Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

ISSN 2320-7078
JEZS 2014; 2 (5): 134-137

Received: 23-08-2014
Accepted: 06-09-2014

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Habitat use of common kestrel (Falconiformes: Falconidae) during winter season, from Eastern Romania

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Abstract
The habitat use and weather influence for Common Kestrel (*Falco tinnunculus*) wintering population of Eastern Romania was studied. During cold period common kestrel use pasture and herbaceous vegetation (w_i = 2.48) and strongly avoid closed habitats, as fruit tree plantations, vineyards and natural and artificial forests. Common kestrel tends to maintain the same hunting area for the entire cold season. They use the same place and also, their number and sex composition was relatively constant during winter months. Regarding GLM analysis, it has shown that the number of common kestrels is independent of weather-related variables, altitude and distance to the nearest settlement. This independence can be explained by their preference to the same hunting area. Common kestrels do not depend on agricultural management during cold season but, they are influenced by pasture and herbaceous association areas, as they use the same hunting sites during whole season.

Keywords: Common Kestrel, *Falco tinnunculus*, winter, habitat selectivity

1. Introduction

Common Kestrel (*Falco tinnunculus* Linnaeus 1758) (*Falconiformes: Falconida*e) is a widespread species which despite being adapted to a large panel of landscape types [13], it is mainly characteristic to farmland. However, it has been reported that the number of the common kestrels has decreased in this habitat in many European countries [6]. This decline might have been caused by the agriculture intensification [14], which has also brought about a significant decrease of the Vole (*Microtus* spp.) population, the main prey of common kestrel [8, 16].

Agriculture is the dominant land use throughout Europe[1] and the management applied to this type of habitat can influence many species which live in the fields. Common Kestrel is one of those species which highly depend on the agricultural practices. They could be with almost 50% more numerous in the fields with tree sites and hedges than in those with intensified agriculture, without natural or semi natural elements [9].

Despite being the most common falcon species in Eastern Europe, the common kestrel there are few studies about it, in this area. In this area, where the agriculture practices are more environmental friendly (being more traditional) than those from Western Europe, we do not know how the population has evolved and which the main threats are. Most of the studies in this area are focusing on breeding period and especially on food or species distribution range. Only a few studies approach the winter ecology of the species [11, 13].

The most critical period for the common kestrel, like for many bird species is wintering in the temperate climatic zones of the winter [12]. Common Kestrel is resident, dispersive, or partially migratory over most of Europe range, but wholly migratory in cooler northern and southern regions [14]. For Romania, common kestrel is a partially migratory species, but only a small percentage of the population spends the winter here. The wintering site selection of this species has not been studied in Romania, so we do not know which kind of factors can affect the population in the cold period. Our study comes to supply this lack of knowledge and to provide new data on the ecology of this species in areas where agriculture is still developing in an extensive way. Also, we are asking if, during the cold season, the land use management influences winter population of common kestrel, as in the breeding period.

2. Materials and methods
2.1. Study Site
We conducted this study in Eastern part of Romania (46°48' 0N, 26°57' 0E), in the Moldavian region, between two main rivers (Siret River and Prut River). This area is a mosaic of different habitat types where agricultural land represents the main type with 56.81%. To be more representative for common kestrel we divided the main Corine land cover (2006) habitat types in 7 categories (Table 1). In the agriculture land we integrated arable land, annual crops associated with permanent crops, complex cultivation patterns, land principally occupied by agriculture, with significant areas of natural vegetation and agro-forestry areas. The agricultural land is mainly cultivated, still in an extensive way for the most part of it, with grains, potatoes and in the last years, rape [5]. In pastures and herbaceous vegetation associations we have integrated pastures, scrub and/or herbaceous vegetation associations. Regarding the pastures, they are usually overgrazed by domestic animals. We considered vineyards and fruit tree plantations as separate habitat types because they are very different as compared to the other agricultural lands.
From a geomorphological point of view the study area consists of a large hilly plain in the north and a fragmented plateau in the center [5]. The elevation varies between 50 and 200 m with peaks over 500 m but not exceeding 700 m, for the most part of the region. The study area could be considered the coldest climatic region of Romania during the winter period, where we also have low mean temperatures, discontinuous snow cover and a relative atmospheric stability.

