MONITORING BETWEEN-YEAR MOVEMENTS AND ASSESSMENT OF ARTIFICIAL BURROW FEATURES USEFUL IN CONSERVATION AND MANAGEMENT OF BURROWING OWLS

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Young western burrowing owls (Athene cunicularia hypugaea) at the entrance to an artificial burrow.

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PROJECT SUMMARY

Our study was designed to (1) monitor between-year movements of burrowing owls (Athene cunicularia), and (2) examine effects of artificial burrow chamber size and tunnel diameter on nest-site selection and productivity in burrowing owls. We conducted studies in two areas, referred to as the Kuna Butte and Grand View study areas. We have monitored nesting burrowing owls in the Kuna Butte study area since 1994 and for two years (since 1996) in the Grand View area. In 1997, we located 55 nests in these two areas, 51 of which successfully fledged young. We individually marked 318 owls (N = 48 adults, 270 young), and banded 5.2 $\pm$ 3.5 (SD) young per nest (range: 0 -11).

Six owls from the Kuna Butte study area returned in 1997, including three males and two females that paired and attempted to breed. The sixth owl was banded as a nestling in 1996 and was located prior to the breeding season. Breeding by this owl in the study area was not confirmed. Of 59 nestling burrowing owls banded in Kuna Butte in 1996, four (two males, one female, and one unknown sex) were detected in the area in 1997. This yields a first-year return rate of 0.068 (i.e., birds returning/birds banded). Return rates were higher for adults than for young, however. Of two males banded as breeders during 1996, one returned in 1997 (return rate = 0.5 returns per adult male banded). Of nine adult females originally banded in 1996, one returned to breed in 1997 (rate = 0.111 returns per adult female banded). Higher return rates for males reflects either higher mortality in, or greater dispersal by, females. The adult male that returned moved 61 m from his 1996 nest to an artificial burrow in 1997. This male acquired a different mate in 1997 than he had in 1996. Also, the adult female that bred in 1996 and returned in 1997 moved to a new nest burrow, 1.47 km from her 1996 burrow. The young owls that returned and were known to have bred nested 160 m, 1.26 km, and 3.92 km from their natal burrows. The young female that returned and bred in 1997 represents our first documentation that first-year females breed in the Kuna Butte study area; that is, until the 1997 breeding season, only first-year males with color bands had returned to breed.

Ten owls (six males and four females) banded in the Grand View study area in 1996 returned to breed in 1997. Of 65 nestling burrowing owls banded in Grand View in 1996, six (four males and two females) were detected in the area in 1997. This yields a first-year return rate of 0.092. As in Kuna Butte, return rates were higher for adults than for young in this study area. Of four adult males banded in 1996, two returned in 1997 (return rate = 0.5 returns per adult male banded). Of five adult females banded in 1996, two returned in 1997 (rate = 0.4 returns per adult female banded). One adult male returned to the same site to breed, and acquired a different mate than in 1996. The other male moved 70 m from his 1996 nest burrow; it is not known if his 1997 mate was different from his 1996 mate. The two females moved 210 m and 230 m, respectively, from their 1996 nest burrows. One of these females acquired a different mate than in 1996. The young owls that were detected and known to have bred nested 100 m, 1.12 km, 1.24 km, 1.52 km, 1.57 km, and 1.77 km from their natal burrows.

Finally, this study examined use of artificial burrows by nesting burrowing owls in both study areas. Natural nest sites (N = 34) used in 1995 or 1996 were surrounded with a cluster of three artificial burrows to examine effects of nest chamber size on nest-site selection and productivity. Each cluster contained three chamber sizes: a 17-L (4.5 gal) plastic container (small), a 19-L (5 gal) plastic bucket (medium), and a 68-L (18 gal) plastic tub (large). Tunnel diameter was 15 cm (i.e., constant) for each artificial burrow within a cluster of three. Twenty-one clusters were occupied by nesting pairs of burrowing owls, with sixteen pairs using large, three using medium, and two using small chambers. This distribution of use differs significantly from uniform and indicates that burrowing owls prefer to nest in burrows with large nest chambers. Despite such preference, there was no effect of chamber size on clutch size, number of fledglings, or nestling growth rates. To assess potential choice for tunnel diameter, a second experiment was performed using clusters of two artificial burrows (N = 24) placed in suitable burrowing owl habitat in both study areas. Each cluster of two offered two tunnel diameters to burrowing owls: a 10 cm (small) and 15 cm (large) plastic tunnel. Plastic buckets (19 L) were used in these clusters to control for chamber size. Of 12 clusters used for nesting, eight pairs used burrows with small-diameter tunnels, and four pairs used burrows with the large-diameter tunnels. This distribution did not differ significantly from uniform, and productivity and nestling growth rates did not differ for pairs nesting in burrows with small- or large- diameter tunnels. Thus, while burrowing owls exhibited a significant preference for large chambers, there is no evidence that tunnel diameter affected nest-site selection. The latter result could stem from smaller sample sizes for the cluster of two experiments rendering a possible Type II error. Therefore, more clusters of two are planned for the 1998 breeding season to increase sample sizes.

