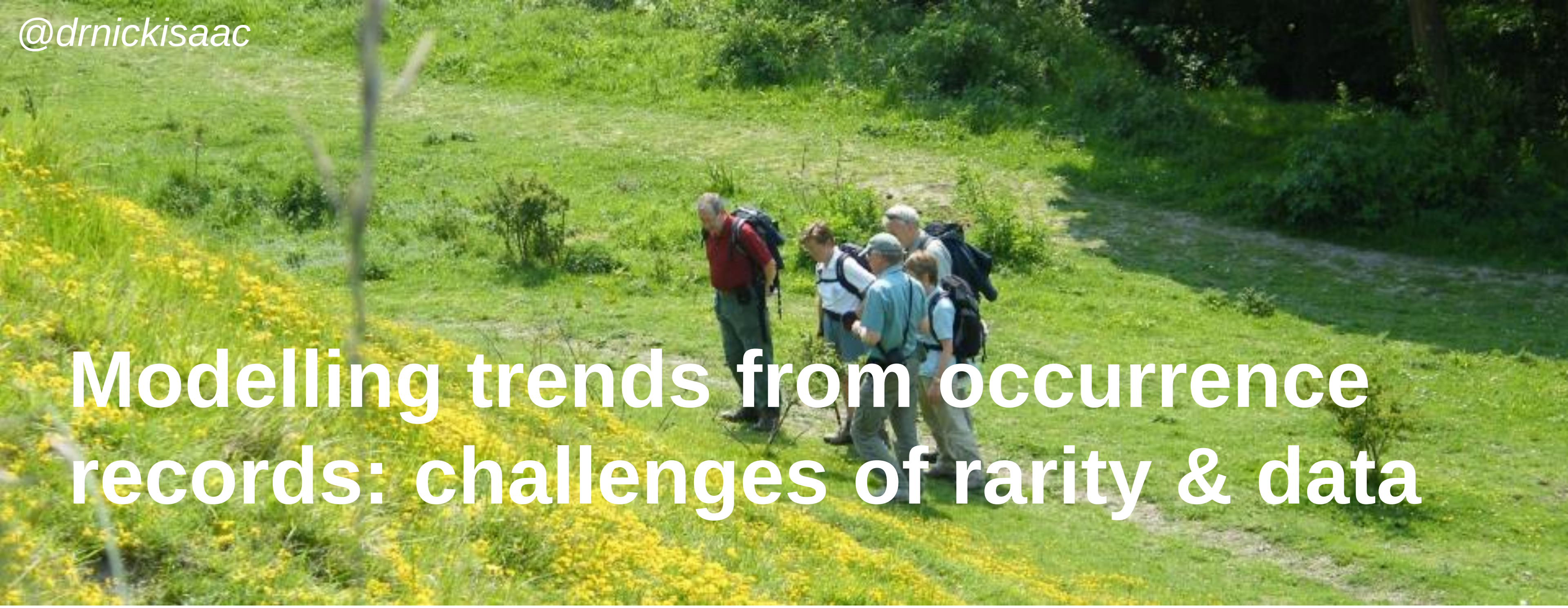

@drnickisaac

Modelling trends from occurrence records: challenges of rarity & data

Nick Isaac, Charlie Outhwaite, Gary Powney & Tom August

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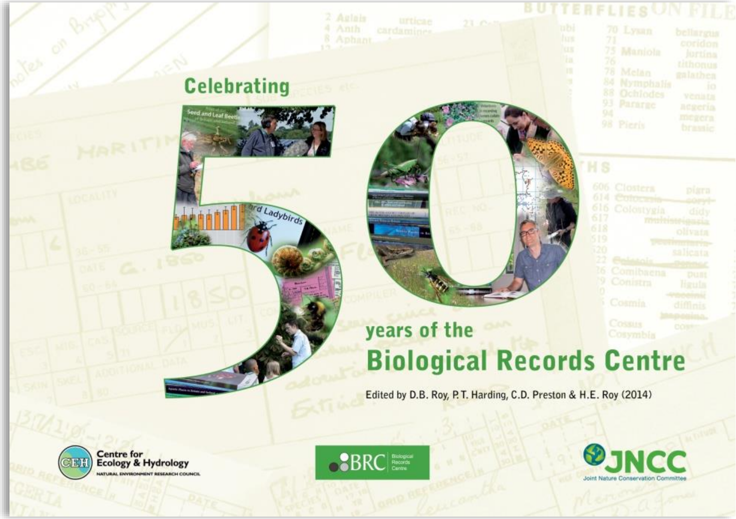
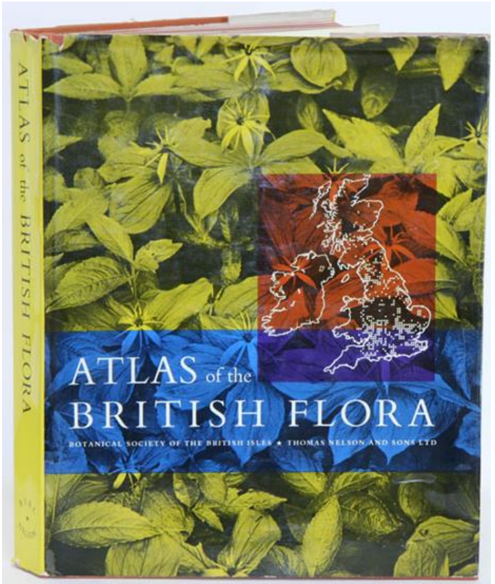
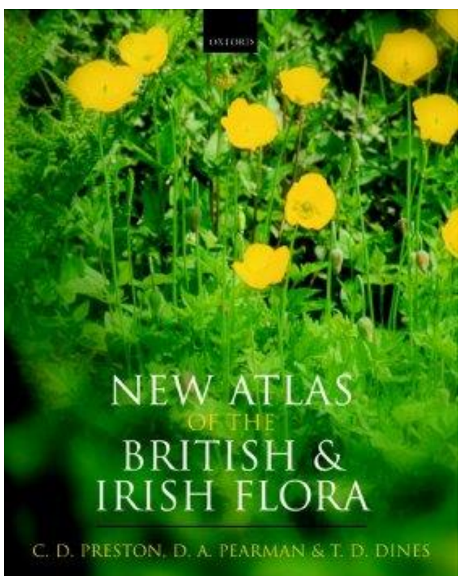
Half a century of map-making

