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Impacts of renewable energy on global biodiversity – an overlooked cost of climate change mitigation?

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- Impacts of collision mortality with wind farms for birds and bats assessed through literature review and metaanalysis

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- Wider impacts of renewable energies assessed through land-use change and species' habitat associations.

Collision mortality: methods

Literature review
Extract data, compile database

Collision data

+

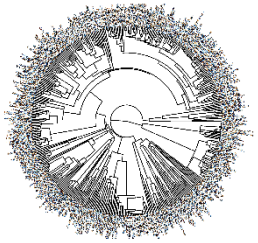
Study data

+

Trait data

+

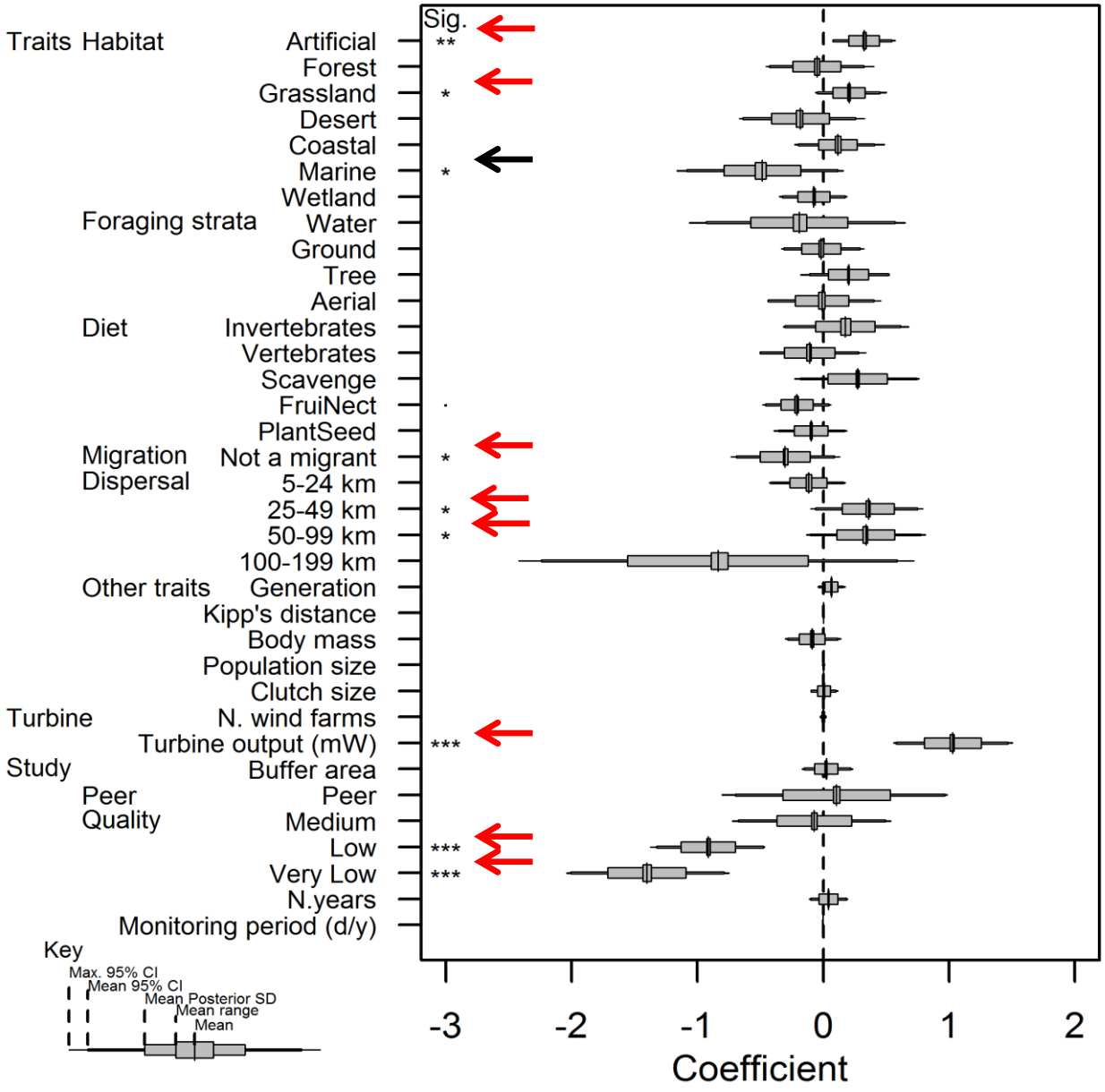
Phylogeny



Trait-based modelling

Predictions to all species based on trait relationships

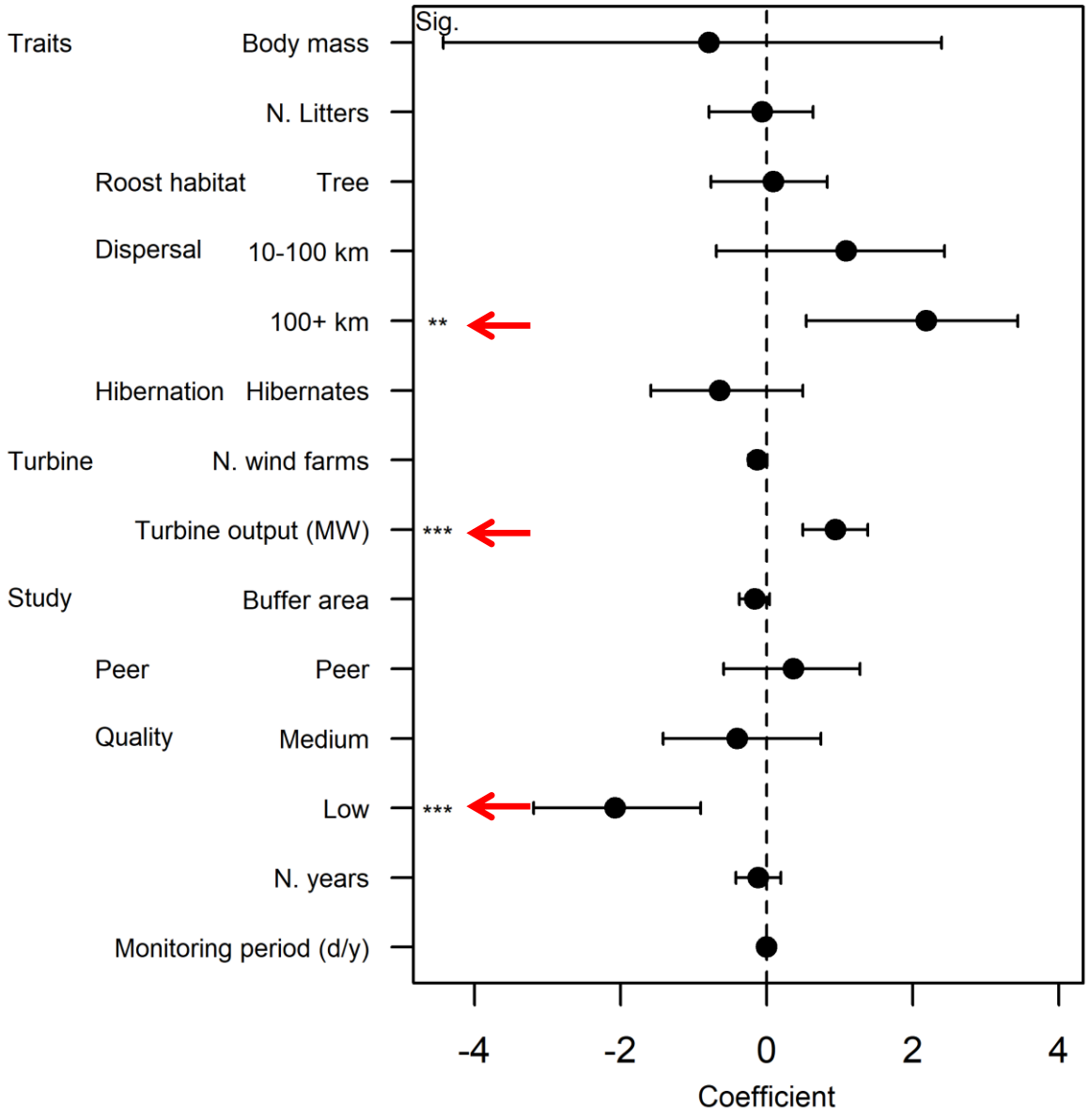
Collision mortality: results



Important predictors:

- Habitat: e.g. Artificial, grassland
- Migration & dispersal
- Turbine size
- Quality of data

