

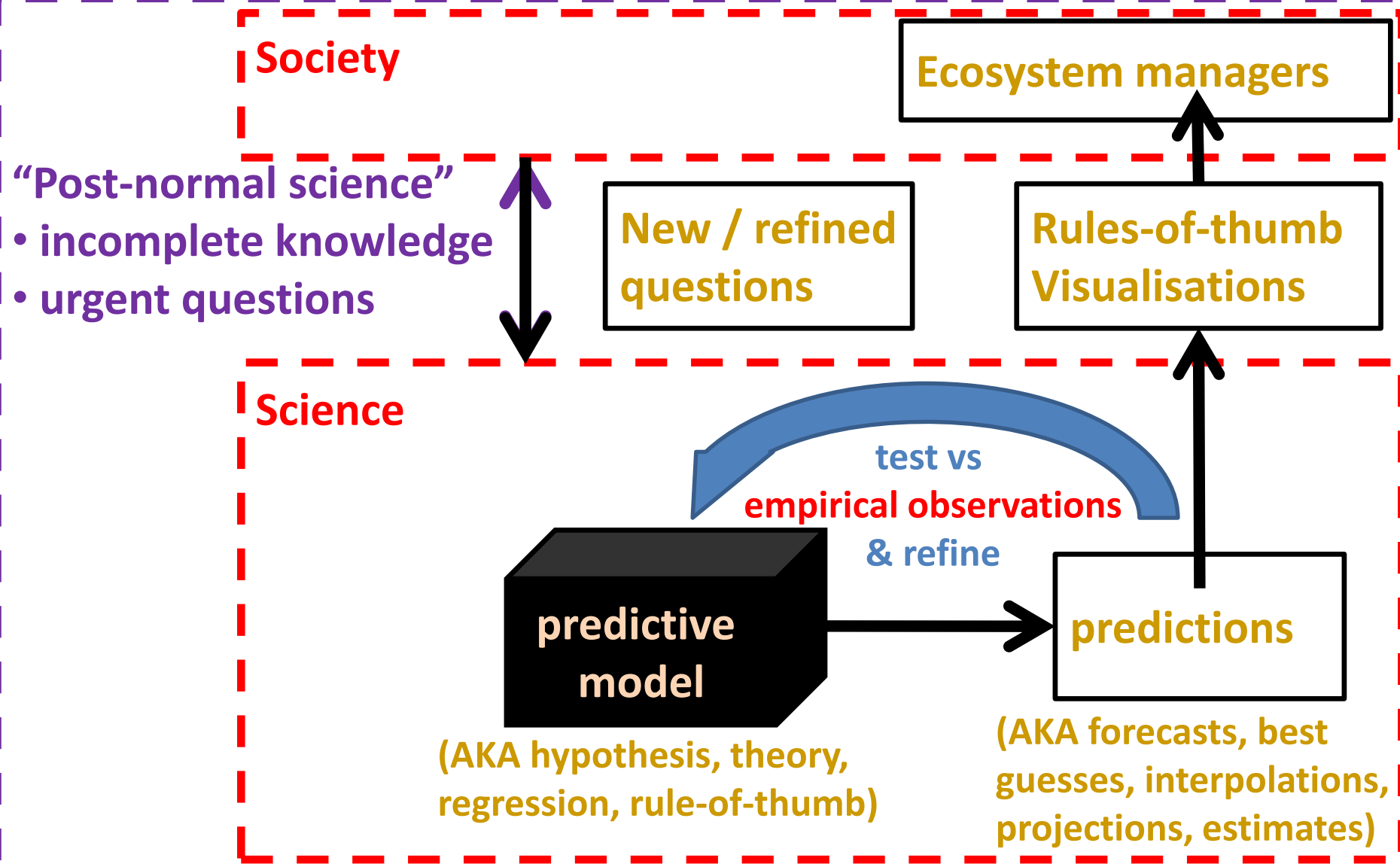
What use are predictions of biodiversity responses to air pollution?