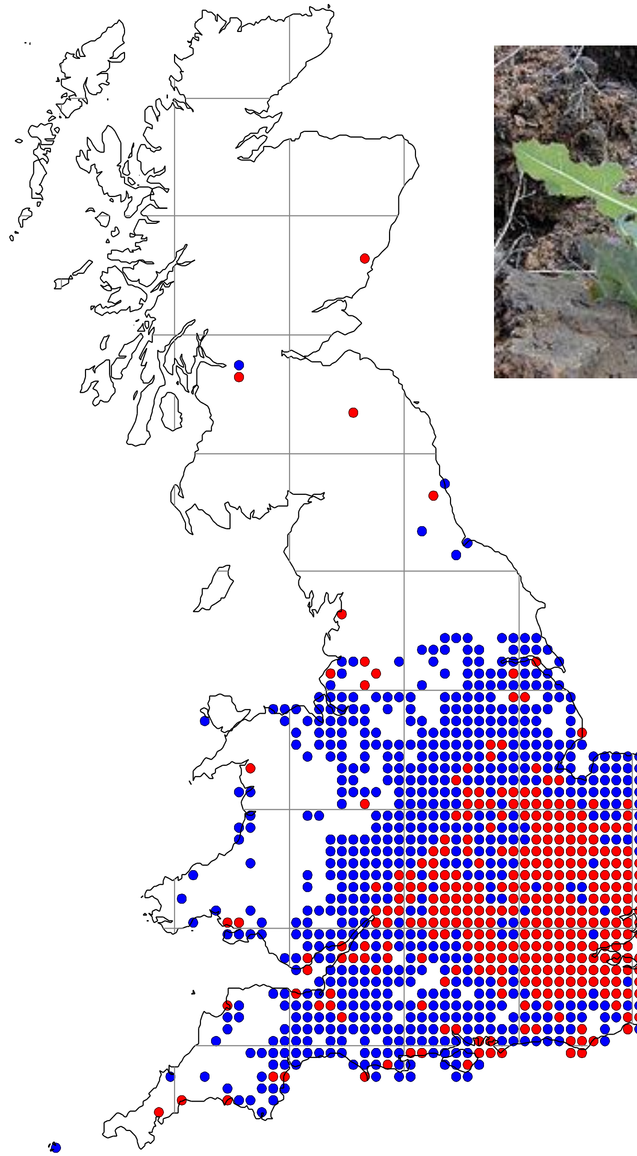


Biological Records Centre

Atlases: Stock & change in distribution







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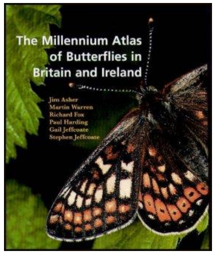
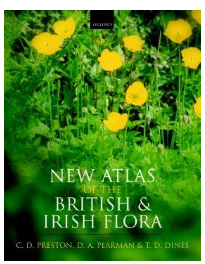
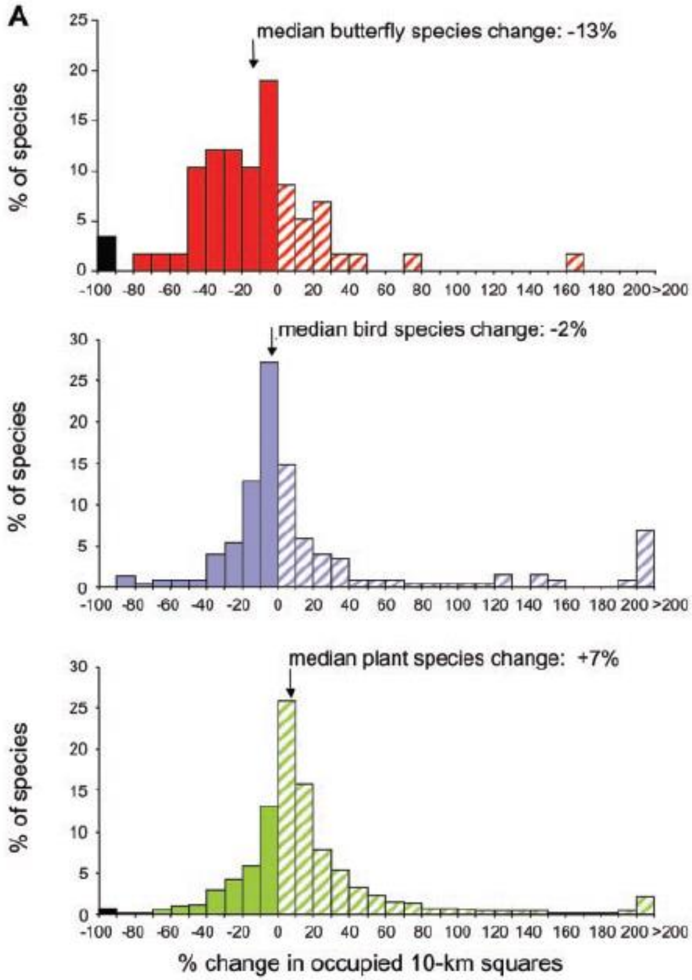
Biodiversity change using atlases





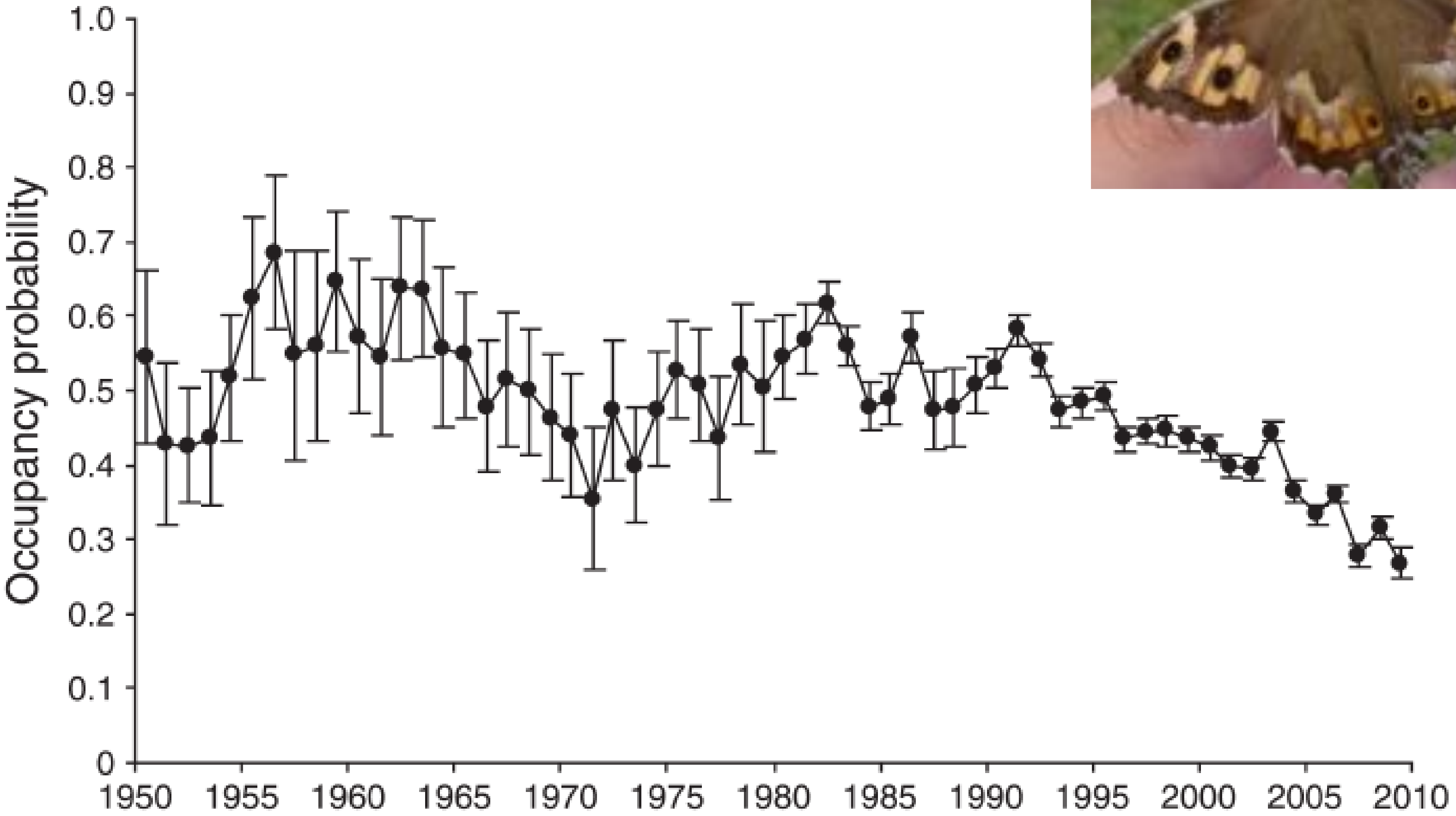


'Square counts' on repeat atlases reveal which species are increasing vs decreasing

Greatest losses occurred among butterflies, then birds

Thomas, JA et al. (2004). Comparative losses of British butterflies, birds, and plants and the global extinction crisis. Science, 303: 1879–81

