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CHARACTERISTICS OF ROOST SITES USED BY BURROWING OWLS (*ATHENE CUNICULARIA*) WINTERING IN SOUTHERN TEXAS

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ABSTRACT—The western burrowing owl (*Athene cunicularia hypugaea*) is threatened in Mexico, endangered in Canada, and declining in most of the western United States. Most previous research has focused on burrowing owl breeding biology, and little is known about its winter ecology. We determined characteristics of roost sites used by western burrowing owls in southern Texas during winter. Data on 46 winter roost sites were collected from 15 November 2001 to 15 February 2002. Of these roost sites, 87% were located on agricultural land, 80% were along roads, and 74% were concrete, steel, or cast-iron culverts. Mean diameter (±*SE*) of roost site openings was 22 ± 1.5 cm. Most roost sites (70%) were located on inaccessible private lands. Bare ground comprised 61% of ground cover within a 10-m radius of roost sites. We recommend that landowners and public-land managers should be encouraged to use smaller-diameter culverts when building roads or replacing old or damaged culverts and to graze livestock or mow around these culverts during winter.

RESUMEN—El tecolote llanero (*Athene cunicularia hypugaea*) está en peligro de extinción en Canadá, amenazado en México, y en decline en la mayor parte occidental de los Estados Unidos. La mayoría de las investigaciones previas se han enfocado en la biología reproductiva en los tecolotes llanero, y poco se sabe de su ecología invernal. Determinamos las características de las perchas usadas por los tecolotes llanero en el sur de Texas en el invierno. Colectamos datos de 46 perchas invernales del 15 de noviembre 2001 hasta el 15 de febrero 2002. De estas perchas, 87% estaban localizadas en tierras agrícolas, 80% a lo largo de caminos y 74% de las alcantarillas eran de concreto, acero o hierro fundido. Las perchas tienen un promedio diámetro de 22 ± 1.5 cm (±EE). La mayoría de las perchas (70%) estaban localizadas en terrenos privados inaccesibles. El 61% de los suelos estuvieron sin vegetación dentro un radio de 10-m de las perchas. Recomendamos que terratenientes y gerentes de terrenos públicos se animen a usar alcantarillas con diámetros más pequeños cuando construyan caminos o reemplacen alcantarillas viejas o dañadas, y pastorear el ganado o cortar el pasto alrededor de las alcantarillas durante el invierno.

The western burrowing owl (*Athene cunicularia hypugaea*) was listed as threatened in Mexico in 1994, endangered in Canada in 1995, and is considered to be a Bird of Conservation Concern by the United States Fish and Wildlife Service (Klute et al., 2003). The western burrowing owl occurs from Alberta and Saskatchewan south through western North America, and through Central America to Panama (Haug et al., 1993). Burrowing owls inhabit mainly dry, open, short-grass plains, as well as agricultural lands and other disturbed habitats (Coulombe, 1971; Haug et al., 1993). Birds in northern breeding areas migrate to southern wintering areas ranging from California to Texas and south to Mexico (Haug et al., 1993).

The northern and eastern limits of the range of the western burrowing owl are contracting (Wellicome and Holroyd, 2001), and overall numbers have declined in recent decades (James and Ethier, 1989). Conversion of native prairie to cropland (Clayton and Schmutz, 1999; Dechant et al., 1999), pesticide use (James and Fox, 1987), habitat fragmentation (Warnock, 1997), and eradication of burrowing mammals (Butts and Lewis, 1982; Desmond et al., 2000) have contributed to the decline of burrowing owls.

Burrowing owls formerly bred in parts of southern Texas (Beckham, 1888; Griscom and Crosby, 1925, 1926; Oberholser, 1974). The loss of much of the native coastal prairie in southern Texas (Box and Chamrad, 1957; Inglis, 1964)

might have contributed to the disappearance of this owl as a breeding bird in the area, and it was considered by Rappole and Blacklock (1985) to be an uncommon to rare winter resident.

