Farmland habitat selection of wintering lesser kestrels in a Spanish pseudosteppe: implications for conservation strategies

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Abstract. The lesser kestrel *Falco naumanni* is a globally threatened species, whose breeding populations seem to have declined due to recent agricultural changes. However, nothing is known about habitat requirements during winter, despite the fact that several populations are overwintering in areas affected by agricultural transformations. We studied population size and habitat selection by wintering lesser kestrels in a Spanish pseudosteppe (Los Monegros), where traditional fallow systems for cereals are rapidly being replaced by intensive and/or irrigated crops. About 15% of the adult population wintered in the study area, as determined by systematic roadside counts compared with accurate censuses made during the breeding season. Wintering lesser kestrels preferred to forage on field margins and stubble, while avoiding abandoned fields, ploughs, scrubland, growing cereals and, mainly, the expanding irrigated crops. This work confirms the need to incorporate the habitat requirements of threatened species over their complete annual cycles; while breeding lesser kestrels scarcely use fallow (ploughed at that time), during the winter, fallow (stubble at that time) is their main foraging habitat. Both fallow land and the present agricultural calendar should be maintained to assure the conservation of wintering lesser kestrel populations.

Key words: agricultural policies, fallow systems, habitat selection, pseudosteppes, wintering lesser kestrels

Introduction

In the European Union (EU), the largest number of bird species with an Unfavourable Conservation Status use lowland farmlands at some point during their annual cycle (Tucker and Heath 1994), most of them using steppic and arable agricultural habitats (Tucker 1997). In these habitats, important changes in the agricultural practices are being developed through the Common Agricultural Policy (CAP) of the EU (Pain and Pienkowski 1997). Information on habitat requirements by species associated with agro-steppes is available only for some species and usually does not cover the non-breeding season (Suárez et al. 1997), despite the fact that agricultural transformations could largely affect overwintering birds (Tucker 1992; Díaz and Tellería 1994) and thus potentially affect their populations (Sutherland 1998a).

The lesser kestrel *Falco naumanni* is a valuable target species for assessing the CAP environmental effects and to identify management strategies for wildlife inhabiting European pseudosteppes (Tella et al. 1998). This small, mainly trans-Saharian migratory falcon is classified as ‘globally threatened’, and 73% of its European populations have declined by >50% during the last two decades (Tucker and Heath 1994). Studies determining both landscape features around lesser kestrels colonies (Parr et al. 1995; Bustamante 1997) and habitat selection through radio-tracking procedures (Donázar et al. 1993; Tella et al. 1998) suggested that the decline of breeding populations has been mainly provoked by recent agricultural changes affecting their foraging habitats. However, although landscape transformations and other potential threats in their wintering quarters are thought to contribute to this decline (Pepler et al. 1996), the winter ecology and habitat requirements of lesser kestrels are largely unknown.

The Spanish lesser kestrel populations, which are the largest in the EU (M. de la Riva, unpubl. data), are progressively becoming sedentary over large agricultural areas (Negro et al. 1991; G. Blanco and A. Sánchez-Zapata, pers. comm.; Authors, unpub. data), often subject to the CAP transformations. Consequently, a knowledge of the size of wintering populations and their habitat requirements is needed for the implementation of conservation plans. This paper supplies the first results on population size and habitat selection by wintering lesser kestrels, through a study conducted in a pseudosteppe of NE Spain where agriculture intensification and irrigation are currently increasing.

Methods

Study area

The study was carried out in Los Monegros (Ebro valley, NE Spain), where lesser kestrels breed on abandoned farmhouses (Forero et al. 1996). The natural vegetation of the Ebro valley has been historically transformed into a large pseudosteppe devoted to extensive cereal crops (barley and wheat) using traditional farming practices. These include grazing of stubble by sheep, little mechanization, little use of fertilizers and biocides, and the existence of relatively numerous field margins. Cereals are sown in October–November and harvested in June, the resulting stubble is not ploughed until January–March and then remains fallow until the next sowing. Currently, new landholding concentration and irrigation plans are being developed in the Ebro valley to replace the cereal fallow system with intensive cultures of alfalfa, winter cereals, maize, sunflowers, deciduous fruit trees, horticultural crops, and rice (Herrero and Snyder 1997). For more details about the study area and farming features, see Tella et al. (1998) and Blanco et al. (1998).

