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PROCENA RIZIKA OD SUDARA PTICA SA VISOKONAPONSKIM DALEKOVODIMA U ZAŠTIĆENIM PODRUČJIMA SRBIJE POMOĆU GIS SISTEMA

ASSESSING THE RISK OF BIRDS COLLIDING WITH HIGH VOLTAGE TRANSMISSION LINES IN PROTECTED AREAS IN SERBIA: A GIS-BASED APPROACH

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Kratak sadržaj: U ovom istraživanju je predstavljena mapa rizika za procenu opasnosti od sudara ptica sa visokonaponskim dalekovodima u zaštićenim prirodnim dobrima u Srbiji. Metodologija uključuje sistem bodovanja zaštićenih i osetljivih vrsta ptica na osnovu statusa zaštite, podložnosti sudarima i prisustva u zaštićenim područjima. Modeliranje distribucije vrsta sprovedeno je za 59 prioritetnih vrsta koristeći MAXENT algoritam, uključujući bioklimatske varijable i podatke o prisustvu vrsta na teritoriji Srbije od 2000. do 2024. godine. Dobijeni modeli su integrisani sa podacima o infrastrukturi dalekovoda i granicama zaštićenih područja u GIS-u. Mapa rizika identifikuje segmente dalekovoda visokog rizika preklapanjem modela distribucije vrsta, lokacija dalekovoda i zaštićenih područja, pružajući prostornu procenu rizika od sudara duž ~56 km visokonaponske mreže Srbije koja prolazi kroz zaštićena dobra. Ključni rezultati uključuju geografske podatke o distribuciji ciljnih vrsta, segmente dalekovoda sa povezanim prisustvom vrsta, i zaštićena područja kroz koja prolaze dalekovodi. Podaci dobijeni ovim istraživanjem predstavljaju prvu sveobuhvatnu procenu rizika od sudara ptica sa dalekovodima za elektroenergetsku mrežu Srbije. Ovakva postavka omogućava operateru mreže da proaktivno primeni mere ublažavanja poput instaliranja divertera za ptice na segmentima dalekovoda visokog rizika. Mapa takođe pokriva Srbiju i moguće je buduće planiranje trasa dalekovoda kako bi se izbegla kritična područja za zaštitu ptica. Ukupno gledano, ovaj pristup mapiranju rizika usklađuje prakse Srbije sa evropskim standardima za zaštitu ptica. Mapa pruža naučnu osnovu za donošenje odluka o merama bezbednosti ptica i doprinosi balansiranju razvoja energetske infrastrukture sa ciljevima očuvanja biodiverziteta. Metodologija se može ažurirati u svakom trenutku u zavisnosti od količine i broja dostupnih podataka.

Ključne reči: *ptice, rizik mehaničke kolizije, visokonaponski dalekovodi, GIS, MAXENT algoritam*

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Abstract: In this paper, we developed a risk map to assess the probability of bird collision hazards with high voltage power lines in protected areas in Serbia. The methodology involved scoring protected and sensitive bird species based on conservation status, collision susceptibility, and presence in protected areas. Species distribution modeling was conducted for 59 priority species using the MAXENT algorithm, incorporating bioclimatic variables and occurrence data from 2000 to 2024. The resulting models were integrated with power line infrastructure data and protected area boundaries in GIS. The risk map identifies high-risk power line segments by overlaying species distribution models, power line locations, and protected areas. It provides a spatial assessment of collision risk across Serbia's ~56 km high-voltage network in protected areas. Key outputs include geographic data on target species distributions, power line segments with associated species presence, and protected areas intersected by power lines. This is the first comprehensive assessment of the risk of bird collisions in protected areas for the Serbian power grid. It enables the grid operator to proactively implement mitigation measures like installing bird diverters on high-risk segments. The map also supports future grid planning to avoid critical areas for bird conservation. Overall, this risk mapping approach aligns Serbia's practices in line with European standards for bird protection. It provides a scientific basis for decision-making on bird safety measures and contributes balance energy infrastructure development with biodiversity conservation goals. The methodology can be updated as new data becomes available to refine risk assessments over time.

Key words: *Bird, Collision Risk, High-Voltage Power Lines, GIS, MAXENT algorithm*

1 INTRODUCTION

The high-voltage grid in Serbia is integral to the transmission of electricity over extensive distances and the stabilization of the energy system. This infrastructure comprises high-voltage transformers, transmission lines and substations, which facilitate the distribution of electricity from production facilities to consumers. The high-voltage network in Serbia operates at various voltage levels, specifically 220 kV and 400 kV. These high-voltage lines enable efficient electricity transmission, thereby minimizing losses that typically occur at lower voltage levels. The total length of Serbia's high-voltage distribution network is approximately 10.000 km, with the following distribution: 220 kV comprises about 1.863 km, and 400 kV covers around 1.795 km.

Bird collisions with the high-voltage transmission power lines constitute a significant ecological concern, potentially adversely affecting bird populations, particularly those that are sensitive and endangered. Such incidents predominantly occur when birds collide with electrical conductors or shield wires. Larger, heavy-bodied avian species, with poor maneuverability such as storks, waterfowl, eagles, hawks, and other raptors being most susceptible. Given the importance of biodiversity and environmental conservation, the issue of bird collisions with high-voltage networks is garnering increased attention in ecological research and energy project planning.

Serbia's avifauna is particularly diverse due to its ecologically favorable position. The country's territory can be roughly divided into three biogeographical regions: Pannonian (primarily Vojvodina), Continental and Alpine (Dinarides). Each of these regions host unique wildlife, including a distinct avifauna. The number of bird species in Serbia represents about 75% of the total European avifauna, which is a significant diversity for the relatively small area the country occupies.

