

More & better fly trends

Nick Isaac
21/9/19



Themes

- We already do a lot with scheme data
- We'd like to work with a wider range of Diptera
- Both models and data can be improved
- What can BRC do to help schemes?



Talk outline

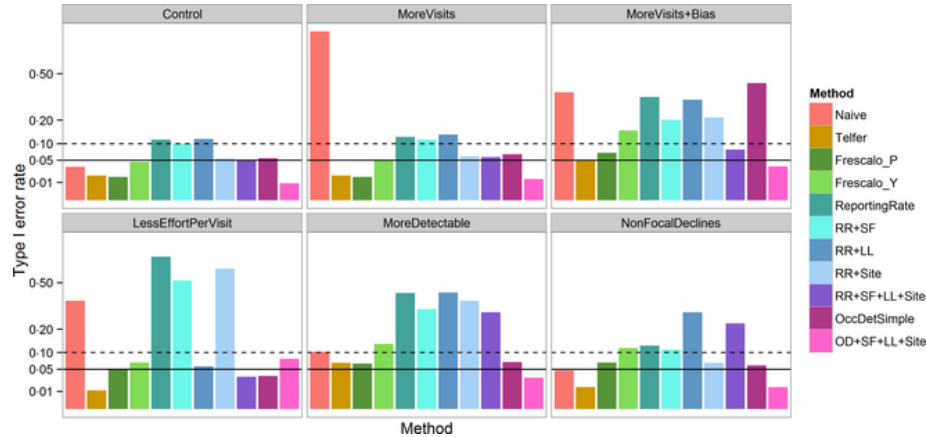
- Understanding bias; developing methods
- Multispecies trends and indicators
- Regional trends & data availability
- Updating the models; improving the models
- Tools for enhanced scheme engagement

Ad hoc recording is biased

- in time
- in space
- detectability
- effort per visit
-



Occupancy models from presence-only data



Methods in Ecology and Evolution



Methods in Ecology and Evolution 2014

doi: 10.1111/2041-210X.12254

Statistics for citizen science: extracting signals of change from noisy ecological data

Nick J. B. Isaac^{1*}, Arco J. van Strien², Tom A. August¹, Marnix P. de Zeeuw² and David B. Roy¹



Journal of Applied Ecology



Journal of Applied Ecology 2013, 50, 1450–1458

doi: 10.1111/1365-2664.12158

Opportunistic citizen science data of animal species produce reliable estimates of distribution trends if analysed with occupancy models

Arco J. van Strien^{1,2*}, Chris A.M. van Swaay³ and Tim Termaat³

- Reverse-engineer the data generation process
- Assume that species are recorded as an assemblage

Occupancy models from presence-only data

Raw observations

Site	Date	Species
A	1/6/2014	Sp2
A	1/6/2014	Sp4
A	24/5/2015	Sp3
A	24/5/2015	Sp4
A	16/6/2015	Sp4
B	12/6/2014	Sp1
B	12/6/2014	Sp3
B	12/6/2014	Sp4
B	1/7/2015	Sp3



Derived dataset

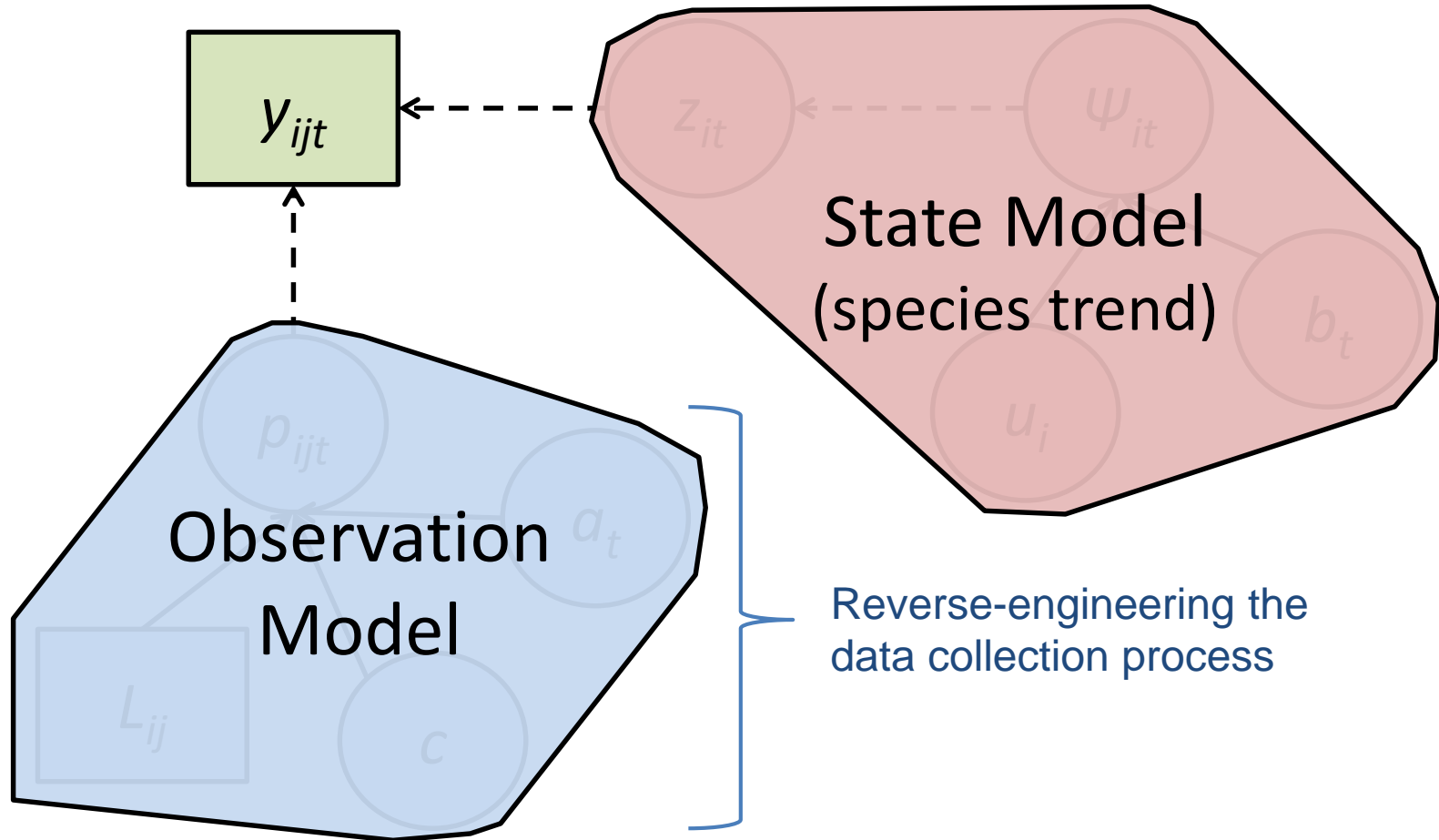
Site	Year	Date	Sp1	Sp2	Sp3	Sp4	L
A	2014	1/6	0	1	0	1	2
A	2015	24/5	0	0	1	1	2
A	2015	16/6	0	0	0	1	1
B	2014	12/6	1	0	1	1	3
B	2015	1/7	0	0	1	0	1

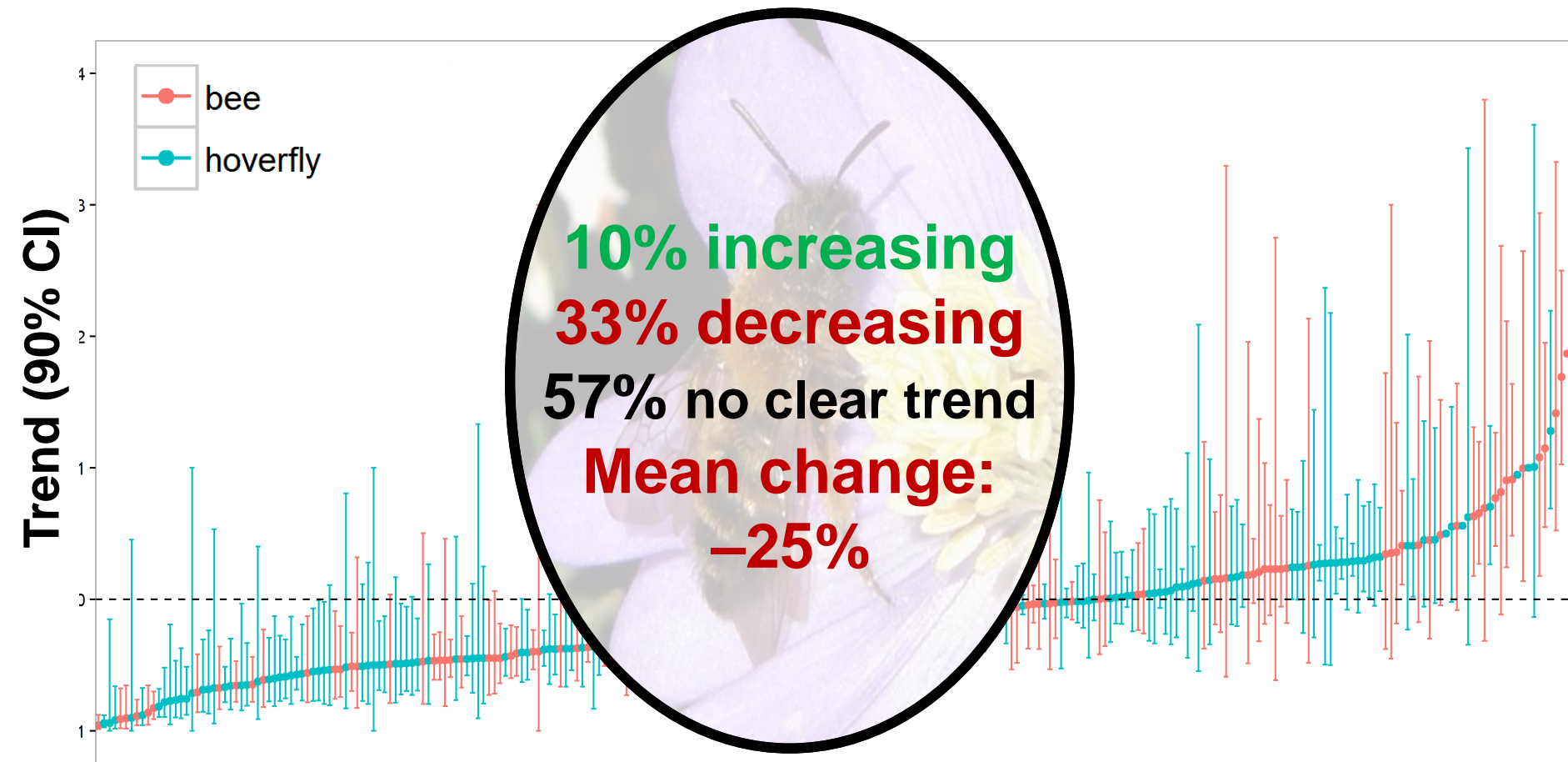
Zero = “failure to detect”