Collision mortality: methods

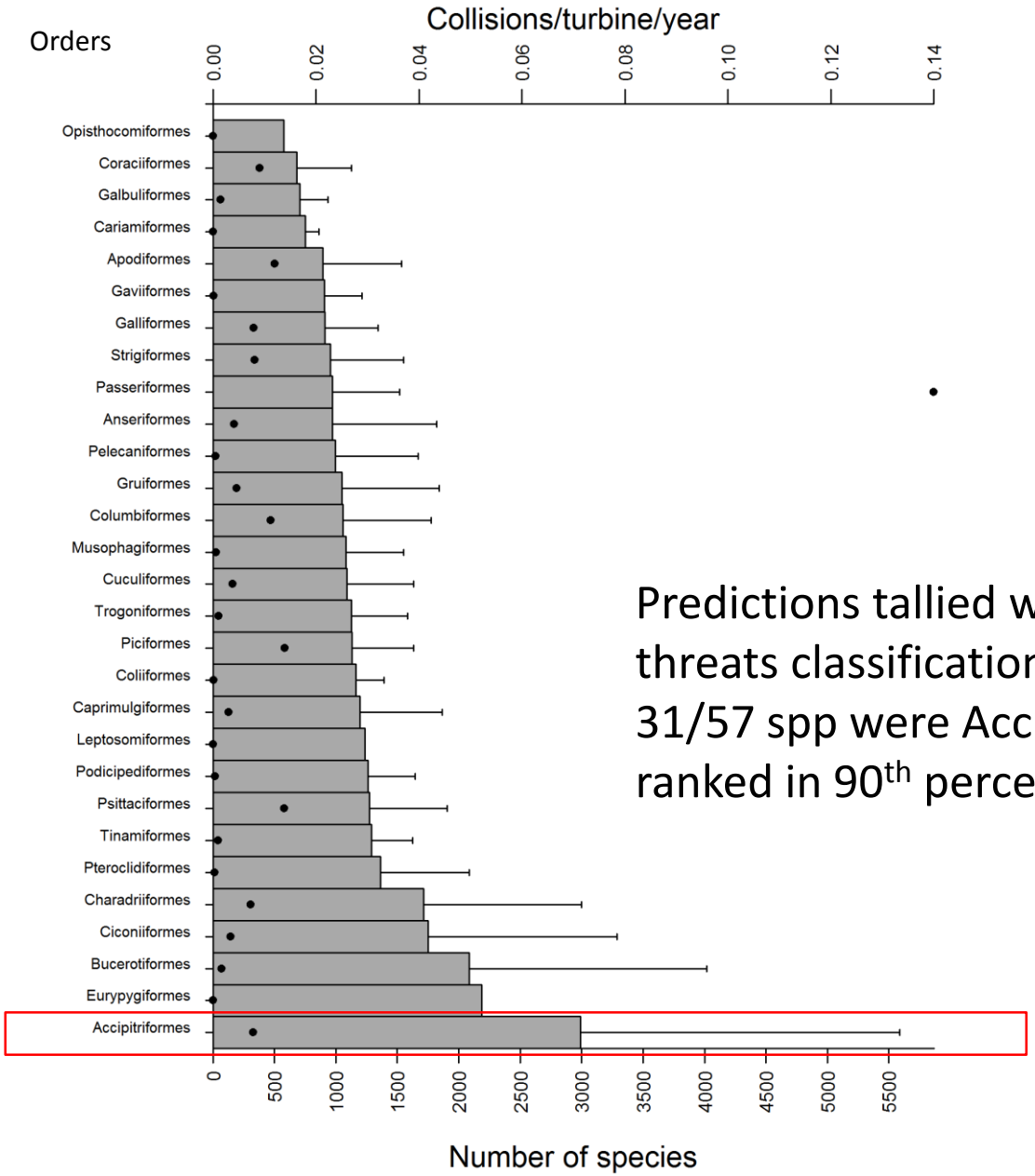


Important predictors:

- Dispersal
- Turbine size
- Quality of data

- Few traits to test
- Predictions based on phylogeny

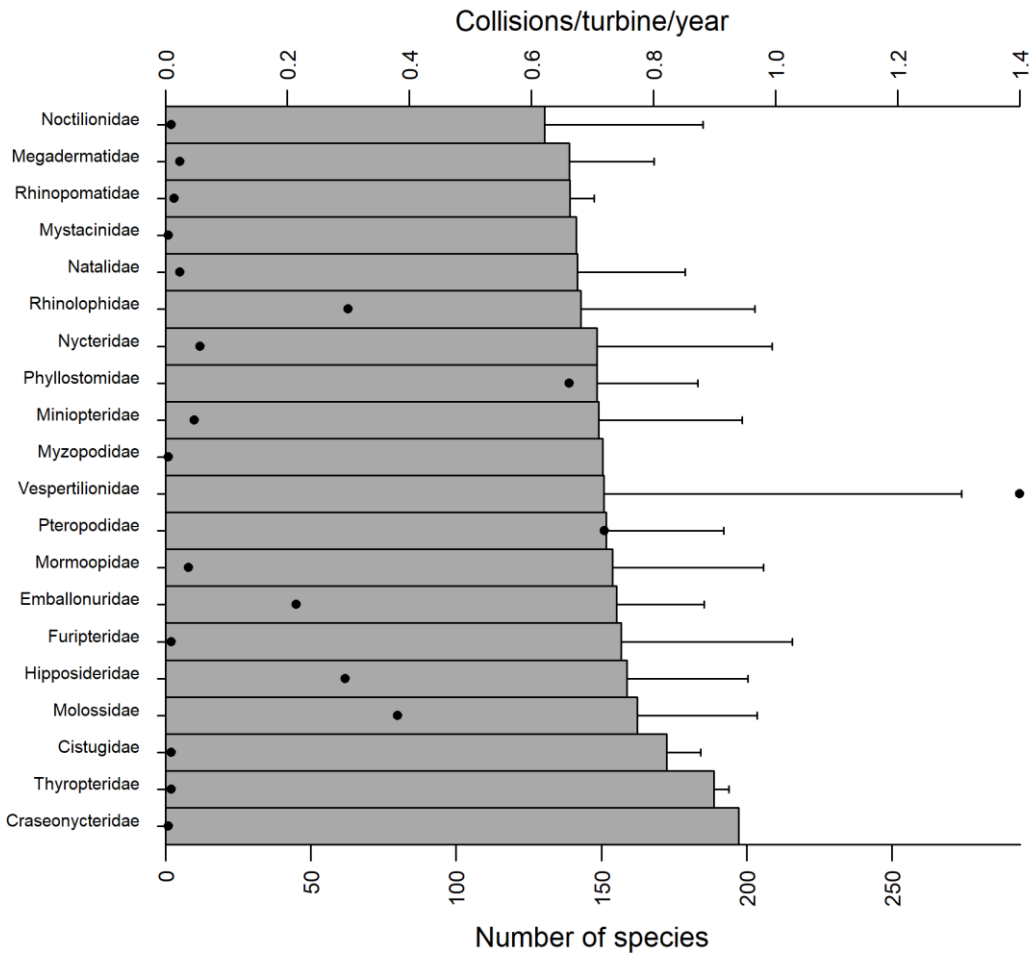
Collision mortality: methods



Predictions tallied well with independent IUCN threats classification for renewable energy: e.g. 31/57 spp were Accipitriformes, of which 26 were ranked in 90th percentile.

Collision mortality: results

Families

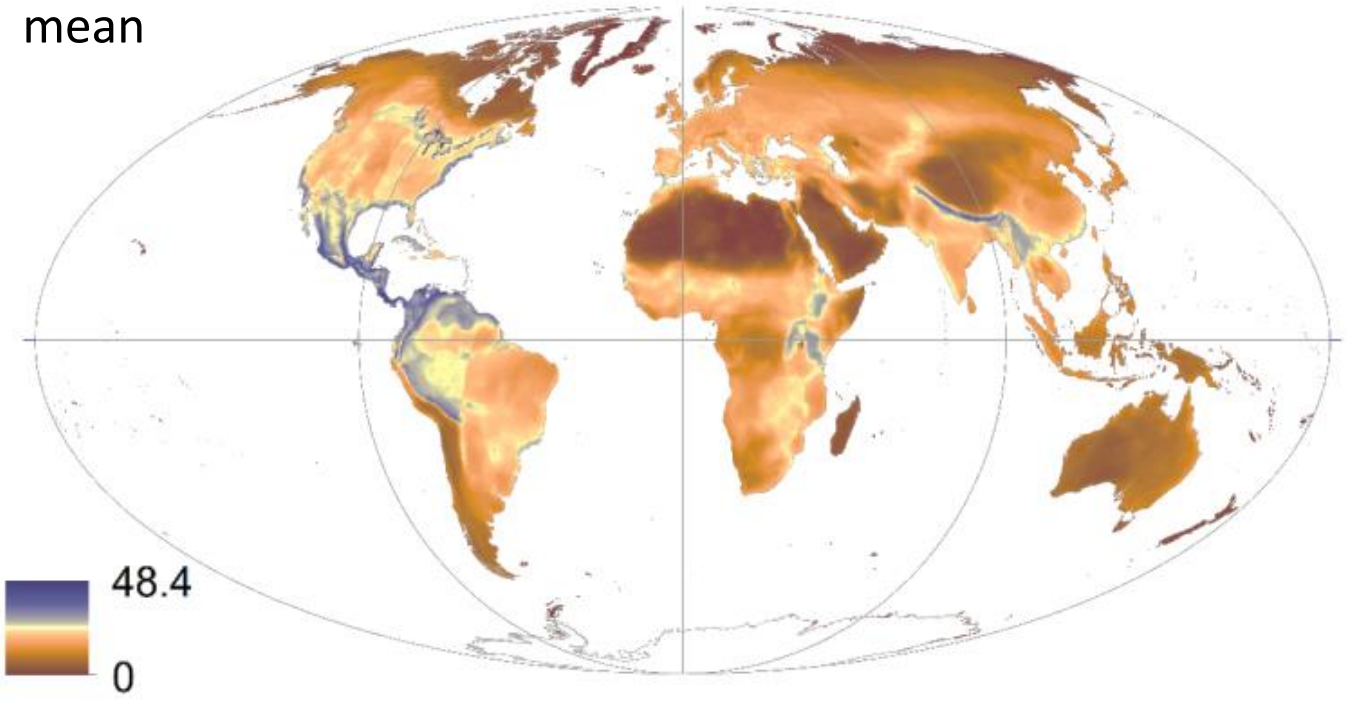


- Less variation - Phylogeny only
- Vespertilionidae – most species, plus contain species most vulnerable (also found by Zimmerling & Francis 2016)