Over 360 bird species have been recorded in Serbia, with 333 species regularly observed [1]. Of the total number of species, approximately 260 are nesting species (present during the reproductive period), while the remaining 100 species are visitors during the migration or winter periods. According to the Rulebook on the Declaration of Strictly Protected and Protected Wild Species of Plants, Animals, and Fungi („Official Gazette of RS“ No. 5/2010 and 47/2011), 307 bird species are strictly protected and 34 are protected.

In addition to species protection, Serbia has a longstanding tradition of safeguarding significant areas to preserve geological, biological, ecosystem and/or landscape diversity. By the end of 2023, 315 categorized protected natural areas had been declared, encompassing a total area of approximately 740.000 hectares. Of these, municipal and city assemblies declared the majority, with a total 208 areas, followed by the Assembly and Government of Serbia with 98 areas and the Assembly of AP Vojvodina with 9 areas (Figure 1). These ratios exhibit significant variation when considering the proportion of land area, as 697 thousand hectares, or 94% of the total area, are designated by the Republican Assembly and Government. These regions are of paramount importance in Serbia, thereby placing the primary responsibility for environmental protection on the republican authorities, particularly the Ministry of Environment. Protected natural assets constitute approximately 8.5% of the total territory of the Republic of Serbia. The objective of this paper is to present developed risk maps that will offer a comprehensive understanding of which segments of the high-voltage distribution network present the greatest threat to avian conservation in Serbia in protected areas.

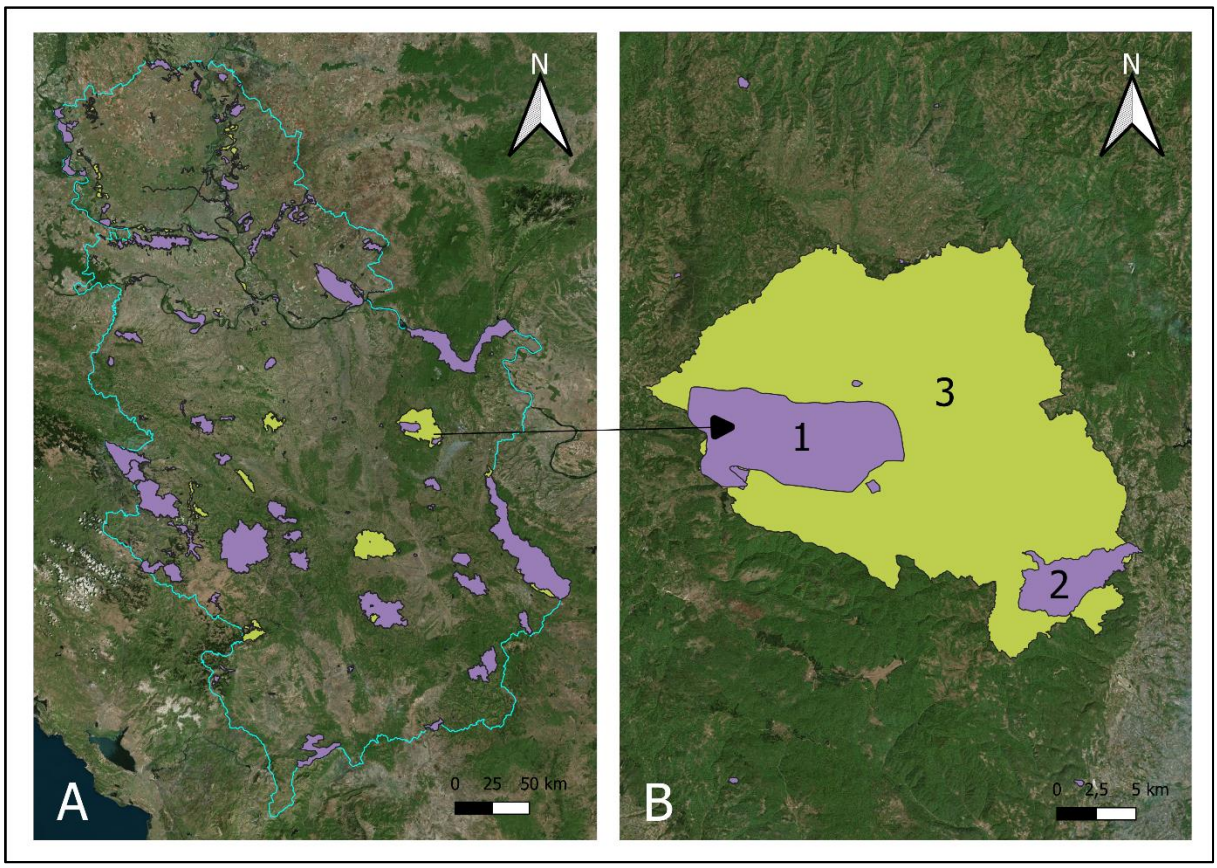

Figure 1: A: Map of protected areas in Serbia; B: 1. Part of the protected area water sheds of Resava, Suvaja, Čemernica, Jelov stream, and Beljanica river; 2. Lazar's canyon; 3. Kučaj – Beljanica.

2 METHODOLOGY

For the purpose of this study, a comprehensive scoring system was developed to assess the probability of bird collisions with the high-voltage power transmission network in Serbia. The scoring system includes several criteria, including:

- Distribution of selected, protected, and sensitive bird species;
- Bird susceptibility to collisions, determined through a review of professional and scientific literature;
- Arrangement of power lines in relation to protected natural areas of the Republic of Serbia (Figure 2);
- Adaptation of the model for modeling selected data.

