Ornis Fennica 91:256–260. 2014

Brief report

First evidence of widespread nocturnal activity of Lesser Kestrel (*Falco naumanni*) in Southern Italy

Marco Gustin*, Alessandro Ferrarini, Giuseppe Giglio, Stefania Caterina Pellegrino & Annagrazia Frassanito

*M. Gustin, G. Giglio, S. C. Pellegrino, LIPU – BirdLife (Lega Italiana Protezione Uccelli), Conservation Department, Via Udine 3, I-43100 Parma, Italy. * Corresponding author's e-mail: marco.gustin@lipu.it*
A. Ferrarini, Via Giuseppe Saragat 4, I-43100 Parma, Italy
A. Frassanito, Alta Murgia National Park, via Firenze 10, 70024, Gravina in Puglia, Bari, Italy

Received 2 August 2013, accepted 29 April 2014

We report here the first description of recorded nocturnal activity of the Lesser Kestrel in Italy. Using accurate GPS data-loggers on nine birds, we registered widespread nocturnal flights with distances from nests up to 19 km. At night, Lesser Kestrels were active even in areas with no artificial illumination. When comparing night-time and daytime periods, we found significant differences for 5-minute flight length and instantaneous flight speed, whereas distance from nest did not significantly differ. We conclude that the need for food during the reproductive period imposes also nocturnal activities to this typically diurnal species. Our study suggests that the Lesser Kestrel might not be a strictly diurnal species. Our findings are now considered by the Alta Murgia National Park and local municipalities in order to refine their conservation strategies by assigning higher conservation priority to areas used by Lesser Kestrels during both daytime and night-time.

1. Introduction

The Lesser Kestrel (*Falco naumanni*) is a migratory, colonial, small falcon breeding mainly in holes and crevices in large historic buildings within towns and villages, or often in abandoned farm houses scattered across the countryside. In Western Europe it is mainly a summer visitor, migrating to Africa in winter (Cramp & Simmons 1980). The species has declined markedly in the last decades, mainly due to agricultural intensification and pesticide use, which affect its foraging habitats and food availability (BirdLife International 2004). Today the Lesser Kestrel is considered a species of "least concern" (BirdLife International 2014). In Italy, the largest colonies are located in the cities of Gravina in Puglia and Altamura (Apulia, Southern Italy), close to the Alta Murgia National Park (Bux *et al*. 2008).

There are many references to roosting behaviour of the Lesser Kestrel in different parts of the world (Rodríguez *et al.* 2009; Limiñana *et al.* 2012), indicating that individuals typically roost all night long. In the wintering grounds in Africa,

