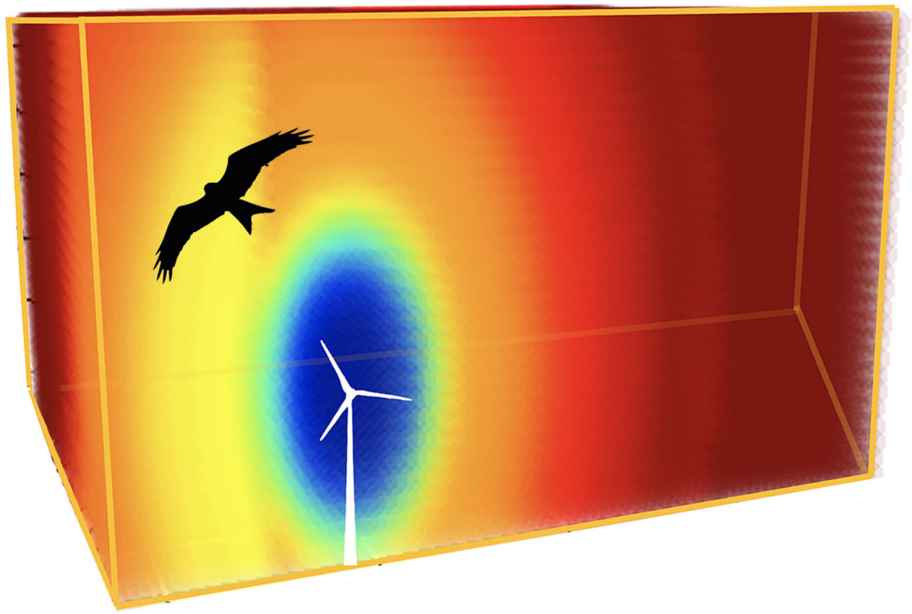
Pilot study ‚Testing probabilistic methods‘

Summary

Dr. Moritz Mercker, Dr. Jannis Liedtke, Dr. Thilo Liesenjohann, Jan Blew



Husum, Mai 2023

Commissioned by:
Hessischen Ministeriums für Umwelt, Klimaschutz, Landwirtschaft und Verbraucherschutz (HMUKLV)

Commissioner:	Hessisches Ministerium für Umwelt, Klimaschutz, Landwirtschaft und Verbraucherschutz (HMUKLV) Mainzer Str. 80 65189 Wiesbaden
Project:	Pilot Study „Testing probabilistic methods“: Testing of probabilistic methods with regard to their technical prerequisites with the aim of validating the method for the determination of the project-related collision / mortality risk of selected breeding bird species at wind energy plants.
Status:	Mai 2023

Contractor:

BioConsult SH GmbH & Co. KG
Schobüller Straße 36
25813 Husum
www.bioconsult-sh.de
j.blew@bioconsult-sh.de

Bionum GmbH – Büro für Biostatistik
Finkenwerder Norderdeich 15 A
21129 Hamburg
www.bionum.de
mmercker@bionum.de

Authors:

Dr. Moritz Mercker
Dr. Jannis Liedtke
Dr. Thilo Liesenjohann
Jan Blew

Cited as: (in German with English summary)

M. Mercker, J. Liedtke, T. Liesenjohann, J. Blew (2023): Pilot Study „Testing probabilistic methods“: Testing of probabilistic methods with regard to their technical prerequisites with the aim of validating the method for the determination of the project-related collision / mortality risk of selected breeding bird species at wind energy plants. Commissioned by the Hessisches Ministeriums für Umwelt, Klimaschutz, Landwirtschaft und Verbraucherschutz.

Pilot study "Testing probabilistic methods"

Summary

1 Background and introduction

The effects of the construction and operation of wind turbines (WT) on birds are divided into four categories: Killing (usually through collision with the rotor blades, but also with the tower), displacement through disturbance, barrier effects (with regard to migrating birds), and direct habitat loss, e. g. through foundations or access roads (Drewitt and Langston, 2006). Within the framework of the presented pilot study, only the prohibition of killing according to § 44 para. (1) 1 of the Federal Nature Conservation Act (BNatSchG) is considered.

Following a resolution of the Conference of German Ministries of Environment of 11 December 2020, the ministries recommended to analyse the technical and legal prerequisites as well as possibilities for the use of probabilistic procedures in licensing new onshore windfarms. This includes theoretical and practical testing of probabilistic procedures and methods, e. g., within the framework of pilot projects. The aim is to ensure the development of consistent procedures that can be applied on a national level.

