Factors associated with nest- and roost-burrow selection by burrowing owls (*Athene cunicularia*) on the Canadian prairies

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Abstract: We examined nest- and roost-burrow characteristics from a declining population of burrowing owls (*Athene cunicularia* (Molina, 1782)) in Saskatchewan. Between 1992 and 2003, 84% of the 584 nests we found were in grassland pastures, even though these pastures constituted only 7% of the potentially available nesting area within our study area. In contrast, less than 3% of nests were in crop fields, despite these fields comprising 90% of the potentially available area. Within grassland pastures, owls selected nest burrows in areas with a higher density of burrows within 75 m (11.1 burrows/ha) compared with non-nest burrows of similar dimensions (5.6 burrows/ha). Richardson's ground squirrels (*Spermophilus richardsonii* (Sabine, 1822)) and badgers (*Taxidea taxus* (Schreber, 1777)) are the primary excavators of suitable nesting burrows in prairie Canada. In our study area, burrowing owls chose to nest and roost in badger-sized burrows, selecting those with taller tunnel entrances and soil mounds relative to unused burrows. We suggest that management for burrowing owl nesting habitat in Canada should consider the owls' avoidance of crop fields and their preference for grassland pastures. Managers should also consider the owls' apparent preference for nesting in areas of high burrow densities and their selection of badger-sized burrows for nesting and roosting.

Résumé : Nous avons examiné les caractéristiques des terriers de nidification et de perchage dans une population en déclin de chevêches des terriers (*Athene cunicularia* (Molina, 1782)) en Saskatchewan. Entre 1992 et 2003, 84 % des 584 nids inventoriés se trouvaient dans des pâturages de prairie, même si ces pâturages ne représentent que 7 % de la surface de nidification potentiellement disponible dans la région d'étude. En revanche, moins de 3 % des nids se retrouvaient dans les champs cultivés, même si ces champs représentent 90 % de la surface potentiellement disponible. Dans les pâturages de prairie, les chevêches choisissent des terriers de nidification dans les zones qui ont une plus forte densité de terriers sur une distance de 75 m (11,1 terriers/ha), par comparaison aux terriers de dimension semblable qui ne servent pas à la nidification (5,6 terriers/ha). Ce sont surtout les spermophiles de Richardson (*Spermophilus richardsonii* (Sabine, 1822)) et les blaireaux américains (*Taxidea taxus* (Schreber, 1777)) qui font l'excavation de terriers adéquats pour la nidification dans la prairie canadienne. Dans la région d'étude, les chevêches choisissent pour nicher et se percher des terriers de la taille de ceux des blaireaux, sélectionnant ceux dont l'ouverture du tunnel et les monticules de terre sont plus hauts par rapport aux terriers non utilisés. Nous suggérons que l'aménagement de l'habitat de nidification des chevêches au Canada tienne compte de l'évitement des champs cultivés par les chevêches et leur préférence pour les pâturages de prairie. Les gestionnaires devraient aussi prendre en considération la préférence apparente des chevêches pour les zones de nidification à forte densité de terriers et leur sélection de terriers de la taille de ceux des blaireaux pour nicher et se percher.

[Traduit par la Rédaction]

Introduction

Burrowing owl (*Athene cunicularia* (Molina, 1782)) populations have declined in many areas of western North America (see Wellicome and Holroyd 2001). In Canada, burrowing owls were listed as an endangered species in 1995 (Wellicome and Haug 1995), and their populations have continued to decline sharply (Skeel et al. 2001). Proximate causes such as high adult mortality (Haug et al. 1993), high juvenile mortality (Clayton and Schmutz 1999; Todd et al. 2003), and low productivity (Wellicome 2000) have been implicated in driving the decline of this species. Pesticides

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(James et al. 1990; Gervais et al. 2000), altered prey population dynamics (Poulin 2003), and habitat loss (Wellicome and Haug 1995) have been considered candidates for the ultimate causes of the declines. Considering the great quantity of grassland that has been cultivated for cereal crops (Gauthier et al. 2002), it is not surprising that modifications to habitat underlie the most common hypotheses for the decline of burrowing owls in Canada (Wellicome and Haug 1995).

