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NESTING HABITAT USE BY BURROWING OWLS IN COLORADO

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ABSTRACT.—Habitats used by nesting Burrowing Owls (*Speotyto cunicularia*), and the fidelity shown to traditionally used nesting areas were studied in 1990 and 1991. Nesting Burrowing Owls (N = 47 pairs) occupied burrows with a shorter distance to the nearest road, and shorter grass and forb height ($P < 0.005$) than generally available, while using black-tailed prairie dog (*Cynomys ludovicianus*) towns with greater burrow density, nearest perch distance, and percentage of bare ground ($P < 0.05$) than available. Of adults banded in 1990, 39% returned in 1991, while only 5% of chicks banded in 1990 returned. Of returning adults, 66% reused the same prairie dog town used the prior year. From 1990 to 1991, 90% of prairie dog towns were reused (N = 18), and 20% of nesting burrows (N = 4) were reused. Burrowing Owls exhibited a strong fidelity to previously used nesting towns, and were moderately site-specific in nesting habitat requirements.

Uso del hábitat de nidificación de *Speotyto cunicularia* en Colorado

RESUMEN.—Tanto el hábitat reproductivo usado por *Speotyto cunicularia* y la fidelidad mostrada a tracicionales áreas de nidificación fueron estudiados en 1990 y 1991. *Speotyto cunicularia* (N = 47 parejas) ocupó galerías subterráneas a corta distancia de la carretera, con hierbas bajas y altas ($P < 0.005$) generalmente disponibles, mientras que usahan las densas galerías existentes en las colonias de *Cynomys ludovicianus,* con nerchas más cercanas y un porcentaje de suelo desnudo ($P < 0.05$) en forma cignifivamente mayor que las disponible. De los adultos marcados en 1990, el 39% retornó en 1991, mientras que sólo el 5% de los pollos marcados en 1990 retornó. De los adultos retornados, el 66% utilizó la misma galería del año anterior. De 1990 a 1991, el 90% de las galerías de *C. ludovicianus* fueron reutilizadas (N = 18), y el 20% de las galerías de nidificación (N = 4) fueron reutilizadas. *Speotyto cunicularia* exhibe una fuerte fidelidad a galerías de nidificación previamente usadas y fueron moderadamente sitio-específicos en los requerimientos de hábitat de nidificación.

[Traducción de Ivan Lazo]

Burrowing Owls (*Speotyto cunicularia*) use open areas with short vegetation (Coulombe 1971, MacCracken et al. 1985, Haug and Oliphant 1990). Largely unstudied are the vegetation and physical characteristics of Burrowing Owl nesting habitats and how they differ from available unused habitat. Green and Anthony (1989) documented this relationship in habitats lacking vegetation-controlling sciurids. They, as well as MacCracken et al. (1985), identified differences in vegetation at burrows used for nesting by owls by contrasting them with control burrows adjacent to the occupied burrow. However, as Burrowing Owl nestlings grew, they usually inhabited burrows nearby the natal burrow (Plumpton pers. obs.), indicating that nesting adults may be selecting qualities in adjacent burrows as well. We know of no study that has contrasted black-tailed prairie dog (*Cynomys ludovicianus*) towns occupied by Burrowing Owls for nesting against available, but unused towns.

The objective of this study was to measure the attributes of nesting burrows and habitats used by Burrowing Owls, and determine how they differed from apparently similar, active prairie dog towns unused by nesting Burrowing Owls. Additionally, we examined

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Table 1. Characteristics of burrows used by Burrowing Owls and unoccupied control burrows at the Rocky Mountain Arsenal, 1990.

	Nest Burrows			Control Burrows		
Variable	$\bar{x}$	SE	(*N*)	$\bar{x}$	SE	(*N*)
Burrow density[a]	28.7	2.5	(19)	21.0	1.4	(19)[b]
Distance to road (m)	105.3	28.8	(19)	209.7	39.6	(19)[c]
Town size (ha)	16.1	7.8	(19)	20.4	5.9	(16)
Forb cover (%)	25.8	2.5	(17)	21.6	2.2	(17)
Bare ground (%)	63.3	3.1	(17)	64.9	2.9	(17)
Forb height (cm)	6.7	0.5	(17)	6.9	0.3	(17)
Vertical density of vegetation at burrows						
0–10 cm	1.82	0.18	(17)	1.81	0.19	(17)
10–20 cm	0.35	0.09	(17)	0.37	0.09	(17)
20–30 cm	0.09	0.04	(17)	0.04	0.05	(17)
30–40 cm	0.04	0.02	(17)	0.00	0.00	(17)
40–50 cm	0.03	0.02	(17)	0.00	0.00	(17)
50–60 cm	0.01	0.01	(17)	0.00	0.00	(17)
60–70 cm	0.00	0.00	(17)	0.00	0.00	(17)
70–80 cm	0.00	0.00	(17)	0.00	0.00	(17)

[a] (#/0.2 ha).
[b] $P < 0.01$.
[c] $P < 0.005$.

successive-year fidelity to burrows and prairie dog towns by nesting Burrowing Owls.

