Practical application of the space use collision risk model (RKR model) in approval procedures

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Pilotstudie Probabilistik (Mercker et al., 2023)

- Development of the Hybrid model for collision risk prediction
- First application for the Red Kite
- Telemetry analyses, resampling, module testing - Species-specific parameters (e.g. habitat preferences, flight altitude distribution, avoidance behaviour)

Fortsetzungsstudie Probabilistik (Mercker et al., 2024): Finalization of the RKR model for the Red Kite

- Publication by the BfN
- Optimized Data basis
- Validation with real collision and telemetry data
- Error reduction
- Project implementations
- Threshold value discussion - Funding: BMWK

Mikroproject RKR-PRO: **Expansion to 4-6 additional bird species**

- Duration: January to Sept. 2025
- Project lead: Research Center Jülich
- Target species: White-tailed Eagle, White Storck, Black Kite,

Honey Buzzard, Imperial Eagle among others.

Figure 1: The timeline illustrates the continuous development process – from the initial idea of contributing to the compatibility of renewable energy use and species conservation within the framework of the energy transition, to the integration of the RKR model into legal frameworks. Ongoing optimization of the data base enables the inclusion of an increasing number of bird species in the modelling.

Introduction

The "Pilotstudie Probabilistik" (Mercker et al., 2023) provided proof of concept for risk prediction regarding the breeding bird species Red Kite at wind energy facilities. The "Fortsetzungsstudie Probabilistik" (Mercker et al., 2024) enables, for the first time, a robust and quantitatively transparent project-specific application based on optimized input data. Validation using real collision and telemetry data shows that the model not only provides consistent risk assessments but also realistically reflects project-specific differences (see Figure 1).

Assessment of the Impacts of Repowering

Using the RKR model, a standardized and transparent calculation of the expected number of collisions per breeding bird and breeding season can be carried out.

This enables the assessment of the project's impacts based on the predicted collision risk using a technical expert evaluation scheme; an extended "traffic light" system is applied for this purpose. The individual collision (lethality) risk is assessed for each wind energy installation using the following categories: Collision Risk (per WEA): ● <1% (low), ● 1–2% (moderate), 2-5% (high), ■ > 5% (very high). "Green" indicates low, "blue grey" moderate, "yellow" high, and "red" very high impact intensity, no mitigation considered (see Figure 2).



Figure 2: The graphic shows a cartographic excerpt with the model-based assessment of collision-related mortality risk for selected wind turbines (P1 and P2). Wind turbines to be deconstructed are shown as pink points (D1 - D3, see Figure 3). The assessment is based on an expert-driven extended traffic light scheme, which determines the predicted impact intensity specific to each location and displays it using a colour-coded system.

Delta analysis in the context of repowering

	Year	P1	P2	D1	D2	D3	Total (decon.)	Total (plan.)	Total (diff.)
Α	2022	0,00547	0,00159	0,01562	0,00243	0,00906	0,02691	0,00705	-0,01985
В	2021	0,00199	0,00446	0,00215	0,00361	0,00193	0,00767	0,00645	-0,00122
C	2022	0,00149	0,00125	0,00204	0,00130	0,00400	0,00731	0,00274	-0,00457
Delta							-257.89 %	100.0 %	-157.89 %
x 1	2022	0,00032	0,00051	0,00035	0,00038	0,00042	0,00116	0,00082	-0,00034
x2	2023	0,00034	0,00024	0,00054	0,00025	0,00065	0,00144	0,00058	-0,00086
x3	2021	0,00025	0,00033	0,00029	0,00026	0,00048	0,00102	0,00057	-0,00045
x4	2022	0,00021	0,00017	0,00033	0,00018	0,00028	0,00079	0,00038	-0,00040

Figure 3: In the final delta analysis, the collision risk of the planned wind farm is compared with that of the existing turbines. The planned wind farm's risk serves as the reference value (100%). The existing risk is shown as negative, since decommissioning removes its collision risk. This combined view reflects the overall impact of the proposed project.

