Bird Communities in Grazed and Ungrazed Oak-Pine Woodlands at the San Joaquin Experimental Range[1]

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***Abstract**: Ten years of spot-mapping censuses in grazed and ungrazed plots at the San Joaquin Experimental Range, Madera Co., California, indicate likely changes in abundance of several bird species. Data do not, however, indicate that any species is in jeopardy as a result of grazing in the foothill woodlands. Brown-headed cowbirds are probably more abundant in the woodlands with cattle than without cattle, but we have no evidence that cowbird nest parasitism is a threat to any host species. Finally, the European starling's possible impact on native cavity-nesting species is uncertain, but we suspect it is significant for some species.*

In 1934, the USDA Forest Service purchased private ranchlands in foothill woodlands of the western Sierra Nevada to establish the San Joaquin Experimental Range (SJER). The stated objective of this acquisition was to undertake range research in California, which "...is most important for the stability of a large industry and for the maintenance of public values to be rendered by grazing lands" (Kotok 1933). Foremost among the public values of interest at the time were a viable livestock industry, sustainable water resources, and rangeland production. Other values were also recognized, including the rich wildlife communities that occur in the foothill woodlands. Publications based on studies of a wide variety of species in all vertebrate classes at SJER began to appear in the late 1930's and early 1940's (Duncan and Coon 1985).

The primary objective of the present study was to evaluate spot mapping as a method to estimate the densities of breeding bird populations. Secondarily, we hoped to attain some insights into possible effects of long-term grazing on bird communities in oak-pine woodlands of the western Sierra Nevada. This second objective was possible only because a 32-ha parcel was set aside in 1934 and has been excluded from livestock grazing ever since. In this paper, we compare the breeding bird community in this ungrazed parcel with that in a grazed study area of equal size. Although the study lacks replication because only one ungrazed parcel was available, we nonetheless believe that some useful biological inferences can be drawn from the results.

Study Area

With an area of approximately 1,875 ha and ranging in elevation from 215 to 520 m, SJER is located in the western foothills of the Sierra Nevada, approximately 31 km northeast of Madera, California. The climate is characterized by cool, wet winters and hot, dry summers. Mean annual precipitation from 1934 to 1994 was 46.7 cm, with about 95 percent of that falling as rain from October through April. Snow is unusual, and daily maximum temperatures have exceeded freezing on all but 2 days in 57 years of weather data taken at the headquarters area. A sparse woodland overstory of blue oak (scientific names of plants in *table 1*), interior live oak, and foothill pine covers most of SJER. An understory of scattered shrubs includes mainly buckbrush, chaparral whitehorn, redberry, and Mariposa manzanita. In a few smaller patches, the overstory is primarily blue oak, and a

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Table 1—Vegetation attributes (mean ±standard deviation)[1] on the ungrazed and grazed plots at the San Joaquin Experimental Range (original data from Waters 1988 and personal communication)

Attribute	Ungrazed plot	Grazed plot	*t*-value	*P*
Mean canopy cover (pct)	26.65 ± 26.53	29.48 ± 17.45	0.56	[a]0.5749
Tree densities (stems/ha)	54.69 ± 58.68	54.69 ± 40.60	0	[a]1.0000
Foothill pine (*Pinus sabiniana*)	30.62 ± 50.79	15.94 ± 26.70	1.62	[a]0.1110
Blue oak (*Quercus douglasii*)	7.50 ± 12.27	10.62 ± 16.64	0.95	[a]0.3431
Interior live oak (*Quercus wislizenii*)	15.00 ± 18.82	25.94 ± 23.58	2.29	[a]0.0247
California buckeye (*Aesculus californica*)	1.56 ± 6.45	2.19 ± 8.90	0.36	[a]0.7181
Mean shrub cover (pct)	20.60 ± 14.40	6.10 ± 7.33	5.68	[a]*<0.0001*
Buckbrush (*Ceanothus cuneatus*)	14.30 ± 13.39	2.13 ± 4.90	5.40	[b]*<0.0001*
Chaparral whitethorn (*Ceanothus leucodermis*)	0	1.13 ± 3.42	2.09	[b]0.0432
Redberry (*Rhamnus crocea*)	1.95 ± 3.24	0.80 ± 2.53	1.77	[b]0.0810
Coffeeberry (*Rhamnus californica*)	1.18 ± 2.96	0.70 ± 2.69	0.76	[b]0.4502
Poison oak (*Toxicodendron diversilobum*)	1.73 ± 4.65	0.18 ± 0.71	2.08	[b]0.0434
Mariposa manzanita (*Arctostaphylos mariposa*)	1.38 ± 3.37	0.85 ± 1.86	0.87	[b]0.3873
Dead shrubs	1.50 ± 3.17	1.10 ± 2.19	0.66	[b]0.5136
Mean shrub height (m)	2.21 ± 0.81	1.73 ± 1.25	2.04	[a]0.0455

