

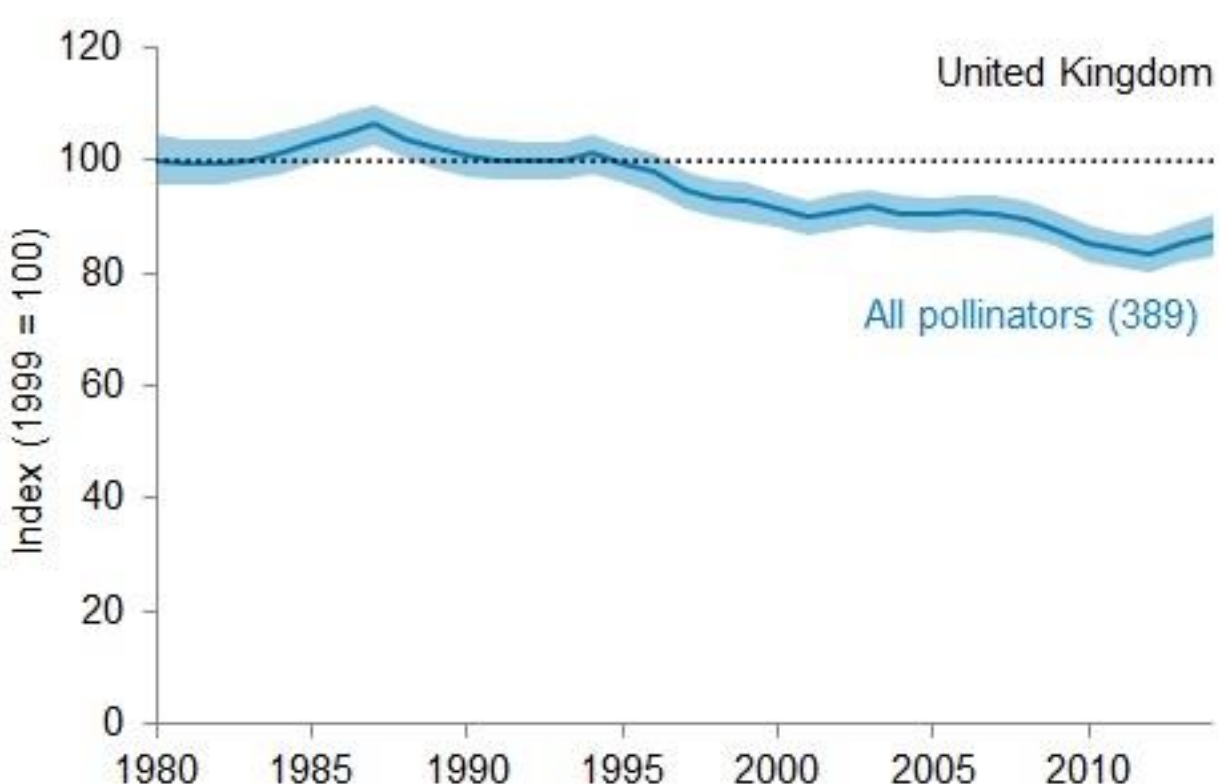
