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PREDATORY BIRD POPULATIONS IN THE EAST MOJAVE DESERT, CALIFORNIA

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ABSTRACT.—We surveyed 7 species of predatory birds weekly during a 12-month period (December 1992 through November 1993) in the east Mojave Desert, California. The Common Raven (*Corvus corax*) was the most frequently observed species with an average of 6.9 sightings per 100 km. Turkey Vultures (*Cathartes aura*), Red-tailed Hawks (*Buteo jamaicensis*), Loggerhead Shrikes (*Lanius ludovicianus*), American Kestrels (*Falco sparverius*), Golden Eagles (*Aquila chrysaetos*), and Prairie Falcons (*Falco mexicanus*) were seen in decreasing order of frequency of observation through the study period. Ravens, Red-tailed Hawks, Loggerhead Shrikes, American Kestrels, and Prairie Falcons were seen throughout the year. Turkey Vultures were not present during winter months, while Golden Eagles were seen only during November and December. Turkey Vultures, Red-tailed Hawks, and ravens were most numerous on agricultural lands, while Loggerhead Shrikes were most common at urban areas. Raven numbers increased with increasing number of linear rights-of-way parallel to the survey route. Perching was the most common behavior type, although Turkey Vultures and ravens were often observed soaring, flying, or standing on the ground near highways. Transmission powerline towers and telephone poles were used as perch sites disproportionately to availability.

Key words: Mojave Desert, predatory birds, perch sites, year-round surveys.

Information on annual variations in the composition of predatory bird communities in temperate environments may be useful in conservation planning, and yet these variations are seldom measured (Newton 1979, Eakle et al. 1996, Rodríguez-Estrella et al. 1998). For example, in the Mojave Desert of California there is little information regarding year-round presence and abundance of predatory birds, although a variety of these species are (1) viewed as important (eagles, hawks, falcons), (2) experiencing population declines (Loggerhead Shrike [*Lanius ludovicianus*], Small 1994; Prairie Falcon [*Falco mexicanus*], Boyce 1986), or (3) allegedly endangering threatened wildlife (Common Raven [*Corvus corax*], Boarman 1993). Between December 1992 and November 1993, we conducted weekly surveys of 7 species of predatory birds over a portion of the eastern Mojave Desert in California. Our purpose was to collect information that might serve as baseline data for wildlife assessments following inevitable changes in land use (e.g., decreased grazing, increased recreation, increased residential development).

STUDY SITE AND METHODS

Our study site in San Bernardino County, California (115°45′E, 34°33′N), is bounded on all sides by mountain ranges (Fig. 1). The northern boundary is the Bristol, Granite, and Providence Mountains; the eastern boundary is defined by the Old Woman Mountains; the southwest border is the Bullion Mountains; and the southern portion of the study area is the Calumet and Sheep Hole Mountains. The Cadiz Valley occupies the southeastern portion of the study area, and Fenner Valley is in the northeast. Our study area comprises a variety of habitats including unvegetated dry lake beds, creosote (*Larrea tridentata*) scrub, and mixed desert scrub communities on the dry, relatively low mountain ranges of the area (Vasek and Barbour 1977). The climate is seasonal, warm (>26°C) in summer and cool (<11°C) in winter, with an annual mean temperature of 17°C ± 9°C (*s*). Average rainfall is <12 cm, with most precipitation occurring between December and March (Johnson 1968).

We surveyed 7 species of predatory birds weekly from an automobile over a 12-month