BIOCONSULT SH, Husum, and BIONUM, Hamburg, were commissioned by the HESSISCHES MINISTERIUM FÜR UMWELT, KLIMASCHUTZ, LANDWIRTSCHAFT UND VERBRAUCHERSCHUTZ to carry out this pilot study on probabilistic methods. In particular, this study is about testing probabilistic methods with regard to their technical prerequisites for determining the project-related mortality risk of breeding bird species, i. e. the risk of collision with wind turbines.

During the project period, the current amendment to the Federal Nature Conservation Act (last version December 2022) added paragraph 6 to § 74, which states that by 30 June 2023, the Federal Cabinet shall submit a report on the introduction of probabilistic methods.

In the report on the presented pilot study, first an overview and general comparison of existing collision risk models is given. Representatives of two fundamentally different classes of models are then further examined and compared: the mechanistic and the empirical collision risk models. In particular, for the mechanistic approach, the existing ideas and models are first explained, and then an improvement/extension of the approaches in the form of a synergetic model (termed 'hybrid model' – which combines habitat modelling with collision modelling) is developed, explained and thoroughly validated with external data and projects. The basis for the development of the hybrid model is a large amount of provided tracking data (GPS data, laser rangefinder data and radar data). The empirical collision risk models are also explained, examined in more detail and comparatively classified; the latter prove to be less suitable for practical use due to the very high experimental effort required.

The application of collision risk models also raises questions about threshold values for allowed additional mortality, which are described and evaluated in a separate chapter. Finally, conclusions are drawn and suggestions for practical application are presented. Last but not least, it is pointed out that further theoretical adjustments and external evaluations are necessary for the application in practice but can be realised with manageable effort.

2 Data basis, methods and results

2.1 Data basis

In order to be able to empirically determine all parameters required for the hybrid model and to carry out a validation with external empirical data, different data were acquired. These are divided into four blocks, namely wind turbine data, bird movement data, bird strike data, and habitat data, which are described in more detail below.

Wind turbine data. In order to be able to empirically investigate bird reactions to wind turbines, all wind turbine locations, metrics (at least wind turbine height and rotor diameter) and time periods (time of completion and, if applicable, dismantling) must be available. For this purpose, the data described in Manske et al. (2022) were used (prepared by the Helmholtz Centre for Environmental Research and the German Biomass Research Centre), which currently represent the most complete and best-validated wind turbine data set for Germany. Additional validation of this data set was carried out on a random basis using data from the publicly available data sets of the individual federal states and from the Marktstammdatenregister (Core energy market data register - https://www.bundesnetzagentur.de/EN/Areas/Energy/CoreEnergyMarketDataRegister/start.html).

Bird movement data. Upon request, we were provided with a total of 19 different data sets (GPS data, laser rangefinder data [LRF] and radar data) (for an overview/characteristics see Fig. 3.1. in the report). This provided us with almost 70,000,000 GPS data points and 120,000 LRF and radar data points. Radar data referred exclusively to the White-tailed Eagle and had already been validated in the respective project. All data were harmonised (with regard to the geographical coordinate system used) and plausibility checked in many ways (e. g. histogram and local plots) in close consultation with the authors. In addition, flight altitudes (e. g. above sea level) were converted to flight altitudes above ground using the European Digital Terrain Model (EU DTM - https://opengeohub.org) or the Copernicus DEM model (https://land.copernicus.eu/imagery-in-situ/eu-dem).

Bird strike data. For the empirical validation of the predictions of the hybrid model by mechanistic collision risk models, data were needed from projects in which both bird flight and bird strike were recorded; data in this regard came from the PROGRESS project (Grünkorn et al., 2016 & 2017).

Habitat data. Europe-wide habitat data were used from the Copernicus Corine Land Cover (CLC) project. In particular, CLC18 data in raster format (100 x 100 m resolution) were used (https://land.copernicus.eu/pan-european/corine-land-cover/clc2018). It should be noted that for future improvements of the approach presented here, habitat variables with higher spatial and/or temporal resolution as well as refinement/adjustment of categories would be desirable (or necessary for some species). Findings on the attraction of smaller woody structures (hedges and tree rows) on the Red Kite, for example, cannot be taken into account here.

