Comparative analysis of bird-bat collisions at a wind power plant in the Department of Rivas, Nicaragua, between 2014 and 2022

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This study analyzes bird and bat collisions at a wind power plant in Rivas, Nicaragua, based on eight monitoring campaigns from 2014 to 2022. Results reveal species-specific patterns and seasonal peaks, emphasizing the importance of continuous biodiversity monitoring during key migration and breeding periods.[b]

Wind energy is positioned as an alternative in the search for cleaner and more sustainable energy sources to combat climate change and reduce dependence on fossil fuels. However, a key environmental concern is the collision of birds and bats with wind turbines. While these technologies have low greenhouse gas emissions, their interaction with local fauna challenges biodiversity conservation efforts (Gasparatos et al., 2017).

Resident birds are especially exposed as they coexist year-round with wind turbines, unlike migratory species. Bats are also significantly affected, though causes remain unclear. Hypotheses include attraction to insect concentrations or difficulty detecting turbine structure (Marques et al., 2014).

Mitigation requires multidisciplinary strategies, including appropriate turbine placement, acoustic deterrents, and collaboration among stakeholders (Ledec et al., 2011; Hayes et al., 2019; Weaver et al., 2020). Yet implementation is difficult due to limited long-term data and scarce Latin American studies (Agudelo et al., 2021). This study aimed to determine the total number of bird and bat deaths, analyze spatial-temporal collision patterns, and relate ecological aspects to these events.

Materials and Methods

Study Site: The study was conducted in a wind power plant in the Department of Rivas, Nicaragua (11°22′19.84″N, 85°45′27.27″W), consisting of 22 turbines with a total capacity of 40 MW.

Data Collection: Data were collected following a standardized national protocol for bird and bat collision monitoring, including formulas for estimating mortality and correcting for detection biases.

Data Analysis: A Chi-squared (χ^2) Goodness of Fit Test (Perez, 2021) was applied to assess statistical significance. Analyses were conducted using Microsoft Excel and extensions.

Results and Discussion

A. Comparative analysis 2014 to 2022

Since bird-bat collision monitoring began in 2014 to 2022, eight non-consecutive monitoring campaigns have been carried out for a total of 30 months over eight years.

B. Birds 2014 to 2022

A total of 119 bird collisions were recorded, representing 25 species across 14 families. Thirty-five individuals were unidentifiable. Three species were listed in Nicaragua's red list, including Setophaga fusca and Coccyzus minor (Near Threatened) and Archilochus colubris (Vulnerable). The most frequent species was *Columbina passerina* ($\chi^2 = 72.05, p < 0.01$). Significant variation was observed in collisions by month and year, particularly in April 2016 ($\chi^2 = 41.60, p < 0.01$).

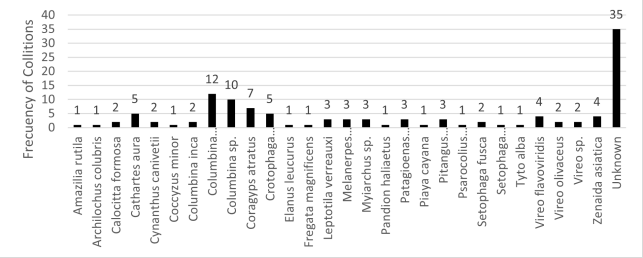

Figure 1: Frequency of bird species collided 2014 to 2022 (N=84).

C. Bats 2014 to 2022

A total of 134 bat collisions were recorded, spanning 18 species across four families. Twenty-four individuals were unidentifiable. No species were found in any threatened conservation category. The species with the highest frequency was *Molossus molossus* ($\chi^2 = 199.69, p < 0.01$).

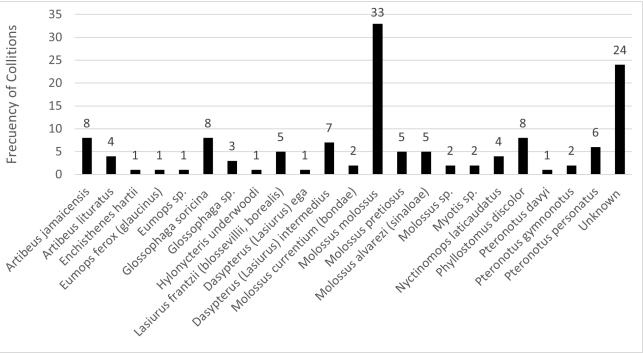

Figure 2: Frequency of bat species collided 2014 to 2022 (N=110).

Conclusions

Monitoring across the eight campaigns revealed temporal patterns influenced by migration and breeding seasons. Months with high collision rates included March-April and September-November. These results support maintaining and expanding the monitoring protocol, especially during seasonal transitions. While collision causes remain unclear for bats, reproductive cycles may be influential, and further ecological study is warranted.

Notes

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b. Original version of this article is Ref. [1]

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