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Preparatory activities for Saker Falcon *(Falco cherrug)* reintroduction in Bulgaria: habitat management and electrocution risk assessment

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ABSTRACT—The Saker Falcon *(Falco cherrug)* is a rare species with a very controversial present breeding status in Bulgaria. In 2009 a team of Bulgarian and foreign organizations came up with a feasibility study, discussing the need for reintroducing Saker Falcons and the means of completing the task in the country. That study formulated a number of criteria for Saker Falcon site suitability and identified the area of the Central Balkan Mountains as most suitable to support and maintain a reintroduced population of the species. This article presents a set of preparatory pilot measures aiming at guaranteeing optimal conditions for the Saker Falcon reintroduction in terms of food supply and electrocution risk mitigation. A set of activities were carried out to support a colony of European Susliks (an important prey for Saker Falcons) through mowing and clearing tall grass and shrub vegetation, preparing temporary holes for the animal. The management measures did not lead to a visible effect on the Suslik population during the first project year. Habitat management and the monitoring should continue 2-3 more years to see if these measures would increase Suslik numbers and enlarge their occupied area. In addition to that, a section of 20 kV electricity distribution network in the proposed reintroduction area was studied in order to assess the potential electrocution risk for the birds. The study located a total of 488 pylons of 6 different types and evaluated their potential threat. As a result a region with a relatively low electrocution risk was identified to assist the selection of initial Saker Falcon releases by hacking.

Key words: *Falco cherrug*, reintroduction, European Suslik, habitat management, electrocution

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Introduction

Saker Falcon *(Falco cherrug)* is a rare species, included in the Red List of the International Union for Conservation of Nature and Natural Resources (IUCN) as “Vulnerable” *(IUCN, 2010).* The last confirmed successful nesting of the species in Bulgaria dates back to 1997, while the last breeding attempt (unsuccessful) was documented in 1998 (*D. Domuschiev,* in litt.). In 2005 two adults and a young bird were observed in the beginning of August in the vicinity of the Central Balkan Mountains (*V. Koychev*, pers. comm.) it is therefore possible that a pair had nested somewhere in the area. Otherwise in the period 2006–2009 only single birds, possibly from the wandering non-breeding Western Palearctic population were regularly seen in Bulgaria *(Ragyov et al., 2009).*

In 2009, after 4 years of surveys in Bulgaria, an international team of organizations (Institute for Biodiversity and Ecosystem Research, Green Balkans, International Wildlife Consultants, National Museum of Natural History, Institute on Zoology, Helmholtz Centre for Environmental Research) came up with a feasibility study, discussing the need for reintroducing Saker Falcons and the means of completing the task in the country *(Ragyov et al., 2009).* The study was a vital element, required by the IUCN prior to the initiation of a release programme *(IUCN, 1987; 1998).* The Feasibility Study discussed the population status of the species (past and present), factors that caused decline and extinction, as well as main habitat and food requirements of the Saker Falcon. It sets up particular criteria (i.e., food supply, nest base and protection level) and explored the potential of 15 key areas to sustain reintroduced Saker Falcons. The study pointed out the area of the Central Balkan Mountains and the adjacent territory (Figure 2) as most suitable for initiating a Saker Falcon reintroduction programme.

As a second phase of the reintroduction programme, a series of activities were initiated to prepare the area of the Central Balkan Mountains for a potential start of Saker Falcon releases i.e., (1) habitat management; (2) study on the potential effect on electricity distribution lines; (3) assessment of local people's attitude towards Saker Falcon and the reintroduction of the species; (4) consultations with relevant governmental and non-governmental organisations regarding the species conservation in Bulgaria.

The present paper aims at describing particular actions for the restoration of European Suslik *(Spermophilus citellus)* habitats in a model colony, and comparing the present status of the Susliks with previous investigations carried out in the area. The paper also presents a pilot survey on the medium voltage (20 kV) power lines in terms of their potential negative influence on the birds in order to identify "safe" locations for the initial Saker Falcon reintroduction.