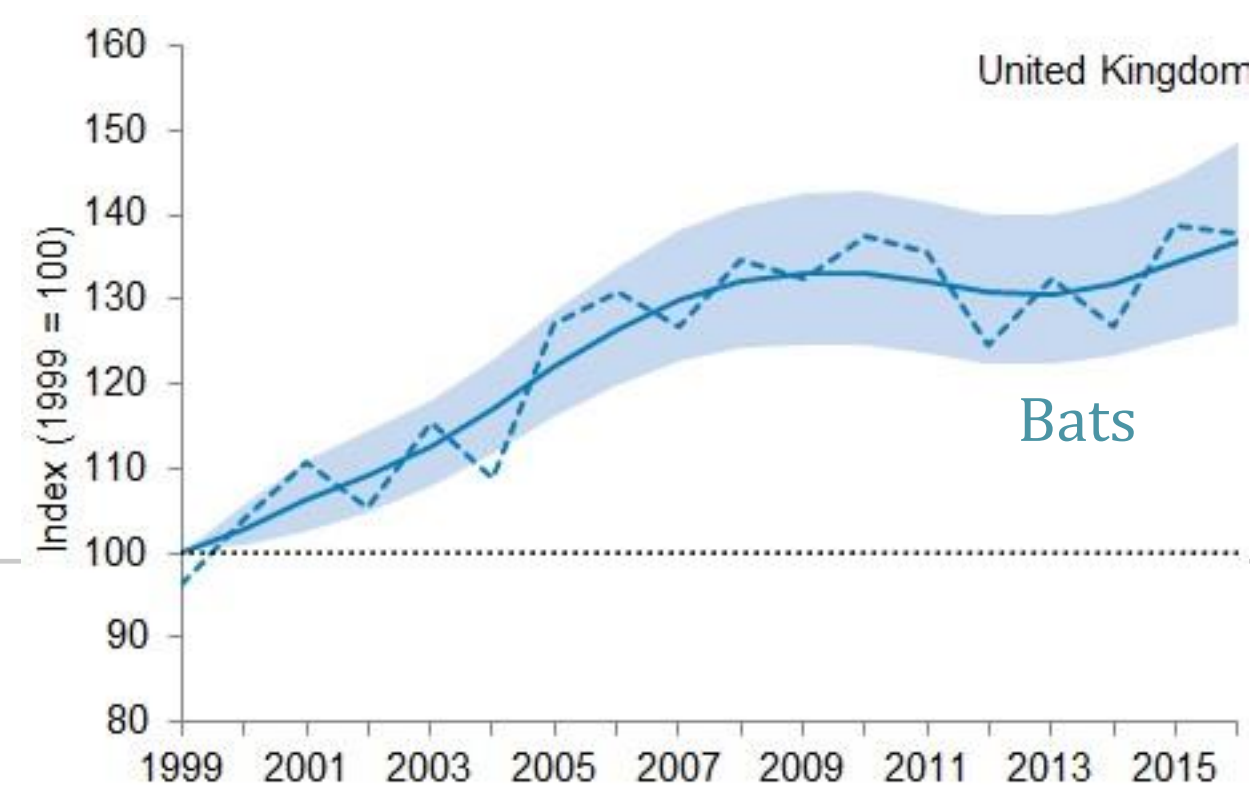
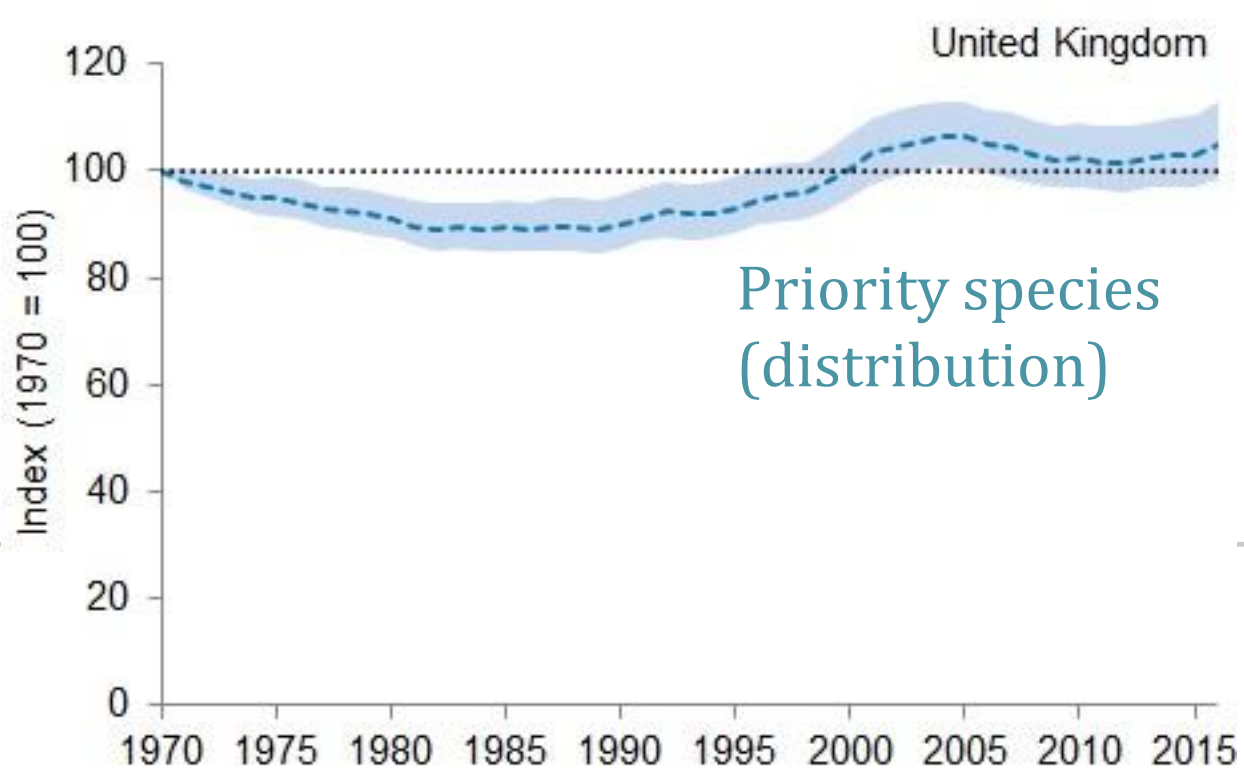
