EFFECTS OF FIRE ON BIRDS IN CHAPARRAL

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ABSTRACT.

Bird life has been studied in burned and unburned grassland and chaparral habitats of the San Gabriel Mountains since a major fire in November 1975. Since the fire, 85 species representing 26 families have been observed. The number of species breeding in unburned chaparral and in burned areas at 975 and 1280 m was essentially the same for three breeding seasons. Some chaparral species occurred in lower relative numbers on burned areas, some were more abudant, and others were not found at all. Birds specialized for taking insects on the wing were more abundant over burned chaparral, and seed and insect feeders were more abundant on burned areas. The number of species present in burned and unburned grassland habitats was lower than that in chaparral areas, and unburned grassland had the lowest number of species, in three seasons sutdied. Seasonal diversity patterns were similar in burned and unburned areas of both habitats, with diversity in grassland being lower than chaparral. Diversity in burned chaparral was greater than in unburned chaparral during breeding seasons. Though species number did not differ significantly between the two areas, numbers of individuals did, accounting for this difference in diversity indices. Chaparral fire may eliminate some species temporarily for post-fire seral stages, but most chaparral species can quickly reinvade burned areas. Increased seed and insect availability apparently permits burned habitats to support a greater number of individuals of chaparral species, and also attracts species not normally found in chaparral, resulting in increased diversity on recently burned areas.

INTRODUCTION

Many of us have grown up with the idea that forest fires are devastating to all in their path; that plants and animals are destroyed in great numbers. Yet it is difficult to find much quantitative data on the effects of fire on animals, especially in Mediterranean ecosystems, and there are conflicting reports as to the effects of fire on avian populations in chaparral and grassland habitats in the San Dimas Experimental Forest, Pacific Southwest Forest and Range Experiment Station.

STUDY AREA

The San Dimas Experimental Forest covers 6,885 ha of land in the San Gabriel Mountains of southern California approximately 45 km east of Los Angeles. Elevations on the forest vary from 458 to 1,678 m (Hill 1963), and the topography is generally quite steep, the average slope being 68% with neraly half of the slopes having angles greater than 70% (Bentley 1961). The forest is dissected by several north-south drainages, and south-facing slopes are covered by chamise (*Adenostoma fasciculatum*) dominated chaparral, while more mesic environments support a mixed chaparral community of chamise, ceanothus (*Ceanothus* spp.), manzanita (*Arctostaphylos* spp.), mountain mahogany (*Cercocarpus betuloides*), and scrub oak (*Quercus dumosa*). Drier south-facing slopes have, in addition to chamise, black sage (*Salvia mellifera*) and buckwheat (*Eriogonum fasciculatum*), while riparian vegetation includes evergreen oaks (*Quercus agrifolia, Q. chrysolepis,* and *Q. wislizenii*), and additional shrub species.

Considerable detail about the forest is summarized by Mooney and Parsons (1973), and post-fire plant succession in the area has been described by Horton and Kraebel (1955), Hanes (1971), Patric and Hanes (1964), Hanes and Jones (1967), and Plumb (1961, 1963). Wright and Horton (1951, 1953) provide a checklist of the vertebrates found there 1936 to 1953. A detailed fire history of the forest is provided by Mooney and Parsons (1973). Of special interest is the fact that 67% of the area was consumed by fire in 1919, 92% was lost in July 1960, and 23.5% was destroyed in November 1975. The Village Fire of November 1975 burned 1619 ha of the Experimental Forest, consuming grassland at the north end of the Bell watershed, dense chaparral north of the Bell watershed, and dense chaparral in the upper East Fork of San Dimas Canyon at the eastern edge of the forest.

