

## VEGETATION AND SOILS OF BURROWING OWL NEST SITES IN CONATA BASIN, SOUTH DAKOTA

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Burrowing Owls (*Athene cunicularia*) in southwestern South Dakota frequently use the burrows of black-tailed prairie dogs (*Cynomys ludovicianus*) for nesting and escape cover. Coulombe (1971) emphasized the importance of understanding the role of burrow selection in relation to owl behavior, physiology, and overall ecology. He also suggested that availability of burrow sites may be the critical factor in Burrowing Owl population dynamics.

Re-use of nest burrows by owls has been reported in the literature, but data are limited (Rich 1984). Previous reports indicate that from 8% to 60% of burrows previously occupied are re-used by Burrowing Owls (Wedgewood 1976, Gleason 1978). Rich (1984) reported that re-use of nest sites by Burrowing Owls in southcentral Idaho ranges from 23% to 49%. Rich noted that owls often abandon seemingly suitable nest sites for no apparent reason.

Prairie dog activities often result in a complete absence of vegetation around their burrows and short vegetation in the prairie dog colony (Bonham and Lerwick 1976, Hansen and Gold 1977). Vacant burrows in Conata Basin quickly revegetate with annual forbs and eventually perennial grasses completely covering the burrows (pers. observ.). Changes in vegetation on abandoned prairie dog burrows could influence Burrowing Owl use. Furthermore, Coulombe (1971) suggested that the owls modify rodent burrows as nest sites. This suggests that soil characteristics may also be important in owl nesting ecology.

Few studies have critically examined the characteristics of Burrowing Owl nest sites, and we know of no published data that quantify characteristics of vegetation and soils of prairie dog burrow sites that are used for nesting by owls. Conata Basin, SD, offers an excellent place in which to examine Burrowing Owl nest site selection, because prairie dog poisoning programs have resulted in a large number of vacant burrows, of differing ages, which are potential nest sites for owls.

The purpose of our study was to characterize the vegetation and soils at abandoned prairie dog burrows used as nest sites by Burrowing Owls, and to compare these factors with those of adjacent unoccupied burrows.

### STUDY AREA AND METHODS

The study was conducted in Conata Basin, which is on the Buffalo Gap National Grasslands in parts of Pennington, Jackson, and Shannon counties of South Dakota. Conata Basin is a lowland area surrounded by buttes and mesas and is bordered on its northern, eastern, and western edges by Badlands National Park. The basin supports short-grass prairie dominated by blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), western wheatgrass (*Agropyron smithii*), scarices (*Carex* spp.), red three-awn (*Aristida longiseta*), scarlet globemallow (*Sphaeralcea coccinea*), woolly Indianwheat (*Plantago spinulosa*), and plains pricklypear (*Opuntia polyacantha*).

The study area had been grazed by cattle since 1900 and

forage utilization often exceeds 60%, resulting in overgrazing (Uresk et al. 1982). Prairie dogs historically (Merriam 1902) and currently occupy the entire Conata Basin ( $\approx 700 \text{ km}^2$ ) despite long-term poisoning programs.

Our study was conducted from April through October 1981. During April and May, we located Burrowing Owl nest sites by observing owls as they defended territories, gathered nesting material, and showed other breeding behavior (Thomsen 1971), and eventually by seeing young. Prey remains, regurgitated pellets, and nesting material also helped in identifying burrows used as nest sites. We searched the entire area for nesting owls.

We estimated canopy cover and height of surrounding vegetation, soil texture, distance to water, burrow diameter, topography, and aspect at confirmed nest sites and at adjacent unoccupied burrows. A "non-nest burrow" was defined as the closest burrow to a nest burrow that was not occupied by prairie dogs, and that could be used by owls. We believed this procedure would provide more accurate information than a random selection of vacant burrows over the entire study area. Owls presumably need search only a relatively small area before finding a suitable burrow.

We estimated plant canopy cover at each nest and adjacent non-nest burrow along four 20-m line transects originating from the center of each burrow. One transect line was oriented toward each of the four cardinal directions. Cover class of each plant species, bare ground, and litter were estimated in a 2- by 5-dm plot spaced at 1-meter intervals along each transect line (Daubenmire 1959). The height of the tallest plant in each plot was measured to the nearest centimeter. Vegetation was sampled during the last week in May and the first week in June.