*Ed Rowe, Simon Smart, Susan Jarvis, Pete Henrys,
Chris Evans & Jane Hall*

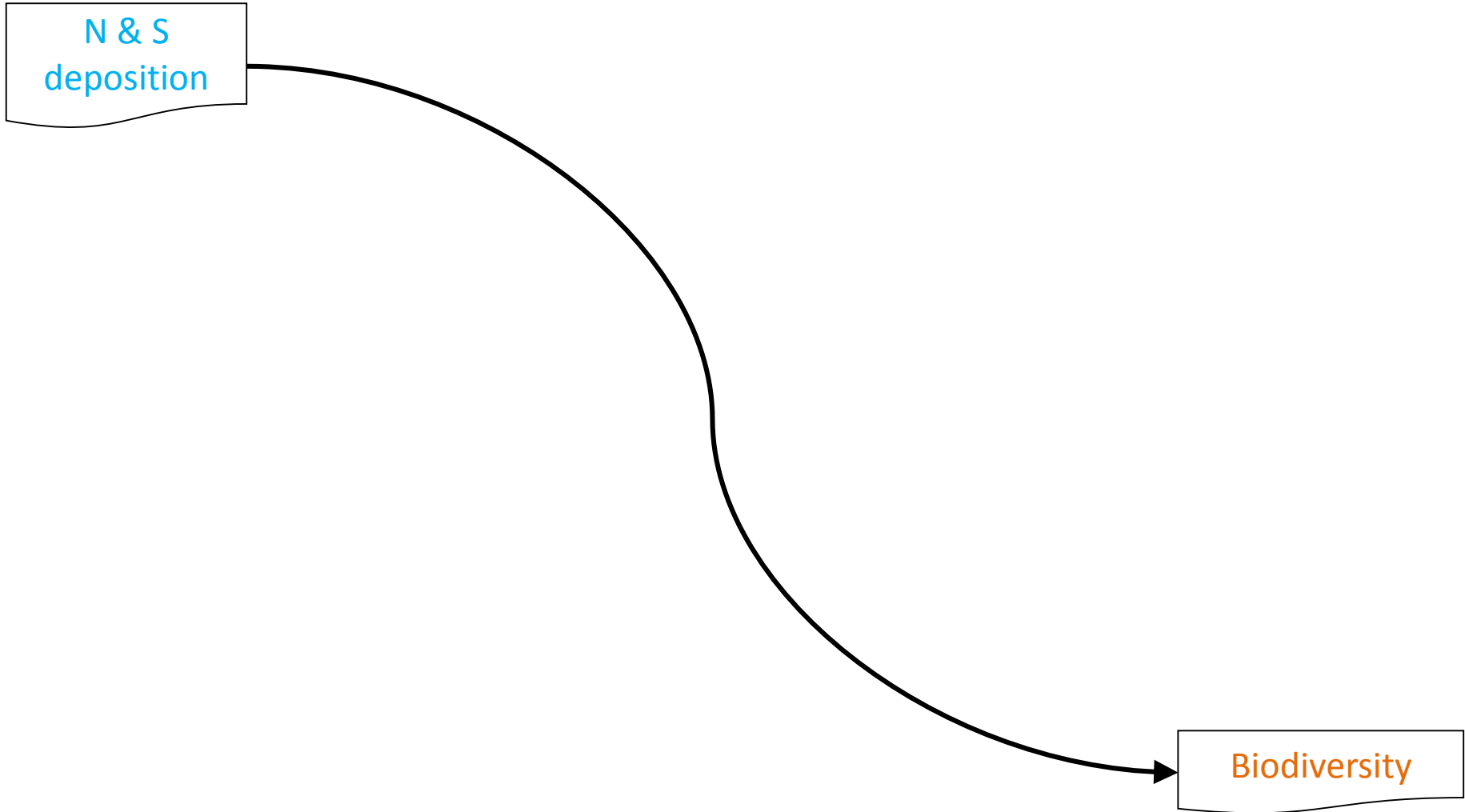
Outline

1. What use are predictions?
2. Can we predict pollution impacts on biodiversity?
3. UK responses to the “Call for Data” under the Convention on Long-Range Transboundary Air Pollution
4. Uncertainties
5. Other potential applications

The role of predictions



Predicting pollution impacts on biodiversity



Predicting pollution impacts on biodiversity

Biogeochemistry

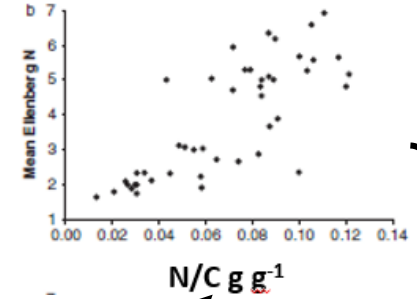
N & S
deposition

Other drivers
e.g. climate

Vegetation & soil
biogeochemistry: *MADOC*

pH, mineral N, biomass

Transfer functions



Plant ecology

Other drivers
e.g. climate

Floristic response:
MultiMOVE

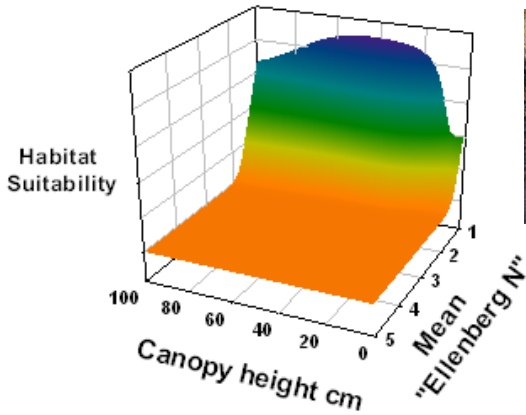
Trait-means:
Fertility, Alkalinity,
Height