METHODS

In the spring of 1976 ecology students under my direction conducted bird surveys in burned and unburned chaparral and grassland of the Experimental Forest. During the spring and summer of 1976 permanent study areas for birds and small mammals were established in Bell 3 (unburned chaparral at 975 m, last burned in July 1960), Oak (burned chaparral at 975 m), Sunset (burned chaparral at 1280 m), 0506 (unburned grassland at 914 m). Burned and unburned sites were matched, insofar as possible, as to elevation, slope, and aspect. Bird life was surveyed on all study areas at varying intervals from March 1976 through May 1978. Surveys were conducted at dawn, frequently in conjunction with small mammal trapping, and survey data were converted to individuals per species per man-hour of observation, and percent of total observations per species, per month, for all surveys. Primary data were subsequently analyzed with regard to five categories. The status of each species was designated as: 1) vagrant (V), if only single individuals were observed; 2) migrant (M), if individuals were observed only in spring or fall; 3) spring breeder (S), if individuals of both sexes appeared in spring and were known, or suspected, to breed on the study area; and 4) resident breeder (R), if members of both sexes were observed year-round and known, or suspected, to breed on the study area. The feeding preferences of the species observed were subdivided into thirteen categories, according to information in Martin *et. al.*, (1951), as follows: 1) scavenger (SC), feeding on carrion, represented by the Turkey Vulture; 2) raptor (R), feeding on live vertebrates and some invertebrates, represented by the hawks and owls; 3) omnivore (O), taking plant and animal foods, represented by the crows and jays; 4) animals/insects (AI), taking vertebrate and invertebrate foods, represented by the Roadrunner; 5) nectar/insect (N), feeding on nectar and insects, represented by the hummingbirds; 6) seeds (S), taking seeds as a major portion of the diet, represented by the Mountain Quail, Mourning Dove, most finches, and some sparrows; 7) fruits (F), taking fruit as the major diet, represented only by the Cedar Waxwing; 8) seeds/leaves (SL), taking seeds and tender leaves as the primary diet, represented only by the California Quail; 9) seeds/fruit (SF), taking seeds and acorns as the primary diet, represented only by the Band-tailed Pigeon; 10) insects/seeds (IS), taking primarily insects and seeds, including the Acorn Woodpecker, Hermit Warbler, Western Meadowlark, Brown-headed Cowbird, Lazuli Bunting, towhees, and many sparrows; 11) insects/fruit (IF), taking primarily insects and fleshy fruits, including the Wrentit, California Thrasher, Robin, Western Bluebird, Yellow-rumped Warbler, Bullock's Oriole, Western Tanager, and Balck-headed Grosbeak; 12) insects in air (IA), taking insect food on the wing, including the Poor-will, White-throated Swift, and all flycatchers and swallows; and 13) insects/vegetation or ground or ground (IV), gleaning insect food from vegetation or ground, including the Yellow-billed Cuckoo, Common Flicker, Hairy Woodpecker, chickadee, titmouse, bushtit, wrens, gnatcatcher, kinglet, and most warblers. Data from the five sutdy areas were subdivided into first, second, and third 12-month period post-fire, and also into five categories of abundance: 1) rare (R), less than 1.0% of sightings per month; 2) occasional (O), 1-10% of sightings per month; 3) uncommon (U), 11-25% of sightings per month; 4) common (C), 26-50% of sightings per month; and 5) abundant (A), greater than 50% of sightings per month. Data on numbers of individuals per species per month were also used to calculate Brillouin's (1956) information-theoretical measure of mean diversity per individual per habitat per month. As an increase in raptors following chaparral fire is reported by Lawrence (1966), observational data on common raptors and ravens from July 1974 through July 1977 are also reported here to check for such a phenomenon following the Village Fire of November 1975.

RESULTS

From March 1976 through May 1978, 85 species representing 26 families were observed in the experimental Forest (Table 1). Vagrants made up 29.4% of the species observed, migrants comprised 17.6%, spring breeding species 16.5%, and residents 36.5%. Species which forage for insects among vegetables or on the ground were most prevalent (20.0% of the total), followed in decreasing order of abundance by those feeding on insects and seeds (17.6%), raptors (14.1%), species taking insects in the air (11.8%), species taking chiefly seeds (10.6%, and those feeding on insects and fleshy fruits (9.4%).

Species which include insects in the diet comprised from 44 to 64% of the totals for each habitat, with insect feeders being most prevalent in unburned and burned chaparral at 975 m, and least prevalent in burned grassland (Table 2). By contrast, species taking seeds in the diet comprised from 30 to 61% of the totals for each habitat, with seed feeders being most prevalent in the grassland habitats (Table 2). Raptorial species occurred with about equal frequency in all habitats, as did the nectar and insect feeding hummingbirds. Species taking both insects and seeds, primarily ground feeders, were most prevalent in unburned chaparral and least prevalent in grassland habitats (Table 1).

