TECHNICAL REPORT

ACTION A.2

Assess collision risk with powerlines and mapping high risk areas at key sites in Bulgaria

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Conservation of the Dalmatian Pelican along the Black-Sea Mediterranean Flyway/Pelican Way of Life

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TABLE OF CONTENTS

1. Introduction

The main method to provide electrical power to end users in Bulgaria, Romania and Greece is by overhead power distribution lines. These lines located in natural habitats of various types and running along pylons of unsafe structure utilizing isolators of different types, sometimes pose a serious threat to birds and their lives. Contemporary studies from various states show that bird mortality, caused by hazardous overhead power lines is one of the main global problems causing loss of biodiversity (Markus 1972, Haas 1980, Ledger & Annegarn 1981, Ferrer & Hiraldo 1991, Ferrer *et al*. 1991, Bayle 1999, Guyonne *et al*. 1999, 2001, Arhipov 2000, Janss 2000, Kruger & Van Rooyen 2000, Van Rooyen 2000, Adamec, 2004, Karyakin *et al.* 2005, Karyakin & Barabashin 2005, Mastina 2005, Medzhidov *et al.* 2005, Pestov 2005, Rubolini *et al.* 2005, Kariakin & Novikova 2006, Cartron *et al.* 2006, Lehman *et al.* 2007, Harness 1998, 2000), Harness *et al*. 2008).

There are two main aspects of the negative effect to birds of the power distribution lines:

- **Electrocution** – when perching on, or taking off, a pylon, a bird may cause electric shock by bridging with its body the power conductors and the earthed parts of the pylon. The risk of such short circuits increases during wet and rainy weather. In addition, the birds' excrement is semi-liquid and may, during defecation, cause a 'voltaic arc' while the birds are perching on a pylon above the conductors.

- **Collision with power lines** – during flight, birds may collide with the power conductors that are difficult to see, especially in poor weather with low visibility. Another reason why birds collide with overhead power cables is that when flying, birds often aim their attention away from the direction of their flight, seeking food on the ground or looking out for threats.

Various studies have recorded the negative consequences for certain species at the population level, such as the Spanish Imperial Eagle (*Aquila adalberti* Brehm, 1861*)* (Ferrer *et al.* 1991), the Eagle Owl (*Bubo bubo* Linnaeus, 1771) (Sergio *et al*. 2004) or the gallinaceous birds (Galliformes) (Bevanger 1995). According to the available evidence, the increased mortality and reduced population of the Steppe Eagle (*Aquila nipalensis* Hodgson, 1833) in Kazakhstan is caused exactly by the power transmission grid (Moseikin 2003).

It is clear from the studies carried out so far, that most of the overhead power lines in Bulgaria are not safe for the birds. The 20 kV power transmission lines are most hazardous (Stoychev & Karafeizov 2004, Demerdzhiev *et al*. 2009, Demerdzhiev 2014) and, also, are among the most widespread in Bulgaria (along more than 110,0000 km). The first systematic study of bird mortality caused by interaction with the hazardous 20 kV power distribution network was carried out in 2004 (Demerdzhiev *et al*. 2009). The results from this study show that a large number of birds of various species die every year by interaction with the hazardous power distribution network, with the most affected orders being *Ciconiiformes* (storks), *Accipitriformes, Falconiformes* (diurnal birds of prey), *Passeriformes* (sparrows) and the family *Corvidae* (corvids).

2. Project sites

This action has been taken place in Bulgaria, Romania and Greece. Collision with power lines is known as a threat for many bird species including Dalmatian Pelican. Mortality of Dalmatian pelicans caused by collisions has been recorded in some project sites including

Mandra- Poda, Amvrakikos and Messolonghi wetlands, Lake Suhaia along the lower Danube. Along project sites Lake Tasaul-Corbu and in the Danube Delta Biosphere Reserve, there are sections of power lines which are located along the most commonly used flyways by Dalmatian pelicans from their breeding grounds to breeding colonies. In many countries with high concentrations of waterfowl birds, the power lines pose a considerable threat and this threat requires assessment to evaluate its severity. Understanding the nature of bird collisions is essential for minimizing them.

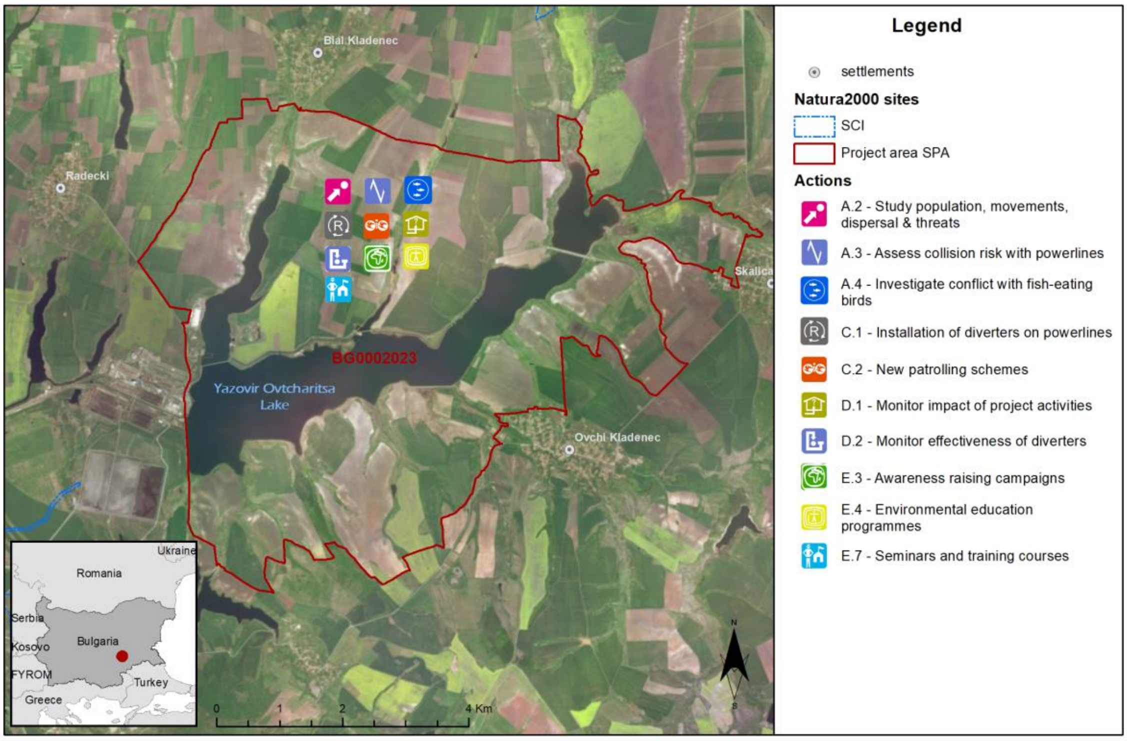
Project sites in Bulgaria:

- **Yazovir Ovtcharitsa BG0002023**

The site is reservoir of the Ovtcharitsa River, east of the town of Radnevo that does not freeze in winter. It is surrounded by low hills of arable land. Immediately next to the dam wall Heating Plant 2 is located. The area is also includes the nearby small pools with standing water, the sedimentation pools of the heating plant and the valleys of several smaller rivers. Ovtcharitsa Reservoir is one of most important places in the world for the wintering Dalmatian Pelican. The peak of the wintering pelicans count for the site is 406 individuals. A large proportion of the Dalmatian Pelicans are young and immature individuals.

Project site 7 : Yazovir Ovtcharitsa

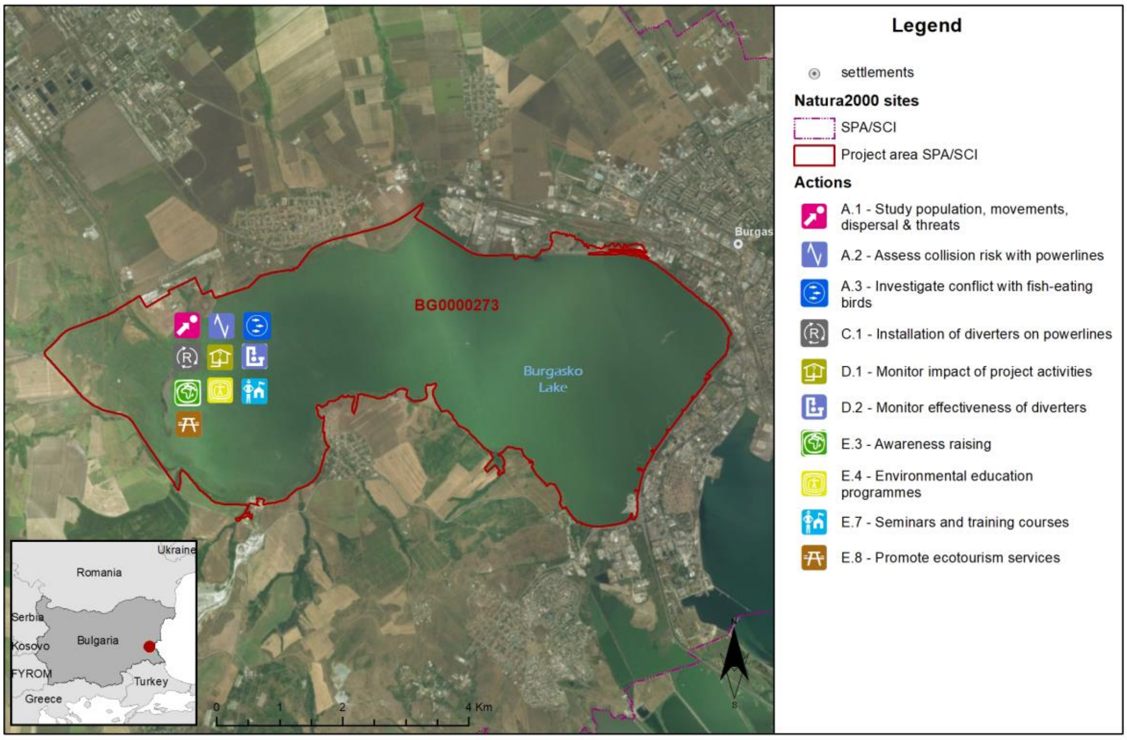
SPA: BG0002023 Yazovir Ovtcharitsa



- **Burgasko Lake BG0000273**

Burgasko Lake is a shallow brackish coastal lake – an open firth with a loose connection to the sea, fringed with hygrophytes. It is located to the west of the city of Burgas. Its entire eastern part and parts of its northern and south-western parts are contiguous with the industrial and residential areas of the city. Burgasko Lake is one of the most important staging sites for the Dalmatian Pelican in this part of Europe. All the population from the Danube Delta stages here during migration. The species occurs at the lake all year round and uses the lake mainly for feeding. In its eastern and western parts, pelicans roost as well, sometimes in flocks up to 130 individuals.