L = List Length \approx Survey Effort

Repeat surveys provide information about detectability

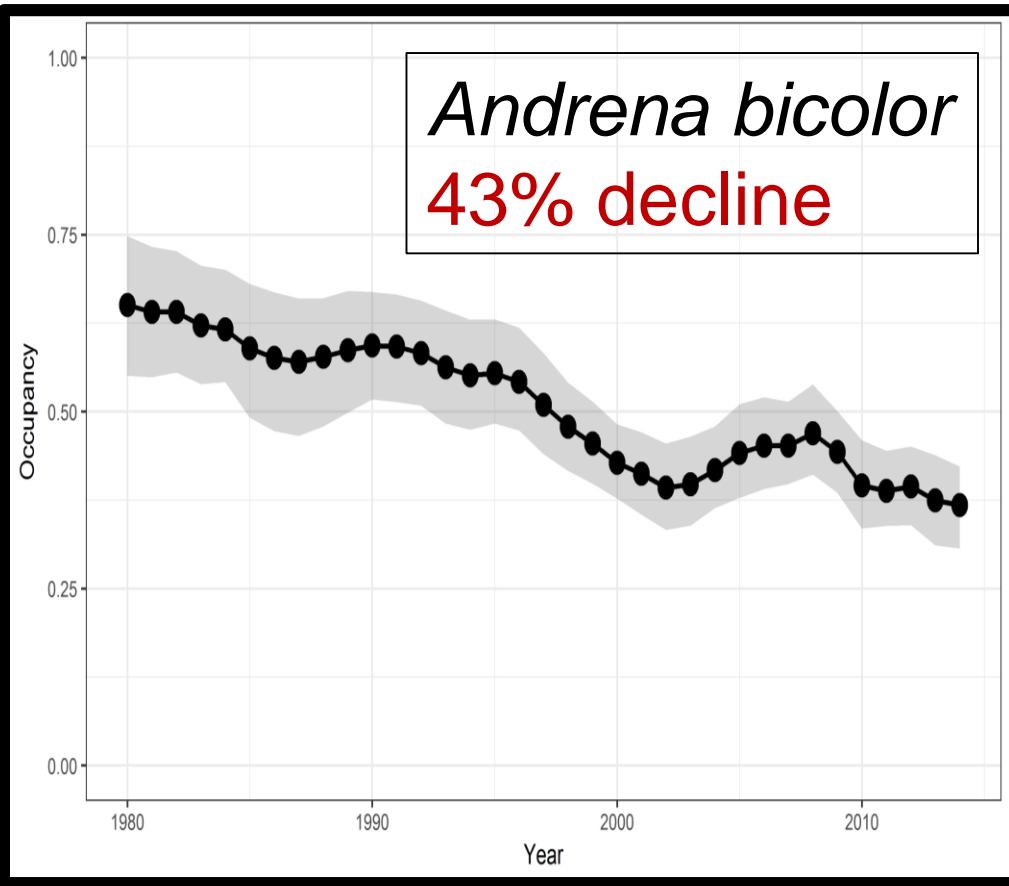
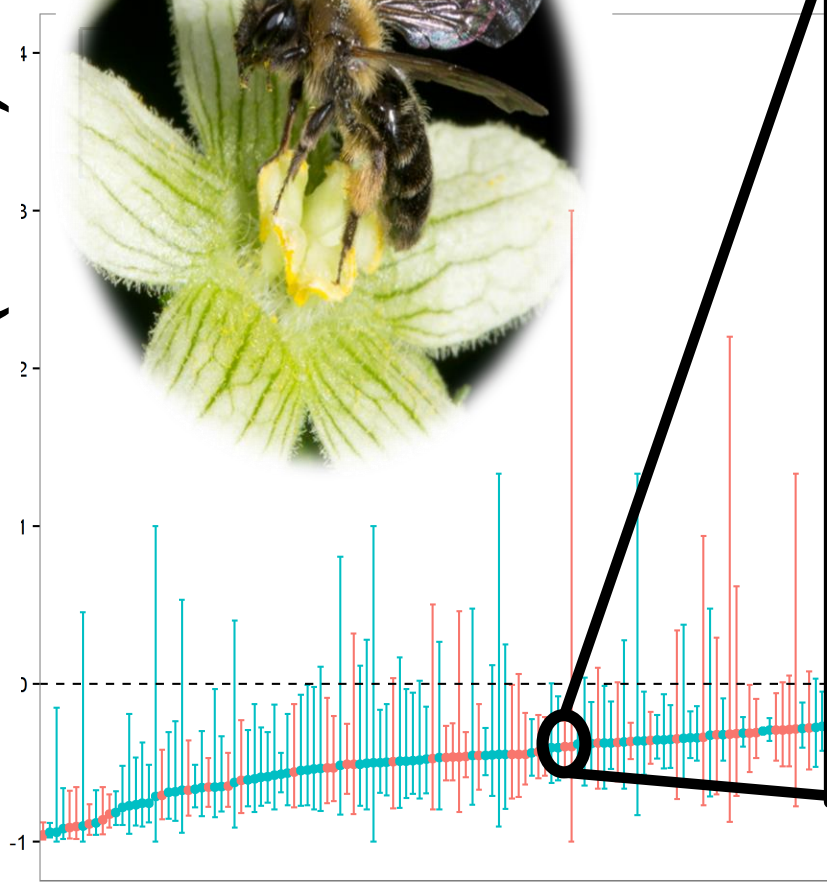
Occupancy models for occurrence records







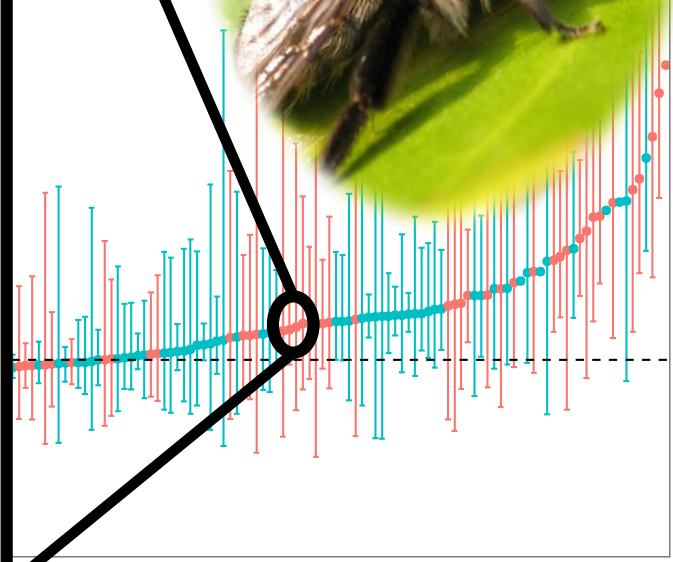
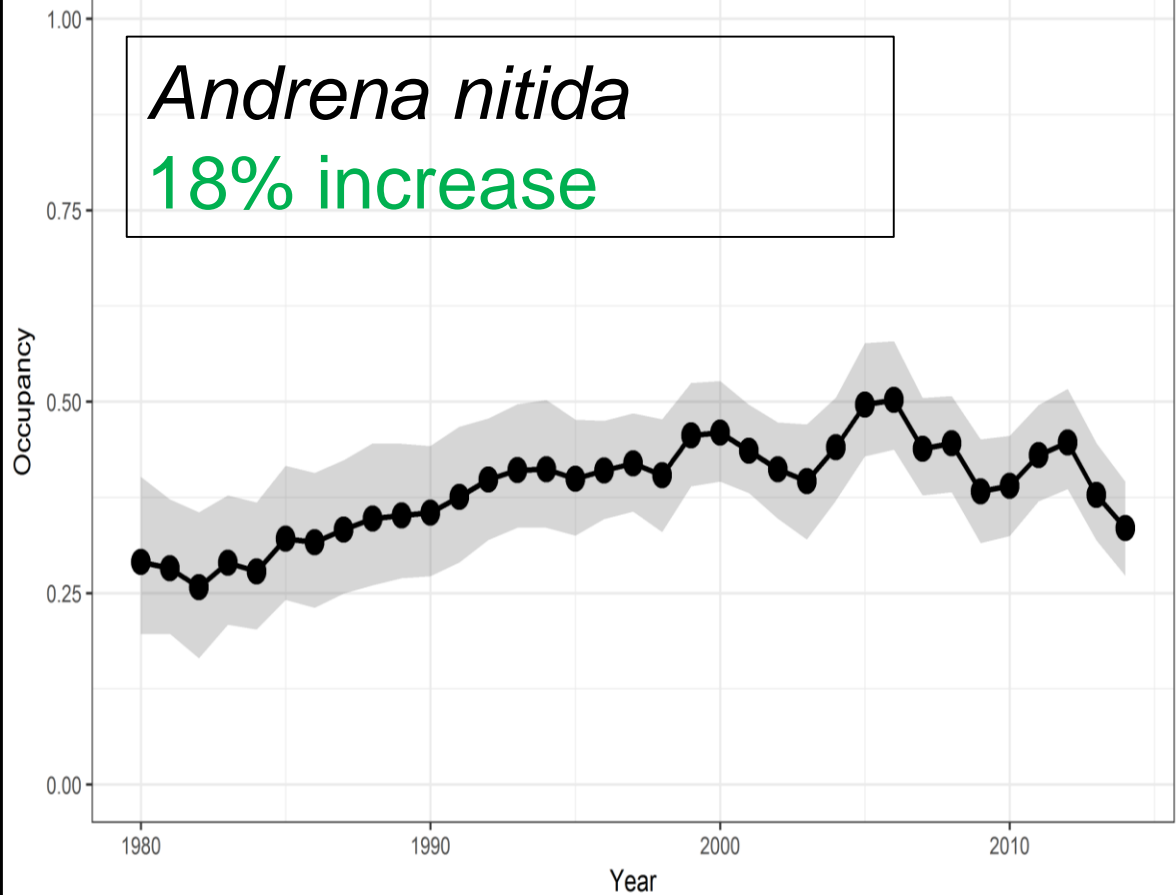
Trend (90% CI)