More species were observed in burned chaparral at 1280 m than in any other habitat, with the second highest number being found in unburned chaparral at 975 m and the lowest number noted in unburned grassland at 914 m (Table 3). Species which were regularly observed in over 10% of the sightings each month were most abundant in unburned grassland, about equal in burned chaparral at 975 m and burned grassland, and lowest in unburned chaparral (Table 3). Over half of the species eventually noted for the habitat were seen in the first 12 months post-fire in unburned chaparral and grassland, and in burned chaparral at 1280 m, while in burned chaparral at 975 m and burned grassland the greatest proportion was seen the second year post-fire (Table 3).

The number of breeding species was essentially the same (17 vs. 16) in burned and unburned chaparral, and also in burned and unburned grassland (13 vs. 14). Breeding species comprised the greatest proportion of the total in unburned grassland, nearly 40% of the total in burned chaparral at 975 m, and about 30% of the total in the other three habatits studied (Table 3). Unburned chaparral had 22-27 species of birds during spring breeding seasons (Figure 1), principally sparrows, wrens, quail, and Scrub Jay, California Thrasher and Wrentit. Species seen regularly over head in this habitat were White-throated Swift, Mourning Dove, and Red-tailed Hawk, the latter nesting in riparian habitat of canyon bottoms. Burned chaparral at the same elevation supported an equal number of species during the breeding season with little difference noted in species composition (Figure 1). Lazuli Bunting, Lark Sparrow, Black-chinned Sparrow, goldfinches, House Finch, and Rufoussided and Brown Towhees were conspicuous members of the breeding community here, while swallows and flycatchers were commonly seen in the area but not known to breed here. Unburned grassland had 13-18 species present during breeding seasons, while burned grassland had 9-12 species (Figure 1). Quail, Mourning Dove, Scrub Jay, Wrentit, Bewick's Wren, California Thrasher, House Finch, Rufous-crowned Sparrow, Brown Towhee, and Song Sparrow were conspicuous members of the community in unburned grassland, while Bewick's Wren, House Finch, goldfinches, Brown Towhee, and Rufous-crowned Sparrow were prevalent in burned grassland.

Brillouin's (1956) diversity indices were calculated from bird census data (Figure 2), and the form of this graph is very similar to that of numbers of species (Figure 2), and the form of this graph is very similar to that of numbers of species (Figure 1). However, the diversity index takes into account numbers of individuals, as well as numbers of spe-ies, present. Seasonal diversity patterns are similar in burned and unburned areas of both chaparral and grassland, with diversity in grassland being lower than chaparral. Diversity in burned chaparral is greater than in unburned during breeding seasons. Though species number did not differ significantly between the two areas, numbers of individuals did, accounting for this difference in diversity indices.

Observational data on common raptors and ravens from July 1974 (prefire) through July 1977 (Figure 3) indicate an increase in the presence of Common Raven post-fire and an apparent decrease in Red-tailed Hawk and Great-horned Owl.

TABLE 1. Avifauna of San Dimas Experimental Forest, March 1976 to May 1978, status[1] (Column 1), feeding niche[2] (Column 2), habitat[3], post-fire seral stage[4] and abundance[5] in each habitat.