For analysis of plant cover, we divided each transect into three segments (the first 5 m, the second 5 m, and the remaining 10 m), resulting in three consecutive rings around each burrow. The first ring was an area of maximum disturbance by prairie dogs, the second had moderate disturbance, and the third was relatively undisturbed prairie (our control). We believed that any differences in plant cover between nest and non-nest burrows would be found within the first 5 or perhaps 10 m.

Multivariate analysis of variance (Hope 1969) was used to determine if litter, bare ground, plant species, and vegetation height differed significantly among all possible comparisons of concentric rings and burrow types. Statistical significance was accepted at a level of  $P = 0.10$  because trends were apparent in the field, but prairie dog activities (digging and clipping of plants) had created an extremely heterogeneous distribution of plants around burrows that increased variance estimates.

Soils were sampled by collecting four subsamples from each burrow mound approximately 20 cm from the burrow entrance to a depth of 15 cm, one at each of the four cardinal directions. These samples included excavated soil from the burrow mound and soil beneath the mound. The subsamples were combined and soil texture was determined by the hydrometer method (Brady 1974) for three replications of each burrow sample. Percent sand, silt, and clay were tested for differences between nest and non-nest burrows with paired  $t$ -tests.

Diameter of the burrow entrance at the widest point was measured to the nearest centimeter for each burrow. Burrow diameters were tested for differences between nest and non-nest burrows with paired  $t$ -tests.

### RESULTS

Canopy cover of plants around burrows used as nest sites differed ( $P < 0.10$ ) from that around non-nest burrows within the first 5 m from the center of the burrow entrance. Plant cover within the next two concentric rings was not different between burrow types or rings. Consequently, we combined data from these rings for final analysis and termed

TABLE 1. Mean ( $\pm$ SE) percent canopy cover of bare ground, litter, and plants on prairie dog burrow sites used by Burrowing Owls for nesting, burrow sites not used for nesting, and native prairie undisturbed by prairie dogs in Conata Basin, South Dakota. N = number of plots sampled for each type.

	Burrow sites		Prairie N = 1,080
	Owls N = 180	No owls N = 180	
Bare ground	42.4 $\pm$ 2.2	46.1 $\pm$ 3.0	39.2 $\pm$ 1.2
Litter	16.3 $\pm$ 1.7	17.3 $\pm$ 2.0	19.7 $\pm$ 1.2
Grasses and Sedges	34.8 $\pm$ 2.2	32.5 $\pm$ 2.6	43.8 $\pm$ 5.6
<i>Bouteloua gracilis</i>	9.8 $\pm$ 1.8	11.9 $\pm$ 2.2	13.5 $\pm$ 1.0
<i>Buchloe dactyloides</i>	13.8 $\pm$ 2.0	9.6 $\pm$ 1.7	12.3 $\pm$ 1.1
<i>Carex</i> spp.	4.1 $\pm$ 1.0	3.0 $\pm$ 0.6	8.9 $\pm$ 5.6
Forbs	44.6 $\pm$ 27.9	16.4 $\pm$ 1.2	16.6 $\pm$ 1.5
<i>Sphaeralcea coccinea</i>	5.7 $\pm$ 0.8	4.8 $\pm$ 0.7	5.9 $\pm$ 1.5
<i>Chenopodium</i> spp.	0.1 $\pm$ *	1.6 $\pm$ 0.7	0.2 $\pm$ 0.1
<i>Plantago spinulosa</i>	6.9 $\pm$ 1.0	4.1 $\pm$ 0.7	5.4 $\pm$ 0.1
<i>Lepidium densiflorum</i>	14.1 $\pm$ 13.9	0.1 $\pm$ *	0.3 $\pm$ 0.1
<i>Draba reptans</i>	1.2 $\pm$ 0.3	0.7 $\pm$ 0.2	1.0 $\pm$ 0.1
<i>Linum rigidum</i>	14.0 $\pm$ 13.9	0.1 $\pm$ *	0.3 $\pm$ *
Shrubs	1.1 $\pm$ 0.4	0.6 $\pm$ 0.3	0.4 $\pm$ 0.1
<i>Phlox hoodi</i>	1.1 $\pm$ 0.4	0.5 $\pm$ 0.3	0.2 $\pm$ 0.1
Cactus ( <i>Opuntia polyacantha</i> )	0.6 $\pm$ 0.3	0.2 $\pm$ 0.1	0.8 $\pm$ 0.2
Height of vegetation (cm)	12.8 $\pm$ 0.6	12.3 $\pm$ 0.5	14.0 $\pm$ 0.3

