Collision risk assessments for bats are inaccurate for large wind turbines

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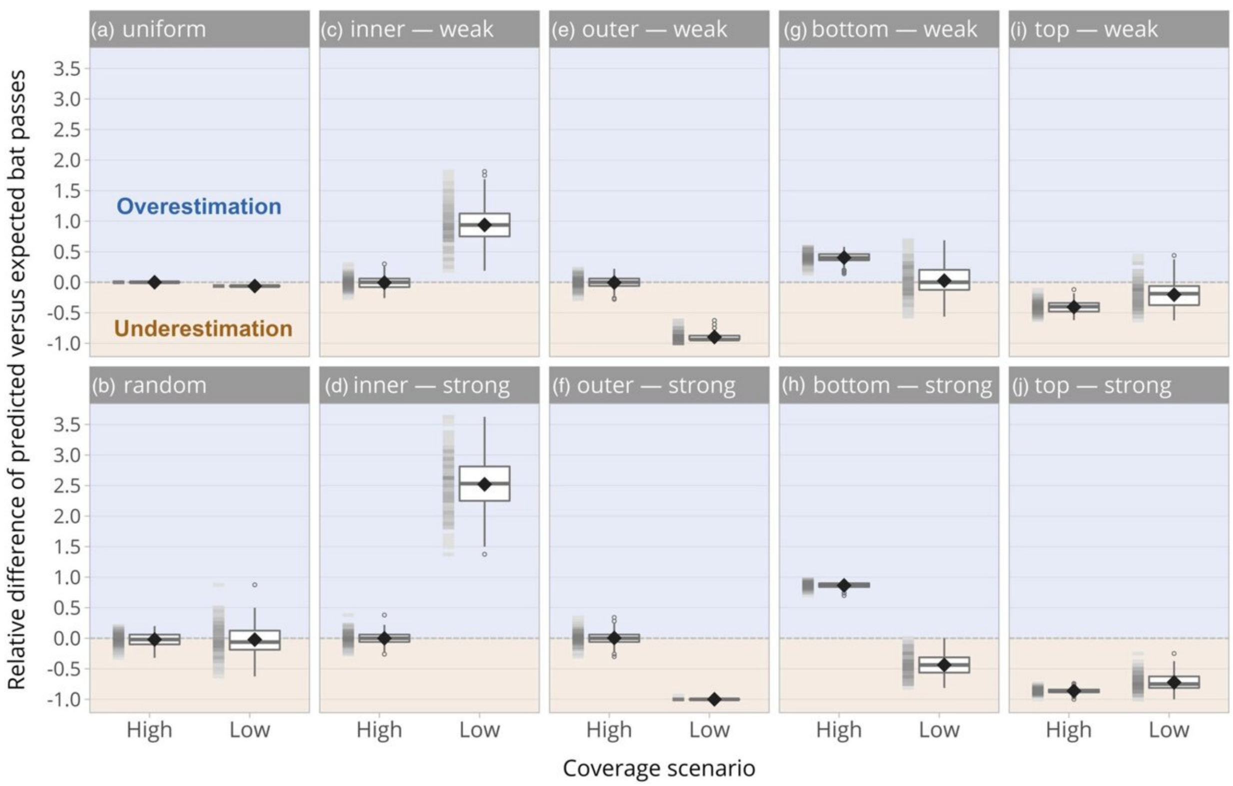

Relative difference between predicted ($n_{predicted}$) and true bat passes (n_{passes}) for the two exemplary scenarios illustrated in Figure 3. Relative differences were calculated as ($[n_{monitored}/prop_{monitored}] - n_{passes})/n_{passes}$ for each combination of area covered by acoustic monitoring at turbine nacelles (x-axis) and distribution (small multiples). All 200 simulations are summarized as box plots with the black diamond visualizing the mean difference and as barcode strips to show single simulation outcomes. Negative values indicate underestimation while positive values indicate an overestimation of bat passes. Credit: *Conservation Science and Practice* (2022). DOI: 10.1111/csp2.12841

Many bats are at risk of colliding with wind turbines. To prevent this, approval procedures for new turbines require acoustic surveys to assess this risk. The surveys help to identify those conditions under which bats are particularly active in the rotor-swept high-risk zone. Knowing these conditions may then help to formulate curtailment times for the operation of wind turbines to reduce the risk of collision.

In a new investigation, a research team led by the Leibniz Institute for Zoo and Wildlife Research (Leibniz-IZW) showed that acoustic monitoring is insufficient if bats are unevenly distributed in the risk zone and if the coverage area of the acoustic detectors is too small—conditions typical for large turbines.