Study Area

The Rocky Mountain Arsenal (RMA) is located in south-central Adams County, Colorado, and covers 6900 ha. RMA is within the north temperate grassland biome, specifically the high plains district of the northern great plains province. The climate is semi-arid, with light rainfall, and moderate to high winds. Average annual precipitation is about 38 cm. Elevation ranges from 1564–1625 m. The climax community for RMA was a shortgrass prairie, but the vegetation is now dominated by five major communities: weedy forbs, cheatgrass (*Bromus* spp.)/weedy forbs, cheatgrass/perennial grassland, native perennial grassland, and crested wheatgrass (*Agropyron cristatum*).

Methods

Physical and vegetation characteristics were measured at all burrows used by nesting owl pairs, and at an equal number of unoccupied control burrows during 1990 ($N = 19$) and 1991 ($N = 28$). Since all nesting occurred in active black-tailed prairie dog towns, control burrows were selected at random from active prairie dog towns (towns) unused by Burrowing Owls. Since Burrowing Owls were capable of evicting prairie dogs from desired burrows (Plumpton pers. obs.), occupancy by prairie dogs at the time of random selection was considered irrelevant.

Physical measurements included compass orientation of the burrow entrance, number of burrows (density) within a 25-m radius (0.2 ha circle), distance within the tunnel from the burrow opening to a vision-obscuring bend, distance from the burrow to the nearest road, distance to the nearest above ground perch (e.g., pole, woody plant) within 25 m, and town size. Nesting burrow orientations were characterized by calculating mean angle ($\bar{a}$), dispersion (r), and angular deviation (s) (Batschelet 1965). Orientation data from used burrows were tested for differences between years using a χ^2 test. A χ^2 goodness-of-fit test was used to determine uniformity of used and control burrow orientations. To determine whether owls selected burrows with orientations different from available, used burrows were tested against control burrows using χ^2 (Batschelet 1965) and Watson's U^2 tests (Zar 1974).

Vegetation measurements included percent occurrence of grass, forb, and bare ground, and were taken at burrows using 10-pin point-frame sampling (Levy and Madden 1933). Ten transects, each 25 m in length, radiated from the burrow entrance at random azimuths. Point frames were placed along transects at 5-m intervals, for a total of 50 sampling points/burrow. Grass and forb height were measured at the nearest occurrence within the point frame at each plot. Vertical density was measured at this same reference point, by inserting a rod vertically into the vegetation, and counting the number of plant contacts with the rod in 10-cm increments. Because of the minimal number of vegetation contacts above 10 cm, and to maintain minimum expected cell counts in the χ^2 test, levels 2–8 (10–80 cm) were lumped for 1990, and levels 3–8 (20–80 cm) were lumped for 1991. A 2×2 and 2×3 contingency table was used in the analysis of 1990 and 1991 data, respectively.

Table 2. Characteristics of burrows used by Burrowing Owls and unoccupied control burrows at the Rocky Mountain Arsenal, 1991.

	NEST BURROWS			CONTROL BURROWS		
VARIABLE	$\bar{x}$	SE	(*N*)	$\bar{x}$	SE	(*N*)
Burrow density[a]	21.3	1.5	(28)	22.3	2.0	(28)
Distance to road (m)	114.5	21.9	(28)	108.3	26.7	(28)
Town size (ha)	29.2	8.7	(21)	5.2	0.7	(21)
Forb cover (%)	34.7	3.2	(26)	42.9	3.3	(26)
Bare ground (%)	53.1	2.8	(26)	37.5	2.3	(26)[b]
Forb height (cm)	6.9	0.5	(26)	9.7	0.5	(26)[c]
Vertical density of vegetation at burrows						
0–10 cm	1.93	0.12	(26)	2.94	0.16	(26)
10–20 cm	0.40	0.08	(26)	0.91	0.09	(26)
20–30 cm	0.59	0.02	(26)	0.19	0.04	(26)
30–40 cm	0.01	0.00	(26)	0.03	0.01	(26)
40–50 cm	0.00	0.00	(26)	0.01	0.00	(26)
50–60 cm	0.00	0.00	(26)	0.00	0.00	(26)
60–70 cm	0.00	0.00	(26)	0.00	0.00	(26)
70–80 cm	0.00	0.00	(26)	0.00	0.00	(26)

[a] (#/0.2 ha).
[b] $P < 0.0001$.
[c] $P < 0.0005$.