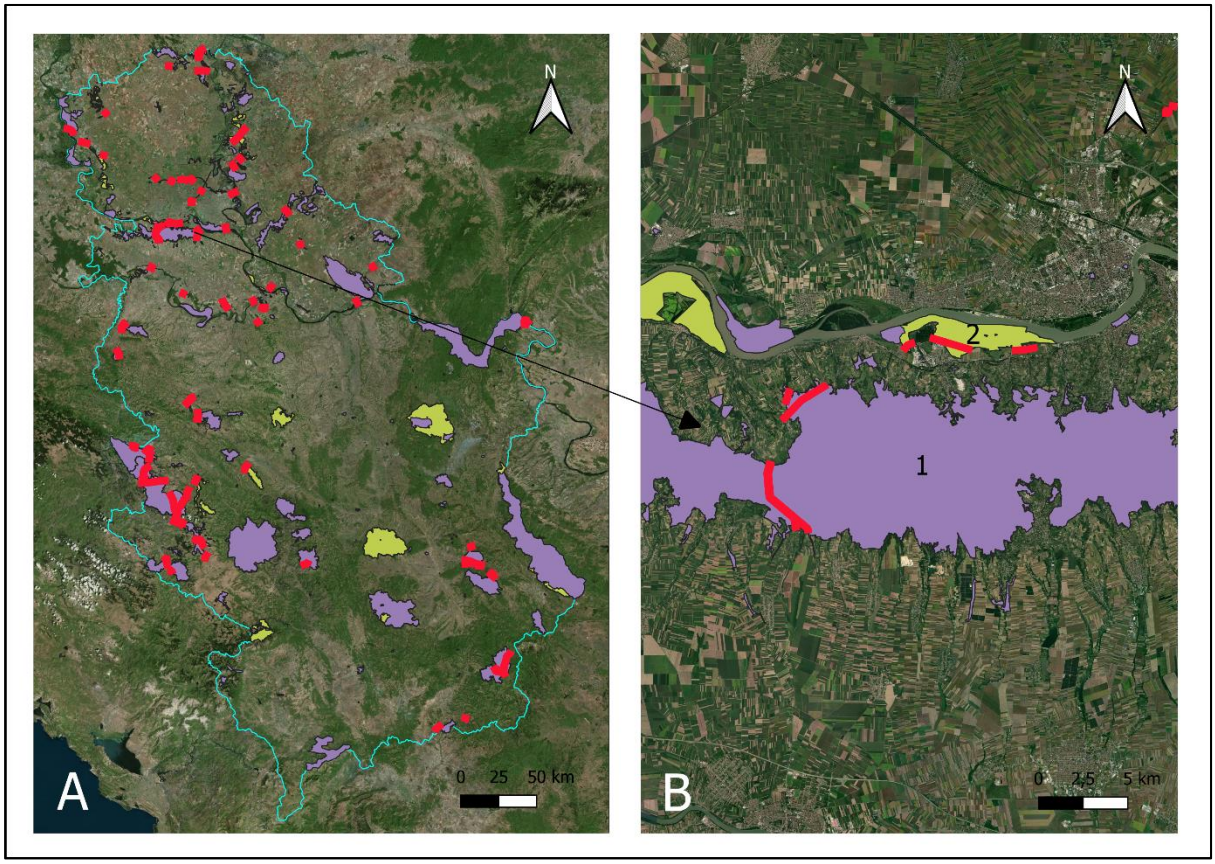

Figure 2: A: Power lines (red lines) crossing all protected areas in Serbia. B: Particular examples of protected areas, such as Fruška Gora National Park and Poloj, with power lines cutting through them.

Individual species scoring was based on each species' status according to:

- IUCN Red List,
- Convention on the Conservation of European Wildlife and Natural Habitats,
- European Union Birds Directive,
- Convention on the Conservation of Migratory Species of Wild Animals,
- Red Book of Birds of Serbia,
- Potential mortality due to collision (derived from scientific literature).

2.1 Scoring sistem

1. The IUCN Red List, recognized as the most comprehensive global database on the endangered status of plant and animal species, serves as the primary reference. This list aims to provide scientifically based information on species extinction risks and serve as a foundation for decision-making regarding their protection. Species are assessed using standardized criteria, including population size, abundance trends, distribution and level of threat.

The IUCN Red List categorizes species into the following threat categories:

- Extinct (EX): Species that have completely disappeared
- Extinct in the Wild (EW): Species surviving only in captivity
- Critically Endangered (CR): Species with extremely high risk of extinction
- Endangered (EN): Species with high risk of extinction
- Vulnerable (VU): Species that may become endangered if threats persist
- Near Threatened (NT): Species not yet endangered but approaching that threshold
- Least Concern (LC): Species with stable populations
- Data Deficient (DD): Species with insufficient data
- Not Evaluated (NE): Species not yet officially assessed

The Red List serves as a key tool for biodiversity conservation and provides guidelines for implementing protection measures at national and international levels.

Scoring based on the IUCN Red List of Birds was performed as follows:

CR species = 20 points, EN species = 10 points, VU species = 5 points, NT species = 3 points.