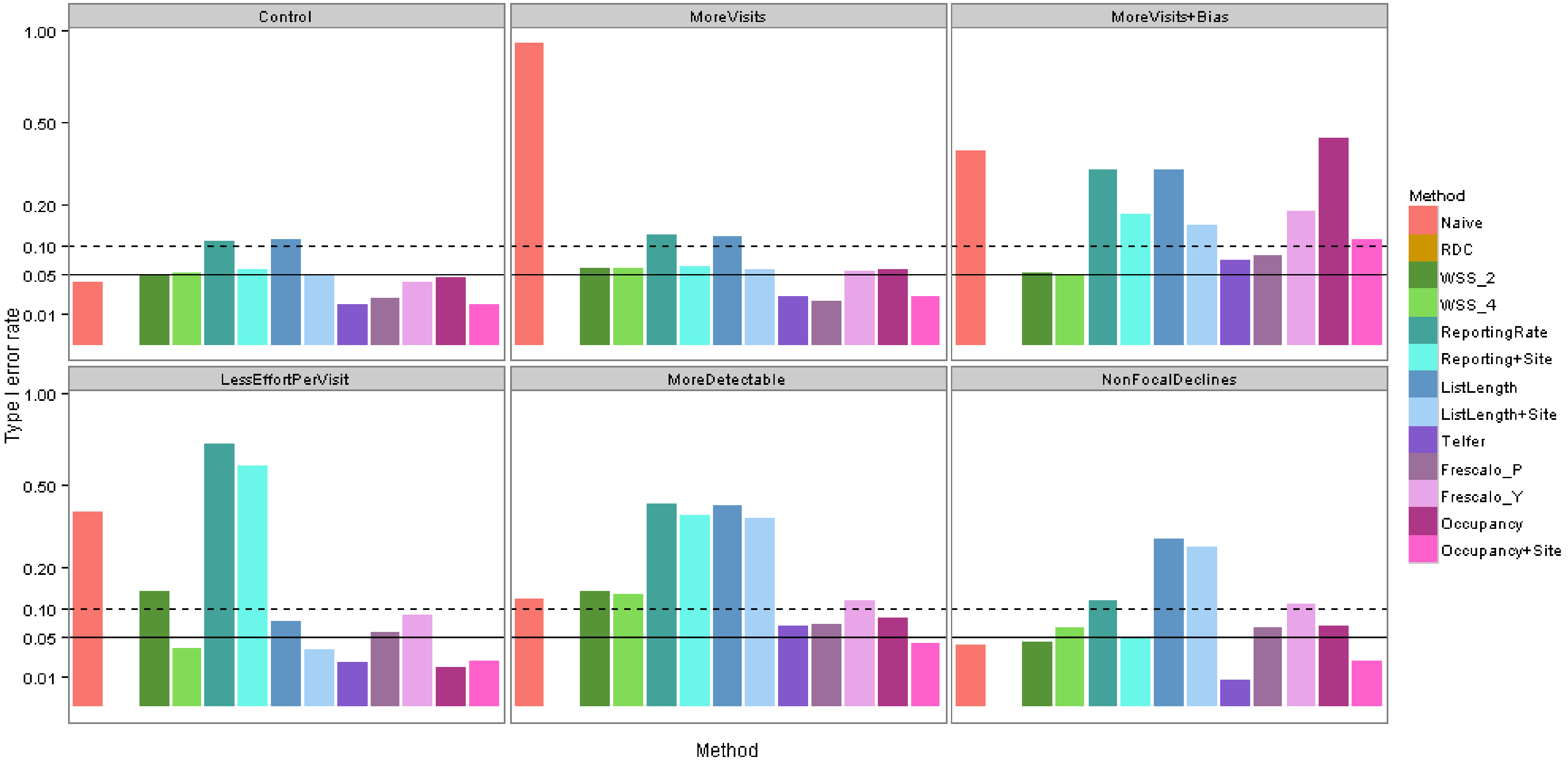
Historical records: Dutch Grayling



van Strien et al (2011) *Ecological Applications, 21, 2510–2520*

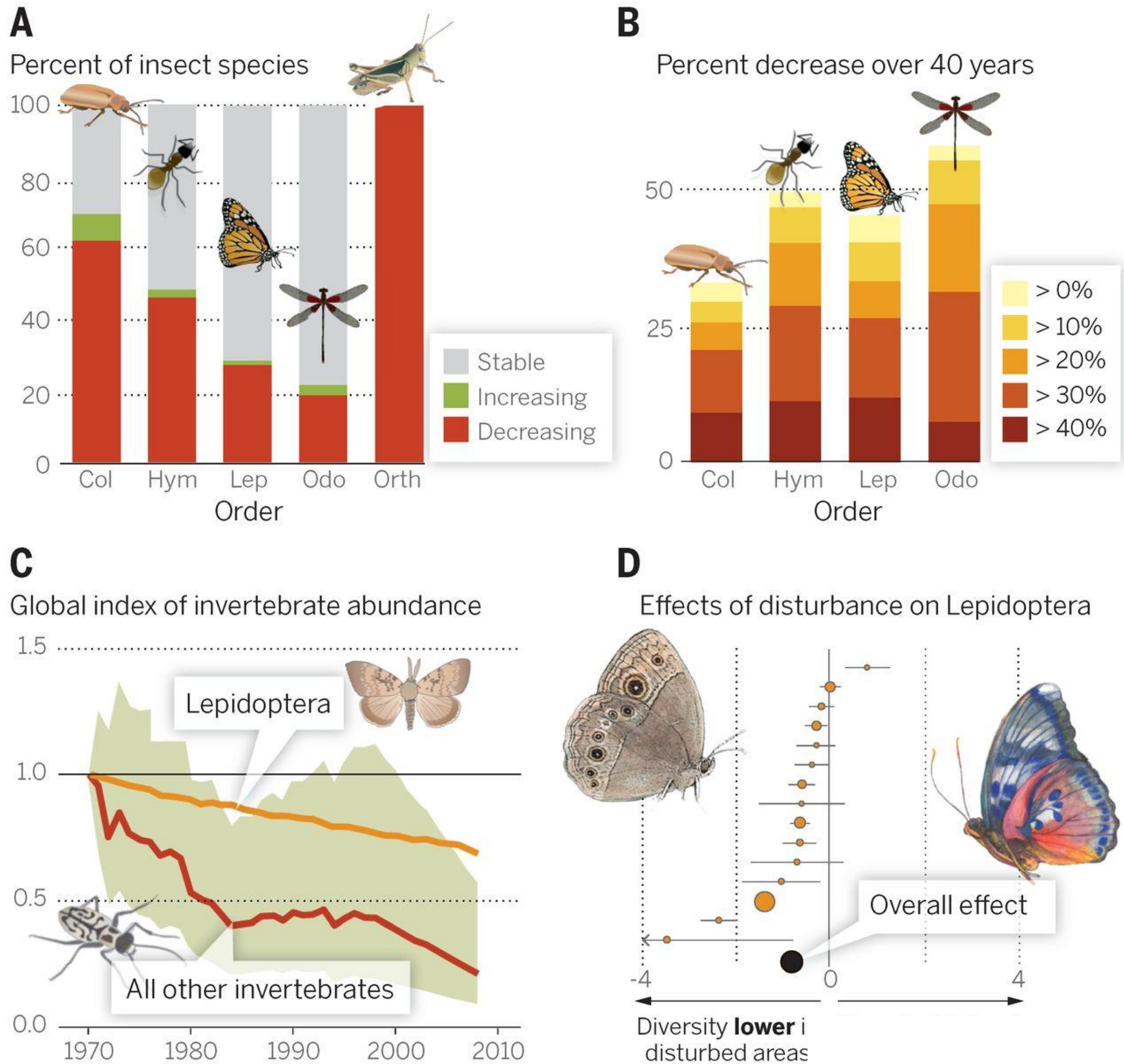
Simulation results: Type I error rates

- Occupancy models outperform other methods



Isaac et al (2014) *Meth Ecol Evol* ***5****: 1052-1060*

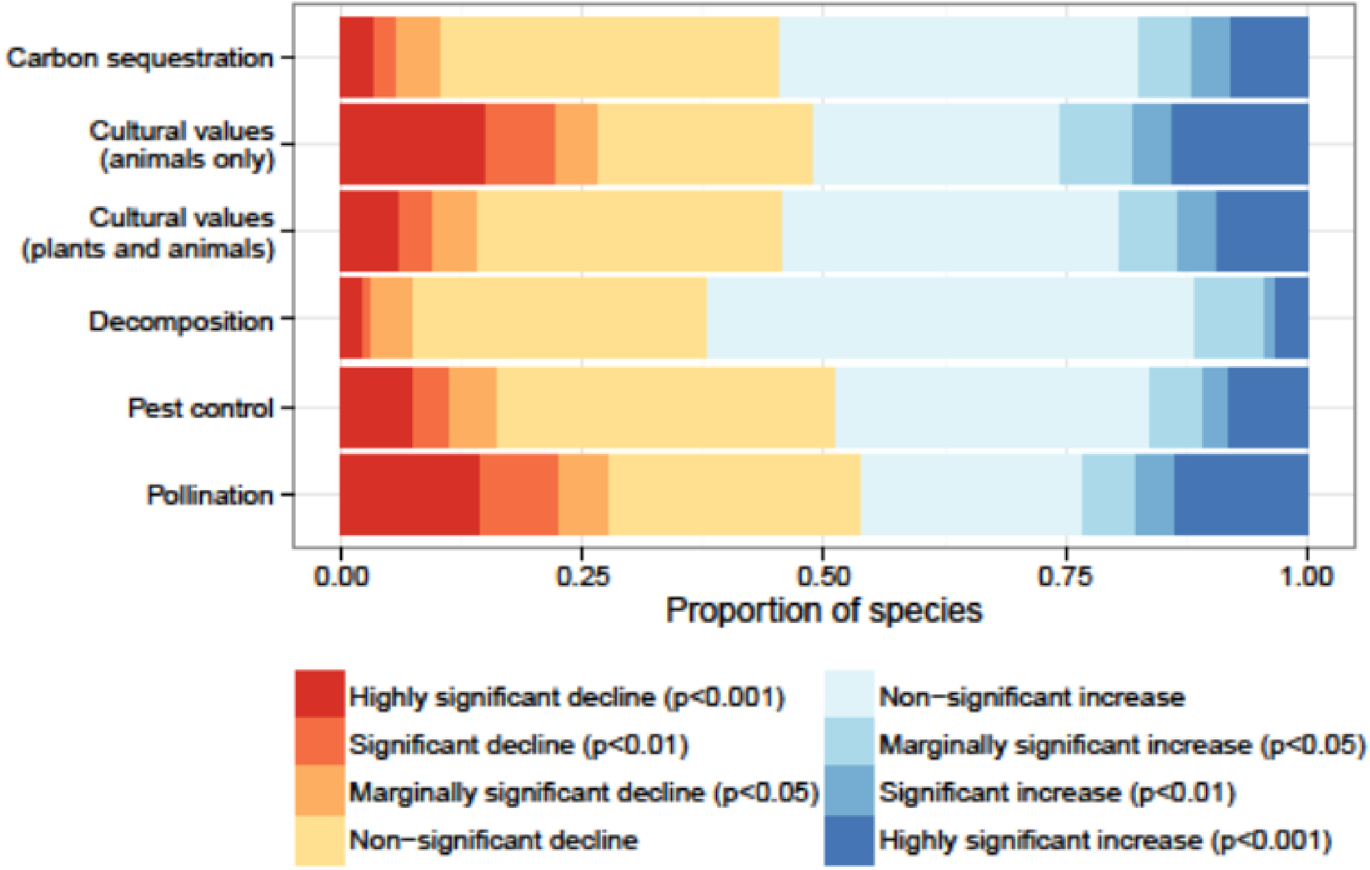
Defaunation Review



Dirzo et al (2014) *Science, 345: 401–406*

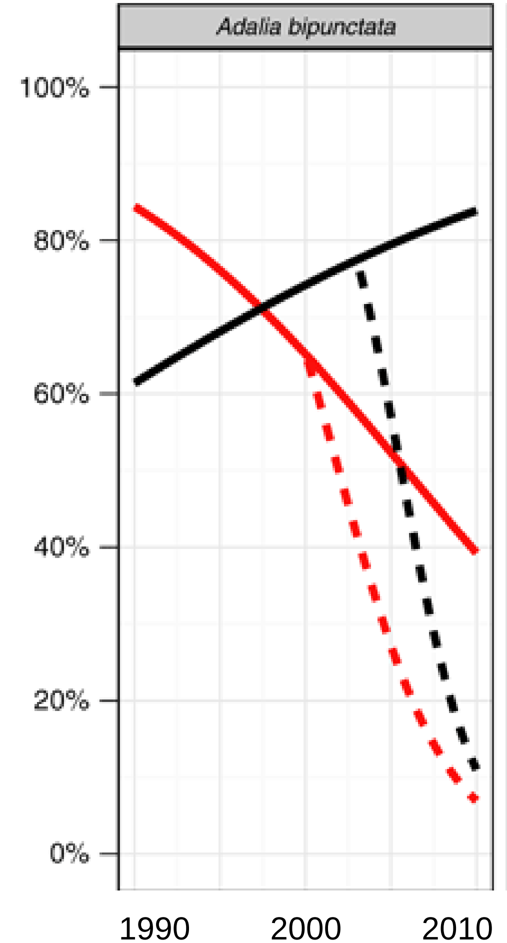
Species trends and ecosystem functions

- Linear trends since 1970 for 4431 species
- Turnover is higher pollinating and pest-controlling species
- These functions may be less resilient to change