European Suslik

Susliks *(Spermophilus citellus)* are considered among the main potential prey of Saker Falcons *(Cramp & Simmons, 1980).* There are several threats to the European Suslik in Bulgaria, most importantly pasture degradation and agricultural intensification. Pasture degradation is usually caused by inappropriate grazing practices and has negative impact on the Susliks in two main ways, overgrazing or insufficient grazing. Insufficient grazing leads to overgrowing of the pastures with shrubs and trees. This factor was very clearly expressed in mountainous regions of the country. Intensification of agriculture has negative impact through enlargement of the agricultural lands and increased use of agrochemicals for crop protection. The transformation of pastures, natural grasslands and meadows into arable fields and perennial plantations also threatens Susliks *(Koshev, 2008).*

European Suslik is a widespread species with fragmented distribution in the Central Balkan Mountains *(Stefanov, 2003).* Some of the Suslik colonies in the area and its adjacent areas have vanished lately while other colonies presently consist of lower numbers of individuals as compared to the past. The decline of the Suslik population was generally caused by ecological succession. Reduced number of grazing animals enabled the growing of tall and compacted grass, which is unfavourable for this small rodent. This was accompanied with a gradual change of the grasslands species composition, which probably turned into yet another causal factor for Suslik population decline and fragmentation *(Stefanov, 2003; 2005; 2006).* Presently a total of 30 Suslik colonies are found in the area of Central Balkan Mountains, covering a total area of 29.5 km^2, which represents 2.44% of the site *(Ragyov et al., 2009).* Our work hypothesis was that the colony on the study area is declining due to overgrowing with vegetation and once cleared, we would expect an increase of the number of individuals and an extension of the area inhabited by Susliks.

Electricity distribution network

Saker Falcons have been proven to willingly use electricity pylons as lookout points, perching sites and nesting platforms, where they occupy nests built by other species and also nest boxes *(IWC, 2011; Puzovic, 2007; Puzovic, 2008).* However, the species can also be negatively affected by the pylons. For instance electrocution on power lines has turned out to be a major cause of Saker Falcon mortality, and the electrocution risk is determined by the pylon type and design *(IWC, 2011).* A satellite tagged male Saker Falcon from Hungary has been found electrocuted in Russia while a female (also satellite tagged) was most probably electrocuted in Western Kazakhstan *(Prommer, 2008).* Approximately 5 cases of electrocution have been recorded in Eastern Slovakia for the past 30 years (*Y. Liptak* per *L. Deutschova*). In January 2005 *K. Bedev* (in litt.) reported a dead Saker Falcon found under a 20 kV pylon near Bourgas, Bulgaria; most probably the bird got electrocuted.

Several studies on the interactions between electricity distribution networks and birds have been accomplished in Bulgaria. *Nankinov (1992)* was the first who outlined the problem between birds and electricity networks in Bulgaria. He studied 315 White Stork *(Ciconia ciconia)* deaths caused by the electricity network and found considerable increase of that type of mortality during the period of 1950s–1980s (2.38% in 1950s to 40.47% in 1980s of the White Stork ring recoveries were due to this type of mortality). This coincides with the development of the electricity distribution network in the country after World War II. This dramatic increase is however possibly biased by increased ornithological efforts and better reporting. *Stoychev & Karafeizov (2004)* first made an assessment of the structure of the power lines in relation to the risk for birds of prey. Later *Demerdzhiev et al. (2009)* and *Gerdjikov (2010)* implemented large scale surveys in Southeast Bulgaria and classified the type of the electricity pylons according to their effect on bird mortality caused by electrocution. The main types of pylons used in Bulgaria are presented in Figure 3.

Our survey represented a pilot study for the area of the Central Balkan Mountains. The structures of the pylons however appeared to be the same or similar to the ones in other parts of the country, and therefore the publications mentioned above can be used as a reference for assessment of the risk for the released Saker Falcons.

Materials and methods

Both pilot measures for habitat maintenance and improvement, and the electrocution risk assessment were undertaken in the area of the Central Balkan Mountains site, identified of highest potential to host a reintroduced Saker Falcon population. The methods used to obtain the results were as follows.