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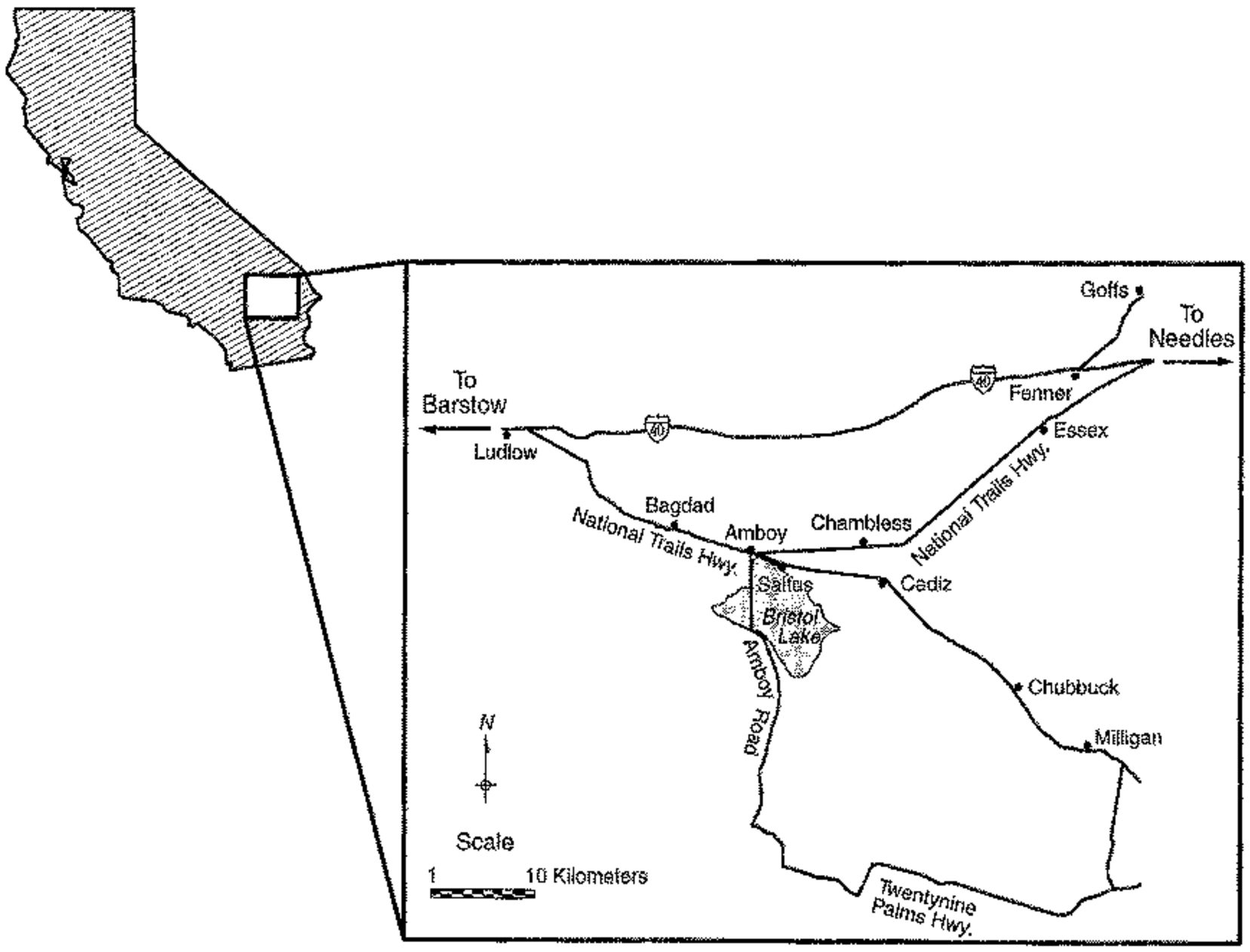

Fig. 1. Study area showing survey route, east Mojave Desert, California.

period (the results of 3 surveys in September were lost when our vehicle was burglarized) along a 500-km-long route consisting of paved and graded dirt roads. The route was categorized based on land use: (1) rangelands (primarily creosote scrub), (2) urban (small towns), and (3) irrigated agriculture (vineyards and citrus groves).

Surveys began at sunrise and required approximately 8 h to complete. Primary (interstate) roads along the route were driven at 85–110 km hr^{-1}, while secondary (2-lane paved) and unpaved roads were driven at 30–85 km hr^{-1}. Our speed was scaled by our ability to drive safely and to scan the terrain. We altered direction and starting point of transect coverage to ensure each area was surveyed during different times of the day (sensu Bunn et al. 1995). All individual Turkey Vultures (*Cathartes aura*), Red-tailed Hawks (*Buteo jamaicensis*), Golden Eagles (*Aquila chrysaetos*), American Kestrels (*Falco sparverius*), Prairie Falcons, Common Ravens, and Loggerhead Shrikes within 365 m of the road were noted and the following information recorded: time of day, behavior (standing on the ground, perched, flying, soaring), and, if perched, perch type (cliff, tree, telephone pole, transmission tower, building, sign, other). When bird identification was problematic, we stopped the vehicle. An index of potential perch sites, defined as any structure (natural or artificial) >3 m in height, was obtained by counting all available perch sites within 365 m on both sides of the survey route.