INTRODUCTION

Burrowing owls (Athene cunicularia) are declining throughout much of their range (Haug et al. 1993, James and Espie 1997). However, owl numbers in southwestern Idaho, and within the Snake River Birds of Prey National Conservation Area appear to be stable or increasing (pers. observ.), although no systematic surveys have been published. Nonetheless, because of the relatively dense nesting distribution, the southwestern Idaho population is becoming increasingly valuable for understanding the biology of burrowing owls. Ideally, information gained from this population not only will help manage it effectively but will aid wildlife managers throughout the species' range to slow population declines.

One essential component of endangered species management is to understand the requirements to successfully reproduce for each species. In the case of western burrowing owls, which for all intents and purposes can be considered to be secondary cavity nesters because they cannot dig their own burrows, this means understanding their requirements for underground burrow systems used for nesting and roosting. While information on the above ground features of burrowing owl nest sites is available in the literature (e.g., Rich 1986, Plumpton and Lutz 1993), there is virtually no information on the below-ground features of burrows important to nesting owls.

Our objectives in this study were to (1) continue color-banding burrowing owls to monitor return rates to the study area, site and burrow fidelity, and between-year movements (i.e., breeding and natal dispersal) by adults and young, and (2) examine nest-site preferences in two field experiments using artificial burrows. Specifically, we wanted to examine effects of underground chamber size and tunnel diameter on choice of nesting site and productivity of owl pairs. This report summarizes activities during the spring and summer of 1997.

METHODS

Study Areas

We studied burrowing owls in two study areas in southwestern Idaho. The first area, in which we have monitored nesting burrowing owls since 1994, was located approximately 3.2 km south of Kuna and 23 km north of the Snake River Canyon, in Ada County (Fig. 1). This area is characterized by big sagebrush (Artemisia tridentata) shrubland, and disturbed grasslands dominated by cheatgrass (Bromus tectorum) and tumble mustard (Sisymbrium altissimum). Surrounding areas contained irrigated agricultural fields (primarily alfalfa, wheat, and sugar beets), scattered residential homes, and several large dairy farms. The topography of this study area was flat to rolling with elevations ranging from 841 m to 896 m. Rock outcrops and a few isolated buttes (e.g., Kuna Butte, elev. 986 m) existed in the region. Mean annual temperatures range from -20° to 45°C, and annual precipitation averages less than 20 cm (NOAA 1985). There was a relatively high density of burrows excavated by badgers (Taxidea taxus) and yellow-bellied marmots (Marmota flaviventris), which burrowing owls used for nesting and shelter throughout the breeding season.

The second study area was located approximately 8 km north northeast of Grand View, in Elmore County , Idaho and adjacent to State Highway 67 (Fig. 2). This area was a mosaic of irrigated agriculture and disturbed grasslands. Elevations ranged from 853 m to 922 m. The area contained very few homes, several paved and dirt roads, and an electrical substation. The Snake River was located approximately 7 km south-southwest of this study area. Annual temperatures and precipitation levels were similar to the Kuna Butte study area, with mean annual temperatures ranging from -29° to 43°C and precipitation averaging 26 cm (NOAA 1985). We have monitored burrowing owls in this study area since 1996.

Artificial Burrow Placement

Before burrowing owls arrived from wintering areas, clusters of two and three artificial nesting systems (ANSs) were buried in or around the two study areas. The clusters of three artificial burrows, used to test for chamber size preferences, encircled natural burrows which were used for nesting in previous years (1995 or 1996; see Belthoff and King 1997). Within the clusters of three, each artificial burrow consisted of a 15 cm diameter tunnel made of flexible, perforated plastic pipe and a plastic nest chamber. We used three chamber sizes in each cluster of three: a 30 cm x 30 cm x 20 cm (17 L; 4.5 gal) plastic container, a 19-L (5 gal) bucket with a 30 cm diameter, and a 50 cm x 35 cm x 40 cm (68 L; 18 gal) plastic tub (Fig. 3a). All entrances within a cluster were equal distance (5 m) from, and were oriented in the same direction as the historical nest burrow entrance (Fig. 3b). Tunnel entrances were 120° apart, and chamber size was randomly assigned within the cluster. All ANS tunnels were 2 m long with a 90° turn between the entrance and the ANS chamber. All tunnels sloped downward (20-30°) towards the chamber, within the range typical of nest burrows within both study areas (Belthoff and King 1997). The tunnel inserted into the chamber on a level plane. The top of each ANS chamber was at least 30 cm underground. To increase the probability of ANS use, a wooden perch was placed in the center of the cluster as in King (1996). Additionally, to increase the likelihood that owls would use the ANSs for nesting, all historical nest burrow entrances, and any suitable burrow within a 10 m radius, were blocked with large rocks to prevent their use during this study. The rocks were removed after juveniles fledged from their nests.

