

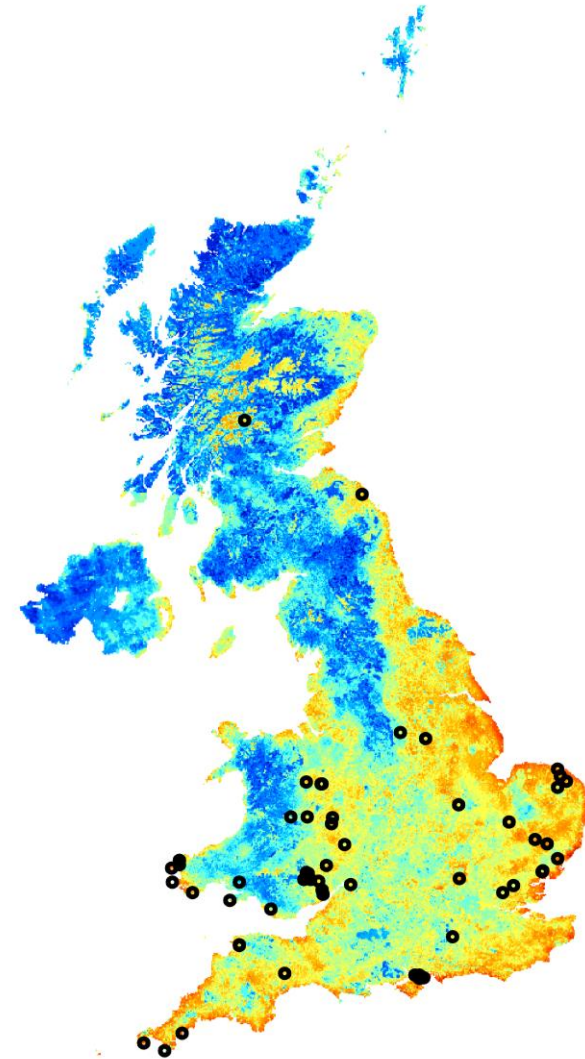
# Large-scale expert validation of species distribution models

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# What is an SDM and how does it work?

- SDMs are models or algorithms that estimate species' environmental preferences
- They compare the environments at locations where species were recorded vs. where they were not
- Often used to estimate habitat suitability at regional and national levels



# We fitted lots of SDMs

- Habitat suitability surfaces are incredibly useful
- So, we fitted models for >6k species
- Using occurrence data from recording schemes

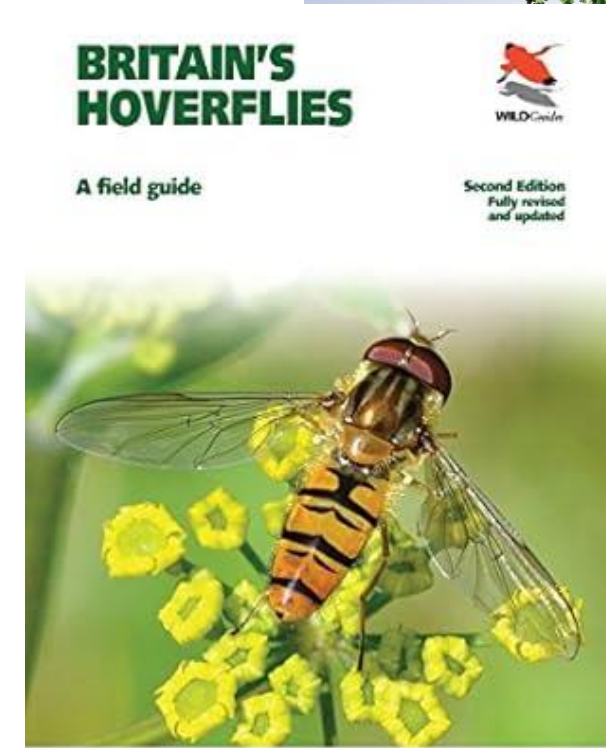
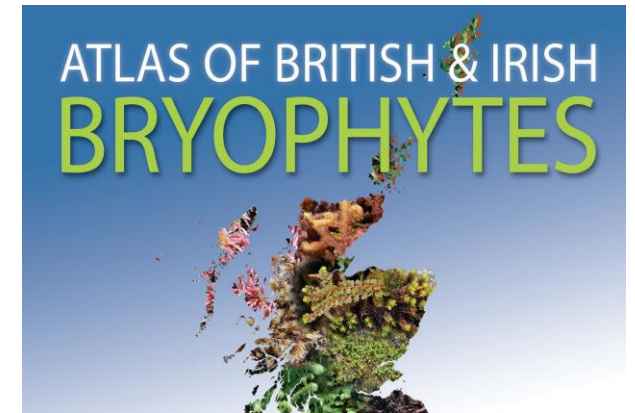
Taxon group	Number of species modelled
Birds	223
Vascular plants	1589
Bryophytes	782
Mammals	59
Invertebrates	2756
Lichens	1017
Herptiles	14
<b>Total</b>	<b>6440</b>

