

ASPECTS OF THE ECOLOGY OF THE EURASIAN KESTREL (*FALCO TINNUNCULUS*) IN IAȘI CITY, ROMANIA

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KEYWORDS	ABSTRACT
Ecology Eurasian kestrel Population Trends Urban habitat	The Eurasian kestrel (<i>Falco tinnunculus</i>) is a diurnal raptor that has been associated with urban areas for several decades and has gotten used to living within cities all over Europe. At the same time, the population trend shows a slow decline on a continental level. In our study, we combined and compared observations introduced in the national database Ornitodata during the years 2021 and 2022 with our data from 2022 and 2023. The quantitative data shows a positive trend in the population compared to the previous year. The 52 individuals present within the city in 2022 were grouped in areas defined as favourable, and for the 11 breeding pairs observed all fledged at least one chick. We have also determined a preference for nesting on the roofs or in the attics of tall buildings, located very close to the green areas that serve as hunting grounds. During the colder months, a large part of the population migrates either to the outskirts or outside of the city. Analysing two sets of pellets from one breeding pair, we have found that the main prey items were small rodents, followed by insects and birds. We have also observed the birds' interaction with the urban habitat and present data regarding the benefits and challenges of synanthropization for this kestrel species.

INTRODUCTION

The city of Iași is located in the area between the Moldavian Plain and the Central Moldavian Plateau. Its urban area covers seven hills: Copou, Șorogari, Cetățuia, Galata, Repedea, Breazu and Bucium-Păun, with a surface of approximately 94 squares kilometres (km²). The topography forced the development of the city on seven terrace levels, with altitudes ranging from 20 – 25 m to 206 m. We mention that the highest densities of population per land area are in Alexandru cel Bun, Dacia, Tătărași-North and Tătărași-South neighbourhoods.

The Bahlui River, a tributary of the Jijia River, runs for 14 km through city territory, from northwest to southeast, flowing into the Jijia River downstream. The tributaries Nicolina, Vâmeșoia and Cîric are also part of the city's hydrographic network. The non-uniformity of annual precipitations causes a significant variation in the flow regime of the rivers, even from one season to another. To avoid flooding risks in the municipal area, reservoirs were set up on the tributaries of Bahlui River: Dorobanț, Aroneanu, Cîric I, II and III or Veneția, and Chirița.

The city's climate is temperate continental, the annual thermal average being 9.3 °C. Winters are cold, and average temperatures reach 20 °C during the summer. A characteristic of the city is the large annual thermal amplitude, as during the transitional seasons the monthly thermal differences can exceed 10 °C. Especially in winter, temperatures can vary a lot throughout the day. The multiannual precipitation average is 533.7 mm. During summer, rain is abundant and dry periods are frequent, occurring mainly in the spring and in the transition period between summer and autumn, with an average duration of 13 days.

Oriental and northern species dominate the spontaneous flora, and numerous ornamental, exotic and indigenous species and varieties have been introduced in urban green areas. The terraced landscape determines layered vegetation, respectively steppe, silvosteppe and forest. Silvosteppe dominates the landscape, and the forest settles in the south (Galata, Cetățuia, Bucium), north and northeast (Breazu forest, Cîric forest park).

We noted the absence of an inventory of the urban fauna, but we mention the existence of studies on some groups of invertebrates and vertebrates inside the city (Nicoară et al. 2007, 2008, 2009, 2010). In the city's avifauna, passerines are best represented (Croitoru, 2009). The bird fauna presents significant diversity inside the Botanical

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Garden, followed by Ciric and Galata forests. Anthropization has determined changes in the avifauna's diversity, some species remaining constant and others varying over the years, as it appears in the studies carried out in the Ciric area (Gache, 2004; Croitoru, 2009; Loghin, 2020; Nechifor et al., 2023).