The clusters of two artificial burrows were placed in areas where habitat appeared similar to those areas in which burrowing owls have nested. These clusters were designed to test for preference of tunnel diameter by burrowing owls. One artificial burrow had a 15 cm diameter tunnel, and the other had a 10 cm diameter tunnel. Chamber size was held constant, i.e., both chambers were 19 L plastic buckets (Fig. 4a). The two burrows were buried adjacent to one another, with a 3 m space between each entrance (Fig. 4b). In the Kuna Butte study area, tunnel entrances were oriented in a south southeast direction, which is typical for natural burrows used as nest sites in this area (Belthoff and King 1997). Entrances in the Grand View study area were oriented in a north northeast direction, which is typical for most natural burrows in the area (Belthoff and King 1997). A wooden perch was placed in the center of all clusters of two. Tunnel lengths and slopes, chamber depths, and all other methods were similar to those used for the clusters of three.

Locating and Capturing Burrowing Owls

We searched suitable habitat in each study area for burrowing owls both on foot and from automobiles. Most surveys were performed during daylight hours. After locating owls, we monitored their nesting activities on a regular basis. Also, historical nest sites were revisited to search for nesting owls. To capture owls we used Havahart® traps and noose rods as described in Belthoff et al. (1995) and King (1996). We also used one-way basket traps to capture adults as they departed artificial burrows. This trap consisted of a 0.5 m section of flexible plastic pipe (10 cm diameter), a small piece of transparent plexi-glass, and an enclosure made of "chicken wire". The plexi-glass was fastened to one end of the pipe but could hinge upwards. This end of the pipe was inserted into the wire basket. The open end of the pipe was inserted into artificial burrow tunnels when a nest needed to be checked. Digging down to the artificial chamber caused any adults in the nest chamber to enter the basket, and the hinged door closed behind it and trapped the owl. Occasionally, we also used this trap to capture juvenile burrowing owls at natural nest burrows.

Upon capture, we recorded each owl's mass (to nearest 0.5 g), wing length, tarsus length, tail length, and length of exposed culmen (all to nearest 0.5 mm). We classified adult owls as females if they had well-developed brood patches. We were unable to discern sex of young owls based on appearance or morphological measurements. We fitted owls with a U.S. Geological Survey aluminum leg band and three plastic, colored leg bands (National Band and Tag Co., Newport, KY) for future identification.

Owl Monitoring

Follow-up visits were made to each nest burrow to determine if nesting attempts were successful. For owls nesting in artificial nest structures, we determined minimum number of eggs produced, nestling survival, and fledgling success. For natural burrows, we recorded number of young owls observed at the entrance, from which we calculated number of young produced. The maximum number of young observed at the entrance to a burrow could be used as an index to the minimum number of young produced by the nesting pair. Successful nests (in artificial or natural burrows) had at least one young owl survive to fledgling age (> 28 days).

Data Analyses

To examine choice of nest chamber size or tunnel diameter by nesting owls, we performed chi-squared goodness of fit tests. Using analysis of variance, we also examined effects of chamber size and tunnel diameter on number of eggs and fledgling rates (number of young fledged/number of eggs) for artificial burrow nest in the Kuna Butte and Grand View study areas. Because fledgling rates were proportions, prior to analysis they were arcsine transformed to meet normalityassumptions (Zar 1996). Growth of nestlings was compared among chambers and between tunnel diameters using weight, tarsus, and tenth primary measurements (average value for brood analyzed) as dependent variables in multivariate analyses of covariance, where age of juveniles (days) and brood size were covariates. Means are reported as $\bar{x} \pm$ SD, and results were considered significant when alpha ≤ 0.05.