# The challenge

- Observations reflect both species' distributions and where people went looking for them
- SDMs struggle to disentangle the two
- So, it's not clear whether the model is predicting habitat suitability or the types of environments that people go
- And the “fit” of the model to the data doesn't tell us much

# Enter taxon and dataset experts

- National curators of the data for their taxon group
- Written autecological papers, field guides and distribution atlases
- Can offer a different perspective on whether the models are predicting habitat suitability correctly





# Expert feedback

- Experts assessed models via Oli's tailored R shiny apps
- Lot of questions about the data and the models
- Main one being how well the models captured the species' true environmental niches

model potentially suitable areas are dealt with in the following section.)

Enter comment here...

Section 2: Species Distribution Model (SDM) predictions

The interactive distribution models shown here are estimates of relative potential environmental suitability at the 1 km scale. The following six questions relate to the model for this species.

**Q6. For the continuous (interactive) map predictions, how well do you consider that the relative environmental suitability estimate matches your expert view of the species' broad environmental niche? (Note that reasons for discrepancies are explored below, and that the final question is a comments box for any other general observations that you may wish to make.)**

None selected  It matches extremely well  It matches well  It matches somewhat well  It doesn't match well  It matches extremely poorly

**Q7. Poor matches between the relative suitability predictions displayed here and your expert understanding of a species' ecology could be partly due to important environmental variables that are not in our model. For example, a species that requires veteran trees, or a specific soil type, might be over-predicted because our models are constructed using a more general set of environmental variables at the 1 km scale, and information on the presence of these features is not included in the model. Do you think that this species' model over-predicts suitability due to unmodelled features of the environment that are necessary for its presence in a 1 km grid cell?**

None selected  Yes  No  Don't know

**Q8. If you answered "Yes" to Q7, please list any additional features of the environment that you consider would be important for improving the 1 km suitability predictions for this species here. Please separate different features using a comma.**

Enter comment here...

**Q9. Another reason for a poor match between your expert knowledge and the model could be that the 1 km distribution of the species used here is not at equilibrium with the environmental variables used in the model. For example, an expanding species may not occupy all of the grid cells in which it could in fact survive, this could lead to an under-prediction of the currently suitable area. A similar issue could occur where you consider that a species is over-predicted relative to the current real world situation, because some habitat, or habitat management, has declined over the time period represented by the data modelled, and the records and/or environmental data used do not capture this change. Do you think that this species is in equilibrium with the environmental variables used?**

Interactive map of the 'species distribution model' (SDM) relative suitability scores

Recall that this is a map of predicted *relative* potential suitability, rather than of absolute probabilities that

(Note that, with the satellite backdrop option on, some areas of coastal sediment appear that look like lan

