High	75–99% scorched canopy and needle consumption	Most woody debris <7.5 cm diameter is entirely consumed; most organic matter is entirely consumed. Mineral soil is exposed, but remains intact. Possible vigorous vegetative regrowth.
High	100% complete consumption of needles	All woody debris is entirely consumed, with the exception of an occasional large log; all litter and duff are consumed, exposing bare mineral soil. Substantial soil erosion may be evident.

Burn heterogeneity. We classified burn heterogeneity of the macroplot, a measure of burn “patchiness” of burn severity, into 3 types as shown in Table 3. For each burn heterogeneity type we calculated the frequency by reporting the number of macroplots where a specific burn heterogeneity type had been recorded, as a proportion of the total number of macroplots.

Table 3. Burn heterogeneity types in post-Las Conchas forest plots in mixed conifer habitat at Bandelier NM.

Burn heterogeneity type	Description
Low	Uniformly affected by burn.
Medium	2 or 3 discrete areas of differing severities.
High	Patchy distribution of differing severities.

Vegetation cover types. We classified vegetation into 5 cover types for the BAND mixed conifer habitat as shown in Table 4. For each vegetation type we calculated

- mean percent cover and standard deviation, by calculating the mean cover for each vegetation type across macroplots (using the cover class midpoints)
- frequency by reporting the number of macroplots where a specific cover type had been recorded, as a proportion of the total number of macroplots

Table 4. Vegetation cover types in post-Las Conchas forest plots in mixed conifer habitat at Bandelier NM.

Vegetation cover type	Description
Mixed conifer forest	Dominated by various combinations of ponderosa pine (<i>Pinus ponderosa</i>), Douglas fir (<i>Pseudotsuga menziesii</i>), white fir (<i>Abies concolor</i>), spruce (<i>Picea</i> sp.), and sometimes other species. Typically consists of a topographically determined heterogeneous mosaic of patches, some of which are dominated by quaking aspen (<i>Populus tremuloides</i>).
Aspen grove ^a	Dominated by aspen. Typically, aspen stands occur in areas that have been impacted relatively recently by disturbance that removed the tree canopy.
Ponderosa pine forest	Dominated by ponderosa pine, occupies the lowest elevation of the montane zone. Often contains elements of the Pinyon-Juniper Woodland type.
Gambel oak shrubland	Dominated by Gambel oak (<i>Quercus gambelii</i>) and other species, such as mountain mahogany (<i>Cercocarpus montanus</i> , <i>C. ledifolius</i>) or serviceberry (<i>Amelanchier utahensis</i>). Occasionally occurs between the Pinyon-Juniper Woodland and Ponderosa Pine Forest types.
Montane grassland	Consists of meadows; scattered in valley bottoms and on dry, steep, south-facing slopes in the montane zone.

^aAlthough stands of quaking aspen are considered to be part of the mixed conifer vegetation type, we estimated the percent cover of aspen grove separately from mixed conifer.

Sapling density. For sapling trees, we calculated density (stems/ha) for each species and DBH (diameter at breast height) size class, and for all species within a size class. Mean density was calculated for the macroplot, and then a mean species density and standard deviation were calculated for the target habitat.

Basal area. We calculated tree basal area (m²/ha) for each species individually, and for all species combined. We calculated snag basal area for all snags. Mean basal area was calculated for the macroplot, and then mean basal area and standard deviation were calculated for the target habitat.

Foliar cover of functional groups. We calculated the mean percent foliar cover of each functional group for the macroplot, using the cover class midpoints, and then the mean and standard deviation across all macroplots for the target habitat.

3 Results

3.1 Summary of bird community data

In 2012, we conducted a total of 144 VCP counts in post-Las Conchas forest plots in mixed conifer habitat at BAND and detected 1,924 individuals of 46 species (Table 5). The most commonly detected species were the yellow-rumped warbler and the warbling vireo. Together these species comprised nearly a quarter (24.32%) of the total number of individuals detected.

The mean number of individuals detected per species during a VCP count, and the frequency of detections for each species detected in BAND mixed conifer habitat are presented in Table 6. The yellow-rumped warbler had the highest mean number of individuals, with an average of 1.81 individuals detected during an 8-minute count. Most of the abundant species, such as yellow-rumped warbler, warbling vireo, western tanager, Williamson's sapsucker, and hermit thrush, were also widespread. Most species with low abundance, such as downy woodpecker, Townsend's solitaire, and plumbeous vireo, were not widespread. Few species, like the hairy woodpecker, had a relatively low abundance, but were fairly widely distributed (Table 6).