Size of the wintering population

We conducted this study on an area of nearly 250 km^2 where home ranges and habitat selection of breeding lesser kestrels were determined in 1994 (Tella et al. 1998). This area was surveyed for wintering lesser kestrels 18 times between 22 December 1997 and 20 February 1998, by driving a car at a slow speed in good weather conditions. A linear itinerary of 62.6 km of sand roads was chosen in order to sample the whole study area, while precluding us from sampling the same individual more than once on the same day. Given that the whole study area is extremely flat and vegetation high is very low (Tella et al. 1996), birds were easily detected within 200 m around the road; no biases in their detectability along the route or among habitats are likely. Censuses were alternatively conducted in the morning and in the evening to avoid possible biases due to circadian rhythms of activity. Relative abundance of lesser kestrels was estimated as the number of birds detected per kilometer in each survey, from which the mean relative abundance was obtained.

To estimate the percentage of the breeding population that actually overwintered in the study area, the same itinerary was surveyed 12 times during July 1998, coinciding with the second half of the chick-rearing period. Since foraging behavior of lesser kestrels did not differ between summer and winter (Authors, unpub. data), roadside censuses are comparable. The relative abundance obtained in winter and summer were thus related to the actual adult population accurately censused during the 1997 and 1998 breeding seasons. These censuses were made by periodically surveying, between early February to late July, all the colonies present in the study area. Juveniles (i.e. birds hatched in the same year) were not considered since, as occurs in other population (Negro et al. 1991), all wintering birds identified by us were adults which bred the previous year in the same study area (Authors, unpub. data).

Habitat availability

We used 1:50,000 maps of cultivation and landscape management edited by the Spanish Ministry of Agriculture to determine the surface occupied by mediterranean scrubland, halophytic vegetation, salt lakes, field margins, and crops. To measure the surface occupied by field margins, we used 0.95 m wide for margins separating fields and 3.4 m for margins separating fields from roads ($n = 104$ random measurements). The proportion of surface occupied by each kind of crop (growing barley and wheat, hereafter ‘cereals’, stubble fields, ploughed fields, abandoned fields, and irrigated crops) was obtained by linearly measuring both sides of the sand road using the kilometer gauge in the car (Parr et al. 1997), with a precision of $\pm$ 50 m. We measured it twice (13 January and 20 February 1998) to take into account the small changes related to the progressive ploughing of stubble; the average was used for the analyses as the best estimate.

Habitat selection

For habitat selection analyses, we considered only those birds observed during roadside censuses while actively hunting (hovering or hunting from perches); we excluded birds resting in the colonies or making directional flights. Each bird observed foraging was attributed only once to the habitat where it was first sighted. If a bird changed its habitat during the few seconds needed for recording the observation, we did not include the new habitat in our calculations to avoid pseudoreplication. The selection of foraging habitats by lesser kestrels was analyzed by means of the Savage selectivity index $w_i = U_i / p_i$, where U_i is the proportion of observations recorded in any one habitat and p_i is the proportion of that habitat in the total. This index varies from 0 (maximum negative selection) to infinity (maximum positive selection), 1 indicating no selection (Manly et al. 1993). The statistical significance of the results is obtained by comparing the statistic $(w_i - 1)^2/\text{s.e.}(w_i)^2$ with the corresponding critical value of a χ^2 distribution with one degree of freedom. The null hypothesis is that birds are using foraging habitat in proportion to availability. The standard error of the index [s.e. (w_i)] was calculated by $\sqrt{(1 - p_i)/(u_+ \times p_i)}$, where u_+ is the total number of foraging records sampled (Manly et al. 1993). Statistical significance was obtained after applying the Bonferroni correction for the number of statistical tests.

A common problem in studies on habitat selection based on unidentified individuals (e.g. Blanco et al. 1998; Bakaloudis et al. 1998), is that the results could be influenced by pseudoreplication because some birds could have been sampled on different days. We are confident our results are not biased by this possibility because: (a) in a detailed radio-tracking study conducted on the same population, all birds $(n = 23)$ showed the same patterns of habitat selection and none showed particular foraging behaviors (Tella et al. 1998), and (b) the time interval between recordings of wintering lesser kestrels (two months) is large enough to assume that the habitat points used are independent events (Manly et al. 1993, pp. 30–31). As in previous studies on habitat requirements of lesser kestrels (Parr et al. 1995, 1997; Tella et al. 1998), the present one was conducted only over one season. However, our results should be realistic because habitat availability in the studied fallow system was basically constant over at least five years (Tella et al. 1996, 1998; Blanco et al. 1998; this study).

