A Comparison of Bird Species Composition and Abundance Between Late- and Mid-seral Ponderosa Pine Forests[1]

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Abstract

We compared the relative abundance of bird species between two ponderosa pine (*Pinus ponderosa*) forests in northeastern California: one with a canopy of large old-growth trees present (Blacks Mountain Experimental Forest, BMEF) and the other with large trees essentially absent (Goosenest Adaptive Management Area, GAMA). We surveyed 24 units at BMEF and 20 at GAMA using point counts and compared the relative abundance of bird species detected at the two locations using Wilcoxon-rank tests. Overall bird species composition was similar at the two locations. Of the 51 species detected at both locations, 29 were detected at both GAMA and BMEF, 14 were only detected at BMEF and 8 were only detected at GAMA. Most of the species that were detected at only one site were rare at the site where they were observed. Plot diversity (the number of bird species detected on a plot) did not differ between the two locations. Bird species were lumped into four foraging guilds, woodpeckers, bark gleaners, foliage gleaners, and flycatchers, to examine if foraging ecology predicted differences in abundance between the two sites. Woodpeckers, bark gleaners, and flycatchers were more abundant at BMEF while foliage gleaners were more abundant at GAMA. Differences in the abundances of individual species were generally consistent with the overall guild differences. For instance, Williamson's Sapsuckers (*Sphyrapicus thyroideus*), Hairy and White-headed Woodpeckers (*Picoides villosus* and *P. albolarvatus*), and Northern Flickers (*Colaptes auratus*) were all significantly more abundant at BMEF than GAMA. The only species whose abundance was not consistent with the difference in guild abundance was the Red-breasted Nuthatch (*Sitta canadensis*), a bark gleaner, which was more abundant at GAMA. These results are consistent with other studies suggesting that woodpeckers and bark gleaners are strongly associated with large trees and snags. The dense canopy of small to medium sized trees at GAMA relative to BMEF may account for the higher density of foliage gleaners at GAMA.

Introduction

Ponderosa pine (*Pinus ponderosa* P. & C. Lawson) and related Jeffrey pine (*P. jeffreyi* Grev. & Balf.) forests which occur from Baja California to British Columbia, and from the Cascade and Sierra Nevada Mountains eastward to the Rocky Mountains, have perhaps changed more in the last century than any other forest type in western North America (Covington and Moore 1994). Two major changes have occurred in these forests: a decrease in the mean diameter of the trees and a change in

[1]An abbreviated version of this paper was presented at the symposium on Ponderosa Pine: Issues, Trends and Management, October 18-21, 2004, Klamath Falls, Oregon.

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the relative proportion of tree species. Many forest stands that had been composed almost exclusively of ponderosa pine are now numerically dominated by white fir (*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.), Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco), and grand fir (*Abies grandis* (Dougl. ex D. Don) Lindl.). The change in the mean diameter of the trees is a result of extensive logging of ponderosa pine forests over the last century while the change in species composition is due to the exclusion of fire and possibly other factors over the last several decades (Agee 1993, Mohr and others 2000, Odion and others 2004, Perry and others 2004, Skinner and Chang 1996).

Although there has been more focus on effects of logging on wildlife in wetter forests of the western United States (e.g., Hejl 1994, Morrison 1992, Sallabanks and others 2000, Zarnowitz and Manuel 1985), there nonetheless are several studies that have examined the effects of logging on wildlife in ponderosa pine forests (Blake 1982, Brawn and Balda 1988, Mannan and Meslow 1998, Szaro and Balda 1979a). From the literature, it appears that the presence of large-diameter trees is critical to some species of wildlife (Brawn and Balda 1988, Finch and others 1997, Weikel and Hayes 1999), but there is a general paucity of good controls or in multi-year replication in such evaluations (Sallabanks and others 2000).