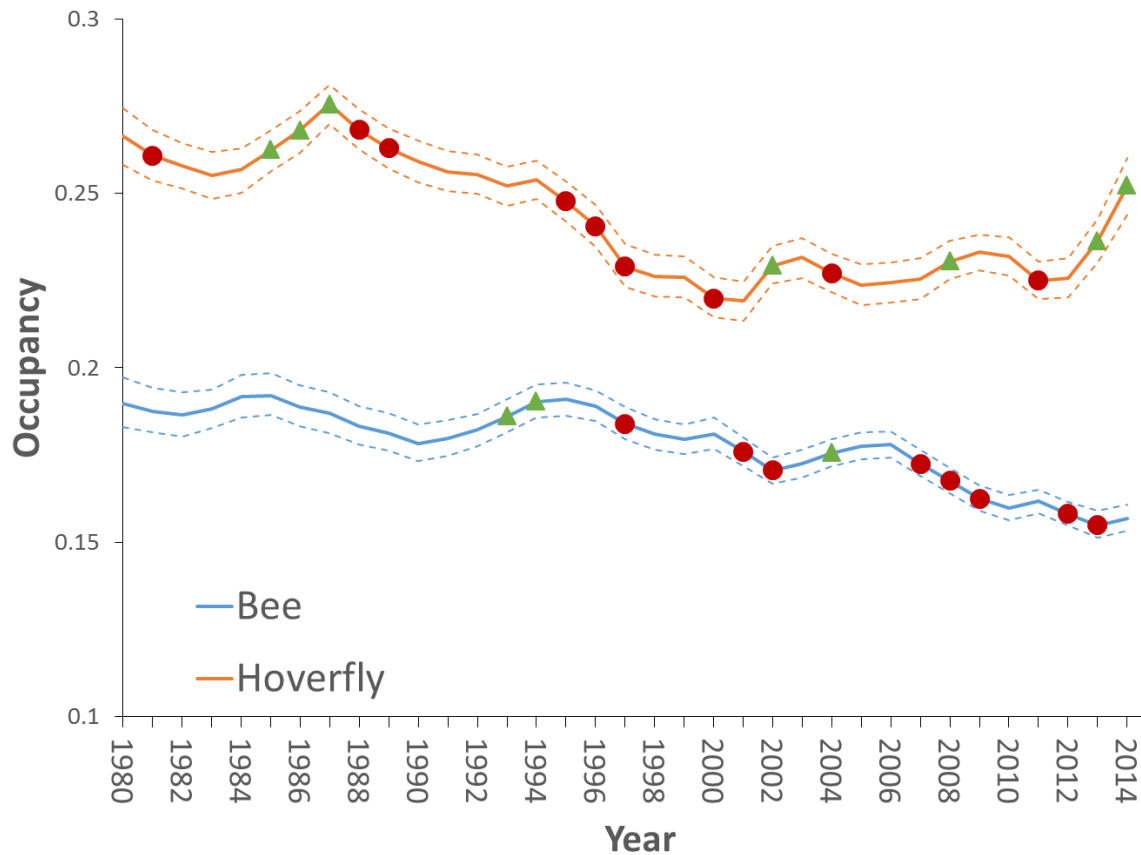
Andrena bicolor
43% decline

Andrena nitida

18% increase

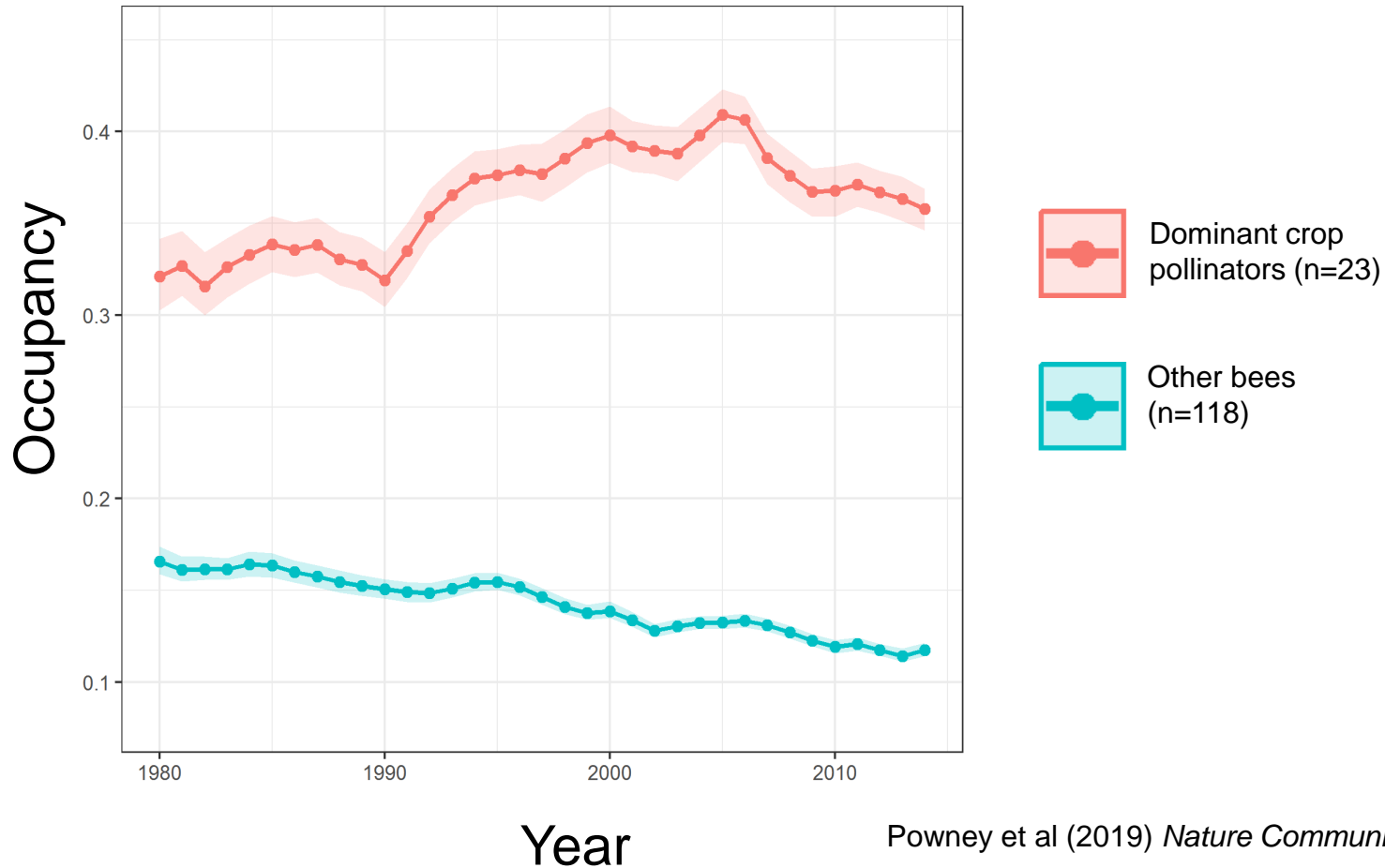


Temporal patterns in occupancy

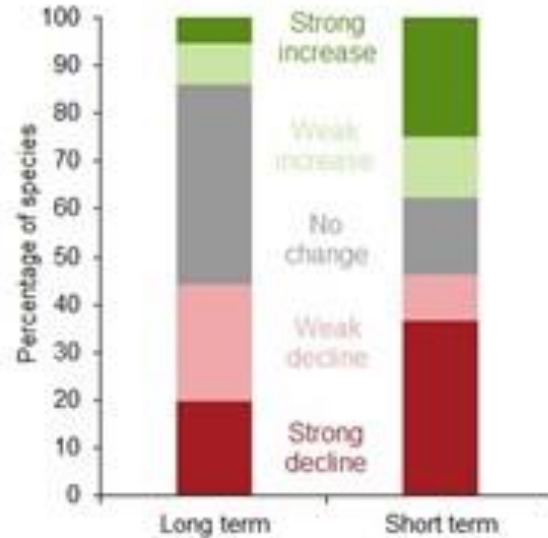
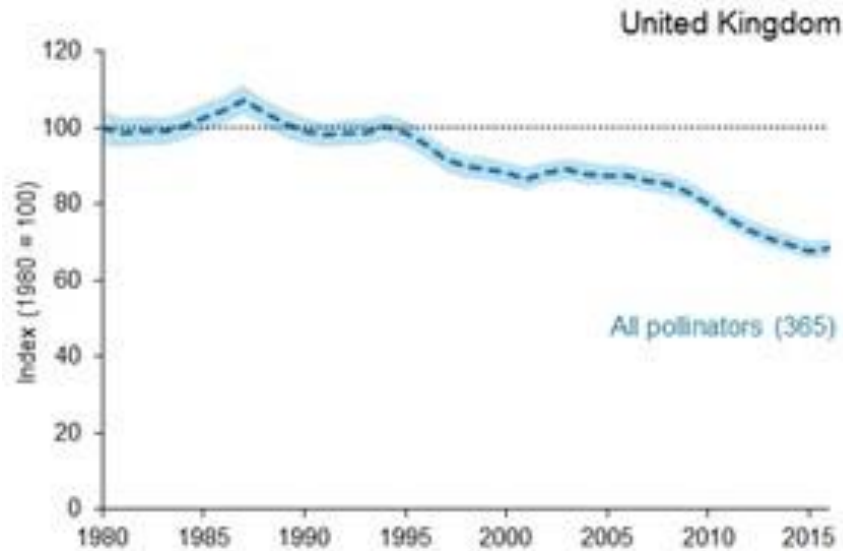


- Hoverflies declines focussed between 1987- 2000
- Bee decline driven by 5 bad years since 2006.

Good news for farmers?



Indicator of pollinating insects (2019)



Based on occupancy models & biological records for 365 species of bees & hoverfly species

Net change: -33%

State of Nature 2016

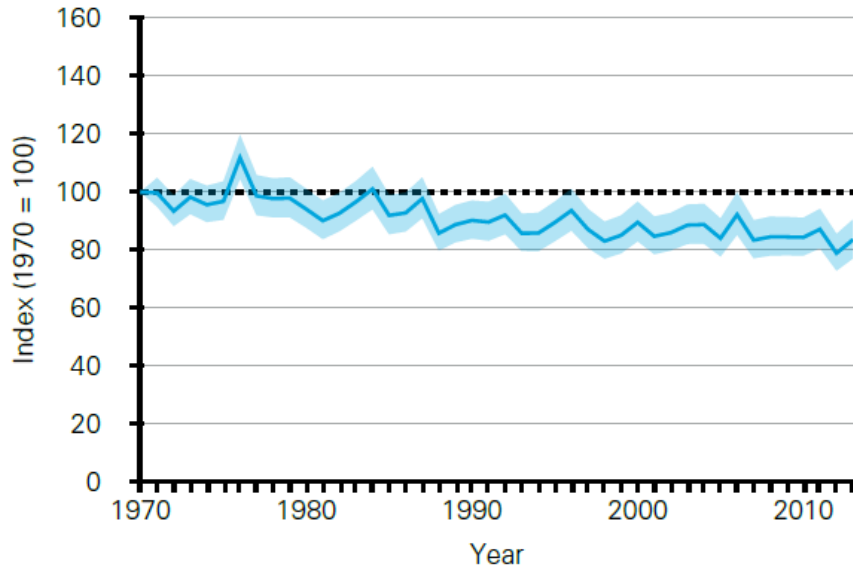


Figure 2

An index of species' status based on abundance or occupancy data for 2,501 terrestrial and freshwater species. The shaded area shows the 95% confidence intervals.



1601 species from biological recording: 2/3 of the total!

New indicators

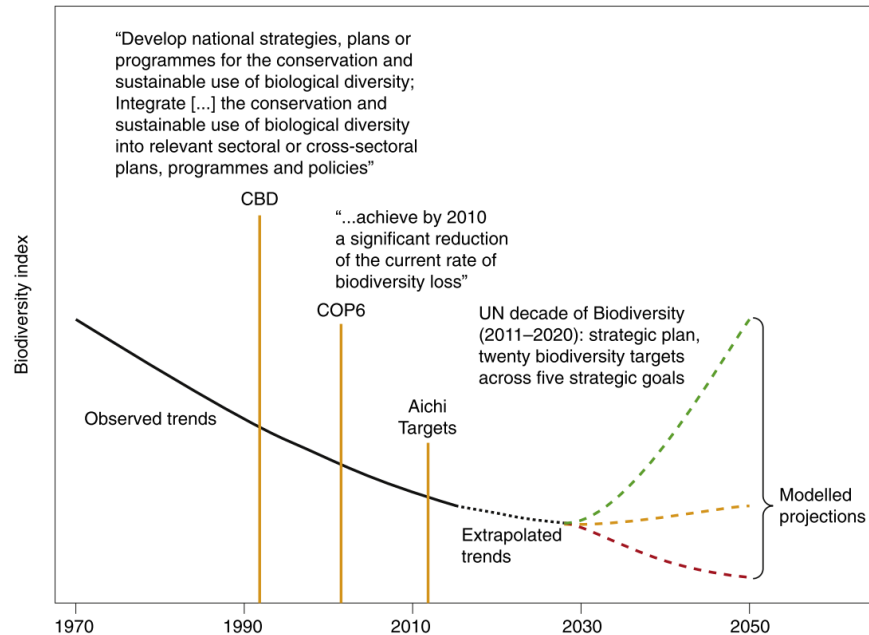


Fig. 1 | Biodiversity declines have continued despite repeated policy commitments aimed at slowing or halting the rate of loss. The Strategic Plan for the Convention on Biological Diversity (2010–2020) includes the 20 Aichi Targets to be achieved by 2020. Recent projections suggest that this is unlikely for most of the targets¹. Yet the 2050 vision requires a much more ambitious goal, which will necessitate recovery of biodiversity and bending the curve by 2030. The black line indicates currently observed trends (to 2015), dotted lines show extrapolations from current trends (black) and projections for biodiversity after 2030 that are declining (red), stabilising (orange) or recovering (green).

Published trends for 5,293 species



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Isaac, Nick

Outhwaite, C.L. *et al*

Annual estimates of occupancy for bryophytes, lichens and invertebrates in the UK (1970-2015)

<https://doi.org/10.5285/0ec7e549-57d4-4e2d-b2d3-2199e1578d84> [Cite this dataset](#)

