CÁTEDRA REN EM BIODIVERSIDADE

BIRD COLLISION WITH POWER LINES: STATE OF THE ART AND KNOWLEDGE GAPS

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REN FCT Fundação para a Ciência e a Tecnologia U.PORTO

CONTEXT

✓ Transmission and distribution electricity grids are expanding rapidly worldwide

Annual growth rate: 5%

Significant negative impacts on biodiversity and, in particular, bird mortality due to:

- Electrocution – mainly Distribution lines
- **Collision – both Distribution and Transmission lines**

✓ Over the past 20–30 years, extensive research has been conducted in order to understand the links between power lines and bird collisions

✓ **However**, peer-reviewed publications summarising available information are still lacking

EXTENSIVE LITERATURE REVIEW

Main objectives:

1) Assess the overall trends in scientific research on bird collisions with power lines

2) Review the factors known to contribute to bird collisions

3) Summarize the strategies currently used to mitigate bird collisions

4) Identify the remaining knowledge gaps and opportunities for future research

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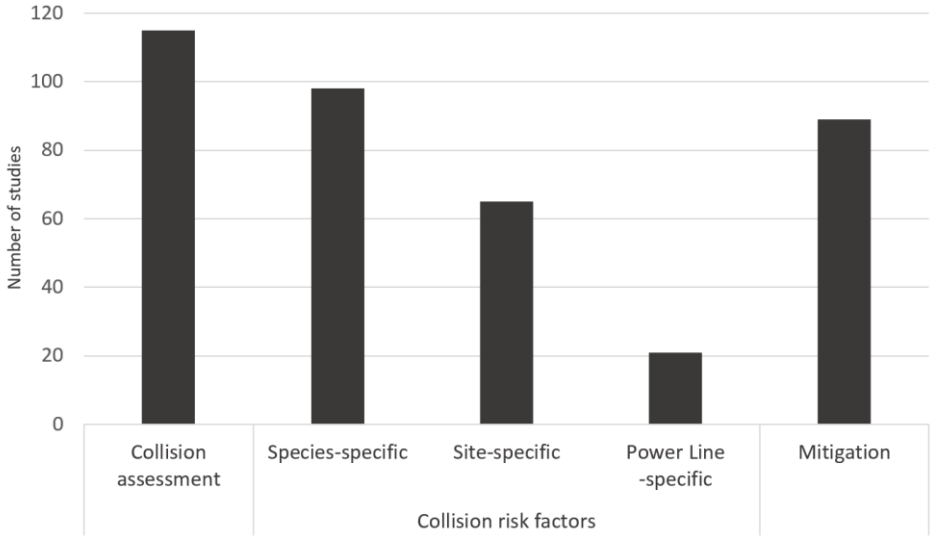
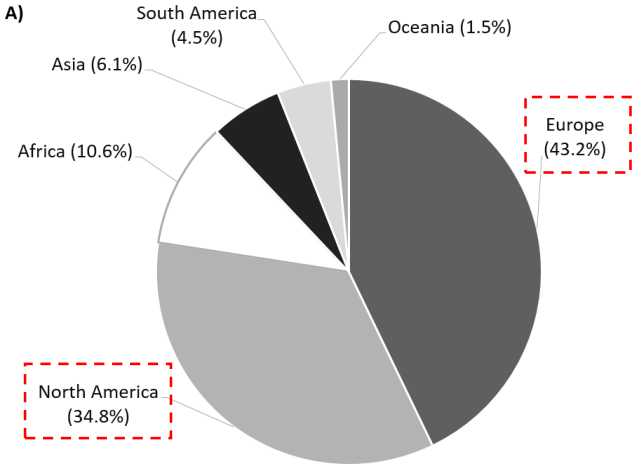
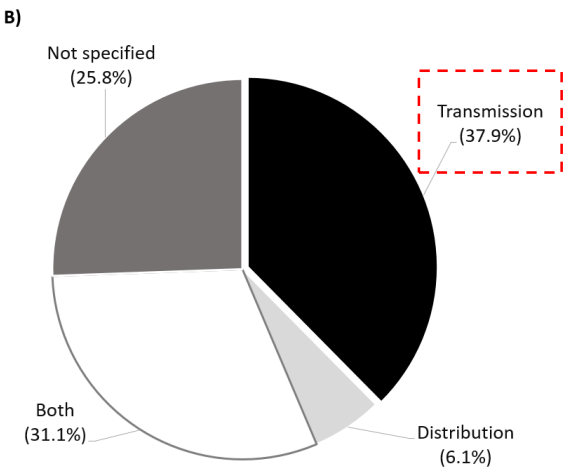
Overall Trends in Scientific Research

