WEBBIRDS: A WEB-BASED DECISION SUPPORT SYSTEM FOR ASSESSING BIRD COLLISION RISK AT WIND FARMS

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INTRODUCTION

The Azov–Black Sea coast is one of Europe's major bird migration corridors. Approximately 8–15 million birds migrate through the region during each migration season.

At the same time, the region has substantial wind-energy potential. Effective assessment of potential impacts on birds therefore requires systematic monitoring, spatial analysis and quantitative risk modelling.

RESEARCH QUESTION

Can an integrated web-based system improve the spatial coverage, processing and quantitative assessment of bird movements and collision risk at wind farms?

AIM

Develop and apply an integrated web-based approach for:

- monitoring seasonal ornithocomplexes;
- analysing migration and spatial movements;
- assessing exposure to the rotor-swept area;
- calculating collision-risk indicators;
- integrating CRM and PBR; and
- supporting expert assessment and management decisions.

METHODS

STUDY PERIOD

2010–2021

14 monitoring sites • 462.42 km² • 25 wind-farm projects

FIELD SURVEYS

Fixed vehicle and pedestrian transect counts; stationary observations from vantage points; targeted surveys during intensive migration; recording of species, abundance, movement direction and flight altitude.

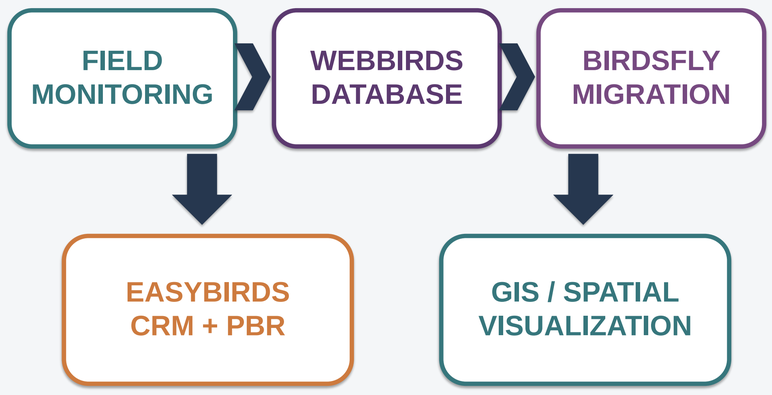
DIGITAL PROCESSING

Field data were entered into a common online storage system and analysed using the WEBBIRDS complex, combining migration analysis, GIS visualization, CRM and PBR.

MODELLING

Mathematical algorithms • regression analysis • clustering • Big Data algorithms • artificial intelligence • computer vision.

WEBBIRDS COMPLEX

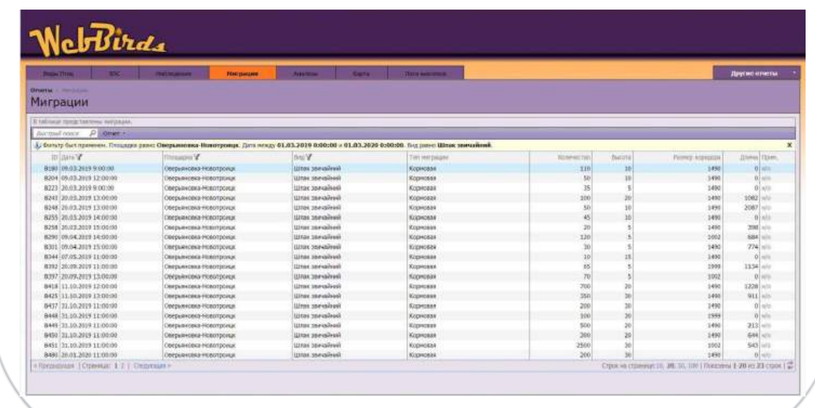


FIELD DATA → ANALYSIS → RISK INDICATORS → MANAGEMENT SUPPORT

DIGITAL MONITORING & GIS OUTPUT



Monitoring sites across the Azov–Black Sea region



Example of migration data generated by the WEBBIRDS application

RESULTS

RISK ASSESSMENT FRAMEWORK

1. AIRSPACE USE

Spatial distribution and intensity of bird movements across the wind-farm territory.

2. FLIGHT ALTITUDE

Below → within the rotor-swept risk zone → above.

3. MIGRATION PARAMETERS

Migration frequency • abundance • flock size • flight altitude • route length • passage-corridor characteristics.

4. RISK COEFFICIENT

Integrates bird abundance, movement characteristics, flight altitude and wind-turbine parameters.

KEY RESULTS

45 SPECIES | **+ 7 GROUPS** | **53.57% S. VULGARIS**

Overianivka & Novotroitsk WPP • March 2019–February 2020

CASE STUDY: BOTIIEVE WIND FARM

2018

66 taxa recorded. For 34 species and one taxonomic group (53.0%), collisions were not expected in any season.

2019

45 of 46 species and one taxonomic group had a risk coefficient of 0. The exception was Larus ridibundus (3.41%).

2020

Most species showed no significant predicted impact. Buteo buteo was the only species for which the model indicated a potentially significant annual threat in the analysed scenario.

2021

45 of 46 species and one taxonomic group had a risk coefficient of 0. Pandion haliaetus was the exception (0.94%).

INTERPRETATION

Low predicted risk was mainly associated with flight below the dangerous height range, low abundance, limited exposure, or movements outside the wind-farm site.

DISCUSSION & PERSPECTIVES

Expand long-term monitoring databases.

Develop mathematical and predictive migration-risk models.

Integrate additional GIS and spatial-analysis tools.

Improve automated processing of large monitoring datasets.

Support adaptive wind-farm management throughout project planning, construction and operation.

CONCLUSIONS

WEBBIRDS provides an integrated digital framework for monitoring and assessing bird movements at wind farms.

The system combines field observations, online data storage, GIS visualization, migration analysis, CRM and PBR.

The approach supports species-specific collision-risk assessment and provides a quantitative basis for expert evaluation.

Application in the Azov–Black Sea region demonstrated predominantly zero or non-significant predicted risks for many recorded species.

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ZAPORIZHZHIA WIND FARM, UKRAINE: IMPACT ON BATS

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Introduction

The complexity of the instrumental study of bats against the background of the legal requirement to assess the impact of WPP on bats makes the organization and implementation of monitoring of their existence conditions in technogenic areas unconditionally urgent.

National legislation in Ukraine clearly declares the need for such work, but unfortunately, there is no methodological standard for collecting and analyzing information [1]. That is why researchers of bats on the territories of wind parks are forced to rely on international practices [2-6]. This paper proposes some methods for carrying out bat research on the territory of the Zaporizhzhia Wind Farm (Ukraine) and the results of their application.

Methods

Three types of ultrasonic detectors were used to record bat signals: Pettersson D240x (2 units), Pettersson D500x (2 units) and LunaBat DFR-1 Pro (1 unit).

Scanning of the territory was carried out using four methods.

Vantage Point Surveys (9 VP)

Transects Surveys (18 transects)

Static detector surveys at ground level

Static detector surveys at meteorological mast at 42 m height

Total detector effort for 2010-2021: 4565 hours.

Totalrecorded bat signals for 2010-2021: 43938

Activity index: $I_x = N_x \cdot 60 = T$ (I_x – activity index (rassed / h);

Nx – number of bat passes; T –registration time in minutes).

To obtain more specific information on the territorial distribution of bats in the project area, we used the Kernel Density estimation (KDE) method for point objects.



Figure 1 Location of the Zaporizhzhia Wind Farm in Ukraine

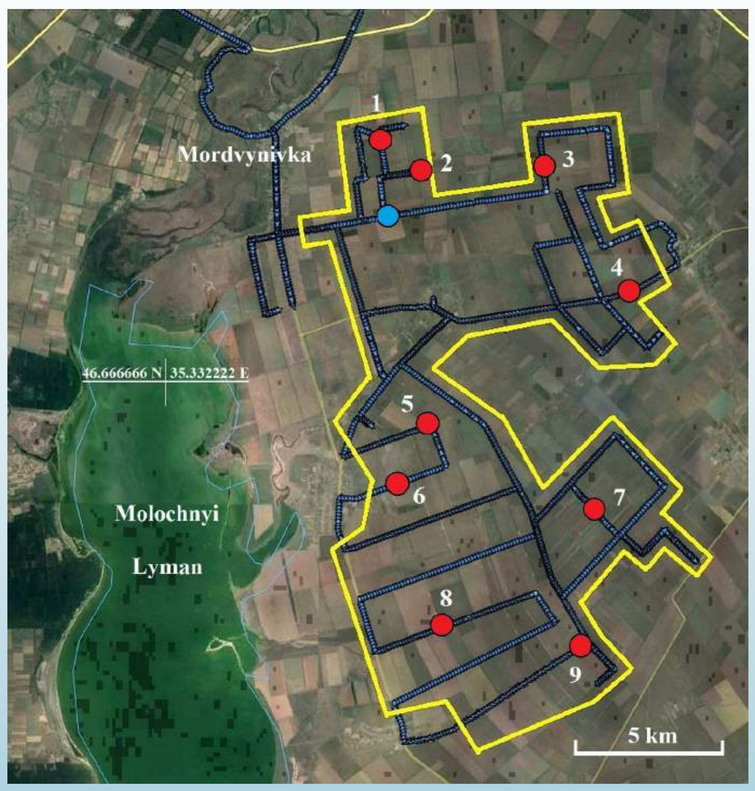


Figure 2 Study area: a yellow line is the boundaries of the wind park; red circle – vantage points (1-9); blue circle – detector site ground level; blue line – transects. Source Google Maps, 2022



Results

Sufficiently extensive field research data are needed for a qualitative assessment of the wind farm impact on bat populations. The most complete studies were in 2019, so we will give a brief description of them.

A total of 4177 signals were recorded. It is obvious that their maximum number was received at a stationary vantage point (2882 signals), since the detector worked all night. The study of voice activity on the transects gave us 694, and at the vantage points 454 signals.

To characterize the behaviour of bats, absolute indicators are insufficient, so there was used the activity index calculated for all three methods and shown in table 1 and figure 2. The maximum indicator in the first half of the year was in the middle of June (June 11 – 31 passes/h), which falls on the time of departure of young bats after the breeding season. In the second half of the year, the highest activity of bats was recorded at the end of August (August 29 – 19.8 passes/h) and indicates the beginning of autumn migration.

Long-term studies (2010-2021) show that in the second half of the year in August-September, the activity of bats was relatively higher than in the first half of the year. The differences with the data in 2019 are probably because the detectors worked exclusively within the Zaporizhzhia Wind Farm, which was represented by agricultural land. In previous years, the results of the analysis of bat activity also included data collected in settlements, on the coasts of the Molochnyi Lyman (Estuary) and the Sea of Azov. It is in these three habitats that the foraging and migratory behaviour of bats has always been more active than in agrocenoses [6-9]

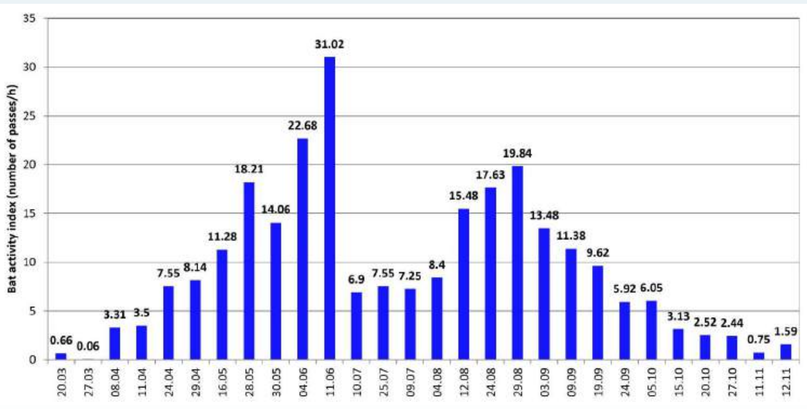


Figure 3 Dynamics of bat activity in 2019 expressed as a activity index

An analysis of the bat behaviour in different periods of the life cycle is shown in table 1. As you can see, the maximum activity of animals was recorded in the period of disintegration of colonies, the beginning of autumn migrations and grouping in flocks (the second half of August), which confirms our long-term surveys. Such results will enable us to assess the wind park impact on bat populations and develop measures to minimize the negative impact.