The Eurasian kestrel (*Falco tinnunculus*) is a medium to small sized diurnal raptor (Porter et al., 2002), whose wide distribution range includes almost all of Europe, Asia and Africa. The European population is mostly sedentary, while the Nordic population is migratory. It is the most widespread species of falcon in Romania, where it is also partly migratory. It occupies varied habitats at different altitudes, being a versatile species that we can also meet inside the urban areas. It usually nests in solitary pairs, in nests located in crevices, hollows or old corvid nests, but does not build its own nest (SOR and Milvus Group, 2022).

The diet of this species in an urban environment is generally composed of insects, reptiles, and small mammals, predominantly rodents from the Arvicolinae subfamily and especially the field mouse, *Microtus arvalis* (Romanowski, 1996; Riegert et al., 2009; Sumasgutner et al., 2014). Inside the urban habitats, especially in the areas with intense anthropogenic activity, the species increasingly depends on small and medium sized birds as a food source, as the availability of rodents lowers (Kübler et al., 2005; Sumasgutner et al., 2014). A preference for passerines is noted, especially for the house sparrow, *Passer domesticus* (Yalden, 1980; Kübler et al., 2009), but the avian prey varies, and may include small, medium or larger birds, e.g. pigeons (Sumasgutner et al., 2014). The common kestrel is an opportunistic species, which can adjust its diet depending on the area in which it is located, being able to consume food of anthropogenic origin such as pieces of cutlet (Kübler et al., 2009).

The main threats faced by the species are of anthropogenic origin: alteration of habitats and trophic resources, pollution, and other disturbances of this nature (SOR and Milvus Group, 2022).

The Eurasian kestrel population appears in numerous studies related to diet and prey (Yalden, 1980; Romanowski, 1996; Kübler et al., 2005; Riegert et al., 2009; Sumasgutner et al., 2014; Lang, 2018), reproductive success and behaviour during nesting (Kübler et al., 2005; Sumasgutner et al., 2014; Kreiderits et al., 2016; Kopij 2018; Kettel et al., 2018; Huchler et al., 2020). With it being a synanthropic species, multiple studies also deal with the threats and challenges it faces in the urban habitat (Hager, 2009; Cianchetti-Benedetti et al., 2016; Kopij, 2018; Spotswood et al., 2021).

MATERIALS AND METHODS

We divided the Iași city's surface area into equal squares, respectively general areas to study the different aspects of the common kestrel's ecology inside the urban habitat. We visited these areas every one – two weeks, during days with suitable weather conditions, to obtain quality ornithological observations. We marked on the map the squares where the presence of at least one individual was recorded (Figure 1).

Our field trips took place in two series, corresponding to the breeding season (April – July 2022) and the wintering period (January – March 2023). The used method was that of active searching within the established general areas, recording both the location of the individuals and contextual information that could give us an overview of their ecology in this space. We used Omegon 8x21 binoculars for the bird's observation.



Figure 1. Map of Iași City and the squares in which we confirm the presence of Eurasian kestrels

We carried out the addition of data, for the relative analysis of the population dynamics on the territory of the city, with the help of the Ornitodata national platform, owned by the Romanian Ornithological Society, which we can access at <https://ornitodata2.sor.ro/ornitodata>. The submission of observations on the platform is done following registration and access granted by its administrators. We have included observations recorded in the city of Iași in 2021, respectively 2022, during the time intervals corresponding to our field trips. In the case of overlapping observations (for the breeding period of 2022), we assumed that these were the same individuals. However, the Ornitodata platform does not provide data on the age or gender of individuals.

In addition to the numerical estimation of the population during these periods, we planned to establish the criteria for nesting site and shelter selection, as well as to follow the interaction of individuals with the surrounding urban habitat. For the analysis of collected pellets, they were numbered, measured, and labelled; later, we dissolved it separately in a mixture of tap water, disinfectant and liquid soap. The pellets were numbered 1 and 2, for the month of collection (May and October respectively), followed by a second number for each pellet in the series. The contents were poured into Petri dishes and analysed. It should be mentioned that, as a result of the process, some small fragments are lost, and the small sample size constitutes a limitation. Therefore, the obtained results are general and the analysis constitutes an introduction exercise, and we assess that we need more research studies to establish the proper diet composition of the common kestrel population in this city.