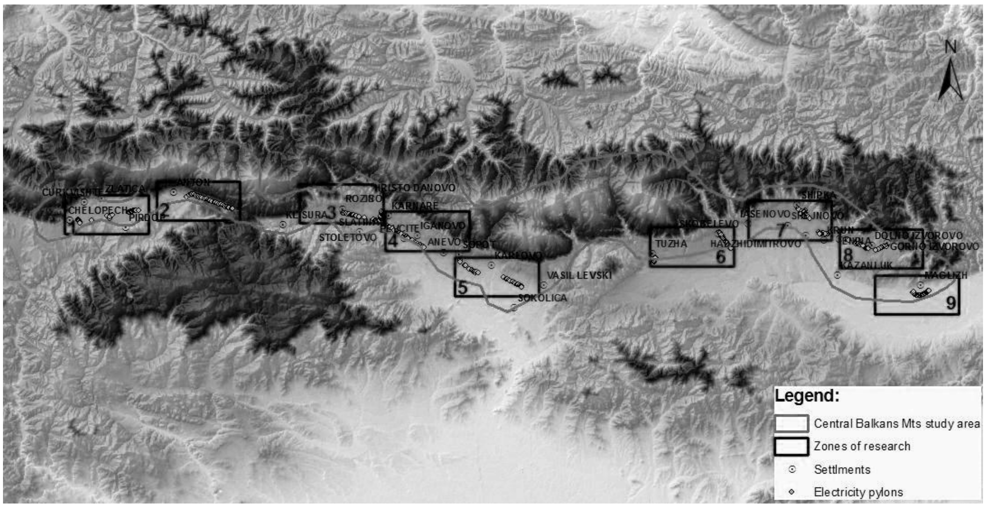

Figure 2. Potential reintroduction area of Sakers in the Central Balkan Mountains with the 9 study zones

Suslik habitat restoration

The selection of a model territory for restoration of the Suslik habitat was based on expert analysis, information provided by the Central Balkan National Park Directorate and authors' preliminary field studies. The summary of the data showed that in "Paradzhika" site (N42°40' E24°57'; 890–1209 m a.s.l.) there is a Suslik colony in a degrading habitat. The Suslik density and the area of the colony declined during the last years. The Suslik colony is situated in a pasture habitat with the following composition: 10% tree species (fruit trees—Wild Plums *Prunus spp.*, Sessile Oak, *Quercus petraea* and Beech, *Fagus sylvatica*; 20% Bracken, *Pteridium aquilinum*; 20% thicket forming shrubs (Briar, *Rosa canina* and Hawthorn, *Crataegus* spp.); and 50% open grass area of no particular habitat type (*I. Nikolov*, pers. comm.).

According to park employees and local people, there has been a significant population decline in the project regions in recent years. Probable reasons are intensive succession as well as shrub and tree overgrowth of large areas.

The team visited the area in April 2010 to identify the appropriate approach and observed the appearance of the first active Susliks in the region 15–20 April. The sites were cleared in July by employees and volunteers of Green Balkans NGO and the National Park Directorate. Shrubs, thorns, ferns, and tall grass were removed, using two mowers (bush trimmers: Husqvarna and Stihl) and two chainsaws (Stihl). Early in October the mowing was repeated to remove the newly emerged vegetation (ferns need to be mowed repeatedly in order to be eradicated). The vegetation removed during the clearing was left near eroded sections of the area.


Type 1. Metal structure with jumper wires and 3 lines


Type 2. Concrete pole with insulators fixed upwards and 3 lines


Type 3. Metal structure with isolators fixed downwards and 6 lines


Type 4. Concrete pole with insulators fixed downwards and 3 lines


Type 5. Metal lattice structure with isolators fixed upwards and 3 lines


Type 6. Switch tower (reproduced from *Gerdjikov, 2010*)


Type 1”. Metal structure with jumper wires and 6 lines


Type 5”. Concrete pole with isolator fixed upwards and 6 lines

Figure 3. The most common types of 20 kV pylons used in the electricity distribution network in Bulgaria

About 3 ha of the area were cleared out in total. Twelve plots (0.25 ha) in the cleared territory were chosen—six control and six experimental plots. The control plots were chosen so they are inhabited by Susliks, and the density and abundance of Susliks were estimated. The experimental plots were not inhabited by Susliks, but they were situated next to the control plots, so occupancy of that territory is expected to prove the work hypothesis.

