

## Livestock Utilization and Bird Community Composition in Mixed-conifer Forest and Oak Woodland in Southern Oregon

### Abstract

We examined the degree to which bird community composition is associated with livestock grazing in the Cascade-Siskiyou National Monument in southern Oregon. We sampled riparian and adjacent upland areas along routes within mixed-conifer forests and oak woodlands. For each route, we generated a continuous measure (0-100%) of livestock grazing utilization and used this measure to group routes into low (0% to 40%) and high (>40%) grazing utilization classes. In 2003 and 2004, we conducted point counts along each route to quantify avian species richness and community composition. In mixed-conifer forest, species richness was significantly greater in upland areas and in areas with high grazing utilization; however, bird community composition differed only between upland and riparian areas and not between areas of low and high grazing utilization. In oak woodlands, bird community composition was significantly different between high and low utilization, but not between riparian and upland areas. Bird communities associated with high grazing utilization had significantly fewer shrub-nesting, foliage-gleaning, and long-distance migrant species than those associated with low grazing utilization. Our results suggest that grazing influences bird community composition in both riparian and upland areas of oak woodland vegetation. Reducing grazing in oak woodlands would likely lead to increases in the relative abundance of long-distance migrants, foliage gleaners, and shrub-nesting species in this habitat.

### Introduction

Throughout North America, cattle are grazed in a wide variety of habitats. Because these habitats are highly variable, it is difficult to make generalizations about the effects of grazing on ecological communities from one landscape to another. This is especially true because fire suppression, dewatering of wetlands and riparian habitat, introduction and spread of exotic vegetation, and timber harvest interact with the effects of grazing in unique ways (Belsky and Blumenthal 1997). Although the local effects of grazing may be difficult to predict, grazing can have large effects on vegetation composition and structure and therefore it should be considered as an important component of land management, especially throughout the Interior West of North America (Belsky and Blumenthal 1997).

Increasingly, the management of non-game wildlife is recognized by land managers and conservation planners as an important objective of public and private land management (Adams et al. 1997, Bolen 2000). In particular, there is growing concern about declining populations of resident and migratory birds (Askins 1993, Bal-

lard et al. 2003). Because grazing is known to affect bird reproductive success (Walsberg 2005) and may lead to changes in vegetation that affect bird community composition (Knopf et al. 1988, Schulz and Leininger 1991), the effect of grazing on bird community composition has become one component considered in management decisions about grazing. Designing monitoring projects that focus on groups of organisms that provide cost-effective information about ecological conditions of interest is an accepted approach for informing management (Vos et al. 2000, Gram et al. 2001) and birds are an effective tool for such monitoring (Hutto 1998, Alexander et al. 2007).

The effects of grazing on bird communities may vary dramatically depending on the intensity of grazing, but the vast majority of grazing studies do not quantify intensity, and those that do, do not use standard methods (Fleischner 1994). In some systems low levels of grazing may have negligible or positive effects, whereas high grazing intensity may have negative effects (Bradford et al. 1998). Furthermore, grazing intensity may be spatially heterogeneous. In mountainous country, livestock prefer flat, wet, grassy meadow and riparian areas over surrounding forests, uplands, and steep slopes, resulting in an uneven distribution of utilization (Platts and Nelson 1985, Fleischner 1994). Riparian habitats are also important to many

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bird species (Rich 2002, Gardali et al. 2006), and heavy grazing in these habitats has been associated with decreased bird abundance and species richness in both western and eastern North America (Taylor 1986, Ohmart 1996, Belskey et al. 1997, Popotnik and Guiliano 2000). Therefore, the spatial heterogeneity in grazing utilization, both current and historic, needs to be explicitly considered in the design of studies that investigate the effects of grazing (Borman 2005).

Bird community composition is well-known to be influenced by vegetation composition and structure (Rotenberry 1985, MacNally 1990). This is especially true in the mixed hardwood-conifer forests of southern Oregon and northern California, where hardwood dominated oak woodlands may occur in close proximity to completely conifer dominated stands (Seavy 2006). However, whether or not livestock grazing in mixed-conifer and oak woodlands of southern Oregon creates biologically significant changes in bird communities has not been studied. Because grazing changes vegetation structure and composition, we hypothesized that variation in bird community composition would be partially explained by the intensity of grazing activity. Specifically, we predicted that guilds associated with shrubs or ground foliage would be less abundant in heavily grazed areas because grazing reduces the volume of these vegetation layers. We also predicted that long-distance migrants would be negatively affected based on previous grazing research (Saab et al. 1995).

