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THE IMPACT OF POWER TRANSMISSION NETWORKS ON BIRDS

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ABSTRACT
A large number of bird species (such as Ciconia ciconia, Corvus sp.) and certain species of birds of prey are often observed perching on electricity poles or power lines, especially in areas with agricultural land lacking trees in the lowland regions of Romania. This type of behavior can lead to the death of individuals, and it is impossible for birds to learn, in the wild, that resting on these structures is dangerous. Several risk factors that contribute to the increase in the number of casualties were analyzed, such as the position of the insulators, the land use where the poles are located, the proximity of busy roads to the poles, the type of power grid depending on the voltage and the presence of tall shrubby vegetation at the base of the poles. Collisions with power lines were also analyzed; however, the number of victims was considerably lower compared to the number of electrocution casualties.
KEY WORDS: *birds, electrocution, collision, power transmission networks, power poles*

INTRODUCTION

Shortly after the installation of the first power transmission networks, the first bird casualties were also identified. Approximately 80% of the studies on this topic have been carried out in Europe and North America, while only 20% were conducted on other continents. However, the few studies performed confirm that the impact of power lines on birds is a global issue (Guil *et al.* 2021). Studies show that in the United States, between several hundred thousand and up to 175 million birds die annually due to collision, in addition to several hundred thousand victims of electrocution (Loss *et al.* 2014).

In Romania, this issue has been mentioned in a few articles. Munteanu and collaborators reported that stork populations are affected by power lines (Munteanu *et al.* 2017). Likewise, Szabó and collaborators discussed conservation measures for certain bird species, including the insulation of power poles (Szabó *et al.* 2012). However, to date, no published study has addressed the impact of power transmission networks on bird fauna in Romania. Some studies have been conducted at the request of electricity transmission and distribution companies, but these have not been published.

This study aims to analyze the impact of power transmission networks on birds and to identify the effectiveness of mitigation methods.

The research was carried out in Timiș County, predominantly in open areas without trees, where electricity poles were the only elevated structures available for birds to perch on. These areas were mainly represented by agricultural land, especially monocultures of cereals or rapeseed, which are the most common crops in Timiș County. Surveys were also conducted in Green Forest and Bistra Forest, as well as in their neighboring areas.

MATERIALS AND METHODS

The transect method was used, with routes selected using satellite images from Google Maps in order to identify the presence of power transmission lines in less accessible areas.

Field surveys were carried out between October 2023 and February 2025. Work was conducted in terms of 2-3 people to simultaneously check both the area beneath the power lines and the adjacent areas within 5 m. The horizontal bars of poles were also inspected to detect potential victims trapped there.

The following data were collected in the field: species, age, sex (when identifiable), type of remains found, type of power transmission network, distance between the lines and the victim (if found under power lines), presence or absence of tall vegetation at the base of the pole (if the victim was found under poles), geographic coordinates on the transect, and the location of each victim. Birds found were collected to avoid duplicate records.

Materials used: Canon EOS 4000D camera, measuring tape, disposable gloves, field notebook, disinfectant and GPS.

A total of 25 field trips were conducted, covering 27 different transects, with 65 km of power lines surveyed. The coordinates of transects and distances covered are presented in Table 1, while figure 1 shows their placement in the field.

TABLE 1. Coordinates of transects, type of power line (M=medium voltage, H=High voltage) and distance covered during transects

Date	Starting point	Finishing point	Type of power line	Distance covered (km)
22.10.2023	N 45.807222; E 21.264944	N 45.808106; E 21.262494	H	0,19
22.10.2023	N 45.806489; E 21.266567	N 45.806125; E 21.267614	H	0,1
22.10.2023	N 45.878153; E 21.210914	N 45. 854815; E 21.232238	M	10,94
4.11.2023	N 45.806616; E 21.264875	N 45.852169; E 21.236326	M	9
12.11.2023	N 45.783226; E 21.259100	N 45.783226; E 21.259100	M	1,44