RESULTS

Trapping and Banding

Between 25 April - 5 July 1997, we captured 326 burrowing owls in the two study areas. These included 12 adult males, 36 adult females, and 270 nestlings and fledglings. Eight of 48 (16.7%) adults captured were owls originally banded in 1996. Appendix A contains band numbers, banding dates, color band combinations, age and sex information for owls initially captured during 1997. A higher proportion of adults was captured than in previous years of the study, primarily because artificial burrows increased trapping efficiency.

Return of Previously Banded Owls

Number of Birds Returning in 1997 In 1997, six burrowing owls with prior histories in the Kuna Butte study area were re-sighted. These birds included three males and two females which paired and attempted to breed during 1997 (Table 1). The sixth owl was banded as a nestling in 1996. It is not clear if this owl attempted to breed in the study area in 1997, as it was not observed after the initial sighting on 22 March 1997. The identity of four of the birds was confirmed via capture and aluminum leg band number verification. The remaining male eluded capture but was identified using its color-bands.

Ten owls banded in the Grand View study area in 1996 returned to breed in 1997 (Table 2). These birds included six males and four females, all of which paired and attempted to breed in 1997 (Table 2). The identity of four of the birds was confirmed by capture. The remaining six owls were identified (at close range) via color-band combinations.

Rate of Return Of 59 nestling burrowing owls banded in the Kuna Butte study area in 1996, four (two males, one female, and one unknown sex) were detected in the area in 1997. This yields a first-year return rate of 0.068 (i.e., birds returning per birds banded). A total of 65 nestling owls was banded in the Grand View study area in 1996, of which six (four males and two females) were detected in the area in 1997 (first-year return rate = 0.092). Of course, these rates represent minimums because (1) all young produced within the boundaries of the study areas in 1996 were not banded, so some of the breeding adults initially banded in 1997 could have been produced in the study areas during 1996 but remained unbanded, and (2) it is possible that more banded birds returned during the 1997 breeding season but went undetected.

Return rates were higher for adults than for young in both study areas. Of two males banded as breeders in Kuna Butte during 1996, one returned in 1997 (return rate = 0.5 returns per bird banded). Of nine adult females originally banded in Kuna Butte in 1996, one returned to breed in 1997 (rate = 0.111 returns per adult female banded). Four adult males were banded in the Grand View study area in 1996, with two returning to breed in 1997 (return rate = 0.5). Of five adult females banded in the Grand View study area in 1996, two returned to breed in 1997 (return rate = 0.4). At this point, there is little information to determine if higher return rates for males reflects higher survival in this sex class or greater breeding dispersal (i.e., out of our study area) by females.

Distance of Movements for Young and Adults The adult male that bred in the Kuna Butte study area in 1996 and returned in 1997 moved 61 m to an artificial burrow (Table 1). This male also acquired a different mate in 1997 than he had in 1996. His 1996 mate was not observed within the study area during 1997, so it is not known if this female died or dispersed. On the other hand, the adult female that bred in 1996 and returned in 1997 moved to anew nest burrow (Table 1). This new burrow was 1.47 km from the 1996 burrow. We were unable to discern if this female retained the same mate between years because the male with whom she paired in 1996 was not captured.

In the Grand View study area, one adult male returned to the same site to breed in 1997, but acquired a female that moved 0.23 km from her 1996 nest burrow (Table 2). The other adult male moved 70 m from his 1996 nest burrow, but it is unknown if he had the same mate as in 1996. The other female that returned moved 0.21 km from her 1996 nest burrow (Table 2). The male(s) with which she mated eluded capture in both 1996 and 1997.

Ten owls initially banded as nestlings in 1996 returned in 1997 (Tables 1, 2). At Kuna Butte, two first-year males bred 2.6 $\pm$ 1.9 km and one first-year female bred 0.2 km from their natal burrows (Table 1). A fourth color-banded nestling from 1996 was observed in the study area in 1997, but nesting was not confirmed. At Grand View, first year males (N = 4) bred 1.0 $\pm$ 0.6 km from their natal burrows, while first-year females (N = 2) moved 1.6 $\pm$ 0.2 km between natal and nest burrows.

Reuse of Nest Burrows Between Years

Placement of artificial burrows during 1997, as well as failure to obtain permission to work on some private lands (e.g., the Kuna Dairy burrows), obscures the analysis of reuse of individual burrows, because natural burrows were obstructed during the artificial nesting system experiments or all historical burrows could not be monitored. However, a reuse analysis can be performed when considering sites (i.e., the general vicinity of an historical burrow in which artificial nesting clusters were placed) rather than individual burrows. Of 20 sites in the Kuna Butte area where burrowing owls nested in 1994, 1995, or 1996, and where sites also were monitored in 1997, 11 or 55% had nesting pairs of owls (Table 3). In Grand View, of the 14 sites occupied in 1996, 11 (78.6%) were reoccupied in 1997 (Table 4). Thus, as reported in previous years (e.g., Belthoff and King 1997), while individuals in the study area "turnover" regularly, there is considerable reuse of sites and individual nest burrows by owls.