Table 5. Bird species and number detected during VCP counts in post-Las Conchas forest plots in mixed conifer habitat at Bandelier NM in 2012. Species are listed in descending order of the total number of individuals detected.

Common name	Scientific name	Total number of detections	Proportion of all detections (%)
yellow-rumped warbler	<i>Setophaga coronada</i>	260	13.51
warbling vireo	<i>Vireo gilvus</i>	208	10.81
western tanager	<i>Piranga ludoviciana</i>	176	9.15
Williamson's sapsucker	<i>Sphyrapicus thyroideus</i>	153	7.95
hermit thrush	<i>Catharus guttatus</i>	150	7.80
Hammond's flycatcher	<i>Empidonax hammondi</i>	96	4.99
pine siskin	<i>Carduelis pinus</i>	89	4.63
dark-eyed junco	<i>Junco hyemalis</i>	86	4.47
chipping sparrow	<i>Spizella passerine</i>	82	4.26
mountain chickadee	<i>Poecile gambeli</i>	78	4.05
ruby-crowned kinglet	<i>Regulus calendula</i>	68	3.53
house wren	<i>Troglodytes aedon</i>	42	2.18
Cordilleran flycatcher	<i>Empidonax occidentalis</i>	41	2.13
red-breasted nuthatch	<i>Sitta canadensis</i>	39	2.03
western wood-pewee	<i>Contopus sordidulus</i>	39	2.03
northern flicker	<i>Colaptes auratus</i>	35	1.82
violet-green swallow	<i>Tachycineta thalassina</i>	31	1.61
hairy woodpecker	<i>Picoides villosus</i>	29	1.51
brown creeper	<i>Certhia americana</i>	24	1.25
Steller's jay	<i>Cyanocitta stelleri</i>	24	1.25
common raven	<i>Corvus corax</i>	21	1.09
American robin	<i>Turdus migratorius</i>	20	1.04
orange-crowned warbler	<i>Vermivora celata</i>	20	1.04
evening grosbeak	<i>Coccothraustes vespertinus</i>	19	0.99
black-headed grosbeak	<i>Pheucticus melanocephalus</i>	17	0.88
broad-tailed hummingbird	<i>Selasphorus platycercus</i>	14	0.73
downy woodpecker	<i>Picoides pubescens</i>	8	0.42
Townsend's solitaire	<i>Myadestes townsendi</i>	8	0.42

Table 5 (continued)

Common name	Scientific name	Total number of detections	Proportion of all detections (%)
plumbeous vireo	<i>Vireo plumbeus</i>	7	0.36
Grace's warbler	<i>Dendroica graciae</i>	6	0.31
western bluebird	<i>Sialia mexicana</i>	5	0.26
pygmy nuthatch	<i>Sitta pygmaea</i>	4	0.21
white-breasted nuthatch	<i>Sitta carolinensis</i>	4	0.21
band-tailed pigeon	<i>Columba fasciata</i>	3	0.16
green-tailed towhee	<i>Pipilo chlorurus</i>	3	0.16
black-throated gray warbler	<i>Dendroica nigrescens</i>	2	0.10
Clark's nutcracker	<i>Nucifraga columbiana</i>	2	0.10
olive-sided flycatcher	<i>Contopus cooperi</i>	2	0.10
red crossbill	<i>Loxia curvirostra</i>	2	0.10
American crow	<i>Corvus brachyrhynchos</i>	1	0.05
dusky grouse	<i>Dendragapus obscurus</i>	1	0.05
MacGillivray's warbler	<i>Oporornis tolmiei</i>	1	0.05
red-naped sapsucker	<i>Sphyrapicus nuchalis</i>	1	0.05
American three-toed woodpecker	<i>Picoides dorsalis</i>	1	0.05
wild turkey	<i>Meleagris gallopavo</i>	1	0.05
Wilson's warbler	<i>Wilsonia pusilla</i>	1	0.05

Table 6. Mean number of individuals detected per VCP count, standard deviation (SD), and the proportion of plots in which each species was detected (plot frequency) in post-Las Conchas forest plots in mixed conifer habitat at Bandelier NM, 2012.