In general, burrowing owls nest in areas of short grasses or other sparse vegetation (Coulombe 1971; MacCracken et al. 1985; Green and Anthony 1989; Haug and Oliphant 1990; Plumpton and Lutz 1993), but their most basic habitat requirement is a burrow. In an environment with few refuges, nesting in a burrow provides owls protection from most grassland predators (Haug et al. 1993), a relatively constant microclimate for nesting and thermoregulation (Coulombe 1971), protection from hazardous or inclement weather such as heavy rain, snow, hail or strong winds (R.G. Poulin, personal observation), and an area in which to cache prey items (Poulin et al. 2001). Juvenile burrowing owls depend on burrows during the post-fledging, premigratory period, roosting almost exclusively in association with burrows (King and Belthoff 2001; Todd 2001). Even during migration and on the wintering grounds, burrowing owls are found roosting in association with burrows (Haug et al. 1993; Clayton 1997). Any understanding of habitat associations or actions to manage habitat for the benefit of this species must include burrows as a key component.

Burrowing owls in western North America do not dig their own burrows, relying on fossorial animals to excavate suitable nest burrows (see Haug et al. 1993 for a complete list of burrow providers). Over much of their US range east of the Rocky Mountains, burrowing owls nest in association with black-tailed prairie dogs (*Cynomys ludovicianus* (Ord, 1815)) (Butts and Lewis 1982; Desmond et al. 2000; Orth and Kennedy 2001). However, outside the range of prairie dogs, viable populations of burrowing owls have persisted in association with burrows created by other species. Burrowing owls once ranged over the entire extent of the Canadian grasslands, and with the exception of approximately 1000 ha of land occupied by prairie dogs in extreme southwestern Saskatchewan, nest burrows are excavated almost exclusively by badgers (*Taxidea taxus* (Schreber, 1777)) and Richardson's ground squirrels (*Spermophilus richardsonii* (Sabine, 1822)).

The obligate association of burrowing owls with fossorial animals leaves them susceptible to changes in the populations or distributions of these animals. Control programs, agricultural activities, and sylvatic plague (*Yersinia pestis* (Lehmann and Neumann, 1896)) have reduced black-tailed prairie dog populations to a minute fraction of their former size throughout much of the US (e.g., Miller et al. 1994). The loss of prairie dogs over such a large area of the US has undoubtedly had significant impacts on burrowing owl populations (e.g., Butts and Lewis 1982). Outside the range of prairie dogs, intensive agriculture could be having a similar effect, eradicating the burrows created by other fossorial species.

Other authors have described characteristics associated with burrowing owl nest-site selection in prairie dog colonies (Butts and Lewis 1982; MacCracken et al. 1985; Desmond and Savidge 1999) and from locations supporting stable burrowing owl populations (Coulombe 1971; Martin 1973; Green and Anthony 1989). In this paper, we proposed to expand on these previous findings by examining burrow selection in Canada, in an area without prairie dogs, and where burrowing owl populations have declined dramatically in recent decades. Because this study pertains to burrow selection in an endangered population of owls in Canada, we believe it could play a role in guiding conservation initiatives. Our purpose was to document the coarse level distribution of burrowing owl nests over an intensively crop dominated landscape and at a finer scale, to assess roost- and nest-burrow selection by comparing attributes of used versus unused burrows.