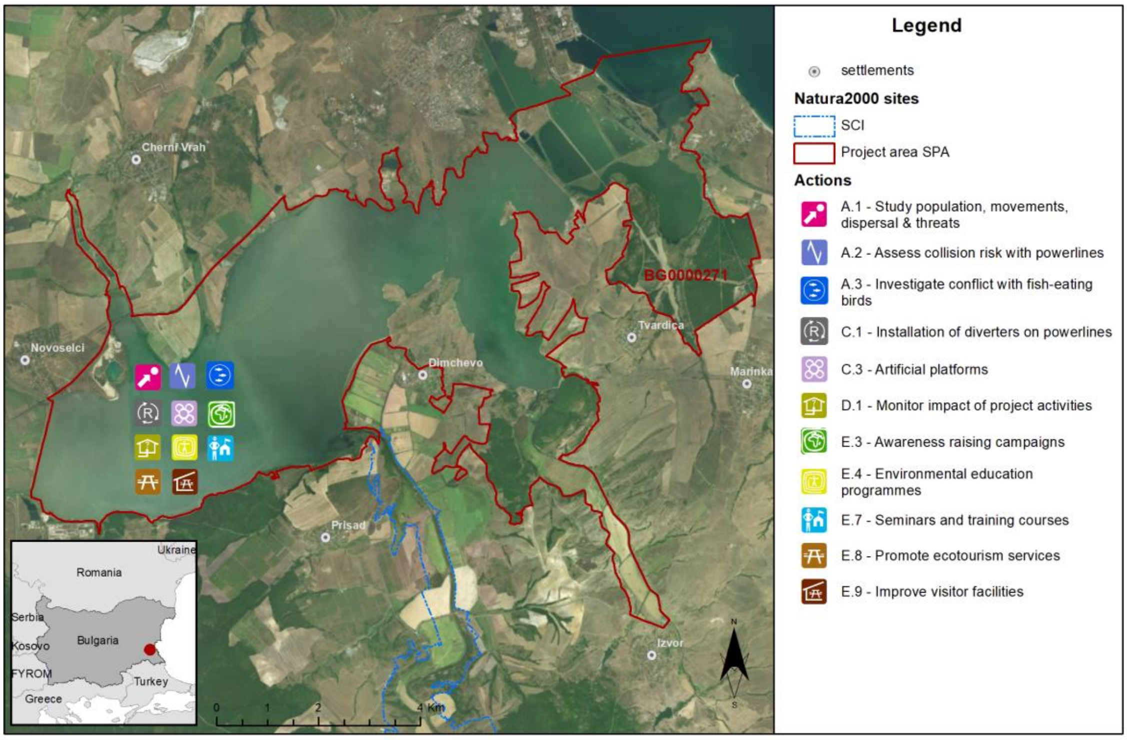
Project site 6: Burgasko Lake
SPA/SCI: BG0000273 Burgasko ezero



- **Mandra-Poda Complex BG0000271**

The Mandra–Poda Complex includes Mandra Lake with its adjacent wetlands. Mandra Lake is located at the Black Sea coast and is the southernmost of the Burgas lakes. Its north-eastern section is continuous with the city of Burgas. This former brackish lake has been converted into a freshwater reservoir. A lagoon, covering the areas of Podaand Uzungeren, has been preserved between the dam of the reservoir and the Black Sea, connected with the shallow marine area of Foros bay. The former oxidising pools of the petrol refinery between the dam and the E87 road (in the Komlushka Lowland) and the cascade-likelocated fishponds in the north-western part of the lake, south of the village of Cherni Vruh, are also part of the complex. Until 1940 Mandra Lake hosted the last mixed breeding colony of the Dalmatian Pelican and White Pelican in Bulgaria. Its disappearance is due to the drainage of the marshlands at the western part of the lake, which has destroyed the huge reedbeds there. Since then the lake and adjacent smaller wetlands have been used by pelicans all year round (sometimes demonstrating breeding behaviour), but no nesting was proved. Being situated at just one-day flight for the pelicans from the Danube Delta, the Mandra, Burgasko and Atanasovsko Lakes are the key stopover area on the migration flyway of these two species. Together with Burgasko Lake, the Mandra Lake is their main feeding place during their annual presence here. The easternmost parts of Mandra–Poda complex (Komlushka Lowland and Poda) are also important roosting sites for the Dalmatian Pelican. During severe winters, when the rest of the Burgas Wetlands get frozen, the Poda Protected Site and Foros Bay are the only area with open water around Burgas, where Dalmatian Pelicans (and all other wintering waterfowl, including White-headed Duck, Common Pochard, and other globally threatened birds) find shelter and food.

