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Ornis Hungarica 2025. 33(1): 177–187.
DOI: 10.2478/orhu-2025-0010

The status and risk of extinction of Saker Falcon *(Falco cherrug)* in the Republic of Moldova

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Received: January 30, 2023 – Revised: December 28, 2023 – Accepted: October 18, 2024

Ajder, V., Ursul, S. & Baltag, E. Ș. 2025. The status and risk of extinction of Saker Falcon *(Falco cherrug)* in the Republic of Moldova. – Ornis Hungarica 33(1): 177–187. DOI: 10.2478/orhu-2025-0010

Abstract The Saker Falcon *(Falco cherrug)* is one of the most threatened birds of prey species of the Eurasian steppe zone. While conservation efforts are successful and populations are growing in Central Europe, in the Republic of Moldova, the population is declining due to low conservation efforts and high environmental pressures on this species. Due to the present survey effort, the breeding areas of Saker Falcon was designated as an Important Bird Area (IBA) site to conserve the species population from the Republic of Moldova. But, habitat loss, main prey decline – Speckled Ground Squirrel *(Spermophilus suslicus)* – lack of nests, intensive agriculture, electrocution, poisoning, shooting, and trapping for falconry have been identified as threats to the Saker Falcon population in the country. Besides these threats, in the last two years, the State Electric Enterprise „Moldelectrica" carried out technical maintenance works on the high voltage power transmission lines, which resulted in removing any existing nests situated on the pillars, including Raven *(Corvus corax)* and Saker Falcon nests. Consequently, in the last two years, none of the Saker Falcon's known occupied territories were confirmed. Given these circumstances, it is extremely urgent to take action and save the Saker Falcon population in the Republic of Moldova. The first step towards efficient conservation is to install artificial nest boxes on high-voltage poles, otherwise, the species risks extinction in the country.

Keywords: bird of prey, Eurasia, steppe, high-voltage pillars

Összefoglalás A kerecsensólyom *(Falco cherrug)* az eurázsiai sztyeppzóna egyik legveszélyeztetettebb ragadozómadár-faja. Amíg a sikeres természetvédelmi erőfeszítések eredményeképpen Közép-Európában nő, Moldovában a védelmi intézkedések gyengesége és a fajra irányuló kedvezőtlen környezeti hatások erőssége miatt csökken az állomány. Az itt bemutatott felméréseknek köszönhetően a Moldovai Köztársaságban a kerecsensólyom élőhelyeit Fontos Madárélőhellyé (IBA) nyilvánították. Ennek ellenére, az élőhelyek elvesztése, a fő zsákmányfaj – a pettyes ürge *(Spermophilus suslicus)* – állományának csökkenése, a fészkelőhelyek hiánya, az intenzív mezőgazdaság, az áramütés, a mérgezés és a solymászati célú befogás a kerecsensólyom-állományt veszélyeztető tényezőként vannak számontartva a Moldovai Köztársaságban. Mindemellett az elmúlt két évben a „Moldelectrica" Állami Áramszolgáltató Vállalat karbantartási munkákat végzett a nagyfeszültségű távvezeték hálózaton, amelynek eredményeképpen eltávolítottak minden fészket, beleértve a holló *(Corvus corax)* fészkeit, és a kerecsensólymok által használt fészkeket is. Mindezek következményeként nem találtuk meg egyetlen korábban ismert kerecsensólyom-revírben sem a fajt. A körülményeket figyelembe véve sürgős intézkedéseket kell tenni a kerecsensólyom-állomány megőrzésére a Moldovai Köztársaságban. A faj megőrzésére tett első lépésként fészkelőládákat kell kihelyezni a nagyfeszültségű távvezeték oszlopokra, különben nagy eséllyel kipusztul a faj az országból.

Kulcsszavak: ragadozómadár, Eurázsia, sztyepp, nagyfeszültségű távvezeték-oszlop

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Introduction

Birds of prey are at the top of the trophic web, controlling prey populations and covering large areas as home ranges with a diverse habitat mosaic (Peery 2000), which enables them to find suitable prey to survive. These characteristics recommend them as an ecosystem health indicator, as their presence certifies the abundance of suitable populations of prey. Some of these species are declining because of ecosystem degradation, thus creating an imbalance in the ecological network which can lead to a lower biodiversity structure.