This dataset provides annual estimates of species occupancy and species trend estimates in the form of growth rates for 5,293 UK invertebrate, bryophyte and lichen species for the period 1970 to 2015. Estimates are provided at the country level for England, Scotland, Wales and Northern Ireland as well as for the UK and Great Britain (GB) where possible. These data were generated using observations of species collated by UK recording schemes and societies as the input data for a Bayesian occupancy model. The outputs resulting from this modelling framework are presented in three forms:

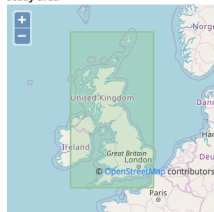
- 1000 samples from the modelled posterior distribution of the proportion of occupied sites for each species for each year and for each region analysed.
- Summary tables from the model outputs detailing mean occupancy and associated statistics including credible intervals and rhat measure of convergence.
- Derived species trend estimates in the form of annual percentage growth rates.

Annual estimates derived from fine-grained data (1x1km squares) have not been determined for this set of species before, making this a unique dataset that broadens knowledge on UK biodiversity change.

Publication date: 2019-03-01

Where/When

Study area



Temporal extent

1970-01-01 to 2015-12-31

Supplemental information

Other useful information regarding this dataset:

[iRecord](#)

Outhwaite, C. L., Chandler, R. E., Powney, G. D., Collen, B., Gregory, R. D., & Isaac, N. J. B. (2018). Prior specification in Bayesian occupancy modelling improves analysis of species occurrence data. *Ecological Indicators*, 93, 333–343.
<https://doi.org/10.1016/j.ecolind.2018.05.010>

Get the data

This dataset is available under the terms of the [Open Government Licence](#) **OGL**

- [Download the data](#)
- [Supporting documentation](#)

Format of the dataset : Comma-separated values (CSV)

