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Nest site characteristics and nesting success of the Western Burrowing Owl in the eastern Mojave Desert

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ABSTRACT

We evaluated nest site selection at two spatial scales (microsite, territory) and reproductive success of Western Burrowing Owls (*Athene cunicularia hypugaea*) at three spatial scales (microsite, territory, landscape) in the eastern Mojave Desert. We used binary logistic regression within an information-theoretic approach to assess factors influencing nest site choice and nesting success. Microsite-scale variables favored by owls included burrows excavated by desert tortoise (*Gopherus agassizii*), burrows with a large mound of excavated soil at the entrance, and a greater number of satellite burrows within 5 m of the nest burrow. At the territory scale, owls preferred patches with greater cover of creosote bush (*Larrea tridentata*) within 50 m of the nest burrow. An interaction between the presence or absence of a calcic soil horizon layer over the top of the burrow (microsite) and the number of burrows within 50 m (territory) influenced nest site choice. Nesting success was influenced by a greater number of burrows within 5 m of the nest burrow. Total cool season precipitation was a predictor of nesting success at the landscape scale. Conservation strategies can rely on management of habitat for favored and productive nesting sites for this declining species.

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1. Introduction

Nest site selection is a key component of avian habitat selection with significant consequences for survival and reproductive success (Cody, 1985). Nest site choices influence the probability of nesting success through such factors as predation, starvation, and competition (Martin, 1995). Avoidance of nest predation plays a significant role in nesting success and may be especially important for ground-nesting species (Martin, 1995). Western Burrowing Owls (*Athene cunicularia hypugaea*) nest in cavities in the ground and are the only North American raptor to do so. For this ground-nesting species, nest site selection factors that reduce predation may be pivotal for nesting success.

Burrowing Owls occur in a wide range of arid and semi-arid habitats in the western U.S. – prairie and annual grasslands, shrub-steppe, and deserts (Haug et al., 1993). They have also adapted to human landscapes including urban and agricultural areas (Haug et al., 1993). Studies examining nest site selection and reproductive success of Burrowing Owls have been conducted in prairie grassland, shrub-steppe, agricultural, and urban environments (Desmond and Savidge, 1999; Green and Anthony, 1989; Lantz et al., 2007; Lutz and Plumpton, 1999; Rich, 1986; Rosenberg and Haley, 2004; Thomsen, 1971; Wellicome et al., 1997). A few studies have been conducted on desert populations; most of these have occurred in grassland habitat in the Chihuahuan Desert of New Mexico and Mexico (Botelho and Arrowood, 1998; Martin, 1973; Rodriguez-Estrella, 1997). However, little information is available on Burrowing Owl populations in natural desert scrub habitat, such as that characteristic of the Mojave Desert. With documented population declines and range contractions occurring at northern, eastern, and western boundaries of Burrowing Owl range, estimates of nest site selection and nesting success (number of nesting attempts that produce fledged young) are essential for understanding owl population dynamics (Haug et al., 1993).

Scale is a critical component of the patterns and processes of ecological studies, including avian habitat selection (Cody, 1985; Wiens, 1989). Concentration of studies at one scale can result in the loss of information when factors influencing populations occur at multiple scales (Wiens, 1989). Studies on Burrowing Owls have identified a number of variables, at multiple scales, that influence nest site selection (Lantz et al., 2007). At the microsite, Burrowing Owls select for open ground, well-drained soils, and reduced vegetation surrounding the burrow (Green and Anthony, 1989; MacCracken et al., 1985). The presence of additional burrows

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adjacent to nest sites is important for establishment of territories (Desmond et al., 2000; Plumpton and Lutz, 1993; Poulin et al., 2005). At the landscape scale, flat or rolling terrain (Butts and Lewis, 1982) and the habitat matrix surrounding nest sites (Orth and Kennedy, 2001; Poulin et al., 2005) are important determinants. We investigated factors influencing nest site selection and nesting success at three spatial scales (i.e., microsite, territory, and landscape) in an eastern Mojave Desert population of Burrowing Owls.

2. Methods

2.1. Study area

We conducted our study at Lake Mead National Recreation Area (LMNRA; 36° 10′ N, 114° 40′ W) in the Mojave Desert of southern Nevada (2003–2005). Our study area included the Nevada portion of LMNRA west of Lake Mead and the Colorado River. LMNRA is located in the eastern Mojave Desert region of the Basin and Range physiographic province (Eaton, 1982). Local topography varies from steep mountain ranges with deep washes to rolling and gently inclined alluvial fans and valley basins. Elevations range from 160 m to 2100 m. Mean monthly temperature is 6.8 °C in January and 33.3 °C in July, with an annual bimodal precipitation cycle of <12.5 cm falling as cool season winter precipitation (74%) and mild monsoonal summer thunderstorms (26%). Precipitation patterns are highly variable both seasonally and annually. Average annual precipitation for the three years of this study (2003–2005) was 22.6 cm ± 1.93 cm, well above mean annual precipitation for the eastern Mojave Desert (National Oceanic and Atmospheric Administration, 2008). Sonora-Mojave creosote bush-white bursage desert scrub association (*Larrea tridentata-Ambrosia dumosa*; Turner, 1982) was the most widespread and dominant vegetation type. This association occurs on bajada slopes and basin floors and contains low perennial species diversity and a high diversity of annual species that germinate during years of increased precipitation.