Project site 3: Mandra-Poda Complex
SPA/SCI code: BG0000271 Mandra - Poda

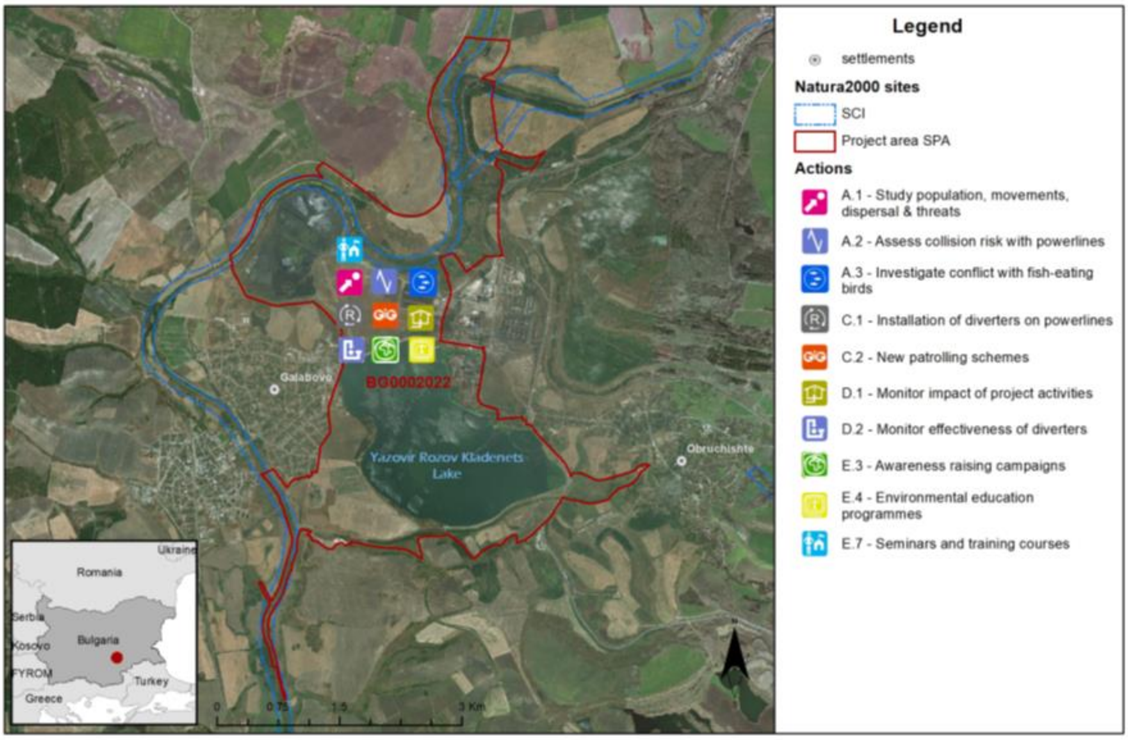


- **Yazovir Rozov Kladenets BG0002022**

A water reservoir, located between the villages of Galabovo and Obruchishte in the Sokolitsa river valley, at the spot where it joins Sazliika River. It is surrounded by low hills (100-130 m high) and by settlements with huge industrial center on the east and west. There is a smaller water reservoir to the north of the reservoir wall, at about 1 km from it. Because of the existing natural connection, the area also includes a part of the shallow valley of the Sazliika River. The reservoir water is used to cool down the nearby heating plant and because of this they keep a comparatively constant temperature in winter, usually higher than the ambient. Rozov Kladenets reservoir is one of most important places in Bulgaria for the wintering Dalmatian Pelican. The peak of the wintering pelicans count for the site is 212 individuals. A large proportion of the Dalmatian Pelicans are young and immature individuals.

Project site 8 : Yazovir Rozov Kladenets

SPA: BG0002022 Yazovir Rozov Kladenets



3. Aim and objective

This study aims to: Study the impact of the 20 kV and 110 kV power lines distribution network as a factor for increased mortality among birds in the areas inhabited by Dalmatian Pelican in Bulgaria, Romania and Greece and to identify the power lines in priority need of isolation in order to prevent deaths among individuals of this particular species.

The data for following tasks will be collected in order to achieve these goals:

- Studying of the species of the victims and identification of taxa, which are most affected by the negative impacts of the 20 kV/110 kV power lines.
- Recording of the type of electricity pylons causing bird mortality by electrocution.
- Recording of deaths caused by collision with power lines.
- Identification of the most bird-unsafe pylons and the most dangerous power distribution lines.
- Recording the effect of the habitats on bird mortality caused by the 20 kV/110 kV power distribution network.
- Recording the effect of the topography on bird mortality caused by the 20 kV/110 kV power distribution network.
- Recording the effect of the annual seasons on bird mortality caused by the 20 kV/110 kV power distribution network.
- Recording the effect of the birds' sizes on bird mortality caused by the 20 kV/110 kV power distribution network.
- Outlining specific measures to prevent bird mortality caused by the 20 kV/110 kV power distribution network.

In parallel with the search for the carcasses, a methodology for flight behaviour observations in the region of the SPA “Mandra-Poda Complex” near Burgas was carried out for a period of two months (October - November 2020).
In the flight behaviour observations:

- Recording all birds directly crossing the power lines for eight days in the month of November from a vantage site, for three hours at sunrise, starting 15 minutes beforehand and for three hours at sunset, finishing 15 minutes after it
- Recording bird related information being the species name, number, and direction grouped into 15 minutes intervals
- Recording birds’ behaviour in relation to reacting to the power lines (changing flight route/not changing flight route).
- Recording weather conditions being rain, cloud cover, wind direction and power (Beaufort scale (RMetS, 2018)).
- Recording if the earth wire has any impact on birds’ behaviour

4. Methodology

4.1. General information

Several types of 20kV power distribution facilities (referred to below as pylons for short) are present in the studied areas in Bulgaria, identified by various combinations of support structure (the pylon) and the number and positioning of the insulators on the structure. The main pylon types are (Annex 1):
- **Type 1** – tension lattice towers with 3 isolators attached sideways;
- **Type 2** – reinforced concrete pylons with 3 standing isolators;
- **Type 3** – lattice towers with 6 isolators positioned on 2 support beams in a downward direction (dual line with hanging isolators);
- **Type 4** – reinforced concrete pylons with 3 hanging isolators;
- **Type 5** – lattice towers with 3 standing isolators;
- **Type 6** – lattice towers (three-pole disconnectors, outdoor, sectionalizers) with 9 standing isolators (switching electric towers/masts);
- **Type 7** – lattice towers with 6 isolators positioned on 2 support beams in a standing (upward) position;
- **Type 8** – lattice towers with 6 isolators positioned on 2 support beams in a standing position (dual line with standing isolators);
- **Type 9** – dual tensioning lattice towers with 6 isolators positioned on 2 support beams in a sideways position with jumper conductors.