OSM (default)  
Satellite  
 SDM

0.2  
0.3  
0.4  
0.5  
0.6  
0.7  
0.8

Leaflet | © OpenStreetMap contributors, CC-BY-SA

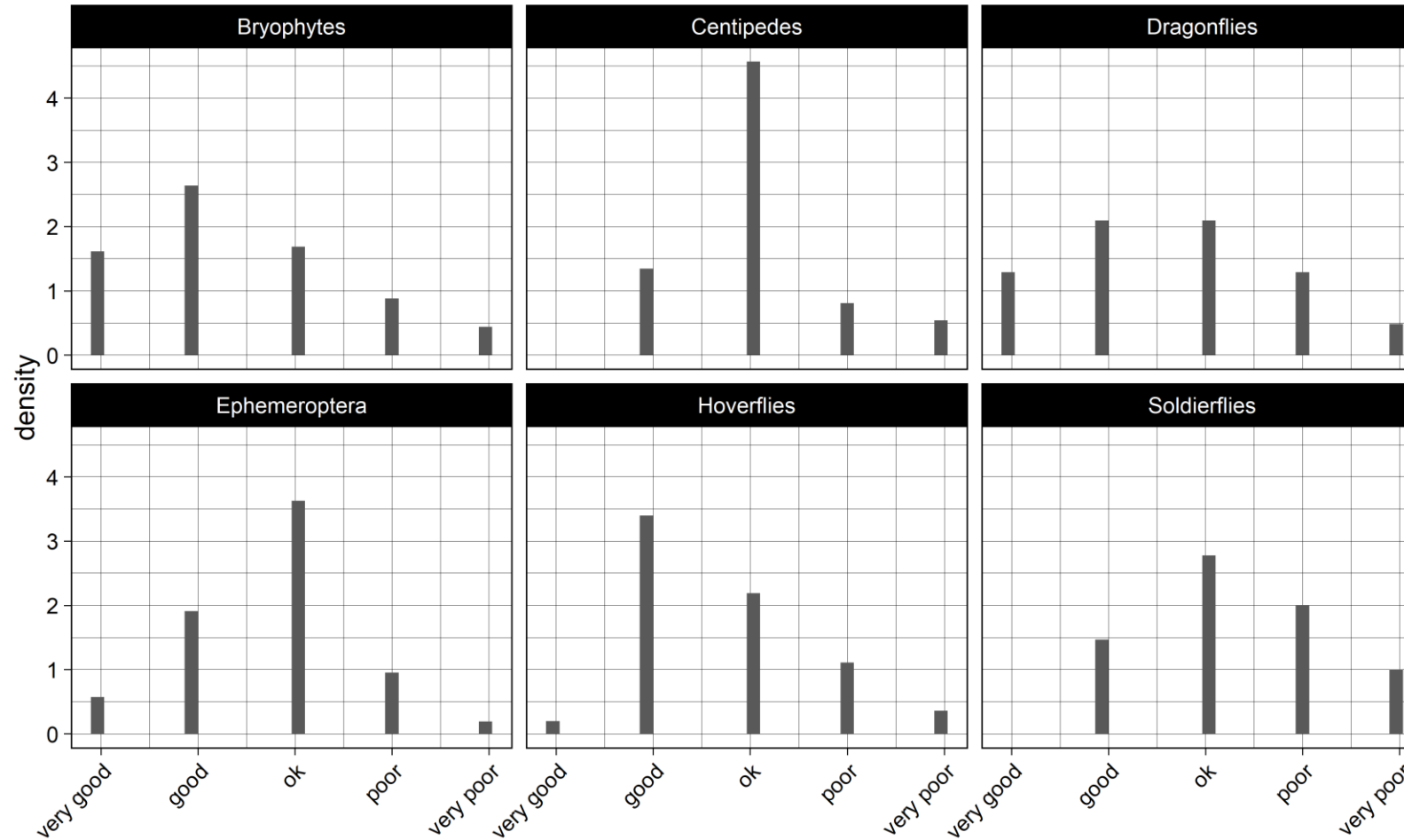
Your previously entered responses for this taxon, if any, appear below. The five m

# We got loads of responses

- Responses from 6 schemes (plus herps)
- We asked experts to rate 100 species (or all species if this was less than 100)
- In total >500 species assessed

Taxonomic group	Number of species modelled	Number of species assessed	Expert initials	Recording scheme
Mosses, liverworts and hornworts (Bryophyta, Marchantiophyta, and Anthocerotophyta)	782	100	CDP	British Bryological Society ( <a href="https://www.britishbryologicalsociety.org.uk/">https://www.britishbryologicalsociety.org.uk/</a> )
Centipedes (Chilopoda)	29	29	TB	British Myriapod and Isopod Group, Centipede Recording Scheme ( <a href="https://www.bmig.org.uk/">https://www.bmig.org.uk/</a> )
Dragonflies (Odonata)	46	46	PT	British Dragonfly Society Recording Scheme ( <a href="https://british-dragonflies.org.uk/">https://british-dragonflies.org.uk/</a> )
Hoverflies (Syrphidae)	226	226	RM	Dipterists Forum, Hoverfly Recording Scheme ( <a href="http://hoverfly.uk/hrs/">http://hoverfly.uk/hrs/</a> )
Mayflies (Ephemeroptera)	38	38	CM	Riverfly Recording Schemes: Ephemeroptera ( <a href="http://www.ephemeroptera.org.uk/">http://www.ephemeroptera.org.uk/</a> )
Soldierflies and allies (Lower Brachycera)	95	95	MH	Soldierflies and Allies Recording Scheme ( <a href="http://soldierflies.brc.ac.uk/">http://soldierflies.brc.ac.uk/</a> )
Total	1216	554	-	-