This paper is the part of a series of evaluations of ponderosa pine wildlife and wildlife interactions in eastside pine forests of northern California (Farris and others 2002, Farris and others 2004, Liebezeit and George 2002, Zack and others 2002). We participated in the design and implementation treatments at two sites (George and Zack 2001, Zack and others 1999): Blacks Mountain Experimental Forest (BMEF) (Oliver and Powers 1998) in Lassen National Forest, and Goosenest Adaptive Management Area (GAMA) (Ritchie and Harcksen 1999) in the eastern part of Klamath National Forest. In brief, the treatments are large-scale (at least 40 hectares), replicated, with different thinning alternatives and with and without prescribed fire.

Here we provide a baseline and comparative basis for understanding the avifaunas at BMEF and GAMA prior to such treatments. BMEF was designated as an experimental forest in the 1930s, and our plots had an outstanding legacy of large and old ponderosa and Jeffrey pines (Oliver 2000). In contrast, GAMA was clearcut in the early 1900s (Ritchie and Harcksen 1999) and has had little logging activity since, making it typical of many western ponderosa pine forests. Thus, we have an opportunity to compare the avifauna between a relatively intact forest of large diameter trees (BMEF) with a mid-seral forest of medium-diameter trees (GAMA). Both sites prior to treatments had considerable encroachment of white fir and high densities of small trees and shrubs in the understory, all typical effects of fire exclusion.

Methods

Study Sites

Blacks Mountain Experimental Forest (lat. 40°40’N., long. 121°10’W.) is located 56 km NW of Susanville, Lassen County, California. Ponderosa pine is the principal tree species with small numbers of Jeffrey pine and incense cedar (*Calocedrus decurrens* (Torr.) Florin). White fir becomes increasingly prevalent at higher elevations. BMEF has two major diameter classes of trees—a scattered overstory of large 300-700 year-old pines and incense cedar and a dense understory

of pines and white fir that is thought to have originated after wild fire exclusion (Oliver and Powers 1998). Although some logging was conducted at BMEF during the 1938-1947 as part of the Methods of Cutting study (Dolph and others 1995), much of the area was never logged making it an ideal location to examine the avifauna of a late-seral ponderosa pine forest. The elevation ranges from approximately 1700-1950 m. In 1995, 12 treatment units (each divided into two split-plots) were established at BMEF to examine the effects of different silvicultural treatments on the flora and fauna (Oliver and Powers 1998).

Goosenest Adaptive Management Area (lat. 41°34'N., long. 121°41'W.) is located in Siskiyou County, 2 km SE of Tennant, CA. The vegetation at GAMA is predominantly 80-year-old, second growth ponderosa pine forest. The dominant tree species are ponderosa pine and white fir. Incense cedar and sugar pine (*Pinus lambertiana* Dougl.) are also common on the northwestern portion of the site. The understory is dominated by greenleaf manzanita (*Arctostaphylos patula* Greene), snowbrush ceanothus (*Ceanothus velutinus* Dougl. ex Hook.), and white fir saplings. The topography is relatively flat with no perennial streams. Elevations range from 1500 to 1645 m. Mean annual precipitation ranges from 38 to 51 cm, with most precipitation falling as snow (Anonymous 1996). The average summer and winter temperatures are 15° C and -2° C respectively (Oregon Climate Service 2000). In 1996, 20 40-ha units were established within the GAMA to test different methods of accelerating the development of late-seral ponderosa pine forest structure (Ritchie and Harcksen 1999).

Point Counts

We estimated the relative abundance of birds on the experimental units at BMEF and GAMA using point counts. Surveys were conducted at BMEF from 20 June-24 July 1995, and at GAMA from 7 June-2 July 1996, prior to the implementation of silvicultural treatments at each site. All experimental units were surveyed at GAMA and both split plots of each of the 12 experimental units were surveyed at BMEF. Because the point count surveys on each split plot at BMEF were sufficiently far apart to avoid overlap, the surveys were analyzed separately. Thus there were 24 survey units at BMEF (split plots at BMEF are hereafter referred to as units). Eight points were surveyed on each unit at GAMA and BMEF. Each survey point was at least 100 m from the unit's edge and 200 m from other point count locations. At each site, each unit was surveyed two times by different observers.