To test these hypotheses, and to evaluate the degree to which the influence of grazing may vary between mixed-conifer and oak woodland habitat, we studied bird communities in the Cascade-Siskiyou National Monument of southern Oregon. Migratory birds are “objects of biological interest” in the monument and such a study was identified as a priority by the BLM (The White House 2000; USDI 2005). Our goal was to compare areas with high and low grazing utilization to understand if grazing utilization explains variation in bird communities and whether or not this variation is consistent across riparian and upland areas of mixed-conifer forests and oak woodlands.

## Methods

### Study Site and Grazing History

The 21,400 ha Cascade-Siskiyou National Monument (hereafter “monument”) in southern Oregon

lies at the convergence of the Cascade, Siskiyou, and Klamath Mountains. Elevation of the monument ranges from 730 to 1,870 m above sea level. At lower elevations and on drier sites, vegetation is dominated by broadleaf species in the form of oak woodlands with both Oregon white oak (*Quercus garryana*) and California black oak (*Q. kelloggii*) or sclerophyllous shrublands (chaparral) in which broadleaf shrubs of the genera *Ceanothus*, *Arctostaphyllum*, and *Baccharis* are abundant (Huff et al. 2005). On wetter sites or middle elevations the vegetation becomes a mix of conifers, including Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), incense-cedar (*Calocedrus decurrens*), and white fir (*Abies concolor*). Hardwoods include tanoak (*Lithocarpus densiflorus*), Pacific madrone (*Arbutus menziesii*), canyon live oak (*Q. chrysolepis*), California black oak, Oregon white oak, and big-leaf maple (*Acer macrophyllum*). The relative composition of these species varies with elevation, aspect, and soils (Whittaker 1960). Recent research suggests that habitat conditions in the monument have shifted since European settlement when grasslands were more prevalent (Hosten et al. 2007 a, Hosten et al. 2007 b).

The federal lands within the monument have been grazed since the late 1860s. The BLM designates allotments subdivided by pastures with individual grazing intensities and schedules. Grazing begins in May, and continues until October, or when snow intervenes. Grazing commences at lower elevation in the spring with the livestock gradually moving higher in elevation as the season progresses. Average grazing intensity within allotments is highly variable, but in total, existing grazing leases authorize a total of 2,714 active Animal Unit Months (Animal Unit Month=one cow + one calf for one month). Before 1960, this area was grazed more intensively at a stocking rate approximately 10 times greater than current (Hosten et al. 2007 c).

### Sampling Design

In 2002, we established approximately 500 sampling locations within the monument, including 202 in mixed-conifer habitats and 166 in oak woodlands. At each location, we established two paired transects; one followed the drainage bottom and the other was located 250 m away along an adjacent slope. Sampling stations were spaced at 250 m intervals along each transect. Data collected

in 2002 were used to classify the forest type at each station as mixed-conifer or oak woodland based on the maximum cover of dominant tree and shrub species. We selected a subset of 25 sampling locations that were dominated by one of two forest types; 15 classified as mixed-conifer forest (dominated by Douglas-fir) and 10 as oak woodland (dominated by *Quercus* spp. and often with ponderosa pine well-represented).

During the vegetation surveys, stations were identified either as riparian (if riparian plant species [e.g. willow (*Salix* spp.) and alder (*Alnus* spp.)] had > 5% cumulative cover) or upland (riparian vegetation < 5% cover). This allowed us to stratify the stations at each location into riparian and upland groups (hereafter “routes”). We refer collectively to the riparian/upland classification as “vegetation type.” In the analyses, we consider routes as independent sampling units. Because not all locations had stations that qualified as riparian vegetation, there were 11 riparian and 14 upland mixed-conifer routes and 9 riparian and 10 upland oak woodland routes. The number of stations varied among routes, from 1 to 18, but most (73%) routes consisted of between 5 and 10 stations.

