

Insight in a behaviour of Central European Red Kites wintering in Italy

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Abstract - Migration and over-wintering strategy of raptors can be influenced by many factors such as sex, age and experience of birds, habitat variability and food availability. Based on the telemetry data of nine Red Kites (*Milvus milvus*), we observed *in situ* their wintering grounds in southern Italy during winter 2019/2020. Red Kites originated from Austria and the Czech Republic arrived to their wintering grounds from 10th September to 5th December 2019 and departed between 9th February and 7th May 2020. Tagged Kites stayed in their wintering grounds from 73 to 207 days (mean 135±46 SD). These birds occupied home range and the core area from 39 to 9,351 km² (KDE 95%; mean 3,591±3,460 SD) and 6 to 1,998 km² (KDE 50%; mean 566±483 SD), respectively. We observed a total of 242 Red Kites at nine communal roost sites (min. = 14, max. = 45 individuals) used by tagged Red Kites. Roosts were situated at an average altitude of 630 m above sea level. Agricultural countryside with small or large fields, small or large forest patches, meadows, pastures, sheep or cattle farms surrounded areas around communal roosts of Red Kites.

Key words: Austria, behaviour, Czech Republic, *Milvus milvus*, raptors, telemetry.

Riassunto - Approfondimenti sul comportamento dei nibbi reali dell'Europa centrale svernanti in Italia.

Le strategie di migrazione e svernamento dei rapaci possono essere influenzate da molteplici fattori come il sesso, l'età e l'esperienza degli uccelli, la variabilità dell'habitat e la disponibilità di cibo. Sulla base dei dati telemetrici relativi a nove nibbi reali (*Milvus milvus*), sono state monitorate le loro aree di svernamento nell'Italia meridionale

durante l'inverno 2019/2020. I nibbi reali provenienti dall'Austria e dalla Repubblica Ceca sono giunti nelle aree di svernamento dal 10 settembre al 5 dicembre 2019 e sono ripartiti tra il 9 febbraio e il 7 maggio 2020. I nibbi muniti di GPS hanno utilizzato le aree di svernamento da 73 a 207 giorni (media 135±46 SD). Questi uccelli hanno occupato home range e core area, rispettivamente, da 39 a 9.351 km² (KDE 95%; media 3.591±3.460 SD) e da 6 a 1.998 km² (KDE 50%; media 566±483 SD). Abbiamo osservato un totale di 242 nibbi reali in nove roost (min. = 14, max. = 45 individui) utilizzati anche dagli esemplari marcati. I roost erano localizzati ad un'altitudine media di 630 m sul livello del mare.

Le aree circostanti i roost dei nibbi reali sono caratterizzate da coltivazioni, prevalentemente erbacee con appezzamenti di diverse dimensioni inframmezzati da aree forestali di dimensioni piccole o grandi, prati, pascoli e allevamenti di ovini o bovini.

Parole chiave: Austria, comportamento, *Milvus milvus*, rapaci, Repubblica Ceca, telemetria.

INTRODUCTION

Red Kite *Milvus milvus* is a medium-sized raptor native to the European continent. Outside of Europe, they have scattered distribution in North Africa and The Middle East. Recent estimates indicate a global population of between 60,000 and 70,000 mature individuals and approximately 35,000 breeding pairs, with a stronghold in Germany, Switzerland, France, and Spain (Génsbøl, 2008; Kirwan *et al.*, 2008; BirdLife International, 2020). In Central European countries including Austria and the Czech Republic, the density of the Red Kite population is much lower, with around 165-185 pairs in the Czech Republic (2016) and 90-130 pairs in Austria (2019) (BirdLife International, 2015; Aebischer, 2019). Red Kites from these areas disperse to winter in Southern Europe in a broad belt from Iberian and Italian peninsulas to the Balkans, but a part of the population stay to winter in their natal area (Škrábal *et al.*, 2021; Literák *et al.*, 2022).

Until the end of 20th century, Red Kite was once a common species widespread from north-western Italy, down the Tyrrhenian side of the peninsula, to southern Italy, Sicily and Sardinia (Iapichino & Massa, 1989; Brichetti & Fracasso, 2003). At present, the Italian distribution of Red Kites is highly fragmented, with a total of estimated 426-519 breeding pairs, essentially concentrated in central and southern Italy (Cillo & Laterza, 2014). The causes of population decline could be habitat degradation and illegal killing through persecution and poisoning (Carter, 2001;

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Wotton *et al.*, 2002). Successful reintroductions in northern Italy have increased populations in Tuscany and Marche (Ferlini, 2019). Beside breeding population, Italy offers wintering grounds for Red Kite from Central Europe during the winter (Raab *et al.*, 2017; Literák *et al.*, 2022). The number of Red Kites varied between 1484 and 1721 with approximately 65% of individuals concentrated in Basilicata throughout winters 2011-2016 in the Italian peninsula (Fulco *et al.*, 2017). The wintering population of Red Kites increased slightly in January 2021, when more than 1800 individuals were counted (Aebischer & Scherler, 2021).