[1]Forty systematically located, circular subplots of 0.08 ha each were sampled on each plot. Significant *P*-values are in italics.
[a]Bonferroni adjustment for multiple comparisons requires a *P*-value of 0.0125 or less for significance at the 0.05 level.
[b]Bonferroni adjustment for multiple comparisons requires a *P*-value of 0.0071 or less for significance at the 0.05 level.

shrub understory is meager or missing. Some areas of typical annual grassland extend throughout the remainder of SJER where the overstory and understory are not dense enough to shade them out or are lacking altogether.

Duncan and others (1985) provided the most recent full summary of the avifauna at SJER, but extensive studies of birds there since 1985 have considerably expanded our knowledge of birds of the area. Available records now total 193 species of birds detected at SJER, but 45 of those have been recorded only once or twice, leaving 148 species that occur at the Range with any regularity. Only 56 of those species are confirmed breeders; common barn-owls (*Tyto alba*) and wrentits (scientific names of most birds in *table 2*) probably also breed at SJER, but their nests or fledglings have yet to be located there.

Methods

Vegetation on the two 29.7-ha plots was sampled by Waters (1988) following the methods of James and Shugart (1970). An "ungrazed plot" was established in the small parcel that was set aside in 1934 to be secure from grazing, and a "grazed plot" of equal size was delineated in a site with approximately the same tree canopy cover, based on inspection of aerial photographs. The two plots were 1.33 km apart. Only major attributes of trees and shrubs were sampled (*table 1*) to provide approximate comparisons of the structure of woody vegetation on the plots. Within each plot, Waters systematically located 40 circular subplots of 0.08 ha each. Unpaired *t*-tests were used to compare measures of vegetation between plots; Bonferroni adjustments for multiple comparisons required *P*-values of 0.0125 and 0.0071 for significance at the 0.05 level (see *table 1*).

We estimated the numbers of territorial birds on the plots for 9 years, 1985 through 1993, using the internationally standardized spot-mapping method (Anonymous 1970, Robbins 1970). To assist field crews with their mapping, steel fence posts with alpha-numeric codes identified all intersections at 30-m intervals on grids covering both plots. Most visits to the plots were done in April each year, but starting and ending dates were adjusted to some extent by spring phenology. The earliest starting date was 22 March, and the latest was 5 April. The earliest ending date was 25 April, and the latest was 5 May. Beginning

Table 2—Mean numbers of territories (±standard deviation) of birds, by nesting guild, per year (n = 9) on an ungrazed and a grazed plot, San Joaquin Experimental Range, from 1985 to 1993[1]