To account for the spatial heterogeneity of livestock grazing utilization transects were established on 39 of the 44 routes as a part of a comprehensive utilization study in the monument (Hosten et al. 2007 c). Starting points for utilization transects were chosen by selecting stations along the route that were considered to be suitable to be grazed by livestock because they had high grass cover and low tree canopy cover. Utilization was assessed by measuring herbaceous removal based on the height of the dominant palatable grass species along 50 m transects following standard key species transect methodologies (Cooperative Extension Service 1999). Before each transect was surveyed the dominant palatable grass species at the transect was identified and a reference plant, that showed no evidence of herbivory, was collected and separated into segments. Each segment was measured and weighed to develop a height and mass table to be used for estimating percent utilization for the species at each point along the transect. Fifty meter tape measures were stretched along each transect and points were established every meter. Surveyors recorded utilization estimates at each point for the transect’s dominant grass by measuring the height of the individual

specimen that was closest to each point. Phytomass percentages were averaged across all plants on each transect to provide a composite utilization score that served as a continuous variable describing livestock utilization (Hosten et al. 2007 c). To simplify the grazing utilization scores, we created a categorical assignment of high and low livestock grazing utilization. Because the majority of utilization scores for transects were between 0 to 20% and 40 to 80%, with only several transects between 20 and 40%, or greater than 80%, we categorized low utilization as 0 to 40% and high utilization as >40%.

Utilization transects were not established at five routes. We categorized livestock grazing utilization at these routes as high or low based on a GIS layer that the BLM provided that categorized average livestock utilization over the last 15 years. The use of these data was justified because the utilization transect data collected in the monument matched closely with the historic grazing GIS data (Hosten et al. 2007 c). However, we did not use these routes in analyses that required a continuous measurement of grazing utilization (see below).

#### Data Collection

Routes were surveyed during the avian breeding seasons between May and early July, twice each year in 2003 and 2004. Bird abundance was recorded using standardized point count methodologies (Ralph et al. 1993). Five-minute bird counts were conducted between sunrise and 1000 PDT at each station, and all landbird species seen and heard were recorded. Counts were conducted only on days when the wind was < 20 kph and it was not raining. All observers were experienced and had been trained for distance estimation and species identification.

All passerines and woodpeckers detected within 50 m of point count stations were included in analyses. Preliminary analyses comparing median detection distances across forest types, vegetation types, and utilization categories suggested little evidence of different detection distances among habitats. For each year, a species was classified as occurring at a station if they were detected at least once during the two visits. Annual species frequency was calculated as the number of stations per route on which a species occurred. Because our preliminary analysis showed that only 3 of the 15 most abundant species, [Cassin vireo (*Vireo*

*cassinii*), western tanager (*Piranga ludoviciana*), and western wood-peewee (*Contopus sordidulus*) differed more than 10 percent between 2003 and 2004, we combined the two years of data and re-calculated avian frequency as the percent of stations within each route where a species was detected on at least 2 of 4 visits.

### Data Analysis

Because of the differences anticipated between bird communities in oak woodland and mixed-conifer forest types, we analyzed species richness and species composition separately for each.

#### *Species Richness*

Species richness (Whittaker 1977) was calculated as the average number of bird species detected per station for each route. We used a two-way ANOVA to investigate the variation in species richness associated with grazing utilization (low or high) and vegetation type (riparian or upland). We began with a model that included a vegetation type x grazing interaction term, but because this term was not significant ( $P < 0.05$ ), we present the results for a model with only the main effects.

#### *Species Composition*

Non-metric multidimensional scaling (NMS) (Mather 1976) was used to ordinate the routes using the species frequencies. Species frequencies were arcsine square-root transformed because values fell between 0 and 1, and similarities in bird community composition were calculated using the relative Euclidian metric. Random starting configurations were used, with 40 runs of real data and 50 runs of randomized data. Monte Carlo tests were used to determine whether the axes generated were stronger than those obtained by chance. These analyses were conducted with PC-ORD Version 4.25 (McCune and Mefford 1999).

To determine if variation in bird community composition was associated with vegetation type (riparian or upland), or grazing utilization (low or high), we started by using a MANOVA to investigate variation in all of the significant ordination axes simultaneously. If we rejected the null hypothesis of no difference among groups, then we used Spearman rank correlations of the continuous measurement of grazing utilization with each axis to determine the strength of correlations between the axis scores describing bird

community composition and livestock grazing utilization. These correlations were plotted on the ordination diagram with an arrow representing the direction and strength of the correlations (McCune and Mefford 1999).