Methods

Study area

The data presented in this paper were collected over a 12-year period (1992–2003), in the moist, mixed grassland ecoregion of south-central Saskatchewan, roughly bound by the cities of Regina (50°N, 104°W), Moose Jaw (50°N, 105°W) and Weyburn (49°N, 103°W). This area is predominantly flat with few rolling hills (elevation range 550–589 m). This area typically has warm, dry summers with the average high temperature of ~26 °C and an average of ~60 mm of precipitation in the month of July. Land use is dominated by the nonirrigated production of cereal crops, leaving only small and scattered patches of native grassland (Gauthier et al. 2002, also see Results in this paper). Native grasslands tend to be dominated by a mix of grasses including prairie Junegrass (*Koeleria macrantha* (Ledeb.) J.A. Schultes), streambank wheatgrass (*Elymus lanceolatus* (Scribn. & J.G. Sm.) Gould), western wheatgrass (*Pascopyrum smithii* (Rydb.) A. Löve), blue grama (*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths), needle and thread (*Hesperostipa comata* (Trin. & Rupr.) Barkworth), porcupinegrass (*Hesperostipa spartea* (Trin.) Barkworth), and green needlegrass (*Nassella viridula* (Trin.) Barkworth).

Burrowing owls in this area nest almost exclusively in burrows created by Richardson's ground squirrels and badgers. Each year, some of the owl nests (total = 58% over 12 years) in our study area were in nest boxes (see Wellicome 2000); however, these nest boxes were only installed at active nests and in no way affected initial nest-site selection by the owls. From 1992 through 2000, some nests in our study area received supplemental food as part of another study (Wellicome 2000). Supplemental food was provided to nearly all of the nests in some years and randomly to half of the nests in other years. Regardless, supplements were only provided after nest burrows had been established and therefore would have had no influence on nest-site or burrow selection. Supplemental feeding always ceased prior to fledging (41 days post hatch), and should have had no effect on chick behaviour and post-fledging burrow selection (see King and Belthoff 2001). There is a possibility that nest box reuse in subsequent years and supplemental feeding may have influenced the nest-site selection of a proportion of our owls, but we suggest that our data are so unambiguous that the impacts of these confounding variables do not detract from our conclusions (see Results on Nest-site selection).

Nest-site selection

Nest locations were found in cooperation with Operation Burrowing Owl landowners and through our own searches. Operation Burrowing Owl was established as a means to encourage burrowing owl conservation and prairie stewardship in Saskatchewan (Hjertaas 1997), and maintains a toll-free telephone number for landowners to call and report burrowing owl sightings (see Skeel et al. 2001). After an owl nest was located, we would return to that area each year and search for owls. Our search efforts involved either searching with binoculars or spotting scopes from a parked vehicle or by walking entire areas (e.g., pasture) in approximately 200-m transects. We are confident that we located the vast majority of burrowing owl nests in our study area each year because of the high public profile of the species and because the population of owls was so small that locating nests was not overly arduous. By finding most of the owl nests in our study area, we minimized the likelihood that there were any significant biases in ability to detect owl nests in the different habitat types.

We categorized each owl nest based on the habitat (or land-use activity) in which it was found (e.g., hay, grassland, crop). The amount of area of each habitat within our study area was calculated from a digitized land-cover map (30-m resolution) in ArcGIS® version 8.2 (Environmental Systems Research Institute Inc. 2003). To assess preference or avoidance of each habitat type, we calculated the difference between the proportion of nests observed in a particular habitat type and the number of nests that we would have predicted based on the availability of that habitat on the landscape. We did not pool data between years because there was a lack of independence in nest-site selection — individual owls often returned to the breeding grounds each year and there was some fidelity to individual burrows (R.G. Poulin, L.D. Todd, and T.I. Wellicome, unpublished data).

Nest-burrow selection

In August 2001, non-nest burrows were selected by walking a random direction from a nest (within the confines of the pasture) and using the first apparently suitable (i.e., badger-sized, apparently unobstructed) burrow that we encountered and was at least 150 m from any active burrowing owl nest. Only badger-sized burrows were used as non-nest burrows since our perception was that these were the burrows generally used as owl nests (later confirmed by our data). Originally designed to be a paired comparison, we were unable to pair each nest burrow with a unique non-nest burrow in some of the smaller pastures. Therefore, we only used a single non-nest burrow within each pasture that contained nest burrows.