Although, there is a recent work regarding to wintering of Red Kites from Central Europe in Western and South-Western Europe, including Italy (Panter *et al.*, 2022), the behaviour of Red Kites at communal roosts during winter period in Italy remained unsolved. Here in this paper, we aimed to a strategy of Red Kites from Central Europe wintering in Italy by using data from Kites originating from Austria and the Czech Republic tagged with GPS/GSM transmitters supplemented with observations *in situ*.

METHODS

We equipped nine Red Kites originated from the border area of Austria and the Czech Republic with GPS/GSM (Global Position System/Global System for Mobile Communication) telemetry devices (20g; Ecotone, Poland, and Ornitela, Lithuania; www.ecotone.pl, www.ornitela.com, respectively) as described previously (Literák *et al.*, 2022). The coordinates of bird positions at their winter grounds were analysed using a geographic information system (GIS) and the software ArcGIS 10.1 with Spatial Analyst and Home Range Tools extensions (Esri, Redlands, USA). We performed Spearman correlation test for non-parametric data using software Unistat (Unistat Ltd., Microsoft Corporation, USA) to assess the relation between age and home range size.

Spatiotemporal activities of these nine tagged Kites were monitored in details throughout the winter period of 2019/2020. Based on the telemetry data, we conducted the field observations from 3rd February to 11th February 2020 at nine communal night roosts of Red Kites in the central and southern part of Italy (Fig. 1, Tab. 1). We counted arriving Kites from late afternoon to the sunset at each roost and described habitats in surrounding areas. To assess the mean elevation of winter home range, we obtained the elevation data from the COPERNICUS Land Monitoring Service's 'EU-DEM v1.1' (<https://land.copernicus.eu/imagery-in-situ/eu-dem/eu-dem-v1.1>) database as a digital elevation model (DEM) at 25 m resolution.

During winter, birds tend to prefer certain areas that they used most of the time during winter, termed a temporary settlement area (TSA). We defined TSA as a place where a bird stayed for > 10 nights within 80 km². This template size was based on roost locations distributed within a 10 km diameter over ten days, thus falling within 80 km² (Ovčiariková *et al.*, 2020). In this study we employed Kernel Density Estimate (KDE) 95 % and 50 % to determine the size of the home range and the core area of wintering Red Kites, respectively.

RESULTS

Nine Red Kites originated from Austria and the Czech Republic arrived to their wintering grounds from 10th September to 5th December 2019 and departed between 9th February and 7th May 2020 (Tab. 2). Birds winter on average for 135 ± 46 days. The number of TSAs used by one Red Kite during the winter varied from 1-3. The size of the home range was ranging from 39 to 9,351 km² ($\bar{x} = 3,591 \pm 3,460$ km²) estimated as KDE 95 %. Core area was ranging from 6 to 1,998 km² ($\bar{x} = 566 \pm 483$ km²) estimated as KDE 50 %. Older birds tagged in 2015, 2016 and 2017 showed tendency to use noticeably smaller areas ($1,388 \pm 928$ km² as KDE 95%) for wintering than younger birds tagged in 2018 and 2019 ($5,027 \pm 3,050$ km² as KDE 95%). Furthermore, we found a negative correlation between age and home range size ($r = -0.8$, $p < 0.05$). Wintering birds occupied winter grounds in average elevation of 661 m above sea level (asl) (Tab. 2).

We counted total of 242 Red Kites at all communal night roosts (min. 14, max. 45 individuals) which were situated at an average altitude of 630 m asl (min. 390 m, max. 940 m). An agricultural countryside with small or large fields and farms was typical for all study areas. In the area of Campomaggiore, Maschito and Masseria Manta, Red Kites used the edge of a large forest as a roosting site. However, small forest patches were used as roosting sites close to Balvano, Barisci, Buccino, Colletorto, Imef-Pantano and Salcito (Tab. 1). A number of Common Ravens (*Corvus corax*) and Hooded Crows (*Corvus cornix*) were roosting jointly with Red Kites at roosts in Maschito and Barisci, respectively (Tab. 1).