			HABITAT				
	1	2	A	B	C	D	E
Turkey Vulture, *Carthartes aura*	V	SC	2/R				2/O
Sharp-skinned Hawk, *Accipiter striatus*	R	R	1/O		2/O		
Cooper's Hawk, *Accipiter cooperi*	R*	R		1/O	2/O	1/O	
Red-tailed Hawk, *Buteo jamaicensis*	R*	R	1/O	1/O	1/O	1/O	2/O
Golden Eagle, *Aquila chrysaetos*	V	R			2/O		
Marsh Hawk, *Circus cyaneus*	V	R		3/O	2/O		2/O
Prairie Falcon, *Falco mexicanus*	V	R	2/R				2/R
American Kestrel, *Falco sparverius*	R	R		1/O	1/O		1/O
California Quail, *Lophortyx californicus*	R*	SL	2/O	3/O	1/O	1/C	2/R
Mountain Quail, *Oreortyx pictus*	R*	S	1/C	1/U	1/U	1/O	1/C
Band-tailed Pigeon, *Columba fasciata*	V	SF	3/U		3/O		
Mourning Dove, *Zenaidura macroura*	S*	S	1/O	1/U	1/O	1/O	1/O
Yellow-billed Cuckoo, *Coccyzus americanus*	R?	IV	3/O				3/O
Roadrunner, *Geococcyx californianus*	R?	AI	1/O				
Barn Owl, *Tyto alba*	R*	R	1/R				
Screech Owl, *Otus asio*	R	R	1/O				
Great-horned Owl, *Bubo virginianus*	R*	R	1/O	1/O	1/O		
Spotted Owl, *Strix occidentalis*	R?	R	1/R				
Short-eared Owl, *Asio flammeus*	V	R			1/R		
Poor-will, *Phalaenoptilus nuttallii*	S	IA	1/O				
White-throated Swift, *Aeronautes saxatalis*	S	IA	i/C	2/O	1/O		
Black-chinned Hummingbird, *Archilochus alexandri*	V	N			2/O		
Costa's Hummingbird, *Calypte costa*	V	N			3/R	1/O	1/O
Anna's Hummingbird, *Calypte anna*	S*	N	1/O	1/O	2/O	2/O	3/U
Rufous Hummingbird, *Selasphorus rufus*	V	N	2/R	2/O	1/O		
Calliope Hummingbird, *Stellula calliope*	V	N			2/R		
Common Flicker, *Colaptes auratus*	R*	IV	1/O	1/U	1/U	2/O	2/O
Acorn Woodpecker, *Melanerpes formicivorus*	V	IS					3/O
Hairy Woodpecker, *Dendrocopos villosus*	R	IV	2/O	2/R	1/O		
Western kingbird, *Tyrannus verticalis*	V	IA			2/R		1/U
Ash-throated Flycatcher, *Myiarchus cinerascens*	S	IA	1/O	2/O	1/O	3/O	3/O
Black Phoebe, *Sayornis nigricans*	V	IA					3/O
Western Flycatcher, *Empidonax difficilis*	V	IA	3/O				
Western Wood Pewee, *Contopus sordidulus*	V	IA		3/O	1/R		
Olive-sided Flycatcher, *Nuttallornis borealis*	V	IA			1/R		
Violet-green Swallow, *Tachycineta thalassina*	M	IA	3/U	2/O	1/O	3/O	1/O
Cliff Swallow, *Petrochelidon pyrrhonota*	M	IA	1/U		1/R		
Steller's Jay, *Cyanocitta stelleri*	R	O	1/O		1/O		
Scrub Jay, *Aphelocoma coerulescens*	R*	O	1/U	2/O	1/U	1/U	1/O
Common Raven, *Corvus corax*	R	O	1/U	1/O	2/O	2/O	1/O
Common Crow, *Corvus brachyrhynchos*	V	O		2/O			
Mountain Chickadee, *Parus gambeli*	V	IV		3/O			2/O
Plain Titmouse, *Parus inornatus*	R	IV	2/U		1/O		
Bushtit, *Psaltriparus minimus*	R*	IV	1/C	3/O		3/O	
Wrentit, *Chamaea fasciata*	R	IF	1/C	2/O	1/O	1/C	1/U
House Wren, *Troglodytes aedon*	R	IV	1/O	1/U	1/R		
Bewick's Wren, *Thryomanes bewickii*	R	IV	1/O	1/O	2/O	1/U	2/O
Rock Wren, *Salpinctes obsoletus*	V	IV			1/R		2/O
California Thrasher, *Toxostoma redivivum*	R	IF	1/U			1/O	1/O
Robin, *turdus migratorius*	M	IF	3/O	2/O	1/O		
Western Bluebird, *Sialia mexicanus*	R	IF		2/C	1/C	3/U	2/C
Blue-gray Gnatcatcher, *Polioptila caerulea*	S	IV	1/O	2/O			
Ruby-crowned Kinglet, *Regulus calendula*	M	IV	1/O				
Cedar Waxwing, *Bombycilla cedrorum*	V	F			1/O		

TABLE 1. Continued...