We established several criteria for the analysis of the fragments. We counted only free molars, not attached to the mandibles. Limb bones, skull fragments, vertebrae and other bone fragments were grouped into "other bones"; we regarded as insect exoskeleton fragments both actual fragments and entire insect heads. We noted the presence or absence of accidentally ingested plant fragments, but did not count them.

RESULTS AND DISCUSSION

During the breeding season of 2021, there are 15 observations submitted on the Ornitodata platform (Figures 2-4), of which 13 were solitary individuals and two were pairs. The individuals seem to be concentrated in three general areas of the city, respectively: three observations correspond to the Canta area and Păcurari road, four, of which one observation of two individuals, around Union Square, and eight, of which one of two individuals, recorded near the reservoir Ciric III, also called Veneția. Due to the number of observations and the small perimeter, we assume the existence of nesting individuals in this area, during the year 2021.



Figure 2. Sightings registered on the Ornitodata platform from April to July of 2021 – Canta area and Păcurari Road



Figure 3. Sightings registered on the Ornitodata platform from April to July of 2021 – area near Lake Ciric III; green – a pair

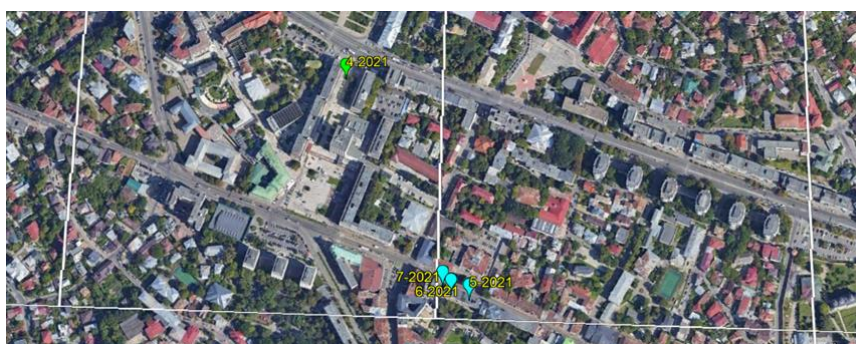


Figure 4. Sightings registered on the Ornitodata platform from April to July of 2021 – area around Union Square; green – a pair

For the same period of the year 2022, we have identified, following the field observations, and the completion and comparison of the data with those on the mentioned platform, a total number of 52 individuals observed in 22 regular locations. We also recorded the presence of individuals in seven additional areas by direct observation and call recognition without determining the shelter or nesting spot. We called these areas of interest. The areas with the highest population density are Zimbru and the area near Culture Palace.

According to the data on the Ornitodata platform (Figure 5), at least three individuals populate the Canta area. One individual was present in the Octav Băncilă Park area and another one in the park of building B of the "Alexandru Ioan Cuza" University of Iași. Three of those observations correspond to the Union Square area, and there is one sighting recorded near dam lake Venetia.