#### *Avian Guilds*

After identifying gradients of bird community composition associated with grazing utilization, we investigated whether the representation of particular guilds was increasing or decreasing along this axis. To do this, we classified all bird species into nesting, foraging, and migratory guilds (Table 1). Nesting and foraging guilds were assigned according to Ehrlich et al. (1988). Breeding birds were categorized as either year-round residents or long-distance migrants based on available range maps (Ridgely et al. 2003, Poole 2005). Year-round residents are species that occur in northern California and/or southern Oregon throughout the year, though they may make significant elevational movements. Long-distance migrants are those that leave the area during the winter. Most of these species winter south of the Mexico/USA border, though a few migrate only as far as the southwestern United States. As described in the introduction, a priori predictions of grazing effects on guilds were based on components of habitat structure that we expected to change as a result of grazing or because these guilds had been identified as sensitive to grazing impacts in other studies.

An index to abundance of a guild was calculated by summing the frequency of occurrence for all species of a guild on each route. We then used correlations to determine if the abundance of a guild increased or decreased along an ordination axis generated from the bird community data. Because we expected that many of these relationships may be non-linear, we used Spearman rank correlations. These correlations were plotted on the ordination diagram with arrows, such that their angle and length represents the direction and strength of the correlations (McCune and Mefford 1999).

#### *Indicator Species Analysis*

When gradients of bird community composition were correlated with the grazing utilization index, we examined the degree to which individual species were uniquely associated with low or high

TABLE 1. The bird species (limited to those detected on 2 of 4 visits within 50 m of a station) detected in the Cascade-Siskiyou National Monument, Oregon during 2003 and 2004. Species listed with common and scientific name, the habitat type that they occurred in, and, for species that occurred in oak woodland, the indicator values and associated p-values for low and high utilization sites.

Species <sup>1</sup>	Forest type	Oak Woodland Indicator Value		P
		Low Utilization	High Utilization	
Acorn Woodpecker, <i>Melanerpes formicivorus</i> <sup>C, H, R</sup>	oak	0	11	0.476
American Robin, <i>Turdus migratorius</i> <sup>T, G, R</sup>	oak/mixed-conifer	0	22	0.207
Bewick's Wren, <i>Thryomanes bewickii</i> <sup>T, G, R</sup>	oak	20	0	0.479
Black-headed Grosbeak, <i>Pheucticus melanocephalus</i> <sup>T, F, M</sup>	oak/mixed-conifer	3	16	0.459
Brown Creeper, <i>Certhia americana</i>	mixed-conifer			
Brown-headed Cowbird, <i>Molothrus ater</i>	mixed-conifer			
Bushtit, <i>Psaltriparus minimus</i> <sup>T, F, R</sup>	oak	29	3	0.300
California Towhee, <i>Pipilo crissalis</i> <sup>S, G, R</sup>	oak	10	0	1.000
Cassin's Vireo, <i>Vireo cassinii</i> <sup>T, F, M</sup>	oak/mixed-conifer	0	22	0.219
Chestnut-backed Chickadee, <i>Poecile rufescens</i>	mixed-conifer			
Chipping Sparrow, <i>Spizella passerina</i> <sup>T, G, M</sup>	oak/mixed-conifer	40	0	0.091
Dark-eyed Junco, <i>Junco hyemalis</i> <sup>G, G, R</sup>	oak/mixed-conifer	20	0	0.471
Dusky Flycatcher, <i>Empidonax oberholseri</i>	mixed-conifer			
Golden-crowned Kinglet, <i>Regulus satrapa</i>	mixed-conifer			
Green-tailed Towhee, <i>Pipilo chlorurus</i> <sup>S, G, R</sup>	oak/mixed-conifer	10	0	1.000
Hammond's Flycatcher, <i>Empidonax hammondii</i>	mixed-conifer			
Hermit Thrush, <i>Catharus guttatus</i>	mixed-conifer			
Hermit Warbler, <i>Dendroica occidentalis</i> <sup>T, F, M</sup>	oak/mixed-conifer	10	0	1.000
House Wren, <i>Troglodytes aedon</i> <sup>C, G, M</sup>	oak/mixed-conifer	20	0	0.471
Lazuli Bunting, <i>Passerina amoena</i> <sup>S, G, M</sup>	oak/mixed-conifer	61	14	0.047
Lesser Goldfinch, <i>Carduelis psaltria</i> <sup>T, F, R</sup>	oak	10	11	1.000
MacGillivray's Warbler, <i>Oporornis tolmiei</i>	mixed-conifer			
Mountain Chickadee, <i>Poecile gambeli</i> <sup>C, F, R</sup>	oak/mixed-conifer	20	0	0.471
Nashville Warbler, <i>Vermivora ruficapilla</i> <sup>G, F, M</sup>	oak/conifer	21	3	0.517
Oak Titmouse, <i>Baeolophus inornatus</i> <sup>C, B, R</sup>	oak	2	17	0.340
Pacific-slope Flycatcher, <i>Empidonax difficilis</i>	mixed-conifer			
Pine Siskin, <i>Carduelis pinus</i>	mixed-conifer			
Red-breasted Nuthatch, <i>Sitta canadensis</i> <sup>C, B, R</sup>	oak/mixed-conifer	0	11	0.472
Red-winged Blackbird, <i>Agelaius phoeniceus</i>	mixed-conifer			
Song Sparrow, <i>Melospiza melodia</i>	mixed-conifer			
Spotted Towhee, <i>Pipilo maculatus</i> <sup>G, G, R</sup>	oak/conifer	34	45	0.591
Warbling Vireo, <i>Vireo gilvus</i> <sup>T, F, M</sup>	oak/mixed-conifer	20	0	0.471
Western Bluebird, <i>Sialia mexicana</i> <sup>C, H, R</sup>	oak	20	0	0.471
Western Tanager, <i>Piranga ludoviciana</i> <sup>T, F, M</sup>	oak/mixed-conifer	0	22	0.217
Western Wood-Pewee, <i>Contopus sordidulus</i> <sup>T, H, M</sup>	oak/mixed-conifer	6	40	0.128
Winter Wren, <i>Troglodytes troglodytes</i>	mixed-conifer			
Yellow Warbler, <i>Dendroica petechia</i>	mixed-conifer			
Yellow-rumped Warbler, <i>Dendroica coronata</i> <sup>T, F, R</sup>	oak/mixed-conifer	3	25	0.308