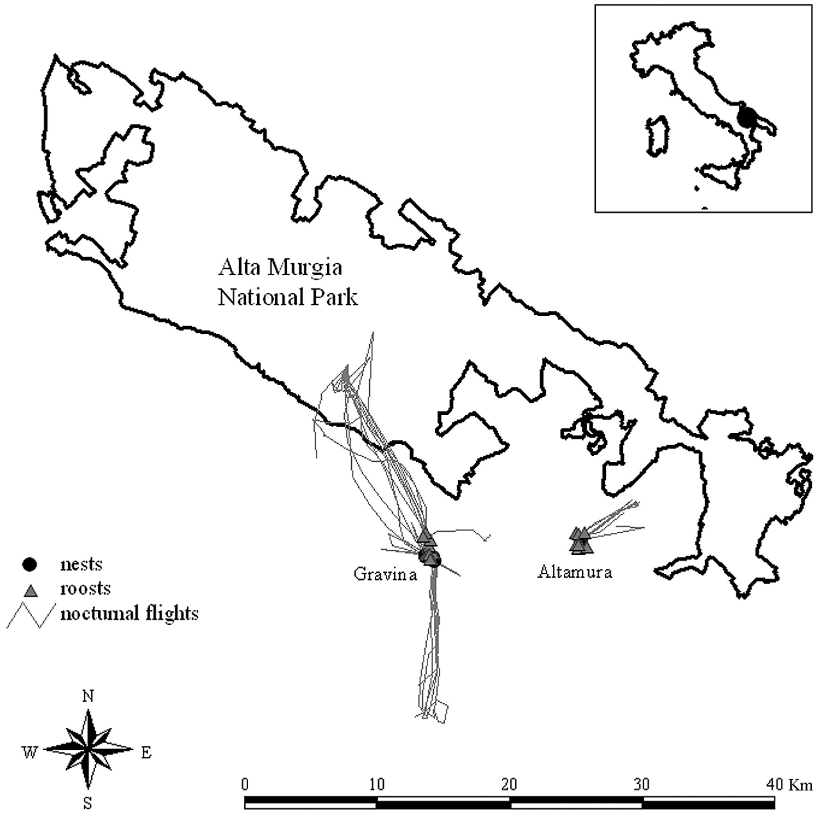

Fig. 1. Study area (Gravina in Puglia, Altamura and Alta Murgia National Park; Apulia, Italy) and nocturnal trajectories followed by four Lesser Kestrels surveyed in the period from June 20th to July 9th 2012. The monitoring effort of nocturnal activities amounted to about 56 hours (670 GPS points) during which the 4 observed individuals totalled 414.1 km of flight.

Lesser Kestrels gather in large traditional roost sites, sometimes numbering thousands of individuals. They arrive in those places at sunset and depart around sunrise. In the breeding grounds in Europe, it has been reported repeatedly that individuals either roost at the nest site (often the two members of the couple together) or at roost sites near the colony (Negro 1997).

Hence, the Lesser Kestrel being considered a typically diurnal species (Cramp & Simmons 1977), little is known about its nocturnal activities at a local scale. To our best knowledge, only two studies focussed on this topic (Andrada & Franco 1974, Negro *et al*. 2000), but they were conducted in an urban area (Seville in Southern Spain) with artificial lighting conditions, and were hence not dealing with widespread nocturnal flight activities on the countryside with no artificial illumination. Furthermore, to date in Italy no reports indicate that the species is active at night in rural or urban areas.

For these reasons, we investigated the nocturnal activity of Lesser Kestrels at a local scale in Italy. The goals of our work were to: 1) compare the night-time and day-time activities of Lesser Kestrels, 2) hypothesize the purposes of nocturnal flights, and 3) try to explain which factors may allow for it.

2. Materials and methods

The study area lies within the SPA (Special Protection Area) "Murgia Alta" IT9120007 which also covers the Alta Murgia National Park, and is included within the IBA (Important Bird Area) "Murge" (Heath & Evans 2000). Surveys were conducted using TechnoSmart GiPSy-4 data-loggers (23 × 15 × 6 mm, 1.8 g plus 3.2 g battery), that provided information about date, local time, latitude, longitude, altitude and instantaneous speed.

Nine individuals (four males and five females) were surveyed in the period from June 20th to July 9th 2012, corresponding to the complete nesting period. Sunset took place at about 21:30 local time, and sunrise at about 6:00 local time. Data ac-