2.2. Survey methods

We focused our surveys on the breeding season for Burrowing Owls in the eastern Mojave Desert; timing and other survey considerations were designed to increase detectability of the owls (Crowe and Longshore, 2010). We used Hawth's tools© extension within ArcMap software (ArcMap 9.3; Environmental Systems Research Institute, Redlands, California 2008) to create random transects throughout our study area and spatially separated transects by a minimum distance of 3.2 km. We constrained random transects to areas with slope less than 25% (Haug et al., 1993). We conducted our surveys at night because owls call primarily during nocturnal hours. We conducted surveys on-foot beginning immediately after dusk (within 30 min) for approximately 3–4 h from 20 February to 31 July, 2003–2005. We surveyed during breeding stages when owls were more apt to vocalize which included territory establishment, pair formation, egg laying, and incubation (Clark and Anderson, 1997). In addition, we conducted surveys during brood-rearing and fledgling-dependency stages thereby surveying during the entire breeding season for our study site. Each survey (sampling unit) consisted of a transect 3.2 km in length with 5 point count stations spaced 800 m apart. We played recorded Burrowing Owl primary song and alarm calls during surveys to increase detection rates (Haug and Didiuk, 1993). At each station, we conducted a point count which included a 3-min passive listening session which was followed by a 3-min owl call-broadcast session (Conway and Simon, 2003). We broadcast vocalization sequences using a cassette player which was held approximately 2 m above the ground and rotated in the four cardinal directions. Broadcast volume was adjusted between 80 and 90 db at 1 m from the cassette speaker and measured using a sound-level meter set on slow response and C weighting (Andersen, 2007). Each transect was conducted once per breeding season. We did not conduct surveys when average wind speeds were >19 km/h or when rainfall was moderate to heavy.

2.3. Nest site selection

We collected data on nest site characteristics at nest and non-nest burrows at two spatial scales: nest microsite and territory patch (Table 1). We established non-nest burrows by walking random orientations from a nest burrow searching a 50-m wide transect. Burrowing Owls in the Mojave Desert do not dig their own burrows and rely on burrows previously excavated by either the desert tortoise (*Gopherus agassizii*) or kit fox (*Vulpes macrotis*). We measured the first burrow excavated by kit fox or desert tortoise found on these random searches as a non-nest burrow. We restricted non-nest burrows to those burrows that owls might reasonably be expected to use, thereby reducing the likelihood that we would find trivial differences between nest and non-nest burrows. We did not include older burrows with blocked or collapsed entrances or simply holes without an associated tunnel dug into the ground by foraging kit foxes and coyotes (<0.5 m deep). In order to

Table 1
Nest site variables measured at multiple spatial scales used in our study of nest site selection and nesting success for Burrowing Owls at Lake Mead National Recreation Area (LMNRA), southern NV, 2003–2005. Categorical variables included burrow type, calcic layer, slope, and soil mound size. Variable description indicates which category was coded as 0 or 1.

Variable	Code	Description
Microsite		
Burrow type	type	Burrows excavated by a desert tortoise (1) versus a kit fox (0)
Height of soil mound	soil	Size of soil mound outside burrow entrance; results from the excavation process; coded 0 for no or small mound (≤7 cm); coded 1 for large mound (>7 cm)
Calcic horizon	calcic	Burrows excavated beneath a calcic soil horizon layer (1) or absence of calcic layer (0)
Slope	slope	Burrows excavated within the slope of a wash or topographic ridge (1) versus level ground (0)
Satellite burrows	b5m	Number of alternative burrows within ≤5 m of the burrow
Territory		
Satellite burrows	b50m	Number of alternative burrows >5 m and ≤50 m from the burrow
Creosote bush cover	larcov	Cover of *Larrea tridentata* measured as linear cover of this shrub along three 50 m line transects radiating from the burrow (m)
Subshrub cover	shrbcov	Cover of perennial subshrubs (e.g., *Krameria grayi*, *Ambrosia dumosa*) measured as linear cover of these shrubs along three 50 m line transects radiating from the burrow (m)
Topography	topo	Visual assessment of the topography within 250 m of the burrow, estimation based on wash height; wash height <1 m (0), wash ≥ 1 m and <2.5 m (1), wash ≥ 2.5 m and <5 m (2), wash ≥ 5 m (3).
Landscape		
Total cool season precipitation	totppt	Amount of precipitation recorded at LMNRA at three sites along the lower Colorado River during the previous winter and the following spring of each nesting season including Oct–Mar (cm).
Distance to nearest road	disroad	Distance from nesting burrow to closest road, paved or unpaved (m).