Upon the applicant's request, the modification approval procedure under the Federal Immission Control Act (Bundes-Immissionsschutzgesetz, BlmSchG) pursuant to § 16b only examines whether the repowering – that is, the replacement or substantial modification of the existing installation – has significant adverse effects on protected assets compared to the current state. Only if such significant negative impacts are identified will the permitting requirements under § 6 BlmSchG be fully reviewed.

The delta analysis is used in accordance with § 16b (1) of the Federal Immission Control Act (Bundes-Immissionsschutzgesetz, BlmSchG) to evaluate repowering. It should be noted that in the case of repowering, the comparison of the impacts of the existing project with those of the repowering project is decisive for determining or refuting a significantly increased risk of killing.

The collision risk of the planned wind farm is compared with the risk posed by the existing wind turbines. The delta analysis calculates the difference between the two risks. The collision risk of the planned wind farm is used as the reference value (100%).

The risk assigned to the existing wind farm is indicated with a negative sign in the delta analysis, as the decommissioning of the existing wind farm eliminates its associated collision risk. When considering the collision risk of the planned wind farm together with the decommissioning of the existing wind farm, the overall impact of the proposed project becomes apparent. This includes both the construction of the planned wind farm and the decommissioning of the existing one. Mitigation measures are not considered in this assessment (see Figure 3).

The Space Use Collision Risk Model (RKR) – Extension to up to six additional breeding bird species

Between January and September 2025, a project funded by the BMWE.IIB5 is being carried out by BioConsult SH GmbH & Co. KG, Bionum GmbH and TB Raab GmbH. The RKR model has already been finalized for the Red Kite (Mercker et al., 2023, 2024a). To adapt the RKR model to a new bird species, all available bird movement data are first collected. In a second step, these data are intersected with land use information and the locations and metrics of wind energy installations (WTGs).

Next, the model's input parameters (such as habitat preferences, flight height distribution, avoidance behaviour around WEAs, intensity of space use depending on distance from the breeding place etc.) are empirically and robustly determined using modern statistical methods. Robustness analyses are then conducted to examine, for example, the extent to which observed habitat preferences can be transferred to different regions within Germany.

In the final step, the calculation documentation (Mercker et al., 2024b) is adapted for each species. So far, 3D space use has already been determined for the species White-Tailed eagle, White Stork, Black Kite, Honey Buzzard, and Eastern Imperial Eagle. Expert consultations on the results for these species are currently taking place. In addition, the avoidance or evasive behaviour of these species is being determined by intersecting high-resolution telemetry, camera, and laser range finder (LRF) data with the operating data of wind turbines. Initial evaluations of available data are also being carried out for the Marsh Harrier, Montagu's Harrier and Hen Harrier.

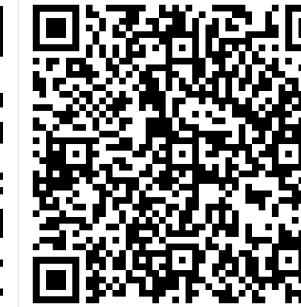
For the Red Kite, the required scope of empirical telemetry data, operational data on rotor speed of wind energy installations (WTG) and accompanying mortality surveys was collected and implemented within the LIFE EUROKITE project. Several publications on the Red Kite have already been submitted (mortality protocol, mortality analyses, collisions at WTGs), and further publications are expected shortly (avoidance behaviour, breeding place association).

As part of the "Fortsetzungsstudie Probabilistik", a calculation rule for project-level application was published for the Red Kite. This ensures reproducible results and does not constitute a black box. For the other species, clear calculation guidelines will also be published by mid-October as part of the RKR-PRO project. The introduction of the RKR method into the German Federal Nature Conservation Act, including a threshold value, is planned for the coming months.

Important links:









The RKR model provides timely, well-founded, project-specific forecasts of land use and collision risk of breeding birds for each breeding site-habitat-WT combination.

Quick and easy - project-related information

www.predictbird.de