4.2. Methodology of the field survey

The power distribution lines must be inspected once each month between March 2020 and February 2021, with at least 20 and at most 30 days between walk-arounds (Demerdzhiev 2014). For DP’s wintering sites and stop-over sites this is September-February while for breeding this is March-August. The walk-arounds are carried out by transect method (Bibby et al. 1999) recording victim remnants within a 20 m. radius around each power-line side. The following parameters were considered for each pylon – GPS coordinates (GPSMAP 60Cx), pylon type, habitat within a 100 m radius around the pylon, topography. The field experts collect data on the following characteristic for each discovered victim: power-line name, type of pylon, GPS coordinates of the victim location, species, age and gender of the bird, if possible, number of victims, condition of victims (fresh carcass, mummified carcass, feathers and bones, only feathers or only bones, with traces of singeing or burns), distance and direction of the location of the victim relative to the pylon and the power conductors, habitat type, and topography. Comparative material (feathers, bones) is used for identification of the victims and of their remnants. Inventoried victims are collected from the respective power line to avoid repeated counting during the next walk-around. All casualties in a radius of 5 m. around the pylon are considered dead from electric shock, and the birds found under the cables, but at a distance of more than 5 m. from the pylon, as dead by collision with the power cables (Demerdzhiev et al. 2009, Demerdzhiev 2014). The data about the casualties will be collected by mobile application like SmartBirds Pro, ObsMapp, E-bird.

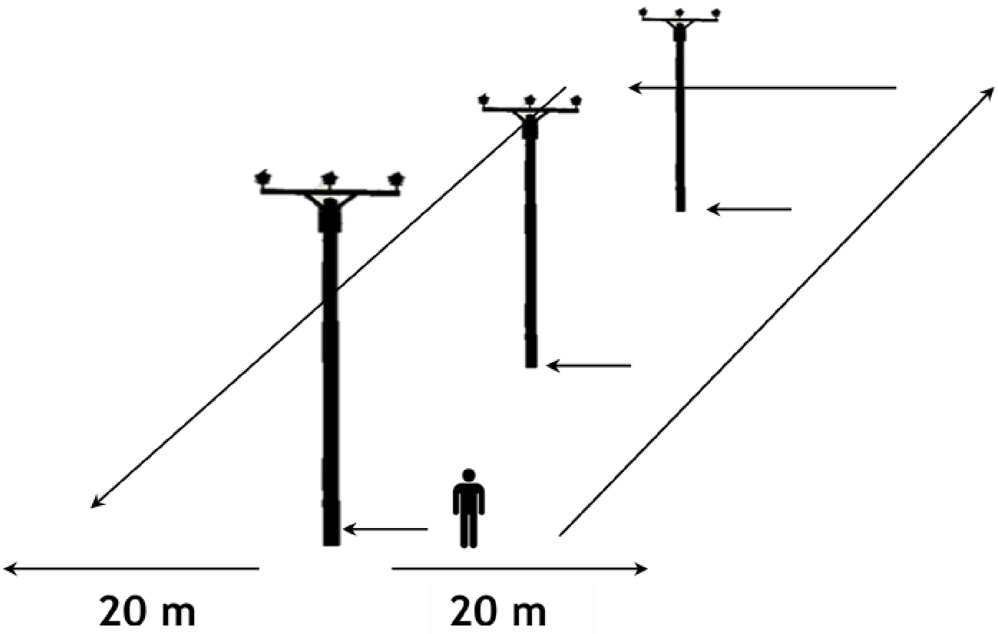
4.3. Methodology for flight observations at SPA Mandra-Poda Complex

On the lines running above water the method of direct carcass counts is not possible, giving place for an alternative assessment of birds' reaction and behaviour when crossing dangerous lines. On this section of power lines direct field observations will be carried out with binoculars and a telescope. These lines intersect an important wetland habitat, where daily movements of bird occur crossing the lines towards the feeding sites on one side and the roosting place on the other. These movements occur in the morning and in the evening, therefore, for eight days vantage observations will be made for three hours at sunrise, starting 15 minutes beforehand and for three hours at sunset, finishing 15 minutes after it. For each observation, the species name, number, direction, and behaviour in relation to reacting to the power lines will be recorded and grouped into 15 minutes intervals. Additionally, the weather conditions will be recorded, being rain, cloud cover, wind direction and power (Beaufort scale (RMetS, 2018)). The earth wire will be recorded for the observations if an increased collision potential is linked to it (Szabó, 2020).

5. Field study

The power distribution lines were inspected once each month between March 2020 and April 2021, with at least 20 and at most 30 days between walk-arounds (Demerdzhiev 2014).
Additionally data were collected on dead pelicans in the studied areas during the regular monitoring in July 2021 - March 2022. The walk-arounds were transects (Bibby et al. 1999) recording victim remnants within a 20 m. radius around each power-line side. The following parameters were considered for each pylon – GPS coordinates (GPSMAP 60Cx), pylon type, habitat within a 100 m radius around the pylon, topography. The following data were recorded in a standard field form for each discovered victim: power-line name, GPS coordinates of the victim location, species, age and gender of the bird, if possible, number of victims, condition of victims (fresh carcass, mummified carcass, feathers and bones, only feathers or only bones, with traces of singeing or burns), distance and direction of the location of the victim relative to the pylon and the power conductors, habitat type, and topography.