At each nest and non-nest burrow, we established a 75 m radius and counted and measured all burrows within that radius. Measurements included the area (width × length) of the soil mound outside of the burrow, mound height (top of mound to surrounding ground level), burrow entrance height, type of burrow (ground squirrel or badger), and compass direction of entrance opening. We used a Rayleigh's test to determine any directionality in entrance orientation. We used logistic regressions to determine if any of the factors that we measured were able to significantly identify differences between nest and non-nest burrows. We tested two logistic regression models: (*i*) three different burrow dimensions (burrow entrance height, mound height, and area) with total number of burrows within 75 m and (*ii*) the three different burrow dimensions with the number of ground-squirrel- and badger-sized burrows treated separately. The purpose of this was to determine if there was any relationship to the total number of burrows and then to determine if there was any relationship to particular types (i.e., squirrel or badger) of burrows. Secondly, we used logistic regression to test whether nest burrows were different from all the burrows on the landscape (i.e., all burrows within 75 m of nest and non-nest burrows).

Roost-burrow selection

Method 1

In 2000, we used radiotelemetry to determine roost-burrow selection by premigratory, post-fledging owls. Young owls were captured with baited noose carpets, spring triggered nets (bow nets), or while they were inside nest boxes. At approximately 30 days post hatch, nestlings (one per nest) were outfitted with a necklace-style radio transmitter (6 g, 3%–4% of body mass; Holohil Systems Ltd., Carp, Ontario). Diurnal roost locations were recorded every other day from the time of fledging until migration (see Todd et al. 2003). We recorded the dimensions of each roost burrow (also known as satellite burrows) used by radio-tagged fledglings, as well as the dimensions of the nearest burrow that showed no signs of owl use (i.e., no whitewash or pellets). Measurements included mound height, mound area, burrow entrance height, type of burrow (ground squirrel, badger, or nest box), distance to nearest perch, distance to nest, distance to nearest wetland, distance to habitat edge, number of burrows within 10 m, average height of vegetation 10 m from burrow, and average height of vegetation at the edge of the burrow. We used a stepwise logistic regression to identify factors that significantly predicted used versus unused burrows. We used a mixed model with a binomial error term and individual owls and burrow pairs as random effects to account for variation attributed to individual owls (Stata® version 9.0; StataCorp LP 2005). This was necessary because of the lack of independence associated with the variable number of observations that we included from individual owls. In each iteration, the analysis removed the factor that explained the least amount of variance. The final model included only those factors that were significant at $p < 0.05$.

Method 2

During August of 2001, every burrow within 75 m of a nest burrow was mapped and measured (as per Nest-burrow selection above). Using whitewash and pellets as evidence, we recorded whether a particular burrow had been used as a roost. At the time of year that we conducted this study, roost burrows were used by both adults and post-fledging juveniles (see Todd 2001). Differences between the parameters measured at used and unused burrows were tested in a logistic regression model. Values are reported as means ±1 SE, as well as the 95% confidence intervals (CI).

Results

Nest-site selection

From 1992 to 2003, we located 584 burrowing owl nests, encompassing a minimum convex polygon of 661 946 ha. Within this study area, 16 664 ha (2.5% of the land) was completely unavailable to burrowing owls for nesting, consisting of roads, water, mud flats, and tree stands. The remaining 645 282 ha was potentially suitable nesting habitat: alfalfa hay fields (0.4% of possible nesting area), roadside ditches (0.5%), urban areas (1.5%), grassland pastures (7.3%), and crop fields (90.3%). Burrowing owl nests were located in grassland pastures at a far greater proportion than expected based on the proportion of grassland habitat available, and were not located in crop fields in proportion to their availability (Fig. 1). Each year, no more than 10% (2.4% ± 1%) of owls nested in crop fields despite the fact that 90% of the potentially suitable landscape was made up of cropland, whereas no less than 65% (85.3% ± 3%) owl nests were located in grassland pastures each year despite the fact that grassland constituted less than 8% of the potentially suitable landscape (Table 1). Hay fields and roadside ditches were used in proportion to their availability on the landscape. Urban lawns may have been used more frequently than expected (Fig. 1); however, it should be noted that 47 of 58 nests found in urban lawns came from a single site (a golf course) in the city of Moose Jaw. As this site's owl population decreased, the proportion of owls nesting in urban lawns approached the expected value.