DISCUSSION

Based on the telemetry data, we suggest that Central European Red Kites arrived to their winter grounds in Italy mostly during October. Moreover, major part of elderly Kites arrived later and departed earlier, probably due to their previous and upcoming breeding season, respectively. Also, birds of the first calendar year age stayed at their wintering grounds more days than adults. These findings fit well in characteristics of migration and over-wintering strategy of Red Kites from Central Europe at their wintering grounds in the Iberian Peninsula, France, Italy and South-eastern Europe (Literák *et al.*, 2019; García-Macia *et al.*, 2022b; Literák *et al.*, 2022). Fulco *et al.* (2017) described that over 60% of Red Kites were concentrated at the wintering grounds in Basilicata region (Italy), where most of our tagged individuals stayed during the study period as well.

Our results show that in migrating Red Kites, juveniles used larger area than adults at their wintering grounds. The same was reported recently in similar studies (García-Macia *et al.*, 2022a; Panter *et al.*, 2022). Moreover, resident Red Kites which over-wintering in their natal area had also this behaviour pattern (Škrábal *et al.*, 2021). The age-related experiences in foraging efficiency might be the reason for decreased spatial use, as age was found to affect by the same way the home range sizes of raptors and other birds' species (Rolando & Carisio, 1999; Rolando, 2002; Nyhus *et al.*, 2018). Home ranges of individual