Point count surveys started within 15 min of sunrise and continued until all points on a plot were surveyed (generally 2 hrs). Count duration was 8 min and started upon arrival at the point. The horizontal distance to each bird was estimated in 10 m bands to 50 m, 51-75 m, 76-100 m, and > 100 m. To reduce the chance of double counting, only birds detected within 100 m of the observer were used in analyses. Also excluded from analyses were birds detected flying over but not utilizing the unit. We computed an index of abundance for each bird species on each unit by dividing the number of detections on a unit by the number of surveys (2) on each unit. Species richness was computed for each unit by totaling all of the species that were detected in each unit during the two surveys. Bird species were grouped into four guilds based on their foraging behavior (*appendix 1*). We compared the relative abundance of bird species detected at the two locations using Wilcoxon-rank tests and a significance level of 0.05.

Results

The overall bird species composition was similar at the two locations. Of the 51 species detected at both locations, 29 were detected at both GAMA and BMEF, 14 were only detected at BMEF and 8 were only detected at GAMA (table 1). Most of the species that were detected at only one site were rare at the site where they were observed. When rare species (<1 detection/10 surveys) are excluded, 5 species were observed only at BMEF and 5 species were observed only at GAMA and 25 species were observed at both sites. The number of species detected on each unit did not differ between the two sites (*table 1*).

The relative abundance of woodpeckers, bark gleaners, and flycatchers was higher at BMEF while foliage gleaners were more abundant at GAMA (*table 2*). Differences in abundance of individual species were generally consistent with the differences in the abundance of guilds at the sites. Hairy Woodpeckers, Williamson's Sapsuckers, and White-headed Woodpeckers (see *appendix 1* for scientific names of bird species) were more abundant at BMEF than GAMA. In addition, Downy Woodpeckers were only detected at BMEF. Thus, both the density and diversity of woodpeckers was higher at BMEF than GAMA. Among the bark gleaners, Mountain Chickadees, White-breasted Nuthatches, Pygmy Nuthatches, and Brown Creepers were all more abundant at BMEF. Of the foliage gleaners, Cassin's Vireos, Warbling Vireos, Golden-crowned Kinglets, Hermit Warblers, and Western Tanagers were all more abundant at GAMA. The only species whose abundance pattern differed significantly from the overall trend in its guild was the Red-breasted Nuthatch that was more abundant at GAMA than BMEF.

Discussion

The songbird and woodpecker communities at BMEF and the GAMA were similar to other ponderosa pine avifaunas, especially when only considering the common species (Hall and others 1997, Laudenslayer and Balda 1976, Szaro and Balda 1979a, 1979b, Rosenstock 1996, Szaro and Balda 1986, Thomas and others 1979). These core species include Hairy Woodpecker, Steller's Jay, Mountain Chickadee, White-breasted Nuthatch, Red-breasted Nuthatch, Brown Creeper, American Robin, Townsend's Solitaire, Hermit Thrush, Western Bluebird, Cassin's Vireo, Yellow-rumped Warbler, Brown-headed Cowbird, Western Tanager, Dark-eyed Junco, Cassin's Finch, and Pine Siskin. All of these species occur at both BMEF and GAMA. Many of these species, in turn, occur widely throughout many western forest types (e.g., Chambers and others 1989, Raphael and others 1987).

Although the core group of common species was similar at BMEF and GAMA, there were five species that were relatively common at one site and absent at the other. The common species present at BMEF and absent at GAMA were the White-headed Woodpecker, Olive-sided Flycatcher, Western Wood-Pewee, Gray Flycatcher, and Fox Sparrow. The White-headed Woodpecker has been found to be associated with large diameter trees (Booth 1991, Dixon 1995), while the Olive-sided Flycatcher and Western Wood-Pewee are associated with a high density of large snags and forest openings (Hutto and others 1992). Thus the absence of these species from GAMA is consistent with the absence of large trees and snags at the GAMA site. Gray Flycatchers occur at the low elevation units at BMEF and are associated with sagebrush (*Artemisia* spp.) which was absent at GAMA (Sterling 1999). Fox

Table 1—*Number of birds detected (mean ± SE) on point counts (detections/survey) at Blacks Mountain Experimental Forest (BMEF) and Goosenest Adaptive Management Area (GAMA) in northeastern California. P values are given for those comparisons where P<0.05. Scientific names of birds are provided in appendix 1.*