Much of the research aimed at conserving burrowing owls has focused on breeding biology, and few studies have examined their winter ecology (Ross and Smith, 1970; Butts, 1973, 1976). Preliminary investigations by the authors and by researchers with the Canadian Wildlife Service indicated that burrowing owl behavior and habitat use in southern Texas are different from that of breeding areas. In southern Texas, we found that burrowing owls disperse widely over cultivated fields and grasslands; they also occur on barrier islands, where their small size and cryptic plumage make them difficult to detect. Although western burrowing owls use abandoned mammal burrows as nest sites (Haug et al., 1993), burrowing owls wintering in southern Texas were observed to use road culverts, in addition to mammal burrows, as roost sites.

Although Texas accounts for a large portion of the overwintering burrowing owl population in the United States (McIntyre, 2004), there has not been an assessment of the ecology of overwintering burrowing owl populations in Texas. Successful management of a migratory bird species requires a comprehensive understanding of its winter ecology. The objective of our study was to describe characteristics of winter roost sites used by burrowing owls in southern Texas.

METHODS—*Study Area*—The study area consisted of 5 counties (10,383 km²) in southern Texas: Kleberg, Nueces, San Patricio, Refugio, and Jim Wells (Fig. 1). These 5 counties are part of the region known as the Coastal Bend of Texas, which is located on the Gulf Coast. The study area is located within the Tamaulipan Biotic Province (Blair, 1950), most of which is now included in the Tamaulipan Brushlands Bird Conservation Region (Rich et al., 2004). The Coastal Bend has a subtropical climate, receiving an average of 76 cm of rain per year, but it is often subject to drought. The Coastal Bend consists mostly of flat land characterized by mixed prairies, transitional riparian forest, oak savanna, and Tamaulipan thorn scrub (Rappole and Blacklock, 1985); however, much of the native prairie and brushlands in the Coastal Bend have been converted to farmland (Jahrsdoerfer and Leslie, 1988). Sorghum and cotton are among the most important crops grown in the area, but other crops, such as corn and hay, are also grown. Fire suppression has allowed brush species, such as honey mesquite (*Prosopis glandulosa*), to invade remaining native grasslands (Johnston, 1963).

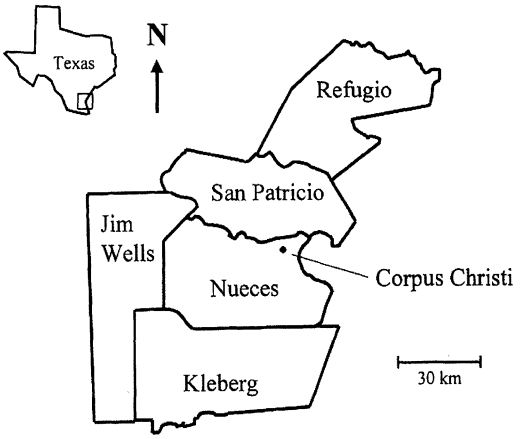

FIG. 1—Location of counties in study area in the Texas Coastal Bend of southern Texas.

Most farmland in southern Texas occurs within a network of rural county roads. In addition, temporary roads often are constructed through cultivated fields by the oil and gas industry to service wells. To provide drainage during heavy rains, culverts are constructed under these roads. The term culvert hereafter refers to the opening of any pipe of varying size and material used for drainage under a road.

Data Collection—The winter period for this project was 15 November 2001 to 15 February 2002. We located burrowing owl roost sites from 15 November to early January by conducting weekly driving surveys between 0700 and 1400 h. We checked road culverts and other possible burrow sites while driving approximately 560 km on rural roads in agricultural or open pasture areas. However, because driving surveys of nesting burrowing owls have low detection probabilities (37.5%) (Conway and Simon, 2003), burrowing owl roost sites were also located by using public outreach at area farm and ranch shows, and through contacts with local landowners and birders. While roadside surveys were biased toward finding roost sites at culverts, we knew from preliminary fieldwork and from interactions with landowners that most burrowing owls wintering in southern Texas roost at roadside culverts. The presence of regurgitated pellets, droppings, feathers, or a burrowing owl was used to identify roost sites. Any owls discovered before 15 November or after 15 February were considered migrants, and their roost sites were not included in the study.