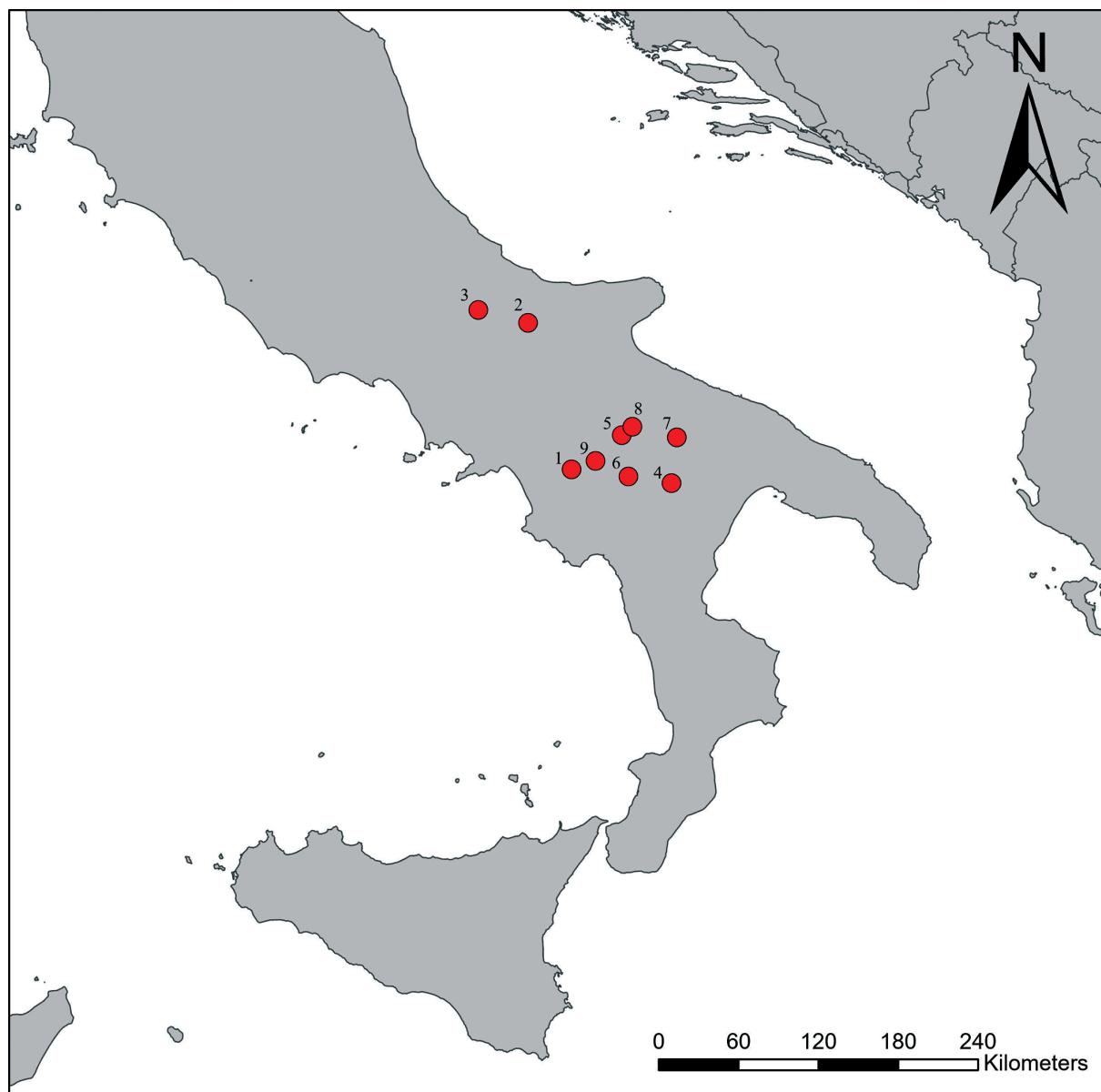


Fig. 1 - Locations of communal night roosts (red points) of Red Kites which were surveyed during the field research in Italy. Red points' numbering represents location of each communal roost as follows: 1) Buccino, 2) Colletorto, 3) Salcito, 4) Campomaggiore, 5) Maschito, 6) Masseria Manta, 7) Barisci, 8) Imef-Pantano, 9) Balvano. For photographs of habitats in areas of these roosts see Supporting information. / Localizzazione dei roost (punti rossi) di nibbio reale rilevati durante la ricerca sul campo in Italia. La numerazione dei punti rossi rappresenta la posizione di ciascun roost come segue: 1) Buccino, 2) Colletorto, 3) Salcito, 4) Campomaggiore, 5) Maschito, 6) Masseria Manta, 7) Barisci, 8) Imef-Pantano, 9) Balvano. Per le fotografie degli habitat presenti nelle aree dei roost si vedano le Informazioni supplementari.

Red Kites wintering in southern Italy varied substantially similarly like home ranges of Red Kites wintering in other parts of Europe (Heredia *et al.*, 1991; Literák *et al.*, 2019; Škrábal *et al.*, 2021; García-Macia *et al.*, 2022a). This variability could be influenced by many factors such as habitat variability, food availability, interspecific and intraspecific competition, birds' age and/or experience, number of occupied TSAs, and methods used to estimate the home range size (Tellería *et al.*, 2013; Škrábal *et al.*, 2021; Panter *et al.*, 2022).

Previously, communal roosts of Red Kites were described in lowlands in South-eastern and Central Europe with the altitude from 4 to 150 m asl and from 150 to

350 m asl, respectively (Literák *et al.* 2019; Škrábal *et al.*, 2021), although Red Kites are usually associated with medium-low elevations being most common between 400 and 600 m asl (Seoane *et al.*, 2003; Sergio *et al.*, 2005; Sergio *et al.*, 2019), birds in this study used communal roost sites at an average altitude of 630 m asl which corresponded with an inhabited areas of over-wintering grounds with an average altitude of 661 m asl. The altitude of communal roosts in Switzerland were situated over 1000 m asl (Aebischer & Scherler, 2021). This condition could be a key factor which influences the space use of Red Kites in southern Italy and point to the high environmental plasticity of Red Kites (see also Panter *et al.*, 2022).

Tab. 1 - Detail information of Red Kites' communal roosts and the surrounding area in southern Italy. Names of locations were depicted by the nearest municipality. For photographs of habitats in areas of these roosts see Supporting information. / Informazioni dettagliate sui posatoi comuni del nibbio reale e sull'area circostante nell'Italia meridionale. I nomi delle località sono stati indicati con il comune più vicino. Per le fotografie degli habitat nelle aree di questi roost si vedano la Informazioni supplementari.

Location	Date of the observation	Tagged Red Kite ID	No. of Red Kites observed	Altitude (m asl)	Habitat characteristics
Buccino	5. 2. 2020	RK1	45	447	Near a small town, gardens, small fields, vineyards, small farms around
Colletorto	4. 2. 2020	RK2	18	660	Agricultural countryside, forest on a slope near a small town, small farms, cultivated fields and abandoned uncultivated fields
Salcito	3. 2. 2020	RK3	29	710	Agricultural countryside, small fields, forest patches, small farms, small chicken farm was situated close to the roosting place
Campomaggiore	10. 2. 2020	RK4	14	630	Mountainous area with large forests, pastures, sheep and cattle farms, wind turbines
Maschito	8. 2. 2020	RK5	22	789	Edge of a large forest, pastures, cattle farms, fields, uncultivated fields, wind power turbines, 70 Common Ravens roosting together with Red Kites
Masseria Manta	6. 2. 2020	RK6	38	940	Agricultural countryside, edge of a large forest, small sheep farms, meadows, orchards
Barisci	9. 2. 2020	RK7	27	418	Flat area, large crop fields, large agricultural farm, some abandoned farm buildings in a countryside, roosting place in a small forest patch in a small valley among fields, 80 Hooded Crows roosting together with Red Kites
Imef-Pantano	11. 2. 2020	RK8	17	390	Flat area, large fields, some pastures and vineyards, sheep farm
Balvano	7. 2. 2020	RK9	32	684	Small farms, forest patches, meadows, vineyards, solitary countryside buildings