2. The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) is an international agreement adopted in 1979 in Bern, Switzerland, under the auspices of the Council of Europe. The aim of the Convention is to conserve wild plant and animal species and their natural habitats, with particular emphasis on endangered species and habitats at risk of disappearance. The Convention obliges signatory states to undertake legislative and administrative measures to protect endangered species and their habitats, prevent exploitation and trade of endangered species and promote international cooperation in biodiversity conservation.

The main components of the Convention include:

- Protection of wild species – Special attention is given to endangered species listed in the Annexes of the Convention.
- Conservation of natural habitats – Signatory states are required to protect key habitats essential for the survival of species.
- Regulation of species exploitation – Control of hunting, fishing, and trade of endangered species.
- International cooperation – Exchange of data, joint strategies, and nature conservation projects among countries.

The Bern Convention has laid the foundation for numerous European nature conservation initiatives, including the establishment of the Emerald Network of protected areas and the adoption of EU Birds and Habitats Directives. Serbia is a signatory to the Convention and has committed to implementing its principles in national legislation.

Scoring:

Annex II (Strictly protected animal species) = 10 points, Annex III (Protected animal species) = 5 points

3. The Birds Directive (EU Birds Directive) is one of the most important legal instruments of the European Union for the protection of wild birds and their habitats. Adopted in 1979, it represents the EU's first piece of nature conservation legislation. The directive aims to preserve all wild bird species naturally occurring in the territories of EU Member States, as well as to protect their habitats.

The main provisions of the directive include:

- Protection of all bird species – The directive covers approximately 500 bird species present in Europe.
- Conservation of key habitats – Establishment of Special Protection Areas (SPAs) as part of the Natura 2000 network.
- Regulation of hunting and exploitation – The killing, capturing, trading and disturbing of protected species is prohibited, except in exceptional cases.
- International cooperation – Member States collaborate to protect migratory birds and preserve their migration routes.

Together with the Habitats Directive, the Birds Directive forms the foundation of the EU's nature conservation policy. Although Serbia is not an EU Member State, its legislation is gradually being harmonized with this directive to support bird and biodiversity conservation.

Scoring: Annex I = 10 points, Annex II = 5 points, Annex III = 3 points

4. The Convention on the Conservation of Migratory Species of Wild Animals – CMS (Bonn Convention) is an international agreement adopted in 1979 in Bonn, Germany, under the auspices of the United Nations. The convention aims to protect migratory animal species and their habitats through international cooperation, as these species cross multiple national borders during their migrations.

The main provisions of the convention include:

- Protection of migratory species – Special attention is given to endangered species listed in Appendices I and II of the Convention.
- Conservation of key habitats – Signatory states commit to protecting areas important for the migration, feeding and breeding of species.
- International cooperation – Countries collaborate through specific agreements and action plans for the protection of individual species and ecosystems.
- Control of hunting and exploitation – The killing, capturing, and trading of endangered migratory species is restricted or prohibited.

The Convention provides a framework for a range of specific agreements and initiatives, such as the African-Eurasian Migratory Waterbird Agreement (AEWA) and the Agreement on the Conservation of Populations of European Bats (EUROBATS). Serbia is a signatory to the Convention and participates in international efforts to protect migratory species.

Scoring: Appendix I = 10 points, Appendix II = 5 points

5. The Red Book of Birds of Serbia uses internationally recognized categories of species endangerment according to the criteria of the International Union for Conservation of Nature (IUCN). The categories in the Red Book of Birds of Serbia are the same as IUCN Red List.

Scoring of Red Book of breeding and non-breeding birds: CR species = 20 points, EN species = 10 points, VU species = 5 points, NT species = 3 points

6. The possibility of mortality due to collision is taken from the literature [2] and the following scoring is applied:

Highest collision factor (III) = 30; Very high collision factor (II-III) = 25; High collision factor (II) = 20; Medium collision factor (I-II) = 10; Low collision factor (I) = 5; No collision factor (0).

A table of scores for each bird species recorded in the Republic of Serbia in relation to national and international protection status, as well as theoretical risk of collision with overhead power line shield wires, is provided in Appendix 1. For distribution modeling and ecological niche analysis, species with a total of 50 or more points were considered. Species not modeled due to insufficient distribution data in the Republic of Serbia (very rare species or those found exclusively in protected natural areas, such as the Great Bustard *Otis tarda* or Eurasian Stone-curlew *Burhinus oedicnemus*) are listed in Appendix 2.

Bird distribution data used for map creation resulted from long-term research and information gathering on bird distribution in Serbia. These data cover the period between 2000 and 2024, providing insights into bird movement dynamics, migratory activities, routes and key habitats.

2.2 General principles applied in risk map development

General principles applied in risk map development followed a multi-phase approach. First, a list of sensitive and protected bird species most susceptible to power line collisions was compiled. To objectively represent significant species, a scoring system was developed based on international and national protection, vulnerability to power line collisions, and species status in the Red Book of Birds of Serbia (Appendix 1). Unmodeled species are listed in Appendix 2, representing species with insufficient data, mainly rare or extinct species in Serbia.

After species selection, all distribution data were mobilized and critically reviewed to eliminate potential errors and biased data. Based on this list, distribution data for individual target species were identified for extraction or collection for the 2000-2024 period. The dataset of 59 most important species was refined, and each species with distribution (ecological niche) in the Republic of Serbia was used for modeling using the MAXENT model [3] in the Wallace platform [4,5] with 19 bioclimatic variables. MAXENT (Maximum Entropy Model) is one of the most frequently used methods for ecological niche modeling and predicting potential species distribution based on presence data. This method uses the mathematical principle of maximum entropy to identify relationships between bird observation locations and ecological factors such as climate, topography and habitat type.