Species	Number of individuals		Plot frequency (%)
	Mean	SD	
yellow-rumped warbler	1.81	1.01	100.00
warbling vireo	1.44	0.98	95.83
western tanager	1.22	0.86	97.92
Williamson's sapsucker	1.06	0.89	97.92
hermit thrush	1.04	0.80	97.92
Hammond's flycatcher	0.67	0.77	77.08
pine siskin	0.62	0.98	64.58
dark-eyed junco	0.60	0.67	79.17
chipping sparrow	0.57	0.77	75.00
mountain chickadee	0.54	0.71	77.08
ruby-crowned kinglet	0.47	0.71	60.42
house wren	0.29	0.65	41.67
Cordilleran flycatcher	0.28	0.55	54.17
red-breasted nuthatch	0.27	0.48	47.92
western wood-pewee	0.27	0.64	29.17
northern flicker	0.24	0.57	47.92
violet-green swallow	0.22	0.52	39.58
hairy woodpecker	0.20	0.45	50.00
brown creeper	0.17	0.39	35.42

Table 6 (continued)

Species	Number of individuals		Plot frequency (%)
	Mean	SD	
Steller's jay	0.17	0.43	39.58
common raven	0.15	0.37	35.42
American robin	0.14	0.44	27.08
orange-crowned warbler	0.14	0.42	29.17
evening grosbeak	0.13	0.51	16.67
black-headed grosbeak	0.12	0.32	27.08
broad-tailed hummingbird	0.10	0.30	27.08
downy woodpecker	0.06	0.26	12.50
Townsend's solitaire	0.06	0.31	12.50
plumbeous vireo	0.05	0.25	8.33
Grace's warbler	0.04	0.20	12.50
western bluebird	0.03	0.22	6.25
pygmy nuthatch	0.03	0.20	6.25
white-breasted nuthatch	0.03	0.20	6.25
band-tailed pigeon	0.02	0.19	4.17
green-tailed towhee	0.02	0.14	2.08
black-throated gray warbler	0.01	0.17	2.08
Clark's nutcracker	0.01	0.12	4.17
olive-sided flycatcher	0.01	0.12	4.17
red crossbill	0.01	0.12	4.17
American crow	0.01	0.08	2.08
dusky grouse	0.01	0.08	2.08
MacGillivray's warbler	0.01	0.08	2.08
red-naped sapsucker	0.01	0.08	2.08
American three-toed woodpecker	0.01	0.08	2.08
wild turkey	0.01	0.08	2.08
Wilson's warbler	0.01	0.08	2.08

We examined patterns in bird species abundance using the mixed conifer bird monitoring data from before (2008 and 2009) and after (2012) the Las Conchas Fire. For this initial analysis we analyzed mean number of birds detected per VCP, unadjusted for detectability, for the 20 most commonly detected species that breed in BAND mixed conifer habitat. We found that 9 species (45%) increased in relative abundance (Figure 2), and 9 species (45%) decreased in relative abundance (Figure 3) after the fire. The relative abundance for 2 species, red-breasted nuthatch and Steller's Jay, did not change.

3.2 Summary of bird habitat data

3.2.1 Burn severity and heterogeneity

The Las Conchas Fire created a landscape mosaic of patches of varying burn severity (see Figure 1). We conducted sampling only in plots still containing mixed conifer habitat (i.e., plots with little to no change in vegetation structure due to fire). Within these plots, we found that canopy burn severity varied considerably. On average, the macroplots contained 68.67% Low canopy burn severity (zero to less than 25% scorched canopy), 18.45% Low-Medium canopy burn severity (25–75% scorched canopy and needle consumption), and 9.59%