We recorded the following characteristics at roost sites: location, habitat type, crop type, accessibility to the general public, groundcover composition, the presence or absence of utility highlines, the number of telephone poles and fence posts, road surface type, roost site type, number of burrow openings, diameter of openings, and orientation of roost site. We noted exact location of each roost site, including county, road number, landmarks, and, if applicable, the name of the ranch, oil field lease, or government installation. Habitat in which each roost site occurred was classified as: 1) barrier island, 2) agricultural, 3) grassland, or 4) woodland. If the roost site occurred in an agricultural

habitat, then we recorded all crop types from the previous summer (cotton or grain) within a 200-m radius of the roost site. Roost sites that occurred on oil field leases, private farms or ranches, or government installations were considered inaccessible to the general public. Roost sites that were considered accessible were culverts or other roost sites on public roads and highways. At 30 of the roost sites, we estimated percentages for each of the following types of groundcover within a 10-m radius: 1) bare ground, 2) grass, 3) forbs, 4) crop stubble, 5) litter, and 6) woody vegetation. Groundcover at the remaining 16 roost sites could not be estimated because of inaccessibility to the roost site locations. We defined crop stubble as standing remains of agricultural crops after harvesting; litter was dead or decaying vegetative debris lying on the ground. All road surfaces were classified as bare ground. If a roost site occurred next to a road, we noted the road surface type: 1) asphalt, 2) caliche (deposits of crushed sand and limestone found in the soils of arid regions and often used as a material for road surfaces), or 3) dirt.

We classified each roost site in one of the following categories: 1) concrete culvert; 2) galvanized, corrugated steel culvert; 3) cast-iron culvert; 4) natural burrow (those formed by erosion or dug by an animal); 5) artificial burrow (polyethylene drainage pipe installed in various study sites as part of another burrowing owl study by Ortega, 2003); or 6) other (rubble piles, etc.). The number of openings was recorded; in cases of closely clustered culverts (≤0.5 m), all the openings were counted. Blocked, crushed, or filled openings were not counted. Burrow diameter was measured to the nearest centimeter using a meter ruler. A compass was used to determine the orientation of roost sites with 2 or more openings (such as the opposing ends of a culvert or pairs of culverts). We classified each orientation as east-west, north-south, northeast-southwest, or northwest-southeast.

RESULTS—Of the 46 roost sites located in the 5-county study area during the winter of 2001-2002, 36 (78%) were in Nueces County. Forty sites (87%) were in agricultural areas, 3 (6.5%) roost sites were on a barrier island, and 3 (6.5%) were in grassland. Twenty-six (65%) of those roost sites in farmlands were within 50 m of land used primarily to grow grain the previous summer. Thirty-two (70%) roost sites were located on land that was inaccessible to the general public, and the 14 (30%) publicly accessible roost sites were located along roadsides. Two publicly accessible roost sites occurred in a partially developed residential area within Port Aransas, a city on a barrier island in Nueces County.

Bare ground was 61.5% (n = 30) of the mean groundcover. All other groundcover types were each <20%: stubble 10.5%, grass 15.5%, forbs 11.5%, litter 0.5%, and woody 0.5%. Only 3 roost sites had trees or shrubs within a 10-m radius. Twenty-nine (63%) of the 46 roost sites had fence posts, telephone poles, or utility highlines within a 50-m radius.

Thirty-seven (80%) roost sites were along roads, of which 24 (52%) occurred on caliche roads, 2 (4%) along dirt roads, and 11 (24%) along paved roads. Thirty-four (74%) of the roost sites were either concrete (n = 15), galvanized, corrugated steel (n = 15), or cast-iron (n = 4) culverts. The remaining roost sites consisted of natural burrows (n = 5), artificial burrows (n = 4), and other (n = 3), which included a pile of concrete rubble, an eroded area beneath a concrete slab, and a dehydrator unit (oil field equipment). Each of 24 (52%) roost sites had 2 openings. Only 12 (26%) roost sites had >2 openings, and 8 roosts (17%) had only one opening.