Table 1 Bat activity index during different periods of the life cycle in 2019

Life cycle	Date	N	T	I_x
Leaving winter roosts by animals	15.03-30.03	12	1970	0,37
Spring migration and the formation of breeding colonies	01.04-20.04	115	2028	3,40
Reproduction and the peak activity of local bat populations	21.04-31.05	862	4462	11,59
Summer flight	01.06-10.08	1154	5040	13,74
Disintegration of colonies, the beginning of autumn migrations and grouping in flocks	11.08-30.08	865	2938	17,67
Autumn migrations and grouping in flocks	01.09-20.10	929	7630	7,31
Last flights between roosts and the beginning of hibernation	21.10-30.11	93	3546	1,57
Total	15.03-30.11	4030	27614	
General mean				8,76

Notes: N – passes (signals), T – total duration in minutes, I_x – passes/h.

Species diversity

In 2010-2019, 6,928 signals were analysed, and 6.636 were identified to species or genus. At least 10 bat species representing 7 taxonomic groups were recorded. Dominants: *Pipistrellus kuhlii + Pipistrellus nathusii* complex (52.85% of all analysed signals). Subdominants: *Nyctalus noctula* (15.99%). *Vespertilio murinus* (15.36%), *Eptesicus serotinus* (6.19%).

The species composition was stable across survey years.

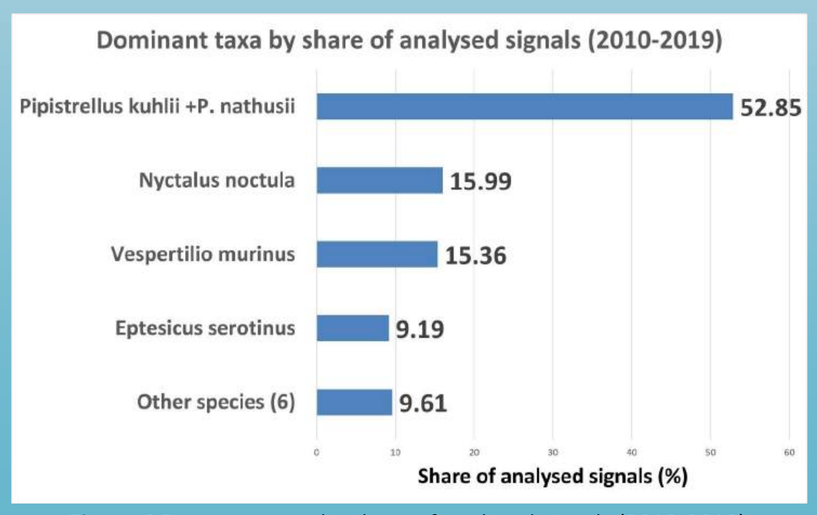


Figure 4 Dominant taxa by share of analysed signals (2010-2019)

Discussion

Given the rather large area of the Zaporizhzhia Wind Farm, it is expected that bats will use it unevenly. Thus, there is a need for zoning the entire territory and identifying places of animal concentration. To do this, we used the Kernel Density estimation method. Each recorded signal of a bat had its own geographical coordinate. A total of 694 signals were documented. In more detail, by seasons, we gave such a characteristic in a previous article [8-10]. Figure 3 shows the results of such zoning for 2019.

Considering the numerical values and the 2-kilometer radius of influence of individual points, we divided the obtained indicators into 6 gradations, which were respectively characterized by low, medium and high signal density (two gradations each).

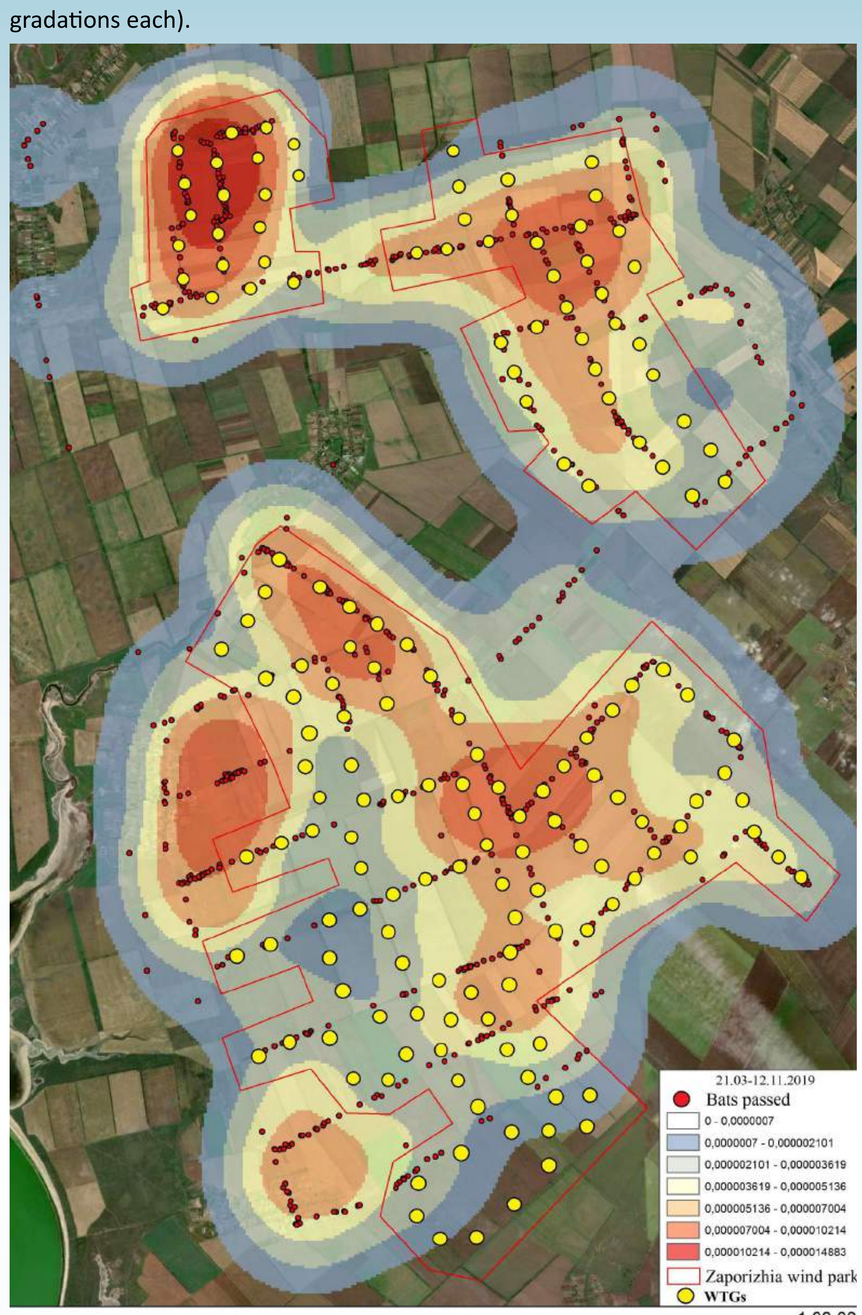


Figure 5 Kernel Density estimation of bat count points within the Zaporizhzhia Wind Farm in 2019 (28 expedition trips, 694 signals)

Conclusions

1.Mean bat activity at Zaporizhzhia Wind Farm was 8.76 signals/h.

2.The highest risk period for bats is August-September.

3.Species composition is stable and dominated by widespread Pipistrellus bats.

4.KDE analysis identified 7 wind turbine generators with high predicted negative impact and 24 with medium impact.

5.The most attractive habitats for bats were settlements and open waters rather than the main agricultural wind park area.

6.Seasonal mitigation measures are required, including increased start-up speed and turbine curtailment at low wind speeds.

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Incorporating Biodiversity into LCA: Quantifying the Impacts of Power Lines on Bird and Mammal Diversity with Norway as a Case Study

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Introduction

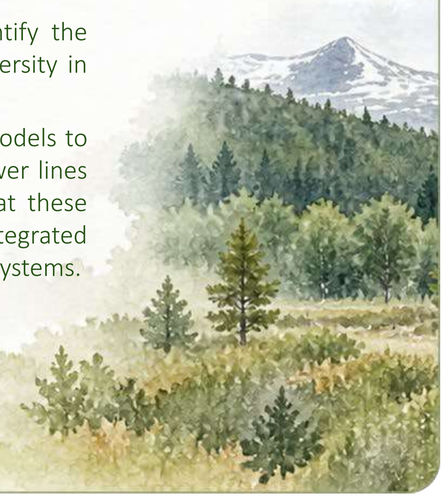
Upgrading and expanding grid networks are critical to the energy transition, yet they can increase pressure on natural areas.

One widely used framework for evaluating the environmental impacts of energy systems is life cycle assessment (LCA). However, LCA energy studies rarely include power lines and often lack a spatial component, focusing on a limited set of impact pathways that exclude impacts such as bird collisions and electrocutions.

But accounting for these impacts is important: the length of grid networks worldwide is expected to increase 2.4-fold by 2060. In Norway, a large share of the transmission grid is expected to be upgraded to increase capacity, while the total length of distribution lines is projected to grow by almost 60% by 2060.

Research question: Can we quantify the impacts of power lines on biodiversity in LCA?

We developed spatially-explicit models to quantify the main impacts of power lines on biodiversity in Norway, so that these impacts can be assessed and integrated into LCA when evaluating energy systems.

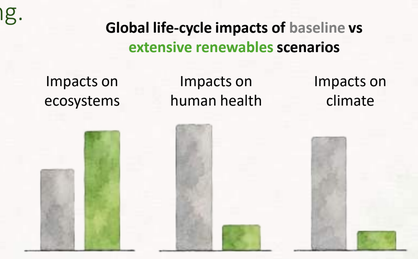


What's LCA?

LCA is a framework that quantifies the environmental impacts of a product or service throughout its entire life cycle: from raw material extraction to production, transport, use, and end of life.

It provides a holistic, system-wide analysis that enables the comparison of impacts across products or scenarios, reveals trade-offs between impacts, and spots unintended problem-shifting.

For instance, an LCA study (Luderer et al. 2019) showed that shifting to low-carbon technologies reduces climate and human health impacts but increases pressure on ecosystems through land use.



Based on Figure 3 in Hellweg et al. (2023), modified and simplified; data from Luderer et al. (2019).