Nest-burrow selection

Neither nest burrows (R_{21} = 3.4, z = 0.54, $P > 0.50$), nor non-nest burrows (R_{11} = 3.4, z = 0.56, $P > 0.50$), nor all burrows across the landscape (R_{514} = 0.1, $z < 0.01$, $P > 0.50$) had entrances that faced in a mean compass direction significantly different from random. The logistic regression models showed that nest burrows and (paired) non-nest burrows did not differ in height of burrow entrance ($P > 0.35$ in all models; nest: 15.4 ± 0.7 cm, n = 22, 95% CI = 13.9–16.8 vs. non-nest: 17.3 ± 1.5 cm, n = 12), mound height ($P > 0.15$ in all models; nest: 17.3 ± 1.2 cm, n = 22, 95% CI = 14.9–19.7 vs. non-nest: 14.8 ± 1.7 cm, n = 12), and mound area ($P >$ 0.73 in all models; nest: 2.3 ± 0.3 m^2, n = 22, 95% CI = 1.8–2.9 vs. non-nest: 2.1 ± 0.2 m^2, n = 12), but that they did differ in the total number of burrows within 75 m (P = 0.05; nest: 19.7 ± 2.5, n = 22 vs. non-nest: 10.0 ± 1.8, n = 12). Separating the ground-squirrel- and badger-sized burrows, the logistic regression showed that the number of ground squirrel burrows (P = 0.06, odds ratio = 1.2; nest: 12.0 ± 1.7 vs. non-nest: 5.1 ± 1.3) was more important than the number of badger burrows (P = 0.65, odds ratio = 1.0; nest: 7.8 ± 1.6 vs. non-nest: 4.8 ± 1.3) in statistically separating nest and non-nest burrows.

Logistic regression for entrance height, mound area, and mound height showed that larger burrow entrances (all: 12.9 ± 0.3 cm, 95% CI = 12.5–13.5, n = 519) significantly separated nest burrows from other burrows across the landscape ($P < 0.01$, odds ratio = 1.2). However, the average burrow on the landscape did not differ significantly in mound height (all: 8.0 ± 0.3 cm, 95% CI = 7.4–8.5, n = 519) or mound area (all: 1.3 ± 0.05 m^2, 95% CI = 1.2–1.4).

Roost-burrow selection

In 2000, we compared the characteristics of roost burrows used by radio-tagged juvenile owls to the closest unused burrow. We used data from nine radio-tagged juvenile burrowing owls, providing comparisons of 28 used burrows versus 26 unused roost burrows. Adjusting for the variance attributed to the nine individual owls, the stepwise logistic regression analysis identified (Wald χ^2 = 19.3, McFadden's ρ^2 = 0.27, $p < 0.01$) that height of tunnel entrance ($P < 0.01$, odds ratio = 1.16) and mound area (P = 0.02, odds ratio = 2.95) were the two variables that significantly contributed to the model that predicted whether or not a burrow was used by post-fledging juveniles. The model correctly classified 67% of active burrows and 65% of inactive burrows. The means of all measured variables are found in Table 2.

In 2001, we compared tunnel entrance height, mound area, and mound height of used (determined by pellets and whitewash) and unused burrows within 75 m of nests. Similar to our results in 2000, the logistic regression model showed that used burrows were significantly (Wald χ^2 = 184.8, McFadden's ρ^2 = 0.34, $p < 0.01$) different than unused burrows in that they had larger mound areas ($p < 0.01$, odds ratio = 2.95), taller mound heights ($p < 0.01$, odds ratio = 1.17), and taller burrow entrances (p = 0.01, odds ratio = 1.06). The model correctly classified 68% of active burrows and 73% of inactive burrows. The means of these variables are found in Table 2.