2.2. Collecting Data Methods
Data were collected during 2010 – 2011 winter season using a vehicle road survey, driving at slow speed, method which is common for diurnal raptors counting, especially in open habitats and in winter season [7, 20, 21, 23, 24]. In the last two weeks of each month of the cold season (October – February) we made 15 transects of 40 km each. From this 15 transects we exclude 3 where we did not observe any common kestrel during our study. On the whole, we covered 480 km/month and 2400 km for the entire season. The observations were made on secondary roads, from a car driving with 30 – 40 km/h between 1000 and 1600. For each individual we took the GPS position of the car and the perpendicular distance to be able to fix the correct position in ESRI ARC GIS software 9.3. Also we took the habitat where we saw the first time, mean elevation of the surroundings, type and height of perch and the age when it was possible. To estimate the perpendicular distance to the bird we used a laser telemetry binocular (Nikon Laser 1200S) with precision +/- 0.5 m, for a range of 10 – 1100 m. The distance of birds less than 10 m was paced or estimated visually.

2.3. Habitat Selections and Statistical Analysis
We calculated, using ESRI ARC GIS software 9.3 and Google Earth images, the percentage composition of each habitat type within a 100 and 500 m radius of initial sighting location (Table 1). For birds first observed while perching we recorded the habitat types at the location when first observed and for hovering birds we calculated the area directly below them. We chose 100 m radius as hunting area and 500 m radius as an extended hunting area.
To compare habitat selection in the different landscapes we used Manly's standardized habitat selection index for constant resources. The index is based on the selection ratio w_i. We examined levels of selection for each habitat type (i) using the selection index (wi) with: $wi = ui/ai$, where ui is the proportion of habitat i in 100 m radius and ai is the proportion of habitat i available in 500 m radius [18]. A w_i value larger than 1 indicates a positive selection for the resource and a value less than 1 indicates avoidance; a value around 1 indicates that the resource was used in proportion to its availability, implying no resource selection. To test if birds had selected studied habitats at random, the ***g***-test was applied (H_o: random selection). Calculations were made with the extension adehabitat in the statistical package R [10, 15].
Using Hawths Tools extension for ESRI ARC GIS 9.3 we generate randomly 200 locations in areas where we have not noticed any individuals of Common Kestrel during the entire winter season. This locations were compared with the observation points to check if there are any difference in habitat structure (natural vs artificial habitats and open vs close habitats) and habitat fragmentation (analyzed as length of ecotone lines = (sums of the perimeter of all habitats - perimeter of circle)/2). To compare this two set of data (observations and non-observation random points) we used T-test.
To detect any difference in number of common kestrel among months and transects we have used Friedman repeated measures analysis of variance (F_r).
A generalized linear model (*GLM*) approach was used to determine the influence of the habitat in the hunting area, low day temperature, mean daily atmospheric pressure, relative humidity [28], snow cover, snow depth, altitude and the distance to the nearest settlement. Prior to the analysis, the distribution of habitat types in the hunting area, low daily temperature, mean daily atmospheric pressure, relative humidity, snow cover, snow depth, altitude and the distance to the near locality data were examined with the Newman-Keuls post hoc test [22]. Taking into consideration that we have different proportions of habitat types within a 100 and 500 m radius of initial sighting location, we have conducted three *GLM* analyses, the third analysis is on the use of the habitat where each individual was observed. We used the best Akaike Information Criterion (AIC). Calculations were made in R studio statistical software.

3. Results and discussions
This study aims is to provide both evidence of habitat selectivity and new information about winter ecology of the common kestrel in Eastern Romania, an area where this type of monitoring was made for the first time. During the study period we counted 100 individuals (46 males, 39 females, 5 juveniles and 10 unclassified) of common kestrel. During our study we observed almost the same number of common kestrel each month (Fr = 1.804, df = 4, P = 0.772), maybe because the individuals maintain the same hunting area. This theory could be argued by the presence of birds around the same place (0 – 1 km distance) each month. We cannot say certainly that they are the same individuals but they maintain approximately the same area and also the proportion of females and males was relatively constant (Fr_{female} = 3.66, Fr_{male} = 4.9, df = 4, all P > 0.1) during the observation months. However, their distribution varied during transects (Fr = 22.276, df = 11, P = 0.022), but we think that this variation is due to different composition of the habitat types and different geomorphological structures which were crossed by our transects.
One major drawback of the protocol used (road transects) is the fact that it does not provide us with sufficient data for a species density study.

We found significant differences between habitat structure in areas where we record Common Kestrels and randomly selected areas without this species. There are more natural or seminatural habitats ($T = 5.02$, $p < 0.0001$) and also there are more open landscapes ($T = 11.47$, $p < 0.0001$) in areas where we observed individuals than in randomly selected ones, without Common Kestrels. But regarding the habitat fragmentation we did not find any differences ($T = 1.59$, $p = 0.113$). We can say that Common Kestrel select natural or seminatural open landscape areas but they are not influenced by the habitat fragmentation.