Oliver *et al* (in press) *Nature Communications*

Drivers of change: Invasive ladybird



Declines in native ladybirds are attributable to the arrival of the invasive Harlequin ladybird

Similar patterns across 8 native species in both GB & Belgium

Roy et al (2012) Diversity & Distributions, 18: 717–725

UK Ladybird Survey

Trends in Early-successional species

- Trends for 299 invertebrates of early-successional habitats
- Woodland species have declined, heathland species increased
- Species with southerly range margins have increased

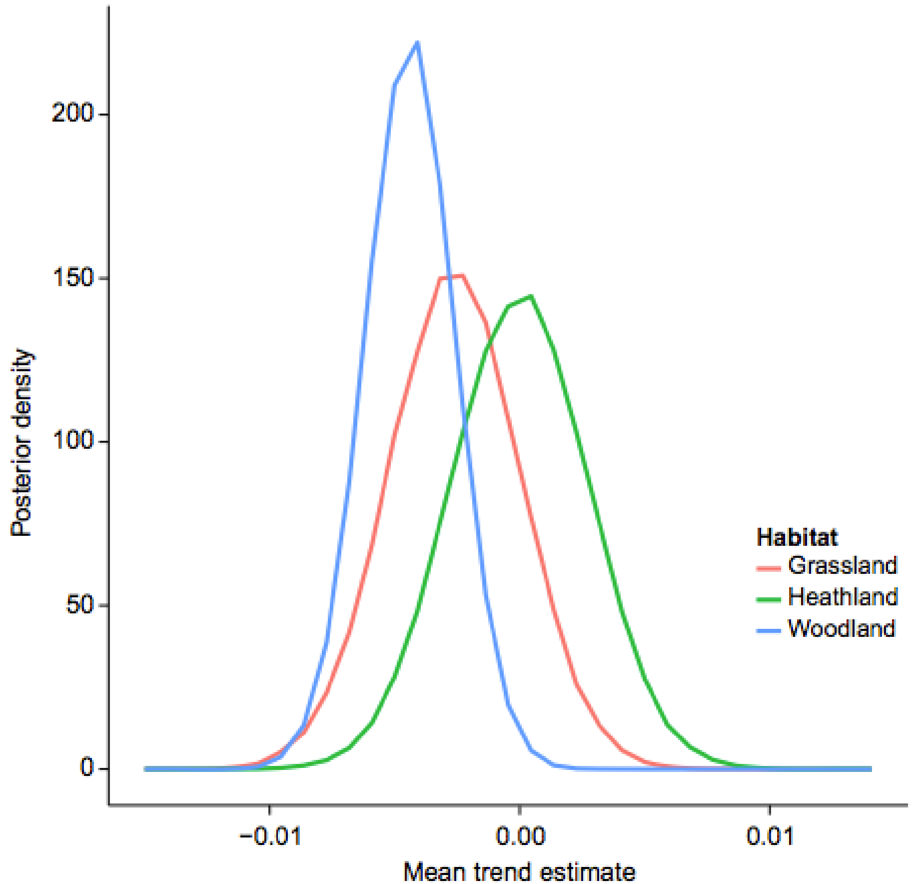


Figure 4. Posterior distribution of effect sizes for the mean trend of species in each ecosystem, from our Bayesian meta-analysis.

Thomas *et al* (2015) *Biol. J Linn Soc 115: 636-646*

Dragonfly Traits & Trends

- Dragonflies with southerly distributions increased relative to other species since 1970.
- Lotic species fared better than lentic

BDS

British Dragonfly Society

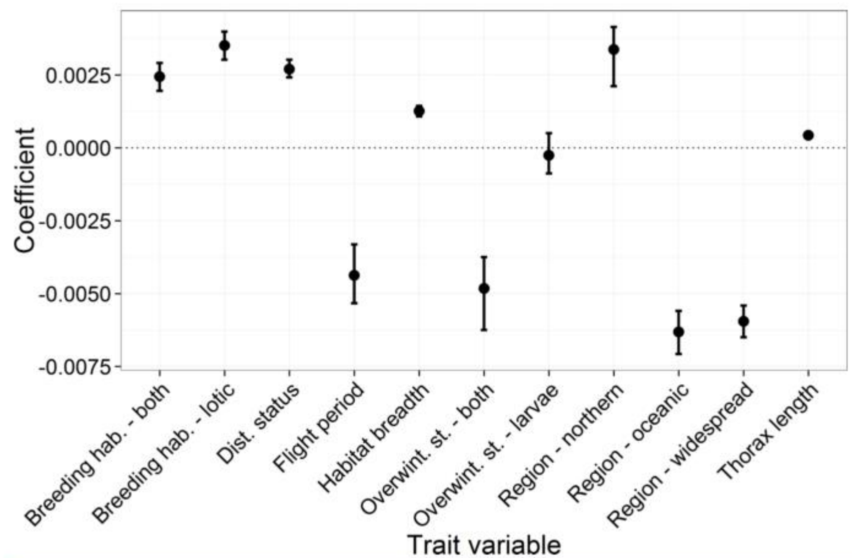
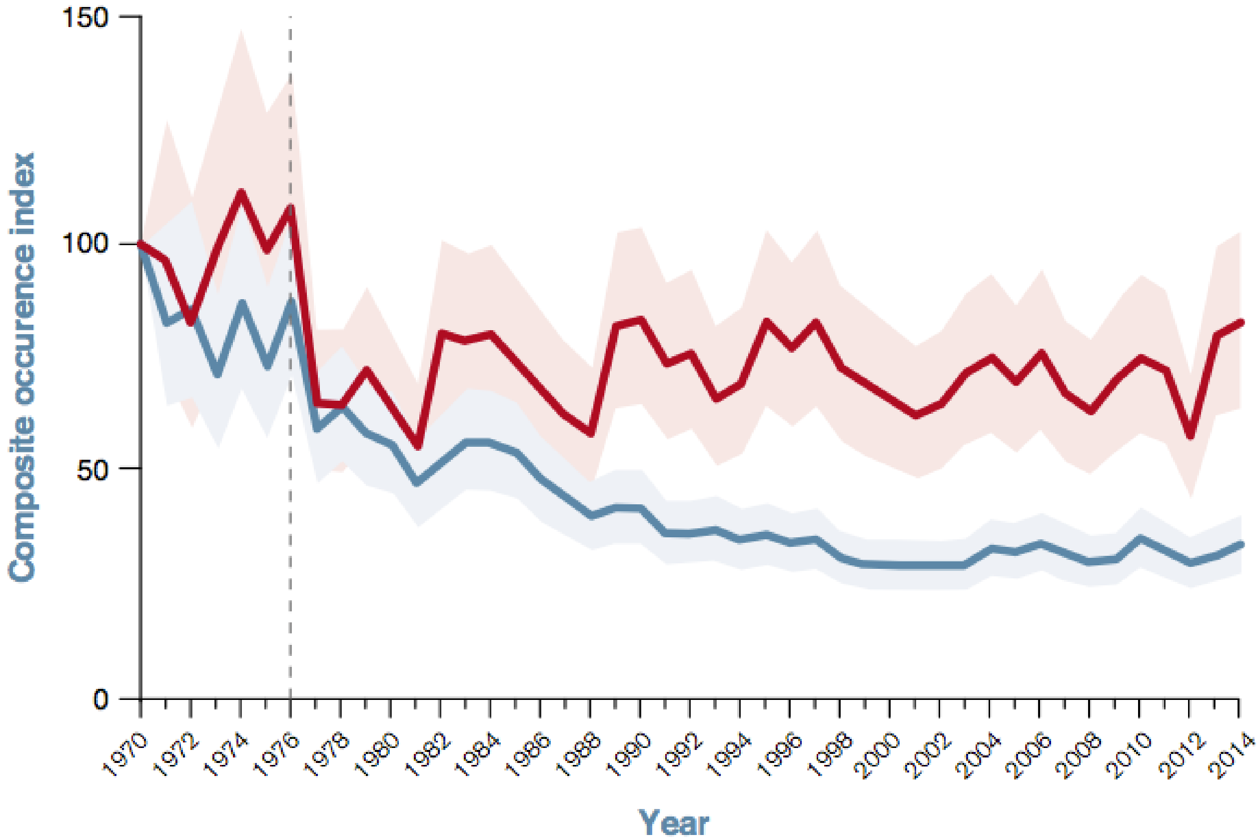
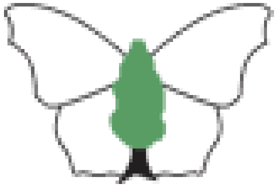


Figure 2 The mean and 95 percentiles of the trait coefficients across 10,000 model iterations. Each categorical variable had a reference category which had a parameter estimate set to 0. The reference categories were as follows: region, "southern"; breeding habitat, "lentic"; and for overwintering stage, "eggs."