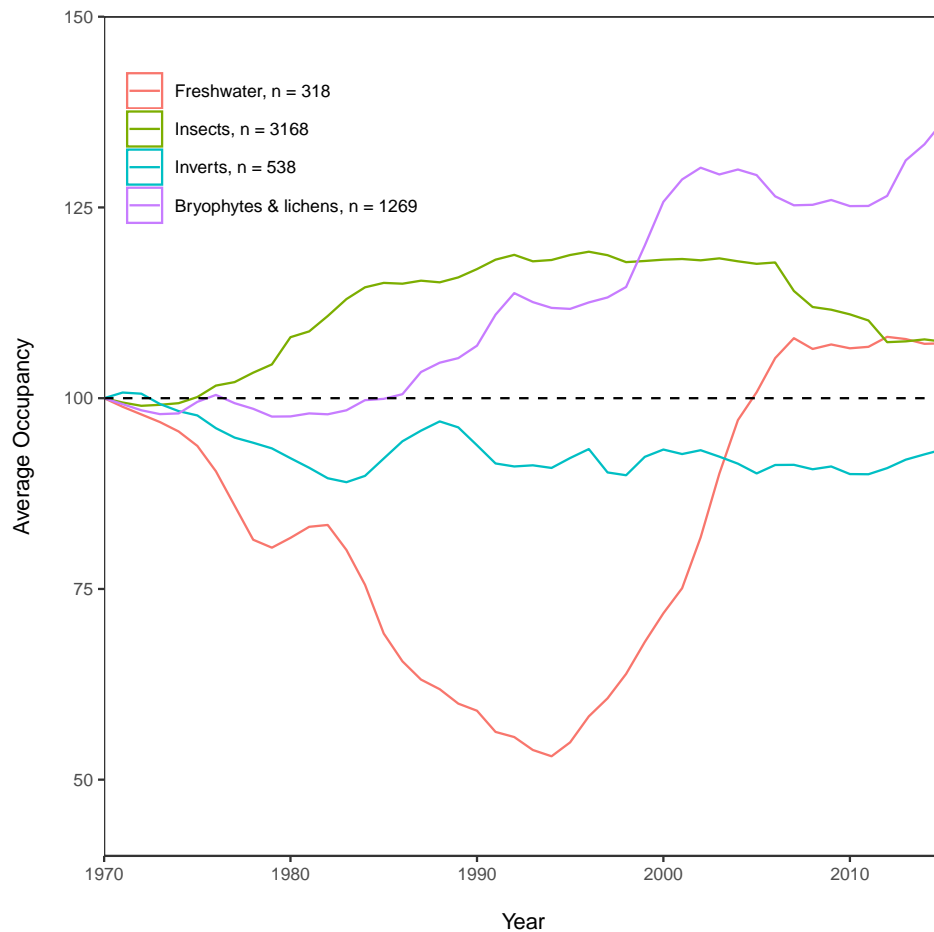
You must cite: Outhwaite, C.L.; Powney, G.D.; August, T.A.; Chandler, R.E.; Rorke, S.; Pescott, O.; Harvey, M.; Roy, H.E.; Fox, R.; Walker, K.; Roy, D.B.; Alexander, K.; Ball, S.; Bartock, T.; Barber, T.; Beckmann, B.C.; Cook, T.; Flanagan, J.; Fowles, A.; Hammond, P.; Harvey, P.; Hesper, D.; Hubble, D.; Kramer, J.; Lee, P.; MacAdam, C.; Morris, R.; Norris, A.; Palmer, S.; Plant, C.; Simkin, J.; Stubbs, A.; Sutton, P.; Telfer, M.; Wallace, I.; Isaac, N.J.B. (2019). Annual estimates of occupancy for bryophytes, lichens and invertebrates in the UK (1970-2015). NERC Environmental Information Data Centre. <https://doi.org/10.5285/0ec7e549-57d4-4e2d-b2d3-2199e1578d84>

[BibTeX](#) | [RIS](#)

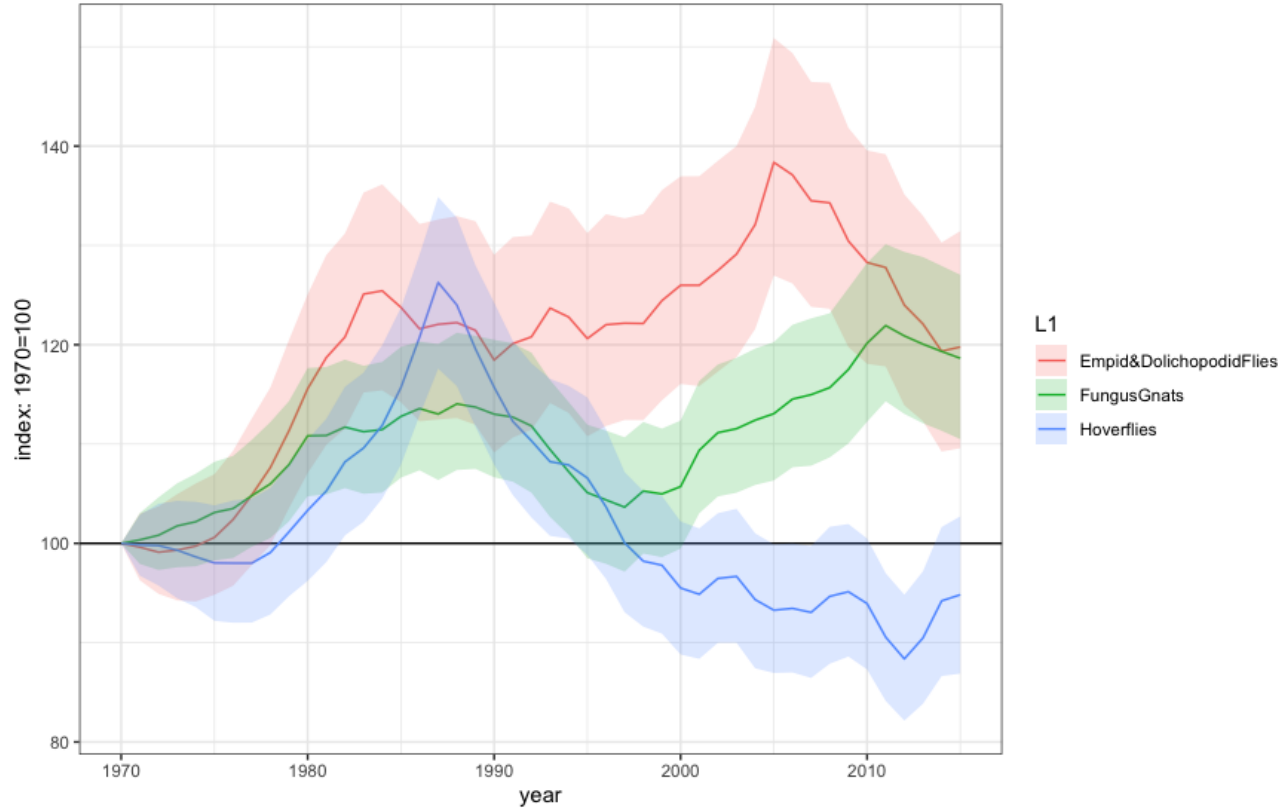
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Taxonomic Group	Recording Scheme	Additional data sources	Country coverage	Year range of input data	N species, input	Number of records	N species, outputs
Ants	Bees, Wasps and Ants Recording Society	Scheme data only	GB	1970 - 2015	60	34,790	29
Aquatic Bugs	Aquatic Heteroptera Recording Scheme *	Scheme, BRC and iRecord data	GB	1970 - 2015	92	61,264	51
Bees	Bees, Wasps and Ants Recording Society	Scheme data only	UK	1970 - 2015	242	255,354	202
Bryophytes	British Bryological Society *	Scheme and BRC data	UK	1970 - 2015	988	1,215,401	569
Caddisflies	Riverfly Recording Schemes: Trichoptera *	Scheme and BRC data	GB	1970 - 2014	186	164,102	123
Carabids	Ground Beetle Recording Scheme *	Scheme data only	UK	1970 - 2014	348	99,628	189
Centipedes	British Myriapod and Isopod Group, Centipede Recording Scheme	Scheme and BRC data	UK	1970 - 2015	51	23,315	22
Craneflies	Dipterists Forum, Crane-fly Recording Scheme *	Scheme and BRC data	GB	1970 - 2015	344	80,620	157
Dragonflies	British Dragonfly Society, Dragonfly Recording Network *	Scheme data only	GB	1970 - 2015	54	734,573	41
Empid & Dolichopodid Flies	Dipterists Forum, Empididae, Hybotidae & Dolichopodidae Recording Scheme	Scheme data only	GB	1970 - 2015	649	92,049	228
Fungus Gnats	Dipterists Forum, Fungus Gnat Recording Scheme	Scheme and BRC data	UK	1970 - 2011	521	57,416	157
Gelechiid Moths	Gelechiid Recording Scheme	Scheme and BRC data	UK	1970 - 2013	152	75,972	86
Hoverflies	Dipterists Forum, Hoverfly Recording Scheme	Scheme data only	GB	1970 - 2014	272	537,873	219
Lacewings	Lacewings and Allies Recording Scheme *	Scheme, BRC and iRecord data	UK	1970 - 2015	82	20,713	30
Ladybirds	UK Ladybird Survey *	Scheme and BRC data	UK	1970 - 2015	47	128,184	37
Leaf and Seed Beetles	Chrysomelidae Recording Scheme *	Scheme, BRC and iRecord data	UK	1970 - 2015	271	67,051	145
Lichens	British Lichen Society *	Scheme data only	GB	1970 - 2015	2,142	877,741	700
Macro moths	National Moth Recording Scheme *	Scheme data only	UK	1970 - 2015	840	18,191,077	714
Mayflies	Riverfly Recording Schemes: Ephemeroptera *	Scheme and iRecord data	UK	1970 - 2015	45	13,9930	35
Millipedes	British Myriapod and Isopod Group, Millipede Recording Scheme *	Scheme and BRC data	UK	1970 - 2012	59	29,118	28
Non-marine Molluscs	Conchological Society of Great Britain and Ireland *	Scheme and BRC data	UK	1970 - 2015	257	154,108	129
Orthoptera	Grasshoppers and Related Insects Recording Scheme *	Scheme and BRC data	UK	1970 - 2015	28	65,269	24
Plant Bugs	Terrestrial Heteroptera Recording Scheme - Plant bugs and allied species *	Scheme, BRC and iRecord data	UK	1970 - 2015	413	129,594	222
Rove Beetles	Staphylinidae Recording Scheme	Scheme and BRC data	UK	1980 - 2015	796	27,757	79
Shield Bugs	Terrestrial Heteroptera Recording Scheme - Shield bugs and allied species *	Scheme, BRC and iRecord data	UK	1970 - 2015	66	27,011	39
Soldier Beetles	Soldier Beetles, Jewel Beetles and Glow-worms Recording Scheme *	Scheme, BRC and iRecord data	UK	1970 - 2015	58	21,943	31
Soldierflies	Soldierflies and Allies Recording Scheme *	Scheme data only	UK	1970 - 2015	148	48,301	83
Spiders	British Arachnological Society, Spider Recording Scheme	Scheme and BRC data	UK	1970 - 2014	626	441,767	402
Stoneflies	Riverfly Recording Schemes: Plecoptera *	Scheme and iRecord data	GB	1970 - 2015	32	56,613	25
Wasps	Bees, Wasps and Ants Recording Society	Scheme data only	UK	1970 - 2015	263	100,474	167
Weevils	Weevil and Bark Beetle Recording Scheme *	Scheme, BRC and iRecord data	UK	1970 - 2015	618	159,541	330