<sup>1</sup>Nesting guild (Tree, Shrub, Ground, Cavity), foraging guild (Foilage gleaning, Hawking, Ground gleaning, Bark gleaning), and migratory guild (Long-distance Migrants or Residents and short-distance migrants), see text for further definitions of guilds.

utilization plots using Indicator Species Analysis (Dufrene and Legendre 1997) as implemented in PC-ORD (McCune and Mefford 1999). This analysis generates Indicator Values (IV) (Dufrene and Legendre 1997) for each species based on a synthesis of relative abundance and frequency among the different clusters:

$$IV_{ij} = A_{ij} * B_{ij} * 100,$$

where  $IV_{ij}$  is the Indicator Value for species  $i$  in group  $j$ ,  $A_{ij}$  is the relative abundance of species  $i$  in group  $j$ , and  $B_{ij}$  is the relative frequency of species  $i$  in group  $j$ . Indicator Values range from 0 (a species does not occur in a group) to 100 (a species always occurs with greatest relative abundance and frequency in a group). Statistical significance of IV was evaluated using a Monte Carlo randomization procedure in which surveys were randomly reassigned to groups 1000 times, and the IV of the randomized data were recorded each time. With this procedure, the probability of Type I error is the proportion of randomized Indicator Values that exceeds the observed value (Dufrene and Legendre 1997).

## Results

### Mixed-conifer

Variation in species richness in mixed-conifer forest was associated with both grazing utilization ( $F_{1,23}=4.63, P=0.042$ ) and vegetation type ( $F_{1,23}=5.79, P=0.025$ ). More species were detected per station on upland routes (mean=1.81) than on riparian routes (mean=1.42), and more species were detected on high grazing utilization routes (mean=1.88) than low grazing utilization routes (mean=1.37). In the NMS ordination of the mixed-conifer bird communities, two dimensions were selected with a minimum stress value of 16, which were stronger than expected by chance (Monte Carlo test,  $P=0.04$ ). Cumulatively, these two axes captured 79% of the variation in the bird community. Variation in the axis scores was associated with vegetation type (Wilk's lambda=0.757,  $P=0.046$ ), but not with grazing utilization (MANOVA, Wilk's lambda=0.992,  $P=0.913$ ).

