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DOES NEST BASKET SIZE AFFECT BREEDING PERFORMANCE OF LONG-EARED OWLS AND EURASIAN KESTRELS?

MOTTI CHARTER¹

Zoology Department, Tel-Aviv University, Ramat-Aviv, Tel-Aviv 69978, Israel

IDO IZHAKI

Department of Evolutionary and Environmental Biology, University of Haifa, Haifa 31905, Israel

YOSSI LESHEM

Zoology Department, Tel-Aviv University, Ramat-Aviv, Tel-Aviv 69978, Israel

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Artificial nest sites are an integral part of many conservation and scientific studies of various avian species (Newton 1998). Those raptors that do not build nests but breed in available open-type nests frequently use old corvid nests such as those of crows. Crows are considered a pest species in many parts of the world, and programs are sometimes established to reduce their number in certain areas, which may in turn reduce raptor numbers (Hadjisterkotis 2003). Nest baskets (Village 1981, Village 1990, Garner and Milne 1997, Charter et al. 2009) have rarely been used as alter-

native nest sites for Long-eared Owls (*Asio otus*) and Eurasian Kestrels (*Falco tinnunculus*; hereafter kestrels) where natural nest sites are limited, and more information is needed in order to understand their effectiveness for conservation purposes.

The occupancy rates and breeding success of raptors vary in nest boxes of different sizes; in some cases, pairs favored breeding in larger nest boxes and were more successful (Van Balen 1984, Korpimäki 1985, Bortolotti 1994), whereas in other cases, nests in medium- and small-sized nest boxes were more successful (Pitts 1988). In this study we used nest baskets of two different sizes in order to determine whether Long-eared Owls and kestrels prefer a particular size nest basket and whether their breeding success differs between the two sizes.

¹ Email address: charterm@post.tau.ac.il

METHODS

The study site (346 hectares, Jezreel Valley, Israel; 32°35'N, 35°13'E) consisted of stands of eucalyptus trees (*Eucalyptus* sp.) surrounded by agricultural fields. The climate is semiarid with maximum and minimum mean daily temperatures (during March through July 1999) of 27.8°C and 15.2°C, respectively, and average yearly rainfall of 452 mm.

Thirty-eight nest baskets were mounted on eucalyptus trees in October 2007 at a height of 5–6 m attached to the main trunks of trees. The nest baskets have an open top and were constructed of a metal frame and soft coconut fiber inner liner. Two different-sized nest baskets were used: 18 of 30-cm outer diameter and 16-cm height; and 20 of 40-cm outer diameter and 20-cm height. We chose these two nest sizes because they represent different extremes of the primary nest builder in the study site, the Hooded Crow (*Corvus cornix*; Cramp and Perrins 1994). To allow kestrels and Long-eared Owls to choose between the two basket types, we distributed the baskets alternately throughout the study area, with distances between baskets averaging 87.9 m (SE = 2.67, $n = 38$). At the end of the 2008 breeding season, in September 2008, we exchanged the locations of the 30-cm baskets with those of the 40-cm baskets. During the 2009 breeding season, the number of baskets was increased to 21 and 19 for the 30- and 40-cm nests, respectively. Data for the years 2008 and 2009 were pooled, as after the nest baskets were exchanged we considered them as new nest baskets even though the overall locations were the same. No location was used twice by the same species in two consecutive years and all nest baskets were cleaned between the two breeding seasons. Furthermore, no differences between occupation and breeding success were found between the two years. Two of the nest baskets were occupied by Mallards (*Anas platyrhynchos*) in 2008 and 2009 and were omitted from the analysis.

We observed the nest baskets at least six times from February 1 to July 15 in both years, using an 8-m pole with a mirror attached to it, and a ladder when nestlings were banded at 18–20 d old. During the study, for each breeding attempt we recorded the clutch size, brood size (number of young observed in the nest during first visit, <1 wk after hatching) and number of young produced (fledged for kestrels [23–27 d old] and “branched” for Long-eared Owls [19–22 d old], as Long-eared Owls leave the nest before they can fly). When laying date was unknown, it was determined by back-calculating using the age of the nestlings on the first visit, as determined by wing length (M. Charter unpubl. data) minus an incubation period of 30 d for Long-eared Owls and 28 d for kestrels (Cramp 1985). For nests that were visited late, only breeding parameters that were known were included in the analysis. We calculated: hatching success as the percentage of eggs that hatched within each clutch per breeding attempt, and fledging success as the percentage of young that fledged from each brood per pair that hatched at least one egg. The number of young fledged is presented per breeding attempt and per successful nest, where a successful

nest is defined as one that produced at least one nestling that fledged/branched.

Descriptive breeding data were analyzed using a Mann-Whitney *U*-test. *Z*-test for two proportions and chi-square test were used to compare occupancy rates and breeding success. Levels of significance were set at $P < 0.05$. Statistical analyses were performed using Statistica 7.1 software and SPSS for Windows version 17.

