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COMPARISON OF AVIAN COMMUNITY DYNAMICS OF BURNED AND UNBURNED COASTAL SAGE SCRUB[1]

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Abstract. Bird species richness, abundance and activity were compared between a control area (CA) of mature coastal sage scrub and a burned area (BA) near Los Angeles, California. Data were collected in paired samples on 80 species of birds from January 1983 to May 1984. The CA provided more habitat requirements for more individuals and species of birds throughout the year than the BA. Nonresidents used highly seasonal food sources that were little used by resident species. The BA was an adequate foraging area only during the spring and did not offer the same variety of vegetation types as the CA. Fire was found to decrease bird species richness in coastal sage scrub, unlike the pattern found in chaparral bird communities.

Key words: Coastal sage scrub; habitat management; burned habitat; foraging areas; seasonality.

INTRODUCTION

Prescribed burning programs in Mediterranean plant communities have raised questions regarding habitat management in both chaparral and lower-elevation coastal sage scrub (Westman 1981a, Minnich 1983). Moriarty et al. (1985) showed that bird species diversity is much lower in the first months after a coastal sage scrub fire and increases to a level comparable to an area of mature scrub within the first year. I did not, however, examine whether bird species diversity increases only immediately following a fire or changes cyclically.

By monitoring changes in bird species richness, abundance, and activity in both burned and unburned coastal sage scrub, I examined how seasonality and fire affected the dynamics of the coastal sage scrub bird community. This expands a previous study (Moriarty et al. 1985) to show that burned areas of coastal sage scrub undergo cyclical changes in bird species diversity and are not adequate foraging areas for the permanent residents for most of the year.

STUDY AREAS

I established two study areas of approximately 2 ha on the campus of California State Polytechnic University, Pomona, Los Angeles County, California. The areas were contiguous coastal sage scrub prior to the fire. Rainfall was concentrated in the late winter and early spring, followed by a summer drought period like that characteristic of Mediterranean climates.

The control area (CA), composed of mature coastal sage scrub, was a small canyon opening toward the east at an elevation of approximately 300 m. The common plant species (and their cover values during the second spring after the fire) were California sagebrush (*Artemisia californica,* 39.7%), toyon (*Heteromeles arbutifolia,* 10.4%) and elderberry (*Sambucus mexicana,* 5.0%). Vegetation in the CA occurred in distinct patches of vegetation types: toyon and live oak (*Quercus agrifolia,* 2.2%) on the north-facing slope; elderberry, Calfornia sagebrush, white sage (*Salvia apiana,* 10.2%) and scrub oak (*Quercus dumosa,* 4.5%) in the lower part of the canyon; and *Bacharris pilularis* (2.2%), California sagebrush, and cactus (*Opuntia basilaris,* 2.7%) on the more xeric south facing slope. The cover was 23.1% herbaceous.

The other study area (BA) was selected from a 9-ha area of coastal sage scrub that burned in August 1981. The fire destroyed all but the largest trees and shrubs. The dominant plant species in the area were wild oat (*Avena fatua*), bromegrass (*Bromus* sp.; total cover of grasses: 13.7%), black sage (*Salvia mellifera,* 10.4%), globe mallow (*Sphaeralcea angustifolia,* 6.8%), Lotus (*Lotus scoparius,* 25.8%), and field mustard (*Brassica campestris,* 5.9%). A few of the larger shrubs had crown-sprouted or survived the fire intact, such as walnut (*Juglans californica,* 3.6%), toyon (1.8%), and elderberry (4.0%). Dead shrubs made up 12.3% of the standing vegetation by cover; miscellaneous plants made up the remaining 15.6%. This area was on a south-facing slope and bordered a woodland composed of walnut and toyon.

METHODS

I censused the birds at approximately weekly intervals from January 1983 to May 1984. A total of 56 paired samples were taken. Each area (random order of CA and BA) was censused for a period of 50 min on consecutive days (weather permitting) within 1 hr of sun-

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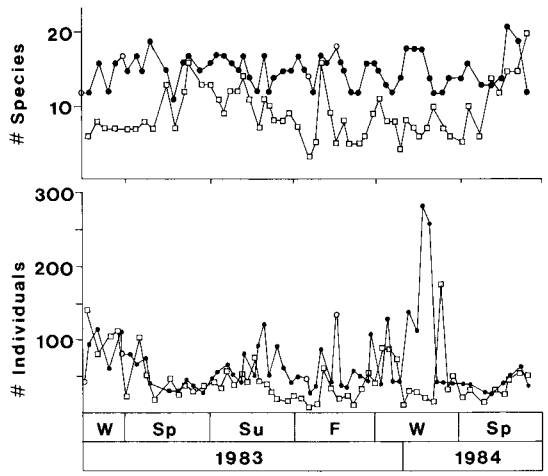