Reproductive Success of Pairs

We monitored 51 nests (N = 24 in Kuna Butte and N = 27 in Grand View) of which 36 were in artificial burrows and 15 were in natural burrows (Table 5). Clutch sizes in artificial burrows ranged from 7 - 12 (Tables 6, 7) and averaged 9.1 $\pm$ 1.1 (range: 7 - 11; N = 15) and 9.9 $\pm$ 1.3 (range: 8 -12; N = 18) in Kuna Butte and Grand View, respectively. No clutch size estimates are available for nests in natural burrows for either study area because underground nest chambers were inaccessible. Overall, 5.9 $\pm$ 2.5 young fledged from nests in artificial burrows (N = 33) in the two study areas. The number of young banded and observed from nests in natural burrows are in Table 5; these values likely estimate the minimum reproductive success at these nests. We banded 5.2 $\pm$ 3.5 young per nest (range: 0 - 11) at the 51 nests monitored in 1997.

Artificial Burrow Experiments

Chamber Configuration Choice We assessed preference for nest chamber size using clusters of three artificial burrows placed around historical nesting sites. For this experiment, tunnel diameter was standardized (i.e., 15 cm pipe), but chamber size varied from small to large. We placed 34 clusters of three (17 in each study area), of which 21 (62%) were used by nesting owls (Table 6). We removed three clusters of three in which owls nested from the chamber choice experiment because (1) some chambers and tunnels were trampled by cattle (N = 2) which rendered one or more of the chamber sizes unavailable to the owls at the time of nest initiation, or (2) one cluster of three was influenced by terrain (i.e., it had to be placed on a steep slope). It is important to note that removing these three clusters from the analysis does not result in a different conclusion. Of the remaining 31 clusters, 18 were occupied by nesting owls. Of these 18 pairs, 16 used the large chamber, and the small and medium chambers were used by one pair each. This distribution of chamber selection differs significantly from uniform ($X^2 = 25.0$, $P < 0.001$) and indicates that burrowing owls prefer large nest chambers. There was no effect of chamber size on number of eggs per clutch or fledgling rate (Fig. 5). Finally, despite significant choice by adult owls for nesting in the largest chamber, there were no differences in growth rates for nestlings in the different chambers (MANCOVA, Wilks' Lambda = 0.6405, P = 0.7391 when analyzing brood averages), although sample sizes for owls nesting in small and medium chambers are very small.

Tunnel Diameter Choice Our second experiment assessed preference for nest tunnel diameter clusters of two artificial burrows placed in suitable burrowing owl habitat. For this experiment, chamber size was standardized (i.e., 5 gallon bucket), but tunnel diameter was either small (10 cm) or large (15 cm). We placed 24 clusters of two (10 in Kuna Butte; 14 in Grand View), of which 12 (50%) were occupied by nesting owls (Table 7). Eight pairs of burrowing owls nested in the burrow with the small diameter tunnel, while four pairs used the burrow with the large diameter tunnel. This distribution of use does not differ significantly from uniform ($X^2 = 1.33$, $0.10 < P < 0.25$) so, at least after our initial field season, it does not appear that owls prefer one tunnel diameter over another. Tunnel diameter did not affect clutch size or fledgling rate (Fig. 6), and there was no significant relationship between tunnel diameter and growth rate in nestlings (Wilks' Lambda = 0.4256, P = 0.2004).

SUMMARY AND CONCLUSIONS

Our ongoing, multiple-year studies of burrowing owls have yielded important information about the return rates and between-year movements of burrowing owls in southwestern Idaho. In 1997, we also initiated a field experiment to examine nest-site selection in burrowing owls using artificial nesting systems. Each of these aspects of our study has yielded results that are significant for monitoring and management of local burrowing owl populations, as well as those in other regions of the species' range. Important results from the 1997 studies are summarized below.

Return Rates and Between-Year Movements of Owls

Return rates for adults and young -From all indications (e.g., Belthoff et al. 1995, Belthoff and King 1996, King 1996, this study), burrowing owls in our study areas in southwestern Idaho are obligate migrants, whereby all members of the breeding population move elsewhere (presumably southward) to winter. This is in contrast to breeding populations of burrowing owls in New Mexico (Botelho 1996), for example, where the owls are partial migrants (i.e., only a portion of the population migrates). We continue to have no information, from band returns or otherwise, about where members of the southwestern Idaho breeding population of burrowing owls overwinter, although a study by the Canadian Wildlife Service is underway which could potentially locate some of our wintering owls (G. Holroyd, pers. comm.). It is clear that understanding the needs of burrowing owls on their wintering areas, and the potential effects of land use practices on burrowing owls within the wintering range, will become a priority for managers of this species in the coming years.