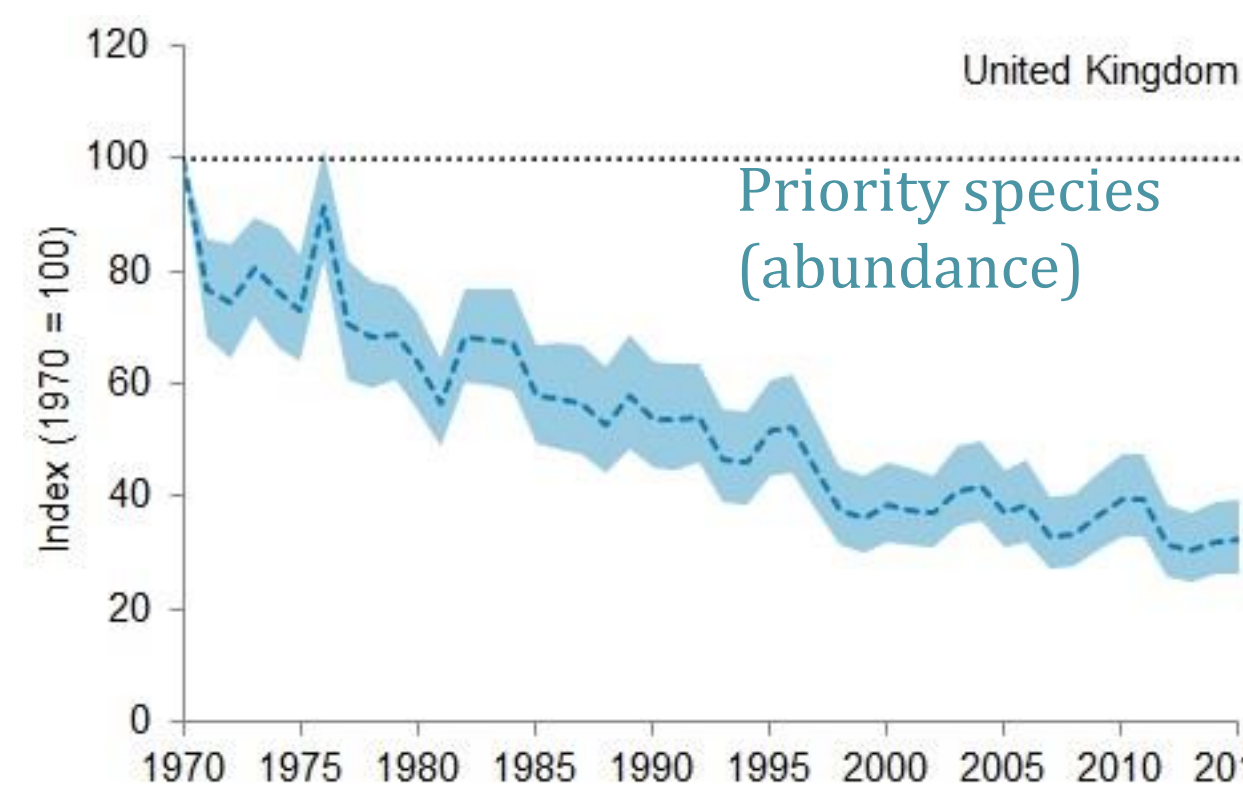