Density and abundance of the Susliks were estimated through linear transects, each 50 m long and 5 m wide (9-10 transects in each plot, 58 transects in total). Four types of Suslik

Suslik hole type	Number of transects	Number of holes	Average number of holes per transect
Horizontal hole with material	58	28	0.5
Vertical hole with material	58	26	0.4
Horizontal hole, no material	58	10	0.2
Vertical hole, without material	58	6	0.1
Total	232	70	1.2

Table 1. Relative abundance of different types of Suslik holes (±SD) in the studied area. Transect length 100 m, covering an area of 0.05 ha

holes were recorded during the transects: horizontal holes with material, horizontal holes without material, vertical holes with material and vertical holes without material. Thirty new holes (7 cm diameter, 40-50 cm depth) were made in the experimental plots to encourage the expansion of the colony. A motor drill (Stihl) was used for digging holes.

Assessment of the electricity network threat

The field work was completed at the end of July by three participants in three days. The assessment was done through on-foot covering of linear transects of the electricity grid (20 kV power line) within the project area. The electricity network in each zone was inspected only once during the study. The study area was divided into 9 zones, starting from the town of Chelopech to the West and ending near the town of Maglizh to the East (Figure 2). These zones are found along the lowland near the mountain foothills where the expected hunting range of the released Saker Falcons lies.

The location of every pylon was recorded with a GPS device and plotted on map (Figure 2). The total length covered was 64 km and comprised a total of 488 electricity pylons of different types. The individual length of the transects in each zone varied between 6.3 km and 9.1 km, and the number of pylons mapped in each transect varied from 30 to 88. For the estimation of the electrocution risk we however only used a random selection of 270 of the pylons (30 in each zone). The Microsoft Office Excel 2007 program was used for the randomization.

The most frequent types of pylons used in Bulgaria are presented in Figure 3. Pylons in our study area were recorded in a standard data sheet describing several elements of the object i.e., (1) material of the basic construction (metal or concrete); (2) number of wires; (3) direction of the insulators (downward or upward); (4) availability of jumper wires along the insulators. Every type of pylon was compared with the type of the pylons described in *Demerdzhiev et al. (2009)* and *Gerdjikov (2010). Demerdzhiev et al. (2009)* classified the different structures of the power lines in the following order: Type 1 (most hazardous), Type 5 (second most hazardous), Type 2 (third most hazardous) and Type 4 (safe for the birds). According to the results of *Gerdjikov (2010)* Type 1 was the most dangerous structure as well, followed by Type 2. Type 5, however, was presented in his study area with only 1 pylon. Type 4 ranked last by risk with only 2 victims during the study period. Pylons

Site	Date of inspection	Number of transects	Relative density Average number of holes per 100 m transect
Ravniya Buk	12.6.2005	19	8 ± 2,98
Karamandra	29.8.2005	4	0,25 ± 0,5
Boluvanya	30.8.2005	9	6,8 ± 3,3
Ravna	07.10.2005	16	1,8 ± 1,7
Paradzhika – *Y. Koshev*	20.07.2009	9	0.4*
Paradzhika – *present study*	2010	58	1.2 ± 1.4

Table 2. Relative density of European Suslik found by *Stefanov (2005)* and the present study (* only 2 holes recorded)

with insulators fixed downwards (like Type 4) are considered by *Stoychev & Karafeizov (2004)* as relatively safe for the birds too. *Gerdjikov (2010)* calculated an index of mortality, called Killing Rate (KR), for the most numerous types of pylons. The KR index varies from 0 to 1; the higher the rate the more dangerous type of pylon it is. Type 1 was with KR = 0.19 while Type 2 with KR = 0.16. Based on findings of *Demerdzhiev et al. (2009)* we estimated that the KR index of the Type 5 would be in the range of 0.16–0.19, in case that type was presented in the study of *Gerdjikov (2010).*

Based on these indices for the purpose of our study we established a Risk Coefficient (RC) for each type of pylon presented in the Central Balkan Mountains area, as follows:

RC = 0 for Type 4, being safe for the birds;
RC = 1 for Type 1, 2 and 5, as the KR is almost the same according to the other studies;
RC = 2 for Type 1" and 5", as those pylons are similar to Types 1 and 5 but constructed with 6 lines instead of 3 and therefore expose the birds to an approximately twice as high risk of electrocution.