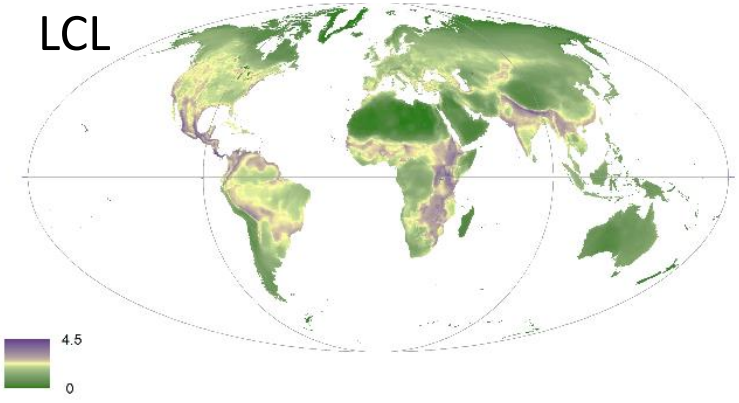
Collision mortality: results

Birds

mean



LCL



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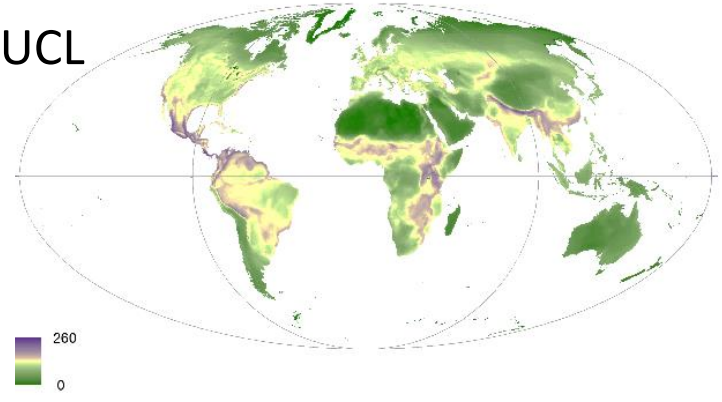
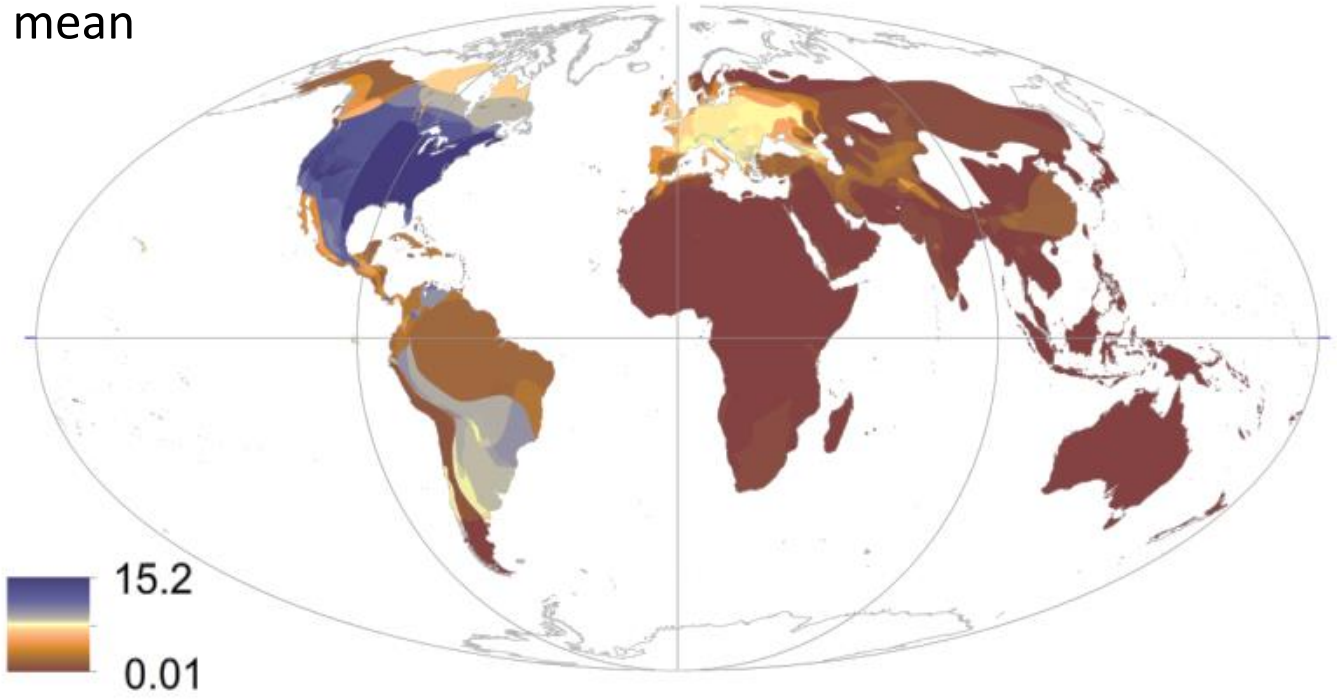