The Saker Falcon *(Falco cherrug)* is a Eurasian bird of prey listed as Endangered because the population trend analysis indicates that it may be undergoing a very rapid decline (Birdlife International 2022) in species range, even if in some European countries the population has increased in the last 20 years (Chavko 2010, Kovács *et al*. 2014, Bauer 2020, Fântână *et al.* 2022). The meta-population in the Pannonian Basin (in Hungary and neighboring countries) is the most stable one across the global range (Prommer *et al.* 2018). These different trends in the Saker Falcon national populations are mainly influenced by conservation actions or, in some cases, especially in those when the species is declining, the lack of them at the national or regional level. The absence of conservation strategies is mostly connected with habitat degradation which leads to low nesting opportunities and to lower prey availability.

In the Republic of Moldova, human pressure on the species grew in the middle of the 20th century, when massive surfaces of natural land were transformed into farmlands because of the agricultural policy in the Soviet Union (Averin *et al.* 1971). After the collapse of the USSR, the large arable land blocks were divided into smaller blocks with diverse land use, including fallow land. That resulted in a mosaic-like landscape pattern that could sustain a high degree of biodiversity. Nowadays, however, the extent of that mosaic of habitats is decreasing again, as smaller blocks are merged into large blocks to increase food production management. In some cases, the large farmland plots incorporate parts of the grassland areas which were intended for animal grazing, just to be able to grow the crop fields. To achieve high yield in these agricultural lands, farmers use high amounts of fertilizers and pesticides to protect the crops (ECHA 2022). All those substances have the potential to affect biodiversity from the lower level of the trophic web, bioaccumulating in the upper levels where raptors are situated, creating an ecotoxicological pressure on the environment (Strungaru *et al.* 2018).

In addition to the habitat changes and ecotoxicological problems, populations of Speckled Ground Squirrel *(Spermophilus suslicus)* – the main prey of the Saker Falcon – started to decrease in the Republic of Moldova (personal observations). The reasons for this decline are rather unknown up to now, but the phenomenon seems to be widespread on a large scale, including also the Ukrainian population (Mikhail Rusin *pers. comm.*).

Despite the protection instituted by the legal framework of the country, there are no effective conservation measures for the Saker Falcon in the Republic of Moldova, as is the case for other large birds of prey. That is largely due to the lack of data on its distribution and ecology in the Republic of Moldova. Before 2013, the species was poorly studied due to the low number of ornithologists in the country. Most of the data from that period is recorded *in verbis* with very few proofs and without any systematic survey. Since 2013, we have been

collecting data systematically in order to assess the avifauna structure in the Republic of Moldova. The process began with the project „Monitoring Important Bird Areas in Moldova to Improve Conservation Management" (2013–2014) funded by Conservation Leadership Programme (Ajder 2014). The data collection continued to be carried out by our team even after the project ended, and we have increased our efforts to survey the Saker Falcon and to achieve a better conservation status through other projects developed in the Republic of Moldova and Ukraine. Further data was collected through the project "Continuation of Saker Falcon and Steppe Biodiversity Conservation in Ukraine" (2015–2016) funded by Rufford Foundation (Prommer 2015). For the first time, the entire High Voltage Power Transmission Line from the South-East of Republic of Moldova was monitored. During the survey, we collected important ecological information, such as diet, other breeding birds nearby, and the nearest souslik colonies. The annual Saker Falcon breeding population survey continued up to 2022, but in some years the field studies were affected by the low number of ornithologists or field volunteers.

The aim of this article is to update the information on the Saker Falcon breeding population from the Republic of Moldova, by presenting the past and present situation of this species in relation to the threats and habitat use at a national scale.

Material and Methods

Study area

The study area covers the territory of the Republic of Moldova (33,843.5 km^2), which is situated between the Prut and Dniester rivers. The human population in the study area is approximately 2.6 million inhabitants (National Bureau of Statistics from Moldova, 2022). The landscape in the central part of the country is represented by hilly areas and relatively low plains, with the highest altitude of 429 m (Bălăneşti hill, Nisporeni district). The land use is mostly agricultural with fragmented parcels, forest patches and pastures, resulting in a mosaic of artificial and natural habitats *(Figure 1)*. The southern part of the country is characterized mainly by steppe and grasslands, which are suitable habitats for the Saker Falcon and its main prey in the region – the speckled ground squirrel.

Field studies

The Saker Falcon monitoring, started in 2013, was focused on the southern part of the Republic of Moldova, and mostly on the areas along the main high voltage power line. The power line crosses the Moldovan-Ukrainian border several times due to the irregular border between the two countries *(Figure 2)*. A total length of 100 km of the high-voltage power line was surveyed, and 389 pylons were checked to identify and count active nests or individuals of Saker Falcon. The observations were conducted with binoculars and spotting scopes, from 10.00 AM till 18.00 PM. The observations took place on calm days, without rain or strong winds.