Tab. 2 - Characteristics of tagged Red Kites wintering in Italy; * date of death; A - Austria, CZ - Czech Republic, GPS (Global Positioning System), KDE (Kernel Density Estimation), asl (above sea level). / Caratteristiche dei nibbi rossi taggati che svernano in Italia; * data di morte; A - Austria, CZ - Repubblica Ceca, GPS (Global Positioning System), KDE (Kernel Density Estimation), asl (sul livello del mare).

Red Kite ID	Sex	Date of tagging/ country of origin	Ring number	Arrival date	Departure date	Duration (days)	No. GPS fixes	Home range (km ²)		Mean elevation (m asl)	No. TSA
								KDE 50%	KDE 95%		
RK1	F	31. 5. 2015/ A	JC57511	5. 12. 2019	16. 2. 2020	73	135	7	39	1097	1
RK2	F	30. 6. 2017/ CZ	CT1911	11. 11. 2019	2. 3. 2020	112	741	6	57	664	1
RK3	F	23. 7. 2016/ CZ	C144030	9. 10. 2019	9. 2. 2020	123	632	103	732	944	1
RK4	M	19. 6. 2016/ CZ	CT732	31. 10. 2019	24. 2. 2020	116	775	394	2,044	796	2
RK5	F	6. 6. 2018/ CZ	CT1933	16. 10. 2019	28. 2. 2020	135	348	229	2,700	534	1
RK6	F	25. 6. 2018/ CZ	CT1984	10. 9. 2019	18. 3. 2020	190	572	1,166	9,351	618	3
RK7	M	22. 6. 2019/ CZ	CT2028	13. 10. 2019	7. 5. 2020	207	560	321	3,076	394	2
RK8	-	8. 7. 2019/ A	G000787	13. 10. 2019	6. 1. 2020*	85	250	418	4,982	460	2
RK9	-	8. 7. 2019/ A	G000788	27. 10. 2019	16. 4. 2020	172	461	1,998	9,257	485	2
Mean				21. 10. 2019	13. 3. 2020	135	497	566	3,591	661	2
SD				24 days	30 days	46	218	483	3,460	236	1

We observed an agricultural countryside with small or large fields, small or large forest patches, meadows, pastures, sheep or cattle farms which surrounded areas close to communal roosts of Red Kites. Thus, a very similar habitat of the wintering areas which was described in Central and South-eastern Europe (Literák *et al.*, 2019; Škrábal *et al.*, 2021). Red Kites wintering in Spain occupied also extensive agricultural landscape with livestock, small fields, occasionally rubbish dumps and artificial feeding stations for raptors (Panter *et al.*, 2022).

We assume that there is a variability among spatiotemporal activities of Red Kites at their wintering grounds across the Europe. Density of Red Kite population, social interactions at communal roosts, habitat characteristics and food availability may have a key role for the wintering ground selection in Italy and elsewhere.

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Ethics statement

The telemetry study of Red Kites was undertaken under permits issued by local nature protection authorities in Austria (MIL2-J-0812/012, GFL2-J-107/014, BHBRN-2019-314986/5-PS), and the Czech Republic (S-JMK 188552/2014 OŽP/Kuč, S-JMK 32177/2015 OŽP/Kuč, S-JMK 30634/2016 OŽP/Ško, S-JMK 177265/2017 OŽP/Ško).

Disclosure statement

The authors declare no conflict of interest.

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SUPPORTING INFORMATION / INFORMAZIONI SUPPLEMENTARI

Additional supporting information may be found online for this article. / Per questo articolo sono disponibili informazioni supplementari online.

S1-S9 - Supporting photographs to “Insight in a behaviour of Central European Red Kites wintering in Italy”. / Fotografie supplementari per “Approfondimenti sul comportamento dei nibbi reali dell’Europa centrale svernanti in Italia”.