As an index of bird abundance, we computed the mean number of bird sightings/100 km for the 7 species observed, by month and by year. For species with >120 sightings (Turkey Vulture, Red-tailed Hawk, Loggerhead Shrike, Common Raven), we evaluated frequency of observation as a function of land use. The greatest part of our survey route ran through creosote scrub (482.4 km), which was used for grazing, while lesser amounts passed through urban areas (14.4 km) and irrigated agriculture (3.2 km). Within the primary land use along our survey route (rangeland), we compared numbers of birds/100 km with the number of linear rights-of-way that ran in parallel (sensu Knight et al. 1995). This number could be as high as 5 when one or more railroad tracks, transmission powerlines, highways, and telephone pole lines paralleled each other. For the entire survey route and for all species except Golden Eagles (with too few observations), the relative frequency of behavioral patterns for each species was calculated. Also, for these

species we calculated the proportion of perch-site use using our potential perch site indices to compute expected values. Because our data were not normally distributed (UNIVARIATE procedure; SAS Institute Inc. 1990), we used the Kruskal-Wallis test (chi-square approximation; NPAR procedure; SAS Institute Inc. 1990) to examine relationships between bird numbers among months, bird numbers and land use, and bird numbers and number of linear rights-of-way in parallel. To test for differences in perch-site use and behavior, we used χ^2 goodness-of-fit tests (PROC FREQ; SAS Institute Inc. 1990).

RESULTS

Populations

Ravens were observed most frequently, with Turkey Vultures, Red-tailed Hawks, Loggerhead Shrikes, American Kestrels, Golden Eagles, and Prairie Falcons seen in decreasing numbers (Table 1). Ravens and Red-tailed Hawks were seen on every survey, while shrikes (81%), kestrels (69%), and Prairie Falcons (56%) were seen on over half the surveys. Turkey Vultures were seen on less than half the surveys (46%), and Golden Eagles were seen on only 3 surveys (6%).

For each species, other than Golden Eagles, there were significant among-month differences in numbers (Table 1; Kruskal-Wallis, all χ^2 values > 17, $n = 45$, df $= 11$, all P values < 0.03). Raven numbers were highest during winter and lowest during spring and early summer. Vultures were first seen on the study area in March and not seen after October. American Kestrels, Prairie Falcons, Red-tailed Hawks, and Loggerhead Shrikes were seen year-round and appeared to be most numerous during winter. Golden Eagles were the least common species, with only 4 seen.

Land Use and Linear Rights-of-Way

Turkey Vultures, Red-tailed Hawks, and ravens were most numerous on irrigated agricultural lands and least numerous on rangelands, while shrikes were most common at urban sites (Table 2; Kruskal-Wallis, all χ^2 values > 21, $n = 45$, df $= 2$, all P values < 0.0001). Raven numbers increased with increasing number of linear rights-of-way parallel to the survey route (Kruskal-Wallis, $\chi^2 = 38.08$, df $= 3$, $P = 0.0001$), although this pattern was not apparent for Turkey Vultures, Red-tailed Hawks, and Loggerhead Shrikes (Fig. 2).

Behavior and Perch-site Use

Perching was the most often observed behavior for all species other than ravens (Fig. 3). Between 42% and 87% of Turkey Vulture, Red-tailed Hawk, American Kestrel, Prairie Falcon, and Loggerhead Shrike observations were of perched birds, while ravens were most often observed flying or soaring. In addition, Turkey Vultures and ravens also were seen on the ground (18% and 28% of all observations, respectively; Fig. 3). Of all vultures and ravens seen on the ground, 42% and 39%, respectively, were seen on roads.

For all species, birds did not use perch sites proportionately to availability (all χ^2 values > 1000, df $= 5$, all P values < 0.001; Fig. 4). Transmission powerline towers and telephone poles were the most frequently used perch types for all species (Fig. 4). Ravens showed the greatest plasticity in use of perches, utilizing all perch types.

DISCUSSION

Populations

Raven numbers were highest during December and January, an observation also noted by Austin (1971). During winter ravens are not spatially tied to nesting sites and food is less common and more ephemeral. Accordingly, ravens are able to form flocks and utilize concentrated sources of food that are either dependable (e.g., landfill sites) or sporadic in occurrence (e.g., road-killed animals; Heinrich 1989).

