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DENSITY AND ABUNDANCE OF BURROWING OWLS IN THE AGRICULTURAL MATRIX OF THE IMPERIAL VALLEY, CALIFORNIA

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Abstract. In concert with conversions of Sonoran desert habitat of the Imperial Valley, California, to intensive agriculture, Burrowing Owl (*Athene cunicularia*) populations dramatically increased in abundance. To quantify the abundance of breeding owls in the agricultural matrix of the Imperial Valley, we conducted surveys in randomly (N = 6) and non-randomly (N = 9) selected 25-km^2 blocks during 1992 and 1993. Based on counts of pairs observed in random blocks, we estimated a density of 2.1 ± 0.6 pairs/km^2 in 1992 and 2.0 ± 0.4 pairs/km^2 in 1993. Total variation (sampling and spatial) was high; estimated densities ranged from 0–7.4 pairs/km^2 among all 15 blocks sampled. Based on the randomly selected blocks, we estimated a total population size of 5600 (95% confidence interval: 3405–7795) owl pairs within the agricultural matrix of the Imperial Valley, indicating one of the largest concentrations of the Burrowing Owl in its entire range. Because the owls nest almost entirely along irrigation drains and canals, this population remains vulnerable to changes in methods of water conveyance.

Key Words: agroecosystems; *Athene cunicularia*; Burrowing Owl; California; Imperial Valley; Sonoran desert.

DENSIDAD Y ABUNDANCIA DEL TECOLOTE LLANERO EN LA MATRIZ AGRÍCOLA DEL VALLE IMPERIAL, CALIFORNIA

Resumen. De acuerdo con los cambios del hábitat de desierto Sonorense del Valle Imperial en California, a agricultura intensiva, la abundancia de las poblaciones del Tecolote Llanero (*Athene cunicularia*) han incrementado dramáticamente. Para cuantificar la abundancia de tecolotes reproductores en la matriz agrícola del Valle Imperial, llevamos a cabo censos en bloques de 25-km^2 seleccionados al azar (N = 6) y sistemáticamente (N = 9) durante 1992 y 1993. Con base en el conteo de parejas observadas en los bloques al azar, estimamos una densidad de 2.1 ± 0.6 parejas/km^2 en 1992 y 2.0 ± 0.4 parejas/km^2 en 1993. La variación total (muestras y espacial) fue alta; la densidad estimada varió de 0–7.4 parejas/km^2 entre los 15 bloques muestreados. Con base en los bloques seleccionados al azar, estimamos un tamaño poblacional total de 5600 (95% de intervalo de confianza: 3405–7795) parejas de tecolotes dentro de la matriz agrícola del Valle Imperial, indicando una de las mayores concentraciones de Tecolotes Llaneros en todo su rango. Debido a que casi todos los tecolotes anidan a lo largo de los drenajes y canales de riego, esta población permanece vulnerable a los cambios en los métodos de conducción del agua.

Palabras clave: Agroecosistemas; *Athene cunicularia*; California; desierto Sonorense; Tecolote Llanero; Valle Imperial.

The Western Burrowing Owl (*Athene cunicularia hypugaea*) was once widespread and fairly common over western North America, but its distribution and abundance has changed markedly during the 20th century. Although many populations have declined in abundance (James and Espie 1997), some to the point of at least temporary local extirpation (e.g., Johnson 1997), others have increased since European occupation. Nowhere is this clearer than in the Imperial Valley of southeastern California.

Historically, Burrowing Owls presumably occurred within the Imperial Valley in low densities, similar to those in the undisturbed portions of the Sonoran Desert in which the Imperial Valley is embedded (Garrett and Dunn 1981). In response to the intensification of agriculture in the early 1900s (Clemings 1996), the Burrowing Owl population within the Imperial Valley became one of the largest and most dense populations of this species in California (e.g., Coulombe 1971, Rosenberg and Haley *this volume*) and probably throughout its range. Understanding this species' ecology in apparently thriving populations may lead to greater insights in managing declining populations. As a first step in addressing this, we conducted a large-scale survey of the agricultural habitats within the Imperial Valley in 1992 and 1993 to quantify density. Here we report the results of that survey, compare densities of Burrowing Owls in the Imperial Valley to those elsewhere in California, and discuss the potential importance of the Valley's population in light of declines elsewhere in California (DeSante et al. 1997, Johnson 1997, Trulio 1998).