Comparative material (feathers, bones) were used for identification of the victims and of their remnants. Inventoried victims were collected from the respective power line to avoid repeated counting during the next walk-around. All victims in a radius of 5 m. around the pylon were considered dead from electric shock, and the birds found under the cables, but at a distance of more than 5 m. from the pylon, as dead by collision with the power cables (Demerdzhiev et al. 2009, Demerdzhiev 2014).



6. Results

6.1. Field survey

39 power distribution lines with a total length of 62.9 km were walked over in the study regions. **A total of 38 dead pelicans (23 Great White pelicans *Pelecanus onocrotalus* and 15 Dalmatian pelicans *Pelecanus crispus*) because of collision with power lines were found during the field survey.** An adult injured Dalmatian Pelican was found at Rozov kladenets dam and was rescued by a BSPB team.

SPA Yazovir Ovtcharitsa BG0002023

No dead pelicans were found at Yazovir Ovtcharitza SPA.

SPA Yazovir Rozov Kladenets BG0002022

2 ind. Dalmatian pelicans were found dead in December 2021 and another 2 ind. were found dead in January 2022 in the region of the Rozov Kladenetz dam because of collisions with power lines. An adult injured bird was found at Rozov kladenets dam and was rescued by a BSPB team.

Map with found dead Dalmatian pelicans at Rozov Kladenets dam

The BSPB team found an adult Dalmatian Pelican injured in a result of collision with power lines close to the wall of the Rozov Kladenets dam

SPA Burgasko Lake BG0000273

3 ind. Dalmatian pelicans were found in April 2020 and January 2022 and 3 Great White pelicans were found dead in April 2020 in the region of the Burgasko Lake because of collisions with power lines.

Map with found dead pelicans at Burgasko Lake

SPA Mandra-Poda Complex BG0000271

In 2020 17 pelicans (15 Great White pelicans and 2 Dalmatian pelicans) were found dead in April and 1 ind. Great White Pelican found in May at Mandra-Poda Complex because of collisions with power lines. In 2021 another 4 ind. Great White pelicans and 4 ind. Dalmatian pelicans were found dead in April 2021 at the same areas because of collisions. In January 2022 2 ind. Dalmatian pelicans were found dead close to the Mandra reservoir's wall again because of collisison.

Map with found dead pelicans at Mandra-Poda Complex

The numbers of victims removed by predatory mammals feeding on carcases has not been accounted for. It is assumed that a significant number of victims has not been registered during the study because their carcasses have been removed by jackals (*Canis aureus* Linnaeus, 1758) and foxes (*Vulpes vulpes* Linnaeus, 1758), present in high numbers and densities in the studied region. It is likely that the actual death rate has been lowered substantially and is higher by an order of magnitude (Ferrer et al. 1991, Guyonne et al. 1999, 2001).

6.2. Flight observations

The findings of the flight observation recorded 7335 birds crossing the power lines over the eight-days long study time, and out of these birds only 158 (2,2%) were recorded to change their flight route in the vicinity of the power lines, but no collisions were observed. Of all the birds recorded 38% of it was the two species of Cormorants (*Phalacrocorax carbo*, *Microcarbo pygmaeus*), because large colonies can be found of these species in the area. It must be noted that most birds increased their flight height before reaching the wires, showing that birds detected the lines in time, and they could react in advance by gaining height for crossing. The weather throughout the observation period was dominated by easterly wind (40,63%), and similarly most of the flights observed happened in this period (44,66%), and also the changes in flights (25,95%). Since the power lines have a north-south layout, the dominating easterly wind could cause problem for the crossing birds from both directions in the form of tail- and headwinds. Similarly, the light conditions throughout the study period was mainly cloudy (90,1%) potentially decreasing the detection of the wires.

The recorded changes describe observations when the birds needed to make a sudden, unprecedented evasive move in order to avoid collision, so these always occurred very close to the wires. The records only included movements that were direct crossings, including landing on the power lines after crossing, because many local birds flew in circles over the lines, were feeding and hunting below and other potentially dangerous movements around the power lines, making it hard to identify whether a bird is crossing the lines, therefore these movements were left out from the assessment. Throughout the study period 38 different species and several unidentified species belonging to six different genera, one family (*Laridae*) and one order (*Passeriformes*) were described. For estimating species specific risk, the birds were grouped into the taxonomical classification where unidentified species could be included as well, and they were calculated together due to the similar morphological build-up, and the potential ability to avoid the wires resulting from this (Table 1).

Table 1: The flight observations including the intensity of the flights and the changes made in the vicinity of the power lines. The last column shows the percentage of the changes occurred per the number of flights.