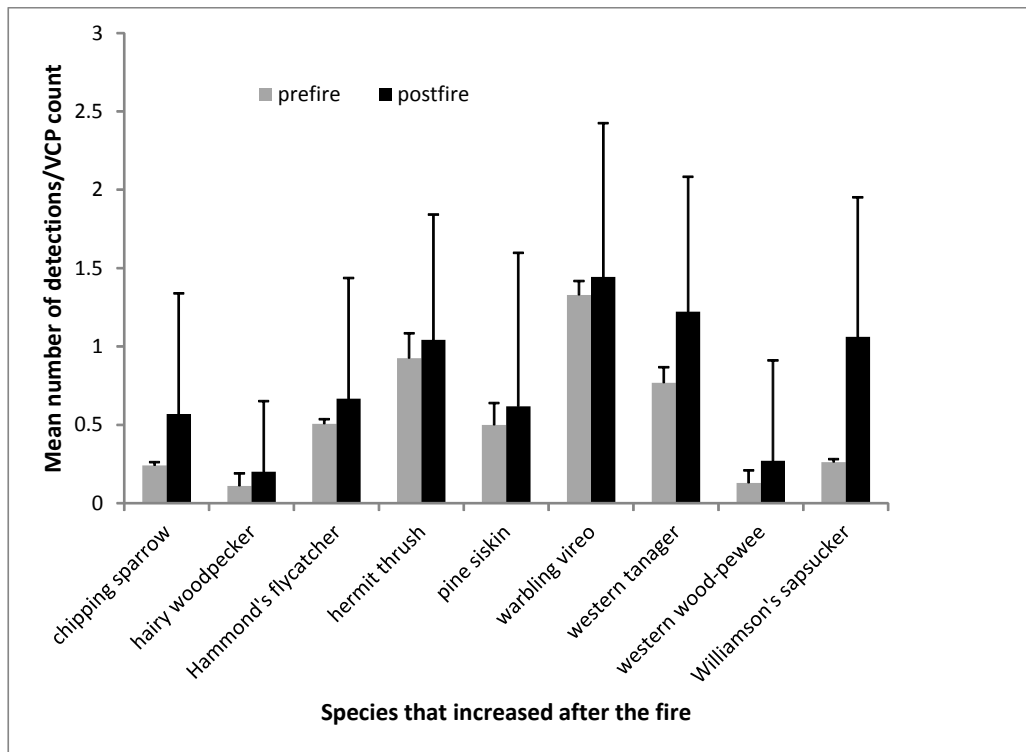


Figure 2. Bird species that increased in mean number of detections per VCP count in post-Las Conchas forest plots (48 plots) in mixed conifer habitat in Bandelier NM in 2012. Prefire data were collected from the original 100 plots in the pre-Las Conchas Fire mixed conifer sampling frame in 2008 and 2009. Error bars represent one standard deviation.

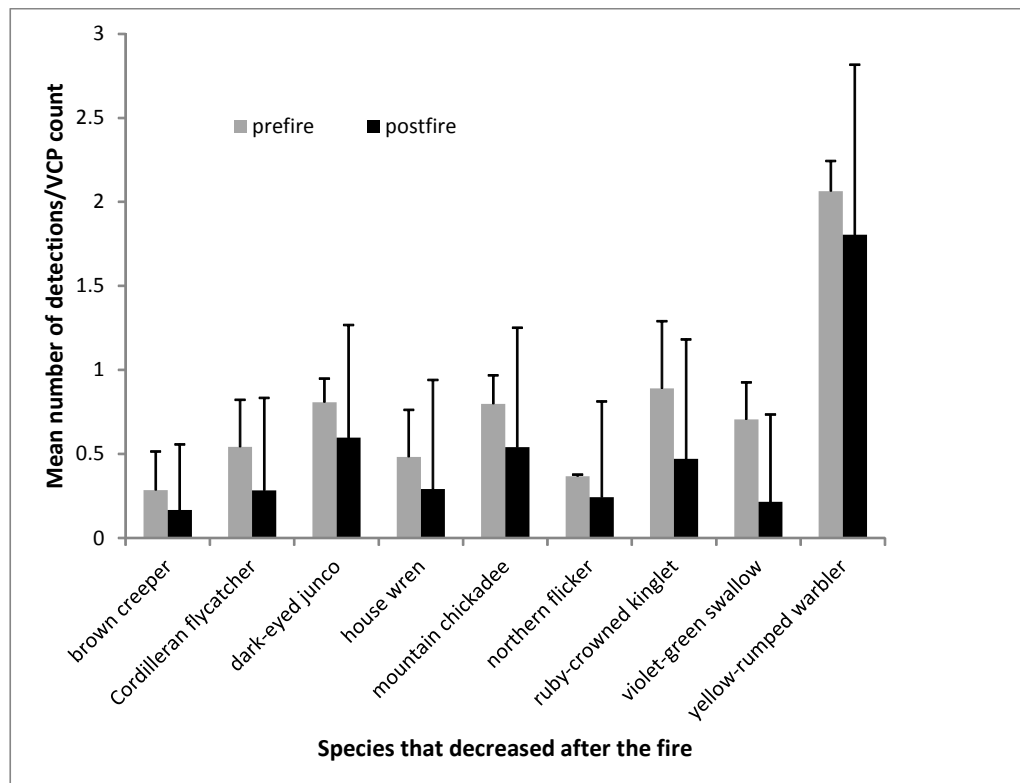


Figure 3. Bird species that decreased in mean number of detections per VCP count in post-Las Conchas forest plots (48 plots) in mixed conifer habitat in Bandelier NM in 2012. Prefire data were collected from the original 100 plots in the pre-Las Conchas Fire mixed conifer sampling frame in 2008 and 2009. Error bars represent one standard deviation.

Medium-High or High canopy burn severity (Table 7). Understory burn severity also varied considerably. Low and Low-Medium understory burn severity comprised the majority (12.34% and 64.64%, respectively), on average, of the macroplot understory cover (Table 8). Low-Medium was the most widely distributed understory burn severity type, recorded on 97.92% of the macroplots. The macroplots contained, on average, 19.64% understory cover characterized as Medium-High or High understory burn severity (all or most of woody debris consumed). The majority of macroplots (85.42%) had either Low burn heterogeneity (31.25%) or Medium burn heterogeneity (54.17%; Table 9).