2.3 Species Distribution Modeling: Key Steps

The primary stages in modeling the distribution of individual bird species of interest for developing risk maps using MAXENT software are as follows:

- Data Collection: Input point data on bird presence from field studies or databases.
- Selection of Ecological Variables: Use climatic data such as temperature, precipitation, vegetation and other factors that influence species distribution.
- Model Training: MAXENT analyzes distribution patterns and generates probability of species presence in specific areas.
- Model Evaluation: Validate the model using statistical methods, such as Area Under Curve (AUC) values.
- Potential Distribution Mapping: The outcome is a map showing suitable habitats for birds, which can be used for species conservation and management (Figure 3).

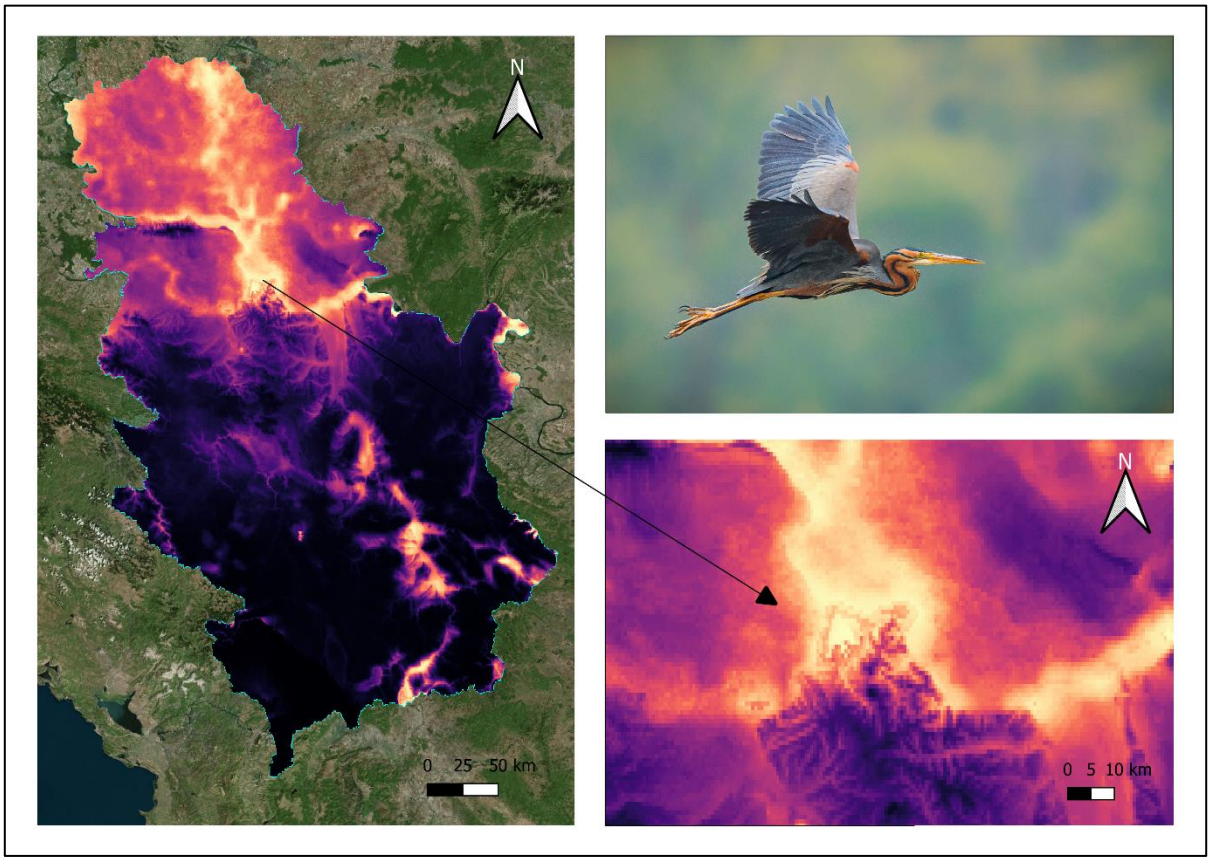

Figure 3: Basic model for suitability of the presence of Purple Heron (*Ardea purpurea*) in Serbia. Low presence probability is represented by dark colours while high presence is represented by light colours.

MAXENT is particularly advantageous for species with limited data, as it requires only presence data without the need for absence information. This method is frequently applied in biodiversity research, endangered species protection and assessing the impact of climate change on bird distribution.

For model validation, the aforementioned AUC value was utilized, with a maximum value of 1. Following recommendations from literature, models with AUC values between 0.7 and 1 were considered valid for this project. Additionally, after obtaining the models, a conservative probability threshold of 75% was adopted to indicate definite species presence in a given area, considering that MAXENT results include probabilities ranging from 1-100% (Figure 4). The presence of species was also determined at the highest possible resolution of one square kilometre (1x1 km).

Subsequently, the models were integrated into QGIS and overlaid with additional data layers for further analysis and visualization.