RESEARCH TRENDS

- ✓ **Over 250 documents** addressing bird collisions with power lines (published between 1971 - 2017)
- ✓ Mainly focused on quantifying bird fatalities, but also on understanding collision risk factors and effectiveness of mitigation measures
- ✓ Mainly conducted in Europe and North America, and in Transmission lines







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BIRD COLLISION RISK FACTORS

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Species-specific factors

Site-specific factors

Power line-specific factors

But, they are frequently interconnected

Some examples:

BIRD COLLISION RISK FACTORS

Species-specific factors

- **Sensory perception / vision**
- **Morphological features**
- **Flight behaviour**
- **Phenology and circadian habits**
- **Age, sex and health**

Great bustard (*Otis tarda*)

E.g., Species with heavy bodies (and relatively small wings) tend to be more prone to collisions.

Some examples:

BIRD COLLISION RISK FACTORS

Site-specific factors

- **Topography**
- **Habitat features**
- **Weather and light conditions**
- **Anthropogenic disturbance**

E.g., Power lines that bisect important bird areas or major flyways pose higher risk to birds.

Some examples:

BIRD COLLISION RISK FACTORS

Power line-specific factors

- **Number of vertical wire levels**
- **Wire height**
- **Wire diameter and earth wire**

E.g., Earth wires have been shown to account for the majority of collisions involving transmission lines.

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MITIGATION STRATEGIES

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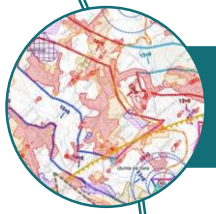
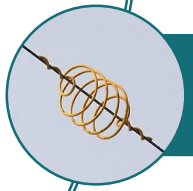
Underground cabling



Route planning

Power line configuration



Wire marking

Habitat management

Some examples:

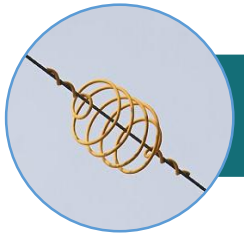
MITIGATION STRATEGIES

Route planning

Strategic planning (at a regional / national scale)

↳ **Study of alternative corridors**

↳ **Adjustment of final route**



Wire marking

Overall, effective in reducing bird collisions

↳ **<u>But, it varies</u>** depending on target bird species, surrounding environment and device characteristics

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KNOWLEDGE GAPS AND FUTURE RESEARCH

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✓ Despite the extensive research…

- **More studies from Asia, Africa and South America are needed**
- **Little scientific evidence for power line-specific factors**

  (e.g. impact of the no. of vertical levels, or wire height and diameter)

- **Several recommendations of good practice are still not supported by scientific evidence**

  (e.g.
  - clustering new power lines with other existing linear elements, or
  - habitat management to change local flight paths and prevent bird collisions)