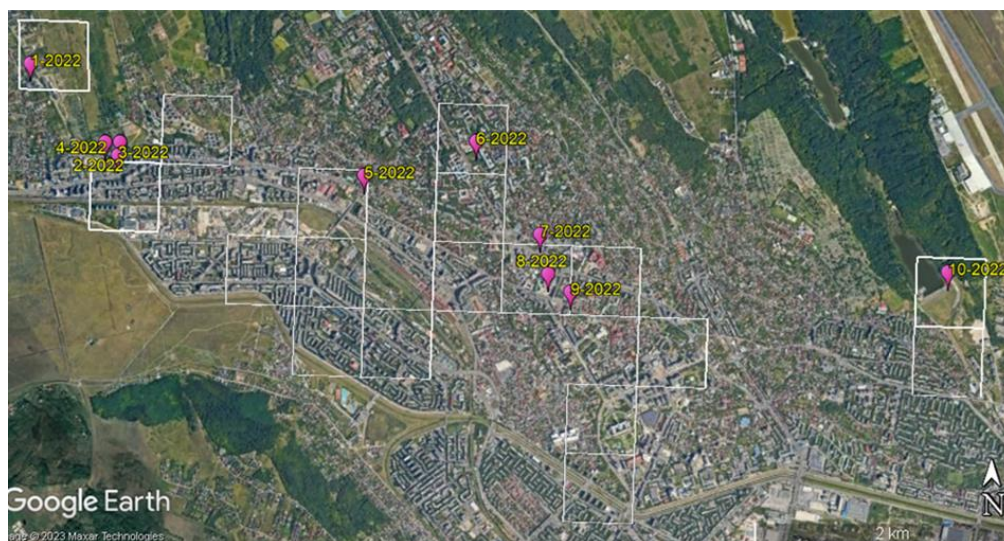


Figure 5. Sightings recorded on the Ornitodata platform from April to July of 2022

The areas of overlap between our observations and those on the Ornitodata platform are Canta and the area of buildings A and B of the "Alexandru Ioan Cuza" University of Iași.

Our field observations (Figure 6) led to the identification of 43 individuals, divided into 11 males, 11 females, 11 juveniles and 9 other individuals without identified sex. The total number also includes the individuals from the areas of interest.



Figure 6. Sightings and areas of interest following our field trips, from April to July of 2022

By analysing the locations and observation areas and considering the mentioned overlaps, we obtained a dispersion index of $ID = 4.45$. This gives us a grouped distribution of the *Falco tinnunculus* population on the territory of Iași. The areas where individuals tend to group are generally less than 500 m away from one or more green areas that possibly serve as hunting grounds. The groups are present in areas where the population of small birds such as *Delichon urbicum*, *Passer domesticus*, *Sturnus vulgaris* and *Apus apus* is also more numerous, in addition to larger birds such as doves and corvids.

We identified 11 nests, eight of them located on the upper levels of apartment buildings. We note a preference for high-rise nesting, as the height regime of the selected buildings was no lower than ground floor plus five floors (G+5), and there was always at least one high-rise building in the areas of interest. Between these, we found five nests located directly on the roof, the other three being more difficult to access and located in attics or lofts. We were unable to determine the exact location of a nest, but it was included in the count. As for the two nests on the ornaments of Culture Palace, they are located at heights from 11 m to 55 m, depending on the location.

The activity of individuals increases in the early hours of the day, until after lunchtime, and depends to some extent on weather conditions. These activity patterns are like those of the diurnal falcon populations in North America (Lang, 2018). We note a change in the activity pattern of individuals in the Zimbru area following the appearance of a common buzzard (*Buteo buteo*) nearby, as they started being more active immediately after sunrise and generally ceased activity after 10 o'clock.

We noticed that the individuals nesting on the apartment buildings on Anastasie Panu Street present a higher volume and frequency of calls compared to other individuals, a peculiarity that we assume is due to the anthropogenic impact and the high and almost constant noise pollution throughout the day in the area.

As for the hunting grounds, they often coincide with the nearest green space, be it a park, a yard, the bank of the Bahlui River or larger green areas on the outskirts of the city. Sumasgutner et al. (2014) also noted a preference for areas close to green spaces in the Vienna Eurasian kestrel population. There are few exceptions, probably due to the intense human activity in that green space: the individuals nesting on the Culture Palace hunt on the banks of the Bahlui River and not inside the Palas Public Garden. Hunting territories overlap to some extent, but we noted preferences depending on the observed pair.