In total, we found 399 burrows within 75 m of the 22 active nest burrows that we examined; we classified 144 of them as badger burrows and 255 as ground squirrel burrows. There were signs of use at 71% of the badger burrows and 32% of ground squirrel burrows.

Discussion

The results of our study suggest that burrowing owls in Saskatchewan preferentially select nest sites in grassland pastures and avoid nesting in crop fields. They choose to nest in burrows surrounded by a high density of other burrows and that tend to resemble badger burrows, having larger soil mounds and taller entrances than random or ground squirrel burrows.

Burrowing owls strongly avoided nesting in agricultural crop fields. Although more than 90% of the potentially suitable land in our study area was crop, less than 3% of burrowing owl nests were found in crop fields (Table 1). Owls showed a preference for nesting in grassland pastures; although less than 8% of the potentially suitable land in our study area was pasture, 84% of nests were found in that habitat type (Table 1). To avoid any biases associated with pseudoreplication caused by high site fidelity of individual owls, we did not pool the data from the 12 years (Table 1, Fig. 1); however, we are confident that the consistency of our results over the 12 years unambiguously demonstrates that burrowing owls in our study area selected grassland pastures and avoided crop fields. It should also be noted that we do not have reason to believe that there were any significant

Fig. 1. Differences in the proportion of burrowing owl (*Athene cunicularia*) nests found and the proportion expected in each habitat from 1992 to 2003. Expected values were calculated from the abundance of each habitat (e.g., 90.3% of land was crop, therefore expect 90.3% of nests in crop fields). Positive bars indicate selection for a habitat; negative bars indicate an avoidance of a habitat.