KNOWLEDGE GAPS & FUTURE RESEARCH

✓ Suggestions of research and innovative approaches…

Knowledge gaps/research questions	Potential research and innovative approaches
Understand individual-level behavioural changes and drivers of collisions	• Bio-logging approaches including use of accelerometers, magnetometers and girometers, to characterise flight behaviour changes of tracked birds, coupled with environmental sensors to measure weather conditions associated with flight patterns. • Assess drivers of flight height and patterns, including species, age, body condition, seasonal, day/night differences, flocking/solitary differences and anthropogenic disturbance. • Development of movement sensors to detect collisions of tracked birds. • Field surveys to assess crossing rates and behavioural reactions to power lines, using the support of technologies including thermal, video and radar.
Assess visual and perceptual aspects	• Experimental approaches to assessing colour differentiation (including UV) and visual field parameters. • Assess behavioural responses to power lines and wire markers (from tracked birds) • Field surveys to assess behavioural responses to power lines and wire markers, using the support of technologies including thermal, video and radar.
Improve knowledge of species affected and hotspots of mortality	• Investigate and model factors driving the occurrence of hotspots of mortality (namely topography, migration routes, land cover features) at species-level and overall. • Characterise species traits (e.g. morphology, habitat, brain size) and region-specific behaviour that increase susceptibility to collision. • Explore the potential of metagenomics to identify species colliding with power lines (through samples in cables).
Characterise population-level impacts	• Development of population models taking into account the cumulative impact of existing or foreseen energy infrastructure, and enabling the assessment of compensatory versus additive mortality. • Long-term studies to assess local/regional population trends.
Improve detection of collisions and methods for fatality estimation	• Technological development and testing of remote bird activity and collision monitoring devices, including thermal, video, small unmanned aircraft, bird strike indicators, and radar. • Development of methods to accurately estimate bird fatality (based on carcass searches) and related correction factors, with particular focus on crippling bias.
Evaluate effectiveness of wire markers	• Development of standardised protocols to improve reliability and potential utility in meta-analyses. Use BACI approach, complemented with assessment of crossing rates and behavioural reactions to wire markers. • Focus research on comparative effectiveness of different types of markers, colour, size, movement (or static) and spacing (for specific types). • Assess technical limitations of wire markers (durability, effects of adverse weather e.g. ice and strong winds, corona effects).
Evaluate effectiveness of non-marker mitigation measures (e.g. thicker earth wires, scaring methods including audio)	• Use BACI approach, complemented with assessment of crossing rates and/or behavioural response to visual/sound deterrents.
Assess the importance of optimal line routing and configuration	• Difficult to test optimal routing using experimental approaches. Alternative strategies include the production of collision risk maps for sensitive species, which can be used to set routes minimising impacts. • Develop experimental procedures to compare mortality between line sections set close versus apart (from other power lines, roads or other linear infrastructures), and with differing number of conductor horizontal levels. As BACI approach is not possible, characterization of crossing rates is important to evaluate differences.

Some examples…

… of topics in which REN Biodiversity Chair is working on:

- *Investigate and model factors driving the occurrence of hotspots of mortality (…) at species-level and overall.*

- *Focus research on comparative effectiveness of different types of markers, colour, size, movement (or static) and spacing (for specific types).*

TO KNOWN MORE...

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Review

Bird collisions with power lines: State of the art and priority areas for research

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ABSTRACT

Transmission and distribution electricity grids are expanding rapidly worldwide, with significant negative impacts on biodiversity and, in particular, on birds. We performed a systematic review of the literature available on bird collisions with power lines to: (i) assess overall trends in scientific research in recent decades; (ii) review the existing knowledge of species-specific factors (e.g. vision, morphology), site-specific factors (e.g. topography, light and weather conditions, and anthropogenic disturbance), and power line-specific factors (e.g. number of wire levels, wire height and diameter) known to contribute to increased bird collision risk; and (iii) evaluate existing mitigation measures (e.g. power line routing, underground cabling, power line configuration, wire marking), as well as their effectiveness in reducing collision risk. Our literature review showed (i) there is comparatively little scientific evidence available for power line-specific factors, (ii) there is a scarcity of studies in Asia, Africa and South America, and (iii) several recommendations of good practice are still not supported by scientific evidence. Based on knowledge gaps identified through this review, we outline suggestions for future research and possible innovative approaches in three main areas: bird behaviour (e.g. further use of loggers and sensors), impact assessment (e.g. understanding the drivers of mortality hotspots, assess population-level impacts, develop methods for automatic detection of collisions) and mitigation measures (e.g. further need of BACI approaches to compare the effectiveness of different wire marking devices). The complex and region-specific interactions between collision drivers and bird ecology continue to limit our ability to predict impacts and the success of mitigation measures.

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