For the wintering period of 2021, the seven observations recorded on the Ornitodata platform (Figure 7) correspond to three sample squares, located in the Tătărași area. Six of these are near the reservoir Veneția, while one specimen was at a greater distance from them. The lack of additional data does not allow the determination of the number, sex, or age, but the continuous presence of individuals in this area over the years is noted.

During the field trips from January to March of 2023 we identified nine individuals: five males, three females and one individual of non-identified sex, respectively. In general, they were observed in the same areas that they populated during the breeding season (Figure 8). The smaller number of individuals identified during this period suggests the partial migration of the population outside or to the outskirts of the city. In the beginning of March, we noted the initiation of courtship behaviour.

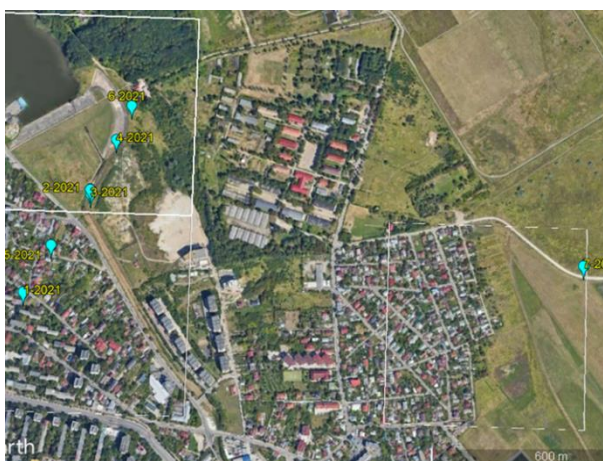


Figure 7. Sightings recorded on Ornitodata from January to March of 2021

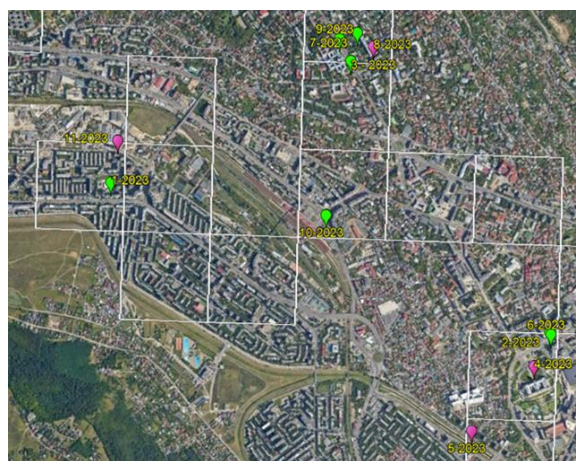


Figure 8. Sightings following field trips from January to March, 2023; green – one individual; pink – a pair

During the trips, we collected six pellets belonging to a single nesting pair, from May and October of 2022. The pellets were on average 3.16 cm long and 1.41 cm in diameter. These contained remains of various origins coagulated in short grey fur, that we counted and inventoried (table 1). Vertebrate remains make up 83.28% of the contents and insect remains only count up to 16.71%, with the mention that they appear especially in the pellets collected in October. More than half of the samples contained plant fragments ingested by accident. The presence of fur and molars, the shape and size of the mandibles, but also the presence among the remains of an autopodium and a forelimb, suggest that the largest part of the prey is small rodents. We also identified insect remains in the

form of mandibles, chitin fragments and wings, but also two entire insect heads. Pellet 2 – 1 contained, in addition to insect remains and bone fragments, two small feathers and a bird's claw, but the small number of remains and the high degree of bone fragmentation did not allow the identification of the bird species.