Taxonomical group	Name	Flight intensity	Change intensity	%
Order	*Passeriformes*	1101	14	1.27
Family	*Phalacrocoracidae*	2895	50	1.73
Family	*Laridae*	549	6	1.09
Family	*Scolopacidae*	65	0	0.00
Genus	*Pelecanus*	892	28	3.14
Genus	*Anas*	962	15	1.56
Genus	*Circus*	160	16	10.00
Genus	*Ardea*	287	25	8.71
Genus	*Cygnus*	184	1	0.54
Species	*Pica pica*	71	1	1.41
Species	*Buteo buteo*	25	2	8.00

The highest rate for making evasive movements near the power lines, just before colliding with them was for the genus Circus, and predominantly the local Marsh harriers (*Circus aeruginosus*) in the area that crossed the lines several times a day at a low height, searching and hunting facing downwards, therefore the power lines remained obscured for their sight up until the latest moments. Nevertheless, they are agile and good at making quick movements, therefore the collision was always avoided. Similarly, to the observed Common buzzards (*Buteo buteo*) that made sudden movements to change their flight route. These birds were on their autumn migration throughout the study period, and used the area as stopover sites, therefore in the mornings when they started to continue their way south gaining height, the limited light conditions and the unfamiliarity of the new area made the lines harder to detect for the birds. The second highest rate of near collisions was attributed to two species: Grey heron (*Ardea cinerea*) and the Great White egret (*Ardea alba*). Both of these birds crossed the lines to reach the feeding grounds and to go back for the roosting sites. They often flew low locating the lines late and started to increase their height with rapid flapping movements, gradually climbing up to cross just over the earth wire. More than half of the changes (53%) made by the two pelican species (*P. onocrotalus* and *P. crispus*) were to avoid collision with the earth wire. This happened because these birds often flew in lines when crossing the wires, and the birds at the front increased their height to fly above the earth wire, leaving the rear of the line gradually less time to gain elevation due to the speed of their flight, resulting in the need to make sudden movements which can be problematic for these large birds. The great number of cormorants observed also meant a higher potential for collision, but the species specific vulnerability depends on the morphological capacities rather than the flight intensity above the wires (Bevanger & Brøseth, 2001), therefore this number of avoidant movements of the cormorants could be the result of the evolutionary trade-off for their diving behaviour when hunting (Thaxter, et al., 2010). The reason for not seeing a higher number at both the duck (*Anas*) and swan (*Cygnus*) species making evasive movements, even though the literature shows their vulnerability is because these species are susceptible for collision but they are not good at making sudden changes due to their low manoeuvrability, therefore if they detect the wires late, the possibility of avoiding them is low (Rayner, 1988). This suggests that these birds could detect the wires earlier, and crossing was not problematic. The rest of the near collision incidents belonging to the passerines and different gull (*Laridae*) species could be attributed to the late detection of the wires, because these species are capable of rapid changes in flight direction and they could avoid the collision.

Since the weather conditions were described every 15 minutes of the observation period, the impactof bad weather conditions could be understood, as a factor potentially increasing the susceptibility forcollisions. For the wind power assessments, the used scale has values ranging from 0 to 12, however,during the analysis the wind power was assigned to values between 0 and 7, because the wind did notreach higher power during the observations. Since different weather conditions lasted for different periods of time, the number of flights and changes during the different conditions are not comparable. Nevertheless, under all weather conditions the observation time had a positive correlation with the number of flights ($r=0.986$, $p<0.05$) and with the number of changes ($r=0.825$, $p<0.05$) as shown by using Pearson's correlation. The regression analysis also shows that there is a strong positive relationship between the observation time and number of flights, under varying wind power conditions ($R^2=0.97$), which is important to note, because it could suggest that flight intensity was not influenced by wind power (*Figure 1*). With a weaker positive relationship, but the number of changesin flight behaviour also connected to the observation time, during the different wind conditions ($R^2=0.68$, $y = 0.9689x - 3.504$).

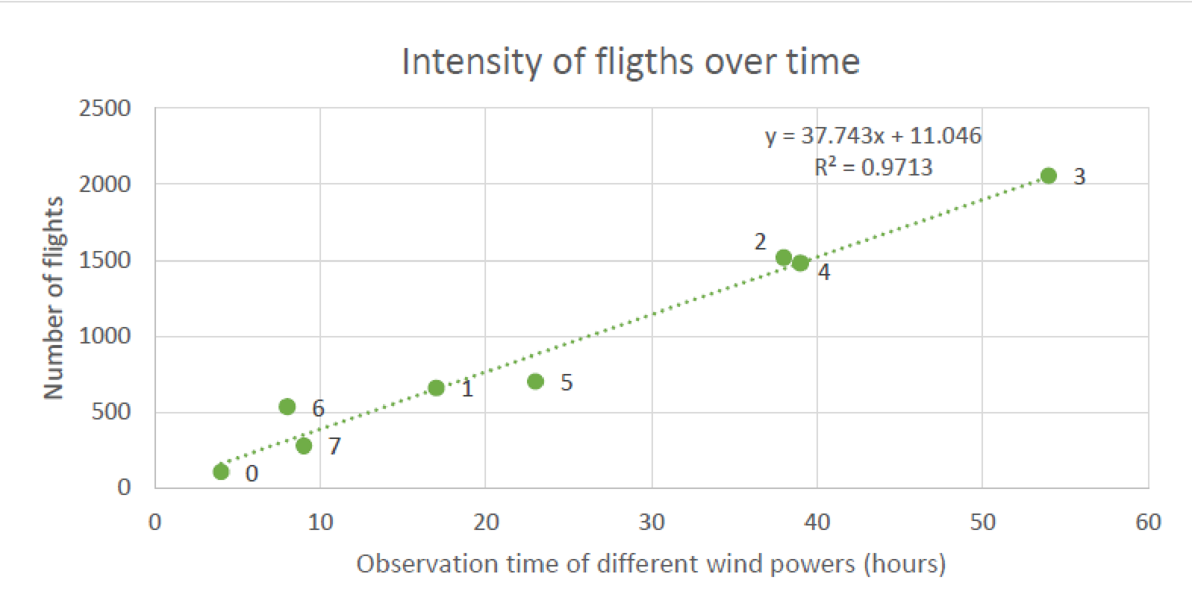


Figure 1: The number of flights over time, to show if flight intensity changes during different wind powers. The individual numbers representing the different wind powers registered (0-7). This graph shows that flight intensity and observation time is strongly positively correlated, even if wind power changes. This suggests that wind power did not influence the flight intensity.