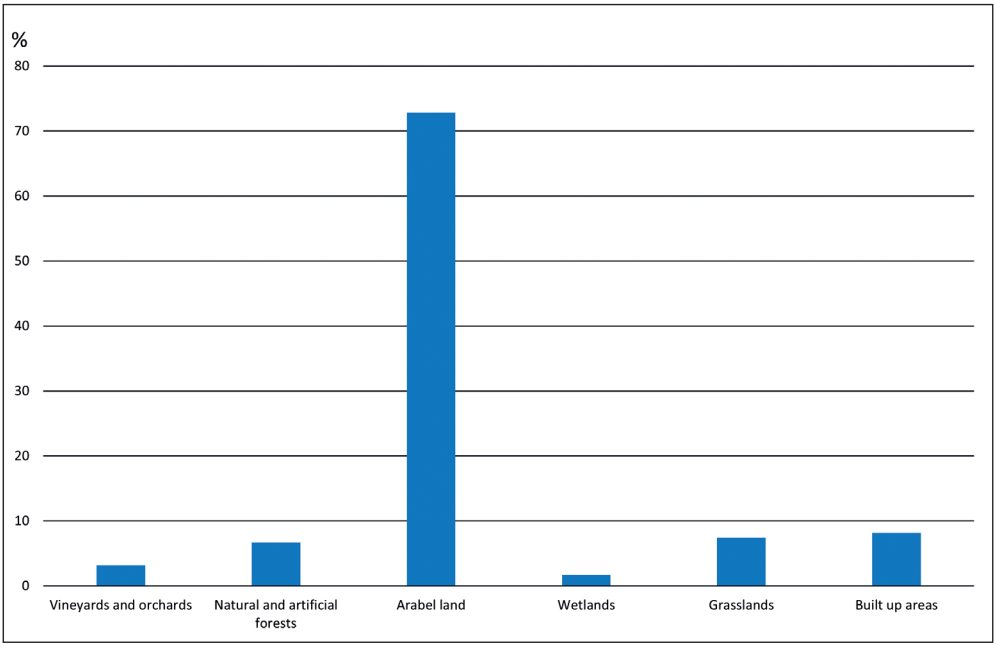

Figure 1. Land use structure for the Republic of Moldova according to the Statistical Yearbook of the Republic of Moldova (Statistica Moldovei 2022)

1. ábra A területhasználat Moldovában a Moldovai Köztársaság Statisztikai Évkönyve szerint (Statistica Moldovei 2022)

All the transects were monitored during the breeding period, between the beginning of April and the end of July and consisted of two separate sets of field observations. The first set of transects (April–May): to identify the breeding pairs and collect data on habitat selection and prey availability in the south and south-eastern part of the Republic of Moldova. The second set of transects (June–July): to identify the breeding success of the Saker Falcon pairs, targeting only the

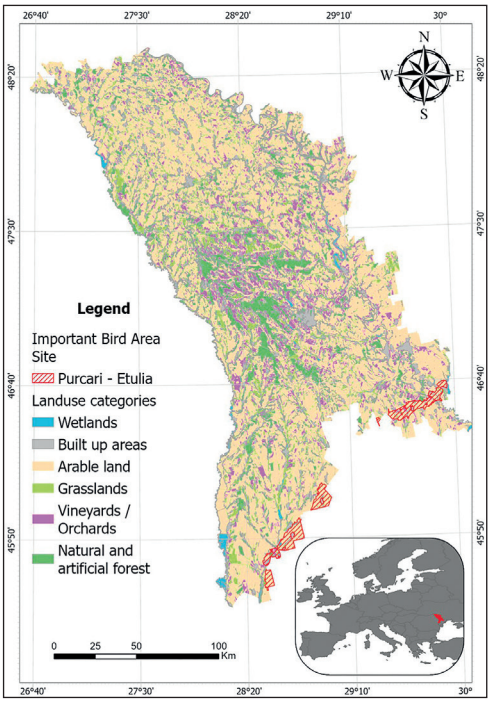

Figure 2. The route of the high-voltage line along with the Important Bird Area proposal (Purcari – Etulia) for Saker Falcon conservation in the Republic of Moldova

2. ábra A nagyfeszültségű átviteli hálózat nyomvonala és a javasolt Fontos Madárélőhelyek (Important Bird Area) terület (Purcari – Etulia) a Moldovai Köztársaság területén

nesting locations and collecting data about the number of fledglings (if possible) and the activity of the adults (the prey and its source).