Turkey Vultures were present from March through October and were most numerous during June. Turkey Vultures are migratory in the Mojave Desert (Small 1994), which our results corroborate. A similar pattern was found for Turkey Vultures in New Mexico (Eakle et al. 1996). Red-tailed Hawks, Prairie Falcons, and American Kestrels were observed more frequently during the winter months, perhaps reflecting an augmentation of northern-latitude birds during winter months as well as offspring following nesting. Eakle et al. (1996) also noted that Red-tailed Hawks are much

TABLE 1. Mean number/100 km ($\pm s_{\bar{x}}$) of predatory birds seen by month in the Mojave Desert, California, December 1992 to November 1993.

Species	Number of birds/100 km												
	Dec 1992	Jan 1993	Feb 1993	Mar 1993	Apr 1993	May 1993	Jun 1993	Jul 1993	Aug 1993	Sep 1993	Oct 1993	Nov 1993	Total
Turkey Vulture	—	—	—	0.30 (0.06)	0.78 (0.08)	0.97 (0.36)	4.93 (1.44)	1.35 (0.39)	1.52 (0.62)	0.90 [a]	3.11 (0.00)	—	1.72 (0.31)
Red-tailed Hawk	1.63 (0.11)	1.74 (0.32)	1.07 (0.11)	0.81 (0.27)	0.78 (0.27)	0.95 (0.19)	0.63 (0.16)	1.85 (0.38)	1.21 (0.26)	1.79 [a]	1.01 (0.30)	1.79 (0.24)	1.21 (0.09)
Golden Eagle	0.67 (0.00)	—	—	—	—	—	—	—	—	—	—	0.22 (0.00)	0.45 (0.05)
American Kestrel	0.56 (0.14)	0.75 (0.17)	0.56 (0.21)	0.60 (0.17)	0.22 (0.00)	—	0.50 (0.17)	0.34 (0.06)	0.36 (0.06)	0.22 [a]	0.22 (0.00)	0.22 (0.00)	0.46 (0.04)
Prairie Falcon	0.22 (0.00)	0.45 (0.11)	0.50 (0.21)	0.52 (0.06)	—	0.34 (0.08)	0.30 (0.06)	0.30 (0.06)	0.22 (0.00)	0.45 [a]	0.67 (0.20)	0.22 (0.00)	0.42 (0.04)
Loggerhead Shrike	3.45 (0.00)	0.84 (0.11)	1.01 (0.32)	0.81 (0.33)	0.67 (0.00)	3.11 (0.00)	0.95 (0.13)	1.79 (0.24)	0.40 (0.11)	0.67 [a]	0.50 (0.14)	0.67 (0.24)	0.81 (0.08)
Common Raven	10.59 (0.69)	11.04 (1.35)	5.89 (0.54)	3.54 (0.50)	5.94 (0.89)	4.48 (0.43)	8.21 (2.34)	6.73 (0.63)	7.98 (2.62)	2.02 [a]	6.17 (1.75)	6.95 (0.71)	6.91 (0.51)

[a]Data from only 1 survey

TABLE 2. Mean number per 100 km (± *s*) of Turkey Vultures, Red-tailed Hawks, Loggerhead Shrikes, and Common Ravens seen at different land-use types, east Mojave Desert, California.

Land use	Number of birds/100 km ± *s*			
	Turkey Vulture	Red-tailed Hawk	Loggerhead Shrike	Common Raven
Rangeland	0.4 ± 0.6	1.2 ± 0.6	0.6 ± 0.6	3.7 ±1.9
Irrigated agriculture	7.8 ± 37.3	8.5 ± 21.1	0.7 ± 4.5	255.2 ± 363.0
Urban	3.6 ± 14.3	1.3 ± 2.7	1.9 ± 3.4	48.2 ± 41.2

more common during fall and winter in New Mexico. Finally, although Loggerhead Shrikes are migratory in other parts of their range, they were seen year-round in our study area (see Small 1994:207).

Golden Eagles were the species seen least commonly. These findings are surprising as Golden Eagles are a regular nesting bird in the Mojave Desert, albeit a species that occurs naturally at low densities due to its large area requirements. Our findings might reflect the naturally low density of eagles, or they may be a result of our survey route not traversing eagle nesting areas. Though speculative, the fact that our only observations were during winter suggests that eagles in the Mojave may undergo elevational migrations from the desert mountain ranges where they nest during summer to desert basins where they occur during winter (Small 1994).