Habitat suitability
for ~1300 UK plant &
lichen species

Evaluation

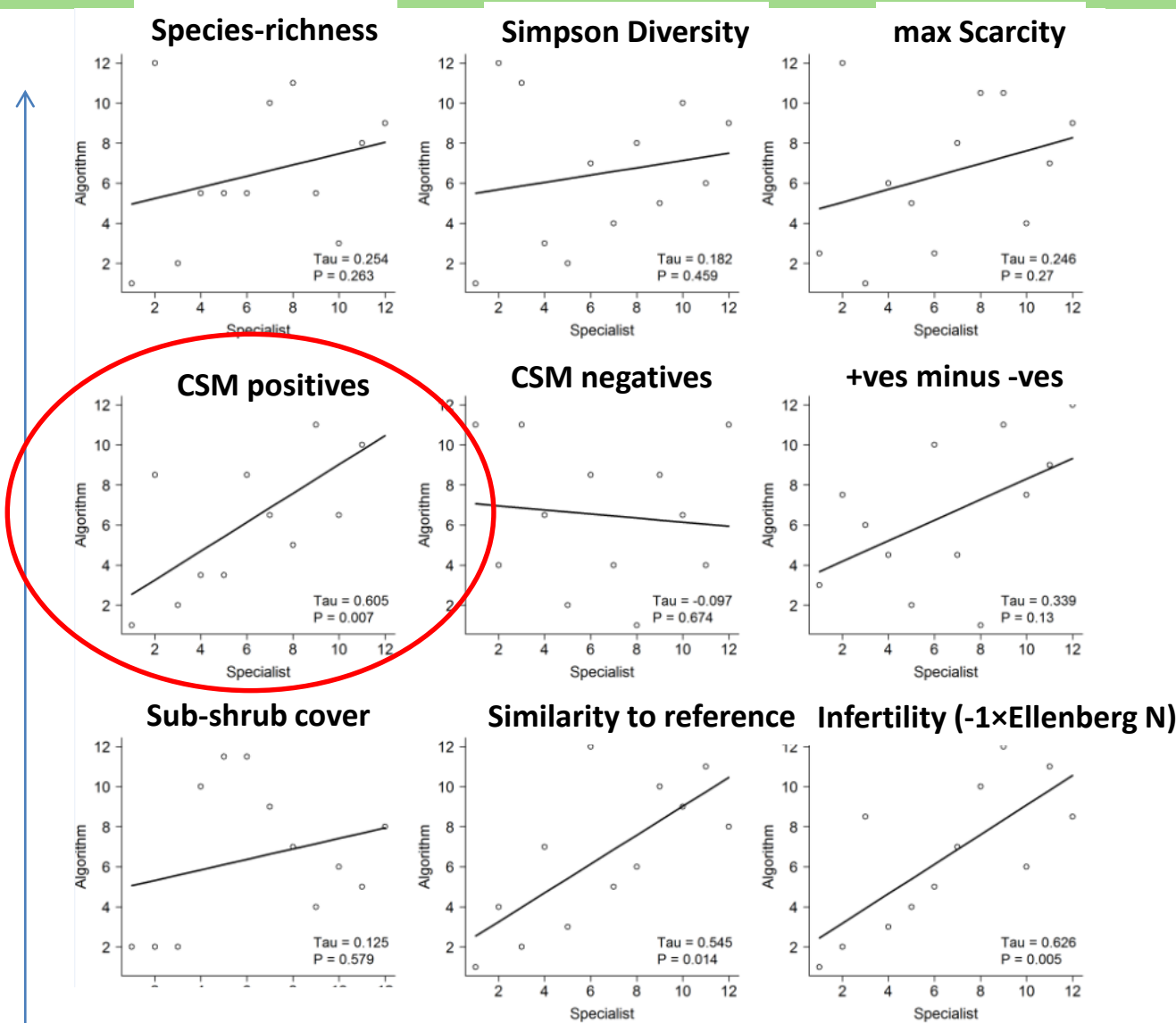
Biodiversity:
HQI

Rhynchospora alba



How should we quantify 'biodiversity'?

Heaths



Ranking according to metric

Ranking according to specialists



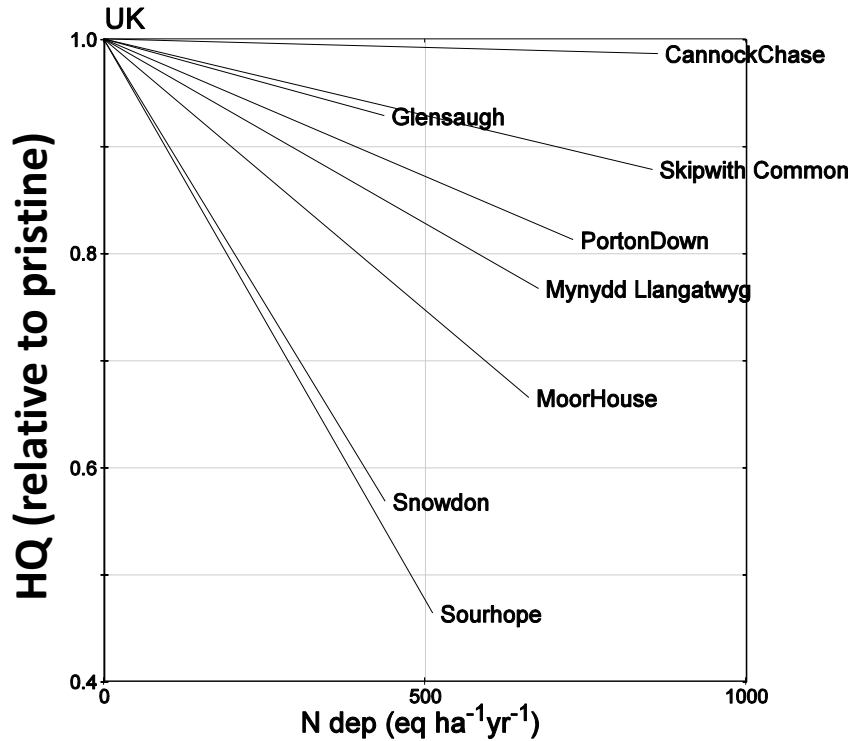
Rowe et al. (submitted, yet again...) PLOS-ONE