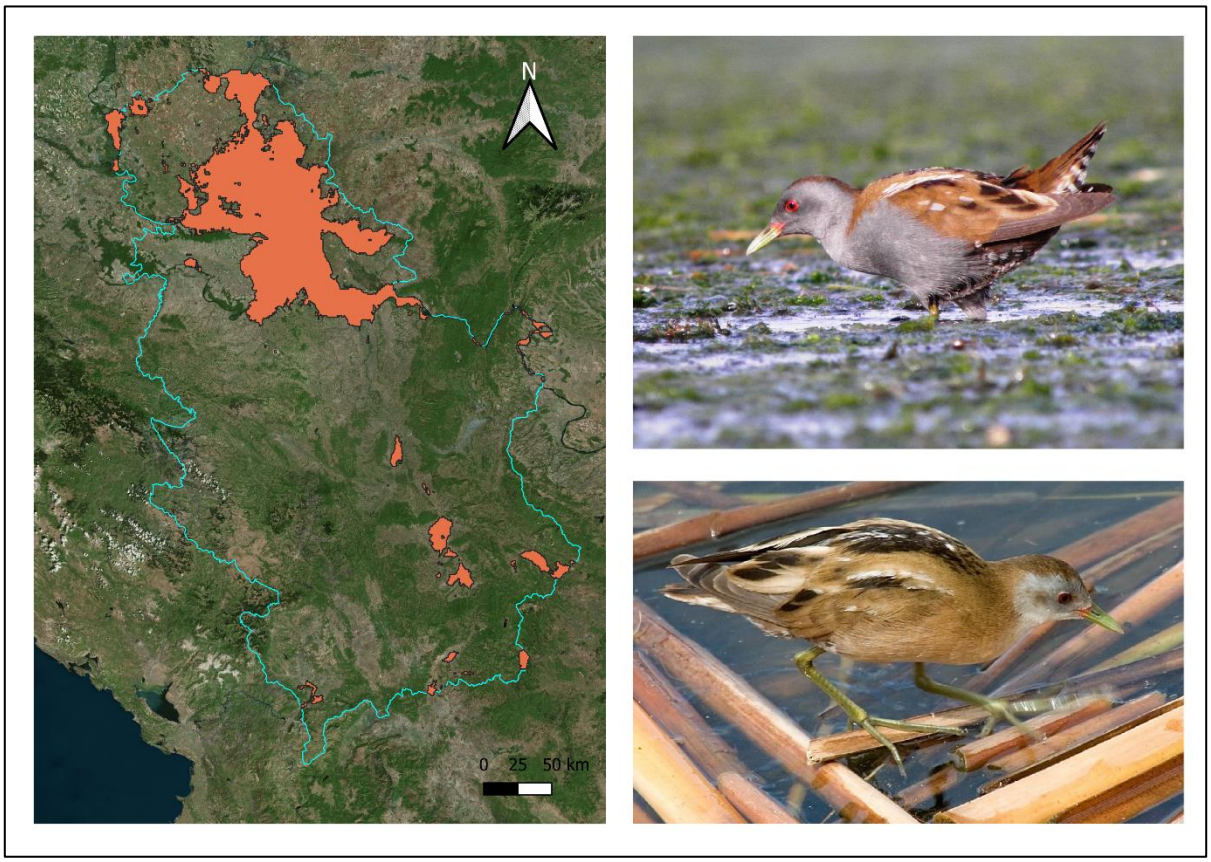

Figure 4: model illustrating the habitat suitability for the presence of Zapornia parva in Serbia. The map displays only areas with a predicted occurrence probability of 75% or higher.

3 RESULTS

Following the modeling of target species distribution, various types of maps, known as „layers“, were generated to represent specific aspects of risk. These layers encompass:

- Geographical data on the presence of target bird species in the Republic of Serbia,
- Locations of major power lines and their segments,
- Locations of protected natural areas and power lines within these regions.

By combining all layers using a scoring system, a landscape-level risk map of bird collisions with high-voltage power lines was created.

The final phase involved integrating this map with EMS's high-voltage power line infrastructure and borders of protected areas in Serbia to assign an appropriate risk score to each segment.

The result is an interactive GIS file that displays the presence of endangered bird species in the Republic of Serbia for each section of the high-voltage power lines in power line sections that cross protected natural areas where all the target bird species present can be observed.

A total of 212 km of high-voltage transmission lines cross protected areas in Serbia. There are 40 protected areas (Table I) with Nacionalni Park Đerdap having the most target species (48 out of 59 modeled species).

Table I: Protected areas with the number of modeled target species that are present.

Protected area	Number of species
Nacionalni park Đerdap	48
Nacionalni park Fruska Gora	47
Poloj	47
Veliki rimski šanac	47
Deliblatska pescara	46
Jegrička	44
Miljakovačka šuma	44
Veliko blato	44
Potamišje	43
Ada Ciganlija	42
Klisura reke Gradac	42
Doline kod Padine	41
Lipovačka suma - Dugi rt	40
Maljen	39
Okanj bara	39
Slatine srednjeg Banata	39
Gornje Podunavlje	37
Kanjiški jaraši	37
Palić	35
Selevenjske pustare	35
Planina Cer	31
Straža	29
Zasavica	29
Bara Trskovača	27
Gornja Mostonga	27
Srednja Mostonga	26
Suva planina	26
Šargan-Mokra Gora	21
Pećina Ravna peć	18
Vražji kamen - Prosečnik	18
Dolina Pčinje	17
Nacionalni park Tara	17
Veliki Rzav	11
Zlatibor	11
Nacionalni park Kopaonik	10

Protected area	Number of species
Uvac	10
Vardenik	8
Planina Jelica	7
Ozren - Jadovnik	6
Selevenjske pustare	1

4 DISSCUSION AND CONCLUSIONS

This risk map, the first of its kind in Serbia, is designed to furnish scientifically grounded information crucial for decision-making concerning the implementation of avian protection measures. Using modern methods and scientific research, this map will enable Elektromreža Srbije AD to identify the sections of the distribution network that pose the greatest risk to the conservation of avifauna and should be equipped with visual markers (diverters) in the future to reduce the risk of bird collisions with conductors and protective wires of power lines.. It will also be important for future planning of high-voltage grid development, as it will help to anticipate bird conservation challenges and avoid „critical“ areas. We recommend updating species distribution models every 10 years due to the impact of climate change on the distribution of bird species.