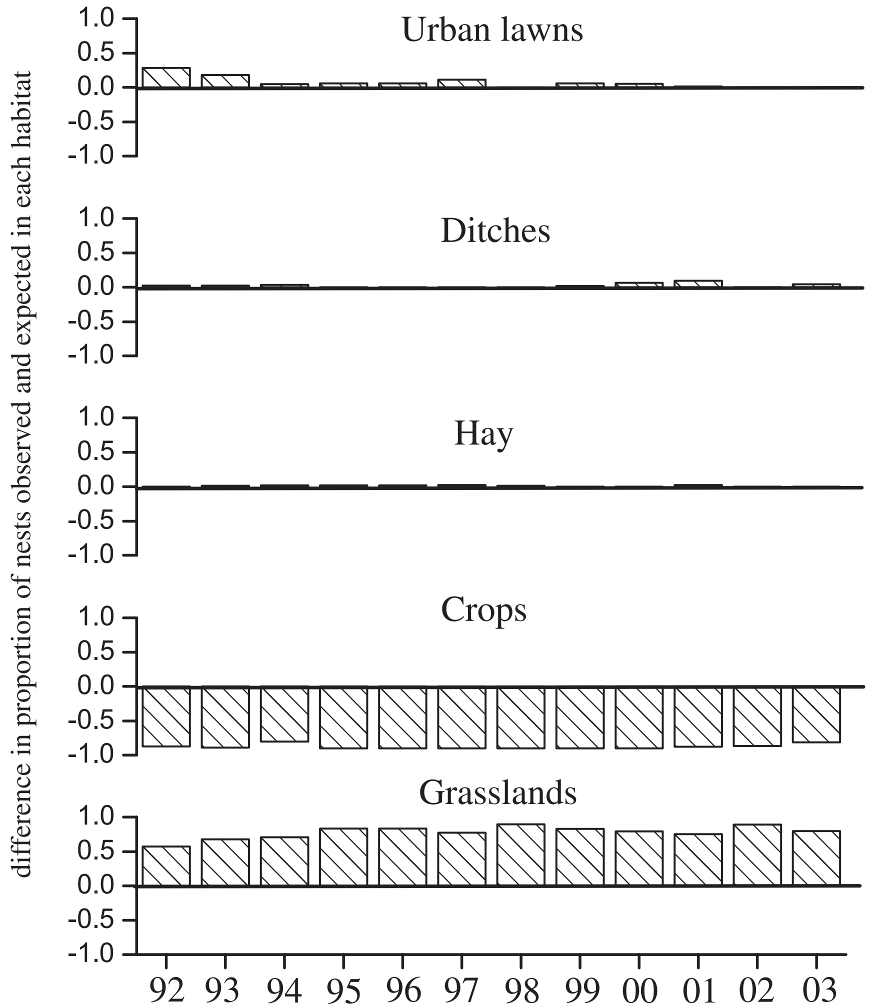

Table 1. The number and distribution of burrowing owl (*Athene cunicularia*) nests across approximately 6200 km^2 of agricultural land in southern Saskatchewan.

	Crops	Grassland	Ditch	Hayfield	Lawn	Nests
1992	2	46	2	0	21	71
1993	1	54	2	1	14	72
1994	5	38	2	1	3	49
1995	0	49	0	1	4	54
1996	0	49	0	1	4	54
1997	0	34	0	1	5	40
1998	0	57	0	1	1	59
1999	0	37	1	0	3	41
2000	0	26	2	0	2	30
2001	1	33	4	1	1	40
2002	1	27	0	0	0	28
2003	4	40	2	0	0	46
Total	14	490	15	7	58	584
% nests	–2.4	–83.9	–2.6	–1.2	–9.9	
% area	–90.3	–7.3	–0.5	–0.4	–1.5	

Note: Percent area represents the proportion that a particular habitat encompassed within the entire area (excluding habitats completely unavailable for nesting, e.g., water).

Table 2. Comparison of the mean (±SE) measurements of used and unused roost burrows by juvenile burrowing owls on the breeding grounds during the post-fledging, premigratory period.

	2000		2001	
	Roost burrow (n = 28)	Unused burrow (n = 26)	Roost burrow (n = 193)	Unused burrow (n = 216)
Soil mound height (cm)	14.3±1.4	9.1±1.3	11.5±0.4*	5.2±0.3*
Soil mound area (m^2)	1.7±0.2*	0.9±0.1*	1.9±0.1*	0.7±0.1*
Burrow entrance height (cm)	21±1.2*	15±1.0*	14±0.4*	11±0.3*
Vegetation height (cm)				
At burrow	8.3±1.0	8.8±1.4		
10 m from burrow	20.4±1.6	20.5±1.8		
Number of burrows within 10 m	2.5±0.3	1.8±0.3		
Distance (m)				
To edge	72±10	68±11		
To nearest perch	51±7	46±8		
To nearest water	158±23	155±24		

Note: Data was attained by radiotelemetry in 2000 and by evidence of use (i.e., whitewash and pellets) in 2001. Logistic regression was used to identify factors that significantly (*) separated used and unused burrows.

changes in the proportion of different land use types (e.g., farmers converting pasture to crop and vice versa) over the course of the study. Given the agricultural community's intolerance for ground squirrels in crop fields and the short life span of burrows in actively cultivated fields, this result is hardly surprising. However, we felt that it was crucial to quantify this phenomenon for species management initiatives and in light of some of the positive associations found between burrowing owls and irrigated crops in the US (e.g., Orth and Kennedy 2001; Belthoff and King 2002).