Date	Starting point	Finishing point	Type of power line	Distance covered (km)
12.11.2023	N 45.858786; E 21.233258	N 45.858779; E 21.233258	M	1,98
26.11.2023	N 45.482180; E 21.160340	N 45.806549; E 21.266536	M	0,1
26.11.2023	N 45.805599; E 21.264391	N 45.806030; E 21.262668	M	0,2
26.11.2023	N 45.858759; E 21.235323	N 45.868453; E 21.229917	M	3,14
10.12.2023	N 45.770138; E 21.321871	N 45.771741; E 21.326353	M	1,34
13.01.2024	N 45.843569; E 21.117800	N 45.843569; E 21.117800	M	0,75
13.01.2023	N 45.783133; E 21.132654	N 45.779872; E 20.995396	M	4,1
24.02.2024	N 45.865057; E 21.320017	N 45.871893; E 21.339282	M	3
30.03.2024	N 45.928577; E 21.312381	N 45.938262; E 21.315688	M	1,24
01.04.2024	N 45.563923; E 20.998632	N 45.570982; E 21.007326	M	2,67
06.04.2024	N 45.239833; E21.267696	N 45.245924; E 21.265928	M	0,87
06.04.2024	N 45.267837; E 21.261832	N 45.274866; E 21.258299	M	2,7
13.04.2024	N 45.565199; E 20.997025	N 45.567991; E 20.968596	M	2,39
13.04.2024	N 45.647936; E 21.140082	N 45.653665; E 21.144322	M	0,74
17.07.2024	N 45.940089; E 21.033174	N 45.935368; E 21.089310	M	2,05
17.07.2024	N 45.904723; E 20.970381	N 45.908884; E 20.966000	M	0,706
18.07.2024	N 44.986138; E 20.532529	N 44.986138; E 20.532529	M	0
24.07.2024	N 45.863319; E 21.252281	N 45.863285; E 21.252327	H	0,1
19.08.2024	N 45.698885; E 21.431182	N 45.698885; E 21.431182	M	0
24.08.2024	N 45.172130; E 23.666653	N 45.172130; E 23.666653	M	0
01.09.2024	N 45.868942; E 21.229424	N 45.868832; E 21.229014	M	1,65
24.09.2024	N 45.776422; E 21.004204	N 45.785237; E 20.979682	M	4,56
20.10.2024	N 45.784709; E 20.979329	N 45.782498; E 20.974994	M	0,82
21.10.2024	N 45.172114; E 23.663217	N 45.172114; E 23.663217	M	0
15.11.2024	N 45.283673; E 21.277151	N 45.277369; E 21.268085	M	1,08
16.11.2024	N 45.752046; E 21.386823	N 45.748955; E 21.389789	M	3,35
26.11.2024	N 45.801971; E 20.907731	N 45.801971; E 20.907731	M	0
07.12.2024	N 45.919799; E 21.139579	N 45. 928042; E 21.048072	M	3,6
23.02.2025	N 45.791019; E 21.239683	N 45.7910190; E 21.239683	M	0

FIG. 1. Distribution in the field of the transects followed to identify victims (source: Google Earth)

RESULTS AND DISCUSSIONS

Species affected by power transmission networks

During the field surveys, 130 victims were collected and identified. They belonged to 16 species, from 10 families and 7 orders. The family with the highest number of species was Corvidae (25% of the species), while the order with the greatest species richness was Passeriformes (37%).

More than half of the victims (64%) belonged to two Corvidae species that feed predominantly in agricultural areas and frequently perch on electricity poles or power lines. These two species were *Corvus frugilegus* and *Pica pica*, accounting 36% and 28% of all victims (Figure 2).

The species *Buteo buteo* represented 13% of all victims. Its feeding behavior includes perching on electricity poles, thus being able to observe prey from a high point. Its large wingspan increases the chances of touching two conductors simultaneously, which results in electrocution.

Among the recorded victims, two were nocturnal raptor species, namely *Athene noctua* and *Tyto alba*, with one individual of each found. Regarding diurnal raptors, four species were identified, with a total of 26 victims.

