Relevance of Bird Strikes on Wind Turbines in Germany: A Review

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Abstract

As Germany aims to increase its utilization of wind power, the potential threat to bird populations due to this expansion is a controversial issue. This paper aims to collect data on the magnitude of bird strikes on wind turbines, review existing protective measures and explore innovative solutions. After a thorough examination of the literature, it was concluded that although the impact on bird populations is significant, it may be overemphasized in popular debates. This statement is not final as further research is necessary to assess the impact of bird strikes and explore new solutions. Comprehensive studies on this specific topic in Germany are limited, which makes a thorough evaluation challenging. While there are measures in place to protect species that may be negatively impacted, it is possible that these measures will not be adequate for all of them. While several innovative methods are under examination, progress in testing and implementation is slow. Lastly, an information problem was identified. Since the topic is highly politicized and polarizing, it is crucial to provide the public with accessible and reliable information on the discussed themes. This is currently not the case due to a lack of data and missing information campaigns.

Keywords: bird strike, wind power, red kite

1 Introduction

With the goal of reducing carbon emissions by 55 percent from 1990 levels by 2030, phase out coal usage for electricity generation and adopt renewable energy, Germany is witnessing a steady increase in the adoption of wind turbines, both onshore and offshore. In the first half of 2023, over 28,000 onshore wind turbines with a total capacity of approximately 59,000 MW are operational in the country [1]. In 2022, wind accounted for 22 % of Germany's gross electricity generation, surpassing lignite at 20 % to become the leading source of electricity [2]. In line with the EEG 2023 (renewable energy law), which aims to increase onshore wind power capacity to 160 GW by 2040, identifying suitable areas for wind power generation is a key priority for expansion. The German population generally views the expansion of renewable energy favorably, with only approximately 9 % of survey participants opposing it [3]. However, the creation of new wind farms is often met with skepticism from both residents as well as environmentalists. One concern regularly raised is the impact of bird strikes on local and migratory birds. In this review paper,the relevance of bird strikes on wind turbines in Germany will be examined. The solutions that are currently in use as well as the ongoing development in this area will be analyzed.

2 Methodology

This paper represents a literary analysis aimed at compiling the existing information regarding the inquiries posed in the introduction. To simplify the process, several AI tools with different levels of usefulness were used for research and writing. Perplexity AI and Chat-GPT were used to refine the central questions and to build a general understanding of the topic. ResearchRabbit was utilized to construct a literary map from the initial literature obtained via Perplexity. Finally, the text was written with the assistance of a translation service and an AI writing assistant from DeepL.

3 Relevance of Bird Strikes in Germany

In 2019, an industry study revealed that protecting flying species like birds and bats was a significant point of contention in 48 % of lawsuits against wind turbines, followed by formal and procedural errors at 32 percent [4]. This highlights the importance of bird strikes in shaping German public opinion on wind turbines. However, determining the legitimacy of these concerns is a challenging endeavor. Data for this issue is primarily collected by counting randomly discovered bird carcasses, as experimental setups raise ethical and logistical concerns. Wind turbines are typically

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situated in somewhat remote areas to prevent disrupting local populations and there is only a short period to locate birds killed by wind turbines before they are either consumed by scavengers or shifted. Furthermore, not all bird carcasses found are documented and recorded. Only a rough estimate of bird fatalities can be determined, with NABU approximating about 100,000 bird deaths yearly. Figure 1 illustrates that this number pales in comparison to the approximately 20 to 100 million deaths caused by domestic cats, 70 million deaths caused by traffic and 100 to 115 million deaths caused by collision with glass panes [5]. Legal and illegal hunting along with power lines account for an additional 2.7 to 4 million deaths combined. A 2009 study suggests that wind turbines cause ap-

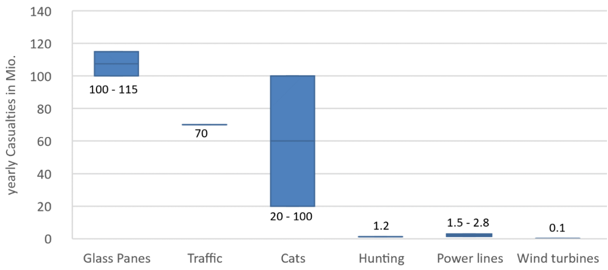

Fig. 1: Causes of bird deaths in Germany based on NABU [5]

proximately 0.3 deaths per GWh generated, whereas fossil fuels cause about 5.2 deaths per GWh generated, mainly as a result of habitat destruction and pollution [6]. Although this study focuses more on the United States, it still provides a compelling picture. However, these results may not apply directly to Germany's situation. Nevertheless, wind turbines do not appear to pose a significant problem in terms of raw numbers. More complexity arises when examining the impact on various species. Research indicates that birds of prey are particularly prone to colliding with wind turbines. The most comprehensive study concerning this issue to date is the PROGRESS study. It focused on northern Germany and determined that there might be a negative impact on the populations of buzzards and red kites [7]. However, criticisms challenge the findings' validity as data was not collected when these species were absent, thus potentially overestimating the perceived threat of wind turbines [7]. The project "LIFE EUROKITE" is currently examining the impact of wind turbine collisions on this species to determine the relevance of potential casualties. The purpose of this pan-European initiative is to collect and analyze telemetric data to ascertain the patterns of habitat use by birds of prey and the perils that threaten their populations [8]. While there are no final results available at present, with the earliest expected at the end of 2023, EUROKITE identifies illegal and accidental poisoning as the primary threats to the kite population [9]. This might further relativize the impact of wind turbines. While wind turbines are not likely the greatest threat to any bird species, they may indeed have a significant, avoidable impact on some. The following chapter describes some well-known means of preventing bird collisions and the current state of research regarding alternative methods.