Guild Species	Ungrazed plot	Grazed plot	*t*-value	*P*
Primary cavity nesters				
Acorn woodpecker (*Melanerpes formicivorus*)	4.8 ± 1.8*	5.2 ± 1.6*	1.02	0.3359
Nuttall's woodpecker (*Picoides nuttallii*)	0.8 ± 0.3*	1.2 ± 0.7*	1.79	0.1108
Hairy woodpecker (*Picoides villosus*)	0.3 ± 0.5	0	2.00	0.0805
Northern flicker (*Colaptes auratus*)	0.2 ± 0.3	0.2 ± 0.3	0.00	1.0000
Guild total	6.2 ± 1.7	6.6 ± 2.0	1.10	0.3027
Mean species richness	2.8 ± 0.7	2.4 ± 0.5	2.00	0.0805
Secondary cavity nesters				
Plain titmouse (*Parus inornatus*)	14.1 ± 5.8*	19.6 ± 8.3*	4.50	0.0020
Bewick's wren (*Thryomanes bewickii*)	6.8 ± 3.3*	5.1 ± 1.7*	1.76	0.1156
Ash-throated flycatcher (*Myiarchus cinerascens*)	5.3 ± 1.3*	7.9 ± 2.2*	3.36	0.0099
House wren (*Troglodytes aedon*)	4.9 ± 4.7	6.6 ± 4.6*	5.35	*0.0007*
European starling (*Sturnus vulgaris*)	2.6 ± 1.9*	4.2 ± 1.1*	2.05	0.0743
White-breasted nuthatch (*Sitta carolinensis*)	2.4 ± 1.3*	3.2 ± 1.5*	1.90	0.0939
Western bluebird (*Sialia mexicana*)	1.4 ± 1.1	1.9 ± 0.9*	1.34	0.2165
Violet-green swallow (*Tachycineta thalassina*)	0.9 ± 0.8	3.4 ± 2.8	3.07	0.0154
American kestrel (*Falco sparverius*)	0	0.4 ± 0.5	2.87	0.0207
Guild total	38.5 ± 6.6	52.2 ± 9.2	3.49	*0.0082*
Mean species richness	7.4 ± 0.7	8.3 ± 0.5	2.29	0.0516
Tree nesters				
Mourning dove (*Zenaida macroura*)	8.6 ± 3.4*	8.5 ± 2.5*	0.11	0.9127
Bushtit (*Psaltriparus minimus*)	7.3 ± 3.4*	7.3 ± 3.7*	0.07	0.9478
Lesser goldfinch (*Carduelis psaltria*)	6.9 ± 3.4*	5.7 ± 2.2*	1.19	0.2670
House finch (*Carpodacus mexicanus*)	4.9 ± 3.6	5.4 ± 4.5	0.76	0.4714
Anna's hummingbird (*Calypte anna*)	4.3 ± 1.3*	3.5 ± 1.0*	1.65	0.1382
Bullock's oriole (*Icterus bullockii*)	1.5 ± 0.8*	0	6.00	*0.0003*
Blue-gray gnatcatcher (*Polioptila caerulea*)	1.1 ± 1.1	1.9 ± 1.4	2.36	0.0462
Lawrence's goldfinch (*Carduelis lawrencei*)	1.0 ± 1.6	0.9 ± 1.2	0.22	0.8337
Hutton's vireo (*Vireo huttoni*)	0.9 ± 0.8	1.0 ± 0.7	0.45	0.6646
Western kingbird (*Tyrannus vociferans*)	0.6 ± 0.5	0	3.35	0.0100
Red-tailed hawk (*Buteo jamaicensis*)	0.4 ± 0.4	0.2 ± 0.4	0.82	0.4379
Great horned owl (*Bubo virginianus*)	0.2 ± 0.4	0	1.84	0.1038
Phainopepla (*Phainopepla nitens*)	0.2 ± 0.5	0.1 ± 0.2	1.00	0.3466
American robin (*Turdus migratorius*)	0.1 ± 0.2	0.1 ± 0.3	0.43	0.6811
Cooper's hawk (*Accipiter cooperi*)	0.1 ± 0.2	0	1.51	0.1690
Long-eared owl *(Asio otus)*	0.1 ± 0.3	0	1.00	0.3466
Common raven (*Corvus corax*)	0.1 ± 0.2	0	1.51	0.1690
Guild total	38.3 ± 8.3	34.5 ± 7.9	1.77	0.1140
Mean species richness	9.8 ± 1.6	7.7 ± 1.5	4.50	*0.0020*
Shrub nesters				
Western scrub-jay (*Aphelocoma californica*)	8.1 ± 3.7*	6.8 ± 2.8*	1.60	0.1465
California towhee (*Pipilo crissalis*)	6.2 ± 2.0*	4.4 ± 1.7*	5.68	*0.0005*
California thrasher (*Toxostoma redivivum*)	1.1 ± 1.0	0	3.22	0.0122
Wrentit (*Chamaea fasciata*)	0.4 ± 0.5	0	2.53	0.0353
Greater roadrunner (*Geococcyx californianus*)	0.2 ± 0.4	0.1 ± 0.2	0.80	0.4468
Guild total	16.1 ± 4.9	11.3 ± 4.2	7.49	*0.0001*
Mean species richness	3.3 ± 0.9	2.1 ± 0.3	3.77	*0.0054*
Ground nesters				
California quail (*Callipepla californica*)	6.8 ± 3.2*	6.4 ± 2.1*	0.27	0.7960
Canyon wren (*Catherpes mexicanus*)	0.4 ± 0.4	0.4 ± 0.4	0.29	0.7824
Lark sparrow (*Chondestes grammacus*)	0.2 ± 0.5	0.4 ± 0.7	0.69	0.5121
Rufous-crowned sparrow (*Aimophila ruficeps*)	0	0.3 ± 0.4	2.29	0.0509
Rock wren (*Salpinctes obsoletus*)	0	0.1 ± 0.2	1.00	0.3466
Turkey vulture (*Cathartes aura*)	0	0.1 ± 0.2	1.00	0.3466