Species	BMEF	GAMA	*P*
Sharp-shinned Hawk	0.04±0.03	0	
Cooper's Hawk	0.08±0.05	0	
Northern Goshawk	0.10±0.07	0	
Red-tailed Hawk	0.10±0.07	0.03±0.03	
Unknown Raptor	0	0.05±0.03	
Mountain Quail	0.02±0.02	0.03±0.03	
Mourning dove	0.06±0.05	0	
Great Horned Owl	0.02±0.02	0	
Unknown Owl	0	0.03±0.03	
Common Nighthawk	0.06±0.05	0	
Calliope Hummingbird	0.02±0.02	0	
Unknown Hummingbird	0.29±0.09	0	0.0026
Williamson's Sapsucker	1.27±0.25	0.15±0.06	0.0002
Downy Woodpecker	0.04±0.03	0	
Hairy Woodpecker	0.98±0.15	0.53±0.13	0.0300
White-headed Woodpecker	0.19±0.07	0	0.0094
Black-backed Woodpecker	0.10±0.06	0.03±0.03	
Northern Flicker	0.88±0.16	0.43±0.11	0.0386
Pileated Woodpecker	0.10±0.05	0.05±0.05	
Unknown Woodpecker	1.33±0.24	0.95±0.18	
Olive-sided Flycatcher	0.19±0.10	0	
Western Wood-Pewee	0.25±0.15	0	
Hammond's Flycatcher	0.52±0.22	0.73±0.26	
Gray Flycatcher	0.23±0.18	0	
Dusky Flycatcher	4.69±0.55	3.88±0.91	
Unknown Empidonax Flycatcher	6.94±0.74	2.23±0.57	<0.0001
Cassin's Vireo	1.96±0.40	3.35±0.67	
Warbling Vireo	0	0.43±0.19	0.0044
Gray Jay	0	0.45±0.22	0.0233
Steller's Jay	0.33±0.13	0.30±0.11	
Common Raven	0.60±0.20	0.23±0.13	
Mountain Chickadee	12.98±0.82	8.18±0.62	<0.0001
Red-breasted Nuthatch	5.79±0.56	7.98±0.62	0.0199
White-breasted Nuthatch	1.25±0.25	0.08±0.04	<0.0001
Pygmy Nuthatch	0.88±0.31	0.05±0.05	0.0102
Brown Creeper	3.75±0.36	0.63±0.19	<0.0001
Golden-crowned Kinglet	1.58±0.31	3.55±0.53	0.0045
Townsend's Solitaire	0.90±0.16	1.00±0.19	
Hermit Thrush	4.58±0.66	6.73±0.68	0.0486
American Robin	2.10±0.37	0.05±0.03	<0.0001
Nashville Warbler	0	6.10±0.76	<0.0001
Yellow-rumped Warbler	8.10±0.55	7.00±0.76	
Hermit Warbler	0	3.68±0.61	<0.0001
Western Tanager	1.94±0.37	5.13±0.67	0.0003
Green-tailed Towhee	0	0.08±0.05	
Chipping Sparrow	2.50±0.49	2.25±0.41	
Fox Sparrow	0.25±0.13	0	0.0177
Dark-eyed Junco	7.83±0.67	4.05±0.53	0.0002
Brewer's Blackbird	0	0.05±0.05	
Brown-headed Cowbird	0.08±0.05	0.43±0.14	0.0275
Purple Finch	0.71±0.31	0.03±0.03	0.0049

Species	BMEF	GAMA	*P*
Cassin's Finch	0.42±0.20	0.18±0.10	
Red Crossbill	0.06±0.06	0.38±0.17	0.0228
Unknown Carpodacus finch	0.88±0.30	0.65±0.25	
Pine Siskin	0.08±0.07	0	
Evening Grosbeak	0	0.28±0.13	0.0044
Black-headed Grosbeak	0	0.03±0.03	
Unknown	1.33±0.30	0.18±0.07	0.0013
Species Richness	18.88±0.56	18.05±0.47	