Powney, Cham, Smallshire & Isaac (2015). PeerJ, 3: e1410

Butterfly indicator from Occupancy models





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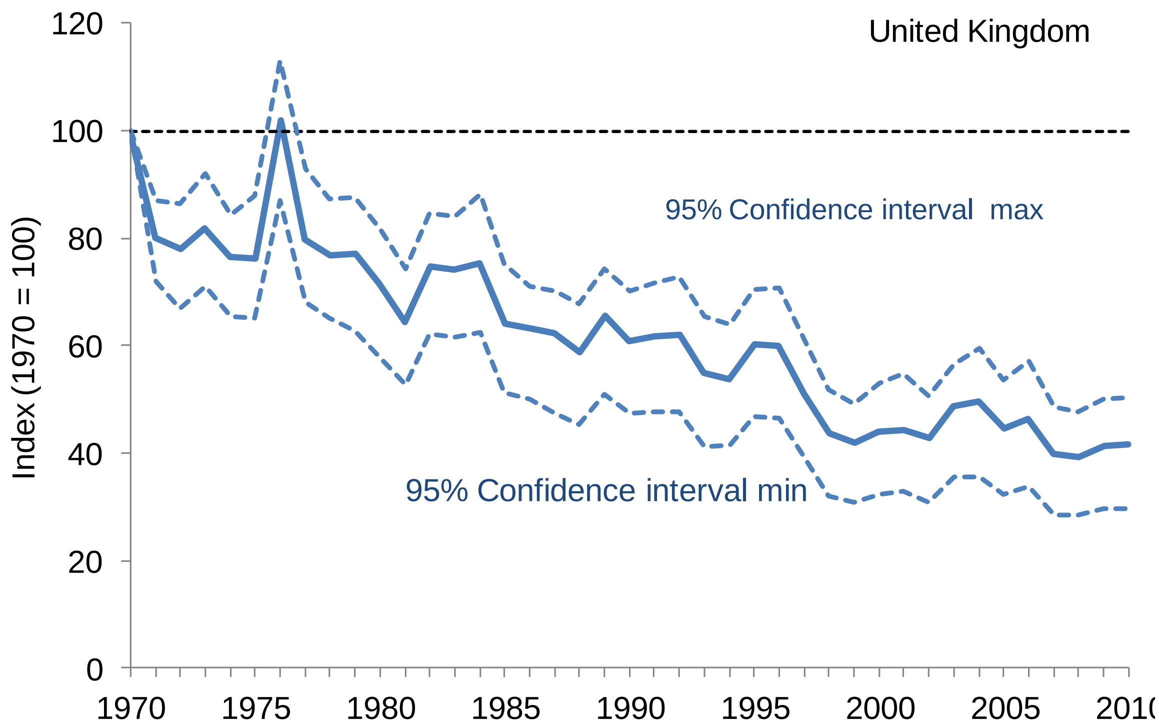
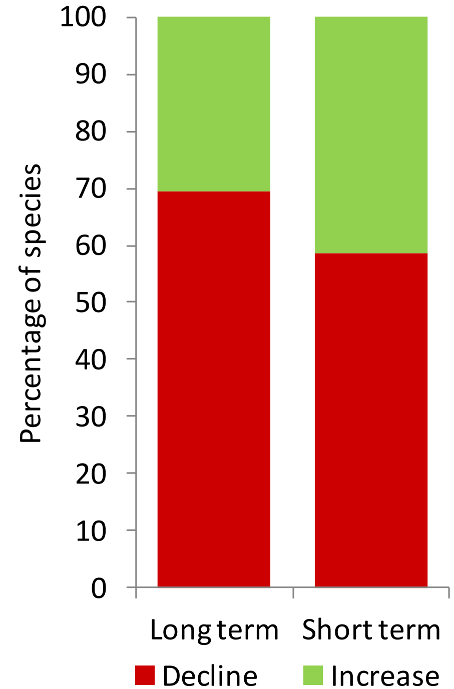
Source: State of Butterflies 2015

Priority Species Indicator [Abundance]

- "Priority Species" defined by 4 National Governments
- Birds, Bats, terrestrial mammals, Butterflies, Moths





Eaton, Burns, Isaac et al (2015) Biodiversity 16: 108-119

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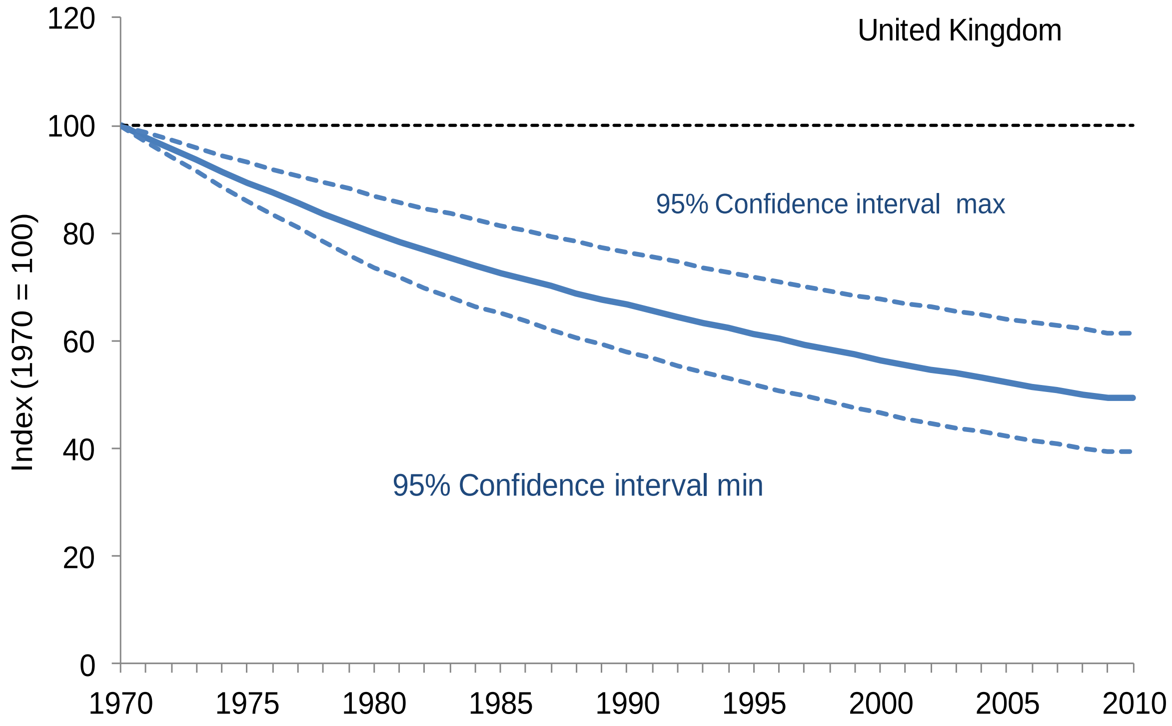
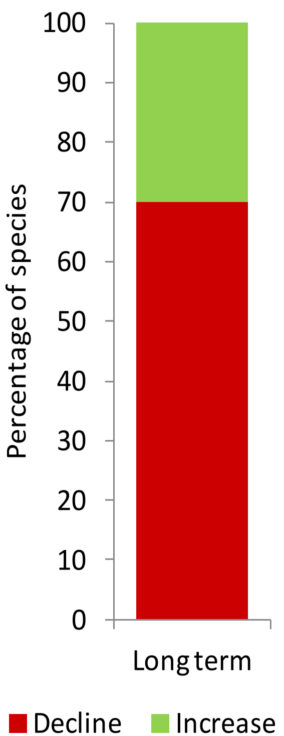
Priority Species Indicator [Distribution]

- Fitted values from linear trend models
- 110 Moths, 62 Hymenoptera & 7 other insects