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6 APPENDICES

6.1 Appendix 1

Table II: A scoring system that was developed based on International and National protection, vulnerability to power line collisions, and species status in the Red Book of Birds of Serbia.

Species	Final score
Otis tarda	105
Falco cherrug	90
Burhinus oedicnemus	90
Charadrius alexandrinus	90
Neophron percnopterus	90
Chlidonias niger	85
Gallinago gallinago	80
Anser erythropus	75
Numenius tenuirostris	75
Aquila heliaca	75
Plegadis falcinellus	75
Chlidonias leucopterus	75
Milvus migrans	75
Podiceps grisegena	75
Recurvirostra avosetta	70
Locustella naevia	70
Limosa limosa	68
Clanga clanga	65
Glaucidium passerinum	65
Sternula albifrons	65
Tetrao urogallus	65
Ciconia nigra	61
Oxyura leucocephala	60
Asio flammeus	60
Clanga pomarina	60
Phalaropus lobatus	60
Porzana porzana	60
Actitis hypoleucos	60
Calandrella brachydactyla	60
Picoides tridactylus	60
Pelecanus crispus	58
Coracias garrulus	56
Himantopus himantopus	56
Zapornia parva	56
Anser fabalis	55
Acrocephalus paludicola	55
Ciconia ciconia	55
Pelecanus onocrotalus	55
Ichthyaetus melanocephalus	55
Tringa totanus	55
Aythya fuligula	55
Branta ruficollis	55
Gavia arctica	55
Gavia stellata	55
Mergellus albellus	55
Aegolius funereus	55
Ardea purpurea	55
Falco vespertinus	55
Sterna hirundo	55
Accipiter brevipes	55
Circus pygargus	55
Hieraaetus pennatus	55
Milvus milvus	55
Oenanthe hispanica	55
Spatula querquedula	55
Gallinago media	53
Tetrax tetrax	53
Alectoris graeca	53
Platalea leucorodia	51
Botaurus stellaris	51
Bubo bubo	51
Ficedula semitorquata	51
Luscinia svecica	51
Calidris alpina	50
Charadrius morinellus	50
Crex crex	50
Grus grus	50
Podiceps auritus	50
Tringa glareola	50
Hydroprogne caspia	50
Streptopelia turtur	50
Arenaria interpres	50
Aythya ferina	50
Calidris alba	50
Acrocephalus melanopogon	50
Dendrocopos leucotos	50
Montifringilla nivalis	50
Pyrrhocorax pyrrhocorax	50
Aythya nyroca	48
Limosa lapponica	48
Falco peregrinus	48
Pluvialis apricaria	48
Calidris ferruginea	46
Haliaeetus albicilla	46
Melanocorypha calandra	46

Ardea alba	45
Branta leucopsis	45
Calidris pugnax	45
Cygnus columbianus	45
Cygnus cygnus	45
Ficedula albicollis	45
Ficedula parva	45
Gelochelidon nilotica	45
Glareola pratincola	45
Ixobrychus minutus	45
Microcarbo pygmaeus	45
Phoenicopterus roseus	45
Strix uralensis	45
Tadorna ferruginea	45
Thalasseus sandvicensis	45
Zapornia pusilla	45
Buteo rufinus	45
Charadrius hiaticula	45
Coturnix coturnix	45
Eremophila alpestris	45
Hydrocoloeus minutus	45
Pluvialis squatarola	45
Aythya marila	45
Aquila chrysaetos	45
Mergus merganser	45
Perdix perdix	45
Spatula clypeata	45
Tichodroma muraria	45
Numenius arquata	43
Vanellus vanellus	43
Calidris temminckii	43
Lymnocryptes minimus	43
Circaetus gallicus	41
Gyps fulvus	41
Circus aeruginosus	41
Mareca strepera	41
Oenanthe oenanthe	41
Alcedo atthis	40
Anthus campestris	40
Ardeola ralloides	40
Calidris falcinellus	40
Calidris minuta	40
Caprimulgus europaeus	40

Charadrius dubius	40
Chlidonias hybrida	40
Clangula hyemalis	40
Curruca nisoria	40
Cursorius cursor	40
Dendrocopos syriacus	40
Dendrocoptes medius	40
Dryocopus martius	40
Egretta garzetta	40
Falco naumanni	40
Fulica atra	40
Lanius collurio	40
Lanius minor	40
Numenius phaeopus	40
Nycticorax nycticorax	40
Phalaropus fulicarius	40
Picus canus	40
Scolopax rusticola	40
Tetrastes bonasia	40
Tringa erythropus	40
Tringa nebularia	40
Tringa ochropus	40
Tringa stagnatilis	40
Bucephala clangula	40
Circus cyaneus	40
Prunella collaris	40
Linaria flavirostris	40
Netta rufina	40
Cettia cetti	40
Columba oenas	40
Curruca crassirostris	40
Tachymarptis melba	40
Anser anser	39
Aegypius monachus	38
Circus macrourus	38
Gypaetus barbatus	38
Haematopus ostralegus	38
Somateria mollissima	38
Falco columbarius	38
Pandion haliaetus	38
Tadorna tadorna	38
Panurus biarmicus	36
Spinus spinus	36