4 Current Measures

Since the prevention of bird strikes on wind turbines is beneficial to both nature conservation and the operation of onshore wind farms, several methods have been developed and fully or partially implemented. For the operation of onshore wind farms in Germany, these measures are legally anchored in § 45 of the Federal Nature Conservation Act (Bundesnaturschutzgesetz, BNatSchG); some measures are listed in Appendix 2. These measures are listed below.

4.1 Siting

The process of determining the location of wind turbines is called "siting" and consists of two parts - macrositing and micrositing. Macrositing usually involves the decision on a general area in which a wind farm is gonna be built based on several factors. Micrositing is the process of determining a precise location for each wind turbine to optimize spatial use, power generation, cost and other relevant factors. It is common practice to consider the protection of birds in the siting process by maintaining a reasonable distance between wind farms and migratory routes as well as nesting sites. Annex 1 of the BNatSchG specifies near, central and extended areas that have to be checked for the protection of 15 species of nesting birds. While this method of micro-siting is supposedly effective for all of the species listed in the legislature, according to NABU most nesting birds tend to use areas in immediate reach of wind turbines anyways and are mostly not negatively impacted by wind parks.

4.2 Anti-Collision System

The purpose of anti-collision systems is to detect specific avian species through the use of cameras and/or radar technology. If a member of the target species is detected falling below the minimum distance, the wind turbine's rotation will slow down and the system will enter idle mode to avoid a collision. So far there is only one anti-collision system that has been thoroughly tested. The system in question is called "IdentiFlight" and is so far only recommended for the protection of red kites. The results of a three-year study at six german locations showed, that on average 92 % of red kite activity in the relevant area was detected, slowing down the turbines in time at a rate of 77-91 % [10], exceeding the requirements posed by the Competence Center for Nature Conservation

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and Energy Transition (KNE). Following these results, the KNE issued a press release in 2021 stating that IdentiFlight is ready for implementation [11].

4.3 Shutdown during Agricultural Management Events

Another viable solution involves temporarily halting the operation of wind turbines during agricultural events in the immediate vicinity of the turbine (mowing shutdown). This measure has been proven effective for certain species, such as red and black kites, among others. The effectiveness, however, depends on the precise timing and surrounding circumstances. These circumstances include windspeed, which influences the flight patterns of red kites, as well as factors such as time of year, use of other measures and duration of usage. An observation is that the risk of collision seems to normalize after about two days [12]. Research indicates that certain species are drawn to the sound of heavy machinery for a brief period [13], thus accounting for the observed impact of this action.

4.4 Creation of Attractive Alternative Feeding Habitats

Alternative feeding habitats are intended to redirect bird activity from the wind turbine's location in the long run by establishing habitats that mimic natural environments, such as wetlands. Implementing this measure can present challenges due to the requirement for long-term agreements between parties and the availability of functional spaces in the surrounding area. This is commonly considered an adjunctive measure rather than a primary solution, it should only be utilized in conjunction with more efficacious strategies.

4.5 Reducing the Attractiveness of Habitats in the Mast Base Area

It is argued that the installation of wind turbines can unintentionally result in the development of abundant hunting grounds for birds of prey. Small mammals, which make up a large part of these birds, are easily spotted on fallow lands, pathways and pitches around the turbine. Additionally, structures such as fences serve as perching sites for birds of prey [14]. Measures to decrease the appeal of these territories involve refraining from creating fallow land and utilizing vertical structures like fences and high seats [15]. The United States Fish and Wildlife Service (USFWS) recommends eliminating carrion, specifically to reduce the attractiveness to golden eagles [16]. Other measures entail abstaining from nutrient input through fertilization [17] and eliminating manure heaps, which have been observed to lure red kites [13].

4.6 Phenology-Related Shutdown

The last measure recommended in the current edition of the EEG involves a phenology-related shutdown of wind turbines. This entails shutdowns during daytime for extended periods of four to six weeks during times of increased activity around nesting sites, such as during mating times. While this technique appears to be effective for all impacted species, it incurs significant energy losses due to the prolonged shutdown. Consequently, it is only recommended as a last resort when no other measures are possible.

5 Research

Expanding on the measures in place to prevent bird strikes, ongoing research is dedicated to finding new methods to combat this issue and enhance current practices. This section will explore some of these approaches.