	1	2	HABITAT A	B	C	D	E
Orange-crowned Warbler, *Vermivora celata*	M	IV			2/O		
Yellow Warbler, *Dendroica petechia*	M	IV	2/R				
Yellow-rumped Warbler, *Dendroica coronata*	M	IF		2/O	2/O		
Glack-throated Gray Warbler, *Dendroica nigrescens*	M	IV	1/O				
Townsend's Warbler, *Dendroica townsendi*	M	IV	1/R				
Hermit Warbler, *Dendroica occidentalis*	M	IS	1/O		2/O		
MacGillivray's Warbler, *Oporornis tolmiei*	M	IV			2/O		
Wilson's Warbler, *Wilsonia pusilla*	M	IV	1/R		2/O		
Western Meadowlark, *Sturnella neglecta*	V	IS	1/R				2/R
Bullock's Oriole, *Icterus bullockii*	S	IF		2/O	1/O		
Brown-headed Cowbird, *Molothrus ater*	S*	IS		2/U	1/O		
Western Tanager, *Piranga ludoviciana*	S	IF			1/R		
Black-headed Grosbeak, *Pheucticus melanocephalus*	S	IF	1/O	2/O	1/O		1/O
Lazuli Bunting, *Passerina amoena*	S*	IS	2/O	2/U	1/U	3/U	1/U
Purple Finch,*Carpodacus purpureus*	V	S			1/R		
House Finch, *Carpodacus mexicanus*	R*	S	1/U	1/C	1/U	1/U	1/C
Lesser Goldfinch, *Spinus psaltria*	R*	S	1/O	1/U	1/U	2/C	2/U
Lawrence's Goldfinch, *Spinus lawrencei*	S	S		2/O	1/C		
Green-tailed Towhee, *Chlorura chlorura*	V	IS		2/R			
Rufous-sided Towhee, *Pipilo erythrophthalmus*	R*	IS	1/O	2/O	1/U	1/O	2/O
Brown Towhee, *Pipilo fuscus*	R*	IS	1/U	1/U	1/U	1/C	1/C
Lark Sparrow, *Chondestes grammacus*	S*	IS	2/O	3/O	2/O		3/O
Rufous-crowned Sparrow, *Aimophila ruficeps*	R	IS	2/R			1/U	2/U
Oregon Junco, *Junco oregonus*	R	IS	2/O	1/C	1/U		2/U
Chipping Sparrow, *Spizella passerina*	M	IS		3/O	2/O		2/U
Black-chinned Sparrow, *Spizella atrogularis*	S	IS	2/O		1/O	2/O	2/O
White-crowned Sparrow, *Zonotrichia leucophrys*	M	IS	1/O	1/U	1/A	1/O	2/O
Golden-crowned Sparrow, *Zonotrichia atricapilla*	M	S		2/O	1/O		
Fox Sparrow, *Passerella iliaca*	V	S				2/O	
Lincoln's Sparrow, *Melospiza lincolnii*	V	S					2/O
Song Sparrow, *Melospiza melodia*	R	IS		1/U	1/O	1/U	

1. Status: V - vagrant or single sightings; M - migrant, observed spring and fall; S - spring, breeding or probably breeding; R - resident, breeding or probably breeding.
2. Feeding Niche: SC - scavenger; R - Raptor; O - omnivore; AI - vertebrates and insects; F - fruit; SL - seeds and tender leaves; SF - seeds and fruit; IS - insects and seeds; IF - insects and fruit; IA - insects in air; IV - insects from vegetation or ground.
3. Habitat: A - unburned chaparral at 975 m; B - burned chaparral at 975 m; C - burned chaparral at 1280 m; D - unburned grassland at 914 m; E - burned grassland at 914 m.
4. Seral Stage: 1 - first 12 month post-fire; 2 - second 12 months; 3 - third 12 months.
5. Abundance: R - rare, less than 1% of sightings for month; O - occasional, 1-10% of sightings; U - uncommon, 11-25% of sightings; C - common, 26-50% of sightings; A - abundant, over 50% of sightings. Example: 2/R means second 12 months/rare.

TABLE 2. Percent composition of species per habitat, by feeding niche[1], and total percent of species per habitat taking seeds or insects as part of the diet.

