

BREEDING RATES OF EURASIAN KESTRELS (*FALCO TINNUNCULUS*) IN RELATION TO SURROUNDING HABITAT IN SOUTHWEST SPAIN

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ABSTRACT.—We studied breeding success of Eurasian Kestrels (*Falco tinnunculus*) in nest boxes in seven different habitat types in the southwest of Spain. A total of 567 nest boxes was installed on power pylons in fallow fields, cereal cropland, holm oak land, olive orchards, pastureland, irrigated cropland, and shrubland. Occupation of boxes did not vary among the habitats and there were no significant differences among the seven habitat types in laying date, clutch size, or breeding success. When habitats with low numbers of breeding pairs were removed from analyses, we were able to detect significant differences in mean laying dates, clutch sizes, and breeding success rates among the three habitat types with the highest sample sizes. Kestrels nesting in pastureland showed higher clutch sizes and higher breeding success than those nesting in the cereal land. A seasonal decline in clutch size was found in all three habitat types with the highest sample sizes. Our results suggested that habitat features influence the breeding biology of Eurasian Kestrels.

KEY WORDS: *Eurasian Kestrel*; *Falco tinnunculus*; *habitat features*; *breeding success*; *agricultural intensification*; *Spain*.

Tasas de reproducción de *Falco tinnunculus* en relación al hábitat circundante en el suroeste de España

RESUMEN.—Se ha estudiado la influencia del hábitat de nidificación sobre la biología reproductora del Cernícalo Vulgar *Falco tinnunculus* en una población reproductora del sudoeste de España. Se instalaron en postes de líneas de conducción eléctrica 567 cajas-nido dentro de siete tipos diferentes de hábitats: Barbechos, siembras de cereal, dehesas arboladas de encinas, olivares, pastizales, cultivos de regadío y áreas con cobertura de matorral. No existieron diferencias significativas en los porcentajes de ocupación de los nidos entre los siete hábitats. No se detectaron diferencias entre los siete hábitats en las fechas medias de puesta, tamaños de puesta y tasas reproductoras de los cernícalos. Sin embargo, cuando se extrajeron de los análisis aquellos hábitats con menor número de parejas nidificantes, existieron diferencias entre hábitats en el inicio de la reproducción. Del mismo modo, el tamaño de puesta y el éxito reproductor variaron entre los tres hábitats con mayores tamaños muestrales. Los cernícalos que nidificaron en pastizales tuvieron mayores tamaños de puesta y mayor éxito reproductor que los que lo hicieron en cultivos de cereal. En los tres hábitats con mayor tamaño muestral se detectó un descenso estacional del tamaño de puesta que no varió entre los hábitats. Los resultados sugieren la influencia de los rasgos del hábitat sobre la biología de reproducción de la especie en nuestra zona de estudio.

[Traducción de Autores]

European Kestrel (*Falco tinnunculus*) populations are declining in the Palearctic because of the intensification of agriculture (Village 1990, Shrubbs 1993). In Spain, the breeding population has remained stable since the 1970s at 25 000–30 000 pairs (Aparicio 1997). Although this population has been used as a tool in experimental studies (Aparicio 1994a, 1994b, 1998), there is little information on its basic biology. Some studies have reported breeding rates (Aparicio 1994a, Gil-Delgado et al. 1995, Avilés et al. 2000), but almost nothing is known about its breeding

biology in different habitats in the Iberian Peninsula.

Nest boxes are readily accepted by kestrels (Village 1990). Although care should be taken when testing hypotheses related to fitness in such artificial nesting situations (Møller 1989), nest boxes offer an exceptional opportunity to conduct breeding studies in cavity-nesting species of birds (Clutton-Brock 1988). The aim of this study was to test the effect of habitat type on the breeding performance of Eurasian Kestrels in the Serena region in the southwest of Spain.

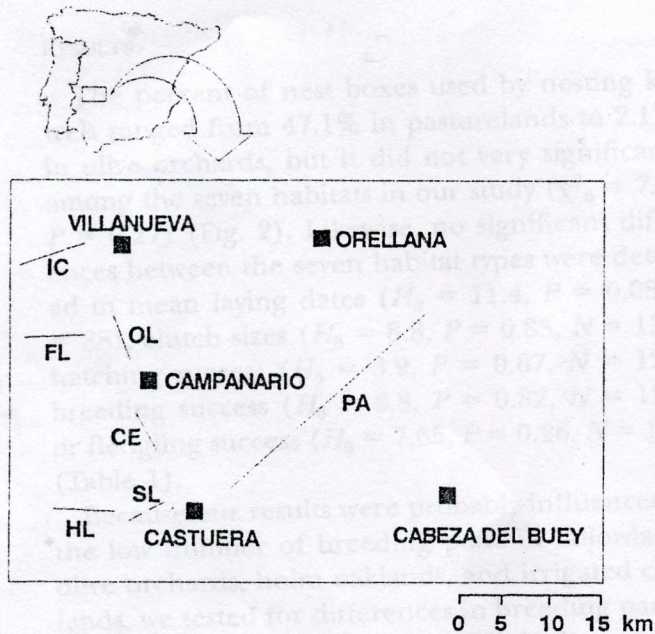


Figure 1. Map of the location of the study area and the length of electric power lines (lines) in each habitat type. Squares represent the major towns in the Serena region. Codes for habitat types are: fallowlands (FL), cereal croplands (CE), holm oaklands (HL), olive orchards (OL), pasturelands (PA), irrigated croplands (IC), and shrublands (SL).