METHODS

This survey was conducted as part of a larger survey of Burrowing Owls in all of California west of the Great Basin and desert areas (DeSante et al. 1997; D. DeSante et al., unpubl. data). For this study, we divided the Imperial Valley into 183 5 × 5 km blocks, of which 112 blocks comprised a strata defined as the agricultural matrix of the Imperial Valley. We randomly selected 6% (N = 7) of these 112 blocks and distributed copies of these seven blocks taken from 1: 24,000 USGS topographic maps to colleagues at the Sony Bono Salton Sea National Wildlife refuge and the Imperial Irrigation District for surveying. Because of time and logistic constraints, only six of the seven randomly selected blocks were surveyed in at least one year (Fig. 1). In addition, we surveyed nine other 5 × 5 km blocks in the agricultural matrix strata of the Imperial Valley. These blocks were selected opportunistically. These blocks were distributed over much of the agricultural areas of the Imperial Valley (Fig. 1).

Surveys were carried out by local ornithologists and by agency biologists following training provided to facilitate standardization of survey methods. Observers surveyed each block between dawn and 10:00 and/or between 16:00 and dusk between 15 May and 15 July, during both 1992 and 1993. We computed density as number of pairs counted/km^2 for each year and sampling strategy (random or nonrandom). Observers searched blocks for owls for an average of approximately 10 hrs/block. We estimated the number of breeding pairs of Burrowing Owls (defined as in DeSante et al. 1997) by multiplying the area of the sampled region by the estimated mean density. We assumed that if an owl was present within the block it would be detected. Because this assumption was unlikely met, our estimated numbers are likely negatively biased.

Habitat within the study area was characterized by agricultural fields, framed by a system of concrete irrigation delivery ditches, irrigation canals, and earthen drains managed by the Imperial Irrigation District and landowners. This characterization was made at the scale of the 5 × 5 km sample blocks, as most of the area sampled was comprised of this agricultural matrix. All pairs observed were found along the system of irrigation ditches, canals, and drains immediately bordering the agricultural fields.

RESULTS

We estimated an average density of approximately two owl pairs/km^2 during 1992 and 1993 within the randomly selected blocks (Table 1). Estimated densities were on average >25% higher in the non-randomly selected blocks, although low precision resulted in overlapping 95% confidence intervals (Table 1). Estimated densities in both the random and non-random blocks varied considerably, ranging from 0–7.4 pairs/km^2. The variation between years was small relative to the variation among blocks (Table 1). However, sampling variation that resulted from detection probabilities of <1.0 and which were likely variable among blocks was partially responsible for the observed variation (sensu White 2000). Counts conducted in both years within a block often differed by >80% (Fig. 1). The large variance contributed to imprecise estimates of density, and hence estimated population size. Based on counts within the randomly selected blocks during 1993, the year all six blocks were sampled, we estimated a total population size of 5600 pairs (95% confidence interval: 3405–7795). The high densities in the non-random blocks give further support to such high densities and the large population size as estimated from the small number of random blocks.

DISCUSSION

Based on qualitative assessments, California has one of the largest populations of both resident and wintering Burrowing Owls (James and Ethier 1989, Sheffield 1997). Density estimates from this survey and other surveys conducted in a similar manner elsewhere in California (DeSante et al. 1997; D. DeSante et al., unpubl. data), suggest that a majority (approximately 70%) of the California breeding population of the Burrowing Owl (excluding the Great Basin, Mojave, and Colorado deserts, and Colorado River valley portions of California) nests within the Imperial Valley. Although the small number of randomly selected blocks sampled and the unknown detection probability lessens the strength of these results, particularly for the comparison of relative abundance among regions, it is clear that the density and abundance of Burrowing Owls is exceptionally high within the Imperial Valley.