The mean diameter of roost sites that could be measured (n = 43) was 22 ± 1.5 cm *SE*. The roost site with the smallest diameter (8 cm) opening was a galvanized, corrugated steel culvert, whereas the largest diameter opening was that of a natural burrow (50 cm). Cast-iron culverts had the smallest mean diameter (16.3 ± 1.3 cm *SE*), whereas natural burrows had the largest (32.4 ± 6.7 cm *SE*) (Table 1). Forty-two roost sites had well-defined openings (i.e., discernible orientations): 17 (37%) were oriented east-west, 6 (13%) were oriented north-south, 9 (20%) were oriented northeast-southwest, and 10 (22%) were oriented northwest-southeast. Four (8%) roost sites (a concrete pile, a concrete slab, and 2 natural burrows) had no discernible orientation.

DISCUSSION—The majority of roost sites that we found were in Nueces County, even though habitat is similar throughout inland areas of the 5-county study site. Our search efforts were concentrated more heavily in Nueces County for several reasons: 1) major media outlets are located in Nueces County, 2) an active bird-watching club is based in the county, and 3) Nueces County has a larger human population than the other counties in the study area. Major media and public outreach efforts probably ensured that more burrowing owls were reported from Nueces County than from other counties in the area. Also, because most of the public outreach during this study was focused on Nueces County, the increased exposure generat-

TABLE 1—Characteristics of winter roost sites of western burrowing owl (*Athene cunicularia hypugaea*) in southern Texas, winter of 2001–2002.

Roost site type	*n*	Diameter of opening (cm)	
		Mean (*SE*)	Range
Concrete culvert	15 (32.6%)	24 (2.5)	10–40
Steel culvert	15 (32.6%)	19 (2.1)	8–32
Cast-iron culvert	4 (8.7%)	16 (1.3)	14–20
Natural burrow	5 (10.9%)	32 (6.7)	17–50
Artificial burrow	4 (8.7%)	19 (2.4)	15–25
Other	3 (6.5%)	*	*

* Only one roost site in this category was measured.

ed more interest and reports. If public outreach had been focused more intensively on another county, it is likely that a greater number of owls would have been reported from that county.

Although generally considered a grassland bird, few burrowing owls were reported from grasslands in this study. The predominance of roost sites in agricultural areas was due to the abundance of this habitat type in southern Texas and the fact that large expanses of grasslands within the study area are inaccessible private land; therefore, these grasslands were less likely to have owls reported from them.

Only 3 roost sites were located on a barrier island (Mustang Island). Small numbers of burrowing owls previously have been reported from Mustang Island and Padre Island. Ortega (2003) reported evidence of burrowing owl use of artificial burrows 11 times in Port Aransas. Both barrier islands have large tracts of undisturbed grassland habitat and would seem to be ideal habitat for burrowing owls. More intensive study of barrier islands might reveal greater use of islands by burrowing owls.

Many roost sites were surrounded by only sparse vegetative groundcover or were completely devoid of vegetation within a 10-m radius. Sparse vegetative cover might allow roosting owls to detect prey (Sissons et al., 2001) and approaching predators (Green, 1983). Burrowing owls did not seem to be excessively disturbed by mowing machines or tractors. A roost site in Jim Wells County located in a highway median was mowed repeatedly, yet the owl did not abandon its roost site. Also, the immediate area surrounding several roost sites located on agricultural land was plowed during the winter without causing abandonment of roost sites. Plowing has been shown to increase owl predation on rodents (de Villafañe et al., 1988; Bellocq, 1997), so areas that are plowed or mowed regularly might be preferred by burrowing owls, as rodents will be less concealed in short grass.

Twenty-nine (63%) of the roost sites had perches, such as fence posts, telephone poles, and utility highlines, nearby. We assumed that burrowing owls would avoid such roost sites, because large raptors, such as red-tailed hawks (*Buteo jamaicensis*), known predators of burrowing owls (Leupin and Low, 2001), and white-tailed hawks (*B. albicaudatus*) often use these types of perches. However, large buteos might not be the main predators of burrowing owls in southern Texas, and actually might deter northern harriers (*Circus cyaneus*) that frequent agricultural areas and are known also to prey on burrowing owls (Leupin and Low, 2001; pers. observ.). Interspecific aggression has been recorded between red-tailed and white-tailed hawks and northern harriers (Johnsgard, 1990). Some studies have shown that burrowing owls seem to prefer short perches, such as fence posts, perhaps to provide a good view of prey or approaching terrestrial predators (Green, 1983). However, only 7 roost sites in our study had fence posts nearby.