Trends in major groups

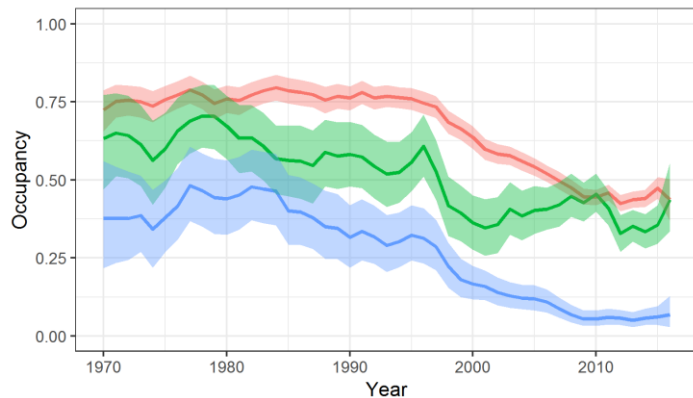


Trends in flies

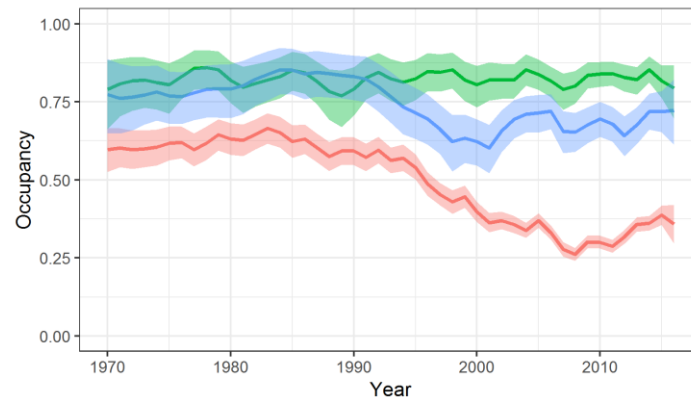


Regional model outputs: moths

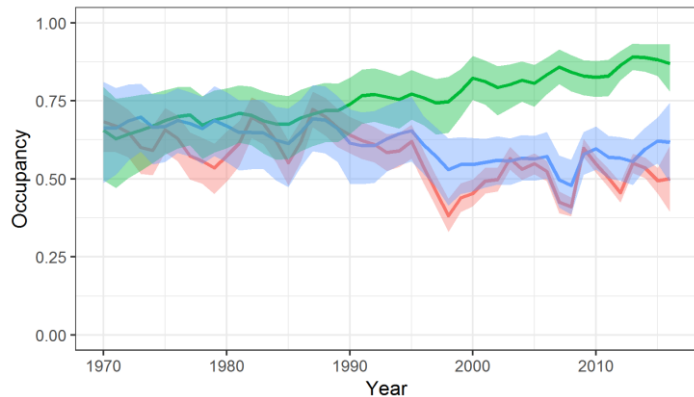
Amphipyra tragopoginis



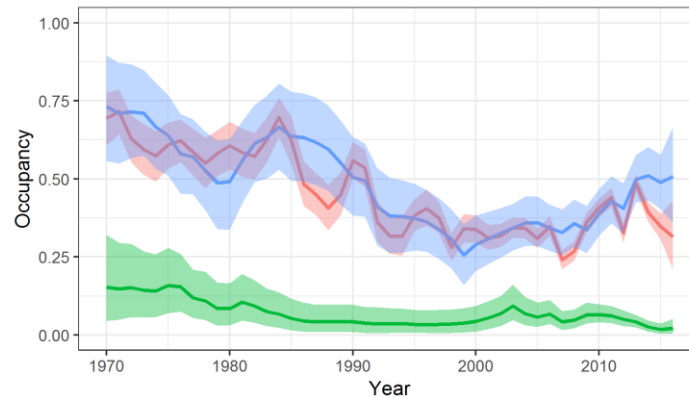
Arctia caja



Apamea remissa



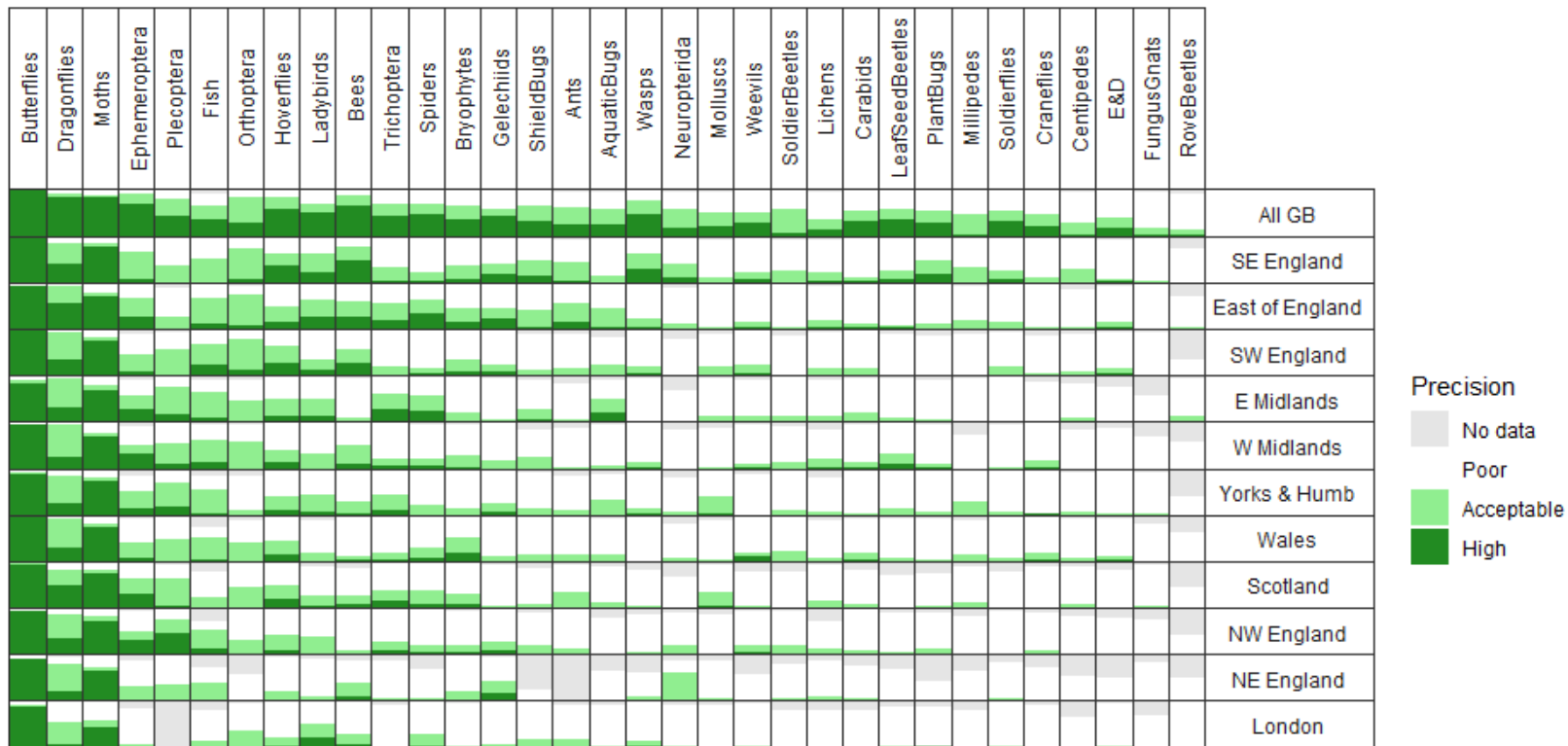
Tholera decimalis



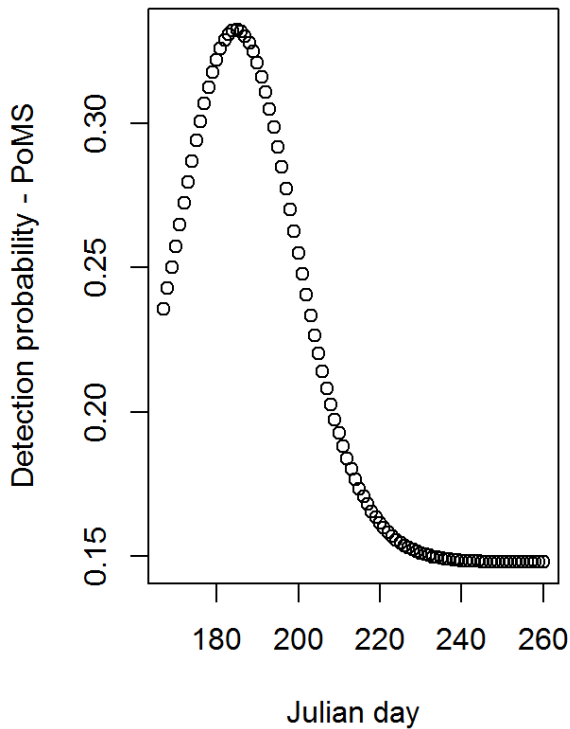
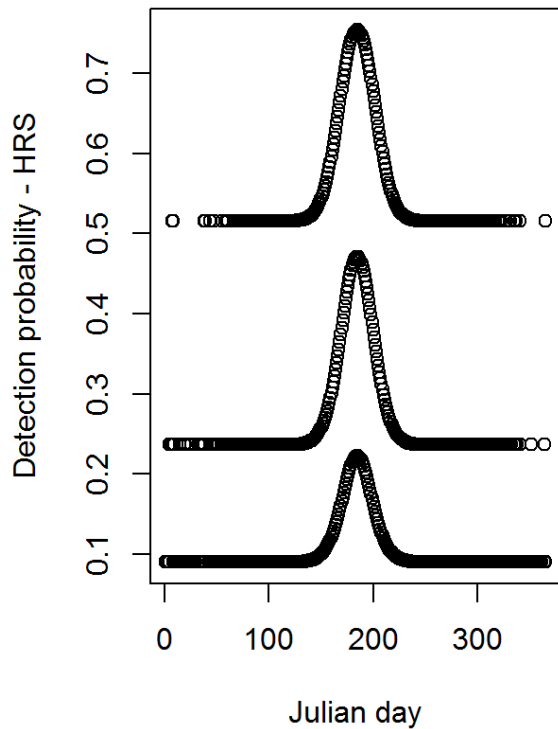
— ENGLAND — SCOTLAND — WALES

— ENGLAND — SCOTLAND — WALES

Do I have enough data for an occupancy model?