	Habitat[1]				
	A	B	C	D	E
SC	1.9				2.6
R	13.2	11.4	13.3	7.4	10.2
O	5.7	6.8	5.0	7.4	5.1
AI	1.9				
N	3.8	4.5	8.3	7.4	5.1
S	7.5	13.6	11.7	18.5	12.8
F			1.7		
SL	1.9	2.3	1.7	3.7	2.6
SF	1.9		1.7		
IS	18.9	22.7	18.3	25.9	28.2
IF	7.5	13.6	11.7	11.1	10.2
IA	11.3	9.1	11.7	7.4	10.2
IV	24.5	15.9	15.0	11.1	12.8
Insects	64.1	61.3	56.7	55.5	43.6
Seeds	30.2	38.6	33.4	48.1	61.4

[1]See legend for Table 1 for explanation of symbols, or text, pages 4 & 5.

TABLE 3. Percent of total species number observed in each habitat, percent common and breeding species per habitat, and percent of total per habitat observed in first, second, and third year post-fire.

	Habitat[1]				
	A	B	C	D	E
Total Species	62.4	51.8	70.6	31.8	45.9
Common Species	22.6	29.5	20.0	40.7	30.8
Breeding Species	30.2	38.6	26.7	51.8	33.3
First Year	67.9	38.6	68.3	59.2	33.3
Second Year	22.6	45.4	28.3	22.2	48.7
Third Year	9.4	15.9	3.3	18.5	15.4

[1]See legend for Table 1 for explanation.

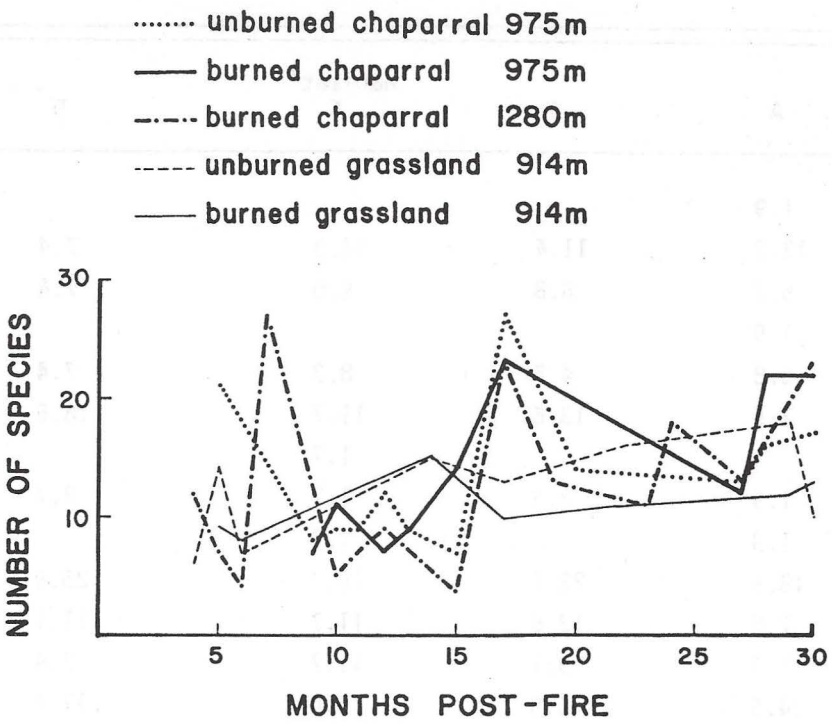

FIGURE 1. Species of birds present in burned and unburned habitats, March 1976 - May 1978.