Table 7. Mean proportion of macroplot cover within each canopy burn severity class, standard deviation (SD), and range; and plot frequency of each canopy burn severity class within macroplots in post-Las Conchas forest plots in mixed conifer habitat at Bandelier NM, 2012.

Canopy burn severity class	Cover (%)			Frequency (%)
	Mean	SD	Range	
Low	68.67	27.82	3.00–87.50	100.00
Low-Medium	18.45	20.96	0.00–62.50	72.92
Medium-High	8.94	12.77	0.00–37.50	47.92
High	0.65	2.77	0.00–17.50	8.33

Table 8. Mean proportion of macroplot cover within each understory burn severity class, standard deviation (SD), and range; and plot frequency of each understory burn severity class within macroplots in post-Las Conchas forest plots in mixed conifer habitat at Bandelier NM, 2012.

Understory burn severity class	Cover (%)			Frequency (%)
	Mean	SD	Range	
Low	12.34	25.41	0.00–87.50	47.92
Low-Medium	64.64	28.66	0.00–87.50	97.92
Medium-High	17.43	22.96	0.00–87.50	62.50
High	2.21	7.93	0.00–37.50	12.50

Table 9. Frequency (%) of macroplots containing each burn heterogeneity type in post-Las Conchas forest plots in mixed conifer habitat at Bandelier NM, 2012.

Burn heterogeneity type	Description	Frequency (%)
Low	Uniformly affected by burn	31.25
Medium	2 or 3 discrete areas of differing severities	54.17
High	Patchy distribution of differing severities	14.58

3.2.2 Vegetation cover types

We found 5 vegetation cover types (mixed conifer forest, ponderosa pine forest, montane grassland, aspen grove, and Gambel oak shrubland) in the macroplots of the BAND mixed conifer sample area (Table 10). The mixed conifer forest cover type was recorded on 85.42% of the macroplots. When we calculated the mean percent cover for each vegetation type, mixed conifer forest was the most common cover type, accounting for, on average, 68.19% of the overall vegetative cover of the macroplots (Table 10).

3.2.3 Tree species composition and structure

Table 11 shows tree abundance by species in terms of basal area for overstory trees, and in terms of density for saplings in 2 size classes. The abundance of snags is expressed in terms of basal area, recorded for all species combined. Figure 4 illustrates basal area of trees by species and basal area of snags. Six tree species were recorded on the sampling plots, with ponderosa pine having the highest postfire basal area (see Table 11 for scientific and common names of tree species). Figure 5 illustrates the density of sapling trees (less than 10 cm DBH) by species

and size class. White fir was the most commonly recorded sapling in both size classes. The average canopy closure in the mixed conifer habitat was 61.72% (SD = 13.27).

Table 10. Mean cover, standard deviation (SD), and range of cover for vegetation cover types, as well as plot frequency in post-Las Conchas forest plots in mixed conifer habitat at Bandelier NM in 2012.

Vegetation cover type	Cover (%)			Frequency (%)
	Mean	SD	Range	
Mixed conifer forest	68.19	34.36	0.00–87.50	85.42
Ponderosa pine forest	17.77	33.98	0.00–87.50	27.08
Montane grassland	5.77	9.03	0.00–37.50	52.08
Aspen grove	2.08	3.72	0.00–17.50	31.25
Gambel oak shrubland	0.16	1.08	0.00–7.50	2.08

Table 11. Basal area of overstory trees, by species, and of all snags, and density of saplings by species in post-Las Conchas forest plots in mixed conifer habitat in Bandelier NM, 2012. Basal area is provided for overstory trees (DBH greater or equal to 10 cm), and density is provided for saplings (<10 cm DBH). Scientific and common names are provided for each tree species.

Species	Common name	Basal area (m ² /ha)	Sapling density (stems/ha) by size class	
			2.5 to <5 cm DBH	5 to <10 cm DBH
<i>Pinus ponderosa</i>	Ponderosa pine	13.34	—	—
<i>Pseudotsuga menziesii</i>	Douglas fir	8.55	—	3.32
<i>Abies concolor</i>	White fir	5.88	3.32	3.98
<i>Populus tremuloides</i>	Aspen	4.64	2.65	—
<i>Pinus flexilis</i>	Limber pine	0.97	0.66	—
<i>Picea engelmannii</i>	Engelmann spruce	0.45	—	0.66
All tree species		33.84	6.63	8.62
Snags		9.05		