The densities reported here are likely among the highest throughout the Burrowing Owl's range, especially when considering the large areal extent of the lowland area of the Imperial Valley (approximately 2810 km^2). Similarly high densities (3.3 pairs/km^2) were estimated within the Imperial Valley by Coulombe (1971) within an 8-km^2 area during the breeding seasons of 1965–1967. More recently, Rosenberg and Haley (*this volume*) estimated 8.3 pairs/km^2 within an approximately 12-km^2 study area. These localized results provide additional evidence to support the high densities estimated from this study. The only other estimate of such high densities over a reasonably large area (35.9 km^2) that we are aware of was Millsap and Bear's (2000) estimate of 6.9 pairs/km^2 for the subspecies *A. c. floridana* in southern Florida. What is extraordinary about our findings, however, is the apparently large areal extent of high densities. Given this large area, the estimated densities, and that detection probability was <1.0 (i.e., a higher number existed than was counted), more

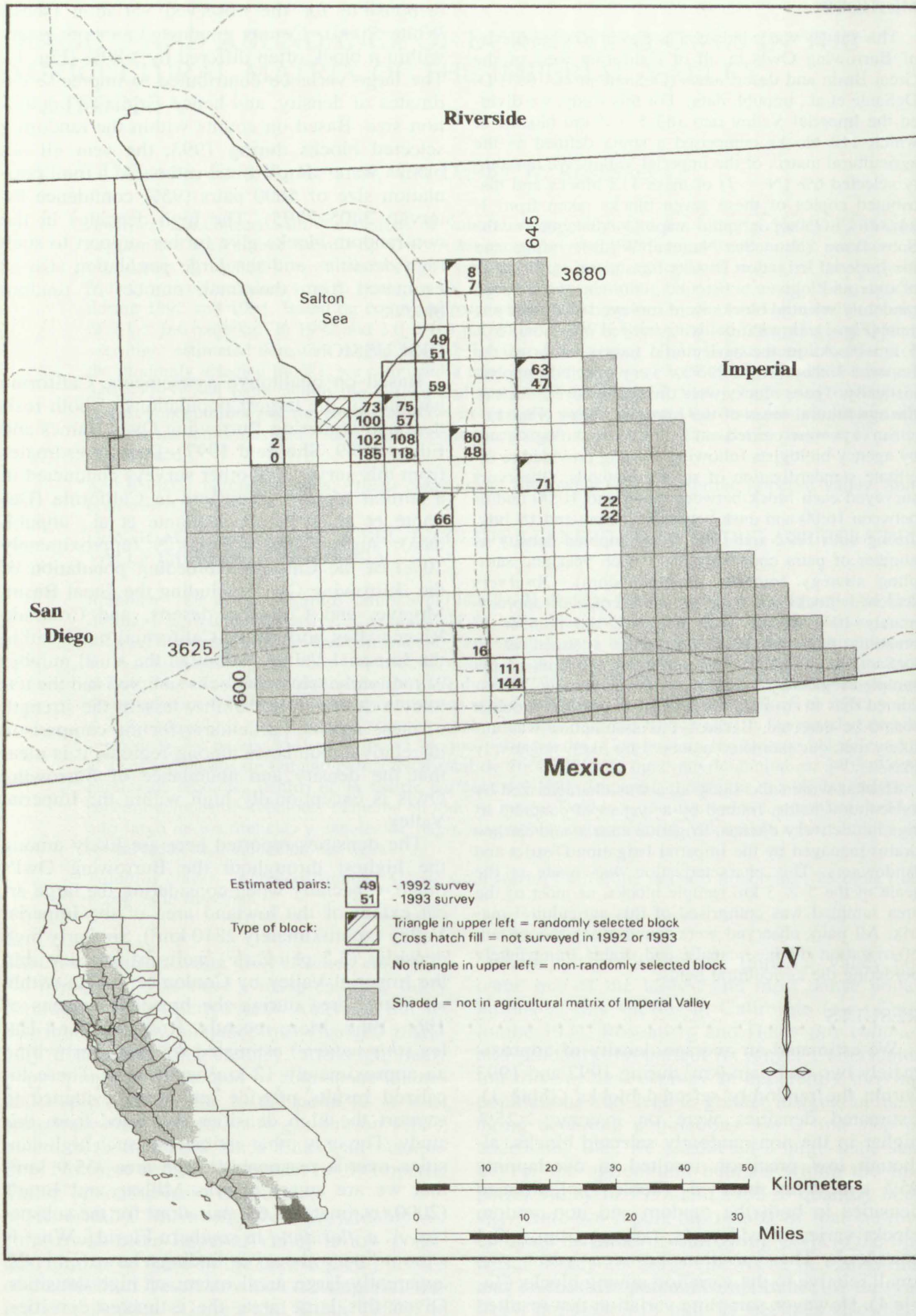
Riverside
Imperial
San Diego
Mexico
Salton Sea
3680
645
3625
600
8
7
49
51
59
73
100
75
57
102
185
108
118
2
0
60
48
63
47
71
66
22
22
16
111
144
Estimated pairs:
49 - 1992 survey
51 - 1993 survey
Type of block:
Triangle in upper left = randomly selected block
Cross hatch fill = not surveyed in 1992 or 1993
No triangle in upper left = non-randomly selected block
Shaded = not in agricultural matrix of Imperial Valley
N
0 10 20 30 40 50 Kilometers
0 10 20 30 Miles