In order to estimate the electrocution risk we established the Electrocution Risk Index (ERI) in each transect calculated as follows:

$$ERI\ (zone\ n) = SUM\ [N\ (pylon\ type\ m) \times RC\ (pylon\ type\ m)]$$

The Electrocution Risk Index was the basis for choosing the most suitable area for initial releases in terms of avoiding potential electrocution problems.

Additionally we recorded the number and species of birds found under the wires and around the electricity poles. All victims within 5 meters of the pylon were considered electrocuted and birds found within 10 m on either side of the lines were considered victims of collision with power lines (following the methodology in *Demerdzhiev et al., 2009*). For future studies habitat type of each pylon was also classified i.e. (1) cultivated land (crop), (2) orchards, vineyards and rose plantations, (3) abandoned land, (4) pasture, (5) swamp, (6) forest.

	Pylon type					
Zone #	**1**	**2**	**4**	**5**	**1''**	**5''**
1	6	22	2	0	0	0
2	0	0	0	0	30	0
3	10	16	4	0	0	0
4	7	23	0	0	0	0
5	2	18	0	0	3	7
6	12	18	0	0	0	0
7	7	22	1	0	0	0
8	13	15	0	2	0	0
9	12	12	0	6	0	0
Total	69	146	7	8	33	7

Table 3. Distribution of the various types among the 9 study zones in the Central Balkan Mountains area.

Results and discussion

Suslik habitat restoration

The initial field visit completed in April showed that Susliks in “Paradzhika” site left their holes and became active two weeks later than the individuals of the plain colonies situated in the foothills of the Balkan Mountains in the same region and more than a month and a half later than those in Southern Bulgaria, the Tundzha river valley. The life cycle of the mountain population was therefore much shorter. This has to be taken into consideration when implementing concrete conservation activities targeting Saker Falcon.

The Suslik abundance in the control plots varied from 2 to 24 holes, probably because of the specific conditions of the habitats (Figure 4). The general abundance of the species found was about 1.2 vertical holes without material/0.05 ha (±0.4) (individuals respectively, (Table 2). According to a large scale research carried out by *Straka (1961),* there were 13 holes per individual. As a total 70 holes were recorded altogether in our study area, it can correspond by calculation to at least 5.38 individuals on the control sites. We therefore consider the overall relative density of the species in the study area as extremely low.

As far as a comparison with the results of *Stefanov (2005)* for other regions in the Central Balkan Mountains is possible, it shows that the relative density of Suslik in the study area is one of the lowest (Table 2).

In 2010, the team did not record any reoccupation by Susliks to the newly cleared territories of the experimental plots. Possible resettlement and expansion of the colony could be expected in a year or two.

Yet, regular grazing of farm animals has already been recorded in the experimental plots. Being attracted to the region by the fresh green grass, the animals maintain the vegetation low through grazing and trampling. The presence of farm animals in these areas is of particular importance for their maintenance in a condition favourable for Susliks. Currently, 120 sheep and ca. 10 cattle are declared to be grazing in the region of the Suslik colony in “Paradzhika” site in an area of 70 ha, although in certain periods, during transhumance, these numbers get higher. The norm of the grazing animals in the National Park is one

No	Species	Cause of death	
		Electrocution	**Collision with lines**
1	*Circus* sp. (male)	1 (pylon type 2)	–
3	*Pica pica*	4 (pylon type 2 and 1'')	–
4	*Corvus corax*	1 (pylon type 2)	–
	Total	6	–

Table 4. Species composition of the victims, cause of death and the types of pylons that caused fatalities

sheep per minimum 0.4 ha at present (according to Central Balkan National Park Management Plan), therefore a maximum of 175 sheep can inhabit those 70 ha pastures. It will be have to be tested in a future study if this value for the livestock at the area can maintain favourable conditions for the Susliks.

The monitoring on the pilot sites will continue in order to trace the success of the habitat conservation measures and secure appropriate and sufficient food source for the Saker Falcons to be introduced on the site.