Collision mortality: results

Bats

mean



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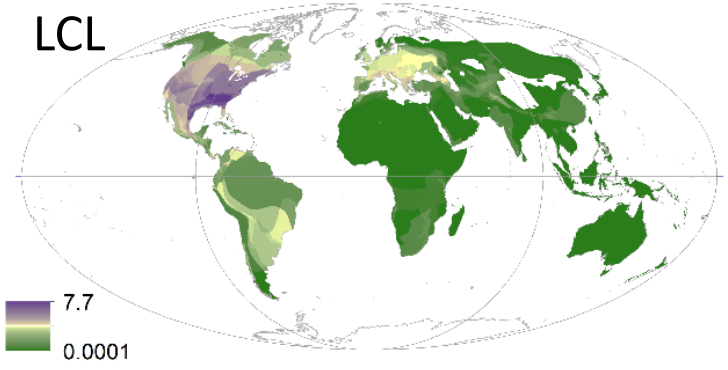

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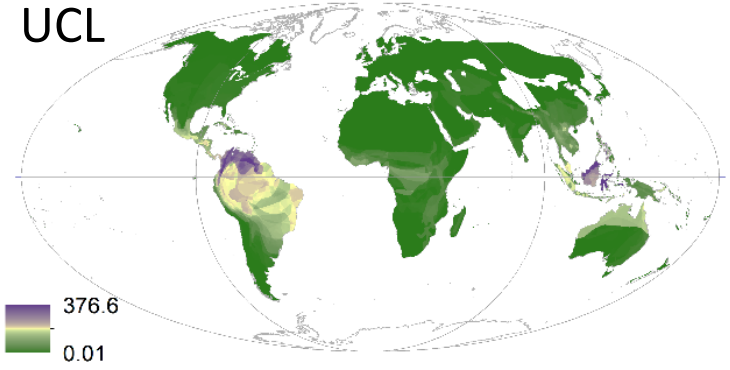
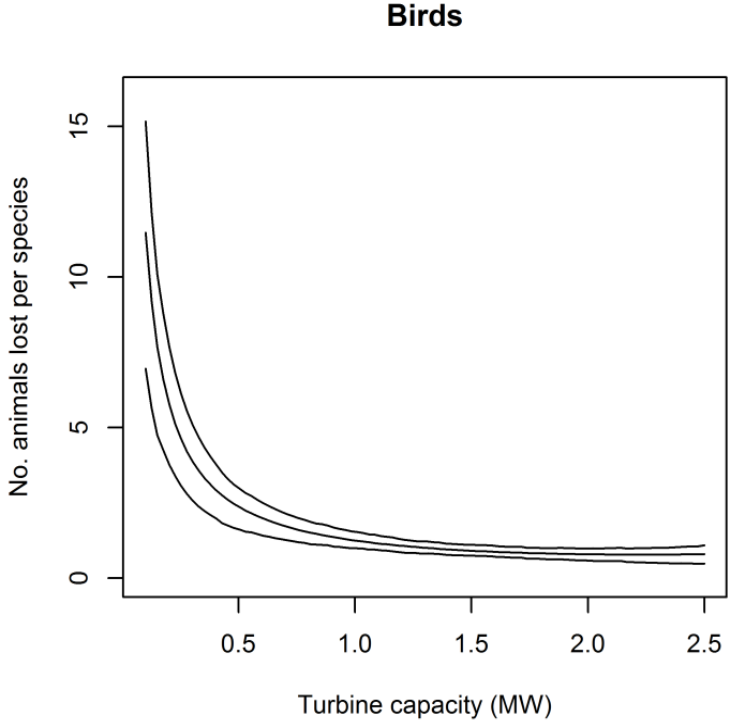
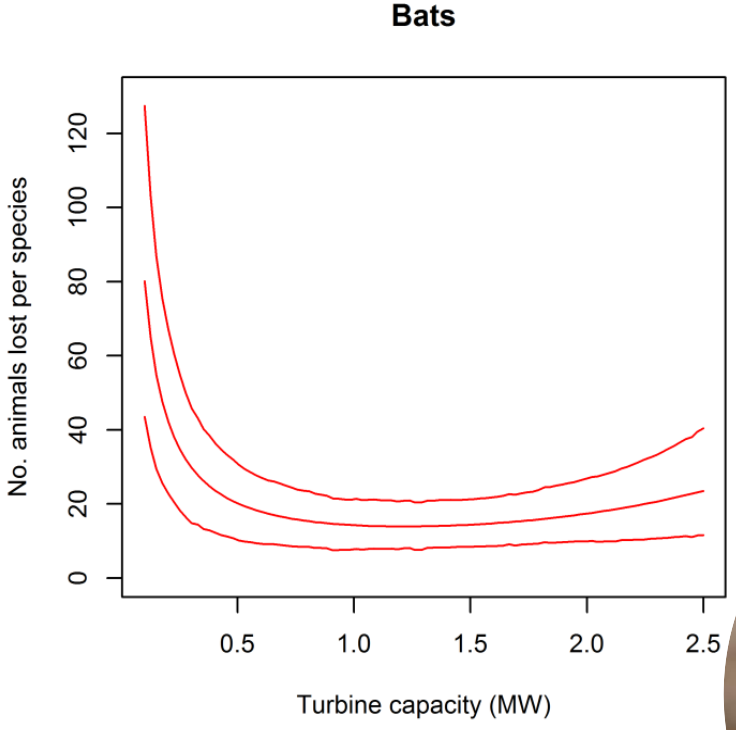