STUDY AREA AND METHODS

The study area was located in the Serena region of Spain (39°03'N, 5°14'W). The climate of the area is Mediterranean and mean temperature and rainfall during May and June is 17.7°C and 11.6 mm, respectively (Avilés et al. 2000). In February and March of 1989, 567 nest boxes were installed on all the power pylons that crossed patches of seven different habitats in the study area: fallowlands ($N = 26$ nest boxes), cereal croplands (oats, wheat, and barley, $N = 159$ nest boxes), holm oaklands (*Quercus rotundifolia*) ($N = 63$ nest boxes), olive orchards ($N = 14$ nest boxes), pasturelands ($N = 237$ nest boxes), irrigated croplands (rice and maize, $N = 18$ nest boxes), and shrublands (mainly *Retama sphaerocarpa*, $N = 50$ nest boxes) (Fig. 1). Habitat patches with possible natural cavities (holm oakland and olive orchards) and farmhouses with possible nesting sites were searched for pairs of breeding kestrels but we did not find any kestrels breeding in natural cavities. We considered a patch of habitat to accurately represent kestrel breeding parameters when all the boxes in it were surrounded at least by 1 km of this same habitat type. The minimum distance between two patches was 1.5 km between holm oaklands and shrublands (Fig. 1). Although we did not make observations of hunting activities of the kestrels, we considered 1.5 km to be a reasonable estimation of the hunting territories taking into account the fact that breeding kestrels forage at a maximum distance of 2 km from their nests in Spain (Veiga 1982). We did not expect any density-dependent effects on kestrel breeding performance because the mean (\pm SD) density of nest boxes was $9.43 \pm$

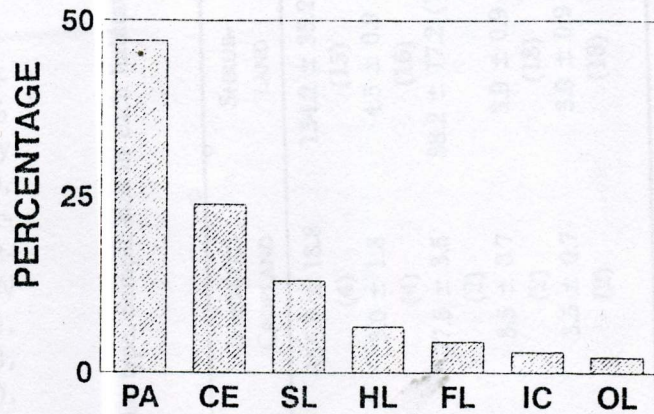


Figure 2. Percent distribution of nest-boxes used by breeding Eurasian Kestrels in relation to habitat type. Codes for habitat types are: pasturelands (PA), cereal croplands (CE), shrublands (SL), holm oaklands (HL), fallowlands (FL), irrigated croplands (IC), and olive orchards (OL). Habitats are ordered in relation to their nest box use.

0.26 boxes/km of power line independent of habitat type, and the percent of boxes occupied by kestrels in all seven habitats was $<50\%$ (Fig. 2).

All the boxes were monitored weekly from the first stages of breeding in 1989. We assumed that nest-box availability in each habitat type did not affect breeding of kestrels because the interhabitat distribution of nest boxes and breeding pairs of kestrels did not vary (G -test: $G_6 = 5.96$, $P = 0.42$), Eurasian Rollers (*Coracias garrulus*) that also use nest boxes began egg laying in our study area at least 1 mo later than kestrels (Avilés et al. 1999), and there was no evidence of damage to kestrel eggs or young by rollers when kestrels were the first to breed in nest boxes (Cramp and Simmons 1980, Avilés pers. obs.). In boxes occupied by kestrels, nest visits were increased to one visit every 3–4 d during the nesting period to determine breeding success accurately. Laying dates were determined by subtracting the incubation period from the hatching date (Cramp and Simmons 1980). When determining hatching dates, we took into account the fact that the laying interval in the species is two days (Cramp and Simmons 1980). We measured percent hatching success as the percent of eggs in each clutch that hatched, the number of fledglings per successful nest with successful nests being those at which at least one young fledged, and breeding success as the number of fledglings per pair that laid at least one egg.

We checked for interhabitat differences in the percent of boxes used using a contingency table with a Chi-square test. Normality of the variables was checked with Kolmogorov-Smirnov tests. Any nonnormality in differences in laying dates, clutch size, and breeding rates among habitat types was checked with Kruskal-Wallis tests. Differences between pairs of habitats were tested using non-parametric Tukey-type multiple comparisons. Seasonal declines in clutch size were analyzed using two-tailed Spearman correlations. We checked for interhabitat differences between clutch sizes and laying dates based on