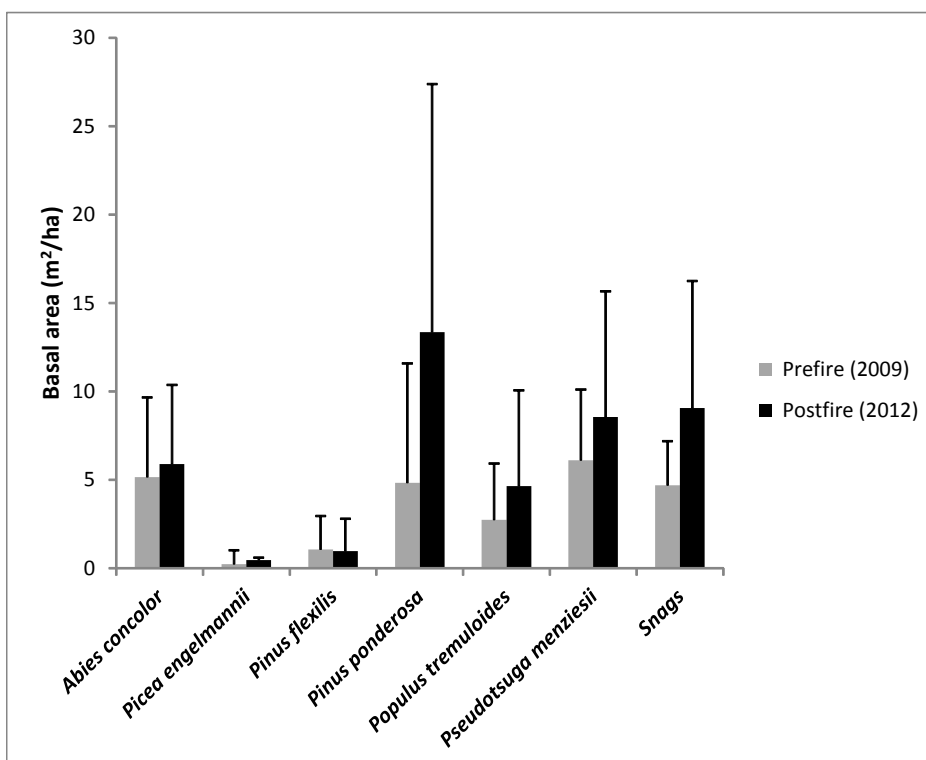
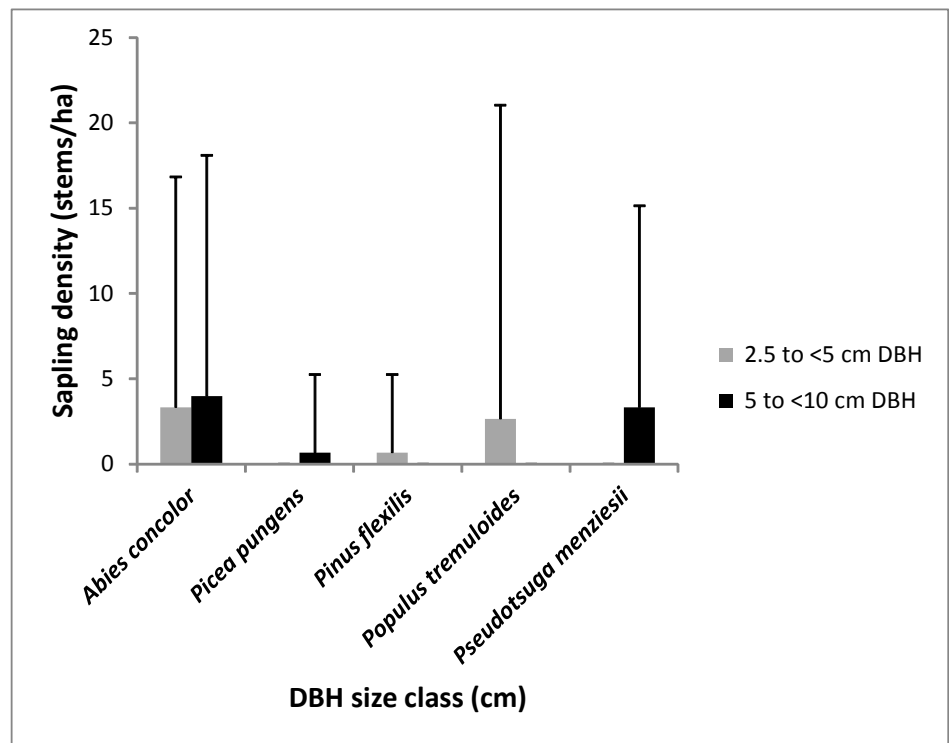


Figure 4. Basal area of trees, by species, and of snags in pre- and post-Las Conchas forest plots (48 plots) in mixed conifer habitat in Bandelier NM, 2012. Prefire data were collected from the original 100 plots in the pre-Las Conchas Fire mixed conifer sampling frame in 2009. Error bars represent one standard deviation.