Burrowing owls are adaptable and will use a variety of roost and nest sites. Breeding burrowing owls use burrows dug under rock outcrops (Rich, 1984, 1986), cement surfaces (Trulio, 1997; Botelho, 1996), lava flows (Gleason and Johnson, 1985), and limestone (Coulombe, 1971). Burrowing owls also have been observed using natural rock cavities as nest sites (Rich, 1986). Burrowing owls use a wide variety of natural burrows excavated by prairie dogs (*Cynomys*), ground squirrels (*Citellus*), kangaroo

rats (*Dipodomys*), badgers (*Taxidea taxus*), skunks (*Mephitis*), gray foxes (*Urocyon cineroargenteus*), and armadillos (*Dasypus novemcinctus*) (Coulombe, 1971; Haug et al., 1993; Rodríguez-Estrella and Ortega-Rubio, 1993). Two of the natural roost sites in our study were located on a large sand mound in an agricultural area, which might have been dug by ground squirrels or kangaroo rats.

In our study, culverts were the most commonly used roost sites by wintering burrowing owls in southern Texas. However, they also used rubble piles, oil field equipment, and a depression underneath a concrete slab as roost sites. During the winter of 1998–1999, a burrowing owl used a hole underneath a rock in a dirt pile near an elementary school in Corpus Christi as a roost site, while another owl used a street storm-sewer drain for a roost site in Port Aransas, Texas (pers. observ.). Burrowing owls readily use artificial burrows as nest sites (Collins and Landry, 1977; Botelho, 1996; Smith and Belthoff, 2001). Burrowing owls will also use artificial burrows outside of the breeding season in Idaho (B. Smith, pers. comm.) and as winter roost sites in Texas (Ortega, 2003).

Roost site diameter range (8 to 50 cm), mean (22 cm), and median (20 cm) in our study were all similar to the dimensions of burrows used in other parts of their range. Prairie dog burrows used by wintering owls in Oklahoma were 10 to 23 cm high and 10 to 20 cm wide (Butts, 1976). Burrows used by owls in the Imperial Valley, California, averaged 20 cm (Coulombe, 1971), while nest burrows in South Dakota were 13 cm in diameter (MacCracken et al., 1985). Smith and Belthoff (2001) found that burrowing owls preferred 10-cm diameter artificial nest burrows. Ortega (2003) found that burrowing owls wintering in southern Texas frequented artificial burrows with 15-cm diameter openings. Roost sites with diameters of $\leq$20 cm might provide more protection from ground predators. Most roost sites in our study had east-west, northwest-southeast, or northeast-southwest orientations, rather than a north-south orientation. Roost sites with an orientation other than north-south might provide burrowing owls shelter from harsh winds associated with the passage of winter cold fronts.

The conversion of coastal prairie to farmland has eliminated natural burrows, thereby forcing burrowing owls to adopt the use of human-made structures, such as road culverts. This increases the risk of owls being hit by automobiles. More attention should be focused on educating landowners about burrowing owls, because much of the remaining burrowing owl habitat is located on private land. Where culverts are used in low-traffic areas, landowners and managers of public lands should be encouraged to use culverts with smaller diameters (8 to 50 cm) and to keep areas surrounding culverts mowed or grazed during winter. Spot treatment of weedy growth around culvert entrances in late summer or early fall might improve culvert entrances as potential roost sites. Culvert maintenance is especially important at small-diameter culverts along less-traveled caliche or dirt roads, where disturbance is minimal. As a management tool, installation of artificial burrows of small diameter (oriented in an east-west direction) might be useful in attracting wintering burrowing owls away from roads.

Nueces County is an important wintering area for burrowing owls, but more study needs to be focused on other counties in southern Texas to ascertain the number of owls wintering in these counties. The barrier islands also need more thorough attention to determine the use of these habitats by owls. Studies on mortality and predation of wintering burrowing owls in south Texas are also needed.

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