As in previous years of our study, return rates for banded adults were higher than those for individuals banded as nestlings. Additionally, return rates for adult males were higher than for adult females. Lower return rates for young of the year as well as adult females could be a result of increased mortality, dispersal, or both in members of these age/sex classes. Female-biased dispersal (i.e., where females move more than males) has been reported in many avian species (e.g., see Greenwood 1980, Clarke 1997) and could account for lower return rates for female burrowing owls. Moreover, lower return rates for juveniles compared to adults are characteristic of the population dynamics of many avian species (e.g., see Payne and Payne 1993).

Burrow reuse The reuse of burrows from year-to-year by breeding populations of burrowing owls is not uncommon (Haug et al. 1983), but the rate of reuse seems to vary among populations. For example, Martin (1973) observed that each of 15 pairs of burrowing owls he studied in New Mexico used burrows that had been occupied in previous years; Plumpton and Lutz (1993) found that 4 of 20 (20%) nesting burrows were reused during the second year of their study in

Colorado, and in south central Idaho, Rich (1984) determined that of 242 nest sites located between 1976- 1983, 115 (39.4%) also were occupied in at least one subsequent year, although this latter study did not confirm breeding in all sites included. Our studies in Kuna Butte and Grand View have documented breeding and reuse of nest burrows by burrowing owls since 1994. In 1997, burrow reuse could not be calculated because entrances to natural burrows were blocked as part of our artificial burrow experiment. However, we were able to calculate reuse of sites rather than individual burrows. Site reuse for Kuna Butte and Grand View together averaged approximately 65% (22 of 34 sites) in 1997. These studies illustrate what may be an important opportunity for management of burrowing owl populations. Over just the few years of our studies, we have observed nest burrows being destroyed through agriculture, fire rehabilitation, and various other activities, including trampling by grazing cattle. Given what appears to be a strong tradition of burrow reuse in this species and in our study areas, preventing destruction of preferred burrows, particularly those that successfully produced young (see Belthoff and King 1996), likely could be an important step to avoid declines in population numbers. Such management practices would be most critical in areas where burrows are limited in availability, which does not appear to be the case in either Kuna Butte or Grand View, where burrows seem abundant.

Artificial Burrows and Nest Site Selection: Effects of Chamber Size and Tunnel Diameter

Our most important result from the artificial burrow experiment was that burrowing owls nested in the largest chamber significantly more often than expected by chance. Because resource managers and researchers throughout the range of this species commonly employ 5 gal buckets (comparable to our medium chambers) as artificial burrows, this result likely will change management practices across the U.S. and Canada. Why the owls prefer to nest in the larger chambers is unknown, but two possible explanations are that (1) larger chambers provide more living space and reduce negative effects of crowding, and (2) microclimates in larger chambers are more suitable for incubation or brood rearing. We hope to distinguish between these alternate hypotheses during the 1998 field season by measuring various aspects of the microclimate within used and unused artificial burrows of all configurations. Finally, our study found no evidence that tunnel diameter affected nest site selection, although the sample sizes we obtained in 1997 were small. Our studies during 1998 will increase the number of clusters of two to more adequately examine potential effects of tunnel diameter on nest site selection in burrowing owls.