(continued)

(Table 2, continued)

Guild Species	Ungrazed plot	Grazed plot	*t*-value	*P*
Guild total	7.4 ± 2.9	7.7 ± 2.0	0.25	0.8103
Mean species richness	1.8 ± 0.8	2.7 ± 1.1	1.74	0.1209
Other species				
Brown-headed cowbird *(Molothrus ater)*	4.2 ± 1.4*	3.2 ± 1.5	2.13	0.0660
Total	4.2 ± 1.4*	3.2 ± 1.5	2.13	0.0660
Mean species richness	1.0 ± 0	0.9 ± 0.3	1.00	0.3466
Summary for all species				
Total territories	110.8 ±14.5	115.4 ±19.6	1.17	0.2761
Species richness	26.2 ± 2.6	23.9 ± 1.6	3.50	*0.0081*
Pairs/ha	3.7 ± 0.49	3.9 ± 0.60	1.17	0.2741

[1]Within each guild, species are listed in descending order of abundance. Bonferroni adjustments for multiple comparisons of differences in density between plots require a *P*-value of 0.0012 for significance at the 0.05 level for individual species and 0.01 for guild totals and species richness. Significant *P*-values are in italics. An asterisk (*) designates species holding territories on a plot in all years of the study.

within 10 minutes of local sunrise in generally fair weather, observers walked along alternate lines of the grids and systematically noted on field maps the locations of all birds detected, using specific codes to designate, as possible, sex, vocalizations, movements, and other specific behaviors (copulation, territorial defense, carrying nest materials or food, and so on). Based on 12 such visits per season to each plot, composite maps of all detections of each species were transferred to separate maps for each species. Observers then interpreted the maps to identify clusters of detections believed to localize the territories of individuals or pairs of each species. Any territory that overlapped the plot boundary was tallied as half a territory when summing the total number of territories of a species on the plot.

Because results on the two plots could be paired within years ($n = 9$), paired *t*-tests were used to compare species richness, the numbers of territories of individual species, and the collective totals for nesting guilds between the plots. We tested for normality using the Shapiro-Wilk test (SAS 1988). Given a basic alpha level of 0.05, Bonferroni adjustments for multiple comparisons gave alpha levels of 0.0100 for comparisons of species richness, 0.0012 for comparisons of species abundances, and 0.0100 for comparisons of guild abundances (excluding "other nesters") between plots. The appropriate alpha level for comparing differences in abundance among guilds *within* plots is 0.0050 (again excluding "other nesters").

Results

Woody Vegetation

Tree densities and percentages of canopy cover were essentially the same on both plots, but foothill pine dominated tree cover on the ungrazed plot and interior live oak dominated on the grazed plot (*table 1*). Total shrub cover on the ungrazed plot was 3.4 times that on the grazed plot ($t = 5.68$; $n = 40$; $P < 0.0001$). Buckbrush, the dominant shrub species on both plots, had 6.8 times the cover on the ungrazed compared to the grazed plot ($t = 5.40$; $n = 40$; $P < 0.0001$). In addition, shrubs on the grazed plot were clearly more affected by browsing than those on the ungrazed plot, although many shrubs on the ungrazed plot were heavily browsed by black-tailed deer (*Odocoileus hemionus*). Browsed shrubs tended to have very dense foliage and shapes like inverted pears or urns.

