Global meta-analysis on wire-marking effectiveness in reducing bird collisions

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cigre

For power system expertise

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Global meta-analysis on wire-marking effectiveness

Study compilation & Analysis

- Compilation of studies conducted until 2019

- **35 studies on wire-marking effectiveness** (using bird carcass searches)

66 separate trials

14 in peer-reviewed articles + **49** in grey literature (21% vs 79%)

- **Study/trial origin:**
  - Europe – 45 trials (68%)
  - USA – 11 trials (17%)
  - South Africa – 8 trials (12%)
  - South America – 2 trials (3%)

GLOBAL META-ANALYSIS ON WIRE-MARKING EFFECTIVENESS

STUDY COMPILATION & ANALYSIS

- Meta-analysis of observed mortality in wire-marked PL sections, *versus* Control sections (weighted by each study/trial "quality", i.e., precision or sample size)

  - To assess:
    - **Wire-marking overall effectiveness** (% reduction in bird mortality)
    - **Effect of potential Moderators:**
      - **Voltage** (<110 kV and ≥110 kV)
      - **Habitat** (Grasslands, Wetlands, Shrublands and Forest-farmland mosaics)
      - **Type of device** (Small spirals, Large spirals and Flappers)

GLOBAL META-ANALYSIS ON WIRE-MARKING EFFECTIVENESS

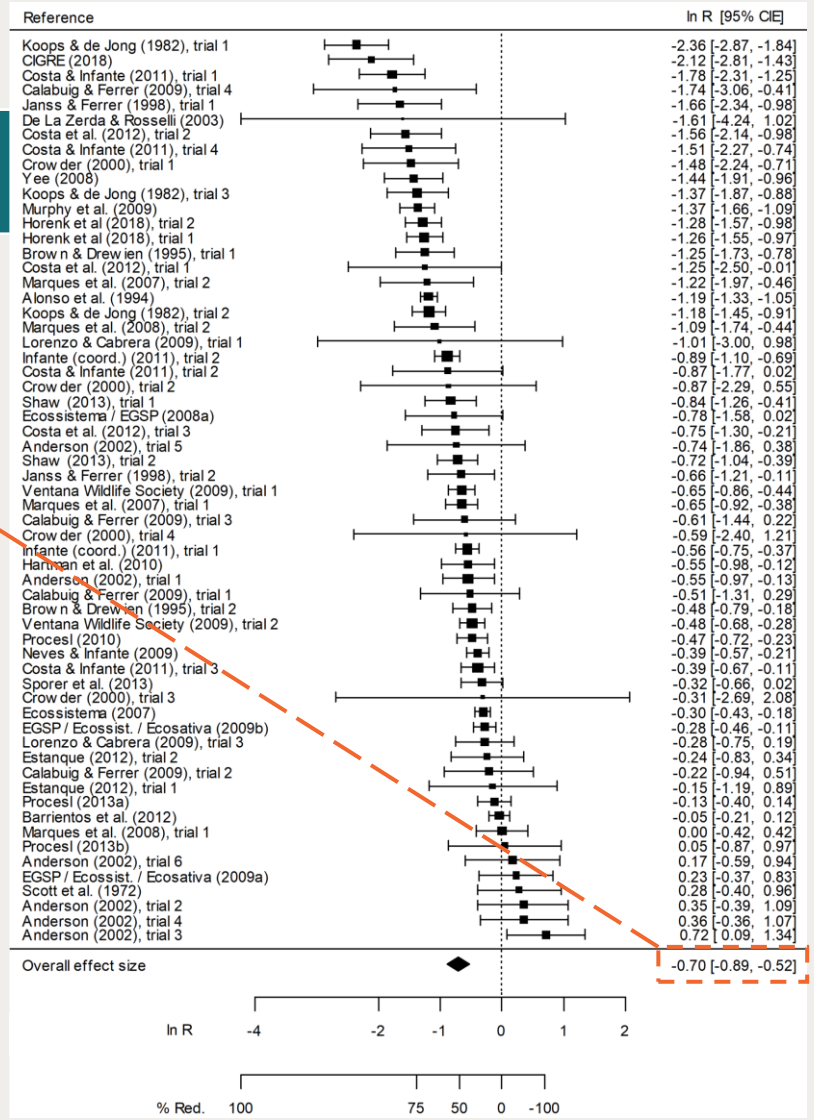
RESULTS

1. OVERALL EFFECTIVENESS

ln(R) [95% CI] = **- 0.70** [-0.89, -0.52]