Electrocution risk estimates

Six types of pylons were recorded in our study area (Table 3). They were all among the most common pylon types used in Bulgaria (Figure 3). Four of those types matched the constructions classified by *Demerdzhiev et al. (2009)* and *Gerdjikov (2010)* (types 1, 2, 4, 5). Two types (1" and 5") were similar to type 1 and 5 but had 6 lines instead of 3. Three of the types described by the authors mentioned above were not recorded in the Central Balkan Mountains (types 3, 6 and 7). Type 6 is considered as particularly dangerous for the birds *(Demerdzhiev et al., 2009)* and type 7 is among the most dangerous ones according to *Stoychev & Karafeizov (2004),* while type 3 is assessed as favourable for the birds due to suspended direction of the isolators *(Demerdzhiev et al., 2009).* The distribution of the various types of pylons among the 9 zones and the total number of pylons is presented in Table 3.

The results of the assessment of the electrocution risk in the study area are presented in Figure 4. As shown, the majority of the zones hold a relatively similar Electrocution Risk Index. The potentially most dangerous zones appear to be N2 or the region on the east of the town of Anton. The second most dangerous transect is N5, the region south-eastwards of the town of Sopot, around Karlovo and west of the town of Vasil Levski. The third most dangerous zone is N9, the territory in the vicinity of the town of Maglizh. These sections should therefore be avoided in the selection of sites for an initial release.

Three zones represent an average threat of electrocution. These are: N4—the territories southeast of Karnare village, around the village of Iganovo and northwest of the town of Sopot; N6—east of the village of Tuzha and southwest of the village of Skobelevo; as well as N8—northeast of the town of Kazalnluk and around the village of Gorno Izvorovo.

The zones with the lowest risk for birds of prey are: N3—a territory east of the town of Klisura, around the village of Rozino and west of the village of Karnare. The second lowest threat is zone N1—the region around the towns of Chelopech, Zlatitsa and Pirdop. The third least dangerous zone is N7—east of the village of Iasenovo, south of the village of Shipka and northwest of the village of Krun. The exact hacking place should therefore be constructed somewhere near these territories. Zone N7 is surrounded by 2 transects of medium level threat only, which provides a large and relatively safe hunting area for the young falcons between the villages of Tuzha and Gorno Izvorovo. Another large area with a relatively low risk of electrocution is found between the town of Klisura and the village of Anevo, comprising a low level risk zone and a medium level risk zone.

A total of 6 dead birds of 3 species from 2 families were found during the present pilot study. All of them were suspected electrocuted and no birds were found under the wires which could potentially be considered as casualties of collision. Among the studied overall number of 488 pylons, pylon type 2 (concrete poles with 3 lines and insulators turned upwards) was proven the most dangerous with a total of 5 casualties found from a total of 42 pylons. In addition, type 1" (metal pylon with jumper wires and six lines) also caused the death of one1 bird. These results (despite the limited numbers of victims found) are in line with the findings of *Demerdzhiev et al. (2009)* and *Gerdjikov (2010)* on the most dangerous types of pylons.

In addition to that, numerous bird species were observed to perch on the wires and the pylons during the field work—especially Common Kestrels *(Falco tinnunculus)*. At the same time a total of 63 birds of prey from seven species were observed in the area, including species such as Imperial Eagle *(Aquila heliaca)*, Golden Eagle *(Aquila chrysaetos)* and Short-toed Eagle *(Circaetus gallicus)*. These observations for only three days once again prove the significance and conservation value of the selected reintroduction site.

Conclusions

Our study showed that the situation of the European Suslik colony in the region of "Paradzhika" site is almost critical—both in terms of abundance as well as occupied territory size. The existing and collected data suggest that without direct conservation measures, the habitat at the "Paradzhika" site will be destroyed by overgrowth of tall shrubs, trees and grass. Our working hypothesis "*Clearing of the territory will increase the numbers and enlarge the area occupied by Susliks*" was not proven during the first season of field work. A few more years of habitat monitoring and maintenance are needed to prove or reject it.

Grazing animals (sheep, cattle and goats) occupied the managed territory quickly after clearing it out. However whether or not their current numbers can maintain suitable habitat for the Suslik is unknown yet and future studies are needed to clarify it.