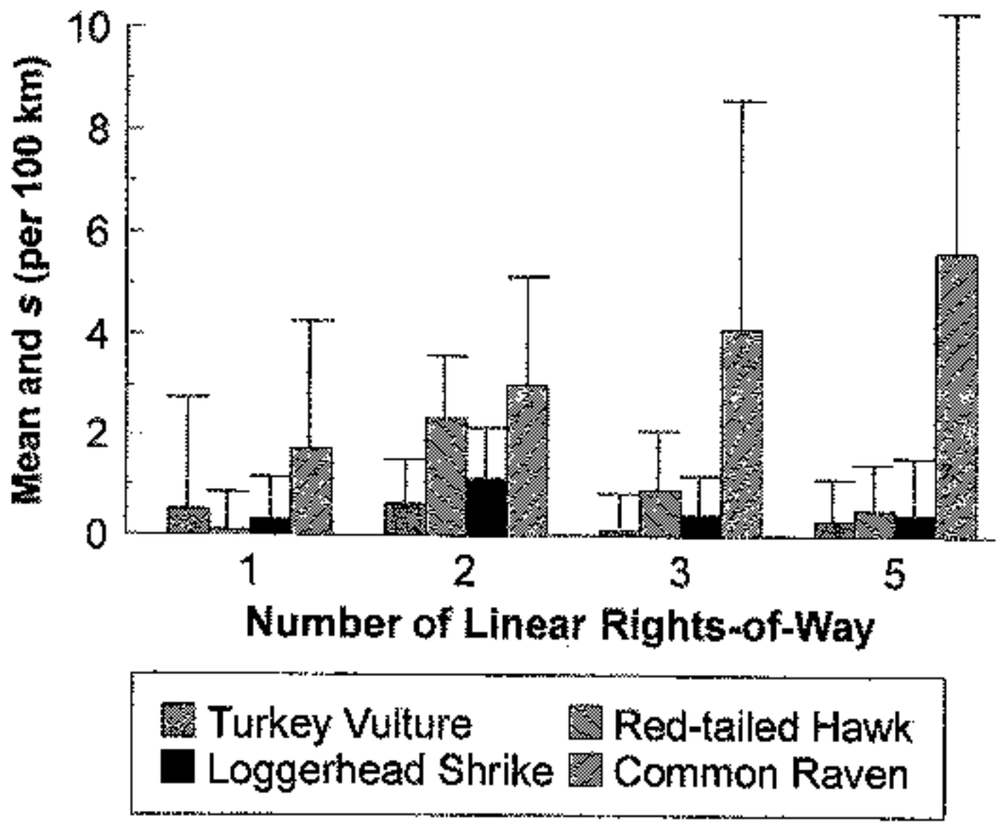

Fig. 2. Mean number per 100 km (± *s*) of Turkey Vultures, Red-tailed Hawks, Loggerhead Shrikes, and Common Ravens seen adjacent to number of linear rights-of-way, east Mojave Desert, California.

Land Use and Linear Rights-of-Way

Turkey Vultures, Red-tailed Hawks, and ravens were most numerous on irrigated agricultural lands and urban areas and less common on rangelands. We suggest these elevated numbers reflect increased abundance, availability, and dependability of food sources (Knight et al. 1993). Urban and agricultural areas are associated with high road traffic and road densities, providing increased levels of road-killed carrion (Knight and Kawashima 1993). In addition, these 2 land uses provide plentiful year-round water and abundant potential nesting sites (e.g., buildings, signs, ornamental trees). For example, almost half (46%) of all raven sightings were made at 2 localities, a small town and a citrus/vineyard complex, which together comprised only 1% of the survey route. The Cadiz Land Company vineyard provides abundant year-round water and a variety of food (i.e., citrus, grapes) in season. The small community of Ludlow appears to be of importance to ravens as it has a sanitary landfill that provides a predictable food supply.

Given that ravens show elevated numbers along linear rights-of-way (Knight and Kawashima 1993), it is not surprising that we found a positive relationship between raven numbers and increasing number of rights-of-way. This finding supports a similar relationship reported for ravens during summer months in the Mojave (Knight et al. 1995).