### Oak Woodlands

Variation in species richness in oak woodland vegetation was not associated with vegetation type ( $F_{1,16}=2.842, P=0.111$ ) or grazing utilization

( $F_{1,16}=1.179, P=0.294$ ). The oak woodland ordination resulted with two dimensions, and a minimum stress value of 15, which were stronger than expected by chance (Monte Carlo test,  $P=0.02$ ). The axes in the oak woodland ordination captured 74% of the variation in the bird community. Variation in the axis scores was associated with grazing utilization (MANOVA, Wilk's lambda=0.566,  $P=0.014$ ), but not with vegetation type (Wilk's lambda=0.874,  $P=0.366$ ). The first NMS axis of the bird community was positively associated with grazing utilization, and the second NMS axis was negatively associated with grazing utilization (Table 2). Thus the bird community composition in oak woodlands showed a detectable difference between routes classified as low utilization, which occurred in the upper left hand region of the 2-dimensional ordination space and high utilization routes that occurred in the lower right hand of ordination space (Figure 1).

TABLE 2. Spearman rank correlations between grazing utilization scores and abundance of nesting, foraging, and migratory guilds with the axis scores of the non-metric multidimensional scaling (NMS) ordination of 18 routes in oak woodlands in the Cascade-Siskiyou National Monument, Oregon, 2003 and 2004.

Variable	Spearman rho (P-value)	
	NMS axis 1	NMS axis 2
grazing utilization	0.39 (0.108)	-0.57 (0.016)
Nesting guilds		
tree cavities	0.08 (0.737)	< 0.01 (0.997)
trees	-0.42 (0.079)	-0.20 (0.414)
shrubs	-0.66 (0.002)	0.44 (0.059)
ground	0.49 (0.035)	0.185 (0.444)
Foraging guilds		
hawking	-0.33 (0.175)	-0.34 (0.157)
ground gleaning	-0.19 (0.439)	0.15 (0.546)
foliage gleaning	0.04 (0.874)	0.48 (0.041)
bark gleaning	0.122 (0.616)	-0.50 (0.032)
Migratory guilds		
long-distance migrants	-0.49 (0.033)	0.31 (0.202)
residents	0.21 (0.387)	0.03 (0.920)

For the 11 guilds of oak woodland birds, the abundance of individuals in 3 of the guilds was significantly correlated with the first NMS axis and in 2 of the guilds with the second NMS axis (Table 2). Collectively, these patterns suggest that birds that nest in shrubs, forage on foliage, and migrate long distances decrease as grazing

utilization increases, whereas species that nest on the ground and forage on the bark of trees increase as utilization increases (Figure 1).

Although few of the Indicator Values were statistically significant, the trends for most guilds were consistent with the results of the multivariate analysis. For example, 6 of 10 long-distance migrants had a greater Indicator Value in low utilization. Similarly, all three of the shrub-nesting species had greater Indicator Values in low utilization. This included the lazuli bunting (*Passerina amoena*), the only species with a statistically significant Indicator Value. Results of the Indicator

Value analysis for the ground-nesting guild were not consistent with the multivariate analysis. Although the ground-nesting guild was positively associated with the component of the bird community gradient that was correlated with grazing utilization (Figure 1), only 1 of the 3 ground-nesting species had a larger Indicator Value in high utilization. Thus, the spotted towhee (*Pipilo maculatus*) association tended towards high utilization, but the other two ground-nesting species, dark-eyed juncos (*Junco hyemalis*) and Nashville warbler (*Vermivora ruficapilla*) had relatively high indicator values tending towards low utilization areas.

