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IMPACT OF WIND ENERGY ON BIODIVERSITY

Project summary

EOLRAP

Modeling raptor flight behavior to improve avoidance and reduction of collision risk with wind turbines

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Introduction

The EOLRAP project offers a freely accessible application, based on the analysis of flight data obtained through GPS telemetry, that makes it possible to optimize the placement of wind turbines and their sizing (ground clearance, rotor diameter) in order to minimize the risk of collision with raptors present in the area chosen for the installation of a wind farm. This project also assesses the trade-off between reducing collision risk and the energy loss resulting from a strategy of temporarily shutting down turbines when weather conditions favor Red Kite flight at rotor height (i.e., at collision risk).

Context and objectives

The development of wind energy affects flying wildlife. Indeed, most bird species found on the European continent have been victims of collisions with turbine blades. The most vulnerable species — particularly those with slow demographics, such as diurnal raptors — could see their population dynamics affected by this additive mortality. It is therefore necessary to propose and evaluate a set of avoidance and collision-risk-reduction measures to ensure that wind energy development does not come at the expense of biodiversity.

The EOLRAP project was organized around two main areas of work:

- The first focused on developing an application to help project developers and government services optimize the placement of turbines and their sizing (ground clearance, rotor diameter) so as to minimize collision risk with raptors present in the area. This freely accessible online application draws on flight behavior modeling results (% of time in flight; height above ground) for six raptor species, based on high-resolution GPS telemetry tracking.
- The second area evaluates the performance of a turbine shutdown strategy applied when weather conditions increase the likelihood of a bird flying at rotor height. This was carried out by cross-referencing Red Kite flight data with weather and energy production data from a wind farm in Haute-Marne over five years. An 80% reduction in collision risk during the breeding season results in an 8% loss of energy production on an annual basis. These results pave the way for integrating dynamic curtailment into strategies for reducing avian collision risk.

Methods and approaches used for the project

The work was carried out following agile-method recommendations for tool development. Design workshops for the tool were held with representatives of developers and wind farm operators (key users), in order to clarify existing processes with them, the usefulness of such a tool, and how it would fit into their workflows. These workshops helped identify priority features for future users, as well as input and output data formats.

The prototype was developed through an iterative process with end users, accompanied by a user guide, before being made available to the general public.

Principal conclusions

- The freely accessible Wind4Birds application was developed to optimize turbine dimensions and their placement relative to the nest of a species of concern, in order to reduce collision risk.

Figure 1: Screenshots of Wind4Birds Module 1, dedicated to the collision risk associated with turbine dimensions.

- Evaluation of the performance of a turbine shutdown strategy applied when weather conditions favor flights at rotor height. The identification of a predictive curtailment strategy that is simple for operators to implement makes it possible to significantly reduce collision risk with only a limited loss of energy production, similar to what has been implemented for bats (Arnett et al., 2011; Bennett et al., 2022). The results indeed indicate that, using hourly data, day, and wind speed recorded by the turbine, stopping the blades under conditions that favor Red Kite flight at rotor height would substantially reduce collision risk. An 80% reduction in collision risk during the breeding season (March–August) could be achieved for an annual production loss of only 8% (Figure 7).

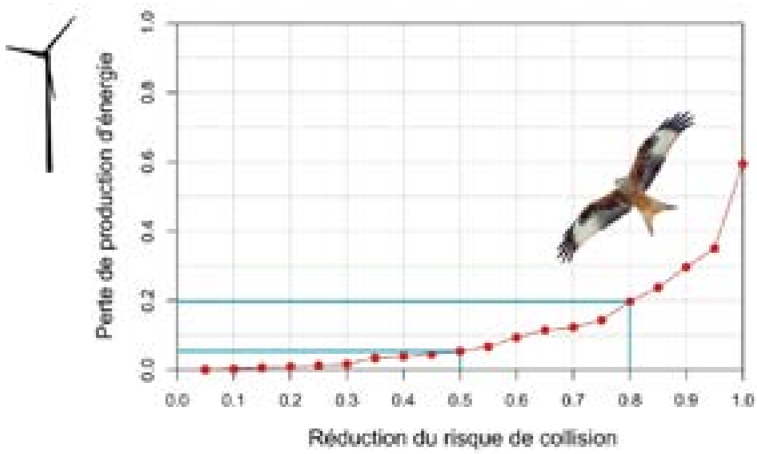

Figure 2: Relationship between the reduction in collision risk achieved by shutting down turbines under conditions favoring Red Kite flight at blade height, and the associated energy production loss over the 6 months of the breeding season. The blue lines indicate that an 80% and 50% reduction in Red Kite collision risk induces a <20% and <6% reduction in energy production, respectively.

Anticipated (or actual) impact of these results for science, society, and public and private decision making

The development of onshore wind power, aimed at decarbonizing energy production in Europe, is expected to lead to a doubling of the number of onshore wind turbines in France by 2035. This increase in the number of turbines will inevitably be accompanied by an increase in the number of bird collisions. It is therefore crucial to develop avoidance and collision-risk-reduction measures. This is precisely what the EOLRAP project concretely offers, by providing all stakeholders with a decision-support tool to optimize the sizing and location of these installations relative to nesting sites of species of concern — particularly useful in the context of repowering projects.

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Furthermore, the EOLRAP project tests, for the first time in birds, the potential of temporarily shutting down turbines when weather conditions favor flight at rotor height, following the model successfully implemented for bats. The results obtained for the Red Kite during the breeding season are promising, with a potential 80% reduction in collision risk during the breeding season for an annual energy production loss of 8%. Such a strategy could advantageously replace the static curtailment imposed on certain wind farms following repeated mortality events (annual production loss of around 25%). Adapted locally to the species present and to at-risk periods (breeding or wintering), this approach could also be implemented preventively with only a marginal annual production loss (<2%).