2.2 New methodological developments and comparison with previous approaches

The results of our study show that mechanistic collision risk models - especially in combination with an empirically well-founded habitat use prediction ('hybrid model') - are a suitable tool for the realistic estimation of project-related collision risks. In particular, the presented method represents a clear improvement, both conceptually and with regard to the empirical foundation (as it is available for the Red Kite), compared to assessment methods e.g. taking only the distance between a wind turbine and the nesting site into account. Compared to probabilistic methods recently presented and discussed by other authors, the hybrid model shows a number of improvements, among others through the strictly empirically based determination of all parameters to be included (based on an unprecedented Germany-wide database), through intensive qualitative and quantitative validation of the model predictions in comparison to external data and studies, and through the quantification of empirical uncertainties. However, a number of points still need to be revised and adapted before the method can be applied in practice (see below). In summary, the presented method represents a clear step towards more realistic assessments of project-related collision risks.

2.3 Calculation of the project-related collision risk

Our analyses suggest that collision risk is composed of a complex interplay of, among others, local habitat, flight height and activity, wind turbine characteristics and distance between wind turbine and breeding site. For this reason, highly simplified assessment methods such as sole wind turbine-nest-distance-based assessments, probably often fail to do justice to reality, and a high proportion of incorrect estimates is therefore possible when considering local constellations with simplified assessment approaches. In addition, there is no empirical validation of the estimated collision magnitudes for the previous (e. g. distance-based) methods.

We therefore recommend (after elaboration of a few, but crucial aspects - see below) the systematic use of the hybrid model for the assessment of project-related collision risk. In principle, the hybrid model can take into account the above-mentioned complex interrelationships in interaction with the local constellation; therefore, a lower rate of erroneous assessments can be expected compared to, for example, purely distance-based assessments. As a computational result of the hybrid model, the project-related collision risk can be predicted for any (real or hypothetical/planned) situation, usually per nest/individual and season (at one or more wind turbines). The hybrid model also makes it possible to quantify the influence of different protection measures (such as changes in the local habitat or the height of the lower rotor passage of a turbine blade) on the collision risk. In repowering projects, the collision risks for the actual wind farm constellation can thus be compared with the planned wind farm constellation and changes in the collision risk due to the repowering project can be assessed. It should also be noted that, in principle, the model can also be parameterised with estimates or measurements of local bird flight activities instead of breeding site information.

2.4 Development potential and further needs

2.4.1 Data and methodological aspects

Before the presented method is used in practice, it is recommended to improve it in a few, but essential points to minimise the risk of systematic bias. We recommend a more empirically sound estimation of micro-avoidance, as well as the use of habitat variables with higher temporal and spatial resolution and a refinement/adjustment of habitat categories.

The method can currently only provide calculations for the collision risk of the Red Kite. For other species (e.g. White-tailed Eagle, White Stork), the existing data basis may be sufficient for the application of the method but would need to be adapted and evaluated. To improve the database for other bird species sensitive to collision risks, we recommend that a sufficiently high number of individuals of the breeding bird population should be fitted with modern transmitters that allow good temporal and spatial resolution, including flight altitude as it has been done for Red Kite already. In addition, it would be desirable if standardised wind turbine and bird movement data from camera-based anti-collision systems were made available for further analyses of avoidance behaviour (including geographical coordinates as well as flight height).

In addition to the above-mentioned telemetry studies, analogy conclusions could also be discussed, in which the results (e. g. on wind turbine avoidance behaviour) of one breeding bird species with a sufficient data basis are transferred to another species.

Finally, it should be noted that the hybrid model presented here can be applied to other currently relevant problems, such as habitat potential analysis and the identification of large-scale areas with a relatively low collision risk, which in turn can be of interest for the designation of dedicated wind energy areas.

2.4.2 Aspects of practice and applicability

Two points are of great importance for the application in practice: external quality assurance and the practical application and traceability in the context of wind farm approval procedures. Both points were not part of the present study, but would need attention before the method can be applied in practice.

With regard to quality assurance, the components and predictions of the presented hybrid model were qualitatively and quantitatively validated in many ways by means of external empirical data and studies. Methodological aspects of the model were documented in detail and reviewed within the framework of the Project Advisory Group, so that a fundamental methodological comprehensibility by experts is given. Nevertheless, an additional external expert validation of the modelling and a final application recommendation or even specification in approval procedures is an important step that is still to take. Further empirical studies to verify the predictions of the hybrid model are desirable, but from our point of view not mandatory; we consider the adaptation of the hybrid model to further bird species to be more important. The comparisons/validations already carried out for the Red Kite within the framework of the present study are considered sufficient.