RESULTS AND DISCUSSION

During the study 36.8% of the nest baskets ($n = 76$) were occupied: Long-eared Owls occupied 19.7% ($n = 15$) and kestrels 17.1% ($n = 13$). The number of 30-cm and 40-cm nest baskets occupied did not differ between the two species.

Long-eared Owls had similar occupancy rates for the 30-cm and 40-cm nest baskets ($Z = 0.11$, $P = 0.91$) and the percentage of pairs that successfully produced young of branching age was also similar between the two sizes of nest baskets ($Z = 0.80$, $P = 0.57$). Similarly, Long-eared Owl clutch size, brood size, and hatching success did not differ between the nest basket sizes (Table 1). However, more Long-eared Owl young were produced per breeding attempt and per successful nest in the 30-cm than in the 40-cm baskets (Table 1).

Kestrels also had similar occupancy rates for the 30-cm and 40-cm nest baskets ($Z = 0.11$, $P = 0.97$), and the percentage of pairs that succeeded in fledging young was also the same in both ($Z = 0.00$, $P = 1.00$). No differences were found between basket sizes for any of the kestrel reproductive parameters (Table 1).

Both species bred in the nest baskets during the study, occupying 36.8% of them. During the two years of the study, rodent populations were low compared to previous years (M. Charter unpubl. data), which suggests that occupancy rate for nest baskets may be higher when rodent populations (i.e., available prey) are larger (Village 1981). The occupancy rate of nest baskets by Long-eared Owls in our study was similar to that reported in England (Garner and Milne 1997) but, unlike that study, nest baskets in the present study were also used by kestrels.

One important finding of our study was that Long-eared Owls occupied the two sizes of nest baskets with similar frequencies, but produced more young in the 30-cm than in the 40-cm nest baskets. Marks (1986) found that the crow nests occupied by Long-eared Owls were larger than the unused crow nests; however, in that study, the difference in size between the occupied and the unused crow nests was very small. In comparison to the 30-cm nest baskets, when the adult owls in 40-cm baskets incubated or brooded young, their view of the surrounding area was limited, which may have affected their ability to spot potential nest predators (mainly crows and other raptors). In the 30-cm nest baskets the adult's head was almost always visible above the sides. In an observational study of natural nest sites, Henorrioux (2002) suggested that Long-eared Owls selected their nests as part of an antipredator strategy.

Table 1. Comparison of reproductive parameters (mean \pm SE and sample size) for Long-eared Owls and Eurasian Kestrels breeding in 40-cm and 30-cm nest baskets in the Jezreel Valley, Israel.

SPECIES	REPRODUCTIVE PARAMETER	40-CM BASKETS (<i>n</i>)	30-CM BASKETS (<i>n</i>)	MANN-WHITNEY <i>U</i> -TEST
Long-eared Owl	Clutch size	3.29 \pm 0.52 (7)	5.00 \pm 0.55 (5)	$Z = -1.87, P = 0.06$
	Brood size	2.63 \pm 0.63 (8)	3.86 \pm 0.77 (7)	$Z = -1.22, P = 0.23$
	Number of young per breeding attempt ¹	1.25 \pm 0.56 (8)	3.71 \pm 0.71 (7)	$Z = -2.20, P < 0.05$
	Number of young per successful nest ¹	2.50 \pm 0.65 (4)	4.33 \pm 0.42 (6)	$Z = -1.99, P < 0.05$
	Hatching success (%)	60.2 \pm 0.16 (7)	64.1 \pm 0.16 (5)	$Z = -0.16, P = 0.87$
Eurasian Kestrel	Fledging success (%) ²	50.0 \pm 0.19 (6)	97.2 \pm 0.03 (6)	$Z = -1.97, P < 0.05$
	Clutch size	4.60 \pm 0.51 (5)	4.17 \pm 0.31 (6)	$Z = 0.73, P = 0.54$
	Brood size	2.67 \pm 0.84 (6)	1.80 \pm 1.11 (5)	$Z = 0.82, P = 0.41$
	Number of young per breeding attempt ³	2.50 \pm 0.85 (6)	1.83 \pm 0.91 (6)	$Z = 0.72, P = 0.47$
	Number of young per successful nest ³	3.00 \pm 0.84 (5)	3.67 \pm 0.88 (3)	$Z = -0.45, P = 0.65$
	Hatching success (%)	66.7 \pm 0.19 (5)	33.3% \pm 0.21 (6)	$Z = 0.91, P = 0.36$
	Fledging success (%) ²	99.3 \pm 0.07 (5)	75.0% \pm 0.25 (2)	$Z = 0.77, P = 0.44$

¹ Young of branching age (19–22 d).