Anas acuta	35
Anas crecca	35
Anas platyrhynchos	35
Anser albifrons	35
Anser brachyrhynchus	35
Aquila fasciata	35
Asio otus	35
Athene noctua	35
Branta bernicla	35
Branta canadensis	35
Cygnus olor	35
Emberiza hortulana	35
Erithacus rubecula	35
Falco biarmicus	35
Ficedula hypoleuca	35
Gallinula chloropus	35
Lullula arborea	35
Luscinia luscinia	35
Luscinia megarhynchos	35
Mareca penelope	35
Melanitta fusca	35
Melanitta nigra	35
Mergus serrator	35
Merops apiaster	35
Monticola saxatilis	35
Monticola solitarius	35
Muscicapa striata	35
Otus scops	35
Pernis apivorus	35
Phasianus colchicus	35
Phoenicurus ochruros	35
Phoenicurus phoenicurus	35
Podiceps nigricollis	35
Rallus aquaticus	35
Saxicola rubetra	35
Strix aluco	35
Tyto alba	35
Acanthis flammea	35
Accipiter gentilis	35
Lanius senator	33
Turdus iliacus	33
Acrocephalus arundinaceus	30
Acrocephalus palustris	30
Acrocephalus schoenobaenus	30
Acrocephalus scirpaceus	30
Aegithalos caudatus	30
Alauda arvensis	30
Alaudala rufescens	30
Anthus cervinus	30
Anthus pratensis	30
Anthus spinoletta	30
Anthus trivialis	30
Apus pallidus	30
Bombycilla garrulus	30
Bubulcus ibis	30
Calcarius lapponicus	30
Carduelis carduelis	30
Carpodacus erythrinus	30
Cecropis daurica	30
Certhia brachydactyla	30
Certhia familiaris	30
Chloris chloris	30
Chroicocephalus ridibundus	30
Cinclus cinclus	30
Cisticola juncidis	30
Clamator glandarius	30
Coccothraustes coccothraustes	30
Curruca cantillans	30
Curruca communis	30
Curruca curruca	30
Curruca melanocephala	30
Cyanistes caeruleus	30
Delichon urbicum	30
Dendrocopos major	30
Dryobates minor	30
Emberiza cia	30
Emberiza cirlus	30
Emberiza citrinella	30
Emberiza melanocephala	30
Emberiza schoeniclus	30
Hippolais icterina	30
Hirundo rustica	30
Iduna pallida	30
Jynx torquilla	30
Lanius excubitor	30
Larus cachinnans	30

Larus canus	30
Larus marinus	30
Linaria cannabina	30
Locustella fluviatilis	30
Locustella luscinioides	30
Lophophanes cristatus	30
Loxia curvirostra	30
Motacilla alba	30
Motacilla cinerea	30
Motacilla flava	30
Oriolus oriolus	30
Parus major	30
Pastor roseus	30
Periparus ater	30
Petronia petronia	30
Phylloscopus collybita	30
Phylloscopus sibilatrix	30
Phylloscopus trochilus	30
Picus viridis	30
Plectrophenax nivalis	30
Poecile lugubris	30
Poecile montanus	30
Poecile palustris	30
Prunella modularis	30
Ptyonoprogne rupestris	30
Regulus ignicapilla	30
Regulus regulus	30
Riparia riparia	30
Rissa tridactyla	30
Saxicola rubicola	30
Serinus serinus	30
Sitta europaea	30
Sitta neumayer	30
Streptopelia decaocto	30
Sylvia atricapilla	30
Sylvia borin	30
Tachybaptus ruficollis	30
Troglodytes troglodytes	30
Turdus merula	30
Turdus philomelos	30
Turdus pilaris	30
Turdus torquatus	30
Turdus viscivorus	30
Upupa epops	30
Pyrrhocorax graculus	30
Buteo lagopus	28
Larus fuscus	28
Accipiter nisus	25
Anser caerulescens	25
Apus apus	25
Ardea cinerea	25
Buteo buteo	25
Columba palumbus	25
Cuculus canorus	25
Emberiza calandra	25
Falco subbuteo	25
Falco tinnunculus	25
Fringilla coelebs	25
Fringilla montifringilla	25
Galerida cristata	25
Larus argentatus	25
Passer hispaniolensis	25
Passer montanus	25
Phalacrocorax carbo	25
Podiceps cristatus	25
Pyrrhula pyrrhula	25
Remiz pendulinus	25
Stercorarius longicaudus	25
Stercorarius parasiticus	25
Sturnus vulgaris	25
Nucifraga caryocatactes	20
Passer domesticus	20
Stercorarius pomarinus	20
Coeleus monedula	15
Corvus corax	15
Corvus cornix	15
Corvus frugilegus	15
Pica pica	15
Garrulus glandarius	10

6.2 Appendix 2

Table III: Species with high scores, but with limited distribution in Serbia that cannot be modeled.

Species	**Final score**
Otis tarda	105
Burhinus oedicnemus	90
Charadrius alexandrinus	90
Neophron percnopterus	90
Anser erythropus	75
Podiceps grisegena	75
Numenius tenuirostris	75
Tetrao urogallus	65
Oxyura leucocephala	60
Phalaropus lobatus	60
Pelecanus crispus	58
Acrocephalus paludicola	55
Pelecanus onocrotalus	55
Branta ruficollis	55
Milvus milvus	55
Gallinago media	53
Tetrax tetrax	53
Montifringilla nivalis	50
Pyrrhocorax pyrrhocorax	50