Collision mortality: results

- Bigger turbines caused more deaths per annum
- Are more smaller turbines better than fewer larger turbines for a set wind farm capacity (here, 10 MW)?
- More smaller turbines have a greater impact than fewer larger ones
- Greater negative impacts on bats than birds for largest turbines





Collision mortality: discussion

- Birds of prey were predicted to be most vulnerable[1,2] related to migration[3], dispersal and habitat

- Bats, long-distance dispersers (> 100 km) most vulnerable[4].

- Birds, long-distance migrants less vulnerable, perhaps unmeasured flight behaviour such as altitude at play?

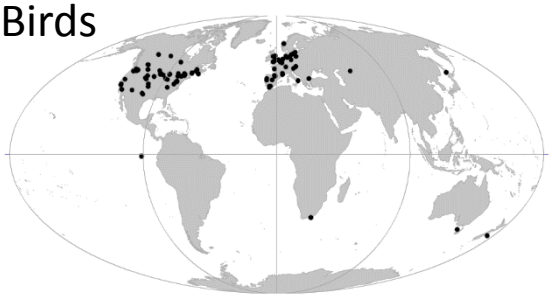
- Species with highest collision rates, mainly k-selected, low fecundity, late age maturity, sensitive to additional impacts of mortality – potential conservation concern

1. Barrios & Rodriguez 2004. J. App. Ecol. 41, 72-81.; 2. Smallwood &Thelander 2008. J. Wildl. Manage. 72, 215-223;
3. Desholm 2009. J. Environ. Mange. 90, 2672-2679.; 4. Voigt et al. 2015. Eur. J. Wildl. Res. 61, 213-219.

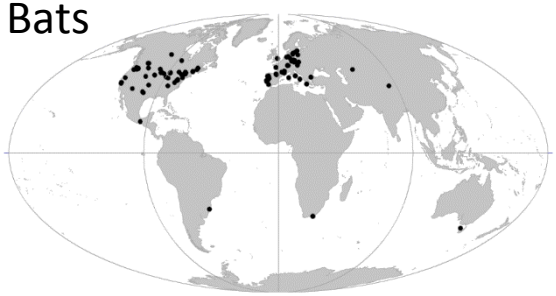
Collision mortality: discussion

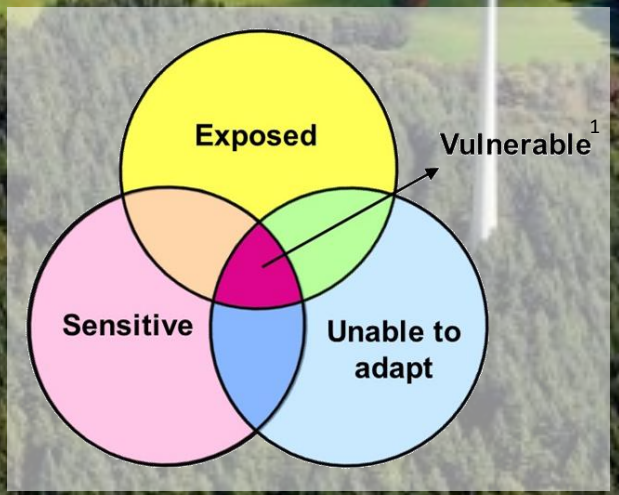
- Data restricted mainly to USA and Europe; caution for extrapolation
- Trait information for bats less comprehensive
- Data quality categorisation may not encompass all facets of studies
- Study ‘vulnerability’ metric reflects both exposure to effect and sensitivity of species, plus does not consider future adaptability
- Vulnerability here may not reflect population level impacts
- Not enough data for offshore wind farms