Results

Wintering population size

By relating the relative abundance of adult lesser kestrels in summer 1998 (mean ± s.e.: 1.857 ± 0.345 birds/km; 95% CI: 1.639–2.075) with their actual number at that time (488 birds), and with the relative abundance in winter 1997–1998 (0.213 ± 0.140 birds/km; 0.128–0.297), we inferred that the wintering population consisted of 56 adult birds (95% CI: 38–70 birds). Since we censused 383 adult birds in summer 1997 in the same study area, 14.6% of them remained to overwinter in the area (95% CI: 10.2–18.3%).

Habitat availability

At present, the study area is still mainly devoted to cereals under fallow systems. Cereals, stubble, ploughed fields, and temporarily abandoned crops occupy 82.3% of the surface (Figure 1). However, a considerable proportion of land has been transformed into irrigated crops, which were not present four years ago (Tella et al. 1998). These crops include maize (50.36% of the irrigated land), ploughed maize (16.9%), alfalfa (15.1%), barley (11.87%), maize stubbles (5.4%), and horticultural crops (0.36%). We pooled these new crops for habitat selection analyses, since agriculture intensification, irrigation and the technology installed for irrigation (see Herrero and Snyder 1997) greatly transformed the landscape. The remnant natural vegetation (Mediterranean scrub and halophytic vegetation) and field margins have become scarce (3.55, 0.97, and 0.8% of the whole surface respectively).

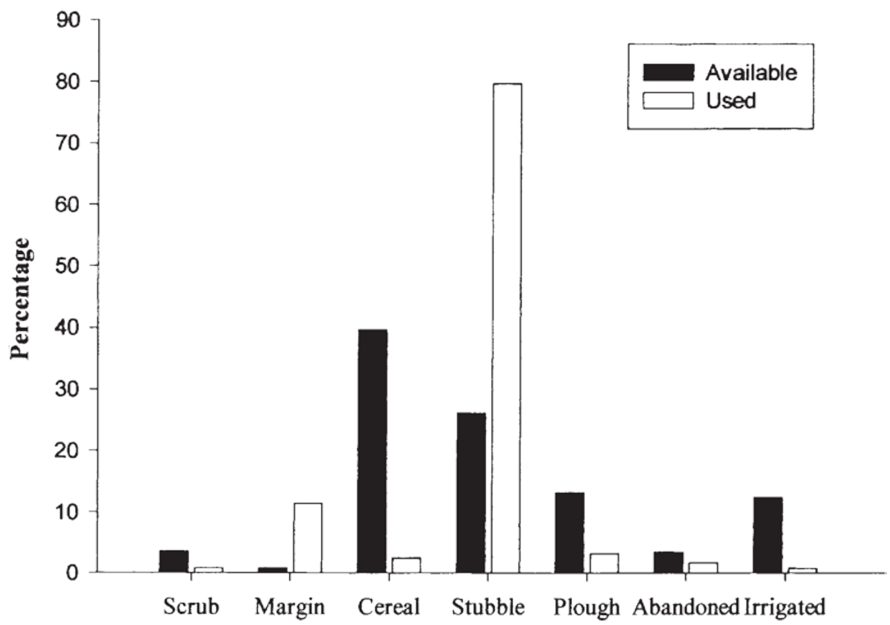

Figure 1. Proportions of habitat available and used by wintering lesser kestrels in Los Monegros, NE Spain.

Table 1. Values of the Savage selectivity index *(w_i)* for each habitat used by wintering lesser kestrels, standard error of the index (s.e.), and statistical significance *(P)*. Significance is reached at $P < 0.007$, after applying the Bonferroni correction for the number of statistical tests.

Habitat	w_i	s.e.	P
Scrubland	0.23	0.076	<0.0001
Field margins	14.22	0.045	<0.0001
Cereals	0.06	0.089	<0.0001
Stubbles	3.05	0.088	<0.0001
Ploughs	0.25	0.086	<0.0001
Abandoned fields	0.46	0.003	<0.0001
Irrigated cultives	0.06	0.086	<0.0001

Habitat selection

From 177 sightings of wintering lesser kestrels, 123 were observed while foraging and considered for analysis. No habitat was used in proportion to its availability (Figure 1); lesser kestrels strongly selected field margins and stubble, while significantly avoiding cereals, ploughed fields, abandoned fields, scrubs, and irrigated crops (Table 1). No observations of foraging lesser kestrels were made on halophytic vegetation. According to the obtained values of the Savage selectivity index *(w_i)* for each habitat (Table 1), wintering lesser kestrels showed the following rank of preferences (sign of the selection in parenthesis): field margins (+) > stubbles (+) > abandoned fields *(−)* > ploughs *(−)* > scrubs *(−)* > cereals *(−)* > irrigated crops *(−)*.