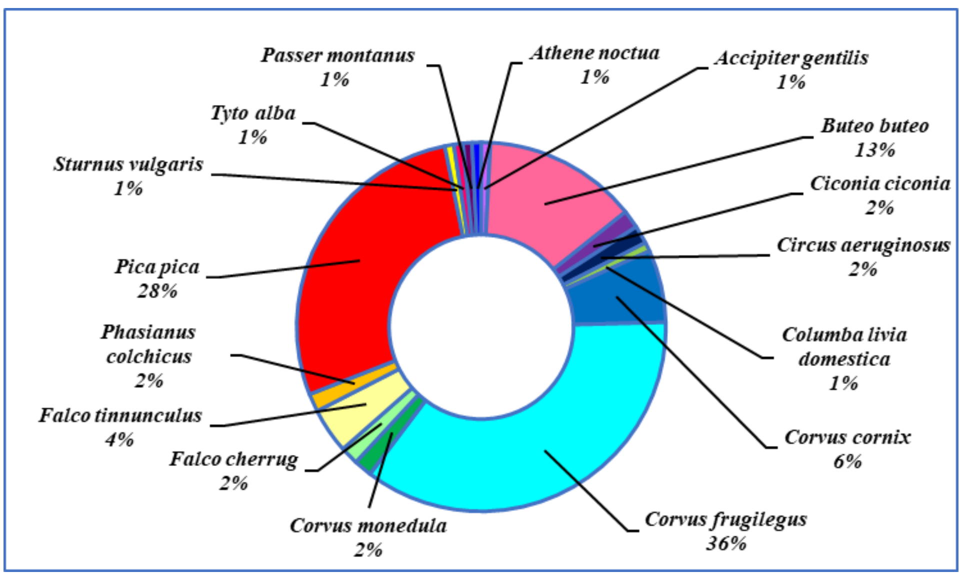

FIG. 2. Percentage numerical abundance of species that were victims of power transmission

Type of transmission networks

The vast majority of bird victims from power transmission (97%) were found under medium-voltage networks and 3% were observed near high-voltage networks, Guil and Perez-Garcia also reported that electrocution victims are often found near distribution lines (Guil *et al.* 2021), a fact also noted by Kagan (Kagan, 2016). In the case of high-voltage networks, electrocution does not occur because the distance between conductors and between the conductor and the pole, is sufficiently large. However, in this case (high-voltage networks), collision with power lines may occur more frequently. In our study, we identified four such victims of high-voltage line collision (species *Buteo buteo, Pica pica* and *Falco tinnunculus*), recorded in 1 kilometer of line investigated. By comparison, in 64 kilometers of medium-voltage lines surveyed, only two collision victims were identified (*Sturnus vulgaris* and *Buteo buteo*). These collisions with high-voltage lines take place usually when weather conditions are unfavorable and visibility is reduced, a fact also reported by some authors (Bevenger, 1994).

Pole placement in relation to surrounding land

A total of 129 birds (99%) were identified as victims of power transmission (both electrocution and collision) in agricultural areas that lacked trees in their immediate vicinity. Since many bird species used elevated perches above ground for hunting or vigilance, in the absence of tall trees they resort to perching on electricity poles.

Additionally, during two field surveys (covering a total of 2.78 km) near Green Forest and close to Bistra Forest, only a single electrocution victim was observed, namely one individual of *Accipiter gentilis.* This highlights the importance of tall trees near power transmission lines (especially medium-voltage) in significantly reducing the number of electrocution victims.

Another important aspect is the position of poles relative to busy roads. The vast majority of power transmission victims (70%) were collected near lines located at a sufficient distance from roads so that vehicle noise could not be heard. Near power lines located close to roads (tens of meters), the number of victims was considerably lower (30%).

Vegetation beneath and around poles

The influence of woody shrub vegetation at the base of poles on the likelihood of electrocution was analyzed (Table 2). The hypothesis behind this analysis was that shrubs at the base of poles make them resemble trees, which could encourage birds to perch on them.