Methods

We modelled species-area and habitat-area relationships based on the idea that reduced habitat size or connectivity can lead to a decline in the number of species within that area. We calculated the reduction in area size based on the impact:



Collision

Rights-of-way (ROW): loss of habitat use; collisions can occur anywhere along the power line



Electrocution

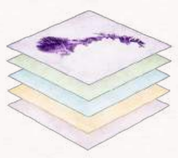
Pylon footprint: loss of habitat use; electrocution risk for birds perching on pylons



Habitat change (i.e. conversion & fragmentation)

ROW in forests and pylon footprint in open landscapes: loss of habitat

We calculated the Potentially Disappeared Fraction of species (PDF) across 13 bird groups (271 species) and four non-flying mammal groups (28 species) in Norway by integrating various data:



Spatial data

(e.g. species richness map, power lines and pylons, land cover, forest cover…)



Species data

(e.g. dispersal distance, wingspan, wing area, weight, diet…)

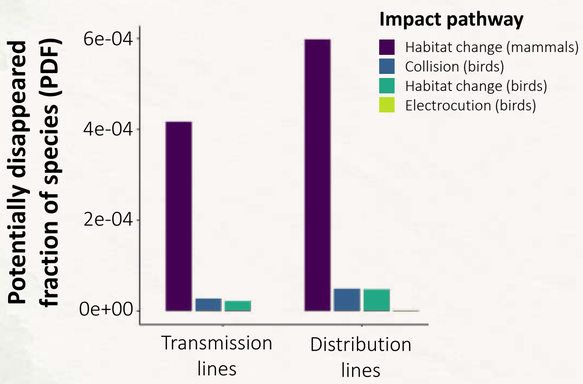


Technical data

(e.g. width of ROW, distance between phases, grid capacity…)

Results

Habitat change had the highest impact on species richness, followed by collision and electrocution. Because of their large extent, distribution lines had higher overall impacts.





Mammals were more affected by **habitat change** than birds, particularly smaller species groups.

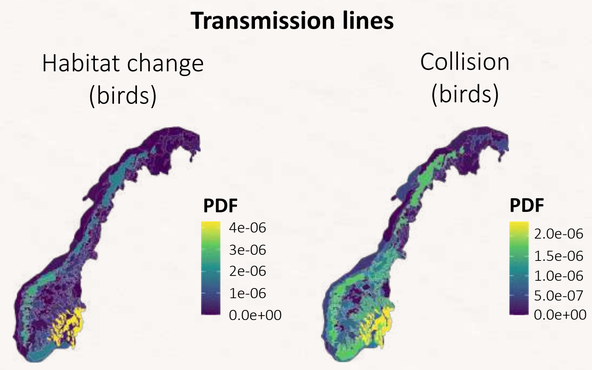


Waterfowl, water birds, seabirds, and gallinaceous birds were most affected by **collision**.



Owls and raptors were the most affected species groups by **electrocution**, followed by corvids and seabirds.

There were spatial differences in impact pathways and power line types: forested landscapes were the most affected landscape type, but overall south-east Norway was the most affected region.



Discussion & outlook

The results emphasise the importance of regionalisation in LCA analyses, as power lines affect species differently depending on species distribution and landscape features.

Moreover, while the scientific literature often focuses on transmission lines, our results show the importance of considering the distribution grid when assessing the impacts of power lines on biodiversity.

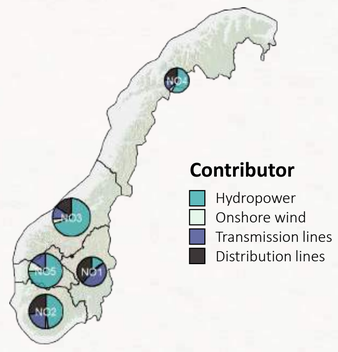
LCA offers a comprehensive, system-wide perspective, yet it often relies on simplified and generalised models. Our models remain limited in their ability to fully address biodiversity impacts. Nevertheless, the LCA field is evolving, with new emerging models and datasets.

These models could be further enhanced by incorporating specific technical data that were unavailable at a national scale, such as information on mitigation measures and pylon design.

Although this work is based on Norway, the models can be applied to any region if sufficient input data are available.

By developing and integrating these models with existing biodiversity LCA models, it became possible to model the Norwegian electricity system.

A system-wide LCA of the Norwegian electricity system showed that hydropower has the greatest impact on species richness. Power lines also contributed significantly to biodiversity impacts, particularly in southern Norway.



The magnitude and distribution of the overall impact from electricity production and transmission across the Norwegian pricing areas (Gilad et al. 2024a). The relative circle size corresponds to the magnitude of the overall impacts across the pricing areas.

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Anthropogenic Impacts and Habitat Preferences of Black Storks (*Ciconia nigra*) during Migration



Integrating movement ecology, behavioral state and habitat modelling for evidence-based planning

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1 Introduction

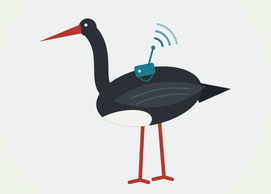
Wind energy and urbanisation is expanding fast in Europe to tackle climate change and urbanisation increase. The black stork (*Ciconia nigra*) is a soaring migratory bird foraging in rivers and ponds. Direct (collision) and indirect (habitat loss, barrier effect) impact of wind farms and urbanisation is still widely debated. This leads to different regulation depending on the country. In France it is one of the few species treated as a **deal-breaker for wind projects**, a stricter status than anywhere else in Europe.

Questions :

- How does the Black stork interact with windfarms during its migration ?
- What are its habitat preferences on its premigration site ?

2 Methods

Equipment of GPS tag



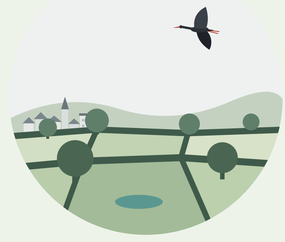
Five adults equipped with GPS tag in 2025, offering data from 5-min and 15-min resolutions.

Behaviour analysis



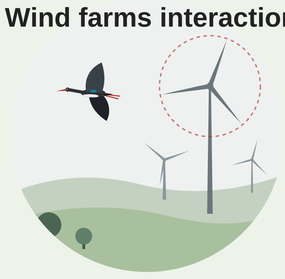
We modelled different behaviours during its migration and premigration stay regarding flight height, speed and accelerometer data, using HMM

Premigration home range and habitat selection



We modelled home range using advanced statistical method (wAKDE). For each feeding, flying and resting behaviour detected on premigration site we studied habitat selection (RSF)

Wind farms interaction



We fitted 2-state hidden Markow models (HMM) on the **European part** of the migration route to identify behavioural states using step length, turning angle and flight height. We assessed the effect of landscape covariates either to the transition probabilities or the concentration of turning angles.

3 Results – Wind farms and migration

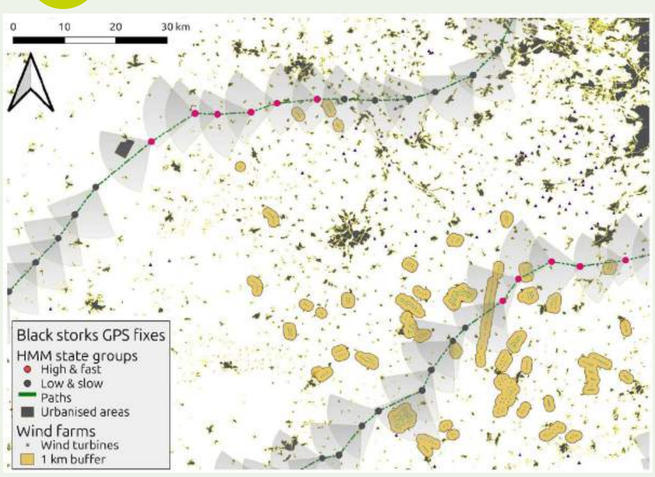


Figure 1. Map sample of migrating black storks. The behavioural state groups determined by HMM are shown with different colours. The landscape elements were measured inside the grey 'sectors' (10 km radius, 90°) a bird is flying towards at each locations.



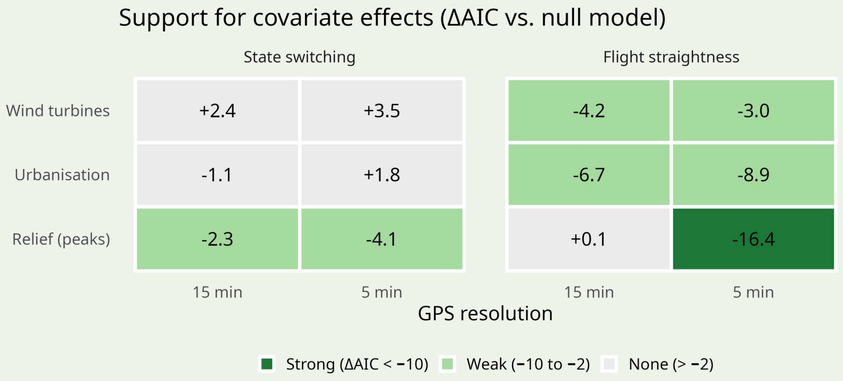


Figure 2. Support for each covariate model relative to the null model (ΔAIC), for 15-min and 5-min GPS fix intervals. Covariates act either on state switching (left) or on flight straightness (right). Negative values indicate an improvement over the null model after accounting for the added parameters; colours show the level of support.

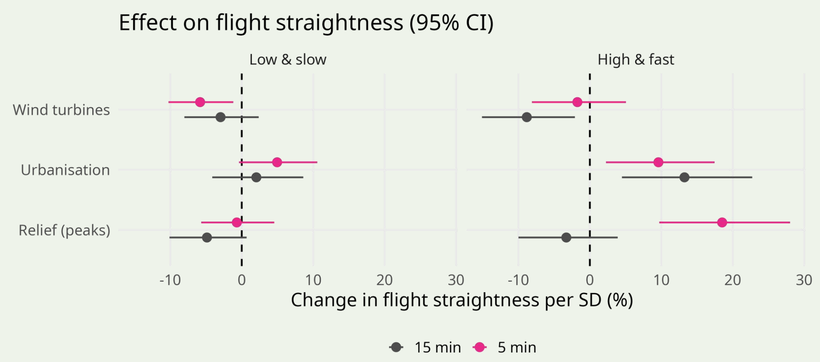


Figure 3. Effect of landscape covariates on flight straightness within each behavioural state. Points show the % change in the concentration of turning angles for a one-SD increase in covariates ; bars are 95 % confidence intervals. Negative values indicate less straight flight. Intensity of effects should be interpreted with regard of Figure 2.