Birds



Bats





1. Foden et al. 2013

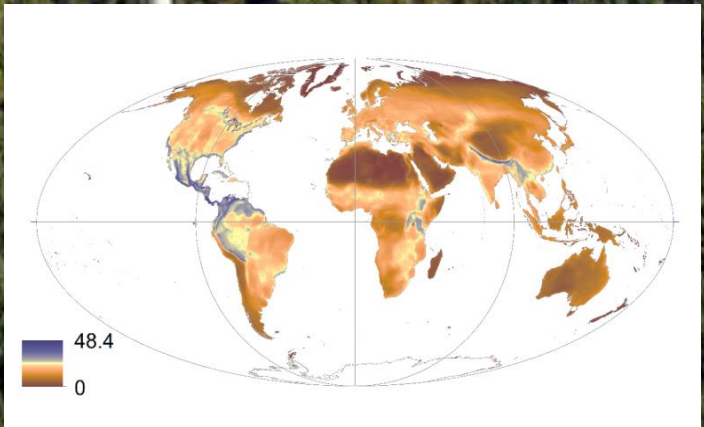
Collision mortality: methods

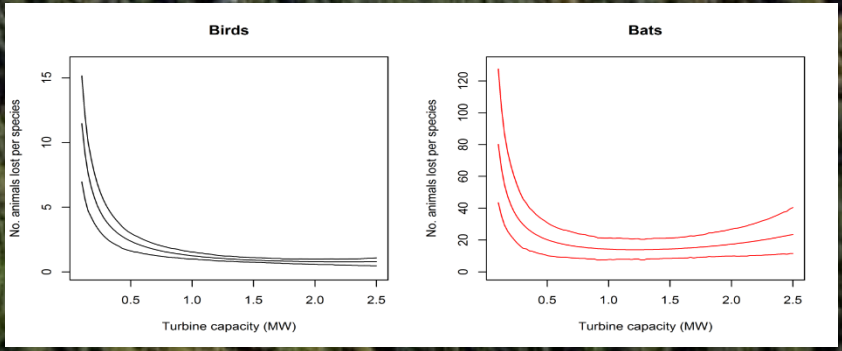
Our study can mitigate against increasing threat of wind farms:

(1) Species-level predictions useful starting point for scoping potential impacts in unstudied areas

(2) Maps can identify areas of high numbers of vulnerable species – spatial planning and siting of wind farms (e.g. avoid migration flyways and coastal bottlenecks)

(3) Determining optimal turbine size and wind farm design to minimise impacts





Collision mortality: methods

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Research

Cite this article: Thaxter CB *et al.* 2017 Bird and bat species' global vulnerability to collision mortality with wind farms revealed through a trait-based assessment. *Proc. R. Soc. B* 20170829.
http://dx.doi.org/10.1098/rspb.2017.0829

Received: 20 April 2017
Accepted: 9 August 2017

Subject Category:
Global change and conservation

Subject Areas:
ecology

Keywords:
biodiversity, climate change, impact, meta-analysis, phylogeny, renewable energy

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Electronic supplementary material is available online at rs.figshare.com.

THE ROYAL SOCIETY PUBLISHING

Bird and bat species' global vulnerability to collision mortality with wind farms revealed through a trait-based assessment

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Mitigation of anthropogenic climate change involves deployments of renewable energy worldwide, including wind farms, which can pose a significant collision risk to volant animals. Most studies into the collision risk of species with wind turbines, however, have taken place in industrialized countries. Potential effects for many locations and species therefore remain unclear. To redress this gap, we conducted a systematic literature review of recorded collisions of birds and bats with wind turbines within developed countries. We related collision rate to species-level traits and turbine characteristics to quantify the potential vulnerability of 9538 bird and 888 bat species globally. Avian collision rate was affected by migratory strategy, dispersal distance and habitat associations and bat collision rates were influenced by dispersal distance. For birds and bats, larger turbine capacity (megawatts) increased collision rates, however, deploying a smaller number of large turbines with greater energy output, reduced total collision risk per unit energy output, although bat mortality increased again with the largest turbines. Areas with high concentrations of vulnerable species were also identified, including migration corridors. Our results can therefore guide wind farm design and location to reduce the risk of large-scale animal mortality. This is the first quantitative global assessment of the relative collision vulnerability of species groups with wind turbines, providing valuable guidance for minimizing potentially serious negative impacts on biodiversity.

1. Introduction

In response to projected impacts of climate change on the environment, human society and health [1], political consensus at the 21st Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC) led to agreement to hold the increase in global temperatures to below 2°C, above pre-industrial levels, and pursue efforts to limit the increase to 1.5°C [2]. Achieving this ambition depends on global emissions peaking around

Thaxter CB *et al*. 2017. Bird and bat species' vulnerability to collision mortality with wind farms revealed through a trait-based assessment. *Proc. R. Soc. B* 20170829. http://dx/doi.org/10.1098/rspb.2017.08.29

Collision mortality: discussion

We are grateful to the project advisory group (including Colin Galbraith, Aida Kowalska, James Watson and Mark Wright) for their advice and support through the project. Thanks also to Nadia Thornton for help with the bat literature review, and to Tina Sommarstorm for help with processing the Pantheria trait data. We thank the Natural History Museum, Tring, UK, and the American Museum of Natural History, New York, USA, for access to bird specimens; and to Nico Alioravainen, Tom Bregman, Samuel Jones, Monte Neate-Clegg, and Catherine Sheard for help compiling biometric data. Picture acknowledgements to: arkive.org,

Picture acknowledgements to: arkive.org, gettyimages, commons.wikimedia.org, allaboutbirds.org, greglasley.com, oiseux.net, uniprot.org, theflacks.co.za, jcabbottnaturephotography.blogspot.co.uk,