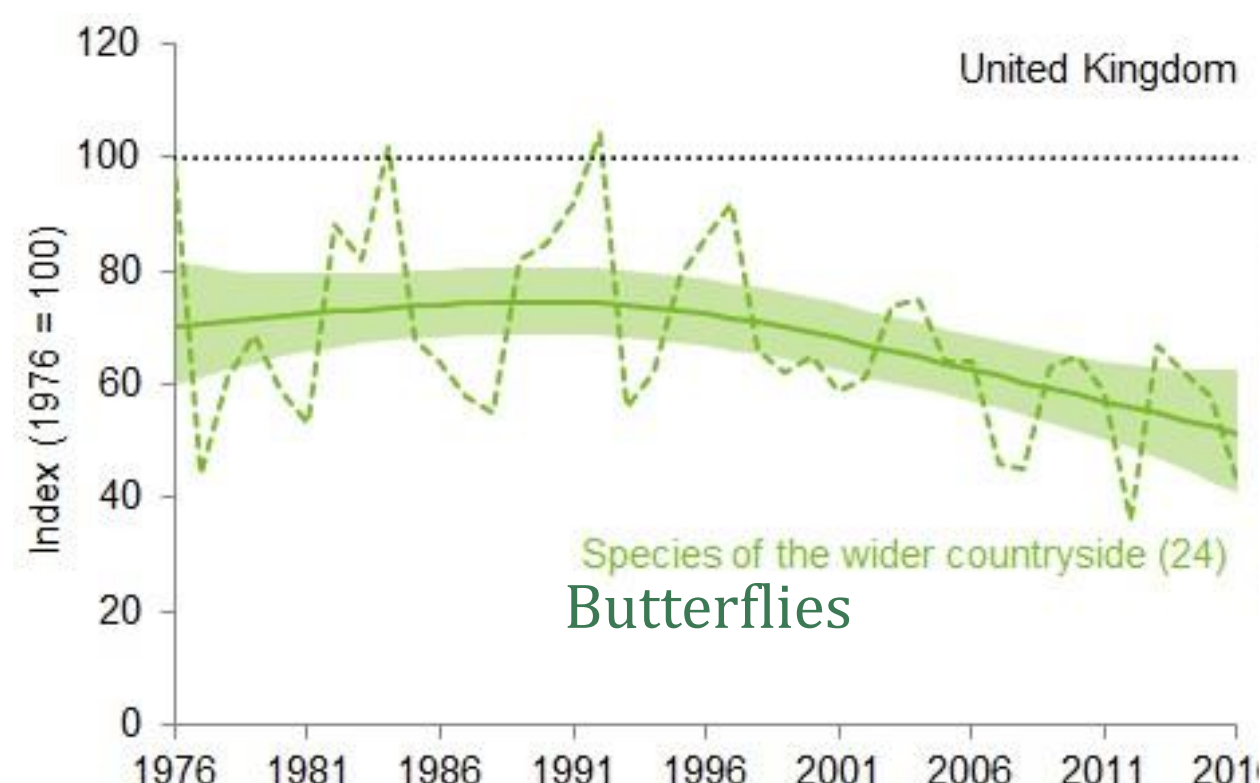
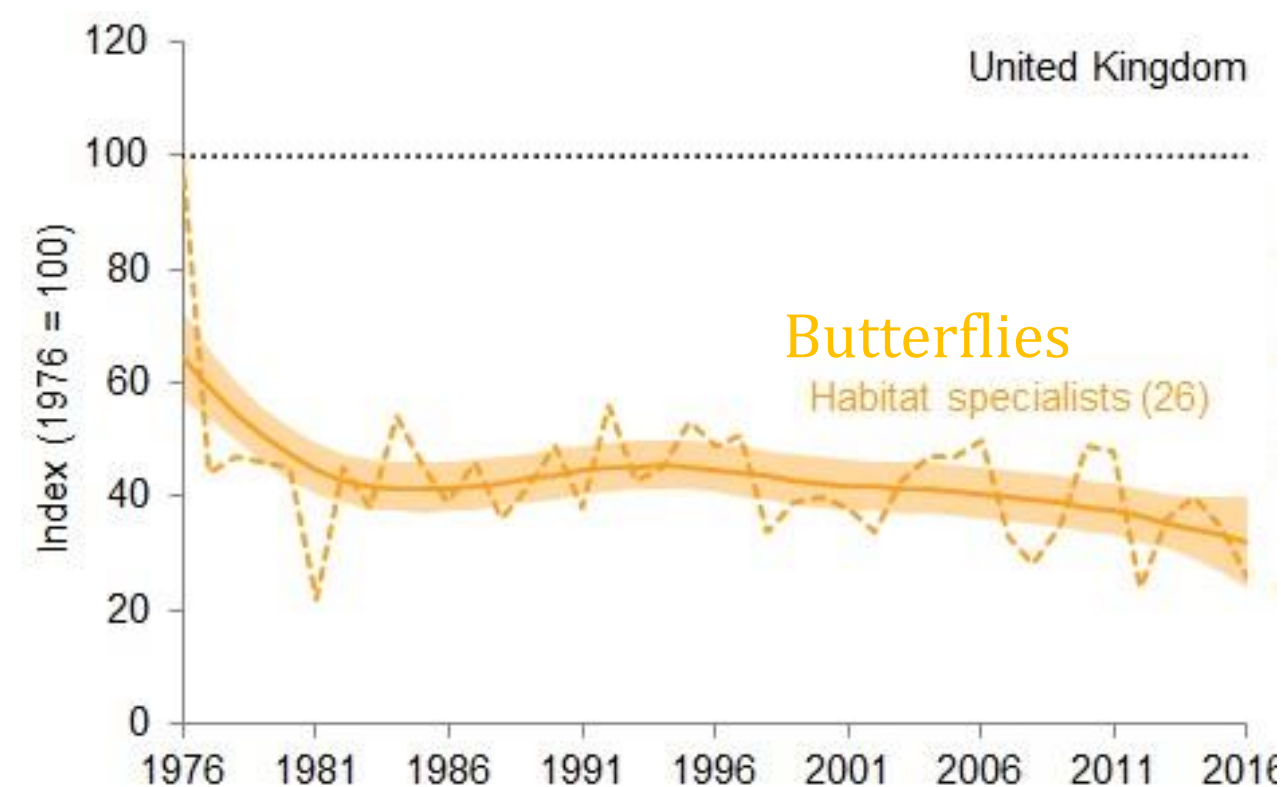