4 Results – Premigration sites

- Pre-migration home range size varied a lot: from **multiple small sites starting from 4.5 km² to one single large 2408.7 km² site**.
  - ➢ **This shows strong individual variation in space use during premigration stay.**
  - **Most of the time was spent resting and feeding**:

    Resting: 56%, Feeding: 41%, Flying: 3%.
  - Feeding habitat selection:

    Individuals significantly **selected broad-leaved** habitats (p = 0.033), significantly **avoided urban** habitats (p = 0.008), and strongly selected areas **close to rivers** (p < 2e-16).
  - Resting habitat selection:

    The same trend appeared for resting, but slightly weaker: more use of broad-leaved habitats (p = 0.076), less use of urban habitats (p = 0.063), and strong selection for river proximity (p < 2e-16).
  - ➢ **This suggests resting sites are often close to feeding areas**.
  - **Flying behavior showed a different pattern**:

    During flight, broad-leaved habitats were still significantly selected (p = 8e-05), as well as small broad-leaved patches (p = 0.081). **Urban areas were not significantly avoided** (p = 0.115)
- ➢ **Flying individuals may be less constrained by urban disturbance than when feeding or resting.**
- ➢ **Individual differences are behavior-dependent: pronounced for resting/feeding site choice, but much less evident during flying (transit) phases.**

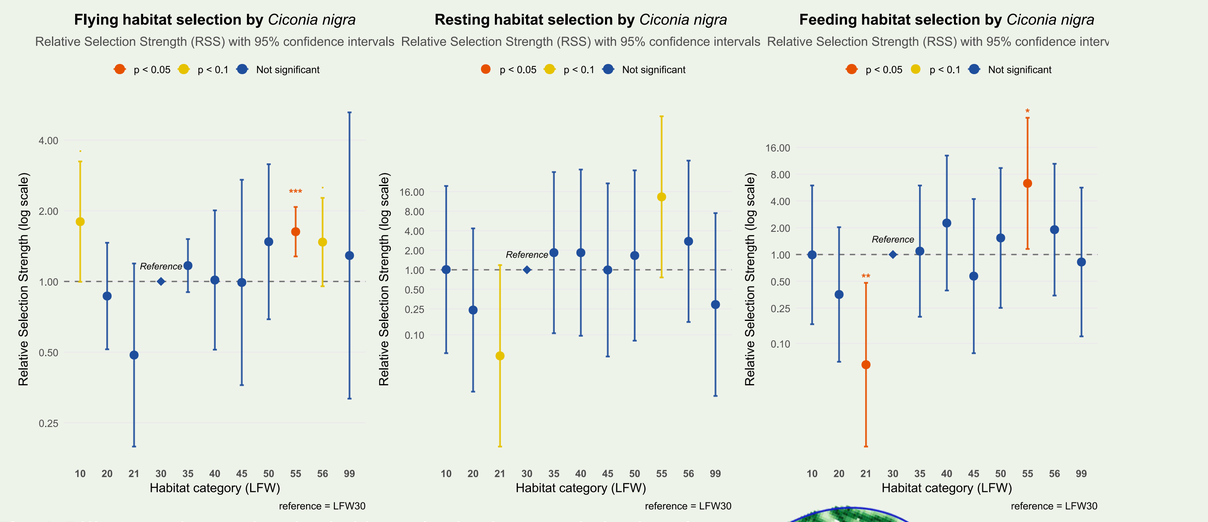


Fig. 4. Differences in premigration habitat selection between behavioural states

➢ **Predictions map** per individual highlights hydrological network and broad-leaved habitats to be highly selected while urban areas are significantly less selected.

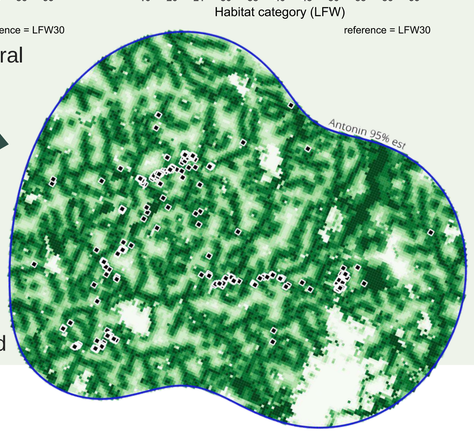


Fig. 5. Prediction map for one individual; greener and darker pixel = more selected

5 Discussion and Outlook

- Premigration space use dramatically varied among individuals, highlighting strong ecological flexibility. Behavior was dominated by feeding and resting.
- Habitat selection analyses showed a clear preference for broadleaved and river-associated habitats over agricultural land, while urbanised areas were consistently avoided for both feeding and resting state. Flying individuals don't seem to be constrained by urbanised area.
- No obvious effects of wind farms on behavioural switch from/to low&slow (~25 km/h; 310 m alt.) and high&fast (~40 km/h; 775 m alt.) state, although there appear to be a weak impact on flight straightness (slightly different between the datasets). Urbanisation shows only a slight effect on flight paths, whilst terrain plays a more significant role.

Take-home message

- **Premigration:** We detected in-between individual differences in home range size, and habitat selection. Habitat preferences are behaviour-dependent : Urbanisation was avoided during feeding and resting while broadleaved areas were selected during feeding, resting and flying.
- **Migration:** No robust effect of wind-turbine density on migratory flight behaviour at both flight height categories; terrain ruggedness acts on trajectory and it is more pronounced with a higher frequency of GPS fixes. These results remains to be confirmed at finer scales.

6 Selected literature

- Anderwald, D., Sławski, M., Zadworny, T., & Zawadzki, G. (2024). Are Current Protection Methods Ensuring the Safe Emancipation of Young Black Storks? Telemetry Study of Space Use by Black Storks (Ciconia nigra) in the Early Post-Breeding Period. *Animals*, *14*(11), 1558. https://doi.org/10.3390/ani14111558
- Garcia-Rosa, P. B., & Tande, J. O. G. (2023). Mitigation measures for preventing collision of birds with wind turbines. *Journal of Physics: Conference Series*, *2626*(1), 012072. https://doi.org/10.1088/1742-6596/2626/1/012072
- Бокотей, А., Dzyubenko, N., & Strus, I. (2021). *What is wrong with the protection zone of a 1-km radius around Black Stork Ciconia nigra nests? 3*, 44-49.
- *Balmori-de la Puente, A., & Balmori, A. (2023). Flight Type and Seasonal Movements Are Important Predictors for Avian Collisions in Wind Farms. Birds, 4(1), 85-100. https://doi.org/10.3390/birds4010007*
- *Marx G. (2026). Collisions de cigognes noires avec des éoliennes terrestres en Europe : Analyse des données disponibles. Collection de l'Observatoire des énergies renouvelables et de la Biodiversité. Projet ICONE. LPO.*

RWE

Peter.Jones@rwe.com

Practical Insights from RWE's Onshore Biodiversity Positive Pilots

CONFERENCE WINGSPAN

Testing practical pathways to biodiversity positive outcomes across onshore wind and solar assets in Europe & Australia

38 Projects & Assets | **Europe & Australia** Diverse contexts | **100 +** Enhancement measures delivered | **2030** Biodiversity Positive Ambition

1. INTRODUCTION

Why biodiversity positive?

RWE's Biodiversity Policy requires new assets to aim for biodiversity positive outcomes by 2030. Our commitment helps to deliver a nature-positive energy transition by integrating biodiversity enhancements into renewable energy infrastructure.

A series of pilots were carried out by RWE to test how biodiversity positive can be delivered at onshore wind and solar PV assets in Europe and Australia.

Our research question

What is the most practical, cost-effective approach to deliver biodiversity positive outcomes at onshore renewables?

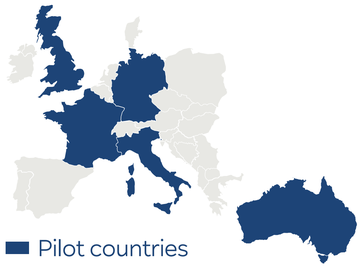
Renewables expansion + **Biodiversity Recovery** = **Nature-Positive Energy Transition**

2. METHOD

Pilot portfolio

Pilots were carried out across Europe and Australia, focusing on 12 development projects and 8 operational..

24 Development Projects | **14** Operational Assets | **5** Countries



Biodiversity enhancement catalogue

All pilots used RWE's Biodiversity Enhancement Catalogue to select positive actions, after application of the mitigation hierarchy.

- **Avoid** — Avoid impacts
- **Minimise** — Minimise impacts
- **Restore** — Restore & offset to pre-development condition
- **Positive Action** — Contribution beyond mitigation

Positive actions selected in following order:

1. **Enhance** natural habitats retained on site
2. **Create** native habitats
3. **Species measures** e.g. nesting boxes, site-specific targeted interventions

Approach 1: Positive Contribution

Delivery of additional voluntary biodiversity enhancement actions above regulatory requirements.

Permit requirements for biodiversity are delivered before additional actions including:

- Habitat Creation
- Habitat Enhancement
- Pollinator Habitats
- Species Measures

Approach 2: Net-Positive Impact

Delivery of a net-gain to all habitats on site relative to pre-development situation. Three % gain scenarios tested.

+ 1% Gain scenario | + 10% Gain scenario | + 50% Gain scenario

3. RESULTS

1 Rapid deployment is possible



100+ Positive contributions | **12** Months

Over 100 enhancements were delivered in 12 months of piloting.

2 Positive Contribution approach is scalable

Positive contribution approach proved practical and easy to implement across countries and different permitting regimes.

Regulatory requirements → **Additional voluntary actions**

It also provided a clear distinction between regulatory and voluntary biodiversity actions improving reporting transparency.

3 Range of metrics allow for progress tracking

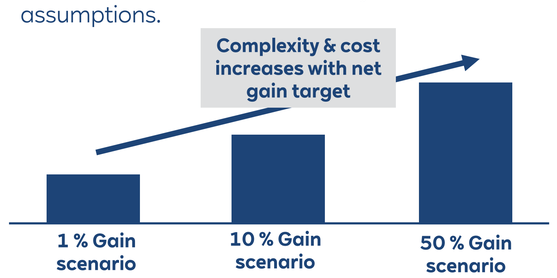
- **Number of Actions**
- **Euro investment**
- **Biodiversity impact**



AI acoustic monitoring of bird songs

4 Impact-based approaches are challenging

Quantitative net-gain targets were associated with higher project costs, greater data requirements and sensitivity to baseline assumptions.



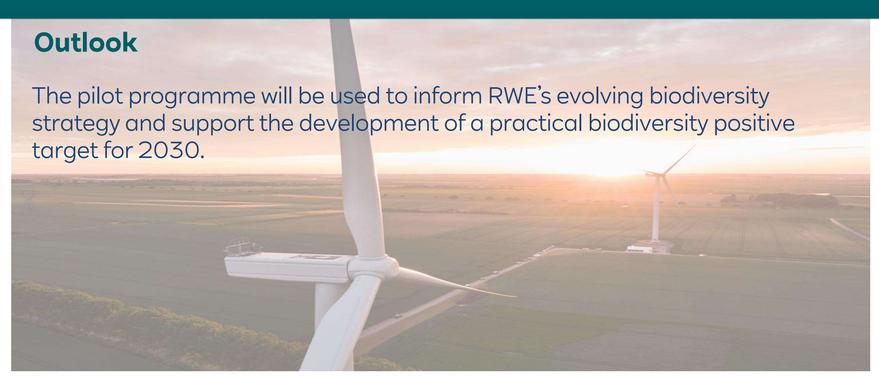
- **Higher Capex & Opex**
- **Higher data requirements**
- **Sensitive to baseline assumptions**

4. DISCUSSION & OUTLOOK

What did we learn?

- ✓ Operational assets offer immediate opportunities for delivering additional voluntary biodiversity actions.
- ✓ This approach provides a positive contribution to 2030 biodiversity goals.
- ✓ A range of metrics are suitable to track progress and report transparently.
- ✓ Impact-based approaches are too complex and costly to implement voluntarily.

Outlook



The pilot programme will be used to inform RWE's evolving biodiversity strategy and support the development of a practical biodiversity positive target for 2030.

Scan to view RWE Biodiversity Policy

KEY TAKEAWAYS

1. Biodiversity enhancements can be integrated into onshore wind assets today.
2. A positive contribution approach enables rapid deployment of biodiversity actions.
3. A range of metrics are needed to track progress and enable reporting transparency.
4. Scalability, practicality and cost-effectiveness are essential.

RWE

Red Kite (*Milvus milvus*) protection in the EUROKITE Life project in Hungary

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[2]: TB Raab GmbH (Technisches Büro für Biologie), A-2232 Deutsch-Wagram, Quadenstraße 13
[3]: Pro Vértes Nonprofit Zrt. H-8083 Csákvár, Kenderesi utca 033/7 hrsz.
Email address: gyorig.elod@mme.hu



Figure 1: During the project, we reached all of Hungary's vocational secondary schools specializing in forestry and game management, as well as many agricultural vocational secondary schools, with the presentation featuring birds of prey. In the picture, László Haraszthy is giving a presentation.

Introduction

The Hungarian Red Kite population is located on the edge of the species' range. In the 1970s, similar to the surrounding countries, the species went extinct across the entire country. In the previous period, it mainly bred in mountainous areas and larger forests. The species has been under strict protection in Hungary since 1954, which is why we are focusing on the species. As a partner in the EuroKite Life project, ProVértes Nonprofit Zrt. participated in the species conservation activities.