Data for all variables except burrow orientation were tested for normality using the Shapiro/Wilk test (Shapiro and Wilk 1965). Data were tested within treatments for between-year differences. When no differences existed between years for either used or control burrows ($P > 0.05$), data were pooled for analysis. When data were normally distributed, *t*-tests were used. When non-normal data could not be normalized with log transformation, Wilcoxon 2-sample tests and Kruskal/Wallis approximations were used (SAS Institute Inc. 1988).

To examine inter-year fidelity to burrows, owls were captured and fitted with color-anodized leg bands engraved with unique alphanumeric codes (Acraft Sign and Nameplate Co., Ltd., Edmonton, Alberta, Canada). Owls were captured following techniques described by Plumpton and Lutz (1992). Fidelity to nesting burrows or towns by Burrowing Owls was determined by resighting in 1991 birds banded in 1990.

RESULTS

Nesting burrows were oriented with a mean angle ($\bar{a}$) = 95°, dispersion (r) = 0.061, and angular deviation (s) = 78.53. The orientations of neither nesting nor control burrows were different from expected in direction categories (nesting: $\chi^2 = 7.45$, $P > 0.05$, df = 7; control: $\chi^2 = 2.47$, $P > 0.05$, df = 7). No difference existed in orientation between used and available burrows ($\chi^2 = 10.06$, $P > 0.05$, df = 5; $U^2 = 0.069$, $P > 0.05$, df = 45).

In 1990, burrows used for nesting were in towns of greater burrow density than control towns (*t*-test, df = 18, $P = 0.009$; Table 1). In 1991, burrow density in towns used for nesting was not different from control towns ($P > 0.05$; Table 2). Used burrows were not different from controls in tunnel length (*t*-test, df = 91, $P = 0.13$; Table 3). In 1990, used burrows were closer to roads than controls (Wilcoxon $z = 2.9$, Kruskal/Wallis χ^2 approximation = 8.9, df = 1, $P = 0.003$; Table 1). In 1991, used burrows were not different from controls in distance to roads ($P > 0.05$; Table 2). Burrowing Owls used burrows farther from perches than control burrows ($z = 2.0$, $\chi^2 = 4.3$, df = 1, $P = 0.004$; Table 3). In both years, used towns were no different from control towns in size ($z = -1.4$, $\chi^2 = 1.9$, df = 1, $P = 0.16$; Table 1 and $z = 1.9$, $\chi^2 = 3.7$, df = 1, $P = 0.06$; Table 2).

Towns that Burrowing Owls used were no different from controls based on percent grass cover ($z = 1.5$, $\chi^2 = 2.5$, df = 1, $P = 0.11$; Table 3) nor was percent forb cover different between used and control towns ($z = -1.5$, $\chi^2 = 2.5$, df = 1, $P = 0.1$; Table 1 and $z = 1.5$, $\chi^2 = 2.3$, df = 1, $P = 0.12$; Table 2). In 1991, mean percent bare ground was greater at used than control burrows ($z = -3.7$, $\chi^2 = 14.2$, df = 1, $P =$

Table 3. Characteristics of burrows used by Burrowing Owls and unoccupied control burrows at the Rocky Mountain Arsenal, 1990–1991.

	Nest Burrows			Control Burrows		
Variable	$\bar{x}$	SE	(N)	$\bar{x}$	SE	(N)
Tunnel length (cm)	86.9	3.93	(46)	77.6	4.60	(47)
Perch distance (m)	11.0	1.35	(29)	6.8	0.64	(40)[a]
Grass cover (%)	11.7	2.4	(43)	17.1	2.9	(43)
Grass height (cm)	7.3	0.97	(43)	11.2	1.22	(43)[b]

[a] $P < 0.005$.
[b] $P < 0.05$.