\* <0.1%.

them "prairie." Plant cover around nest and non-nest burrows within the first ring differed ( $P < 0.10$ ) from prairie. Although not specifically tested, grass cover was greatest on prairie and nearly equal between nest and non-nest burrows. Forb cover was greatest around nest burrows, while non-nest burrows and prairie were nearly equal in forb cover. Shrub cover followed the same pattern as forb cover, while cover by cactus was similar between nest burrows and prairie (Table 1).

Step-down  $F$ -tests, as well as univariate  $F$ -tests, indicated that vegetation height, cover of Hood phlox (*Phlox hoodi*), bare ground, stiff stem flax (*Linum rigidum*), and blue grama differed ( $P < 0.10$ ) among nest burrows, non-nest burrows, and prairie (Table 1). Vegetation was tallest in prairie and equally tall between burrow types. Cover of Hood phlox was greatest at nest burrows and least on the prairie, bare ground was least prevalent on prairie followed by nest burrows, stiff stem flax was greatest on nest burrows followed by non-nest burrows, while blue grama cover was greatest on prairie followed by non-nest burrows (Table 1).

Soils of both nest and non-nest burrows were classified as silty clay loam. Soil texture differed between burrow types, but the differences were not statistically significant. Sand content was greater ( $P < 0.14$ ) at nest burrows, while silt content was greater ( $P < 0.30$ ) at non-nest burrows. Clay content was nearly equal ( $P < 0.50$ ) between burrows (Table 2).

Nest burrows had a larger ( $P < 0.05$ ) diameter than non-nest burrows:  $13 \pm 1$  versus  $11 \pm 1$  cm ( $\bar{x} \pm$  SE).

TABLE 2. Mean ( $\pm$ SE) percent sand, silt, and clay of soils of prairie dog burrow sites used by Burrowing Owls for nesting and adjacent non-nest burrow sites.

Soil characteristics (%)	Burrows	
	Nest	Non-nest
Sand	28.6 $\pm$ 4.1	22.3 $\pm$ 2.1
Silt	43.4 $\pm$ 4.8	49.0 $\pm$ 3.1
Clay	31.3 $\pm$ 4.5	28.7 $\pm$ 4.0

## DISCUSSION

Our results indicate the Burrowing Owls in Conata Basin nest in vacant prairie dog burrows that are in early stages of plant succession where vegetation height is lower than surrounding prairie. High values of canopy cover for annual forbs and low values for most perennial plants indicate these early stages of plant succession. Forb cover was similar between non-nest burrows and undisturbed prairie.

Prairie dog activities increase cover of buffalograss and decrease cover of blue grama on short-grass range (Bonham and Lerwick 1976). Abandoned prairie dog burrows with high cover values for buffalograss are in early stages of plant succession. The apparent difference in cover of the two dominant perennial grasses also indicates early plant successional stages at nest burrows. Cover of buffalograss was greater at nest burrows, while blue grama cover was dominant ( $P < 0.10$ ) at non-nest burrows (Table 1).

Burrowing Owls may select vacant prairie dog burrows in early stages of plant succession for several possible reasons. Plant cover is greater at nest burrows than at non-nest burrows owing to the abundance of annual forbs. When owls begin nesting at the study area, most annual forbs are seedlings, or have not yet sprouted, thus those burrows are essentially bare. Owls may be simply selecting open burrows. As the growing season progresses, annual forbs eventually dominate the burrow. Although we sampled burrow vegetation early in the growing season, there was a one- to two-week period from the time a nest burrow was confirmed to the time it was sampled. These facts, however, still emphasize the relationship of burrow use by owls and plant succession. Furthermore, greater cover at nest burrows would provide more concealment for emerging young owls than at older burrows. Annual forbs were well-established by the time young owls were active at burrow entrances and left the nest. Also, recently vacated burrows in early stages of plant succession would be in better condition (less cave-ins, erosion, and litter accumulation), and would require less modification than older burrows. Burrowing Owls often use the same burrow as a nest site in consecutive years. Habitual use of a burrow could influence burrow selection until plant succession results in complete coverage of a burrow. All the nest

burrows sampled in this study had been previously used by Burrowing Owls.