Method

The first pair appeared again in 1990. Since then, monitoring of the species during the breeding season has been coordinated by the Raptor Conservation Section of the BirdLife Hungary.

Monitoring, Nesting

After initially slow growth, by 2026, we knew of 58 breeding pairs or well-defined territories (Figure 2). In Southwest Hungary, an isolated subpopulation has formed, but scattered breeding pairs also exist along the Danube and Tisza rivers, and in western Hungary the increasing populations in Austria and Slovakia have led to the species' reappearance in 2005. Between 1990 and 2026, at least 386 chicks fledged (Figure 5).

Migration and wintering

Within the framework of the EuroKite project, 45 red kites have been tagged in Hungary by the end of 2026. According to the telemetry data, the Hungarian Red Kites are partial and short-distance migrants (Figure 3). The wintering areas of first-year birds (n=29) are distributed as follows: remained within the Carpathian Basin (n=13), Serbia (n=1), Croatia (n=1), Bosnia and Herzegovina (n=1), Greece (n=2), Crete (n=2), Northern Italy (n=1), Central Italy (n=4), Southern Italy (n=4). The majority of second-calendar-year birds wintering in the Carpathian Basin (n=13), but they have also been recorded in the Czech Republic (n=1), Southern Italy (n=1), and Crete (n=1). The birds that lived for three or four years (n=10) all remained in the breeding area.

The first survey of wintering Red Kites was organized in 2018, when a larger roost site became known, where 39 individuals were counted. In January 2026, we already had conducted surveys at 33 night roost places, which of 9 had no Red Kites at that time, while at 22 sites, the presence of 479 individuals was confirmed. The record so far was at the end of November 2025, when 562 specimens were counted at 39 surveyed locations (Figure 4).

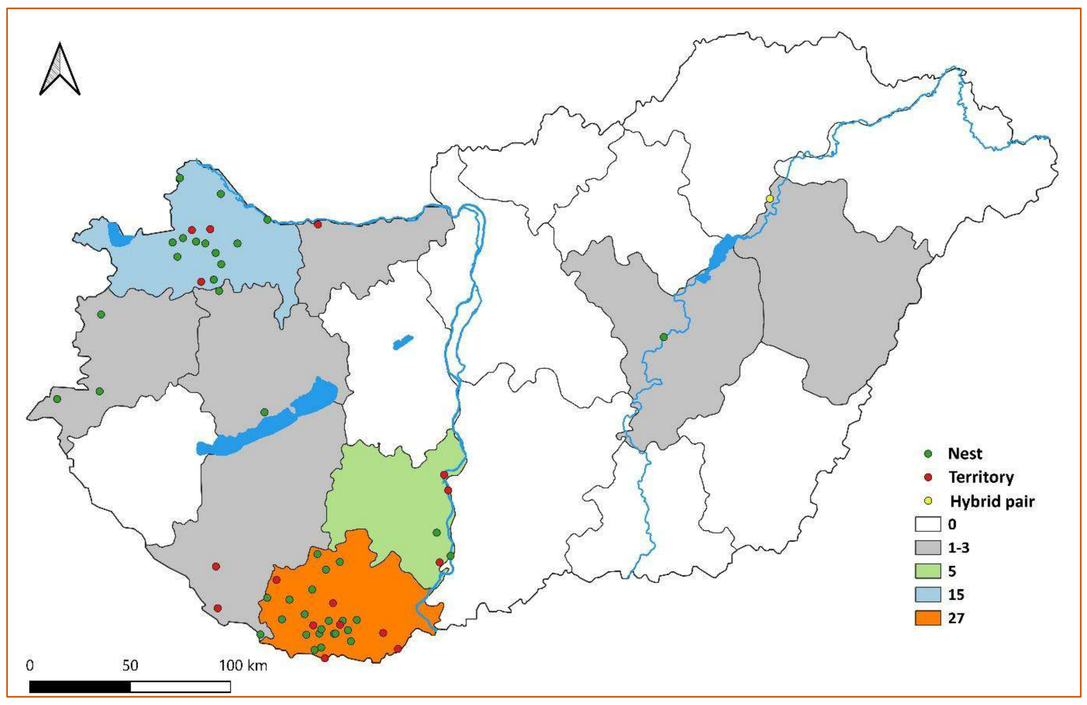


Figure 2: Red Kite breeding sites in 2026. Green: known nest; red: unknown nest, only territory; yellow: known hybrid nest.

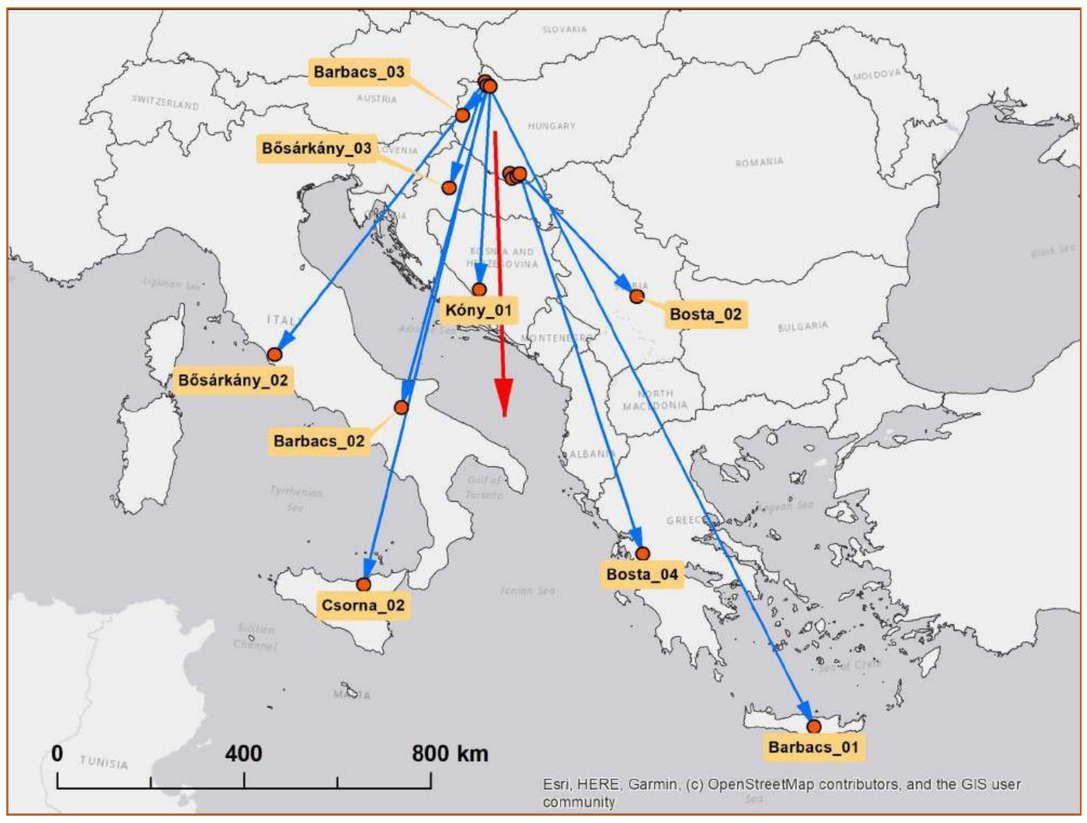


Figure 3: Wintering locations of first-year Red Kites with telemetry until winter 2024.

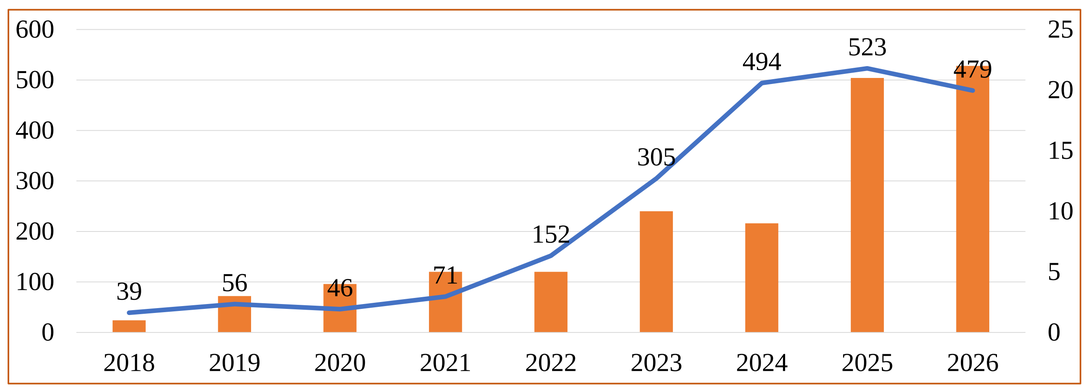


Figure 4: January Census 2018-2026. Number of individuals (scale on the left) and locations (scale on the right).

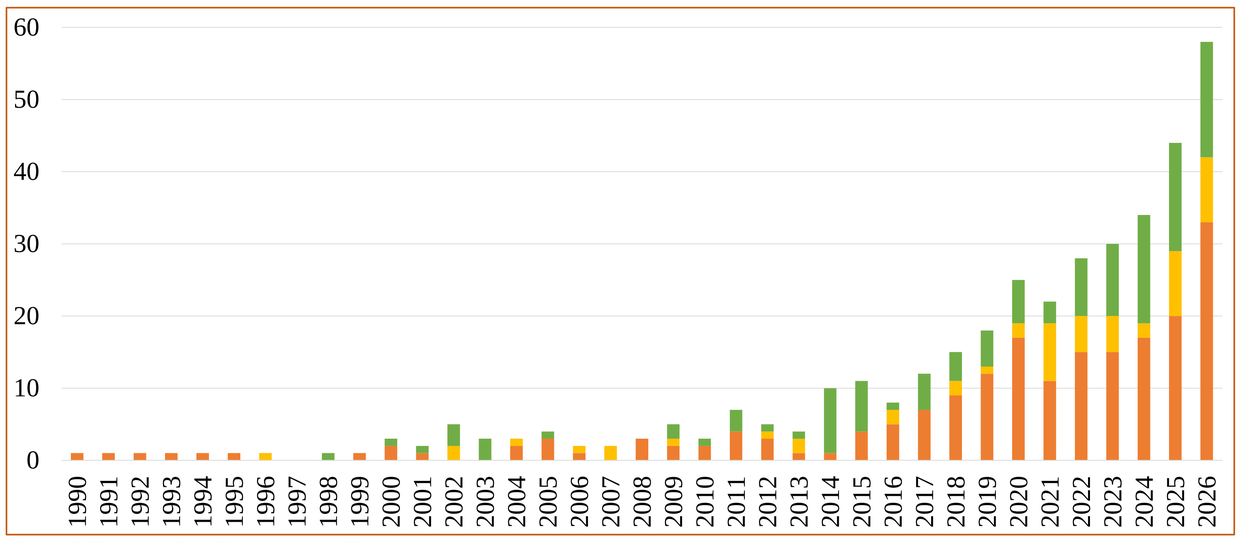


Figure 5: Hungarian Red Kite population. Green: nesting outcome or nest location unknown; yellow: unsuccessful nesting; red: successful nesting.

Raising awareness

With the aim of preventing mortality, we sought to expand the knowledge of professionals in related fields through several initiatives.

We delivered a total of 106 presentations to wildlife managers and vocational students, focusing on the conservation of birds of prey and the issue of poisoning (Figure 1). Furthermore, we produced a field guide for identifying birds of prey—distributing 10,000 copies to professional hunters and wildlife managers—to help dispel misconceptions stemming from misidentification.