In the context of practical (expert) application, the method must be easy to use (e. g. by providing user-friendly software) and there must be a basic understanding of the modelling process so that the model can be applied correctly and appropriately, and the results can be checked by a regulatory authority.

3 Derivation of threshold values

By applying the hybrid model derived above, it is possible to directly relate the quantitative collision probability values to a likewise quantitative threshold value of the permissible additional project-related mortality in order to directly determine the permissibility of a wind energy planning project. According to § 44 of the Federal Nature Conservation Act, the permissibility of a project is still subject to the condition that the individual risk of killing may not be significantly increased, whereby 'significant' is not understood here in the statistical sense.

While the hybrid model, based on the use of a large number of new empirical data, presents a valid method that can be implemented for the Red Kite for the time being, even though in our view there are still a few points that need to be improved, the derivation of a species-specific threshold value of the permissible additional project-related mortality is not trivial, either technically or legally. The determination of project-independent mortality, to which a threshold value of permissible additional mortality would refer, is subject to numerous influencing variables. A uniform value for the Red Kite, for example, has yet to be determined. The permissible level of additional project-related mortality can be determined on the one hand on the basis of population biology, but on the other hand it can also be determined on the basis of law-making procedures.

In the event that an agreement has been reached on the amount of additional project-related mortality that is permissible, questions of cumulative effects must be clarified: are the additional mortality rates added up for the approval of further wind turbines in the same wind farm? How are these values assessed in the case of a multiple project environmental impact assessment, in which cumulative impacts must be explicitly considered?

With further telemetry projects of breeding bird species sensitive to collisions with wind turbines, as well as with further standardised wind turbine and bird movement data, e. g. from camera-based anti-collision systems, a constantly increasing empirical data base can be expected. This will help to continuously improve and substantiate relevant estimates and assessments. However, this also entails the task of regularly updating and validating methodological aspects and threshold settings against the background of new findings and data.

In conclusion, it is assumed that with the present pilot study and the development of the hybrid model, we have come considerably closer to the primary goal of providing a technically valid, comprehensible, and verifiable method for approval procedures in order to be able to objectively assess and quantify the project-related collision or killing risk. In addition to this aspect, the hybrid model also provides a suitable basis for currently relevant problems such as habitat potential analysis or, on a larger scale, the creation of regional conflict risk maps.

4 References

Drewitt, A.L., Langston, R.H.W., 2006. Assessing the impacts of wind farms on birds. Ibis 148, 29–42.

Grünkorn, T., Blew, J., Coppack, T., Krüger, O., Nehls, G., Potiek, A., Reichenbach, M., von Rönn, J., Timmermann, H., Weitekamp, S., 2016. Ermittlung der Kollisionsraten von (Greif-)Vögeln und Schaffung planungsbezogener Grundlagen für die Prognose und Bewertung des Kollisionsrisikos durch Windenergieanlagen (PROGRESS). Schlussbericht zum durch das Bundesministerium für Wirtschaft und Energie (BMWi) im Rahmen des 6. Energieforschungsprogrammes der Bundesregierung geförderten Verbundvorhaben PROGRESS, FKZ 0325300A-D.

Grünkorn, T., Blew, J., Krüger, O., Potiek, A., Reichenbach, M., Von Rönn, J., Timmermann, H., Weitekamp, S., Nehls, G., 2017. A large-scale multispecies assessment of avian mortality rates at land-based wind turbines in Northern Germany, in: Köppel, J. (Ed.), Wind Energy and Wildlife Interactions. Presentations from the CWW2015 Conference. Springer, pp. 43– 64.

Liesenjohann, M., Blew, J., Fronczek, S., Reichenbach, M., Bernotat, D., 2019. Artspezifische Wirksamkeiten von Vogelschutzmarkern an Freileitungen. Methodische Grundlagen zur Einstufung der Minderungswirkung durch Vogelschutzmarker - ein Fachkonventionsvorschlag (BfN-Skripten 537). Bonn - Bad Godesberg (DEU).

Liesenjohann, M., Blew, J., Fronczek, S., Reichenbach, M., Bernotat, D., 2020. Wirksamkeit von Vogelschutzmarkern. Ein Fachkonventionsvorschlag zur Minderungswirkung an Freileitungen. Naturschutz und Landschaftsplanung 52, 184–190.

Manske, D., Grosch, L., Schmiedt, J., Mittelstädt, N., Thrän, D., 2022. Geo-Locations and System Data of Renewable Energy Installations in Germany. Data 7, 128. https://doi.org/10.3390/data7090128