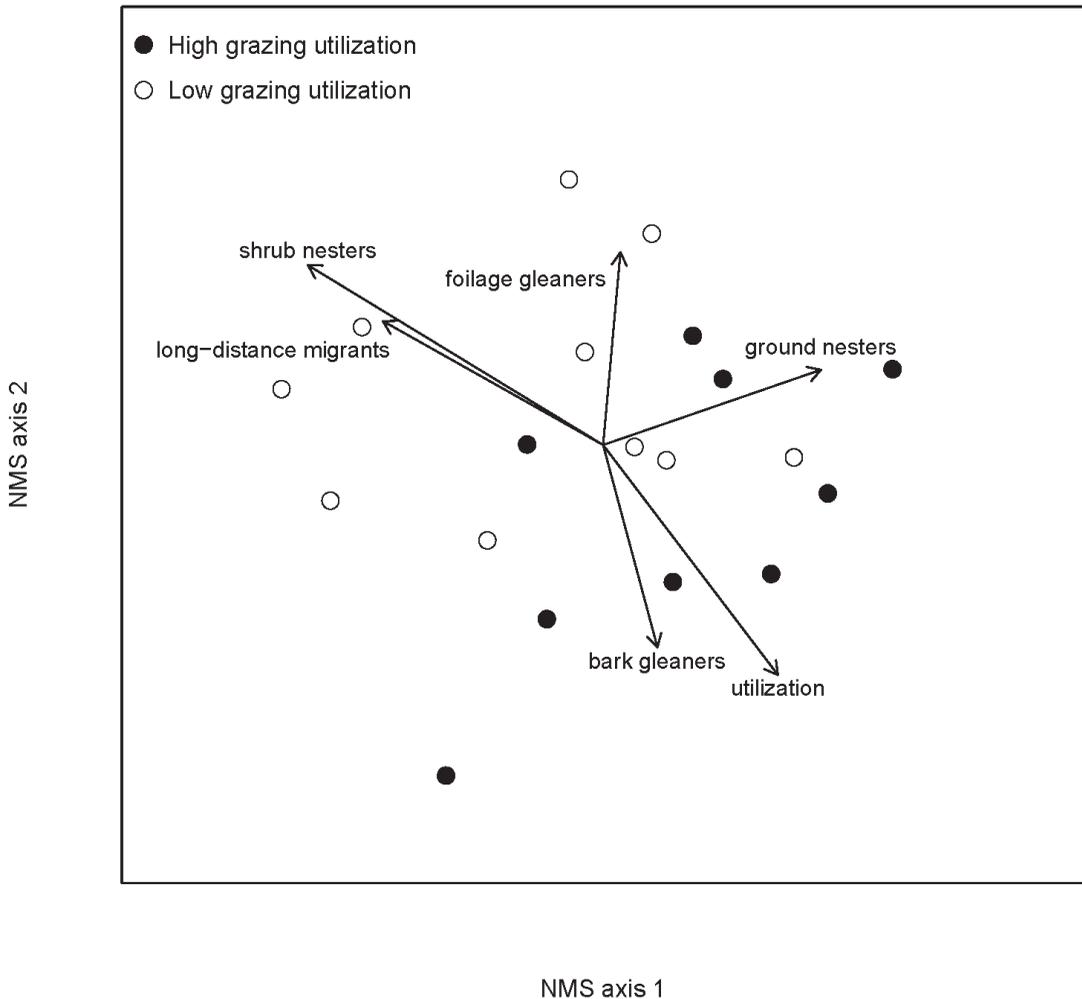


Figure 1. Non-metric multidimensional scaling ordination of bird communities in oak woodlands of the Cascade-Siskiyou National Monument, southern Oregon during 2003 and 2004. Arrows represent the strength and direction of correlations between NMS axes and grazing utilization scores and the abundance of birds in nesting, foraging, and migratory guilds (see Table 2 for correlation coefficients).

## Discussion

Our results suggest that the effects of grazing on bird community composition differs between forest types. In mixed-conifer forests, areas of high grazing utilization had slightly greater species richness than areas with low grazing utilization. However, avian composition in high and low utilization areas was not significantly different in mixed-conifer forests. Thus, in mixed-conifer forest, grazing may increase the overall number of bird species using the area, but does not change bird community composition. In contrast, in oak woodland habitats species richness did not vary between high and low grazing utilization areas, but the composition of the bird community did. There was stronger evidence of differences in community composition between high and low grazing utilization than there was between riparian and upland areas.

Using the ordination axis, we identified a bird-community gradient, along which high utilization sites had higher scores than low utilization sites (Figure 1). We assume that these ordination axes represent a grazing gradient (as measured by avian frequency of occurrence) where routes with the lowest scores are least affected by grazing and routes with the highest score are most affected by grazing. We propose that this measure of grazing impact provides more information than our grazing utilization scores because it uses the bird community composition to integrate the influence of grazing over many years, rather than relying on a measure collected in a single year.