To prevent electrocution, we held 12 presentations and two operational coordination meetings for technicians to nearly 500 professionals, managers, and training specialists from all electricity utility companies in Hungary. Furthermore, large numbers of birds congregate at waste disposal sites—which also serve as significant overwintering grounds for red kites—leading to mass bird mortality on the power grid, particularly among white storks. Given the urgent need for intervention, we organized a conference to address this issue; at the event, the relevant ministry, national park directorates, and NGOs jointly defined future monitoring efforts and nature conservation interventions.

We have produced a publication aimed at a broader audience, as well as a four-part short film series covering general raptor conservation, the importance of satellite tagging, illegal poisoning, and the issue of electrocution.

Causes and investigation of destruction

Reason for getting into hands Red Kites in Hungary to date are: shooting (n=2), poisoning (n=8), trapped in game management traps (n=2), electrocution (n=4), predation by Goshawk (n=5), starvation (n=2), collision by traffic (n=1) and unknow (n=3) (Figure 6).

To investigate bird mortality caused by electrocution, 14,500 utility poles were inspected in areas where red kite's nest or overwinter. A total of 793 bird carcasses were found; however, no red kite carcasses were discovered during the survey. In several instances, official regulatory decisions mandated that the relevant utility companies implement bird-friendly retrofitting at sites where strictly protected species were affected or where significant bird mortality had occurred.

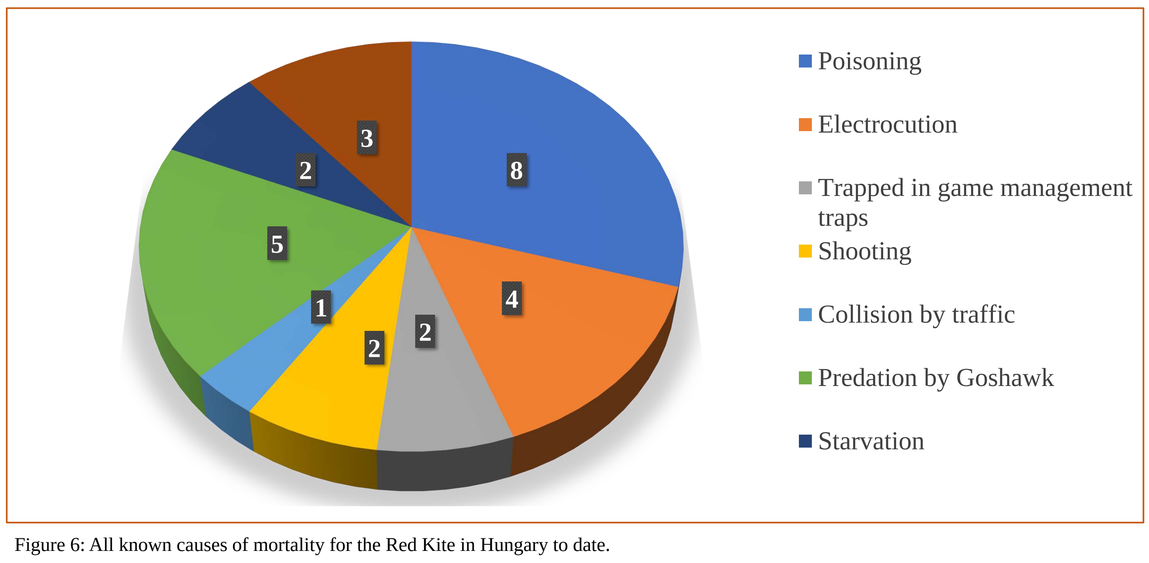


Figure 6: All known causes of mortality for the Red Kite in Hungary to date.

Outlook

Several articles have been produced regarding our research and monitoring activities (see references), and we have also presented our work at several conferences in Hungary, as well as at the 4th International Symposium on the Red Kite, held in Binaced, Spain.

In collaboration with experts and other nature conservation organizations, we have incorporated our findings and our knowledge regarding the red kite into a national species conservation plan. We have submitted this document to the ministry responsible for nature conservation, where it will be included in official national documentation—thereby ensuring the long-term protection of the species and the implementation of measures related to it.

Acknowledgements

We are grateful to the volunteers of BirdLife Hungary, the staff of the National Park Directorates, who participated in the field data collection, with a special mention to László Bank, who has been monitoring the presence of the species in Baranya County since the beginning.

We would like to thank TB Raab GmbH for their help with telemetry.

The conservation of the species was supported by BirdLife Hungary, Pro Vértes Nonprofit Zrt. and the LIFE EUROKITE Project (LIFE18 NAT/AT/000048).

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Haraszthy L., Bank L., Spakovszky P., Julius E. & Wojta M. (2025): Wintering population of Red Kites (Milvus milvus) in Hungary between 2018 and 2024. Heliaca 21: 55–56.

Spakovszky P., Vig E. A., Győrig E., Bagyura J., Bank L., Bereczky A., Haraszthy L., Kozma L. & Váczi M. (2025): First migration of Red Kites (Milvus milvus) telemetry tagged in Hungary. Heliaca 21: 57–67.

Electrocution on Medium-Voltage Power Lines as a Major Threat to the Reintroduced Northern Bald Ibis

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Bernhard Gönner[1] & Johannes Fritz[2,3]

INTRODUCTION & BACKGROUND

Electrocution on medium-voltage power lines is a leading cause of human-induced mortality for large birds globally and poses a critical threat to the ongoing reintroduction of the **Northern Bald Ibis** *(Geronticus eremita)* in Central Europe, a species classified as Endangered on the IUCN Red List. Since 2002, hand-reared birds have been trained via human-led migration to establish a self-sustaining migratory population breeding in Austria and Germany and wintering in Italy and, since 2023, also in Spain. Population viability analyses show the **reintroduced population, currently around 390 individuals**, is not yet self-sustaining without active management, making the reduction of anthropogenic mortality a priority for the EU-funded **'LIFE Northern Bald Ibis' project** (LIFE20 NAT/AT/000049 – LIFE NBI).



Fig.1a: Adult Northern Bald Ibis (*Geronticus eremita*). Picture: C. Esterer



Fig.1b: Group of juvenile Northern Bald Ibises during the human-led migration, guided by a microlight aircraft. Picture: Waldrappteam

The reintroduced Northern Bald Ibis population frequently uses power poles as roosting places during day and night, as they provide attractive elevated perch sites in their open agricultural foraging habitat. In **Germany** grid operators are **legally required to built or retrofit power poles to make them save for birds**, such legislation is missing in Austria, Italy and many other European countries.

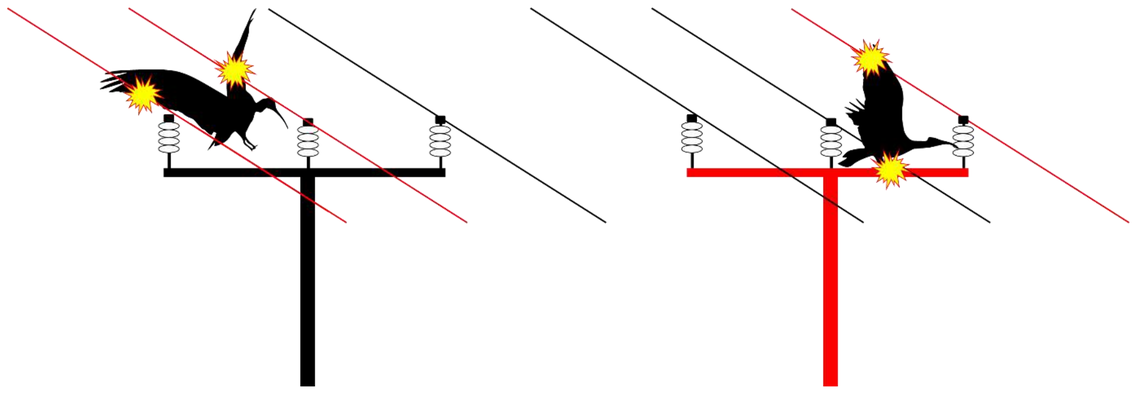


Fig.2: Mechanisms of bird electrocution on medium-voltage power lines. A bird creates a fatal short circuit either by simultaneously touching two live conductors (left panel) or by connecting a live conductor to an earthed pole structure (right panel). Graphic: M. Heiderer

The risk of electrocution is influenced by different factors. Large birds – like the Northern Bald Ibis – are more likely to connect electrical components with their wings, beaks, or feet. Most electrocution events recorded in the Northern Bald Ibis population happened on **power poles bearing horizontal insulators and/or complex branching constructions**. These designs include several areas for the birds to land and sit on, with small distances between energized and/or earthed components.



Fig.3a & b: Two high-risk medium-voltage power poles with horizontal insulators and complex constructions in Austria. Pictures: C. Esterer

Between 2014 and 2025, **electrocution** was the most frequent cause of death in the reintroduced Northern Bald Ibis population, responsible for **29,6 % of all cases** with known mortality cause. During this period, a total of **119 cases of electrocution** were recorded. The cause of death could be determined in 57 % of all mortality cases.

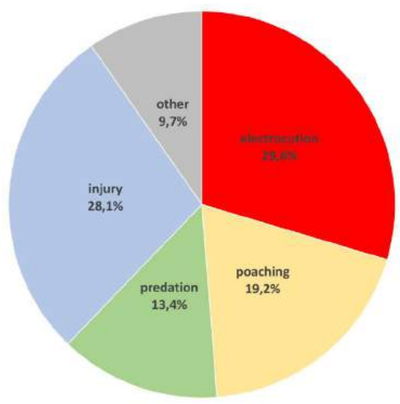
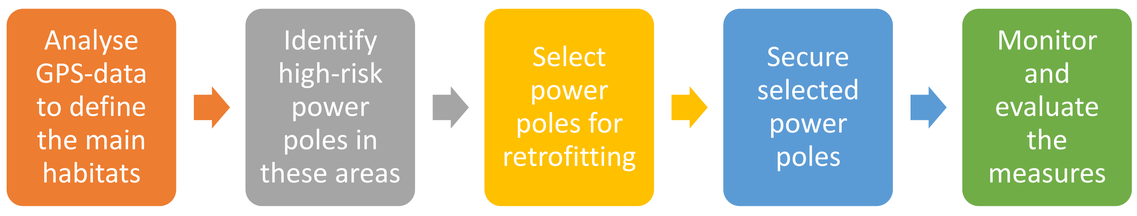


Fig.4: Causes of mortality (% of cases with known cause) in the reintroduced European Northern Bald Ibis population, 2014–2025 (N = 402 cases with known cause).

METHODS & MEASURES

High-risk poles were identified by combining **GPS-derived habitat-use data** from the reintroduced population with **structural risk assessments**, focusing on poles bearing horizontal insulators and complex branching configurations that allow large-bodied birds to bridge live and earthed components.

A **five-step workflow** guided the selection and retrofitting of power poles across three Austrian federal states, **surrounding the breeding colonies** of Kuchl, Rosegg and Burghausen.



RESULTS & DISCUSSION

Retrofitting measures where carried out by the regional grid operators. In 2024, 43 high-risk power poles were retrofitted in Upper Austria by **Netz Oberösterreich GmbH**. In Carinthia, **Kärnten Netz GmbH** carried out measures on 71 power poles, finished by the end of 2025. The **regional government of Land Salzburg** contracted retrofitting of 60 power poles to grid operator **Salzburg Netz GmbH**, measures here are still ongoing.

Therefore within the 'LIFE Northern Bald Ibis' project a total of **174 high-risk power poles are being retrofitted against electrocution**. As the measures are just recently finished or still ongoing, it is currently not possible to draw any conclusions about the effect of these measures on mortality in the Northern Bald Ibis population. Nevertheless, no incidents have occurred in the areas where the measures were implemented.