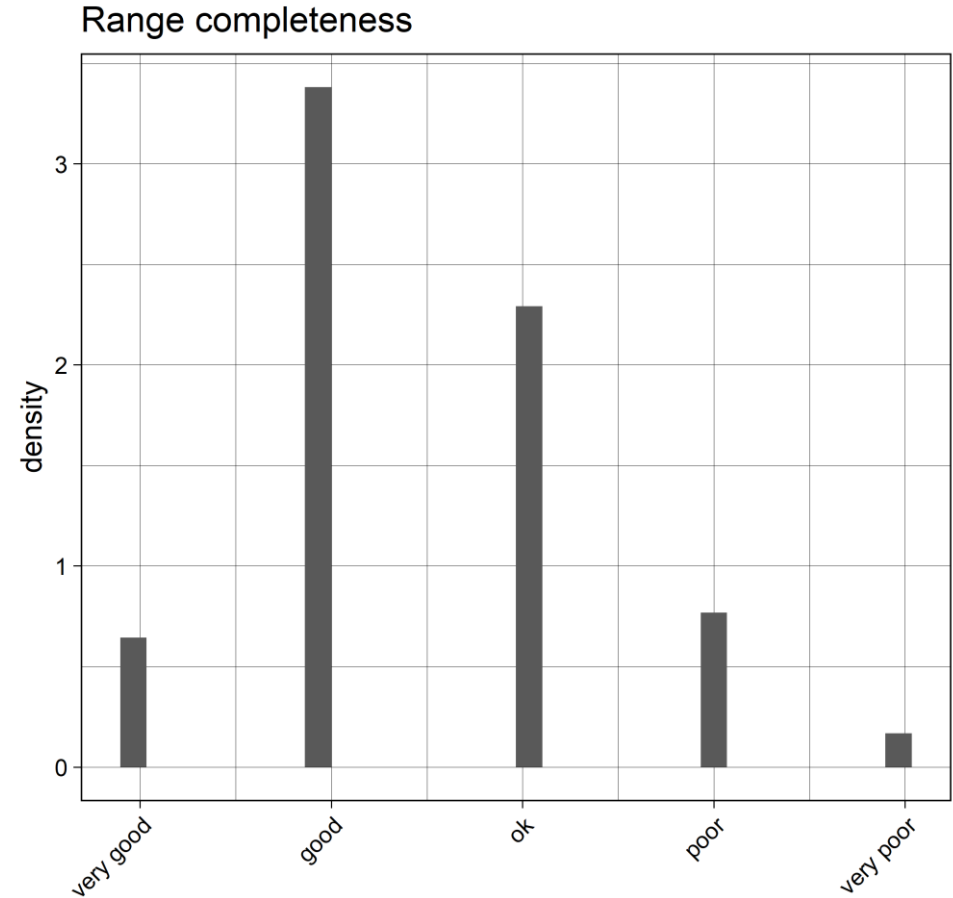
# Are the models any good?





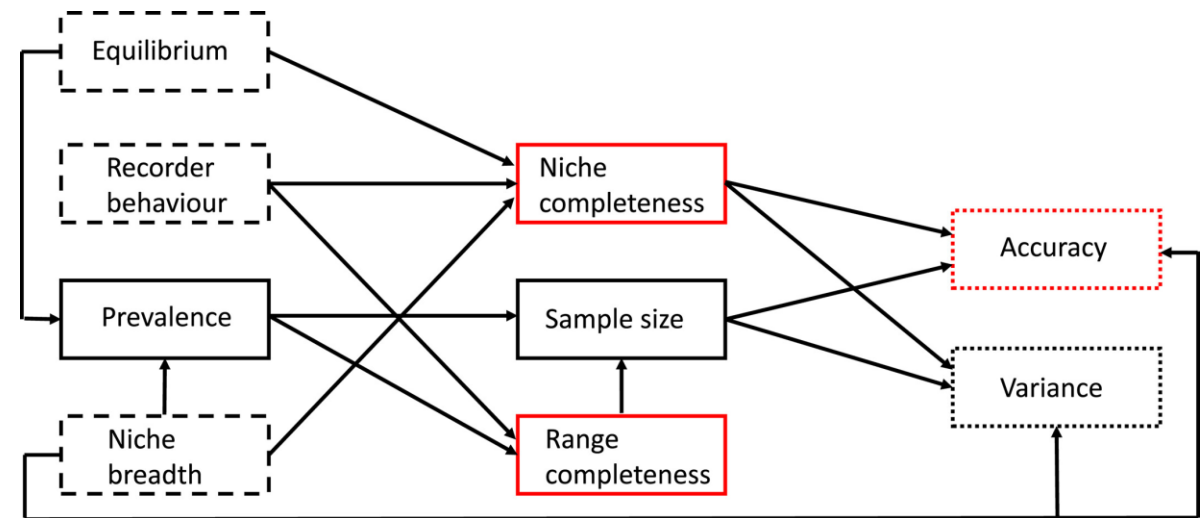
# Some additional questions

- Do the records cover the species environmental niche and geographic range?
- Is the species at equilibrium with its environment?
- So, we had lots of info on the species, the data and model performance