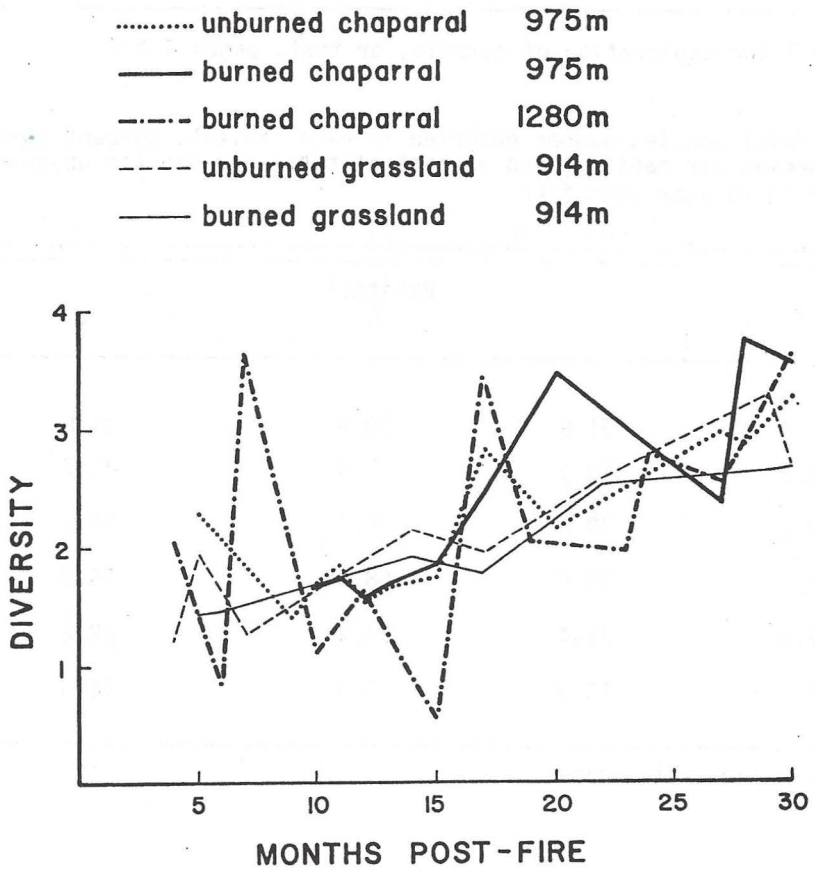

FIGURE 2. Bird diversity in burned and unburned habitats, March 1976 - May 1978.

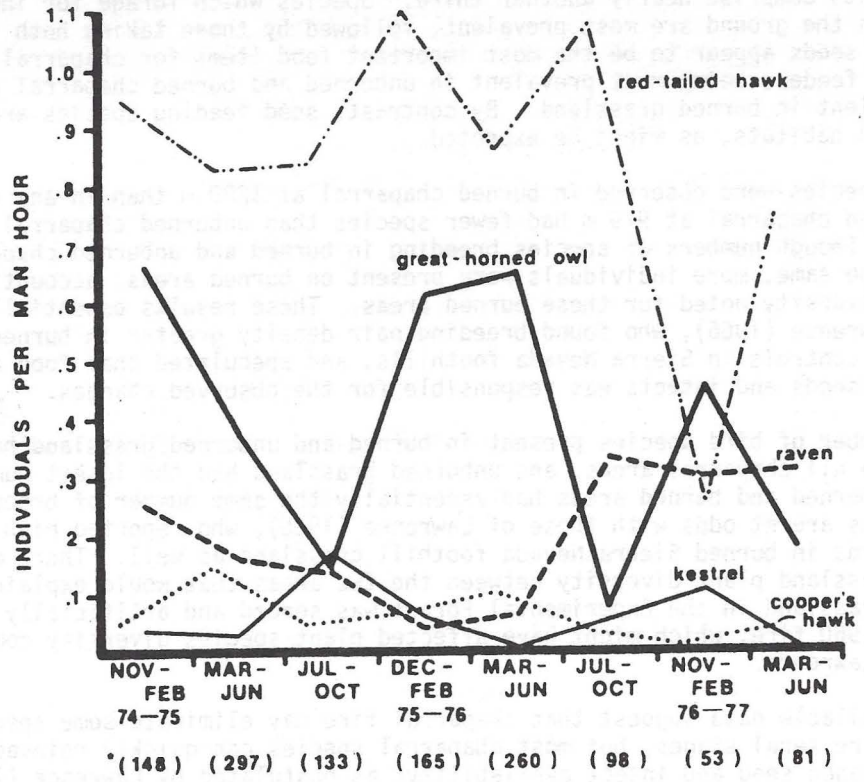

FIGURE 3. Presence of raptors and ravens November 1974 - June 1977, individuals per man-hour of observation, and total man-hours*.

Studies of Red-tailed Hawk and Great-horned Owl populations concentrated on a 780 ha area of the Bell watershed from fall 1974 through summer 1978. During 1975, six pairs of hawks utilized the study area, and five nests produced an average of 3.2 eggs per nest and fledged 2.6 young per nest. In 1976 sex pairs were again present, but only three of the 1975 nests were occupied. One pair moved from their burned out 1975 site to an unburned area 0.4 km away and laid two eggs in a new nest, but the eggs disappeared within a week. The three nests observed in 1976 produced an average of 2.0 eggs per nest and fledged 2.0 young per nest. In 1977 six pairs were again present, but only two nests could be found. One of these failed and the other fledged two young. Only four pairs were found on the study area in 1978, and three active nests were located. These nests fledged an average of 1.7 young per nest.