Of the 124 victims found at the base of electricity poles (electrocution victims), only 22% were found under (or immediately next to) poles that have tall woody vegetation at the base. Among all raptor victims (orders Strigiformes, Falconiformes, Accipitriformes), 21,4% were electrocuted at poles with woody vegetation at the base. Likewise, 21,8% of non-raptor species (orders Passeriformes, Galliformes, Columbiformes, Ciconiformes) were identified under poles with shrubs at their base.

Thus, it can be stated that the presence or absence of woody vegetation at the base of poles does not influence the likelihood of electrocution at electricity poles. Table 2 excludes victims of collision with power transmission lines (1 individual of *Sturnus vulgaris,* 3 individuals of *Buteo buteo,* and 1 individual of *Falco tinnunculus*).

Collision VS Electrocution

In terms of impact on birds, the presence of poles – through the risk of electrocution – accounted for the cause of death in 95% of identified victims. Thus, we can state that one electrocution victim was identified for every 528 meters of power lines surveyed, corresponding to approximately 12 poles. Collision with power transmission lines accounted for only 5% of identified victims.

TABEL 2. Record of the presence or absence of shrubs at the base of electricity poles in relation to species and number of individuals that were victims of electrocution

	Presence of shrubs	
	Yes	**No**
Corvus frugilegus	8	38
Pica pica	8	27
Corvus monedula	1	1
Buteo buteo	2	14
Falco cherrug	1	1
Passer montanus	1	0
Corvus cornix	3	5
Falco tinnunculus	1	4
Athene noctua	1	0
Accipiter gentilis	1	0
Ciconia ciconia	0	2
Circus aeruginosus	0	2
Columba livia domestica	0	1
Phasianus colchicus	0	2
Tyto alba	0	1
Total of raptors	**6**	**23**
Total of non-raptors	**21**	**75**
TOTAL	**27**	**98**
Total victims of electrocution	**125**	

Additionally, during the field surveys, a victim of the species *Falco cherrug* was collected, showing specific electrocution features such as necrosis of the legs and wing injuries, found approximately 100 meters from high-voltage lines. Following necropsy, specialists confirmed that the bird had been electrocuted in a city in Hungary; although the incident did not kill the individual immediately, it weakened it to the point that it was no longer able to feed (personal communication: Gábor Deák, LIFE21/NAT/HU/101074704). This case indicates that the number of electrocution victims caused by power transmission networks may be higher than initially assumed.

Mitigation methods

Mitigation methods to prevent electrocution include: insulating conductors with rubber strips; spikes along the horizontal bars of poles; spikes at insulators; T-shaped perches (Ferrer, 2012); nest platforms for *Ciconia ciconia*; and mounting insulators below the bar (Demeter *et al*. 2004). Among the methods mentioned, during field surveys we observed rubber strips insulating conductors, spikes mounted at insulators and nest platforms for *Ciconia ciconia*. Out of 64 km of medium-voltage lines, we identified only 7 poles with rubber insulators, but these ones also had victims (*Pica pica* – 1 individual, *Corvus frugilegus* – 3 individuals, *Corvus monedula* – 1 individual).

Prevention methods for collision with power lines include: installing reflective devices, attaching black rubber strips, mounting colored shapes along high-voltage lines and installing raptor silhouettes (Ferrer, 2012). During fieldwork, colored spheres and reflective devices were observed. Along the 1 km of high voltage lines surveyed, spikes at insulators were present on all poles, while colored spheres were only observed on high-voltage lines near the airport and airfield.

CONCLUSIONS

Electrocution represents the major impact of power transmission network on birds. Of the 130 victims recorded from power transmission networks, most belonged to the family Corvidae. In addition, many raptor species were among the victims, most frequently individuals of *Buteo buteo*. The victims of electrocution also included two individuals of *Falco cherrug*, a species considered at risk of extinction.

Among the mitigation methods against electrocution observed in Romania are: insulation of conductors with rubber strips, placement of insulators below the horizontal bar of poles, installation of spikes at insulators and nest platforms for birds. For collision prevention, colored spheres and reflective devices were observed during fields surveys, used to increase the visibility of high-voltage lines.

Given the high number of victims, it is necessary to install more mitigation mechanisms against electrocution and collision with power transmission networks, in order to reduce as much as possible their impact on birds.

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