² Defined as the percentage of young that fledged from each brood per pair that hatched at least one egg.

³ Young of fledging age (23–27 d).

Although the kestrel breeding success was similar between the two nest basket sizes, the average number of fledglings per breeding attempt in nest boxes in another study from the same region (3.2 fledglings; M. Charter unpubl. data) was greater than that in nest baskets in this study (2.2 fledglings). Because both studies were conducted in the same region during the same years, this difference in breeding success is probably due to the higher risk of predation in the more open nest baskets. In another location in Israel among date palms, kestrels also had higher reproductive success in nest boxes than in open nest sites (Charter et al. 2007).

Despite the differences between the breeding success of the Long-eared Owls in the two sizes of nest baskets, these baskets proved efficacious as nest sites, as they were occupied and successfully used by both species. In another study, albeit smaller, in a different area (Charter et al. 2009), 40-cm nest baskets were used with similar success. The ability to introduce artificial nest sites for Long-eared Owls and kestrels can contribute to the conservation and study of these species. By manipulating nest basket locations, various aspects of their ecology, such as competition and predation, can be studied using experimental field designs that would not be possible if the birds were using empty nests of other species.

¿EL TAMAÑO DE LA ESTRUCTURA DE LOS NIDOS AFECTA EL DESEMPEÑO REPRODUCTIVO DE *ASIO OTUS* Y *FALCO TINNUNCULUS*?

RESUMEN.—Los nidos artificiales son elementos importantes en muchos estudios científicos y para la conserva-

ción de especies de aves. Aquí presentamos los resultados de un estudio que determinó si la lechuza *Asio otus* y el halcón *Falco tinnunculus* utilizan cestas artificiales para anidar, y si estas aves seleccionan un tamaño particular de cesta. Durante nuestro estudio, 36.8% de las cestas de anidación que colocamos fueron ocupadas por las dos especies. Las lechuzas ocuparon los dos tipos de tamaño de cesta, de 30 cm y 40 cm de diámetro, pero fueron más exitosas en producir polluelos prevolantones en las cestas de 30 cm (tanto el número de crías como el porcentaje de crías por nido fueron mayores). Los halcones también ocuparon los dos tamaños en proporciones similares, pero no encontramos diferencias en sus parámetros reproductivos entre parejas que criaron en los dos tipos de cestas de anidación. Especulamos que las diferencias en el éxito reproductivo de *A. otus* podrían deberse a que las cestas de menor tamaño permiten una mayor visibilidad, facilitando la detección de depredadores.

[Traducción del equipo editorial]

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PREY USE BY SWAINSON'S HAWKS IN THE LESSER PRAIRIE-CHICKEN RANGE OF THE SOUTHERN HIGH PLAINS OF TEXAS

ADAM C. BEHNEY

Texas Cooperative Fish and Wildlife Research Unit, Department of Natural Resources Management, Texas Tech University, Lubbock, TX 79409 U.S.A.

CLINT W. BOAL¹

U.S. Geological Survey, Texas Cooperative Fish and Wildlife Research Unit, Department of Natural Resources Management, Texas Tech University, Lubbock, TX 79409 U.S.A.

HEATHER A. WHITLAW

U.S. Fish and Wildlife Service, Box 42125, Texas Tech University, Lubbock, TX 79409 U.S.A.

DUANE R. LUCIA

Texas Parks and Wildlife Department, 1702 Landmark Lane, Lubbock, TX 79415 U.S.A.

KEY WORDS: *Swainson's Hawk*; *Buteo swainsoni*; *Lesser Prairie-Chicken*; *Tympanuchus pallidicinctus*; *diet*; *Great Plains*; *Texas*.

Swainson's Hawks (*Buteo swainsoni*) breed across the open grass and shrublands of western North America, where their distribution overlaps with several species of upland game birds (*Galliformes*). Swainson's Hawks prey primarily on small mammals, birds, and reptiles (Schmutz et al. 1980, England et al. 1997, Giovanni et al. 2007).

However, Swainson's Hawks are also reported to infrequently take gallinaceous birds, including Greater Sage-Grouse (*Centrocercus urophasianus*) and Sharp-tailed Grouse (*Tympanuchus phasianellus*; Dunkle 1977, Schmutz et al. 1980, Gilmer and Stewart 1984).

Bednarz (1988) found that Northern Bobwhite (*Colinus virginianus*) and Scaled Quail (*Callipepla squamata*) accounted for <2% of Swainson's Hawk diets in shinnery oak (*Quercus havardii*) rangelands of southeastern New Mexico. In shortgrass prairie of the Texas panhandle, Giovanni et al. (2007) found that Scaled Quail was the only gallinaceous bird detected in the Swainson's Hawk diets, but accounted for <1% of prey deliveries.

¹ Email address: clint.boal@ttu.edu