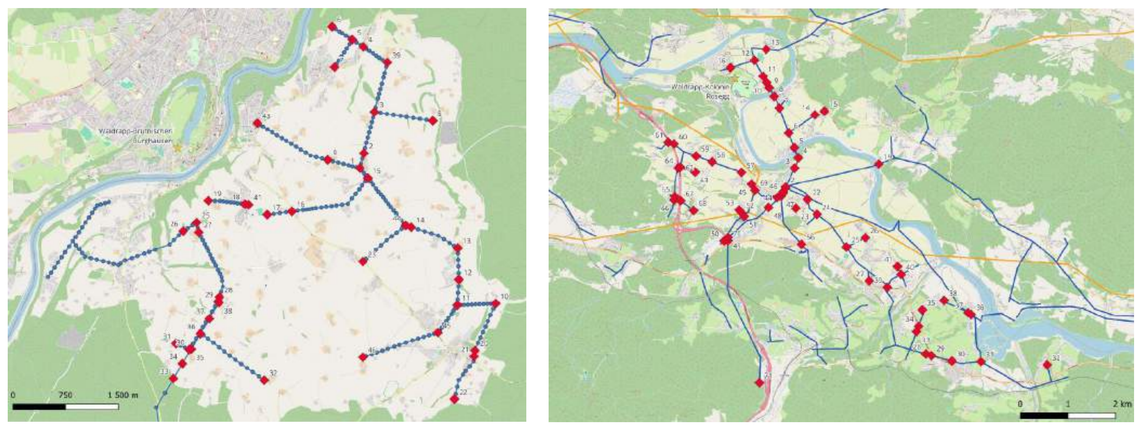


Fig.5a & b: Overview of measures against electrocution in Upper Austria (left) and Carinthia (right). Red: targeted power poles (Upper Austria: N = 43; Carinthia: N = 71); blue dots (only left): other power poles; blue lines: medium-voltage power lines in the project area; orange lines (only right): high-voltage power lines in the project area.

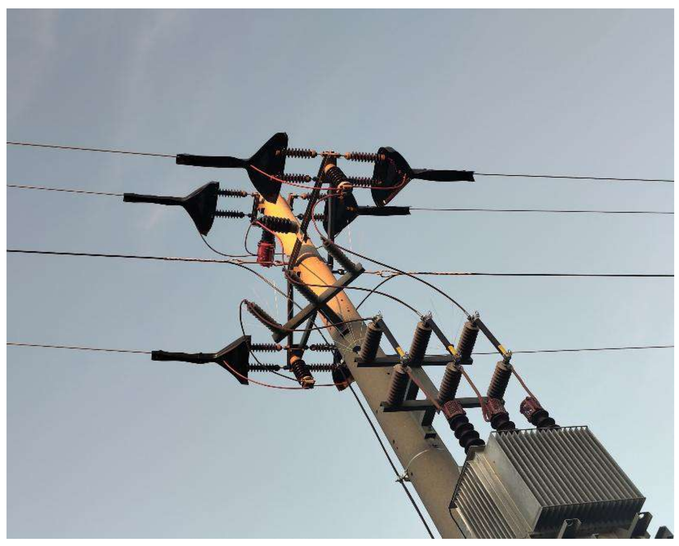


Fig.6a: Retrofitted power pole in Upper Austria with cover caps (black), insulation tubes (red), and insulated cages (red). Picture: B. Gönner



Fig.6b: Retrofitted power pole in Carinthia with insulation tape (red) wrapped around the power line and connection. Picture: B. Gönner

The findings highlight that **a regulatory framework mandating bird-safe infrastructure represent the most effective and scalable solution to electrocution mortality**. We call for harmonised, legally binding bird-safe power pole standards across all range states of the Northern Bald Ibis, particularly in Austria and Italy, where 84% of all recorded electrocution cases in the population occur.

Acknowledgements

This work was carried out within the LIFE Northern Bald Ibis project (LIFE20 NAT/AT/000049 – LIFE NBI), co-funded by the European Union.
We thank all partners, sponsors, and collaborators of the Northern Bald Ibis reintroduction project.

Co-funded by the European Union

Wind energy development and the conservation of the greater mouse-eared bat (*Myotis myotis*)



Integrating movement ecology, habitat modelling and population dynamics for evidence-based planning

Jean-François Godeau[1], Pierrette Nyssen[1], Arnaud Beckers[2], Julien Otoul[2]

[1] Ecofirst SC, Belgium · [2] CSD Ingénieurs, Belgium

Introduction

Wind energy is expanding fast in Europe, increasingly in and near forests. The greater mouse-eared bat *(Myotis myotis)* forages mainly in forests. Its collision risk is considered low, but indirect effects - displacement and loss of foraging habitat - are still debated. In Wallonia (Belgium) it is one of three bat species treated as a **deal-breaker for wind projects**, a stricter status than anywhere else in Europe.

Question: Does wind energy development really threaten *M. myotis,* and what evidence should guide planning?



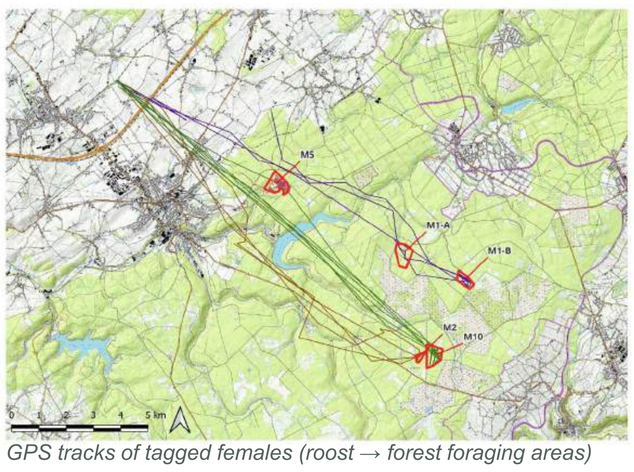
Objectives - 3 studies, Belgium 2023–2026

1. **Movement ecology**
   How high do females fly and where do they go?
2. **Habitat modelling**
   Where does the species occur in Wallonia?
3. **Population dynamics**
   Do wind farms affect colony trends in Europe?

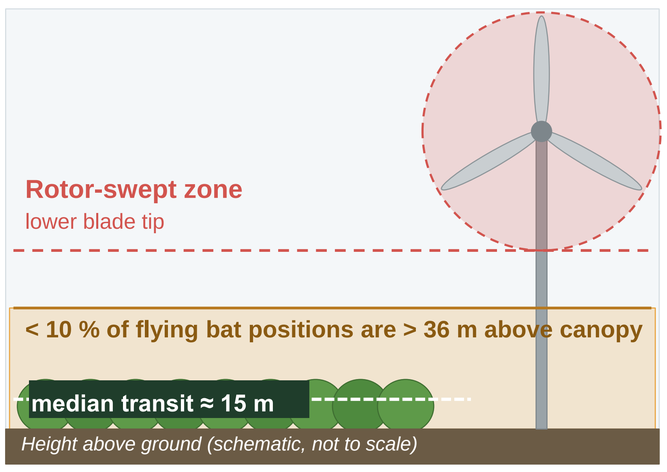
1 Movement ecology — bats mainly fly below the rotors

Method

- **24 lactating females** tagged with miniaturised GPS loggers at maternity roosts (2 colonies)
- 9 usable tracks, 672 usable fixes
- Measure flight altitude during transit and foraging



GPS tracks of tagged females (roost → forest foraging areas)



Result

< 10 %

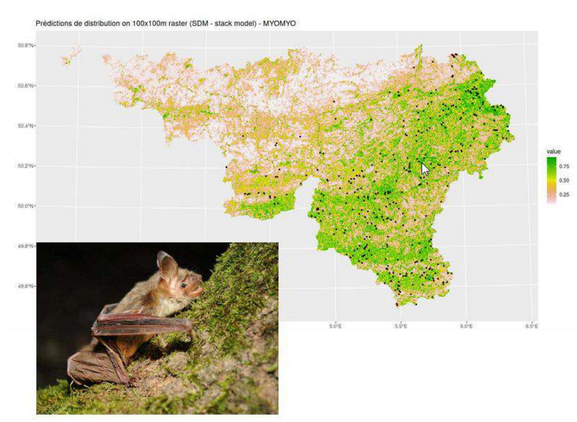
of locations from tagged females are higher than **36 m above the vegetation**.
Foraging: within or below the canopy (≈12 m high), within 10-15 km of the roost.

More information:

2 Habitat modelling — a reliable map for Wallonia

Method

- Existing acoustic monitoring data
- **Species Distribution Modelling (SDM)** combining four algorithms
- Predictions on a 100 m grid; same approach for other forest bat species



Predicted habitat suitability of M. myotis in Wallonia

Use in planning

- Screen sites early, at regional scale
- Target field surveys where habitat suitability is high
- Base siting decisions on predicted habitat suitability

Result

≈ 40 %

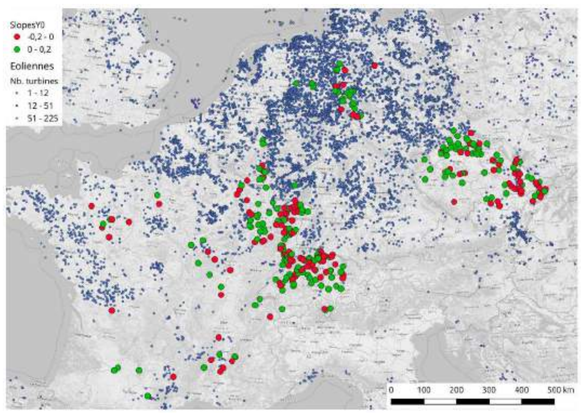
of Wallonia potentially used regularly (conditions favorable to the species).
In Belgium the species is restricted to Wallonia (no known colony in Flanders).

More information:

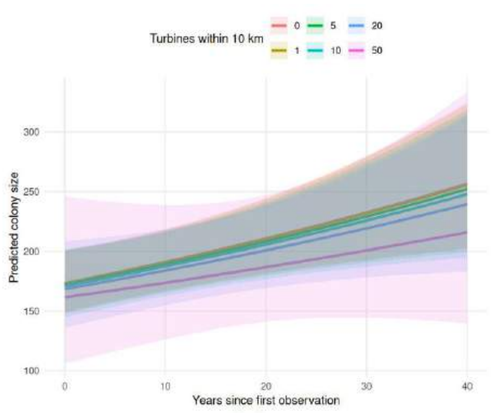
3 Population dynamics — no wind-farm effect in Europe

Method

- **6 countries** (BE, CH, CZ, DE, FR, LU), 1985–2025
- 330 maternity colonies; 5,762 counts
- 14,552 wind farms: turbines within 10 km of each colony, and annual evolution of the situation
- Three complementary approaches: GLMM (neg. binomial); before-after test; land-use change (CORINE)



Colonies trends (green = increase, red = decrease) and wind farms (blue)



Predicted colony size with time (no significant differences)

Result

No effect

of turbine number on colony size nor trend (p = 0.73).
Urbanisation of farmland is the stronger driver.

More information:

Discussion & outlook

- **Collision risk is low:** most flights stay far below the rotor-swept zone; risk is limited to rare high transit flights.
- **Plan at regional scale:** the distribution model supports strategic siting based on map analysis.
- **No population signal of a wind farms negative impact** across 6 countries and 40 years; landscape change (urbanisation) explains trends better.

Take-home message: the **lack of evidence** of a negative impact of wind turbines on the greater mouse-eared bat should NOT hide evidences of fatalities on other bat species (eg. migrating bats) !