FIGURE 1. Number of species (top figure) and number of individuals (bottom figure) in burned and unburned areas of coastal sage scrub. Open squares indicate samples in the burned area; solid circles indicate samples in mature coastal sage scrub. Open circles denote unpaired censuses, which were not entered into analyses.

rise. I recorded species, number of individuals, and activity of birds that used the immediate study area. I observed birds from a fixed elevated point that allowed a view of the entire study area. This allowed me to collect habitat use data on birds without bias caused by movement through the dense vegetation in the CA.

All birds and their activities were observed for as long as they were in the study area. Bird density was low enough during this study so that the problem of missing an observation of one bird while watching another was minimal. Analyses include sequential observations of birds; movement of an individual to a new plant was recorded. For analysis of activity, I used all sequential observations, since Morrison (1984) found no difference in analyses using point (first) versus sequential activity observations except in detecting rare foraging strategies. Activity was classified into foraging (gleaning, surveying from the air [hawks], ground foraging, etc.), perching (as in resting behavior; flycatchers perching between sallies were considered to be foraging), aggression, and reproduction (copulation, courtship display, nest building, etc.). I determined dietary categories from observing foraging birds in the area during the study.

Permanent residents were defined as species present in at least one of the study areas during all four seasons, and seasonal residents as those present on at least five counts during the season. "Regular species" were present on three or more counts and were therefore considered to be seen regularly in areas of coastal sage scrub.

I tested ratios of number of individuals of each species in each study area to determine area preferences. A 1:1 ratio of CA to BA would indicate no preference for either area (χ^2 goodness-of-fit test using Yates' correction). I used polynomial regression to determine cyclical patterns of diversity and abundance values. Unless otherwise stated, statistical analyses follow Zar (1974). A critical value of 0.05 was required for all statistical analyses.

TABLE 1. Ratios of individual sightings of "regular" non-resident bird species in the control (CA) and burned (BA) areas and their area preference. CA and BA indicate a significant preference (pref.) for the control area or the burned area, respectively, and a dash indicates no significant preference for either area.

	Ratio (CA/BA)	Pref.	χ^2
Winter residents			
Sharp-shinned Hawk (*Accipiter striatus*)	6/4	—	0.1
Say's Phoebe (*Sayornis saya*)	0/14	BA	12.1
Ruby-crowned Kinglet (*Regulus calendula*)	57/1	CA	52.2
Western Bluebird (*Sialia mexicana*)	79/96	—	1.5
American Robin (*Turdus migratorius*)	97/11	CA	66.9
Cedar Waxwing (*Bombycilla cedrorum*)	602/92	CA	373.3
Yellow-rumped Warbler (*Dendroica coronata*)	14/263	BA	222.0
White-crowned Sparrow (*Zonotrichia leucophrys*)	51/16	CA	17.3
Dark-eyed Junco (*Junco hyemalis*)	10/12	—	0.0
Summer residents			
Black-chinned Hummingbird (*Archilochus alexandri*)	7/13	—	1.3
Ash-throated Flycatcher (*Myiarchus cinerascens*)	8/18	—	3.1
Western Kingbird (*Tyrannus verticalis*)	1/11	BA	6.8
Phainopepla (*Phainopepla nitens*)	61/5	CA	45.8
Black-headed Grosbeak (*Pheucticus melanocephalus*)	27/9	CA	8.0
Brown-headed Cowbird (*Molothrus ater*)	29/38	—	1.0
Northern Oriole (*Icterus galbula*)	17/11	—	0.9
Spring (S) or fall (F) transients			
Wilson's Warbler (S & F) (*Wilsonia pusilla*)	6/7	—	0.0
Lazuli Bunting (S) (*Passerina amoena*)	0/37	BA	35.0

RESULTS

I recorded 80 bird species in the two study areas, but 45 of these species occurred on three or more counts. The number of species remained relatively high in the CA throughout the year, while the number fluctuated from low to moderate in the BA (Fig. 1). Both areas had many individuals (often flocks) during the fall and winter and far fewer individuals during the breeding season (Fig. 1). Using polynomial regression, I verified the cycling trend (third degree polynomial) for the number of species in the BA ($r = 0.70$, df = 52, $P < 0.001$), but found no seasonal trend in the CA (tested through a fourth degree polynomial of which none were significant). This suggests the number of species was roughly the same all year long in the CA, but increased greatly during the spring in the BA.