In southern Saskatchewan, burrowing owls arriving in the spring encounter crop fields in a state of stubble from the previous year's harvest or fallow. In that condition, crop fields may very much emulate preferred burrowing owl nesting habitat. However, an area cannot be considered a burrowing owl nesting habitat unless it supports burrows, and our data strongly suggests that all burrows are not equally selected by burrowing owls. Compared with other potentially suitable nests, burrowing owls in our study selected nest burrows that were surrounded by nearly twice as many other burrows within 75 m. This result is comparable to Plumpton and Lutz (1993), who found that in 1 of 2 years of their study, burrowing owls in prairie dogs colonies in Colorado nested in burrows that had a significantly higher density of burrows (114 vs. 105 burrows/ha) within 25 m than a non-nest paired burrow. Similarly, Desmond and Savidge (1999) found that successful nests were surrounded by an average of 94 prairie dog burrows within 75 m, whereas unsuccessful nests were only surrounded by an average of 26 burrows. There are several possible explanations for selecting nest burrows in an area of high burrow density. Burrows are used for a variety of functions beyond nesting, including protection from aerial predators and inclement weather, a place to cache food (Haug 1985; Poulin et al. 2001), and roosts for dispersing fledglings (King and Belthoff 2001; Todd 2001).

At larger scales, burrowing owls avoid croplands and choose areas of high burrow densities in which to nest. At a smaller scale, burrowing owls choose to nest and roost in burrows that have a particular entrance size and a relatively large mound of soil at the entrance. In southern Saskatchewan, where ground squirrels and badgers are the primary burrow providers, our data clearly show that burrowing owls select nest burrows consistent with the dimensions of badger burrows. Owls chose nest burrows with an entrance height of 15–16 cm, an entrance smaller than the average badger burrow (18–19 cm) but larger than the average ground squirrel burrow (9–10 cm). We hesitate to claim that they are selecting burrows created by badgers because of the variation in the size of ground squirrel burrows and the possibility that ground squirrel burrows can be enlarged by other species. Interestingly, the nest-burrow entrances in prairie dog colonies have been reported as 11–13 cm high (Butts and Lewis 1982; MacCracken et al. 1985), those in rock squirrel (*Spermophilus variegates* Erxleben, 1777) burrows were at least 14 cm high (Martin 1973), and Haug (1985) reported owls in central Saskatchewan using badger burrows with entrances that averaged 13 cm high. As far as we are aware, this is the first study to compare the dimensions of those burrows used as nests versus those available. The reason burrowing owls select burrows with a particular entrance size may be as simple as selecting a burrow that is large enough to accommodate the owls while still small enough to prevent large predators (e.g., foxes, coyotes) from easily accessing the nest. Smith and Belthoff (2001) found that artificial nest burrows were selected based on the internal dimensions of the burrow and nest chamber, and quite reasonably, this could be correlated to the size of the burrow entrance or the soil mound.

Burrowing owls chose to roost at burrows with similar attributes as nest burrows. One factor in common with all of our used versus unused comparisons is that used burrows had larger soil mounds than unused burrows. We can only speculate on the reason that they choose burrows with large soil mounds, but it may be logical to assume that taller soil mounds provide them with a somewhat elevated perch in a landscape otherwise scarce in perches, as well as providing them some indication of the internal dimensions of the burrow (Smith and Belthoff 2001). It should be noted that burrowing owls are capable of modifying and expanding burrows, and we concede that our measured dimensions of the nest burrows could have been manipulated by the actions of the owls themselves. However, our results are not inconsistent with our perception of the typical nest burrows that we find at the beginning of spring, before owls have had a chance to expand their burrow entrance. Also, we rarely observed owls entering or modifying roost burrows and the roost burrows that the owls selected in our study were comparable to nest burrows in their dimensions; they resembled badger-sized burrows.

Understanding the attributes by which burrowing owls select roost or nest burrows is important for understanding the basic biology of this species. The importance of these attributes may be especially meaningful for management activities in Canada. We suggest that any conservation efforts aimed at increasing nesting habitat for burrowing owls in Canada should include actions that conserve or restore grassland habitats. Within these grassland habitats, we also suggest that actions promoting high densities of burrows (i.e., ground squirrels, badgers, nest boxes) will improve nesting (and roosting) habitat quality.

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