Common Kestrels are less dependent on semi-natural habitats and are able to nest in fragmented woodland[9]. But in the cold season common kestrels do not keep their breeding territory and the population which winter in the study area could be found in or near pastures and herbaceous vegetation associations for which they show selectivity ($w_i = 2.48$, Table 1). The influence of pasture and herbaceous vegetation associations on a number of common kestrel was revealed also by *GLM* analysis (t value = 3.672, $P<0.001$). During the winter, food becomes scarcer and birds of prey need to direct to those habitats where their hunting method and their adaptation are advantageous. Kestrels have higher prey capture rates and greatest number of overall captures in the cold season, when foraging over pasture [2, 3]. Pastures and herbaceous vegetation are also important for other Kestrel species during the cold season. American Kestrel (*Falco sparverius*) uses predominantly open habitats and especially pastures during winter and avoid close habitats, like forests, probably because these types of habitat are not suitable for hunting and may increase the predation risk [4]. As American Kestrel, the Common Kestrel avoids, during the cold period, fruit tree plantations or natural and artificial forests (Table 1), probably for the same reasons as the American Kestrel. Even if they predominantly use agricultural land during the breeding period, they do not show the same interest in this type of habitat in the cold season ($w_i = 0.98$). So, we can say that agriculture management has a small influence on common kestrel population during the winter period.

Table 1: Habitat types within a 100 and 500 m radius of initial sighting location used by Common Kestrel (n = 100) in winter months

Habitat type	Habitat types in the study area (%)	Habitat types in the 500 m radius (%)	Habitat types in the 100 m radius (%)	w_i
artificial surfaces	9.07	5.56	9.65	1.06
agricultural land	56.81	58.51	55.58	0.98
vineyards	3.85	1.05	1.47	0.38
fruit trees plantations	0.86	0.08	0	0
pastures and herbaceous vegetation associations	12.64	31.24	31.30	2.48
natural and artificial forests	14.18	1.24	0.14	0.01
wetlands and water bodies	2.58	2.31	1.86	0.72
***G*-test (df=6)**	44.364 (P < 0.0001)			

Regarding *GLM* analysis, the number of common kestrels has not been influenced by weather-related variables, altitude or by distance to the nearest settlement, but it has been influenced by pastures and herbaceous vegetation associations from the inside of 500 m radius (Table 2). Even if the number of common kestrel has not been influenced by altitude, most of the individuals were seen less than 150 m high (86%). We cannot say that our data have been influenced by small altitude of the landscape, because we had big parts of transects which cross high hills or plateaus. The independence between weather – related variables and altitude during the winter period could support their confidence in the same hunting area.

Table 2: General linear model (*GLM,* R studio software) for the observed number of Common Kestrel individuals

Variable	*t* value	*P*
artificial surfaces	-0.647	0.658
agricultural land	0.892	0.556
vineyards	-1.090	0.265
fruit trees plantations	-0.285	0.827
pastures and herbaceous vegetation associations	3.745	**P < 0.001**
natural and artificial forests	-1.522	0.123
wetlands and water bodies	-1.464	0.136
low daily temperature	1.232	0.265
mean daily pressure	0.270	0.744
relative humidity	-0.316	0.736
snow cover	1.762	0.096
snow depth	-1.261	0.228
altitude	-0.267	0.818
distance to nearest settlement	-0.804	0.425
AIC	100.56	

Model factors consist of gender (control variable), habitat type within a 100 m and 500 m radius of initial sighting location, weather-related variables, altitude and distance to the nearest settlement. Significant *P*-values are in bold.

In the cold season most of the individuals were seen perching (73%) on different supports, especially on trees (46.58%) and electric poles (45.21%). Sitting and looking for prey is the most common hunting method used by common kestrel during this season [17]. This hunting method had a small energy cost and it is also very common for other raptors in winter, like Common Buzzard [19, 25, 26]. They use predominantly trees and electric poles. But this selection could have also been influenced by our study method, because transects were made along roads, which has usually electric wires nearby.

In conclusion, even if the common kestrels do not depend on agricultural management during cold season, they are influenced by pasture and herbaceous association areas, as they use the same hunting sites during whole season.

4. Acknowledgements

We wish to thank to Florin Stavarache, Jeremie Tudoux, Petrişor Galan, Lucian Fasolă for their help during the monitoring program and also to Mr. Constantin Ion and Mr. Ştefan Remus Zamfirescu for his help and suggestions in data analysis. This work was supported by the strategic grant POSDRU/159/1.5/S/133391, Project―Doctoral and Postdoctoral programs of excellence for highly qualified human resources training for research in the field of Life sciences, Environment and Earth Science‖ co-financed by the European Social Fund within the Sectorial Operational Program Human Resources Development 2007 – 2013. The study complied with the Romanian laws.

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