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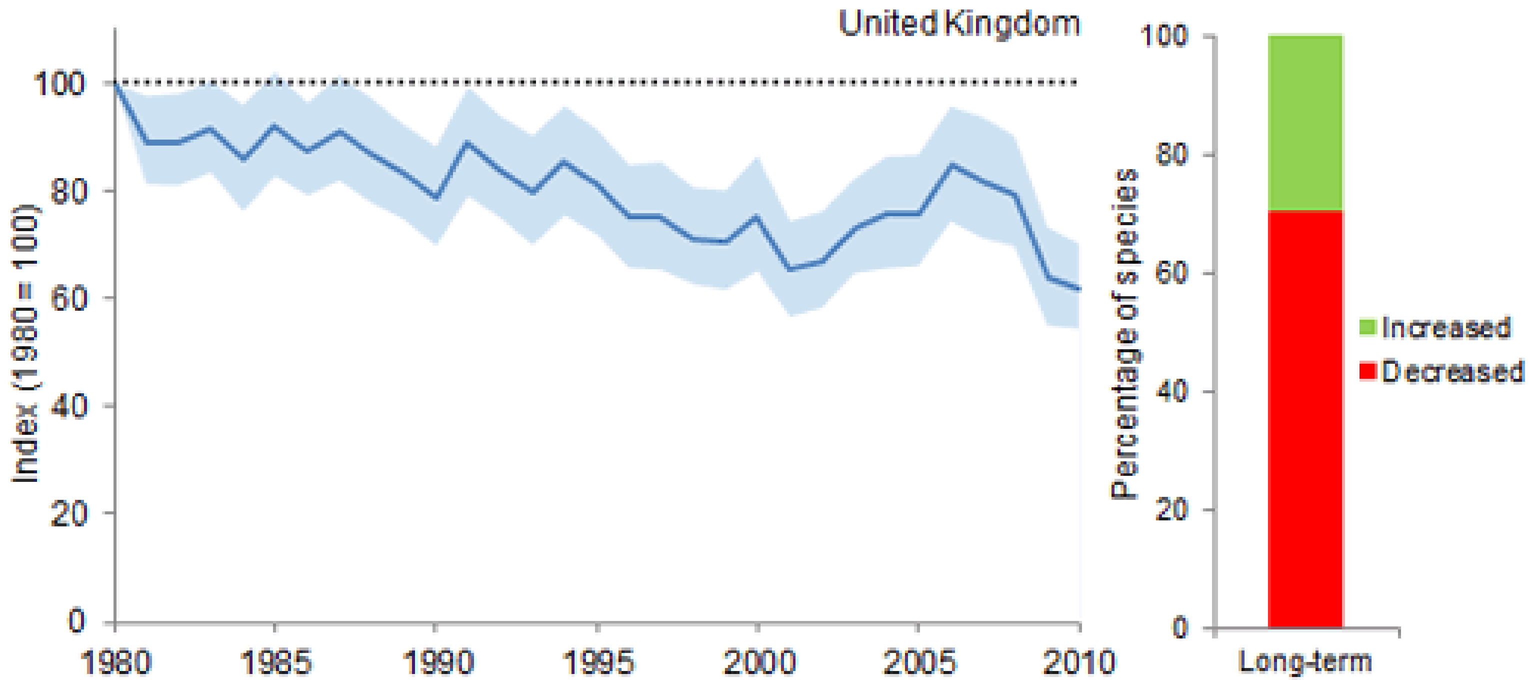
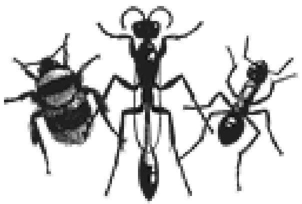
Eaton, Burns, Isaac et al (2015) Biodiversity 16: 108-119

D1c: Indicator of Pollinating Insects 2014

- from Occupancy models for 216 bee species





Indicators from Occupancy models 2015

- D1c: Pollinator Indicator 1980-2010
- C4b: Priority Species 1970-2012

Until 19 January!

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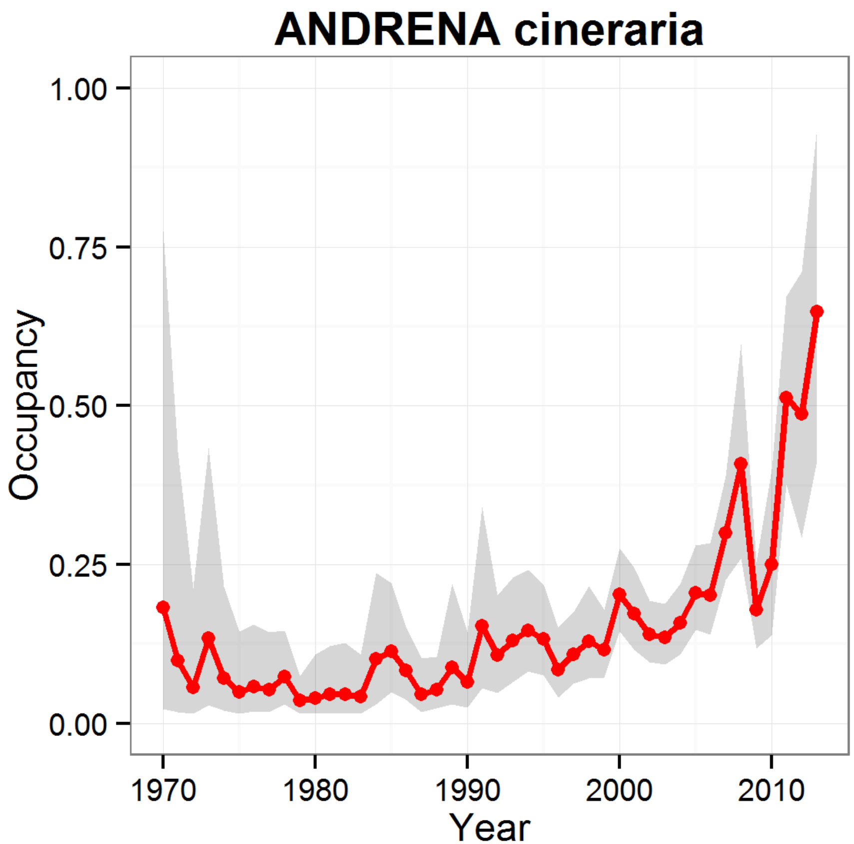
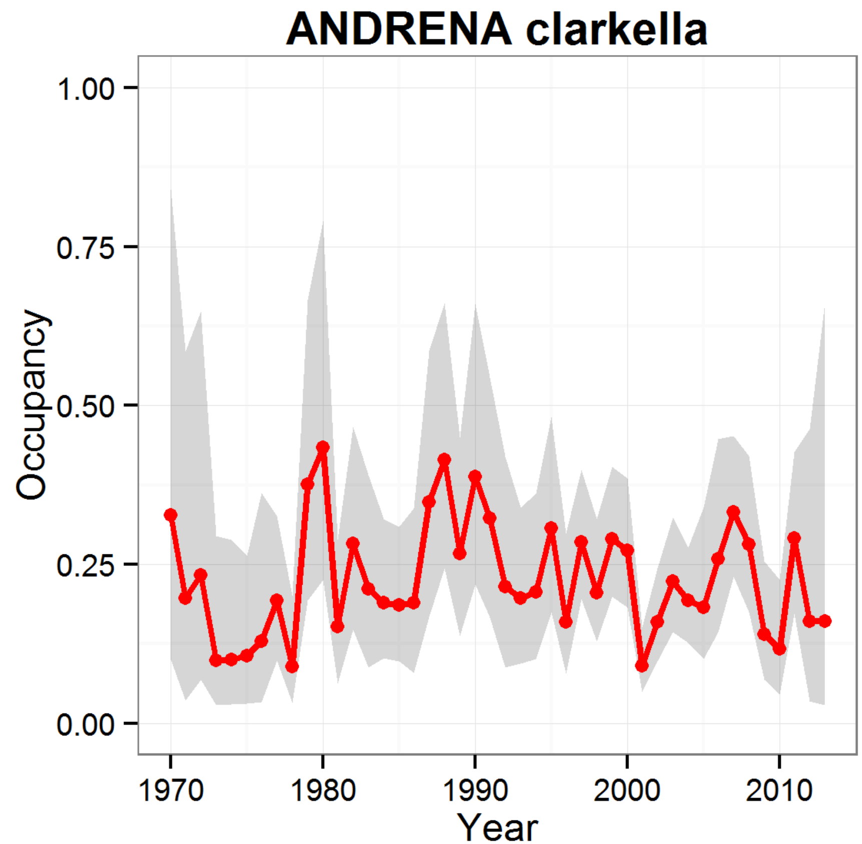
Occupancy models of British bees





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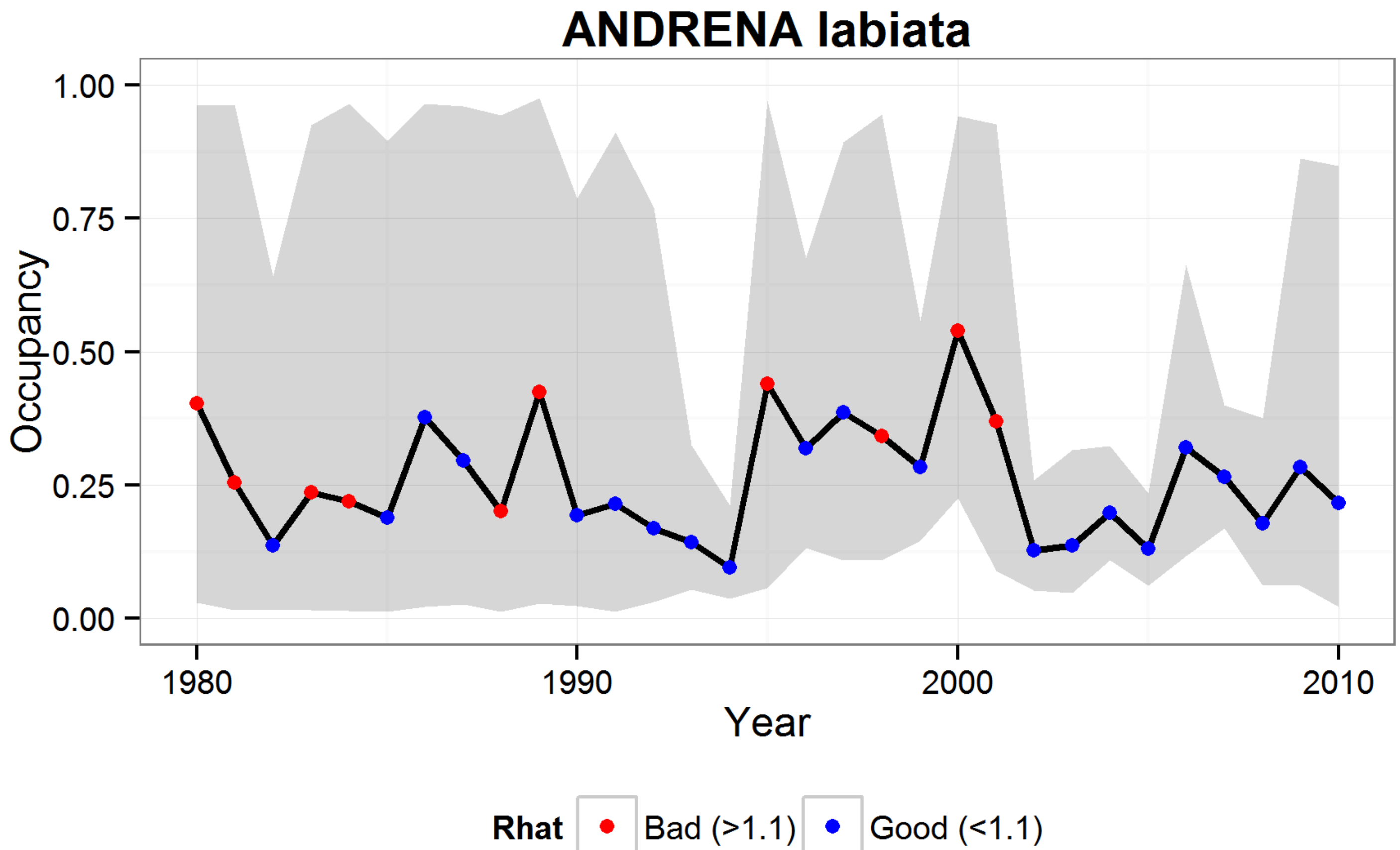
Occupancy models of British bees