Table 2—*Number of birds (mean ± SE) in different foraging guilds detected on point counts (detections/survey) at Black's Mountain Experimental Forest (BMEF) and Goosenest Adaptive Management Area (GAMA) in northeastern California. P values are given for those comparisons where P<0.05.*

Guild	BMEF	GAMA	P
Flycatchers	12.81±0.70	6.83±1.33	0.0014
Foliage	13.58±1.06	23.15±1.25	0.0001
Bark Gleaners	11.67±0.77	8.73±0.70	0.0049
Woodpeckers	4.90±0.54	7.00±0.76	<0.0001

Sparrows are more common at elevations higher than those found at GAMA (Weckstein and others 2002).

Three of the common species present at GAMA but absent at BMEF were species that are generally associated with denser, more closed canopy forest. These include the Warbling Vireo, Gray Jay, and Hermit Warbler. The other two species either occur erratically across the landscape (Evening Grosbeak) or are associated with extensive shrub patches (Nashville Warblers) that were not present at BMEF.

Despite differences in the species composition of the bird communities at the two sites, bird species richness did not differ. Thus, the presence of species associated with large-diameter trees at BMEF and those associated with a more closed forest canopy at GAMA resulted in no difference in the number of species detected on units at the two locations. Thus, the presence of large trees and an associated more open canopy does not lead to an increase in the number of bird species. This underscores the point that bird species richness (or diversity) at a particular site should not be used as a measure of the success of restoration efforts in ponderosa pine ecosystems.

One of the most consistent differences in the bird communities between BMEF and GAMA was the greater abundance of woodpeckers and bark gleaners at BMEF. Woodpeckers as a group and several species individually were more common at BMEF including the Williamson's Sapsucker, Hairy, and White-headed Woodpeckers, and the Northern Flicker. White-breasted Nuthatch, Pygmy Nuthatch, and Brown Creeper, all bark gleaners, were more common at BMEF than they were at GAMA. Mountain Chickadees, which do feed as bark gleaners, but also in the foliage of trees, were also more common at BMEF. A strong exception to the above pattern is found with the Red-breasted Nuthatch, which is more common at GAMA. Red-breasted Nuthatches rarely feed on the tree bole, in contrast to the other bark gleaners in this guild (e.g., Adams and Morrison 1993). In addition, Red-breasted Nuthatches typically fed on medium-diameter, not large-diameter trees in the Sierra

Nevada (Airola and Barrett 1985) but the opposite was found in coastal Douglas-fir forests (Weikel and Hayes 1999).

Other species were more common at BMEF included hummingbirds (often unidentified to species), American Robins, Dark-eyed Juncos, and Purple Finches. Robins and Juncos, both ground foragers, seemingly take advantage of the generally more open forest structure at BMEF.

Foliage gleaners were consistently more abundant at GAMA than BMEF. Warbling Vireos, Golden-crowned Kinglets, Hermit Warblers, and Western Tanagers, all foliage gleaners, were more abundant at GAMA. Foliage gleaners may be favored at GAMA because of the high encroachment of white fir and associated high canopy cover and foliage volume at the site (Ritchie and Harcksen 1999). Other species that were more abundant at GAMA relative to BMEF include the Hermit Thrush, Brown-headed Cowbird and Red Crossbill. Hermit Thrushes are generally associated with higher elevation fir forests (Hejl and Verner 1988) and may also be responding to the high level of white fir encroachment at GAMA. Higher densities of Brown-headed Cowbirds at GAMA may be related to the higher densities of potential hosts for this brood parasite, particularly among warbler species. Red Crossbills are highly erratic in time and space across all forest types, and so may not indicate any real differences between sites.

The greater abundance of flycatchers at BMEF is difficult to explain because many of the flycatchers could not be identified to species at both sites (*table 1*). It is clear, however, that the species richness of flycatchers was much higher at BMEF as 3 of the 5 species were only detected there. Olive-sided Flycatchers responded strongly to differences in the abundance of flying arthropods between burned and unburned sites in north central California (Meehan and George 2003). Furthermore, the abundance of flying arthropods was positively associated with the cover of ground vegetation, down wood, and shrubs and saplings. It would be interesting to examine whether differences in ground vegetation, down wood and the associated arthropod fauna between BMEF and GAMA explains differences in flycatcher abundance between the two sites.