Comparing Bird Communities

Among the 58 species of birds that have nested at SJER, 42 have been recorded as territorial on the two plots collectively, with 38 on the ungrazed plot, and 33 on the grazed plot. On each plot, only 16 species held territories in all 9 years of the study, and 14 of those species were the same on both plots. Neither the total numbers of territories nor territorial densities differed significantly between plots (*table* 2). Mean species richness on the ungrazed plot was significantly greater than that on the grazed plot, but few differences were found between the abundances of individual species on the two plots (*table* 2). Among species that held territories on both plots at least in some years, California towhees and Bullock's orioles were significantly more abundant on the ungrazed plot, and house wrens were significantly more abundant on the grazed plot. According to Simpson and others (1960:422), given the same means, standard deviations, and paired *t*-values, no other species would test significantly different between plots even with an infinite number of years sampled.

Eight species have held territories only on the ungrazed plot during the course of this study: one primary cavity nester—hairy woodpecker; five tree nesters—Cooper's hawk, great horned owl, western kingbird, common raven, and Bullock's oriole; and two shrub nesters—wrentit and California thrasher. These species have all been detected regularly during the breeding period in grazed locations at SJER away from the grazed plot. Only the hairy woodpecker, wrentit, and California thrasher are considered to be uncommon to rare breeders at the Range, but our annual (1985-1995) point counts in March and April at 210 counting stations throughout SJER produce low numbers of these species at various places at SJER nearly every year.[3]

Only four species have held territories on the grazed plot but not on the ungrazed plot: a secondary cavity nester (American kestrel) and three ground nesters (turkey vulture, rock wren, and rufous-crowned sparrow).

Comparing Guilds

On the ungrazed plot, the pooled abundances of species in the nesting guilds (excluding brown-headed cowbirds) all differed significantly among themselves ($P < 0.005$) except primary cavity nesters vs. ground nesters and secondary cavity nesters vs. tree nesters. On the grazed plot, all guilds differed among themselves except primary cavity nesters vs. ground nesters and shrub nesters vs. ground nesters. The rank order of abundance of territories by guild was the same on each plot—secondary cavity nesters were most abundant, then tree nesters, shrub nesters, ground nesters, primary cavity nesters, and other species (*table* 2). In terms of species, the ungrazed plot had more tree-nesting species (both mean and total numbers) than any other guild, followed by secondary cavity nesters. Although the grazed plot had a higher total number of tree-nesting species than secondary cavity nesters, the mean number of tree nesters on the grazed plot was less than that of secondary cavity nesters.

Collectively, the nesting guilds that depend on trees for nest sites (primary and secondary cavity nesters and tree nesters) comprised 76.3 percent of the species and 75.0 percent of the territorial individuals on the ungrazed plot, and 69.7 percent of the species and 80.8 percent of the territorial individuals on the grazed plot. Particularly striking in these comparisons was the marked contrast in abundance between secondary cavity nesters (45.2 percent of all territories) and tree nesters (29.9 percent of territories) on the grazed plot but not on the ungrazed plot (34.8 percent vs. 34.6 percent) (*table* 2). The grazed plot had significantly more territories of secondary cavity nesters than the ungrazed plot,

[3] Unpublished data on file, Forestry Sciences Laboratory, Fresno, CA.

and eight of nine species of secondary cavity nesters had more territories, but not significantly more, on the grazed grid.

For most guilds on both plots, the percentages of total territories were about the same or slightly smaller than the corresponding percentages of total species. In contrast, however, the numbers of territories held by secondary cavity nesters were out of proportion to the numbers of species that were secondary cavity nesters—by 1.65 times on the ungrazed plot and by 1.66 times on the grazed plot.

Another striking aspect of these bird communities was the small representation by shrub nesters—only 5 species (13.2 percent) and 16.0 territories (14.5 percent) on the ungrazed plot, and 3 species (9.1 percent) and 11.3 territories (9.8 percent) on the grazed plot. Significantly more territories were held by shrub nesters on the ungrazed than on the grazed plot, but the proportional difference (1.4 times) did not approach that in total shrub cover (3.4 times) or cover by buckbrush (6.8 times). Buckbrush was the predominant shrub species used for nesting on the ungrazed plot, but shrub nesters on the grazed plot tended to use interior live oaks with a shrub-like growth form.