Terms: positive indicator species; HQI

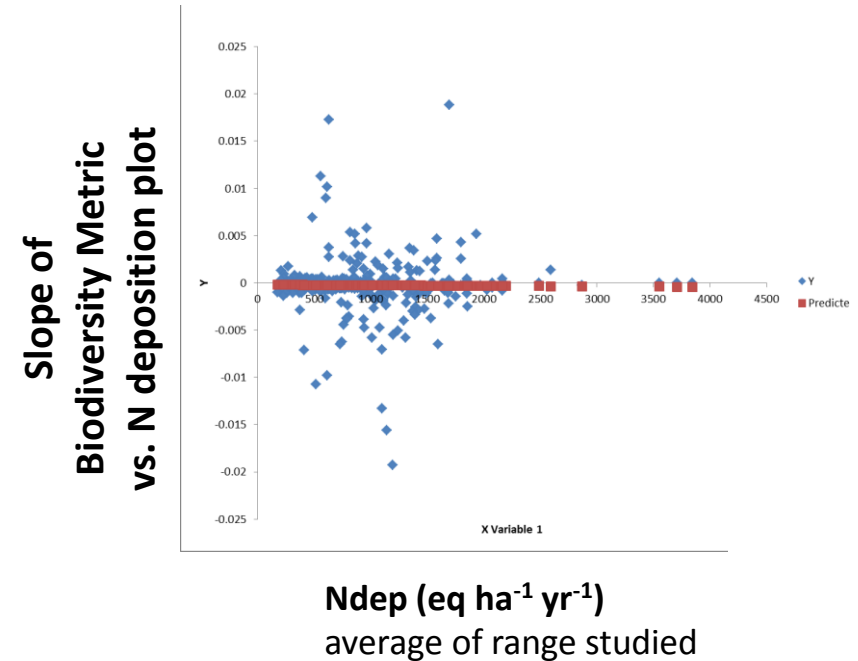
- **Positive indicator species** are listed in the JNCC Common Standards Monitoring guidance
- Species were selected for use in site evaluation on the basis that they:
 - indicate favourable condition
 - are not very scarce
 - are distinctive for the habitat
- Habitat Specialists were asked to consider “overall habitat quality”
- The best-correlated metric was “number of positive indicator species”
- We can’t predict species presence, so we calculate mean **habitat suitability for locally-occurring positive indicator species**
- This remains an indicator of overall habitat quality, so is termed **HQI**

More N deposition → decrease in *HQI*

UK response: N decreases Habitat Quality



c.f. countries using Similarity, Simpson's etc.