The mean number of species per count was significantly higher in the CA than in the BA (15.0 and 9.1 respectively, paired sample t-test; $t = 128.48$, $P < 0.001$). The CA had more species than the BA in all but two of the 56 paired samples. The mean number of individuals per count also differed significantly between the areas (CA–63.7 individuals, BA–41.5 individuals; paired sample t-test, $t = 2.90$, $P < 0.05$). The BA was more variable in species number and abundance when expressed in relation to the mean (coefficient of variation, variance ratio test of logs, $F = 6.74$, $P < 0.001$ for comparison of species richness; $F = 2.00$, $P < 0.05$ for species abundance).

When regular bird species were tested for their area preferences, (Tables 1 and 2) the majority of the birds preferred the unburned area. When the regular species were grouped into dietary categories, only the flycatchers as a group preferred the BA. Species in other dietary categories preferred the CA (raptors showed no preference for either area). Toyon fruit and elderberries were consumed almost exclusively by nonresidents. American Robins (*Turdus migratorius*) and Cedar Waxwings (*Bombycilla cedrorum*) ate toyon fruit in the winter, Phainopeplas (*Phainopepla nitens*) and a large influx of House Finches (*Carpodacus mexicana*) ate elderberries in the summer.

When these same common bird species were classified as resident or nonresident, I found no significant difference in the number of permanent residents and nonresidents between the two areas (contingency table of residents and nonresidents in each area, $\chi^2 = 0.98$, df = 1, $P > 0.25$).

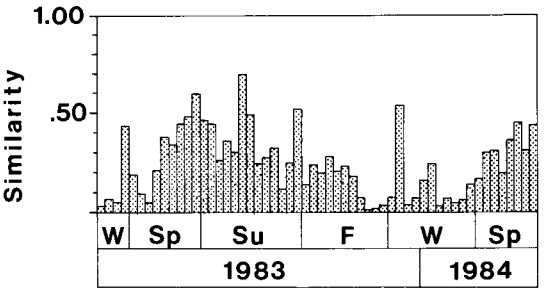

FIGURE 2. Seasonal similarity (%) of bird communities in burned and unburned coastal sage scrub from winter 1983 to spring 1984. Each bar represents a paired census.

TABLE 2. Permanent resident bird species seen regularly in the control (CA) and burned (BA) study areas. Ratios and area preference of each are indicated as in Table 1.

	Ratio (CA/BA)	Pref.	χ^2
Red-tailed Hawk (*Buteo jamaicensis*)	30/3	CA	20.5
American Kestrel (*Falco sparvarius*)	2/13	BA	6.7
California Quail (*Calipepla californica*)	482/43	CA	365.4
Mourning Dove (*Zenaida macroura*)	73/44	CA	6.7
Anna's Hummingbird (*Calypta anna*)	95/60	CA	7.4
Nuttall's Woodpecker (*Picoides nuttallii*)	18/8	—	3.1
Northern Flicker (*Colaptes auratus*)	20/30	—	1.6
Scrub Jay (*Aphelocoma coerulescens*)	112/65	CA	12.0
Bushtit (*Psaltriparus minimus*)	376/110	CA	144.5
Cactus Wren (*Campylorynchus brunneicapillus*)	26/0	CA	24.0
Bewick's Wren (*Thryomanes bewickii*)	27/3	CA	17.6
House Wren (*Troglodytes aedon*)	35/13	CA	9.2
Wrentit (*Chamaea fasciata*)	125/0	CA	123.0
Northern Mockingbird (*Mimus polyglottos*)	129/33	CA	55.7
California Thrasher (*Toxostoma redivivum*)	65/15	CA	30.0
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	134/22	CA	79.0
Brown Towhee (*Pipilo fuscus*)	223/141	CA	18.0
Rufous-crowned Sparrow (*Aimophila ruficeps*)	57/27	CA	10.0
Song Sparrow (*Melospiza melodia*)	20/4	CA	9.4
Western Meadowlark (*Sturnella neglecta*)	7/9	—	0.1
House Finch (*Carpodacus mexicanus*)	327/542	BA	52.7
Lesser Goldfinch (*Carduelis psaltria*)	68/301	BA	145.8

The two areas were most similar (proportional similarity index, Brower and Zar 1977) during spring as the number of species was increasing in the BA (Fig. 2). These values fell to lower levels during the late fall and winter. There was a significant cyclical pattern in proportional similarity which followed the seasons (third degree polynomial, $r = 0.69$, df = 52, $P < 0.001$).