0.0002; Table 2). For both years combined, Burrowing Owls used towns with shorter mean grass height than controls ($z = 2.3$, $\chi^2 = 5.5$, df = 1, $P = 0.02$; Table 3). In 1990, mean forb height was not different at used and control burrows ($z = 0.7$, $\chi^2 = 0.5$, df = 1, $P = 0.49$; Table 1). In 1991, mean forb height was shorter at used than control towns ($z = 3.5$, $\chi^2 = 12.3$, df = 1, $P = 0.0005$; Table 2). For each year separately, the vertical density of vegetation at burrows in nesting towns was not different from controls ($\chi^2 = 0.18$ and 1.61 for 1990 and 1991, respectively, $P > 0.05$; Tables 1 and 2).

In 1990, 34 adult Burrowing Owls were captured. Nineteen adult males and 15 adult females from 22 mated pairs received color leg bands. Prior to migration from the area, three adults were found dead. In 1991, 12 of the known remaining 31 (39%) returned to the RMA; eight (66%) used a burrow within the same town used in 1990. The mean inter-nest distance for those owls that occupied the same town in 1990 and 1991 was 100.9 m (range = 34.4–251.1 m). Of the 20 prairie dog towns used by all owls in 1990, 18 (90%) were reused in 1991. Of the 20 burrows used by all mated pairs in 1990, four (20%) were reused in 1991. Of the eight 1991 adults choosing burrows used in 1990, three (37%) were birds banded in 1990. At least two other burrows which were used for nesting in 1990 had unbanded pairs occupying them in 1991.

Discussion

For cavity-nesting bird species, both nest site placement and orientation may influence the microclimate of the nest (Inouye et al. 1981). However, Burrowing Owls in this study used nesting burrows without regard to compass orientation, as was reported in previous studies without supporting statistics (Coulombe 1971, Butts 1973, Martin 1973, Butts and Lewis 1982).

In 1990, Burrowing Owls used burrows in areas with greater burrow density than available. Growing chicks often dispersed into burrows near the natal burrow while still largely dependent on the adults. Use of areas for nesting with greater burrow density may be explained by this habit. Chicks often foraged a short distance from the natal burrow while parent birds were hunting, and high burrow densities may provide needed escape burrows for these owlets. However, for unknown reasons, selection for high burrow density was not observed in 1991. Selection for either high burrow density in 1990 or nonselection in 1991 may therefore have been a chance occurrence.

Burrowing Owls are known to select areas with more bare ground and less grass cover than the surrounding area (MacCracken et al. 1985, Green and Anthony 1989). In our study, greater amounts of bare ground, and lower grass and forb height were selected for, but neither percent grass nor forb were selected for. Bare ground and short grass and forbs may afford Burrowing Owls visual security from predators and easier foraging (Green and Anthony 1989). Green and Anthony (1989) found Burrowing Owls used areas with less ($P < 0.05$) vertical density of vegetation from 0–10 cm than "potential" burrows, although their study was done in vegetation uncropped by sciurids. In our study, all burrows used by owls were in active prairie dog towns featuring short vegetation, and vertical density did not differ between used and control burrows.

Green and Anthony (1989) found that elevated perches were not used by Burrowing Owls where the surrounding vegetation was less than 5 cm in height. Similarly, in our study, Burrowing Owls used burrows with perches farther away than at control burrows; vegetation height at these burrows averaged less than 8 cm. Although Burrowing Owls often used elevated perches, they were apparently unnecessary in the short vegetation of active towns. Burrowing Owls at RMA appear to occupy habitats based on similar criteria to those studied elsewhere; they occupied areas featuring short, sparse vegetation.

Burrowing Owls were moderately selective of the physical variables (3/6 significant) and vegetation variables (3/6 significant) we measured. Several variables we measured were different between used and control burrows for only a single year. These included burrow density and road distance in 1990, and bare ground and forb height in 1991. We believe that single-year differences were attributable to climate: in 1990, the area received little rainfall, and the differences between full-grown vegetation and that which was cropped by prairie dogs were small. Thus, selection of physical, rather than vegetative, characteristics was observed in only this year. Conversely, in 1991, with far greater rainfall and greater differences in cropped versus uncropped vegetation, selection was for shorter forb height and more bare ground. Based on these data, we suggest that habitat alterations that diminish burrow availability and that allow vegetation to grow uncropped (>8 cm) and beyond early successional stage will adversely affect nesting Burrowing Owls.

Burrowing Owls show a high degree of fidelity to traditionally used nesting towns at RMA. Towns that have been used in consecutive years probably represent the best nesting habitat present at RMA. Management for Burrowing Owls therefore should include protection of active, traditionally used towns. A form of active management, in the event of extirpation of prairie dogs, would include artificial maintenance of vegetation height and succession by mowing. Mowing would be most critical around mid-March, when birds first arrive from migration and select nesting burrows.

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