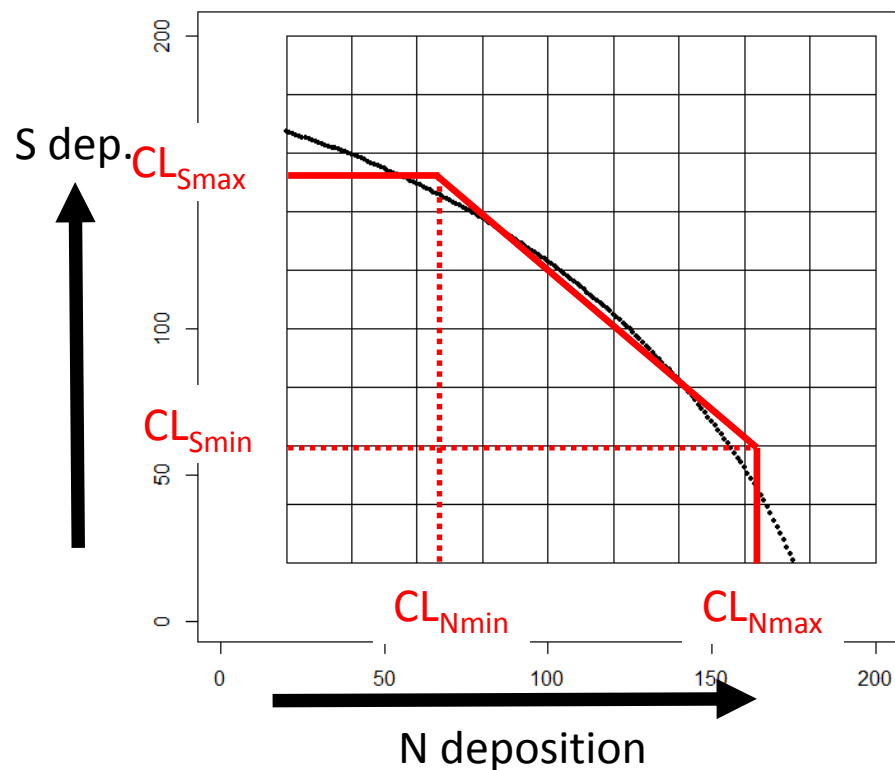
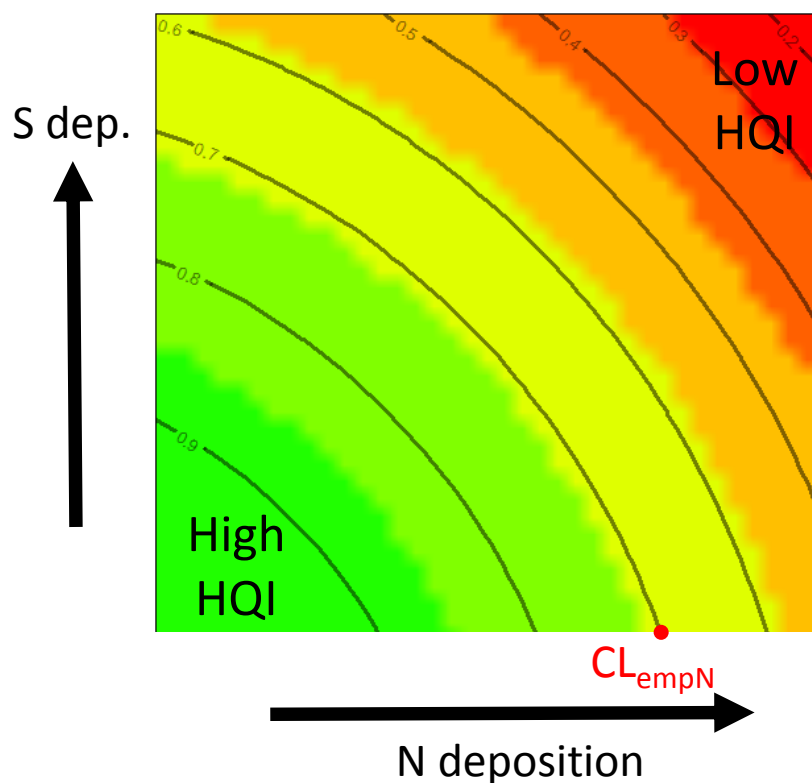


“...the TF came to the conclusion that a common biodiversity indicator such as habitat suitability indicator would be useful in addition to indicators that meet specific parties’ requirements. These indicators will be calculated using lists of species characteristic of EUNIS habitats.”

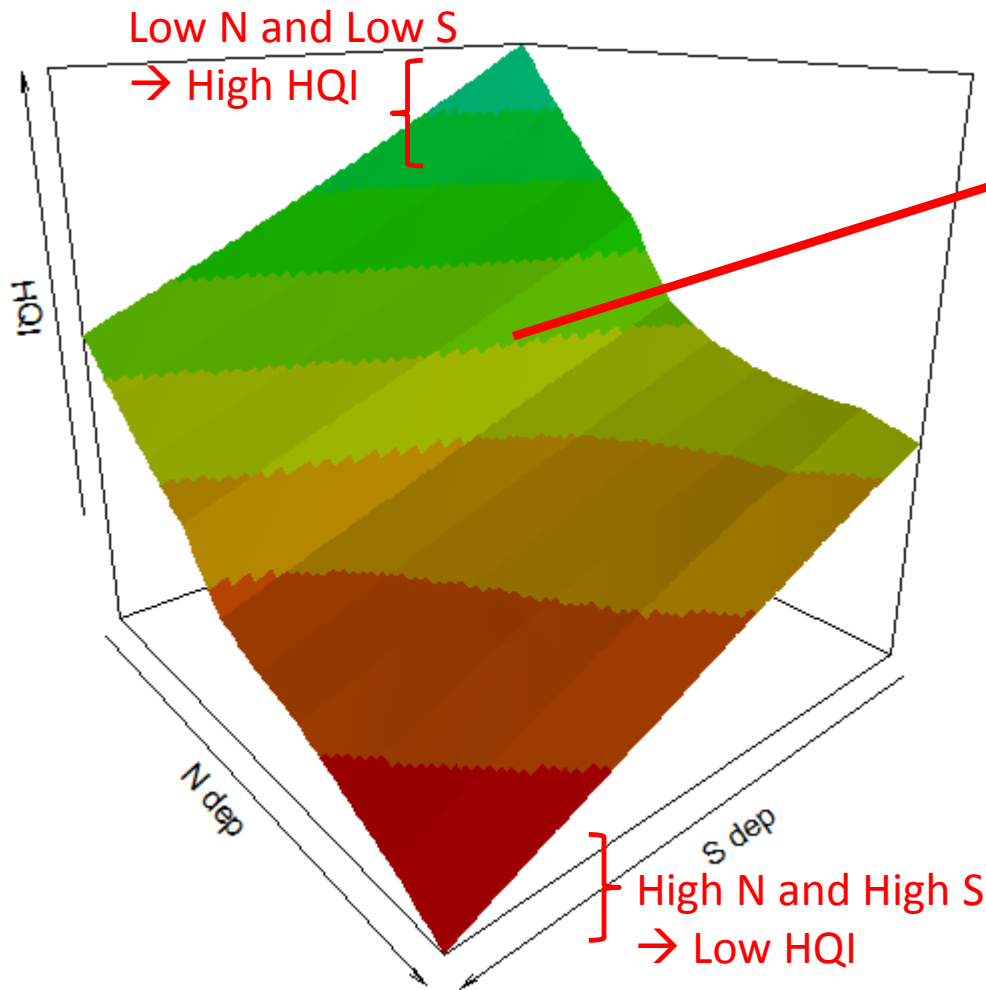
Chair’s report, CCE/TF-ICP-M&M workshop, Rome, 2014