~ 50.4 % reduction in mortality rates

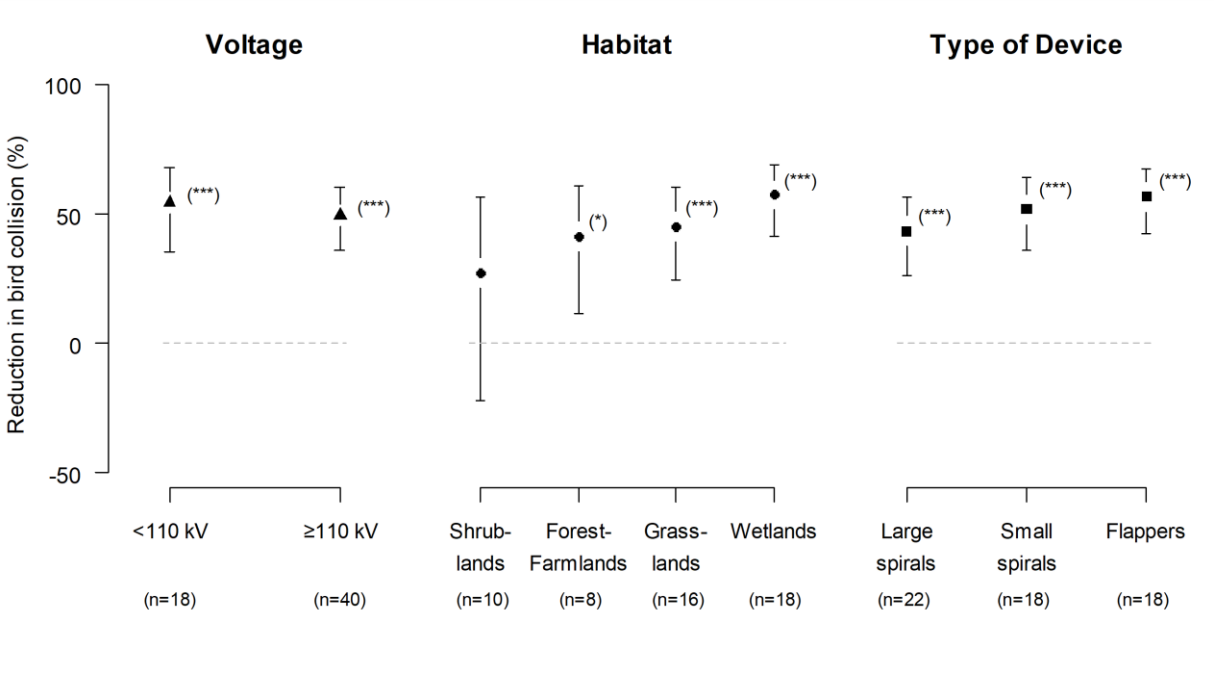
in wire-marked PLs, compared to controls



Global meta-analysis on wire-marking effectiveness

Results

2. Moderators effect



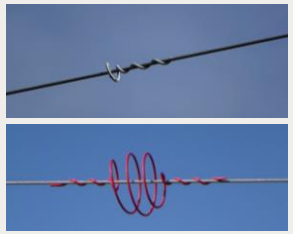
'Habitat' effect:

- Tend to be more effective in wetlands (e.g., cranes)

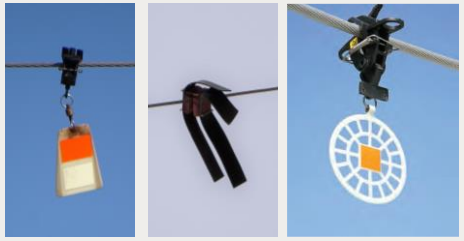
'Type of device' effect:

- 'Flappers' tend to be more effective (in reducing bird collisions), than Static devices (large/small spirals)

Static



Dynamic



However…

- 'Voltage' , 'Habitat' and 'Type of device' had no significant moderating effect on Ln (R)

»»» **High heterogeneity (among study outcomes)**

GLOBAL META-ANALYSIS ON WIRE-MARKING EFFECTIVENESS

NEXT STEPS

- **Continuous development of wire-markers' design and deployment**

- **Conduction of more "well-designed" studies**

List of recommendations for improvement of future studies / experiments

- **Assessment of wire-markers durability**, particularly in studies using Flappers

CIBIO's compilation (2021) » **only 7 studies available**

Summary of the main limitations of field studies and recommendations to maximize their individual power and improve the overall knowledge on wire-marking effectiveness. BACI – *Before-After-Control-Impact*, BA - *Before-After*; CI - *Control-Impact*.