TABLE 1. ESTIMATED BURROWING OWL DENSITIES (OWL PAIRS/KM^2) IN 25-KM^2 BLOCKS SAMPLED WITHIN THE AGRICULTURAL MATRIX OF THE IMPERIAL VALLEY, CALIFORNIA, DURING MAY–JULY 1992 AND 1993

	1992					1993				
			Estimated density					Estimated density		
Block type	Number of blocks	Owl pairs	Mean	SE	Range	Number of blocks	Owl pairs	Mean	SE	Range
Random	4	206	2.1	0.6	0.3–3.0	6	296	2.0	0.4	0.3–2.8
Non-random	7	467	2.7	0.7	0.1–4.4	9	695	3.1	0.8	0.0–7.4
All	11	673	2.5	0.5	0.0–4.4	15	991	2.6	0.5	0.0–7.4

than 11,000 (95% confidence interval: 6810–15,590) adult Burrowing Owls inhabited the agricultural ecosystems of the Imperial Valley during the surveys.

Although such a large population of a species considered to be declining in parts of its range (James and Espie 1997) could, at least theoretically, serve as an important source population for future management strategies, its current value for persistence of declining populations elsewhere in California may not be great. Potential dispersal from the Imperial Valley population to declining populations may be limited by unsuitable intervening habitat and by the dispersal characteristics of the resident Imperial Valley population itself, although juvenile dispersal remains unknown (Rosenberg and Haley *this volume*). Given the wide distribution of Burrowing Owls across their range in California, the value of a large but localized potential source population to regional persistence may not be great. However, given the rapid development of much of the grassland and desert regions of California, the apparent extirpation of the species in the Coachella Valley immediately north of the Imperial Valley, the reduction in numbers in other parts of California (DeSante et al. 1997, Johnson 1997, Trulio 1998), and the lack of a statewide conservation strategy, the importance of the Imperial Valley population may increase.

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FIGURE 1. Distribution of 5 × 5 km blocks in which Burrowing Owls were counted in 1992 and/or 1993 in the Imperial Valley, CA. Shaded areas represent portions of the Imperial Valley above sea level and without a major agricultural matrix. Non-shaded areas represent agricultural matrix of the Imperial Valley and include the 112 blocks from which a random sample of seven blocks were selected. Numbers embedded in the blocks are the number of Burrowing Owl pairs counted in 1992 (upper right) and 1993 (lower right). The cross-hatched block was randomly selected but was not surveyed. The numbers outside of the blocks refer to the southwest corner of the 5 × 5 km block referenced by the Universal Transverse Mercator system of the block. The UTM values shown are 10^{-3} of the given value.