'Biodiversity-based' CL functions

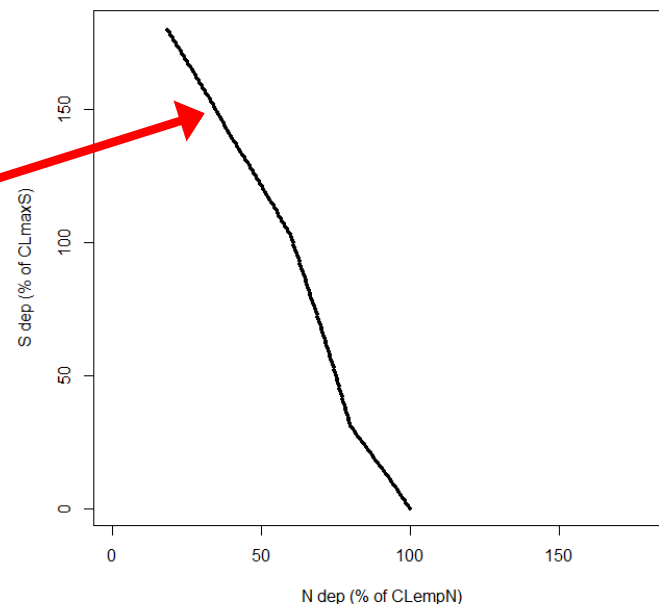
- Determine a critical threshold for HQI , corresponding to *ecosystem damage* or *unfavourable habitat condition*
- ... by calculating HQI under N deposition at the **empirical critical load**, with zero non-marine S deposition, from 1980-2100
- Calculate the combinations of S and N deposition that give $HQI = HQI_{crit}$
- Simplify the response function into the form requested in the Call for Data



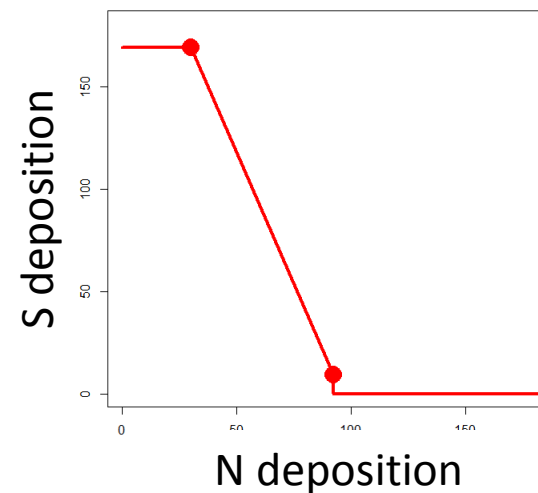
Example: dry acid grassland, Cadair Idris



“contour” where $HQI = HQI_{crit}$



Simple approximate function



Progress

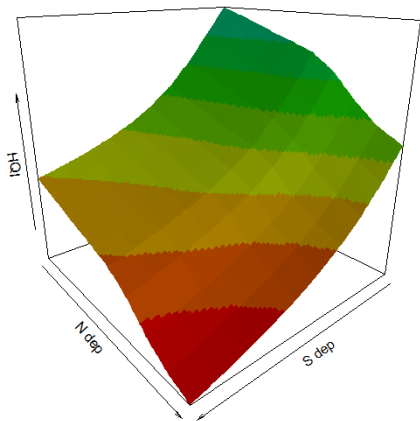
2016 defining CL functions for 445 SAC sites

EUNIS	Habitat	<i>n</i> sites
D1	bog	126
E1.7	dry acid grassland	43
E3.52	wet acid grassland	30

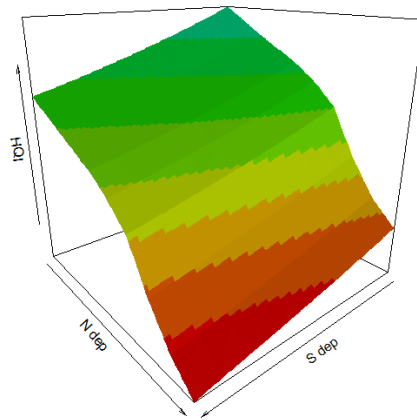
EUNIS	Habitat	<i>n</i> sites
F4.11	wet heath	119
F4.2	dry heath	127