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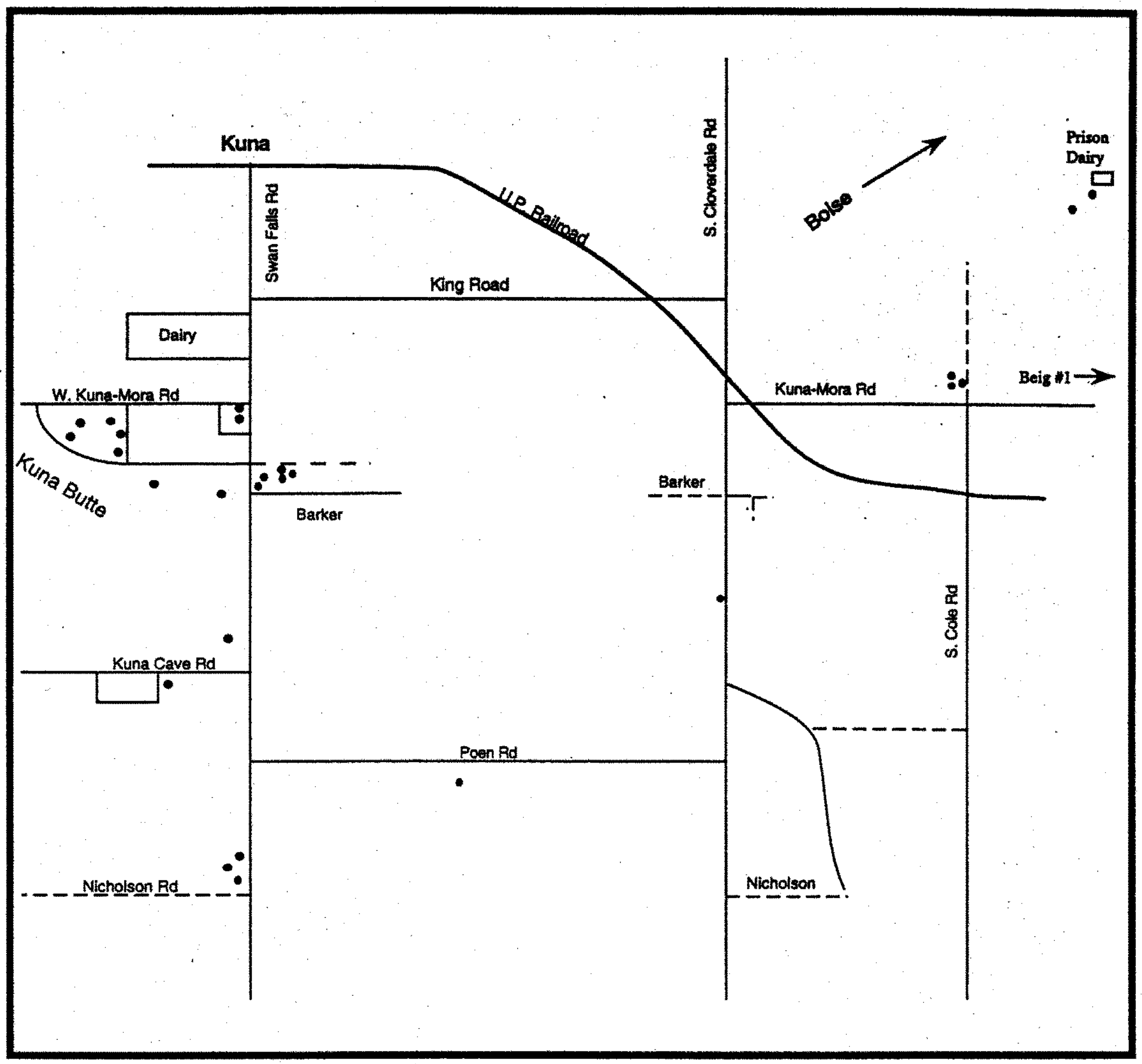

Figure 1. Schematic of Kuna Butte study area located approximately 3.2 km south of Kuna, Ada County, Idaho. Occupied (1997) burrowing owl nest sites are indicated by filled symbols. Scale: 1 in. = approx. 0.8 mi.