Topic	Main limitations in existing studies	Recommendations for future research
Experimental design	• Adoption of sub-optimal experimental designs (e.g. BA or CI), due to restrictions on the collection of mortality data prior to wire-markers installation and/or selection of (true) controls. • Increased biases in effect size estimates, due to limitations in the field methods used to determine the bias correction factors of bird mortality (e.g. bird crossing rates, removal and detection rates).	• Perform dedicated studies to assess wire-marking effectiveness, in order to enable the adoption of a BACI design. • Select a relatively fine spatial-scale alternation between marked (impact) and non-marked (control) sections ('paired samples' approach) to perform the mortality surveys. Each pair of control-impact sections should not be too far apart to ensure that their differences (in terms of habitat, bird communities, scavengers' community, carcass detection, etc.) are neglectable. This allows the evaluation of wire-marking effect solely based on observed mortality rates, without the need for additional corrections. • If only sub-optimal designs can be adopted (i.e., BA or CI design), conduct additional field experiments (namely carcass removal/detection trials and surveys to determine bird-crossing rates) to account for variations in bird mortality arising from external factors not related to wire-marking. Ensure that robust sampling schemes are adopted in order to minimize the uncertainty associated with the estimation of those correction factors.
Sampling effort	• Conduction of short-term studies, which fail to detect temporal changes (seasonal or inter-annual) in bird mortality rates. • Adoption of low-effort carcass search protocols (in terms of search frequency and length of power line surveyed), which can lead to biased bird mortality estimates due to the stochasticity nature of bird collision events and limitations in carcass detection.	• Ideally, carcass searches should be performed by the same observer(s). • Guarantee that seasonal and between-year variations in bird mortality are properly surveyed, both in wire-marked and control sections. Each experiment should cover, at least, one year prior to wire-marking treatment plus 2–3 years post-treatment. • Ensure that, within the study seasons, the survey effort is appropriate for the study-site and/or target species, in terms of the expected number of bird collisions and/or carcass detection probability. Whenever these are expected to be low, the survey effort (carcass search frequency and extension of power line surveyed) should be increased in order to guarantee reliable conclusions.
Confounding variables	• Mix of potential ecological and/or project-related confounders (e.g. mix of different types of devices or habitats) in a same experiment. • Insufficient number of experiments per combination of moderators, which limits the statistical power of meta-analyses.	• Avoid the mix of wire-marking treatments (combinations of different devices and/or wire-making intensities) in a same experiment, to prevent confounding effects and increase the survey effort (per treatment sections and controls). • Test the effectiveness of a same wire-marking treatment (type of device and wire-marking intensity) in different ecological circumstances (e.g. habitat types, bird communities).
Reporting	• Unclear and/or selective reporting of study details and results, which hampers the calculation of effect size statistics and/or extraction of covariates (moderators) required for meta-analyses. • Reporting of effect size statistics only for trials which evidenced statistically significant effectiveness ('p-hacking'), despite the informative value of non-significant results.	• Describe clearly the experimental design, study temporal/spatial coverage and survey methods used. • Discriminate the survey effort (e.g. number of carcass searches and kms searched) for each *treatment* and *control* section, and/or *before-after* study periods. • Provide complete information about study area (e.g. habitat, target bird species), power line features (voltage, dimensions, wire arrangement, etc.) and wire-making details (devices characteristics and wire-marking intensity). • Report all study outcomes, regardless of statistical significance and direction of the effect. • Present either raw bird mortality counts or summary effect size statistics, including mean mortality rates, associated variation measures and sample size. • Report summary effect size statistics separately for each *treatment* and *control* section, and for each study period (i.e., *before* and *after* treatment).
Dissemination and access to study findings	• Publication bias towards studies showing positive wire-marking effectiveness, or novel findings; • Limited access to studies conducted internally by the energy companies or under EIA processes (i.e., studies which were not conducted primarily with a scientific purpose).	• Promote study publication, ideally, in peer-review journals, even those with negative (or not significant) effects; • Ensure access and dissemination of study results, by making grey literature reports openly available online; • Carefully choose the title, abstract content and keywords, to maximize study retrieval in systematic literature searches (e.g. using Google Scholar).

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Research article

Re-assessing the effectiveness of wire-marking to mitigate bird collisions with power lines: A meta-analysis and guidelines for field studies

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ABSTRACT

The expansion of overhead power lines worldwide challenges companies of energy transmission and distribution, regulators and environmental consultants, among other stakeholders, to effectively mitigate their negative impacts on wildlife. Wire-marking is currently the most widespread and recommended measure to reduce bird collisions with these infrastructures. Nevertheless, and despite its importance for a bird-friendly development of energy projects, there is still much uncertainty about what explains wire-marking effectiveness.

We performed an extensive literature review and meta-analysis to evaluate the overall effectiveness of wire-marking in reducing bird collisions with power lines, including the possible influencing factors of power line voltage, habitat and type of device. We gathered data from 35 field studies across the world (which included 66 trials) assessing the effectiveness of wire-marking based on regular carcass searches beneath power lines.

Overall, wire-marking reduced bird collisions with power lines by half (50.4%; 95% Confidence Interval Estimate: 40.4–58.8%), although this estimate of effectiveness is lower than the one reported in a meta-analysis performed in 2011. Despite the effort to include both peer-reviewed and grey literature studies in the present meta-analysis, the risk of publication bias could not be entirely excluded and may be still overestimating the true overall effect of wire-marking. High heterogeneity among the study outcomes hindered the power to detect clear

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