- Proble: lots of species' models look like this!



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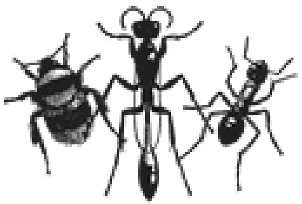
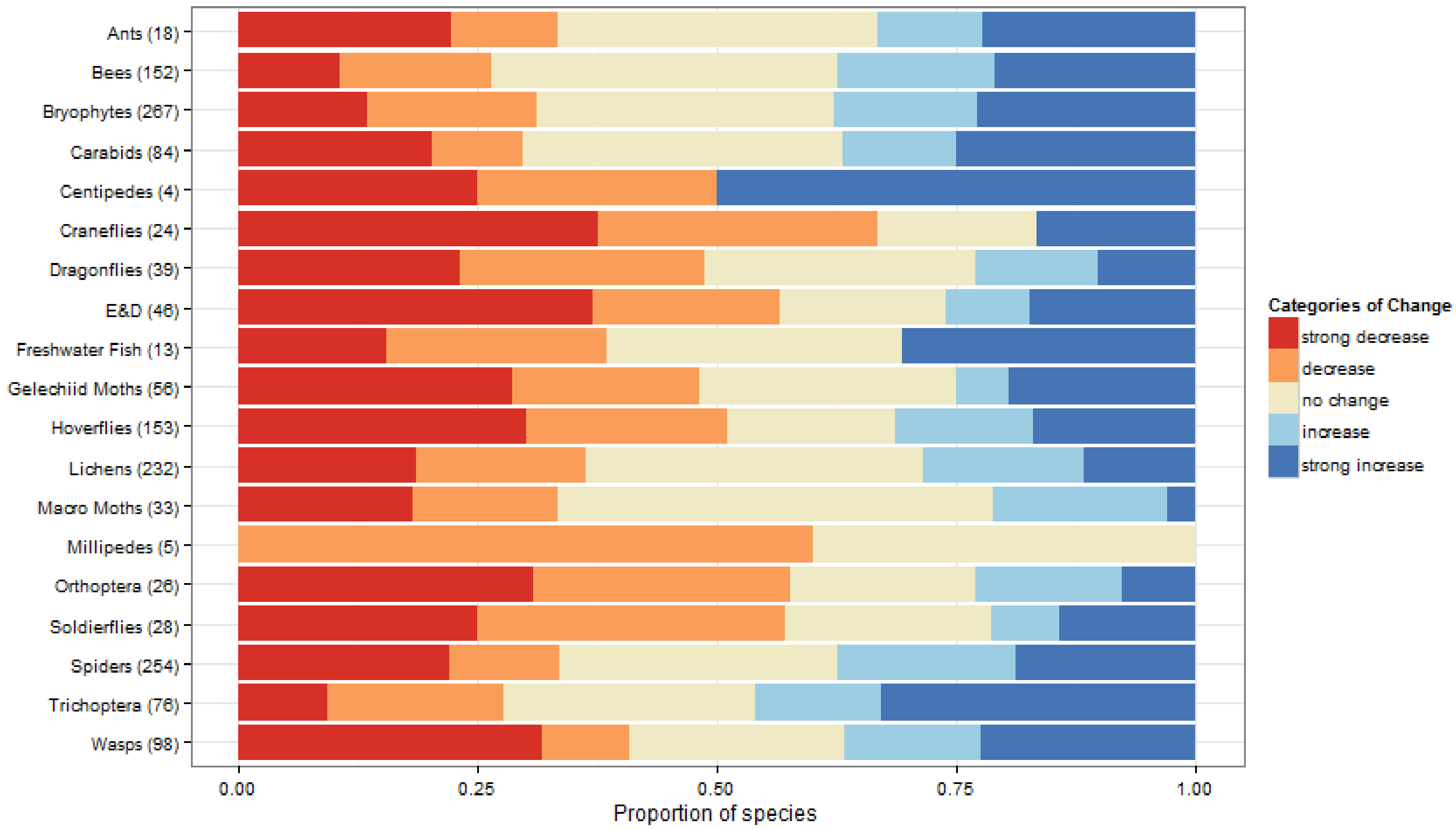


How far can we take this?

Taxonomic Group	Total number of species
Dragonflies	69
Hoverflies	287
Mosses	1,267
Bees	243
Spiders	658
Caddisflies	206
Gelechiid moths	152
Grasshoppers & allies	83
Wasps	275
Lichens	2,193
Ground beetles	355
Freshwater fish	75
Soldierflies	150
Empid & Dolichopodid flies	677
Ants	58
Craneflies	359
Centipedes	53
Millipedes	61
Non-marine molluscs	233
Total	7,493

Charlie Outhwaite, PhD project

Trends by taxon



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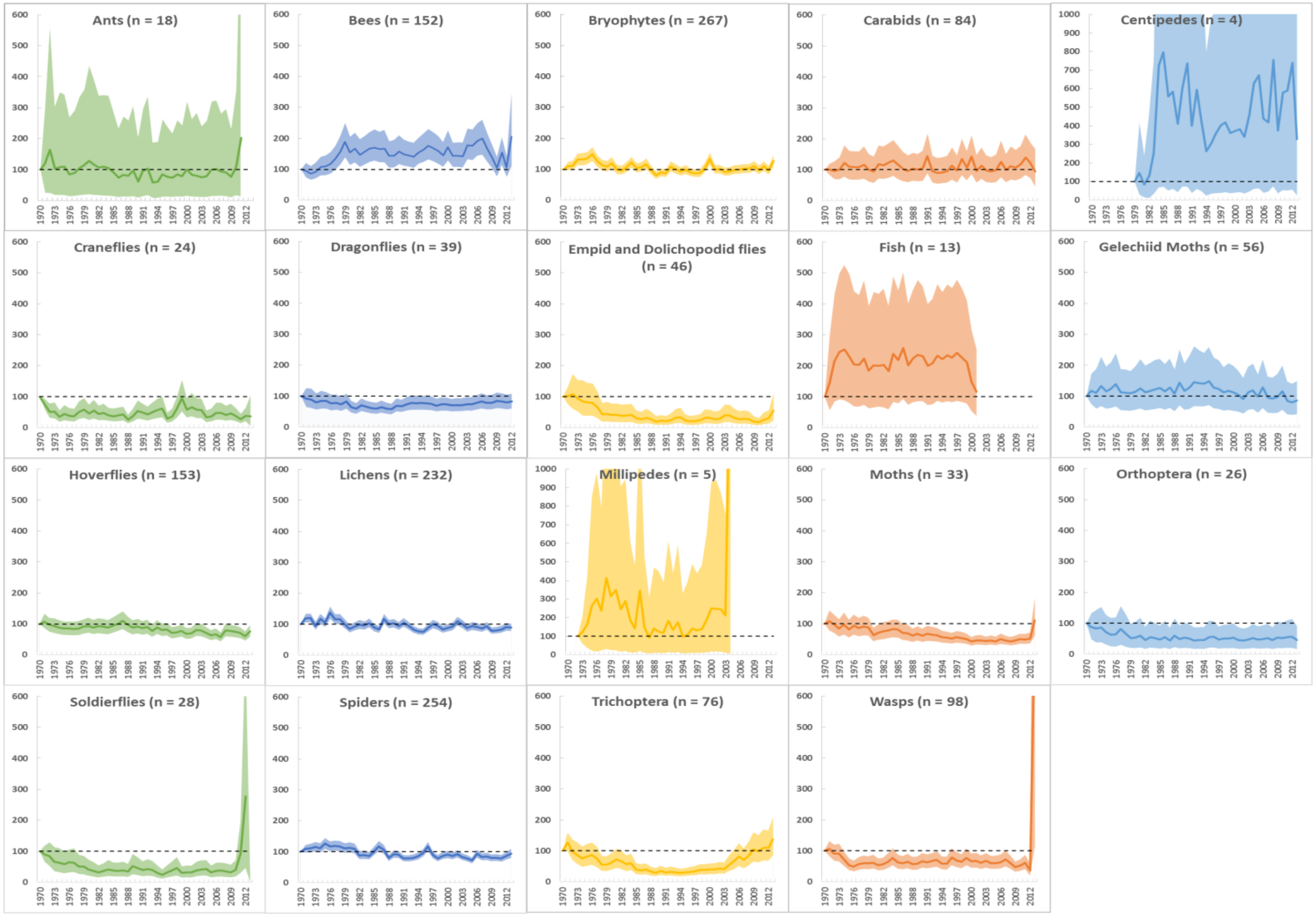
Indicator plots, by taxon



Charlie Outhwaite, PhD project

How far can we take this?