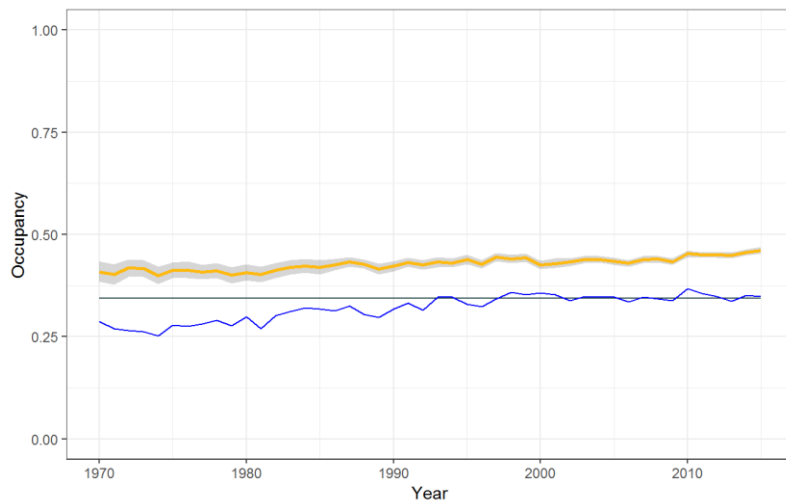


Improving the model: record date

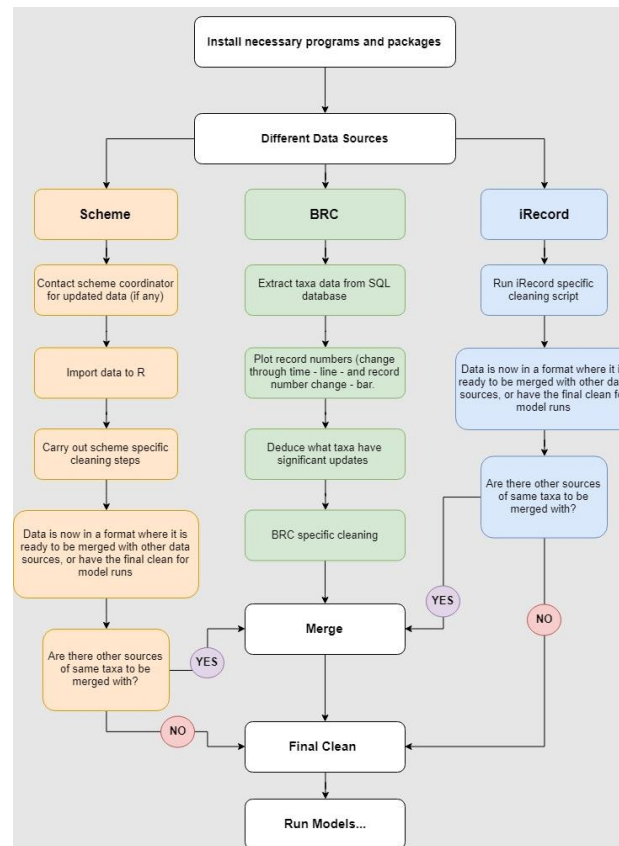
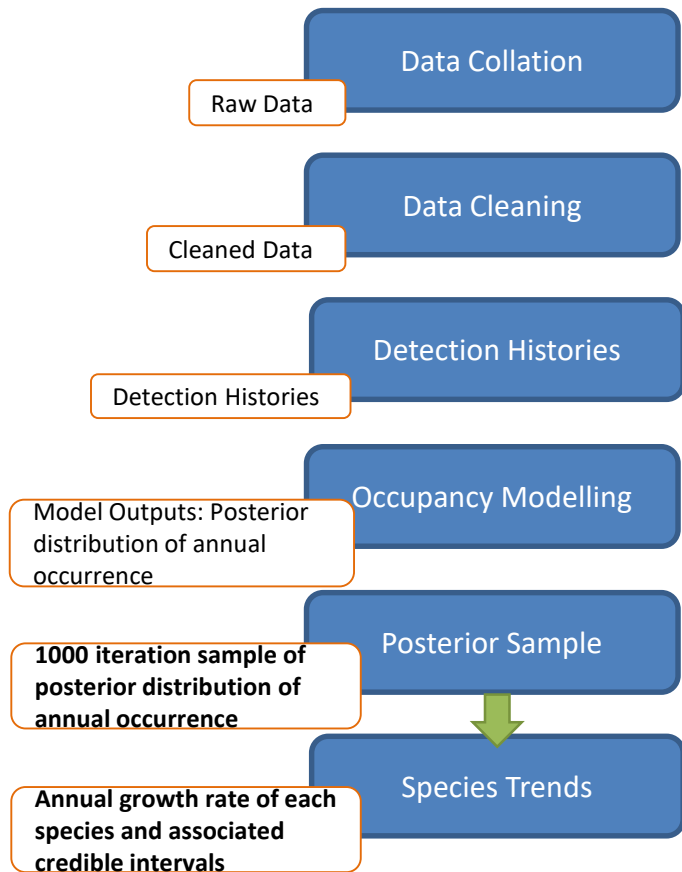


Improving the model: new simulations

- Adding record date
- BSBI recording pattern
- Extending the Methods paper
 - Pulses
 - Annual Lists
 - Recorder memory
 - Misidentifications
 - Changes in phenology over time
 - Habitat effects (trashed sites don't get revisited)

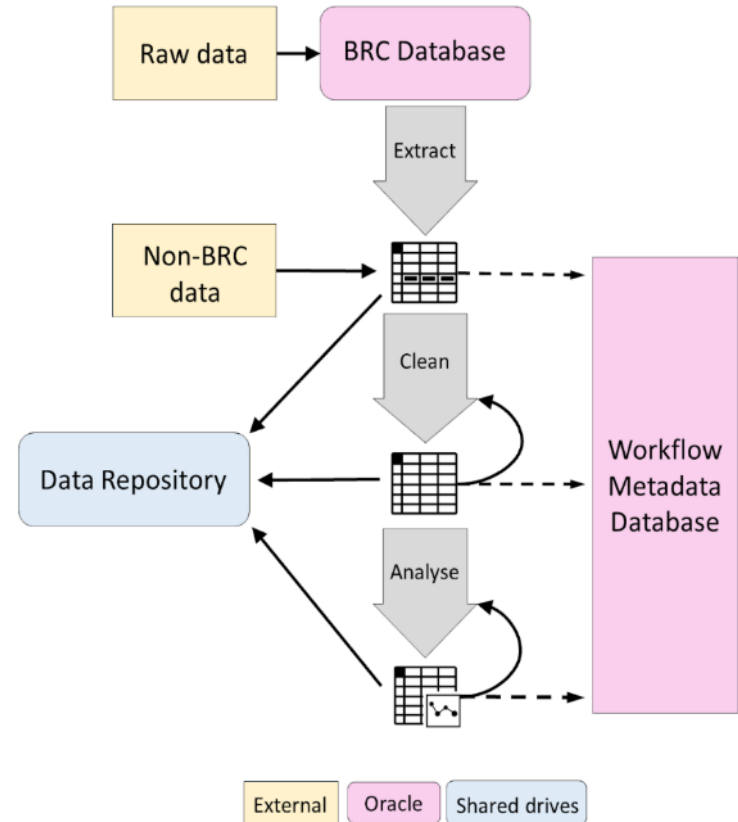


Updating the models



Workflows & auditing

- Each year the data grows and the model structure becomes more refined.
- Keeping track of model outputs requires good book-keeping!