Acoustic surveys should therefore be accompanied by carcass searches, and acoustic monitoring should be supplemented with additional ultrasonic detectors, for example, at the lower streak point of rotor blades, the team explained in a paper in the journal *Conservation Science and Practice*.

Energy production from wind power is an important pillar of the German energy transition to reduce dependence on fossil and nuclear energy sources and achieve climate-neutral energy production. The German government recently formulated ambitious targets to rapidly expand wind power production over 2% of Germany's land area. To maximize energy yield, large wind turbines with particularly long rotor blades are increasingly being used.

Unfortunately, many rare and protected bats collide with the turbines. "Mass mortality of bats at wind turbines can be prevented if turbines are temporarily shut down during periods of high bat activity. The losses in energy production are small and should be tolerable given the limited costs and considerable returns from energy production through wind power," says Christian Voigt, head of the Department of Evolutionary Ecology at Leibniz-IZW.

Within the framework of approval procedures for new turbines, acoustic surveys are carried out inside the high-risk zone of wind turbines—the area swept by rotor blades. The aim is to determine those times during the day and night and the environmental conditions, such as critical ambient temperature and wind speeds, when bats are active and when turbines should be therefore temporarily shut down.

Voigt says, "In order to formulate effective shutdown times for bat protection, the acoustic survey must focus on the high risk zone of the rotating rotor blades. Currently, turbines are getting larger and larger and the techniques for acoustic detection with ultrasonic detectors is not keeping up with this technical development. The technical solutions to protect bats could therefore become unreliable for large turbines, potentially not only at the expense of bats but also at the expense of energy production."

Together with a colleague from Leibniz-IZW and an expert in the acoustic detection of bats at wind turbines, Voigt therefore investigated the factors which affect the quality of the predictions of the relevant analytical statistical models.

For this purpose, in a simulation they varied the spatial distribution of bats and the detection range of ultrasonic detectors in the high-risk zone around the rotor blades. The detection range of ultrasonic devices decreases with the length of rotor blades and with increasing echolocation frequency of the bats. High-frequency echolocation calls are particularly attenuated during sound propagation and therefore can only be detected by ultrasonic devices over short distances of 10–20 meters.

The results showed that if bat fly-throughs were evenly distributed in the high-risk zone, the predictions of the models were accurate even for large turbines. Also, bat species with low-frequency echolocation calls are adequately detected because they are detected over relatively long distances. However, if the spatial distribution was uneven, there can be both underestimation and overestimation of the acoustic activity in the high-risk zone—depending on the specific spatial distribution of the bats—and thus produce incorrect curtailment times for the operation of the turbines.

Underestimation may also occur if bats with high-frequency echolocation calls approach the turbines particularly frequently. "If the acoustic activity of the bats is underestimated, turbine operations are not sufficiently curtailed and many bats die. If, on the other hand, acoustic activity is overestimated, the shutdowns are too strict and the turbines do not produce energy even though no bats are in danger," Voigt says.

"We therefore need to improve acoustic surveys at large wind turbines, for example by using more sensitive and additional ultrasonic detectors. And of course, it would also help if we could better understand the spatial distribution of bat fly-throughs at turbines and better predict where exactly they may collide with the blades."

This would improve bat protection, especially at the new very large turbines, while simultaneously improving energy output. In addition, carcass searches on new turbines are needed to determine whether the recommended shutdown times are effective. "Trust in such models is good, factual checks are better," Voigt recommends.

Wind turbines pose a major conservation problem worldwide, as many bats and birds of prey die at turbines. Migrating bat species and those that hunt for insects in open airspace are particularly affected by colliding with rotor blades. The most effective protection for bats is to erect wind turbines only at sites where low bat activity is recorded, the authors say.

In addition, when new turbines are erected, curtailment of operation should be mandatory during periods of high bat activity. This is practiced at about 25% of the 30,000 turbines operating in Germany. No bat protection is practiced at more than 20,000 old turbines in Germany. Since an average of 15 bats die at each wind turbine per year, the estimated bat strike fatality rate at wind turbines in Germany is in the region of a hundred to two hundred thousand bats per year.

"Precise and effective curtailment requirements of turbine operations for bat protection should be the rule for both new and old turbines in order to achieve an ecologically sustainable energy transition," concludes Voigt.

More information: Christian C. Voigt et al, Modeling the power of acoustic monitoring to predict bat fatalities at wind turbines, *Conservation Science and Practice* (2022). DOI: 10.1111/csp2.12841

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