The level of electrocution risk is relatively similar along the study area (with one exception of Zone N2). The study however helped to identify the least and the most dangerous territories in regards of the potential electrocution threat. The area between Tuzha village and the town of Kazanluk are considered the most favourable places for constructing hacking facilities and implementing initial Saker Falcon releases.

Despite the limited number of bird victims found during the power line survey, the results support the findings of previous studies namely i.e. (1) pylons with insulators fixed upwards are the most dangerous for birds; (2) pylons with insulators fixed downwards are

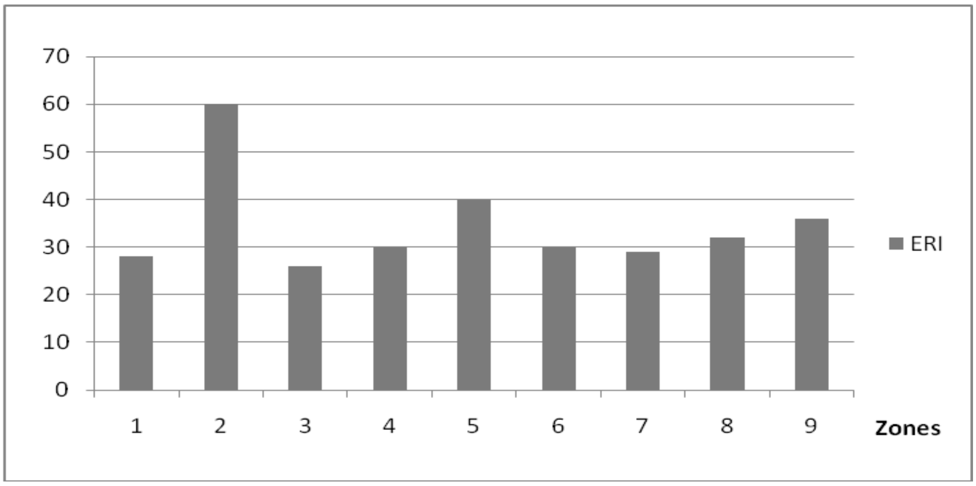

Figure 4. Electrocution risk assessment (columns represent the level of Electrocution Risk Index /ERI/ in each zone of the study area)

safe for birds; (3) pylons with jumper wires (see Type 1", Figure 3) cause considerable mortality but they are relatively rarely used in Bulgaria.

Recommendations

The efforts aiming at managing and supporting the habitats need to be continued in the future, namely:

1) Mowing of already cleared territories and continuing the monitoring of the Suslik colony in order to record the effect of the measures applied. If the activity has a positive effect on the Suslik population more territories should be included in the project (i.e. other colonies in the reintroduction area). Clearing, mowing, and removing ferns should be carried out at least twice or three times a year, depending on the plant growth rate before the process becomes "natural" by using livestock.

2) Reducing the bracken coverage from 20% to 5% through cutting and uprooting. This is not a plant species of Community importance, neither is it protected nationally or of particular conservation significance. Moreover, according to the agricultural regulations, this is a weed, obstructing pasture management. However, small percentage of this species has to be preserved, since it is a pioneer plant species for these particular areas.

3) Supervising the owners of farm animals grazing in the region to secure maintenance of the pastures in good agricultural and environmental condition in conformity with national park regulations. If possible, the owners have to clear on their own the pastures used. For sustainability of the process, once the habitats are cleared and made suitable for Susliks, the future maintenance should be done through animal grazing.

4) Future studies are needed for revising the regulations related to the number of grazing animals per area unit in the region (one sheep per minimum 0.4 ha) in order to understand if this is enough for maintaining the habitats in favourable conditions for the Susliks.
5) Placing an information signboard describing the importance of the colony, considering the tourist route passing the area.

We consider these measures of extreme importance for securing the survival and expansion of the Suslik colonies and therefore guaranteeing sufficient food source for the Saker Falcon population to be introduced within the target area.

The recommendations in regards to the electrocution threat are as follows:
1) Appropriate measures should be undertaken to retrofit the sections especially in the territory around the selected initial hacking site and in those territories that pose the greatest threat for the birds in the area. These measures should also be undertaken considering the concentration and species composition of the birds observed during the field studies.
2) Further research is needed in order to fully understand the impact of power lines in the area and be able to completely minimize the threat of electrocution.

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