Table 1. Inventory of the pellet contents

Series & no.	Vertebrate fragments				Insect fragments		Fur	Plant fragments
	Mandibles	Incisors	Molars	Other bones	Mandibles	Exoskeleton		
1 – 1	2	2	1	12	-	-	Yes	Yes
1 – 2	3	4	5	108	4	7	Yes	No
1 – 3	-	2	-	83	-	-	Yes	Yes
1 – 4	-	1	2	34	-	-	Yes	No
2 – 1	-	-	-	6	11	14	Yes	Yes
2 – 2	2	1	5	21	8	15	Yes	Yes
Total	7	10	13	264	23	36	-	-
		294			59			

The city's kestrel population occupies various tall buildings, taking advantage of the protection and stability that they provide (Sumasgutner et al., 2014), but a major disadvantage of their use derives from renovations resulting in the destruction or damage of nests. New constructions are also gradually reducing green space, essential for the population in terms of hunting. Shelter and nesting spaces are gradually decreasing in several large cities due to modernization (Sumasgutner et al., 2014). The placement of artificial nests in different areas of the city could compensate the reduction of space and serve not only to the kestrels, but also to other bird species that live inside the urban habitat.

In terms of available food resources, situations differ depending on the city. In Vienna, chick mortality increases with higher building density and decreases in areas with more green spaces because, during the nest site' selection, the kestrels tend to choose less favourable locations in terms of food availability (Sumasgutner et al., 2014). Another effect of urbanization is a reduction in egg numbers, with urban kestrels laying on average one egg less than their peri-urban and rural conspecifics (Kettel et al., 2018), while inside the population studied by Huchler (2020), the urbanization is linked to delayed nesting. Kreiderits et al. (2014) finds a link between the local weather conditions and the reproductive success, with the reproductive success and chick survival increasing in years with warmer and drier springs. However, Kopij (2018) considers that the urban kestrels have constant access to abundant prey. As all pairs observed inside the city successfully fledged one chick, further studies could draw conclusions on the reproductive success.

Besides electrocution and collisions with vehicles, urban falcons risk collision with various anthropogenic structures (Hager, 2009, Cianchetti-Benedetti et al., 2016), especially the buildings with glass surfaces, which become increasingly more common (Hager, 2009).

Increased pollution inside the cities poses a danger to bird populations, affecting the air quality and subsequently the health of individuals (Sumasgutner et al., 2023). The noise of human activity can cause changes in the birds' behaviour, too (Cicort-Lucaciu et al., 2022): we observed the more intense and frequent calls of the individuals on Anastasie Panu Street compared to those of individuals inhabiting other areas of the city.

There are, at the present time, no studies regarding the effects of urbanization on the common kestrels in Romania. At a European level, the population is in long-term decline. Although the species increasingly uses the urban habitat, the challenges associated with it contribute to the decrease in reproductive success and thus to the population decline; for these reasons, it is thought that the species has fallen into an ecological trap within cities (Sumasgutner et al., 2014).

CONCLUSION

Following the study carried out in Iași City in 2022, we identified 52 common kestrels. The population trend is positive compared to 2021. We noticed their clustered dispersion, with kestrels preferring areas with tall buildings, located near green spaces used as hunting grounds due to accessibility. The areas with the highest density are the Zimbru and the area surrounding the Culture Palace.

During the breeding season of 2022, we found 11 nests located on or in buildings, in areas with a high degree of urbanization. Each monitored pair successfully fledged at least one chick.

In the cold season, we identified nine individuals out of the 52 present in the previous months. The urban kestrel population in Iași is therefore partially migratory, the majority withdrawing for wintering either to the outskirts or outside the city.

Individuals can modify their activity patterns and behaviour depending on the conditions of the area they occupy, responding to both anthropogenic and natural factors.

Their diet consists mainly of small rodents, with insects having a greater share in the cold months. They also consume other vertebrates, including small birds.

In general, the movement of the Eurasian kestrel population from the natural areas towards the urban habitat results in reduced access to sufficient food sources. Existing data correlates this with a decreased reproductive success, suggesting that the species is falling into an ecological trap. Continued modernising of the urban landscape poses a threat to the common kestrel population due to the reduction of potential shelter and nesting sites, but also of the green spaces suitable for hunting.

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