The fieldwork was carried out by a team of up to four experienced ornithologists and their assistants. The team was covering the entire length of the high-voltage power line for one day or a maximum of two days in case the observers had to spend more time with one nest/pair in order to check its status. The survey was conducted by car, with the team driving below the high-voltage power line. Each pillar and its surrounding landscape were carefully inspected with binoculars and spotting scopes. When a nest or an individual of Saker Falcon was spotted, the surveying team carefully monitored it to check exactly their status. Only the presence of a nest with incubating individuals or with juveniles was considered as breeding territory. All the field data were entered into census protocols designed for raptor breeding counts, and they were further integrated into a GIS database.

During the field survey, we recorded all the possible threats to identify the type of conservation actions needed to support the species. Special attention was given to the presence of Raven *(Corvus corax)* nests on the high-voltage power line pylons, which could serve as nests also for Saker Falcons. The land use structure was downloaded from FAO 2014, and it was used to quantify their preference for specific areas. To calculate the land use structure around the Saker Falcon nests, a buffer area of 5 km radius was generated using "Buffer Analysis Tool" in ArcGIS Pro v. 2.9.2, after which we extracted a percentage of each land use category inside of this area, using "Clip Analysis Tool".

During the field surveys, we also recorded the locations of the Speckled Ground Squirrel colonies as the main prey for the Saker Falcon population, but due to the lack of available mammologists, a comprehensive population study of this species could not be accomplished.

Results

Population

During the 2013–2023 period, the maximum number of active pairs observed was 4, in 2016, while the lowest was 0, in 2021 and 2022 *(Table 1)*. The highest fledgling number was also recorded in 2016: 7 chicks from 4 nests *(Figure 3)*. The lowest number of chicks was recorded in 2014 and 2020 – only 1 chick. For the last three years (2021–2023), no active pairs were recorded, which means no fledglings were observed either *(Table 1)*.

The land use structure around the Saker Falcon nests was covered mostly by arable land (65.4%), while wetlands represented the lowest coverage (4.56%), followed by vineyards/orchards (4.01%) *(Table 2)*.

Threats

During the survey period, we have recorded three main threats for the Saker Falcon population from the Republic of Moldova. The first one is habitat degradation, in which small plots of agricultural fields are converted to large croplands and farmlands. While the

Table 1. Saker Falcon breeding population from the Republic of Moldova during the 2013–2023 period

1. táblázat A kerecsensólyom fészkelőállomány alakulása a Moldovai Köztársaságban a 2013–2023 közötti időszakban

Index	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of adult birds	6	6	6	8	8	6	8	6	0	0	0
Number of active nests	3	1	2	4	2	3	3	1	0	0	0
Number of abandoned nests	0	2	1	0	2	0	1	2	0	0	0
Number of chicks (minimum number of birds identified in the nest)	3	1	3	7	2	4	2	1	0	0	0
Highest number of chicks/nest	1	1	2	4	1	2	1	1	0	0	0
Percent of coverage high-voltage power line	50	90	100	60	60	50	50	40	40	70	90

steppe area is undergoing degradation due to low level of grazing which leads to scrub encroachment and eventually afforestation, as the climax vegetation is forested steppe.

The second threat is represented by the decline of the Speckled Ground Squirrel population. We observed the phenomenon on site because the few colonies known to us became extinct.