Behavior and Perch-site Use

Red-tailed Hawks, American Kestrels, Prairie Falcons, and Loggerhead Shrikes were most often seen perching, a frequently used mode of hunting for these species (Bent 1950, Brown and Amadon 1968). Although transmission powerline towers and telephone poles were among the least common potential perch

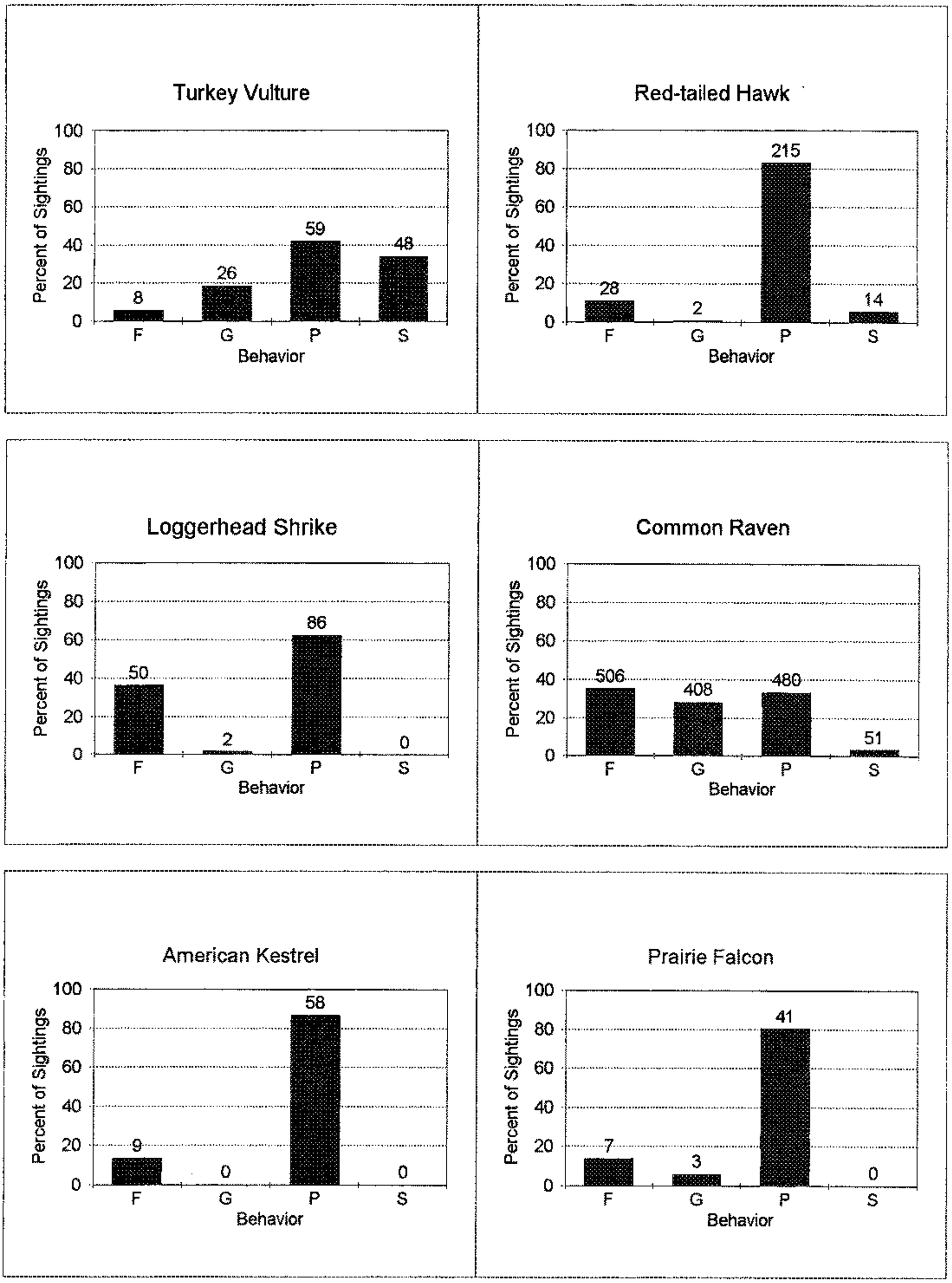

Fig. 3. Proportion of 6 species of predatory birds seen flying (F), standing on the ground (G), perched (P), or soaring (S), east Mojave Desert, California.