Burrows used for nesting were in soils with a greater sand content than non-nest burrows. Although this difference was statistically insignificant ( $P < 0.14$ ), it may be biologically significant. The significant difference in burrow entrance diameter between nest and non-nest burrows indicates that Burrowing Owls modify prairie dog burrows used as nest sites. Presumably, sandy soil would facilitate enlarging burrow passageways. Coulombe (1971) stated that in California burrow diameters averaged 20 cm, and suggested that owls may modify burrows that have been abandoned by rodents. In addition, sandy soils drain rapidly, which would reduce nest flooding during frequent spring and summer rainstorms.

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#### TERRITORIALITY AND INTERSPECIFIC AGGRESSION IN STEAMER-DUCKS

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Steamer-ducks (*Tachyeres* spp.) are large diving ducks of southern Argentina and Chile, and the Falkland Islands (Murphy 1936). Four species are recognized currently (Humphrey and Thompson 1981): Flying Steamer-Duck (*T. patachonicus*), Magellanic Flightless Steamer-Duck (*T. pteneres*), Falkland Flightless Steamer-Duck (*T. brachypterus*), and White-headed Flightless Steamer-Duck (*T. leucocephalus*). Flying Steamer-Ducks breed in both freshwater and marine habitats; the three flightless species are strictly marine in distribution (Humphrey and Livezey, in press). All members of the genus feed primarily on large molluscs and crustaceans obtained from the bottom by diving and shallow-water foraging, or found exposed during low tide (Murphy 1936; Weller 1972; Livezey and Humphrey, unpubl.).

Steamer-ducks are renowned for their pugnacity; numerous observers have described their intense, sometimes fatal territorial combat (Vallentin 1924; Reynolds in Lowe 1934; Murphy 1936; Pettingill 1965; Cawkell and Hamilton 1961; Weller 1972, 1976). Territoriality in other wa-

terfowl rarely involves combat and generally is shown only toward conspecifics (McKinney 1965, Seymour 1974, Seymour and Titman 1978, Stewart and Titman 1980), although exceptions are known (McKinney et al. 1978, Savard 1982).

Recently, Nuechterlein and Storer (1985) described interspecific aggression of Flying Steamer-Ducks on several freshwater lakes in the Argentine Andes. These authors frequently observed combat between male *T. patachonicus* and regularly noted "mass spooks" of grebes, coots, and ducks when territorial pairs of *T. patachonicus* called or approached. They also witnessed two severe attacks (one fatal) by males on Red Shovelers (*Anas platylea*), and found carcasses of five more shovelers and one Yellow-billed Pintail (*A. georgica*) which were determined to have been victims of steamer-ducks. Nuechterlein and Storer argued that the massive skeletal and muscular morphology of steamer-ducks makes the "costs," or risks, of interspecific aggression negligible, and that this renders "profitable" the attacks on the possibly food-competitive shovelers. They also suggested that such killings may serve as displays of fighting ability in males, and hence be maintained partly by sexual selection.

As part of an ongoing study of the morphology, systematics, and ecology of steamer-ducks, we have observed all four species of *Tachyeres* at a number of ecologically diverse localities: Ushuaia, Tierra del Fuego, Argentina (December 1980-January 1981); Puerto Deseado, Santa Cruz, Argentina (January-February 1981); Puerto Melo, Chubut, Argentina (February 1981, December 1981, January 1982); Andean lakes of Santa Cruz and Chubut (December 1981-January 1982); Puerto Montt and nearby lakes, Region X, Chile (December 1982-January 1983); and Port Stanley and Lively Island, east Falkland Islands (January-