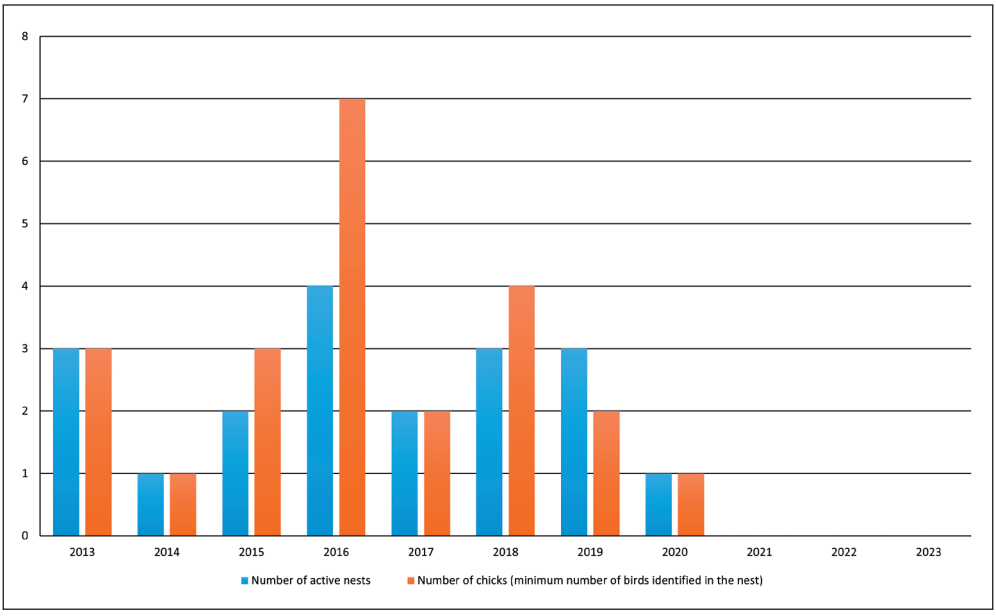

Figure 3. The number of active nests and chicks for the Saker Falcon population from the Republic of Moldova during the 2013–2023 period

3. ábra Az aktív kerecsensólyom-fészkek és a fiókák száma a Moldovai Köztársaság területén a 2013–2023 közötti időszakban

Table 2. Land use composition in a radius of 5 km around the Saker Falcon nets
2. táblázat A területek művelési ágak szerinti megoszlása a kerecsensólyom-fészkek körüli 5 km-es sugarú körben

Land use category	Coverage percent	Land use composition
Wetlands	4.56	Lakes, rivers, fish farms, marshland
Built-up areas	9.62	Villages, industrial areas, towns
Arable land	65.41	Irrigated and non-irrigated cropland
Grassland	8.78	Pastures, grasslands with bushes
Vineyards / Orchards	4.01	Vineyards and orchards
Natural and artificial forest	7.64	Natural and artificial forests, lines or patches of trees

We have documented the process, but unfortunately we do not have a comprehensive study to quantify this decline.

A third threat is linked to an ongoing forestation campaign initiated in our country in 2023, known as Forest Generation "Generația Pădurilor." This initiative aims to identify open spaces, typically used as pastures and grasslands, for the purpose of planting forests. However, this effort inadvertently gives rise to a significant issue. The conversion of grasslands into forests poses a challenge by altering the habitat suitable for the Speckled Ground Squirrel, disrupting existing colonies and entire ecosystems. This could be categorized as habitat degradation, taking on a more radical aspect. In the vicinity, particularly within the designated Important Bird Area "Purcari – Etulia" dedicated to Saker Falcon conservation, we identified 24 such areas affected by this conversion.

The absence of large nests on high-voltage electrical pillars represents the fourth threat. This became particularly evident over the last three years when the State Electric Enterprise "Moldelectrica" physically removed all nests, sticks, and small branches from the pylons.

We have also identified a series of threats that affected other bird species in the area: electrocution, poisoning and illegal shooting. Although we did not document any mean that those threats affect the local population of Saker Falcon, we cannot exclude potential incidents involving the species.

In addition, the discussions, and fears about possible trapping of adults and fledglings and/or taking chicks from nests for falconry remain in place, even though we did not record any such actions during our survey.

Discussion

According to Osterman, the Saker Falcon was a common bird in Moldova at the beginning of the 20th century (Averin *et al.* 1971). Unfortunately, there is no estimation of the breeding population, not even for the middle of the 20th century. Further research done by Averin, Gania and Uspenskii (Averin *et al.* 1971) had shown that between 1956 and 1968 there were ten Saker Falcon pairs present in eight small forests with a total area of 84.5 km^2 scattered around the country. The breeding range had rapidly changed in a relatively short period of

Figures 4a, b Saker Falcon nesting and feeding habitats in the Republic of Moldova
4a és b ábra Kerecsensólyom fészkelő- és táplálkozóhelyek a Moldovai Köztársaságban

time – only 50 years. Drastic changes occurred in the breeding ecology as well: according to the Red Book of Moldova (Duca *et al.* 2015), in the last century, the Saker Falcon was spread in small numbers in meadow forests and rocky areas along the Dniester River. Since then, the species switched from trees and sometimes cliffs to high-voltage electrical pylons, being concentrated nowadays mainly in the southern part of the country. Currently, the Saker Falcon nesting areas are situated in open habitats, mainly surrounded by arable fields and grasslands. Most of them are closely positioned to the Speckled Ground Squirrel colonies. During our survey, we did not find any Saker Falcon pair breeding on trees or cliffs. Instead, all the nests found so far were situated on high-voltage power line pylons *(Figures 4a, b)*.