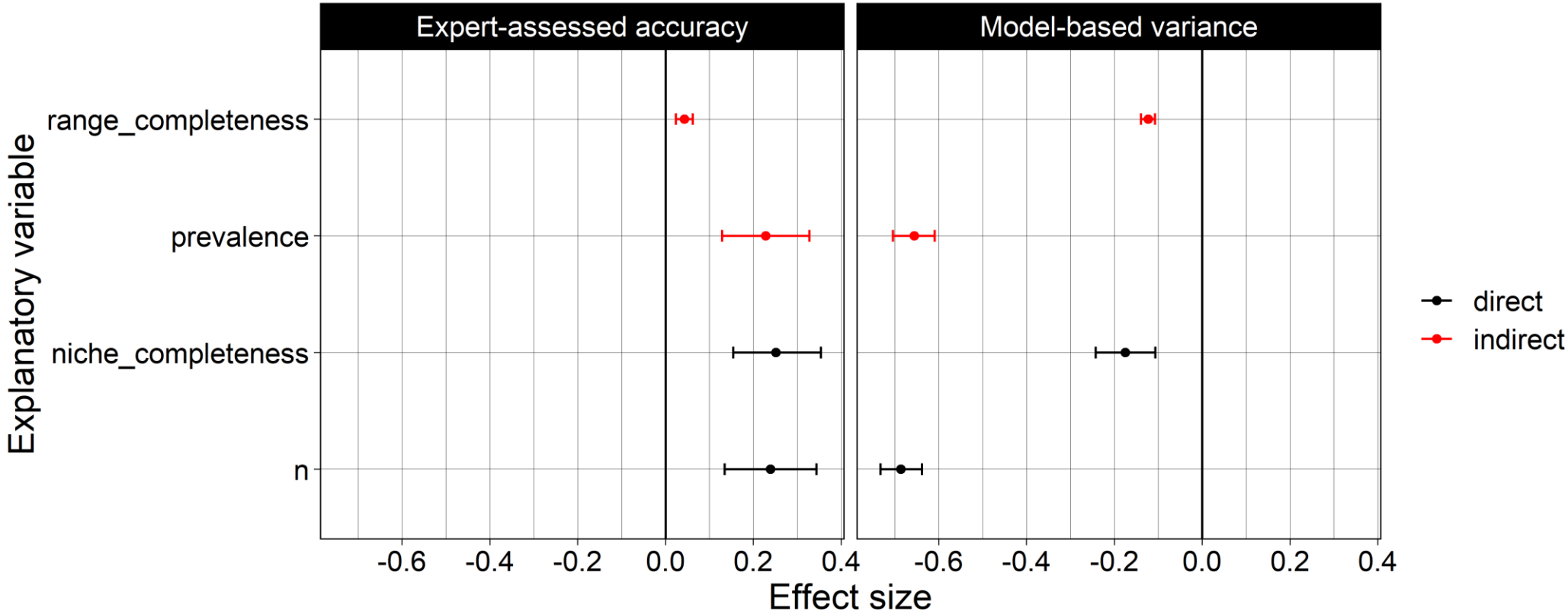
# Causal inference about the drivers of model performance

- Came up with causal diagram depicting causes of accuracy and variance
- “Nodes” denote variables and “edges” denote effects
- Theorise, test, refine, repeat
- Final model analysed statistically



Boyd, R. J., Harvey, M., Roy, D., Barber, T., Haysom, K., & ... Pescott, O. L. (2023). Causal inference and large-scale expert validation shed light on the drivers of SDM accuracy and variance. *Diversity and Distributions*, 1–11. <https://doi.org/10.1111/ddi.13698>

# Causal inference about the drivers of model accuracy



# Summary

- Experts told us what the data could not: whether the models were any good at predicting habitat suitability
- They also provided info on the data and species
- The result was a quite unprecedented dataset
- And we used it to work out what makes a good (and bad) model

# Thank you

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