2017 simulate **all** UK 1 km² squares with acid / N-sensitive habitats

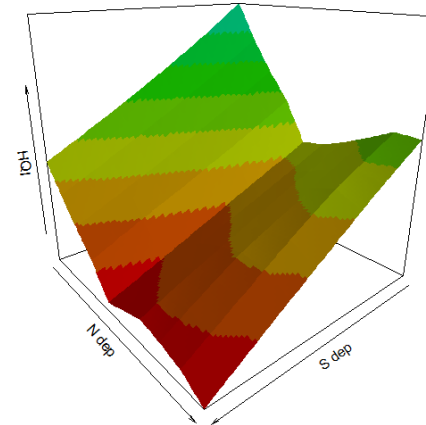
Inverpolly
Dry heath



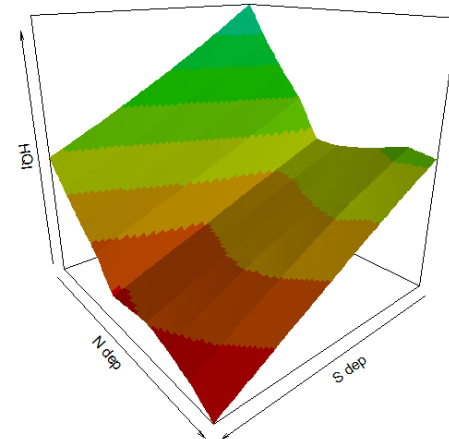
Dartmoor
Dry heath



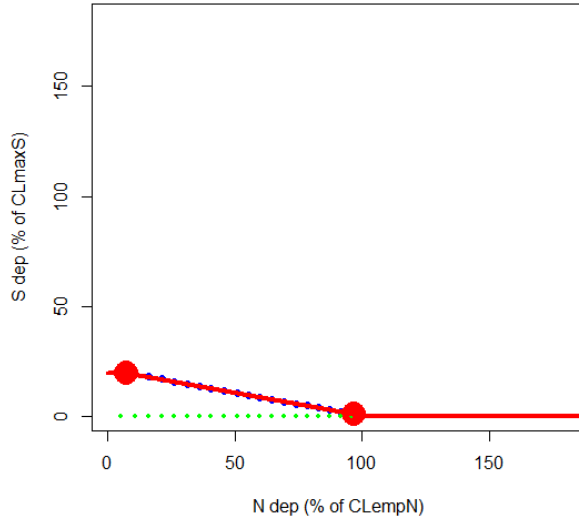
North Harris
Dry acid grassland



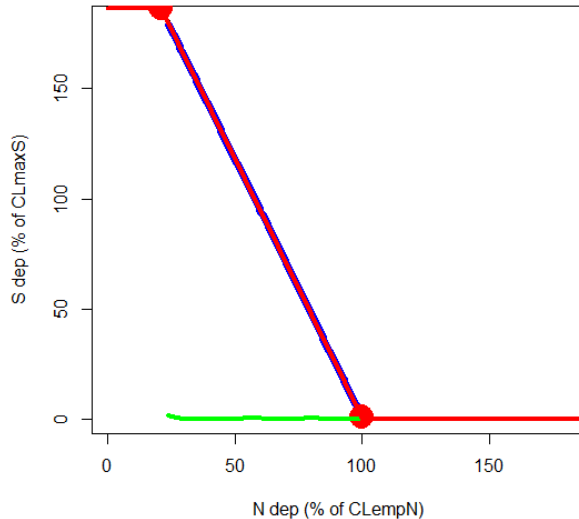
Snowdonia
Dry acid grassland



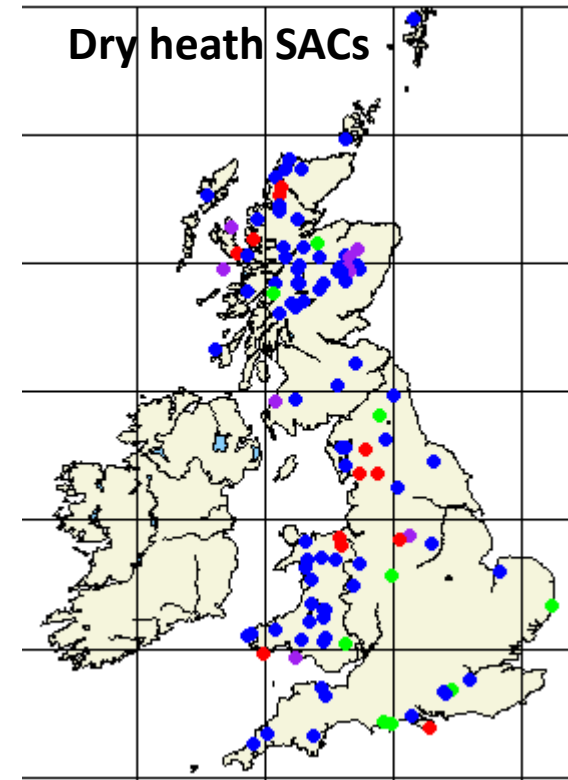
Sites vary in acid-sensitivity



● Sensitive: damaged by only 23% of CLmaxS (at zero N deposition)



● Insensitive: damaged only by 185% of CLmaxS (at zero N deposition)



CLSmax / CLmaxS (%)

- 0-50
- 50-100
- 100-200
- 200-300

Uncertainties

Biogeochemical / ecological

- Should we take into account limitation by P, etc.?
- How do productivity and grazing interact → canopy height?
- Should we incorporate direct effects of NH_3 ?
- ...