The activity patterns of birds differed markedly between the areas (contingency table of the four activity categories, $\chi^2 = 593.6$, df = 3, $P \ll 0.001$). The CA was used extensively for foraging (55% observations) while the BA was used primarily as a resting area (65% of observations) (contingency table of foraging and nonforaging in each area, $\chi^2 = 523.5$, df = 1, $P \ll 0.001$). The two areas also differed in the percentage of foraging observations in each season (Wilcoxon's paired-sample t-test, $t = 0$, $n = 8$, $P = 0.01$). The BA was used for foraging primarily during the spring and early summer by permanent residents, while use of the CA for foraging was more equitable through the year.

DISCUSSION

The control area provided required habitat elements for more species and individuals, offered a wider range of foraging opportunities than the BA, and was preferred by permanent residents requiring available food during the summer drought. The initial increase in bird species diversity in the BA in the first year after the fire (Moriarty et al. 1985) proved to be only the upward swing in the cycle, as diversity of the BA again dropped during the following winter.

My study indicates that bird community dynamics in coastal sage scrub are very different than those of chaparral communities. The patterns demonstrated in this study add another dimension to the differences between these two communities (see Kirkpatrick and Hutchinson 1980; Gray and Schlesinger 1981; and Westman 1981a, 1981b, and 1981c for other differences). Wirtz's (1982) study of burned and unburned chaparral indicated an increased diversity in the burned area every spring during a 42-month period following a fire, which is similar to my results. However, in my study, birds in most diet categories preferred the CA. The CA apparently provided a wider range of foraging opportunities than the BA. Only the flycatchers preferred the BA in my study, whereas the flycatchers in Wirtz's (1982) study showed no preference for either burned or unburned plots. He also demonstrated that more granivores used burned areas of chaparral; in my study granivores preferred unburned areas of coastal sage scrub. Overall, Wirtz found a higher bird species diversity on burned chaparral plots, especially in the first two years after a fire. The present study revealed, as did Moriarty et al. (1985), that seasonal patterns are similar in these two Mediterranean communities, but preference for burned areas (and hence species diversity after fire) is lower in burned areas of coastal sage scrub in the first 1½ years than in areas of mature coastal sage scrub.

More species preferred the vegetationally heterogeneous CA than the relatively uniform BA. A wider range of foraging opportunities are present with each additional and different patch of vegetation. Roth (1976) found a significant correlation between horizontal heterogeneity in shrub and forest habitats with bird species diversity. His study, and another by Willson (1974), suggest that the greatest influence on bird species diversity in a shrub habitat is the presence of trees, which produce a mosaic of foraging opportunities. Not only does this allow spatial separation of foraging birds, but certain tree species (such as the toyon and elderberry) would attract frugivores as well as providing a substrate for leaf gleaners.

Several studies have demonstrated that winter visitors use abundant though patchy food sources (Leck 1972, Karr 1976, Herrera 1978). Herrera's (1978) study of Mediterranean birds in southwest Spain suggested that nonresidents were generalists because of their ability to use spatially unpredictable resources. My study, however, suggests that nonresidents (including the limited range foraging groups of frugivores, flycatchers, and nectarivores such as hummingbirds and orioles) could be called specialists. Their food sources were very seasonal (winter or summer fruits, spring flowers, and summer insects) and patchy in distribution (at least in the fruiting trees). Residents, in contrast, used a variety of food sources and did not depend on the highly seasonal foods even when available. My study supports others (Leck 1972, Karr 1976, Herrera 1978, Wagner 1981, Lewke 1982, Rosenberg et al. 1982) in finding that nonresidents are using highly seasonal food sources that are not exploited by the permanent residents. The peak in bird numbers in my study corresponded to the ripening of toyon fruit during the winter, and I suggest similar peaks would not occur in areas devoid of fruiting trees.

The increase in observations of bird species and foraging in the spring indicates that the BA is an adequate foraging area only during this season. The majority of birds in the CA foraged, while birds in the BA were merely perching, perhaps resting on their way to

another foraging location. Fire is detrimental to habitat quality for most permanent residents due to the reduction of vegetational structural heterogeneity and, therefore, of foraging opportunities. The BA also probably lacked safe, concealed nest sites and was therefore marginal habitat for birds breeding in coastal sage scrub. The lower bird species richness in burned areas of coastal sage scrub shown in this study suggests that prescribed fires are not advisable, contrary to the current trend in managing chaparral communities.

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