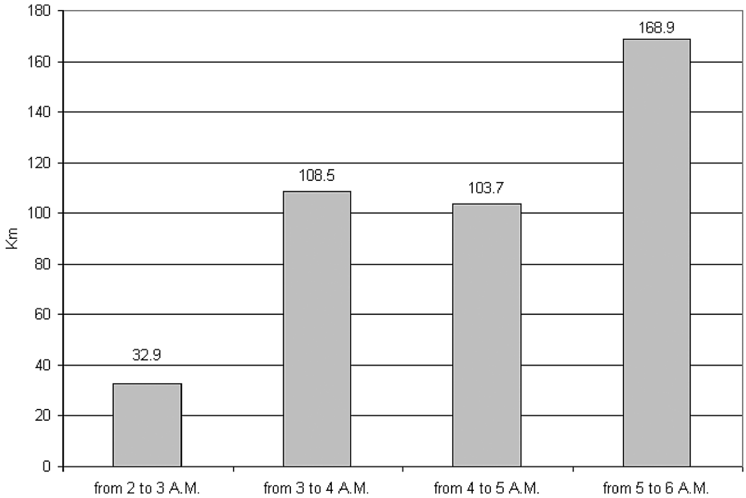

Fig. 2. The total distance travelled (in km every hour from 2:00–6:00 local time) by the four observed Lesser Kestrels during nocturnal flights.

quisition occurred every 5 minutes during two time periods: day (6:00–21:30) and night (21:30–6:00). *In situ* surveys allowed us to locate nests and roosts used by the observed individuals. Birds were captured and fitted with data loggers at their nest boxes when they were delivering food to their nestlings. To download the data from the data-loggers, birds were recaptured at their nest boxes after batteries were exhausted three days later.

GPS data were imported into the GIS GRASS (Neteler & Mitasova 2008). Layers used for the subsequent analyses were: a) boundaries of the Alta Murgia National Park, b) land cover at 1:10,000 scale, c) digital terrain model of the study area (digitized at 1:10,000 scale by the authors from the available topographic maps of Apulia Region), d) boundaries of Gravina in Puglia and Altamura, e) nest and roost locations. Flight height above ground level was calculated by subtracting terrain elevation from altitude above mean sea level provided by data-loggers. This step allowed us to detect locations of the study area where Lesser Kestrels remained motionless at the terrain level (i.e., flight height equal to 0 m), this indicating potential hunting activities. Five-minute flight length was measured as the length (in km) of flight between two successive GPS acquisitions. In addition, for each GPS point we calculated the distance in meters from the nest.

Descriptive statistics on the flight variables were extracted from the GIS data, and thereafter used as response variables in inferential tests. As the data points from the same individuals could not be treated as independent (uncorrelated) observations, we compared the averaged night and day activities for all individuals, using a study design that corresponds to a classic two sample *t*-test. For the same reason, we used GPS data about diurnal flights for those individuals showing only diurnal activity (or for whom GPS locators did not return nocturnal data), and data about only nocturnal activity for those individuals having flight activity during both diurnal and nocturnal periods. Last, we correlated nocturnal activity (i.e., average per-individual nocturnal flight length) with moon visibility in order to detect a possible relationship between nocturnal flights and natural light conditions. All the descriptive and inferential analyses were performed using R (R Development Core Team 2010). Tests were considered significant for $p < 0.05$.

3. Results

We found evidence of nocturnal flights of Lesser Kestrels in both Gravina in Puglia and Altamura colonies (Fig. 1). Four individuals (2 males and 2 females) out of nine showed nocturnal flight activities. GPS locators for some reason failed to collect data during the night for the remaining five individuals. Hence, for inferential tests we used data from four individuals for depicting nocturnal flight behaviour, and data from the remaining five individuals for diurnal flight behaviour.

The nocturnal monitoring effort was almost 56 hours (N_1 = 670 GPS points) during which the four observed individuals totalled 414.1 km of flight, unevenly distributed during the 4 hours of nocturnal monitoring (χ^2 = 89.703, df = 3, $p < 0.001$; Fig. 2). The diurnal monitoring effort for the remaining five individuals was about 148 hours (3,260.2 km; N_2 = 1,776 GPS points).

Two flight attributes (5-minute flight length and instantaneous speed) out of three were significantly higher ($p < 0.05$; online Supplement A) for the diurnal period than for the nocturnal one. Instead, the distance from nest did not differ significantly ($p > 0.05$; online Supplement A). The correlation between moon visibility and the average (per-individual) nocturnal flight length (online Supplement B) was significantly negative (Pearson's correlation coefficient = –0.959, $p < 0.001$).