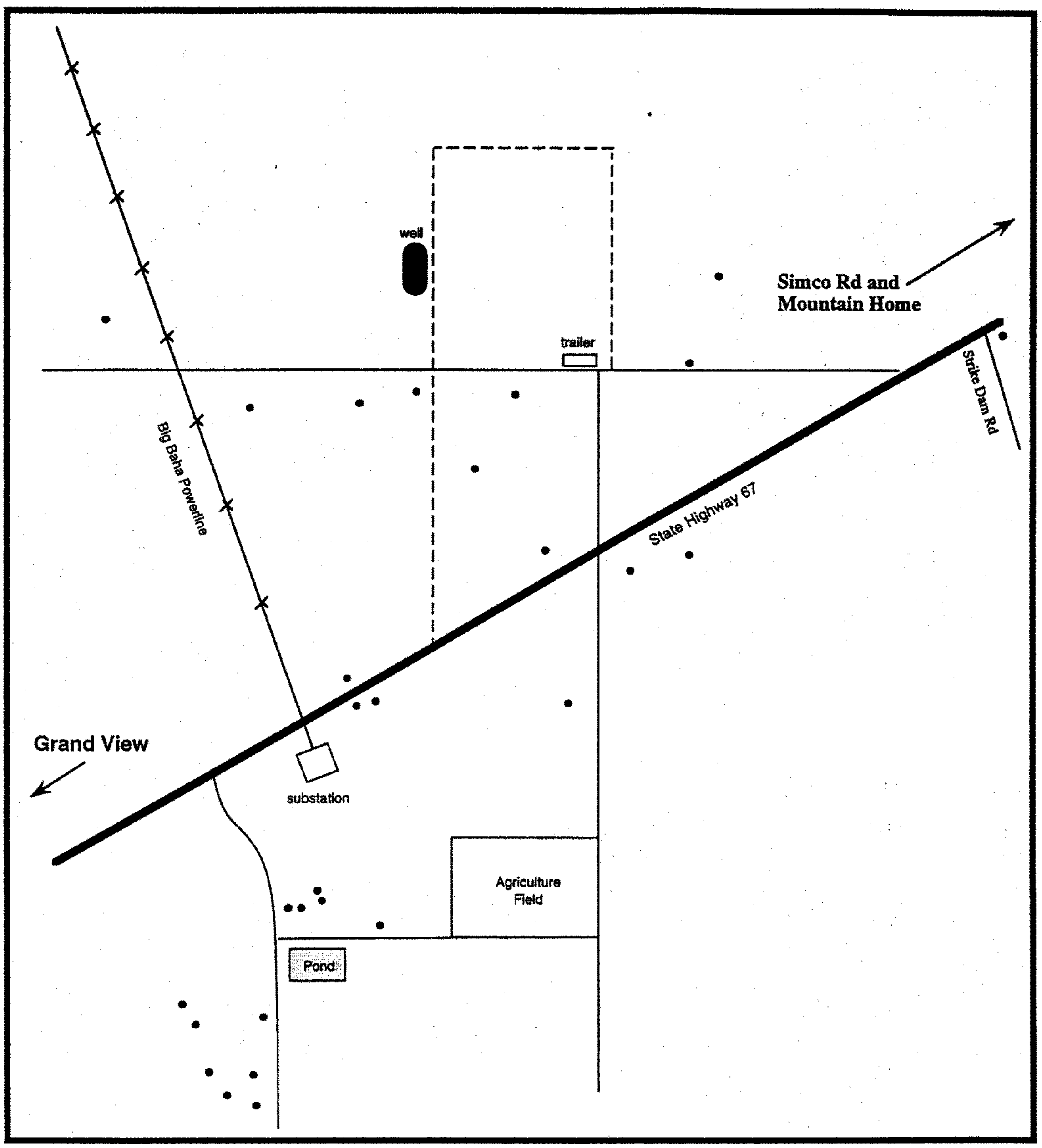

Figure 2. Schematic of Grand View study area located approximately 8 km north northeast of Grand View in Elmore County, Idaho along State Highway 67. Occupied (1997) burrowing owl nest sites are indicated by filled symbols. Scale: 1 in. = approx. 0.25 mi.

a)

b)

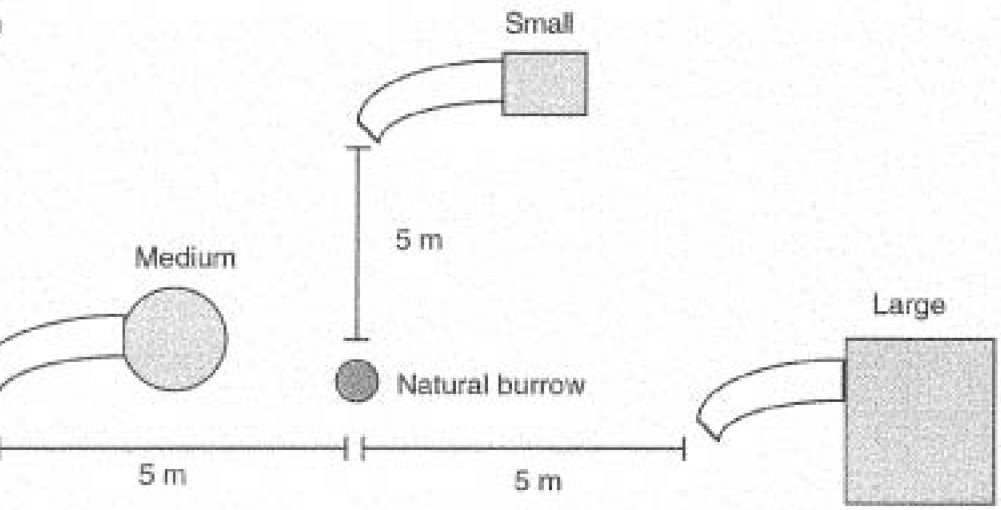

Figure 3. (a) Chamber materials for the chamber choice experiment. From left to right are the small, large, and medium chambers. (b) Configuration of chambers around natural burrows for the chamber choice experiment (see text for explanation).