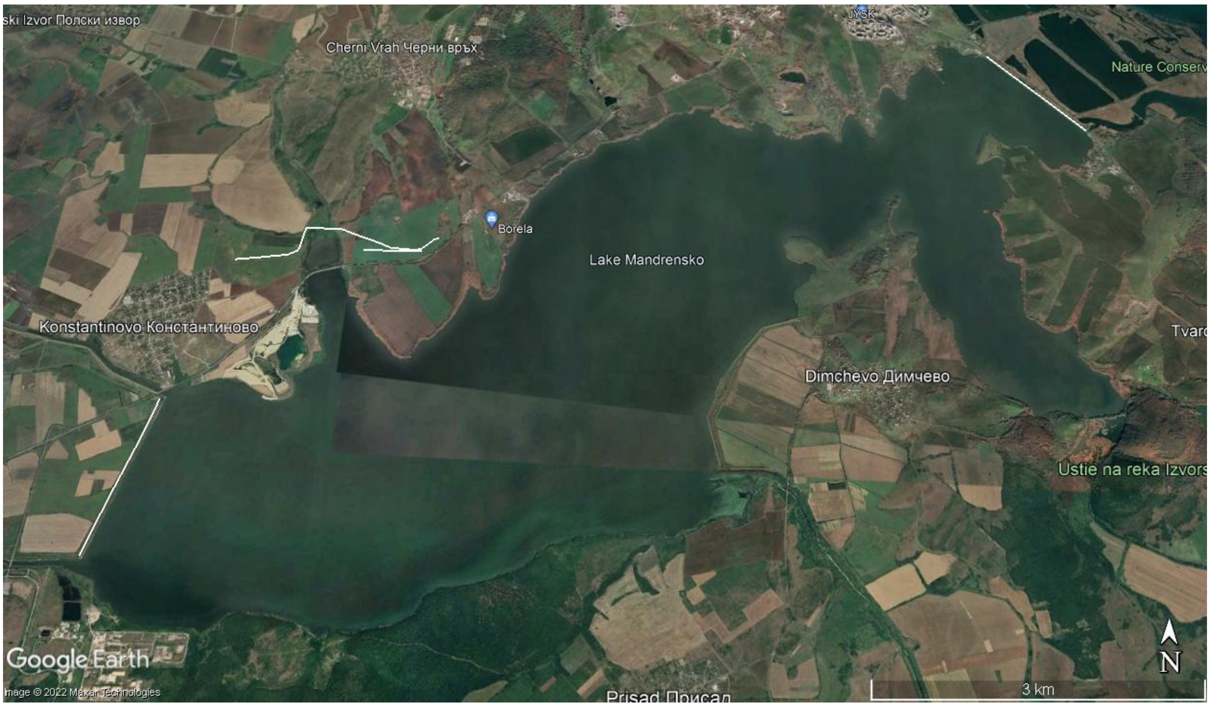
7. Mapping high risk areas at key sites in Bulgaria

As a result of the field study, the following risk sections of power lines were identified:

7.1. **SPA Yazovir Rozov Kladenets BG0002022** – 4.96 km hazardous power lines

7.2. **SPA Burgasko Lake BG0000273** – 13.09 km hazardous power lines, located at NE and NW part of the project site.

7.3. **SPA Mandra-Poda Complex BG0000271** – 6.56 km hazardous power lines, located at W, NW and NE part of the project site.



8. Conclusion and recommendations

Death by collision on overhead power lines is a one of most important threat for the Dalmatian Pelican (*Pelecanus crispus*) in Bulgaria and immediate mitigation measures are required to be implemented. Pelicans are amongst those bird groups at high risk from collisions along with other species such as herons, storks, swans, cranes, some species of vultures and eagles. Flight behaviour and other biological attributes contribute to species risk. Individual losses from collision mortality are unlikely to affect large and robust populations. However, for species that are rare or endangered, the loss of a few or even one individual may impact a local population or the overall population's viability.

While power lines are only one of numerous causes of bird injury and mortality, collisions with power lines can be reduced. A number of diverter models are commercially available and have been effectively used for a few decades by the power supply companies in order to mitigate bird collision casualties. Immediate safety is needed by mounting diverters on the most risky sections of the surveyed power lines indicated in the report. These protection measures will not only benefit the protection of birds, but will also be of exceptional importance for the power distribution companies, because by reducing the cases of dying birds, they will reduce the power cuts, the technical problems, and the need for their elimination. As a consequence, the power distribution companies will reduce their power-line repairing and maintenance costs.

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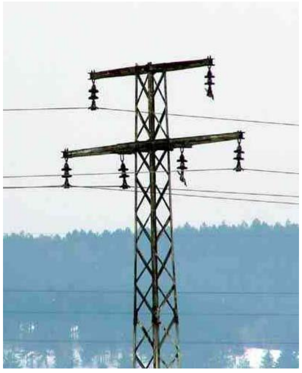
Appendix 1. Type of the electrical 20kV pylons

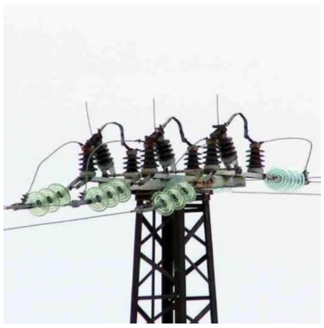

1


2


3


4


5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7


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