4. Discussion

Our work provides the first description of recorded nocturnal activity of Lesser Kestrels in Italy.

We registered widespread flights with distances from nest sites up to almost 19 km. At night, Lesser Kestrels were active even in areas with no artificial illumination. In fact, at night the study area is almost completely unilluminated, with the exception of Gravina in Puglia, Altamura and few farmhouses present in the countryside and within the national park. In Italy, harvesting activities during the night can sometimes occur using artificial illumination, but this was not our case as we verified *in situ*. We observed an unevenly distributed nocturnal flight activity during the four hours of monitoring effort. Although higher activity levels happened close to sunrise, Lesser Kestrels showed substantial flight activity in conditions without any visible sunlight.

We found significant differences for two out of three flight attributes when comparing night-time and daytime periods. Scarce or no illumination might force Lesser Kestrels to be more restrictive in their nocturnal behaviour. However, distance from nest to the foraging grounds was not significantly different in the two time periods. A simple reason accounts for this: during night-time, the observed Lesser Kestrels were used to forage in the same areas they utilized at daytime. We base this conclusion on several arguments. First, GPS data (and successive GIS analyses) revealed that Lesser Kestrels stayed nearly motionless on ground during night-time in the same areas they used for foraging in the daytime. Secondly, these areas do not correspond to roosts because Lesser Kestrels stayed there for a limited amount of time (< 20 minutes). Third, these areas correspond to pseudosteppes with traditional agro-pastoral systems, which are particularly suitable for their foraging activities (Tella *et al*. 1998).

During the monitoring period, moon visibility was always higher than 60%, with full moon happening on July 2nd (data from the meteorological office of Apulia Region; online Supplement B). Although we expected a positive correlation between flight efforts and moon visibility, we found a negative one. The study area is almost completely without artificial illumination, hence a source of natural illumination was needed by Lesser Kestrels for their nocturnal foraging activities.

While a minimum cut-off level of moon visibility was necessary, we hypothesize that above that threshold the average per-individual flight length was likely driven by factors other than natural lighting conditions, such as foraging success/failure during the daytime. Negro *et al.* (2000) observed that, compared to the daytime, nest provisioning for Lesser Kestrels is minor at night, and therefore the main purpose of the adult birds' flights at night is probably to feed themselves. This is very important because birds in better condition typically breed early and produce larger clutches and more offspring (Catry *et al*. 2012). Hence, despite the decreasing natural illumination, it is plausible that surveyed Lesser Kestrels were forced to more frequent nocturnal activities in order to feed themselves, determining the observed negative correlation.

Our study suggests that Lesser Kestrel is not a strictly diurnal species. At night, the birds exhibited widespread foraging activity even in rural areas with no artificial illumination. We hypothesize two possible reasons for this behaviour. Firstly, the average difference in temperature between day and night was elevated in the study area during the monitoring period (about 20°C; data from the meteorological office of Apulia Region), and hence it could be energetically more profitable for Lesser Kestrels to hunt during the night. Secondly, the behaviour and availability of potential prey animals might be very different between day and night. Instead, on the basis of our *in situ* knowledge of the study area, we can exclude an outbreak of some mostly nocturnal prey during the monitoring period.

Since we might have uncovered some unusual nocturnal behaviour by an otherwise diurnal raptor species, we are now planning to extend our monitoring to a larger number of individuals and colonies. In addition, in order to detect if nocturnal activities of Lesser Kestrels are a prerogative of the reproductive period, we are also planning to extend our surveys to the pre-reproductive period (from May to June). Further investigation is also necessary to support the hypothesis that a minimum threshold of natural illumination is needed for nocturnal flights, by extending GPS monitoring to periods of time with low levels of moon visibility. Our findings are now considered by the Alta Murgia National Park and local municipalities (Gravina in Puglia and Altamura) in order to refine their conservation strategies by assigning higher conservation priority to areas used by Lesser Kestrels during both daytime and night-time.