During 1975, nine pairs of Great-horned Owls uitlized the study area. Five nests observed produced an average of 2.2 eggs per nest and fledged 1.6 young per nest. In 1976, at least 12 pairs of owls, plus seven additional males, were located on the study area, but no active nests could be found; none of the 1975 nests were used. In 1977, at least nine pairs were located on the study area, but only two nests were found and both failed. The number of birds present in 1978 was not ascertained, but no nests were again found, despite intensive searching during the breeding season.

DISCUSSION AND CONCLUSIONS

Recent data from the San Dimas Experimental Forest are still subject to Bendell's (1974) criticism of not extending over a long enough period to assess the true affects of a particular fire, but this report of ongoing studies should serve to improve our understanding of avian post-fire succession in chaparral.

Residents constitute more than one-third of the species observed in the area studied, while vagrants comprise nearly another third. Species which forage for insects among vegetation or on the ground are most prevalent, followed by those taking both insects and seeds. Insects and seeds appear to be the most important food items for chaparral bird species, with insect feeders being most prevalent in unburned and burned chaparral at 975 m and least prevalent in burned grassland. By contrast, seed feeding species are most prevalent in grassland habitats, as might be expected.

More species were observed in burned chaparral at 1280 m than in any other habitat, though burned chaparral at 975 m had fewer species than unburned chaparral at the same elevation. Though numbers of species breeding in burned and unburned chaparral were essentially the same, more individuals were present on burned areas, accounting for the increased diversity noted for these burned areas. These results essentially agree with those of Lawrence (1966), who found breeding pair density greater in burned chaparral than in unburned controls in Sierra Nevada foothills, and speculated that food availability in the form of seeds and insects was responsible for the observed changes.

The number of bird species present in burned and unburned grassland habitats was lower than that in all chaparral areas, and unburned grassland had the lowest number of species, but both unburned and burned areas had essentially the same number of breeding species. These results are at odds with those of Lawrence (1966), who reported high densities of breeding birds in burned Sierra Nevada foothill grassland as well. There may be differences in grassland plant diversity between the two areas that would explain these different results. Grassland in the Experimental Forest was seeded and artificially maintained following the 1960 fire, which might have affected plant species diversity compared to the area studied by Lawrence.

The available data suggest that chaparral fire may eliminate some species temporarily from post-fire seral stages, but most chaparral species can quickly reinvade burned habitats. Increased seed and insect availability, as postulated by Lawrence (1966), apparently permits burned habitats to support a greater number of individuals of chaparral species, and also attracts species not normally found in chaparral, resulting in increased diversity on recently burned areas. Grassland on the Experimental Forest may have reduced plant species diversity, thus accounting for limited bird diversity in this habitat.

Observational data on common raptors and ravens (10 species of raptors are considered uncommon) were examined for evidence of post fire increase in numbers, as has been reported by Lawrence (1966) for chaparral. Only ravens increased in frequency of occurrence post-fire. As scavengers and predators on invertebrates and small vertebrates, they may find food availability greater in recently burned areas.

Red-tailed Hawk and Great-horned Owl densities were among the highest reported for North America in 1975, (c.f. Baumgartner 1938, 1939, Fitch 1940, 1947 Fitch et al. 1946, Hagar 1957, Luttich et al. 1971, and Orians and Kuhlman 1956), and reproductive success was also high. In three seasons post-fire densities remained high, or increased, but reproductive success decreased. Red-tailed Hawks are reported to still have normal reproductive success in North America (Henny and Wright 1969), while Great-horned Owls may exhibit reproductive cycle fluctuations in response to prey availability (Rusch et al. 1972). There were two separate extenuating circumstances preceeding the 1976 breeding season; a severe drought and an extensive fire, and the drought continued in 1977. It is assumed that adequate feeding areas remained in unburned habitat after the fire. However, destruction of habitat may have concentrated birds in parts of the study area which did not burn, as suggested by an increase in Great-horned Owls, resulting in overexploitation of food resources and dampening of reproductive effort.

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