The European Starling

Although the numbers of starling territories did not differ significantly between plots, starlings on the grazed plot outnumbered those on the ungrazed plot by 1.62 times ($t = 2.05$; $P = 0.07$). More importantly, starlings were observed nesting and foraging in most areas of the grazed plot, which generally had only a relatively sparse ground cover of short grasses and forbs as a result of grazing. On the other hand, starlings did not forage over most of the ungrazed plot, which had a nearly continuous ground cover of tall grasses and forbs. Most of their foraging there occurred in the northwest corner of the plot, which included a small section of horse pasture. All starling nests on the ungrazed plot were located near plot edges, most of them in or adjacent to the horse pasture. Unlike most other species nesting on these plots, starlings have overlapping territories, with up to three pairs nesting in different cavities in the same tree. On the ungrazed plot, most of these territories were concentrated in the horse pasture.

Discussion

Avian Biodiversity

Although all major habitat divisions contribute to bird species richness in these two communities, avian biodiversity is largely driven by the availability of tree cover. Secondary cavity-nesting species comprise a very high proportion of the nesting species and territories. Most excavated nest cavities in these habitats can be attributed to the acorn and Nuttall's woodpeckers, as northern flickers and hairy woodpeckers are uncommon to rare nesters in these study areas. Consequently, although most species of secondary cavity nesters do use natural cavities to some extent, they still depend on the acorn and Nuttall's woodpeckers for a continuing supply of nesting sites. These are, therefore, keystone species upon which 35-45 percent of the nesting birds in the community depend.

The fact that territories of secondary cavity nesters were significantly more abundant on the grazed than on the ungrazed plot may have reflected the fact that the grazed plot had 1.6 times more cavity trees and 1.4 times more nest cavities than the ungrazed plot (Waters 1988:25). Such a relationship could be expected if available nest cavities limited the number of secondary cavity nesters on these plots. On the basis of an exhaustive cavity-blocking experiment on these two plots in 1985 and 1986, however, Waters (1988) concluded that cavities were not limiting the numbers of secondary cavity nesters.

Most of the species that held territories on the ungrazed plot but not the grazed plot have been found nesting in other locations at SJER where grazing occurs. This is the case with the Cooper's hawk, great horned owl, long-eared owl, hairy woodpecker, western kingbird, common raven, California thrasher, and Bullock's oriole. Grazing has probably reduced the numbers of some of these species in the oak-pine woodlands, but it has certainly not threatened their populations. These woodlands provide only marginal habitat for the hairy woodpecker, which finds optimum habitats in the conifer forests at higher elevations in the Sierra Nevada.

Possible Concerns Related to Grazing

Direct Effects

Reduction in shrub cover and in grass and forb biomass are the most conspicuous effects of grazing on habitats important to these bird communities. The greater cover by shrubs on the ungrazed plot probably accounts for the significantly greater number of territories of shrub nesters there, and it almost certainly accounts for the fact that territories of wrentits and California thrashers were found only on the ungrazed plot. Both of these species are associated with dense chaparral (Grinnell and Miller 1944). Because the scattered shrubs and patches of shrubs at SJER are approaching the lower elevational limit of shrubs in the western foothills of the Sierra Nevada, they probably represent marginal habitat for wrentits and California thrashers. Both species are more abundant at higher elevations in the foothills, where more extensive shrubfields occur. Consequently, although grazing in the foothills has most likely resulted in a decline in numbers of these two species, this has probably not put either of them in jeopardy in the western Sierra Nevada as a whole.

Indirect Effects

European Starling—Since its initial occurrence in California in the early 1940's (Grinnell and Miller 1944:572), the European starling has become abundant and widespread, especially in woodland habitats at lower elevations. It was first recorded at SJER in the early 1960's and several nesting pairs were established by 1970 (Duncan and others 1985). No nesting pairs were present on either the grazed or ungrazed plot in 1978,[4] but a few pairs were nesting on each plot by 1985 (Waters 1988).

Data from our extensive point-count work throughout the grazed landbase of SJER from 1985 through 1995[3] show that the starling's numbers nearly doubled there in the last 5 years compared to the first 5 years. This may have resulted from their learning to forage well enough to breed successfully in the oak-pine woodlands. According to Duncan and others (1985:30), large flocks of starlings were seen feeding in wet swales along the entrance road to SJER in March 1974. Stomach contents of 21 birds collected then contained almost exclusively the larvae of the range crane fly (*Tipula* sp.). Because we have not seen starlings forage in the tall grasses and forbs on the ungrazed plot, we believe their range extension and increase in abundance in the foothill woodlands have been enhanced by grazing, which results in short grasses and forbs so the birds can forage easily on the ground.