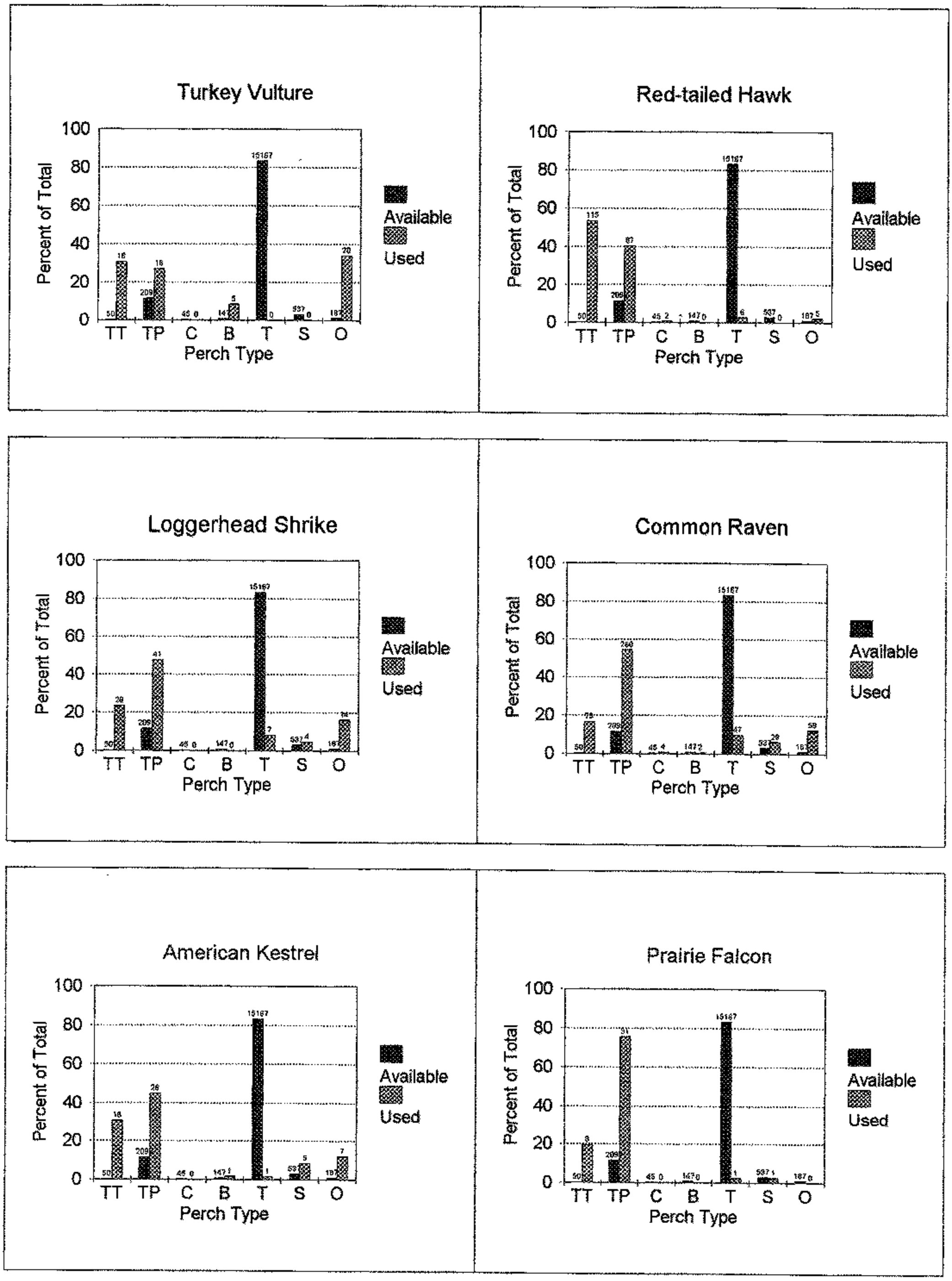

Fig. 4. Proportion of perch types used by 6 species of predatory birds, east Mojave Desert, California. TT – transmission tower, TP – telephone pole, C – cliff, B – building, T – tree, S – sign, O – other.

sites, they were the most frequently used structures by all species. Ravens and Turkey Vultures were often seen on the ground, particularly along roads, reflecting their propensity to scavenge road-killed wildlife (Knight and Kawashima 1993). Stahlecker (1975) found that although transmission towers constituted only 1.5% of available perches in a grassland area in Colorado, 81% of raptors seen during surveys utilized them as perches. Likewise, Craig (1978) noted that almost 78% of all raptors observed perched along a 187-km survey route in Idaho were on power poles or wires. In the Mojave Desert tall powerline towers and telephone poles, when compared with shorter perch sites such as trees or signs, may provide birds with a wider range of vision, easier takeoff, and greater attack speed when hunting prey on the ground (Knight and Kawashima 1993).

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