5.1 Siting

As described in chapter 4.1, bird protection is already considered in the siting process. This process is continually reviewed to include more details to achieve this goal. An example of this is the identification and avoidance of areas with updrafts, which are known to attract soaring birds of prey [18]. An open access tool based on a geographic information system (GIS) and thermal imagery has been developed at the Norwegian Institute for Nature Research (NINA) as a cost-effective tool that could be used for this purpose [19].

5.2 Anti-Collision Systems

Anti-collision systems are already being used to protect red kites, as mentioned in chapter 4.2. In addition, current research aims to extend this technology to other species. Researchers at Identiflight tested the existing system's efficiency for safeguarding sea eagles, which lack adequate protection measures [20]. Reaching similar results as in safeguarding kites, it is expected that this system can be implemented in the future.

5.3 Deterrence through Acoustic Signals

One way to keep certain species of birds away from wind turbines may be the Use of long range acoustic devices (LRAD). A study conducted in Cadiz, Spain demonstrated the effectiveness of this technique for various species, including the griffon vulture [21]. Different species have varied reactions to specific noises and mimicking naturally occurring sounds proves to

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be more effective while avoiding acclimatization in comparison to artificial noises [22].

5.4 Ultraviolet Lighting

In a pilot study, researchers at NINA found that ultraviolet lights can diminish bird flight activity. During UV light exposure with a 365 nm wavelength, 27 % less activity was recorded compared to control nights [23]. The measure is still in its early stages of research and has not been widely implemented.

5.5 Painted Structures

There are promising studies investigating the low-tech solution of improving turbine visibility by painting them black. The impact varies based on the portion of the turbines that is coated.

5.5.1 Tower

In a recent study, it was found that the lower 10 meters of ten wind turbines were painted. Following the implementation of this measure, a decrease of 48 % was observed in the discovery of ptarmigan willow carcasses, without any adverse impact on the surrounding, unpainted towers [24]. While this measure seems promising, it may not effectively achieve the goal of protecting raptors. The potential impact on willow ptarmigans could be significant, given their propensity for colliding with the bases of towers.

5.5.2 Blade

In another experiment conducted by researchers at NINA, a single turbine blade was painted black. Subsequently, the effects of this alteration were analyzed. The results show that "there was an average of 71.9 % reduction in the annual fatality rate after painting at the painted turbines relative to the control turbines" [25]. While this is a significant accomplishment, the researchers observe a significant variability between years, indicating the necessity for more research. Nevertheless, implementing this measure appears to be a highly cost-effective solution, particularly when painting the blades before their installation on the tower.

6 Discussion

As demonstrated in this paper, the significance of bird strikes is a debatable topic for numerous reasons. Although certain species seem to be affected negatively to a significant extent, quantifying this impact is difficult. The crux of the matter revolves around data collection issues. To date, the PROGRESS study, published in 2016, remains the most extensive research on this matter in Germany. A central finding of the study was that current collision prediction models are inadequate, an issue that has yet to be resolved. The findings of the EUROKITE project are anticipated to provide insight into the effects of certain significant species, although not all have been thoroughly examined. The buzzard, which may be adversely impacted as per the PROGRESS study, is not the focus of this project. Given the context, further research is necessary to investigate the impact of bird strikes on these species. Without accurate determination of the impact of wind turbines on certain species, it is impossible to quantify the urgency with which this issue should be addressed. Not knowing the precise extent of the impact is not a justification for disregarding its existence entirely, nor is the notion that there are greater risks to the population of the species at hand. Some Conservationist groups contend that the expansion of wind energy is crucial to achieving the goal of renewable energy and combating climate change, which poses a greater threat to diversity overall [26]. This expansion should be undertaken cautiously while implementing measures to mitigate their impact on endangered species. In this paper, various measures currently in use, as well as those under development, are presented. The evidence suggests that there is a significant amount of untapped potential. While some measures are currently in use, it remains unclear to what extent they are utilized and their level of effectiveness. For the experimental measures, there seems to be a lack of testing and implementation in Germany. In particular, some of the measures being researched at NINA seem promising, but there are no sources of testing in Germany, even though some of the proposed methods are relatively low-tech, such as the painting of rotor blades. Testing and implementation of these or other measures is crucial to ensure that the planned massive increase in wind power over the next few decades does not lead to unexpected adverse effects, most likely necessitating more costly and less effective retrofitting of protection measures. Finally, it is necessary to disseminate information regarding the utilization of these measures. There is a lack of accessible and comprehensive data available to individuals who are not extensively involved in this matter to fully comprehend the ramifications of bird strikes and the actions being implemented. One website that has served this purpose to some extent is "www.wind-ist-kraft.de," an informational campaign and website operated by the German Nature Conservation Ring (DNR) with support from the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV). However, the Internet Archive indicates that this website has been unavailable since at least March 14, 2017.

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7 Conclusion

Overall, further research is needed to examine both the impact of wind turbines on bird populations and the development of new measures to prevent bird strikes. Although other factors can have a greater impact on bird species, such as collisions with powerlines and poisoning, it is crucial to mitigate preventable negative impacts and promote acceptance of wind power expansion among the population. There is also a lack of easily accessible information regarding this research and the effectiveness of measures. Half-baked disinformation campaigns are a potential threat in the absence of information campaigns.

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