Starlings use nest cavities similar in size and shape to those used by native species, especially western bluebirds and violet-green swallows (Purcell 1995). Consequently, their successful "invasion" of foothill oak-pine woodlands may negatively affect some species of secondary cavity nesters there. Starlings often used nest cavities that were used in prior years by other secondary cavity nesters. In addition, we have seen starlings use cavities for winter roosts at SJER, some of which we knew to be used previously for winter roosts by other species.

[4]Personal observation, J. Verner.

Indirectly then, by enhancing habitats for starlings, grazing in the foothills may be having a negative influence on the numbers of some native cavity-nesting bird species.

Brown-headed Cowbird—Because cowbirds regularly associate with cattle for access to supplemental food sources, they are probably more abundant in the foothill oak-pine woodlands today than they would be in the absence of grazing. Grinnell and Miller (1944:437) state that their numbers "...increased phenomenally in the Sacramento Valley since 1927, if not earlier." Because the center of each plot was only 225 m from the nearest edge, cowbirds on the ungrazed plot would have ready access to supplemental food sources associated with nearby livestock. This may explain why we did not observe a significant difference in the numbers of cowbirds between the two plots, and it also makes it unlikely that we would ever detect a significant difference between plots in the rate of cowbird nest parasitism on any host species.

None of our data suggested that nest parasitism by cowbirds has threatened the viability of any host species that currently breeds at SJER, although it may depress populations of some hosts, such as the California gnatcatcher and Hutton's vireo. Although cowbirds probably contributed to the extirpation of the least Bell's vireo (*Vireo bellii pusillus*) from central California (Goldwasser and others 1980), the lowland distribution of this species probably did not include SJER.

Other Studies

We are not aware of any similar study elsewhere in the oak-pine woodlands that ring the Central Valley of California. The generally minor impacts of grazing on the bird communities reported in this study, however, contrast markedly with similar studies in other habitats. This is particularly the case in riparian habitats, where densities of some bird species differ by orders of magnitude in response to grazing (for example, Taylor 1986 and recent review by Ohmart 1994). An excellent review by Bock and others (1993:296) summarized existing literature on the relations of neotropical migrant bird populations to grazing:

> Among 35 plains species for which data are available, 9 responded positively to grazing, 8 responded negatively, 8 showed a graded response, from generally negative in shorter grasslands to generally positive in taller grasslands, while 8 were unresponsive or inconsistent. A similar comparison for riparian woodlands revealed that 8 of 43 species responded positively to grazing, while 17 were negatively affected, and 18 were unresponsive or showed mixed responses. Data for shrubsteppe habitats are much more limited, but only 3 of 23 species probably have been positively affected, at least by current grazing practices, while 13 probably have been negatively influenced, and at least 7 species showed mixed responses. Virtually nothing is known about effects of grazing on birds of coniferous forests.

A Need for Replication

This study is based on a comparison between one grazed and one ungrazed plot. As such, it is an unreplicated case study. On the basis of more extensive knowledge from throughout their ranges in the western Sierra Nevada, however, we believe that our results at SJER attain more general significance when taken in the context of the known habitat relations of these bird species. Nonetheless, additional comparisons involving other matched pairs of grazed and ungrazed pastures are needed to confirm or negate results of this study. Opportunities for such replication exist at the Hopland Research and Extension Center in Mendocino County—pastures of 126 and 48 ha that have excluded livestock grazing since the late 1950's (Timm 1996)—and the Sierra Foothill Research and Extension Center in Yuba County—pastures of 66 and 44 ha that have excluded livestock grazing since 1972 (Connor 1996).

Conclusions

Overall, results of this study do not show that grazing has led to the loss of any bird species that regularly nests in this foothill oak-pine woodland. The direct effects of reduced shrub cover and height by grazing on shrub-nesting birds are not as pronounced as we might expect. It is almost certainly true that the number of cowbirds in these woodlands is higher with cattle present than would be the case without them. Whether nest parasitism by cowbirds is a serious concern for any host species remains to be evaluated; however, no evidence of such an impact is yet available. Similarly, the question of the starling's possible impact on other secondary cavity nesters remains uncertain at this time, although we suspect it could be significant for some native species, especially if starlings continue to increase in abundance at SJER.

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