Transfer functions (abiotic conditions → trait-means)

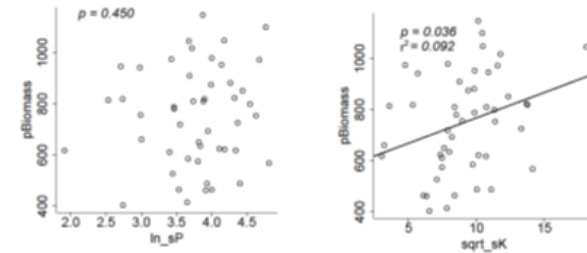
- Are we using the correct predictors?
- Are the data adequate e.g. for calcareous habitats?

Species responses

- Are the niche models realistic? (→ BSBI 'eyeballing' project)

Summarising species responses

- Would summaries other than *HQI* be useful?

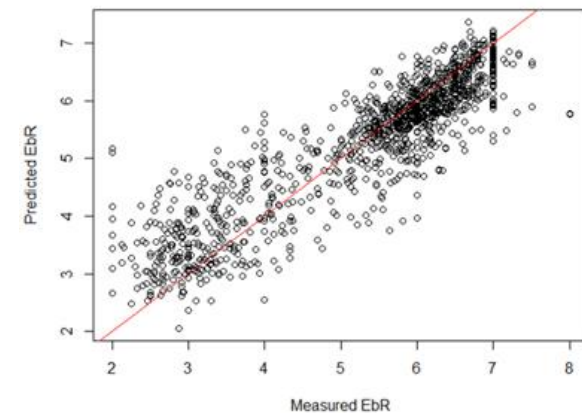


Phosphorus (organic)

Potassium

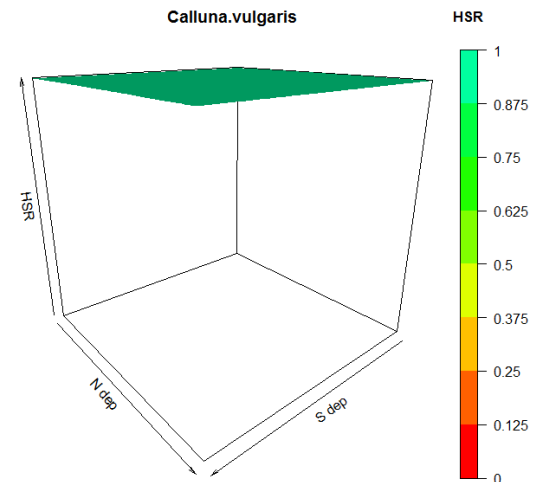
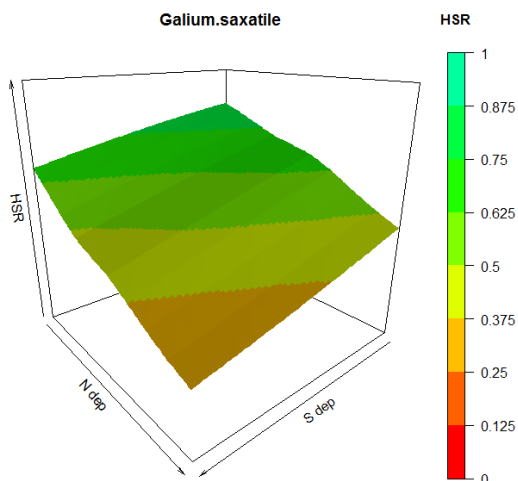
Rowe et al. 2016 STOTEN

doi: 10.1016/j.scitotenv.2016.03.066



How else might these predictions be used?

- We can predict effects of [N, S, management (via height), temperature, precipitation] on [productivity, soil pH, C, water quality, ~1300 UK plant and lichen species, HQI]
- Versions responsive to [ozone, phosphorus, salinity] are in development
- Predictions of habitat suitability for individual species → [species-dependent functions e.g. pollination, methane-ducting, etc.; dependent species (animals, fungi etc.)]
- Example questions:
 - “Which species is most vulnerable to an increase in N deposition at my site?”
 - “How would P fertilisation affect nitrate leaching and biodiversity?”
 - “What does blocking ditches in bogs do to the greenhouse gas balance, including effects of increasing *Eriophorum* abundance?”



Hoy SAC, dry heath

Conclusions

1. What use are predictions?

Predictions test understanding, and enable scenarios to be explored

2. Can we predict pollution impacts on biodiversity?

Yes

3. UK responses to the “Call for Data” under the Convention on Long-Range Transboundary Air Pollution

The UK remains one of the key participants

4. Uncertainties

Many, but many outputs make sense

5. Other potential applications

Limited only by our imaginations