Figure 5. Saker Falcon adults near the nest on an electric pylon
5. ábra Öreg kerecsensólymok egy távvezeték oszlopon lévő fészek mellett

The last official data claims that in 2007 the breeding population of Saker Falcon was estimated at 5–13 pairs (Munteanu *et al.* 2007). In the following 6 years there were no studies on Saker Falcon, so we do not have any data on their breeding population. In the first year of our survey (2013), the documented population consisted of only 3 breeding pairs, while a modest increase was observed in 2016 when 4 breeding pairs were recorded. During the survey period the number of individuals fluctuated, but this could be influenced by some changes in the nest location. Therefore, the Saker Falcon population from the Republic of Moldova seems to be part of the south-eastern Ukrainian population, and it is probably linked to the south-eastern Romanian population as well.

Nest locations did not change through the survey period except for one case, when the pair moved from one pillar to another in 2017. They remained in the same area, but they used an alternative nest on another pylon at 500 m from the original nest *(Figure 5)*. A potential reason for change was maybe the sleet and snowfall in mid-April (20th and 21st), which severely affected the central and southern parts of the country. Due to this harsh weather event, two pairs abandoned the breeding process, and the other two pairs were supposed to start to breed again judging by the size of the juveniles, with a one-month gap. During the 2017 breeding season, we recorded only one young fledgling in each of the two active nests at the middle of July. For these reasons, the late April snowfall is presumed to have affected the breeding of the Saker Falcon in 2017.

Raven nests on electric pillars are of a crucial importance for Saker Falcon breeding in Vojvodina (Rajković 2015), just as in the Republic of Moldova. Without those natural nests, it is highly necessary to install artificial boxes for falcons to ensure suitable breeding areas. That action is urgent, especially now, when the conservation status of the Ukrainian population could be affected by Russian aggression. The installation of artificial nest

boxes is very successful in supporting local populations in Hungary (Bagyura *et al.* 2012), Austria, Slovakia (Chavko *et al.* 2014), Serbia (Rajković 2015), Southeastern (Romanian Ornithological Society *pers. comm.*) and Western Romania (Milvus Group *pers. comm.*). During 2020–2022, consequently to the maintenance works on the high-voltage lines performed by the State Electric Enterprise Moldelectrica, all the nests were removed. As a result, no active pair was observed during the monitoring in known breeding areas or in other sites close to them.

The main threat to the Saker Falcon population in the Republic of Moldova is habitat loss, followed closely by the population decline of main prey species and the lack of nests. While the first two threats require a more elaborate strategy, the third one could be resolved with a relatively low amount of effort. Other potential threats identified towards the Saker Falcon population in the Republic of Moldova are intensive agriculture, electrocution, poisoning, shooting, and trapping for falconry. While we did not record any incidents related to the last three threats involving Saker Falcons, we documented such incidents involving other species of birds of prey, which lead us to consider those threats as potential risks. These threats ware not evaluated due to the low number of ornithologists in the Republic of Moldova and a low detectability rate. Still, we cannot exclude it, especially in this area where the authorities are not aware of the practice.

The first main result of this survey was the designation of an Important Bird Area (IBA) site to conserve the Saker Falcon population from the Republic of Moldova (Ajder 2014, BirdLife International 2023). That site covers the entire Saker Falcon distribution in the Republic of Moldova, including steppe and non-intensive agricultural fields. The IBA database has been used to propose the entire area as an Emerald site, which has international recognition. However, the legal process of national adoption of the Emerald Network is still ongoing, thus the Saker Falcon population and its breeding area do not yet have a real legal protection in the Republic of Moldova now. Even if the process has been completed, the Emerald Site covers only a part of the IBA site (less than 25%) due to a set of changes imposed by the governmental department in charge of this process.

Acknowledgements

We would like to express our gratitude to the monitoring team, including Laurențiu Petrencu, Gheorghe Țîcu, Alexandru Țurcan, Laura Taftur, Mihai Ghilan and Mikhail Rusin, whose valuable observations contributed to our understanding of the status of the speckled ground squirrel in the study area. Additionally, we extend our thanks to the teams involved in the projects ‘Monitoring Important Bird Areas in Moldova to Improve Conservation Management’ and ‘Continuation of Saker Falcon and Steppe Biodiversity Conservation in Ukraine,’ where precious data was collected. The study adhered to the laws of the Republic of Moldova.

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