Figure 5. Size structure of sapling trees. Mean density (number of stems/ha) of sapling trees in 2 size classes (2.5 to <5, and 5 to <10 cm DBH) in post-Las Conchas forest plots in mixed conifer habitat in Bandelier NM, 2012. Error bars represent one standard deviation.



3.2.4 Understory cover by functional group

The understory of the mixed conifer habitat at BAND was mainly comprised of perennial grasses and forbs, with few shrubs and tree seedlings (Table 12). There was considerable variation in the amount of shrub and herbaceous cover—mean foliar cover for this functional group ranged from 0.50% to 51.25%.

Table 12. Foliar cover, standard deviation (SD), and range of functional groups in post-Las Conchas forest plots in target mixed conifer habitat in Bandelier NM, 2012.

Functional groups	Foliar cover (%)		
	Mean	SD	Range
Tree seedlings	2.07	2.76	0.00–12.75
Total shrub and herbaceous cover (no trees)	21.77	13.21	0.50–51.25
Perennial grasses, graminoids	13.03	10.28	0.38–41.38
Annual grasses	0.02	0.11	0.00–0.75
Forbs	9.49	7.08	0.13–31.25
Shrubs, dwarf shrubs and woody vines	1.03	2.15	0.00–12.00
Standing dead herbaceous	5.00	5.71	0.00–21.38
Woody standing dead	1.32	1.20	0.00–4.13

4 Discussion

These data represent the third year of sampling the mixed conifer bird community at BAND, and the first year of sampling after the Las Conchas Fire in June 2011. The fire impacted much of the park's mixed conifer habitat and created a landscape mosaic of patches of varying burn severity, from unburned to severely burned areas.

The altered landscape resulting from the Las Conchas Fire provides a unique opportunity to study the effects of fire on mixed conifer birds, as we have data for 2 years before the fire and, at present, data for one year after the fire. Almost all studies of fire effects on coniferous forest birds of the western United States have compared burned areas to unburned areas and lack prefire data (Smucker et al. 2005; see Kotliar et al. [2002] for a review). An exception is a study by Johnson and Wauer (1996) that assessed the effects of BAND's La Mesa Fire of 1977, comparing prefire bird abundance in unburned areas to postfire bird abundance in the same areas, which included burned and unburned sites.

The sampling frame for the SCPN bird monitoring program consists of post-Las Conchas forest plots still containing mixed conifer habitat (i.e., plots with low to moderate changes in vegetation structure), and precludes sampling across the full range of burn severities that would have been represented had we retained our original sampling frame. As a result, in 2012, the number of sampling plots was reduced by approximately half, but these plots were widely distributed across the park's mixed conifer zone and we adjusted our sampling effort to acquire a sample size of VCP counts comparable to those of previous years. The monitoring data allow us to examine the effects of the fire on the bird community within still-forested plots in mixed conifer habitat, but do not allow us to compare pre- and postfire forest areas to postfire heavily burned areas.

Several factors, including time since fire, likely affect bird responses to fire. There can be immediate effects on bird survival when fire burns occupied habitat. Short-term responses (generally less than 5 years) and longer-term responses are likely affected by several factors including burn severity and tree mortality, burn extent, and the landscape context of burn severity and size—including the availability of unburned or low burn severity forest habitat. Longer-term responses of the bird community are also likely affected by management actions, fire frequency, postfire successional processes, and ungulate herbivory.

Since we did not sample adjacent burned sites, and it is likely that landscape scale factors such as burn severity and burn and forest patch size affect mixed conifer bird species distribution and abundance, we used knowledge of a species' natural history traits to conceptualize probable changes in bird species abundance in adjacent burned forest and the probable effects of these changes on the mixed conifer bird community we sampled in forest sites. During the breeding season following the fire, increased bird abundance in the post-Las Conchas forest sites could be due to movement from, and decreased abundance in, burned areas. Or it may be due to an increase in burn-associated species in burned areas, which could lead to an increase in abundance in adjacent post-Las Conchas forest areas. Decreases in abundance in post-Las Conchas forest sites could be due to movement by burn-associated species from the forest areas into burned habitat, or decreases in abundance in both burned areas and forest areas due to factors other than the fire.

Our preliminary examination of relative abundance of the most commonly detected bird species in forest areas in mixed conifer habitat before and after the Las Conchas Fire, using data unadjusted for detectability, shows species-specific changes. Of the 20 most commonly detected species, 9 (45%) species increased, 9 decreased, and 2 species did not change in relative abundance.