Discussion

The percentage of birds staying to overwinter in 1997 (ca. 15%) is relatively low. However, lesser kestrels were not observed during winter surveys conducted in 1991–1993 in the same study area (Tella et al. 1996; Blanco et al. 1998). This change from migratory to sedentary behavior in lesser kestrels is becoming common across wide areas and, as has been noted for other species (Sutherland 1998b; Marchamalo et al. 1997), an increase in size of wintering populations is expected with time. Although juvenile lesser kestrels invariably migrate, adults which become sedentary tend to do it for their lifetime (F. Hiraldo et al., unpub. data). Thus, significant alterations to their foraging habitats during winter could negatively affect their post-breeding survival and thus the population dynamics of this species, since demographic models are mainly sensitive to adult survival (Hiraldo et al. 1996).

Two important conclusions of relevance for conservation strategies are derived from this study. First, the frequently neglected need to incorporate the habitat requirements of threatened species over their complete annual cycles into conservation plans (Blanco et al. 1998) is newly emphasized. During the breeding season, lesser kestrels select field margins and cereals (at that time full-grown and recently harvested cereals), whereas other habitats such as the fallow (at that time ploughed) are non-preferred or strongly avoided (Tella et al. 1998). However, the present study shows that the same lesser kestrels in winter strongly depend on the fallow fields (at that time present as stubble until ploughing time) as the major foraging habitat source. Therefore, the elimination of fallow systems through agriculture intensification using unirrigated cereals could be not a major threat for breeding lesser kestrels, but could largely affect the increasing wintering populations. In addition, the agricultural calendar is also important because cultivation of earlier growing cereal varieties would lead to the earlier ploughing of stubbles, eliminating the main foraging habitat for wintering lesser kestrels.

The second conclusion deals with the potential effects of irrigation on foraging habitat availability for lesser kestrels, which we were not able to assess in 1994 because irrigation transformations did not include the lesser kestrel distribution at that time (Tella et al. 1998). The present results show that, at least during winter, lesser kestrels strongly avoid irrigated crops. This is not surprising for several reasons. First, the tall vegetation structure of crops such as maize and sunflowers preclude the lesser kestrel foraging most of the year (Donázar et al. 1993). Some irrigated legumes, such as alfalfa, could offer better foraging profitability (Donázar et al. 1993), but at present the proportion of surface occupied is scarce, and there are no expectations of a further increase (Herrero and Snyder 1997) . On the other hand, a reduction in the arthropods preyed on by lesser kestrels is likely, because of the increase in the use of biocides and fertilizers, the change of rotational farming towards intensively cultivating all the land, potentially altering the life cycles of prey, and changing soil composition when irrigated (Donázar et al. 1993; Herrero and Snyder 1997). At present, only ca. 8.5% of the study area has been transformed by irrigation. However, 4748 km^2 of pseudosteppes are planned to be irrigated in the Ebro valley in the near future (Herrero and Snyder 1997) with the economic support of the EU, which will affect 62% of our study area and more than half of the whole distribution of lesser kestrels in the Ebro valley.

In conclusion, our study confirms previous suggestions indicating that farming management is the key for the conservation of lesser kestrel populations (see Tella et al. 1998), adding the need to maintain the fallow and the agricultural calendar to sustain the wintering populations, and showing the first negative effects of irrigate transformations. As is the case for other species in the same (Blanco et al. 1998) and different areas of the EU (Bignal and McCracken 1996; Donázar et al. 1997), the maintenance of traditional agro-grazing systems should be urgently promoted. The protection of some areas (e.g. under the Natura 2000 network, Beaufoy 1998) could help in this sense. This step, however, would be not sufficient, since it would support only a small fraction of the European populations with the risk of loosing the rest due to agricultural intensification, then promoting the fragmentation of populations and making further conservation strategies difficult, which should be based on landscape rather than on ‘island’ management (e.g. Wiens 1994). Current conservation trends (Bignal and McCracken 1996; Pain and Pienkowski 1997) highlight the importance of combining agriculture with nature conservation in wide areas as the most viable way to preserve endangered species associated with agro-systems. This objective could be afforded through the economic support of the Agri-environment Regulation (2078/92), or alternative market measures to enhance dry cereal farming through price policies on products obtained in areas of wildlife conservation importance.

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