Acknowledgements. We are grateful to the Alta Murgia National Park that funded this study. We thank Dr. Ugo Mellone (University of Alicante) for his useful suggestions. We are also grateful for comments from referees and editors that improved the manuscript.

Evidens för utbredd nattlig aktivitet hos rödfalkar i södra Italien

I denna artikel redovisar vi för tidigare odokumenterad nattlig aktivitet hos rödfalkar (*Falco naumanni*) i södra Italien. Vi monterade exakta GPS dataloggrar på nio rödfalkar och m.h.a. dessa registrerade vi utbredda flygturer, som utsträckte sig upp till 19 km från boplatsen. På natten var rödfalkarna aktiva även i områden utan artificiell belysning. Vid jämförelse av dagtida- och nattlig flygaktivitet fann vi signifikanta skillnader i både flyktsträcka och momentan flykthastighet, men inte beträffande falkarnas avstånd från boplatsen.

Vi drar slutsatsen att ett ökat behov av föda under häckningsperioden får denna vanligtvis dagaktiva rovfågel att uppvisa regelbunden aktivitet även på natten. Således visar vi att rödfalken inte är en strikt dagaktiv art. Våra resultat beaktas nu av Alta Murgia nationalpark och vid kommunal planering, så att områden som används av rödfalkar under både dag- och nattetid prioriteras vid åtgärder med naturskyddssyfte.

References

Andrada, J. & Franco, A. 1974: Actividad nocturna en *Falco naumanni*. — Ardeola 19: 471.

BirdLife International 2004: Birds in Europe: Population Estimates, Trends and Conservation Status. — BirdLife International, Cambridge.

BirdLife International 2014: Species factsheet: *Falco naumanni*. Downloaded from http://www.birdlife.org.

Bux, M., Giglio, G. & Gustin, M. 2008: Nest box provision for lesser kestrel *Falco naumanni* populations in the Apulia region of southern Italy. — Conservation Evidence 5: 58–61.

Catry, I., Franco, A.M.A. & Sutherland, W.J. 2012: Landscape and weather determinants of prey availability: implications for the Lesser Kestrel *Falco naumanni*. — Ibis 154: 111–123.

Cramp, S. & Simmons, K.E.L. (eds.) 1980: The birds of the western Palearctic, Volume 2 (Hawks to Bustards). — Oxford University Press, Oxford.

Heath, M.F. & Evans, M.I. 2000: Important bird areas in Europe: priority sites for conservation. —BirdLife International, Cambridge.

Limiñana, R., Romero, M., Mellone, U. & Urios, V. 2012: Mapping the migratory routes and wintering areas of Lesser Kestrels *Falco naumanni*: new insights from satellite telemetry. — Ibis 154: 389–399.

Negro, J.J. 1997: The Lesser Kestrel. — Birds of Western Palearctic Update 1: 49–56.

Negro, J.J., Bustamante, J., Melguizo, C., Ruiz, J.L. & Grande, J.M. 2000: Nocturnal activity of Lesser Kestrels under artificial lighting conditions in Seville, Spain. — Journal of Raptor Research 34:327–329.

Neteler, M., Mitasova, H. 2008: Open Source GIS:A GRASS GIS Approach. — Springer, New York.

R Development Core Team 2010: R: a language and environment for statistical computing. — R Foundation for Statistical Computing, Vienna, Austria.

Rodríguez, A., Negro, J.J., Bustamante, J., Fox, J.W. & Afanasyev, V. 2009: Geolocators map the wintering grounds of threatened Lesser Kestrels in Africa. — Diversity and Distribution 15: 1010–1016.

Tella, J.L., Forero, M.G., Hiraldo, F. & Donázar, J.A. 1998: Conflicts between Lesser Kestrel conservation and European agricultural policies as identified by habitat use analyses. — Conservation Biology 12: 593–604.