While there appear to be species-specific responses to fire, there also appear to be patterns across species in the changes in relative abundance of species based on shared natural history traits. For example, of the 9 most commonly detected species that increased in post-Las Conchas forest areas after the fire, 7 (78%) were either long-distance migrants (chipping sparrow, Hammond's flycatcher, warbling vireo, western tanager, and western wood-pewee) or move to lower elevations and different habitats in the winter (hermit thrush and Williamson's sapsucker). All, with the exception of the sapsucker, are open cup nesters that build their nests in the foliage of trees. The Williamson's sapsucker is a cavity nester but depends on live trees, as it feeds exclusively on conifer

sap and phloem during the prenestling period of the breeding season (Gyug et al. 2012). It does not inhabit large and intensely burned areas, and has never been shown to have a positive numeric response to burns (see Saab et al. 2005), although it may nest in snags at the edge of burns while foraging in adjacent forest (Raphael et al. 1987, Gyug et al. 2012). The increase in abundance of these 7 species may be due to the movement of individuals, upon arrival from their wintering grounds, from unsuitable burned territories, without tree foliage or live trees with sap, to already occupied post-Las Conchas forest areas in mixed conifer habitat where foliage for nesting or tree sap is available. Such movements from burned to adjacent habitats are little-studied but have been reported for Brewer's sparrows in sagebrush habitat (B. Walker, personal communication in Smucker et al. 2005) and for birds in BAND's forests (Johnson and Wauer 1996).

Just 2 of the species that increased postfire are resident species, the hairy woodpecker and the pine siskin. The hairy woodpecker nests in cavities (not foliage), forages for insects in tree bark, and has been found to increase in abundance in burned forests (Johnson and Wauer 1996, Kotliar et al. 2002, Saab et al. 2005), especially in burned forests with recently killed and dying trees that attract high densities of bark beetles and wood-boring beetles. Johnson and Wauer (1996), in their study of burned and unburned forest in BAND before and after the La Mesa fire in 1977, reported an increase in hairy woodpeckers in both burned and unburned forest; they supposed that the increase in woodpeckers in unburned habitat was due to an overflow resulting from larger increases in burned areas. The increase of pine siskins may be due to an overall increase in the species in response to fire as this species may respond to short-term increases in the availability of seeds after wildfire (Smucker et al. 2005), but still requires the tree foliage of still-forested sites to build their nests in.

The species that decreased in post-Las Conchas forest areas in mixed conifer habitat have markedly different natural history traits than those that increased. Of the 9 most commonly detected species that decreased, 6 (67%) were resident species (brown creeper, dark-eyed junco, mountain chickadee, northern flicker) or move to lower elevations and different habitats in the winter (ruby-crowned kinglet, yellow-rumped warbler). Three migrant species also decreased (Cordilleran flycatcher, house wren, violet-green swallow). Six of the 9 (67%) species that decreased, including all of the migrant species, have "closed" nest types in that they are cavity nesters or nest in crevices (see Saab and Powell 2005). Trees and snags with suitable sites for nest cavities, or with crevices and natural cavities, are essential for reproduction of cavity- and crevice-nesting species and their availability may limit population size. If conditions in burned areas became unsuitable and closed nesters moved into nearby post-Las Conchas forest areas in mixed conifer habitat to attempt to nest, competition for limited nest sites would likely have increased, given that these sites were already occupied by cavity and crevice nesting individuals. Alternatively, burned areas may provide more abundant resources for species that have been observed to have a positive response to fire, such as house wren and violet-green swallow (Kotliar et al. 2002, Bock and Block 2005, Saab and Powell 2005), and individuals may have moved from post-Las Conchas forest sites into burned habitat. These processes could account for the apparent decreases in species abundances in post-Las Conchas forest areas in mixed conifer habitat postfire.

In conclusion, we responded to the Las Conchas Fire of 2011, which burned approximately half of the mixed conifer bird sampling plots at high or moderate severity, by re-assessing the remaining habitat and sampling only in monitoring plots with no evidence of fire or with low canopy burn severity—plots with little to no changes in vegetation structure. A preliminary comparison between prefire (100 plots) and postfire (48 plots) relative abundances of the most commonly detected bird species in mixed conifer habitat indicates that natural history traits, including nest type and substrates used for nesting (e.g., open nests in tree foliage, cavity nests in snags) affect species responses to fire. Bird species responses and the effects of the fire on the mixed conifer bird community will likely change with time after the fire. Continued monitoring in BAND's remaining mixed conifer habitat will provide data to track changes in bird species abundance, distribution, and habitat metrics over time.

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