Feedback to schemes: RShiny

← → ↻ https://gpowney.shinyapps.io/bee_sdm_app/ ☆ 🗨️ 📧 📄 📁 📂 📅 📆 📇 📈 📉 📊 📋 📌 📍 📎 📏 📐 📑 📒 📓 📔 📕 📖 📗 📘 📙 📚 📛 📜 📝 📞 📟 📠 📡 📢 📣 📤 📥 📦 📧 📨 📩 📪 📫 📬 📭 📮 📯 📰 📱 📲 📳 📴 📵 📶 📷 📸 📹 📺 📻 📼 📽 📾 📿 📱 📲 📳 📴 📵 📶 📷 📸 📹 📺 📻 📼 📽 📾 📿

Status and trend summary

Broad taxonomic group

Bee

Species

BOMBUS pascuorum

BOMBUS hypnorum

BOMBUS jonellus

BOMBUS lapidarius

BOMBUS magnus

BOMBUS muscorum

BOMBUS pascuorum

BOMBUS pratorum

BOMBUS terrestris

PLOT TREND SDM

Figure 1: Annual occupancy estimates.
BOMBUS pascuorum - n = 12304

Occupancy

Year

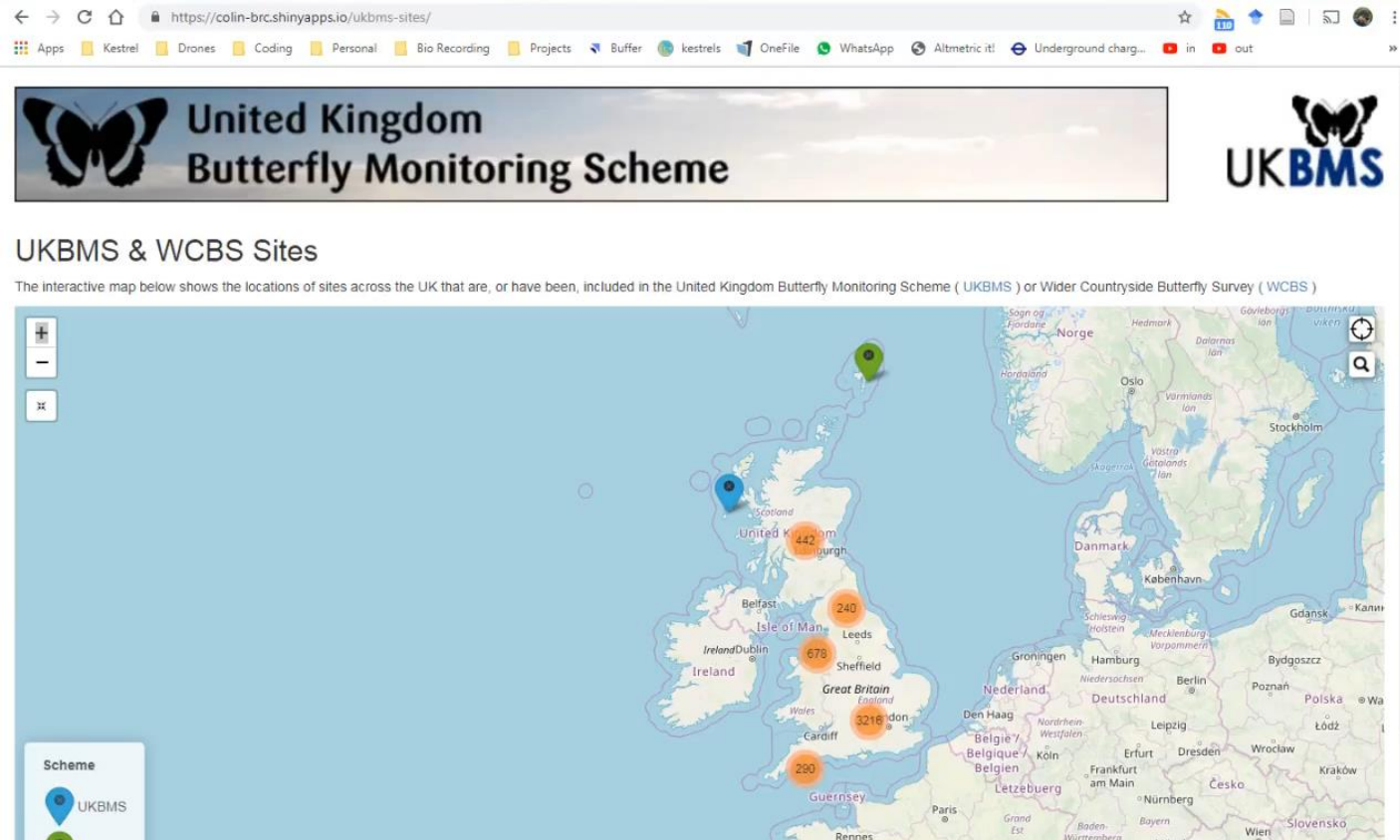
Rhat ● Good (<1.1)

Trend estimate (proportional change in occupancy)

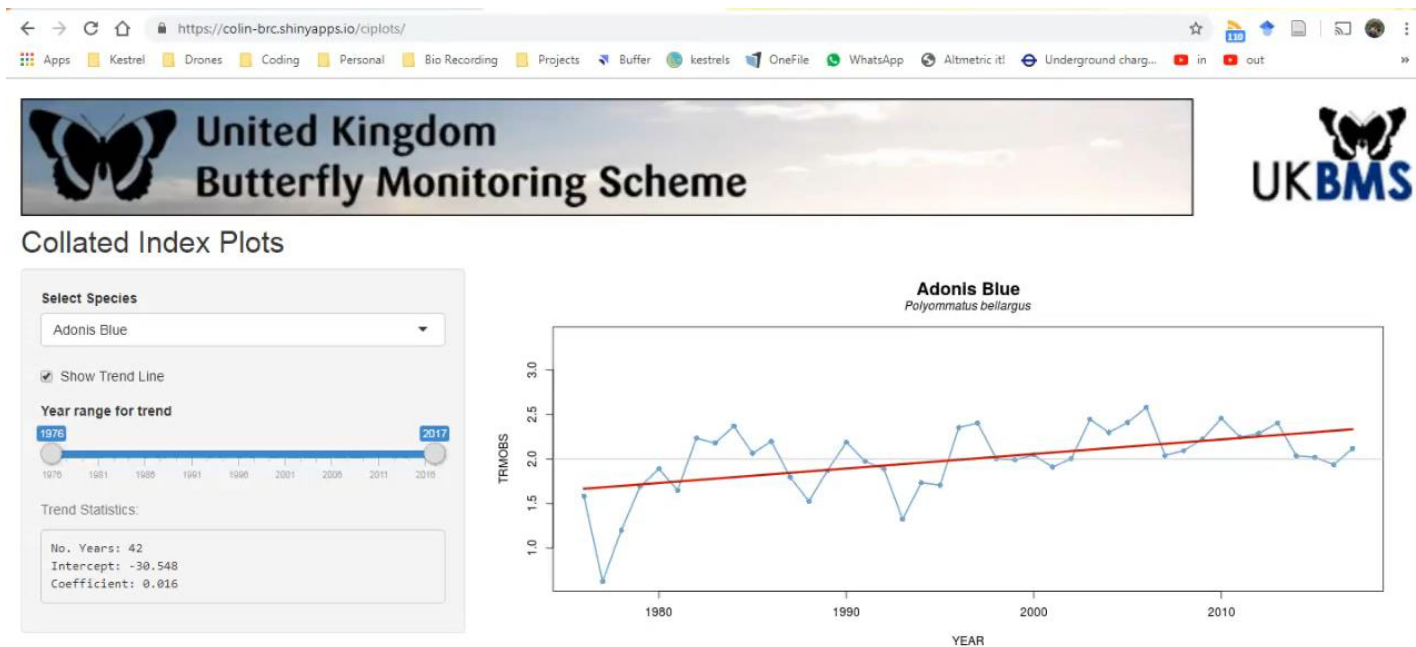
TimePeriod	Trend	LowerCI	UpperCI
Long-term (1980-2014)	0.84	0.54	1.27
Short-term (2009-2014)	0.03	-0.04	0.09

Long-term trend direction

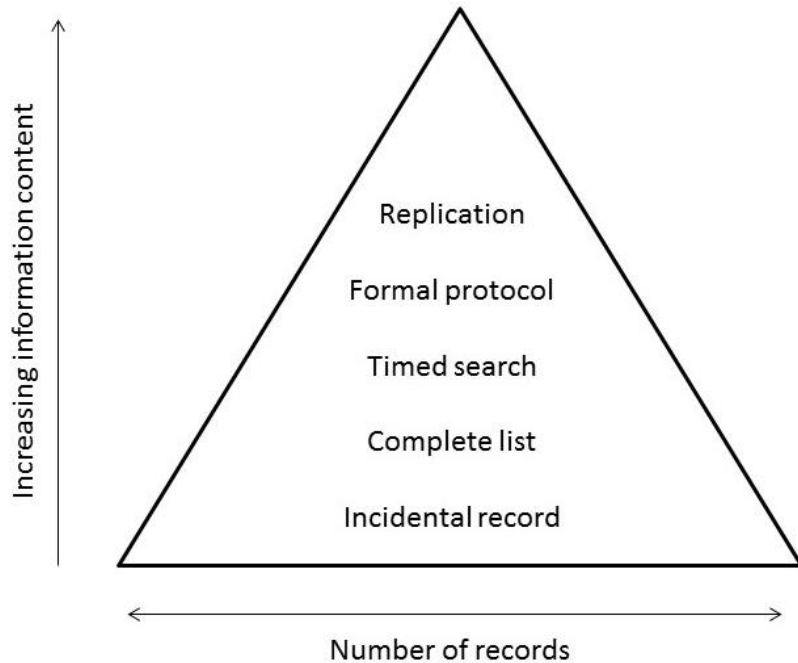
Feedback to schemes: RShiny



Feedback to schemes: RShiny



Trading off Quality vs Quantity



- In the absence of meta-data, we have to assume all records are incidental
- Can we do better than reverse-engineering?
- A little bit of meta-data would go a long way

Themes

- We already do a lot with scheme data
- We'd like to work with a wider range of Diptera
- Both models and data can be improved
- What can BRC do to help schemes?



Discussion points

- What Diptera groups and datasets should we be looking at?
- What scheme-specific biases should we model?
- What information can you provide (to increase model reliability)?
 - Complete lists
 - Repeat visits (within and across years)
 - Time spent searching
 - Narratives about motivation
- What information should we make available?
 - For the scheme
 - To feedback about model reliability