Selected literature

Barré, K., Le Viol, I., Bas, Y., Julliard, R. & Kerbiriou C. (2018). Estimating Habitat Loss Due to Wind Turbine Avoidance by Bats: Implications for European Siting Guidance. Biological Conservation 226 (October): 205-14. https://doi.org/10.1016/j.biocon.2018.07.011

Gaultier, S. P., Lilley, T. M., Vesterinen, E. J. & Brommer J. E. (2023). The Presence of Wind Turbines Repels Bats in Boreal Forests. Landscape and Urban Planning 231: 11. https://doi.org/10.1016/j.landurbplan.2022.104636

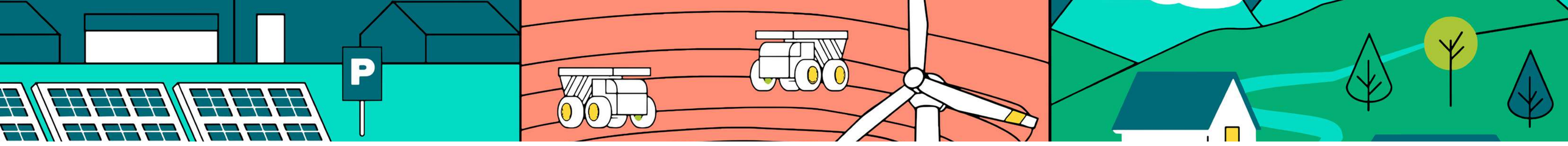
Ellerbrok, J. S., Delius, A., Peter, F., Farwig, N. & Voigt, C. C. (2022). Activity of forest specialist bats decreases towards wind turbines at forest sites. Journal of Applied Ecology, 59, 2497–2506. https://doi.org/10.1111/1365-266 4.14249

Godeau, J.-F. & Nyssen, P. (2023). Modélisation des habitats naturels des chauves-souris forestières sur base des données acoustiques existantes. Rapport final. Ecofirst S.C. https://doi.org/10.13140/RG.2.2.21269.69605

Nyssen, P., Beckers, A., Renard, P., Godeau, J.-F. (2023). Etude de l'utilisation de l'espace et du temps par le grand murin par GPS loggers miniaturisés. Ecofirst S.C. and CSD Ingénieurs. https://doi.org/10.13140/RG.2.2.20583.62884

Nyssen, P., Doumont, E., Godeau, J.-F., Casier L., De Neyer, L., Van Den Abbeel, N. et Beckers, A. (2026). Impact des éoliennes sur le développement des colonies de grand murin (*Myotis myotis*) en Europe, Rapport final, mars 2026, Ecofirst S.C. and CSD Ingénieurs. https://doi.org/10.13140/RG.2.2.21372.30080

The studies about Habitat Modelling et GPS-survey were carried out under a public contract awarded by the Service Public de Wallonie. European population study was funded by the Un Vent de Nature fund, managed by the King Baudouin Foundation. We thank all organisations and volunteers in BE, CH, CZ, DE, FR and LU who shared colony counts.



Mapping Artificial Land Surfaces to Accelerate Nature-Positive Renewable Energy Deployment:

A Spatial Decision Support Framework from the LIFE REALS Project

WINGSPAN Conference · 3–5 November 2026 · Berlin

Artificial Land Surfaces(ALS): an opportunity

- **Mining sites** and related infrastructure (waste deposits, lakes)
- **Industrial zones** – closed, operating and planned; rooftops and buildings
- **Landfills** – closed
- **Transport infrastructure** – parking lots, highways, railways, abandoned tracks
- **Irrigation systems**

Which are suitable?

- **Technical suitability** – wind and sun potential, distance to grid, slope and aspect, road access, flood risk.
- **Environmental sensitivity** – exclude protected areas, water bodies, riparian zones, IBAs, Ramsar, UNESCO, Natura 2000, forests.
- **Social / cultural / other** – urban settlements, military areas, cultural and archaeological sites, airports.

Why ALS?

Renewables need space, but greenfield development can compete with agriculture, ecosystems and communities. Reusing already developed or disturbed sites can help reduce that conflict.

- **Less pressure on natural land:** reusing built or disturbed sites reduces conversion of undeveloped areas
- **New purpose for constrained sites:** capped landfills and former mines can host renewables where safety allows
- **Protect natural land:** use surfaces already altered by human activity.
- **Make existing assets more productive:** pair power generation with parking, waste management or site restoration.
- **Serve nearby demand:** rooftops and industrial sites may be close to electricity users and grid connections.
- **Support site reuse:** give inactive or constrained land a productive purpose.

Objective:

By 2028, LIFE REALS will help authorities and stakeholders identify and unlock opportunities for renewable energy deployment on artificial land surfaces by addressing key regulatory, planning and knowledge barriers, reducing pressure on natural ecosystems and supporting nature-positive energy deployment.



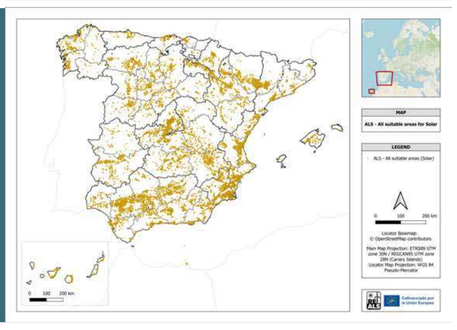
Results

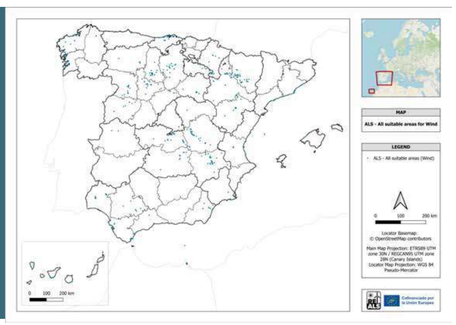
National spatial analysis reports of artificial land surfaces suitable for deployment of wind and solar power

Maps of the spatial distribution of ALS categories for wind and solar, by municipality

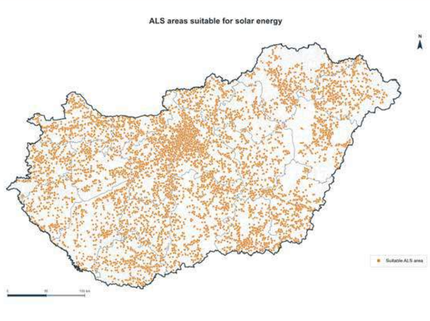
Approximate area estimates for each ALS class suitable for RES projects and further calculations

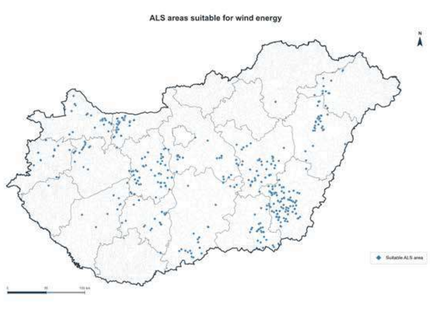
Spain



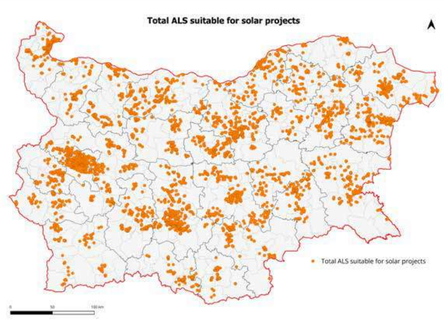


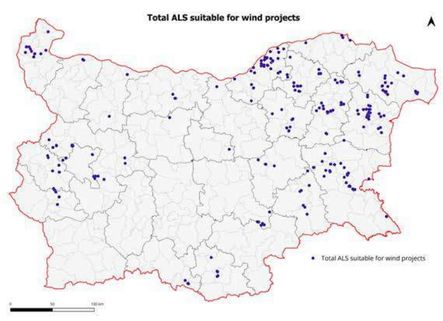
Hungary



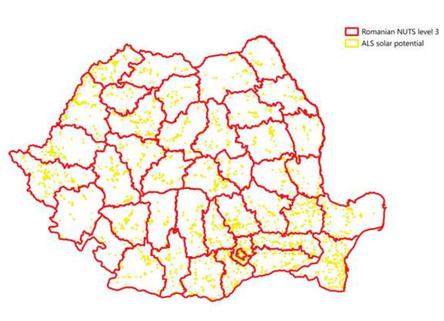


Bulgaria



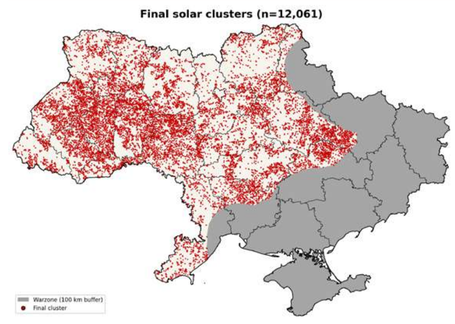


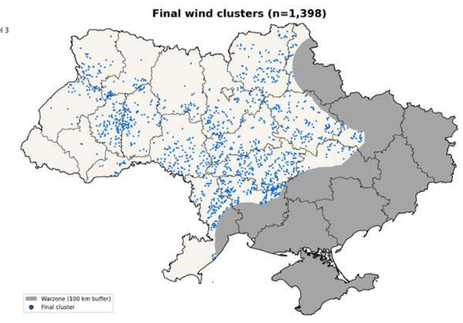
Romania





Ukraine





Legal and administrative barriers of onshore wind and solar PV on ALS

- ALS territories do not play a highlighted role in RES regulations in the 5 project countries.
- As a result, ALS investments are generally perceived as less favourable by investors.
- ALS sites are significantly more promising for PV than for wind, mainly due to spatial constraints, geotechnical stability and safety zones for wind energy.
- The most promising ALS sites are operating industrial parks.
- For other types of ALS, regulatory easements (or financial incentives) are likely to be needed to exploit their potential.
- The most important barriers for ALS sites are reclamation requirements, structural issues, and the coexistence of energy regulations with other types of regulations.
- Most countries lag behind with implementing key provisions of RED III.

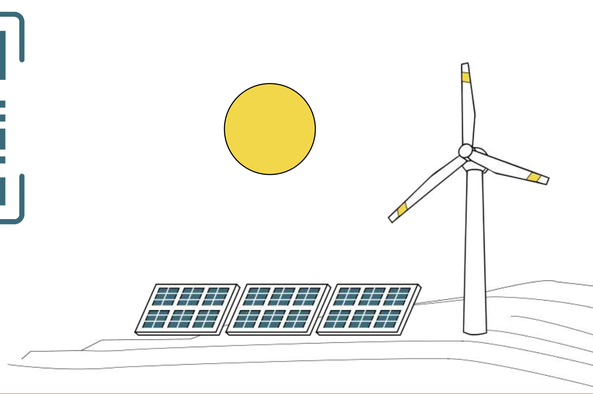
LIFE REALS Knowledge Hub

Access the LIFE REALS Knowledge Hub:

- Maps and reports on the potential of ALS for wind and solar power
- Barrier assessments and policy recommendations
- Good practices from five European countries
- Guidance materials and training resources
- Project updates and stakeholder exchange

From Evidence to Action: What's next

- **Validation of national spatial analyses in pilot municipalities**
- **Assessment of socio-economic barriers to ALS deployment**
- **Development of national and EU policy recommendations**
- **Capacity building for permitting authorities and stakeholders**
- **Expansion of the LIFE REALS Knowledge Hub**
- **Continued engagement through national and European taskforces**



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