Despite the differences in abundance in some species between the two sites, it is important to recognize that several common species occur at similar densities. For example, Chipping Sparrow, Yellow-rumped Warbler and Cassin's Finches are similarly common at both sites. Chipping Sparrows are ground-feeding birds, while Cassin's Finches are often detected in the high canopy feeding on cones. Yellow-rumped Warblers are primarily foliage gleaners and therefore the lack of difference in abundance between the two sites is not consistent with overall greater abundance of foliage gleaners at GAMA.

The main differences between the ponderosa pine forest sites are the higher densities of bark gleaners at BMEF in comparison to the higher densities of foliage gleaners at GAMA. Large-diameter trees at BMEF mean more trunk surface to forage upon. Hairy and Black-backed Woodpeckers at BMEF often feed on larval bark beetles in snags, while White-headed Woodpeckers mostly feed on large living ponderosa pines (Hughes 2000). Large-diameter trees were preferred foraging substrates for Hairy Woodpeckers and Chestnut-backed Chickadees (*P. rufescens*) by Weikel and Hayes (1999) in their coastal study noted above. Further, they found that Brown Creepers selected trees with deeper furrows in the bark (Weikel and Hayes 1999). We have no measured bark furrow depth.

The forest at GAMA includes many small- and medium-diameter white fir, and this may provide a basis for the high densities of leaf gleaners. Brawn and Balda (1988) proposed that high densities of foliage gleaning warblers and tanagers in ponderosa pine forests was due to more productive foliage of intermediate-aged trees. Airola and Barrett (1985) followed insect gleaning birds in Sierra Nevada mixed-conifer forests (with oak) and found that Hermit Warblers preferred pine, whereas Golden-crowned Kinglets, Yellow Warrblers, and Western Tanagers preferred white fir. Cassin's Vireo showed no such preference.

Finally, we should also note that bark gleaners are cavity nesters, and foliage gleaners are cup nesters. Thus, it is possible that the driving difference between BMEF and GAMA bird densities is not tree diameter but rather is cavity availability. We have found that cavities, and occupied cavities, are much more common at BMEF compared to GAMA (Zack and others 2002), but we have no way to measure whether substrate for cup nesters is higher at GAMA. Brawn and Balda (1988) consider the paucity of snags with cavities to be a major reason for the hypothesized declines in chickadee, nuthatch and bluebird (*Sialia* spp.) populations.

This comparison of bird communities at our two sites provides a baseline for understanding the ongoing experimental treatments at both BMEF and GAMA. Sallabanks and others (2000), in a review of bird response to timber harvest, noted that only a minority of studies were the result of experimental treatments and most were not long term. The result is that most studies do not truly address cause and effect issues nor do they address the relationships of birds to treatments as the vegetation develops and changes following treatment. This study is indeed correlational, and only a comparison of patterns from one year at each site. But it is a foundation of ongoing evaluation of these avifaunas with experimental silvicultural treatments. While the details of the treatments differ (see Zack and others 1999, Ritchie and Harcksen 1999), both sites have plots that were thinned, and plots that were burned. Monitoring avifauna use after these treatments will allow us to more clearly understand broad differences in the responses of both bark gleaners and foliage gleaners.

Acknowledgments

We thank Christian Buckley, Shay Childress, Mike Van Hatten, and Joe Liebezeit for their diligence in conducting point counts at the two sites. Kerry Farris provided help with the logistics at Blacks Mountain and many insightful discussions over the years. Staff at the Goosenest Ranger District, Klamath National Forest provided logistical support at Goosenest Adaptive Management Area. Steve Zack has been supported by the Wildlife Conservation Society since 1998. The members of the interdisciplinary research team at the Pacific Southwest Research Station provided many helpful comments and suggestions during the planning and implementation of this research. This is contribution no. 21 of the Blacks Mountain Ecological Research Project and no. 12 of the Goosenest Adapative Management Area Ecological Research Project

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