In other systems, grazing impacts on bird communities have been attributed to changes in vegetation structure and composition (Bock et al. 1993, Ammon and Stacey 1997). These changes may represent the combined effects of soil compaction, vegetation removal, reduced topsoil, and water availability associated with grazing (Ryder 1980, Schulz and Leininger 1991, Bock et al. 1993, Ammon and Stacey 1997). Tracking such changes, Taylor (1986) found that increased grazing on a yearly basis significantly reduced shrub volume, shrub height, and bird abundance. Some authors have proposed that lower bird abundance in cattle-grazed riparian habitat may be due to lower insect production, hence, prey base of insect eating birds (Ryder 1980, Fleischner 1994). Furthermore, grazing often reduces ground cover and increases occurrence and size of bare ground patches that

may be important to ground-nesting birds (Green and Kauffman 1985, Willard 1989).

To assess if similar mechanisms were important in our system, we investigated how the abundance of nesting, foraging, and migratory guilds varied across the grazing gradient that we identified based on the ordination of the bird community. Shrub nesting birds decreased in abundance and ground nesting birds increased in abundance across the gradient. Foliage gleaners were more abundant and bark gleaners less abundant in low utilization sites (Table 2). Altered shrub structure, as well as lower insect production, that result from grazing might explain impacts on foliage gleaners. Similarly, reduced shrub volume might increase foraging opportunities for bark gleaners by opening access to more bark surface. We propose, however, that nest-site selection in response to altered vegetation structure is probably more important than foraging site selection. This would be consistent with evidence that food availability is often not a limiting factor for birds in mountain environments (Samson 1980).

The lack of species with statistically significant Indicator Values was probably largely a result of the relatively modest sample size. However, the directions of non-significant trends corroborate the regression analysis of species that migrate long-distances and nest in shrubs. However, they also shed doubt on the conclusion that ground-nesting species are more abundant in areas where grazing utilization is higher. Only the spotted towhee had a greater Indicator Value in this area, dark-eyed junco and Nashville warbler had distinctively greater Indicator Values in low utilization areas.

The decrease in abundance of shrub-nesting birds across the grazing utilization gradient is consistent with results of previous studies. Reduced volume of the shrub layer as a result of grazing may explain why foliage gleaning birds decreased in abundance with increasing grazing utilization. Contrary to our expectations, the abundance of ground nesting species increased across the utilization gradient. This may have resulted if a decrease in the cover of shrubs provided more nest sites for ground-nesting birds.

Grazing may also influence avian community composition by changing reproductive success through impacts that include nest trampling, nest predation, nest parasitism through cowbird attraction, competition, and lowered productiv-

ity of insect prey (Ryder 1980; Samson 1980, Kovalchik and Elmore 1992, Fleischner 1994, Ammon and Stacey 1997). Such effects may be especially important for ground-nesting species (Walsberg 2005). This pattern raises the possibility that ground-nesting birds may suffer reduced reproductive success in our system and further demographic studies are warranted to investigate the role of grazed areas as ecological sinks (Puliam and Danielson 1991).

We also found that long-distance migrants were less abundant in areas of high grazing utilization than in areas of low grazing utilization. This result is consistent with previous studies. In the western United States, livestock grazing has been associated with reduced abundance of 46% of 68 neotropical migrant species (Bock et al. 1993).

### Management Implications

Our results from this study in the Cascade-Siskiyou National Monument suggest that the effects of grazing on avian communities vary between mixed-conifer forest and oak woodland. The greatest effects of grazing appear to be in oak woodlands, where the abundance of shrub-nesting species, foliage gleaners, and long-distance migrants was lower, and the abundance of ground-nesting species higher at more heavily grazed sites. In contrast, we could find no evidence that grazing was associated with bird community composition

(although it did influence species richness) in mixed-conifer habitat. Oak woodland habitats are among the most threatened in southern Oregon and the reduction of grazing is one of the bird conservation recommendations that have been identified for this habitat (Altman 2000). Our data suggest that reducing grazing utilization would likely benefit long-distance migrants, foliage gleaners, and shrub-nesting birds in oak woodland habitats of southern Oregon.

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