Taxonomic Group	Total number of species	Species producing reliable results	Percentage of species lost	Total number of visits
Dragonflies	69	39	43%	246486
Hoverflies	287	153	47%	131629
Mosses	1,267	267	79%	81345
Bees	243	152	37%	73545
Spiders	658	254	61%	70557
Caddisflies	206	76	63%	62052
Gelechiid moths	152	56	63%	52845
Grasshoppers & allies	83	26	69%	43721
Wasps	275	98	64%	36162
Lichens	2,193	228	90%	32132
Ground beetles	355	84	76%	31786
Freshwater fish	75	13	83%	28193
Soldierflies	150	28	81%	23028
Empid & Dolichopodid flies	677	46	93%	20134
Ants	58	18	69%	18649
Craneflies	359	24	93%	17551
Centipedes	53	4	92%	12291
Millipedes	61	5	92%	10196
Non-marine molluscs	233	0	100%	4237
Total	7,493	1,604	79%	

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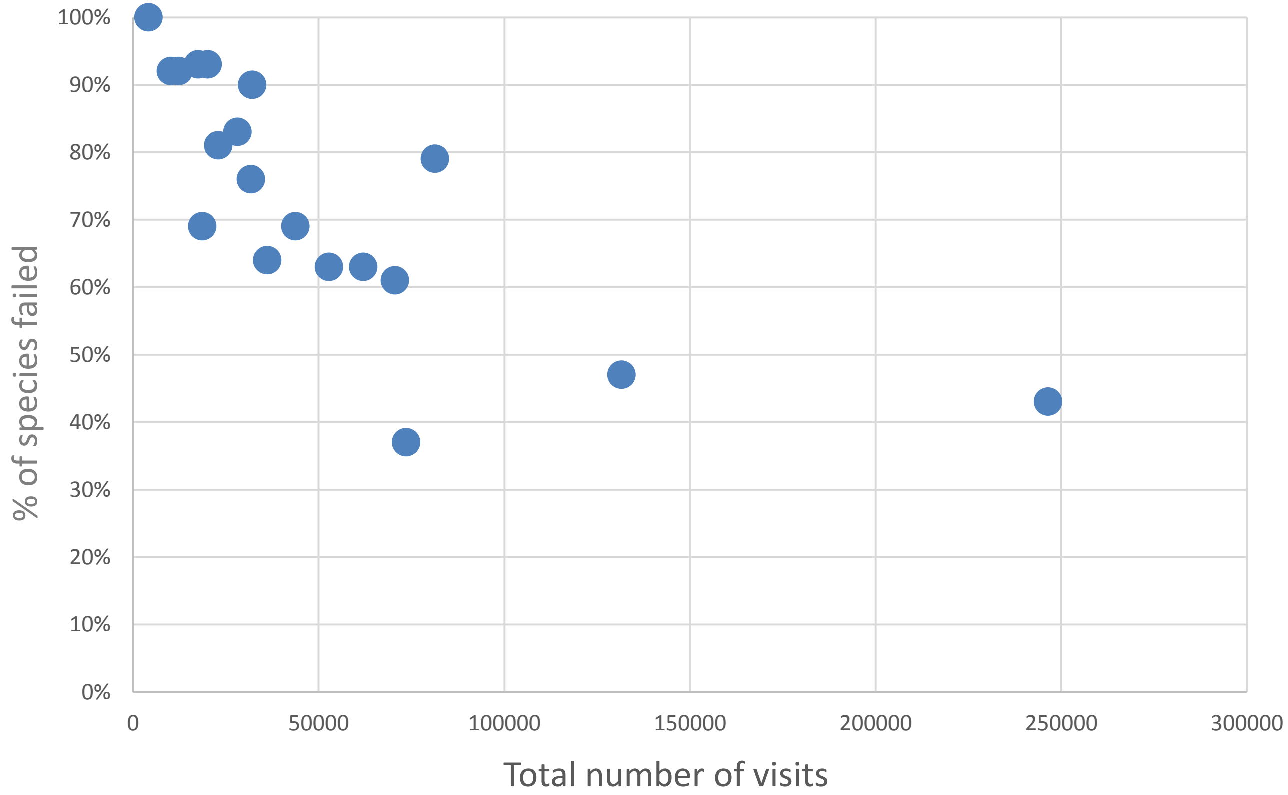
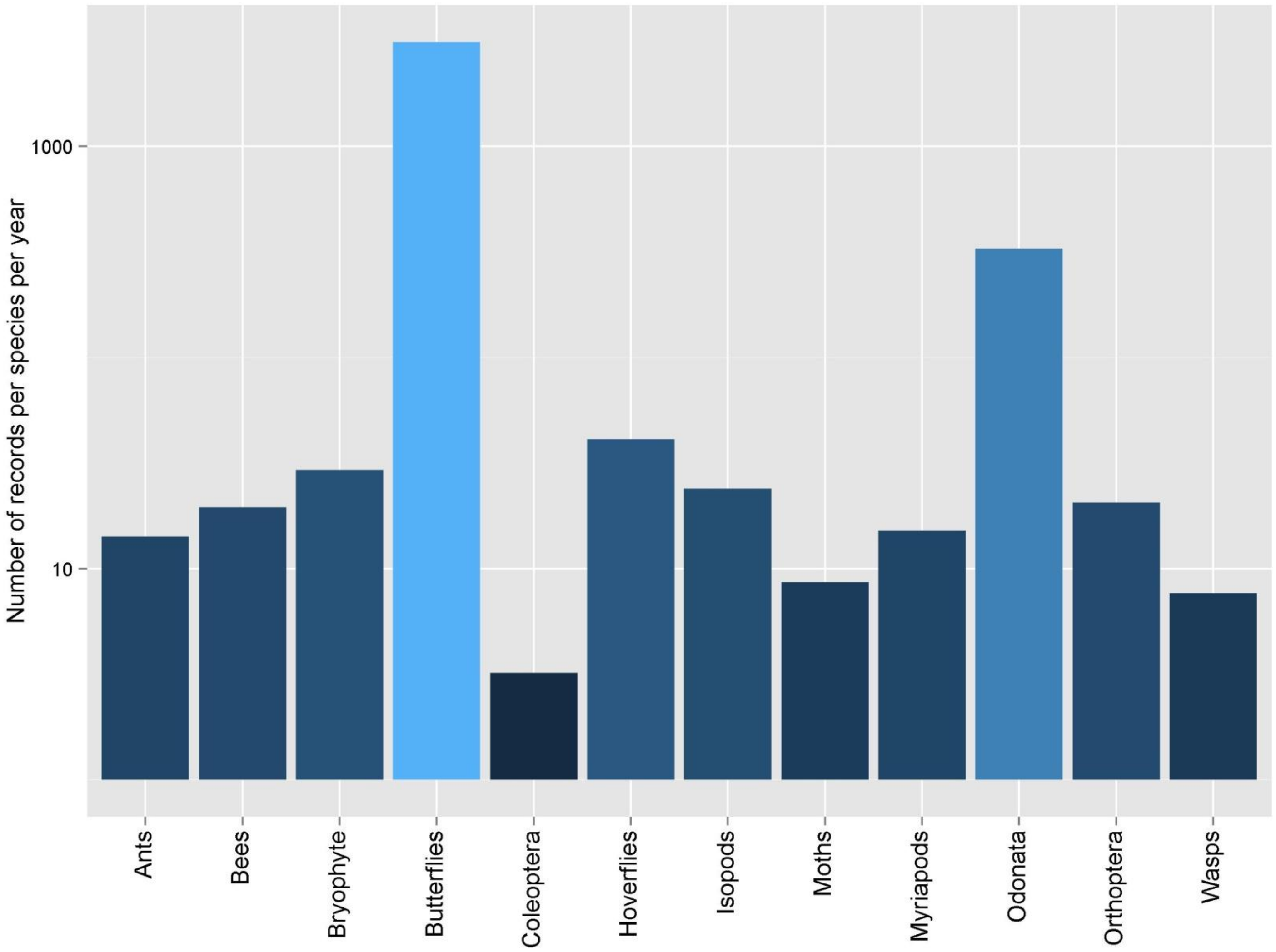
Data rich groups



Recording intensity by taxonomic group



Summary

- Occupancy models make it possible to model change from biological records
- Works really well for butterflies, dragonflies, bees
- Not so good for other groups, or rare species
- We have some ideas!

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Acknowledgements

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Stephen Freeman

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BDS
British Dragonfly Society
British Myriapod and Isopod Group
Botanical Society of the British Isles
Dipterists Forum

UK Ladybird Survey
Department for Environment Food & Rural Affairs
CEH Centre for Ecology & Hydrology
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