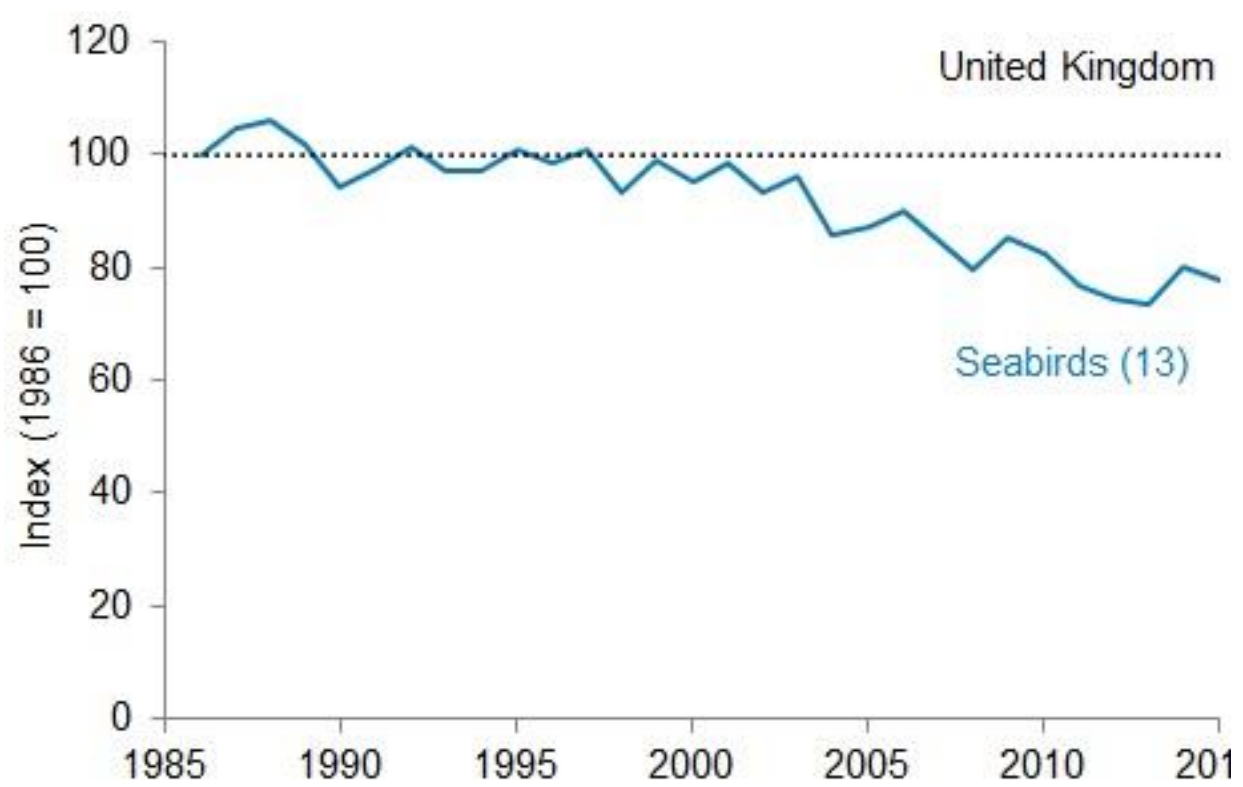
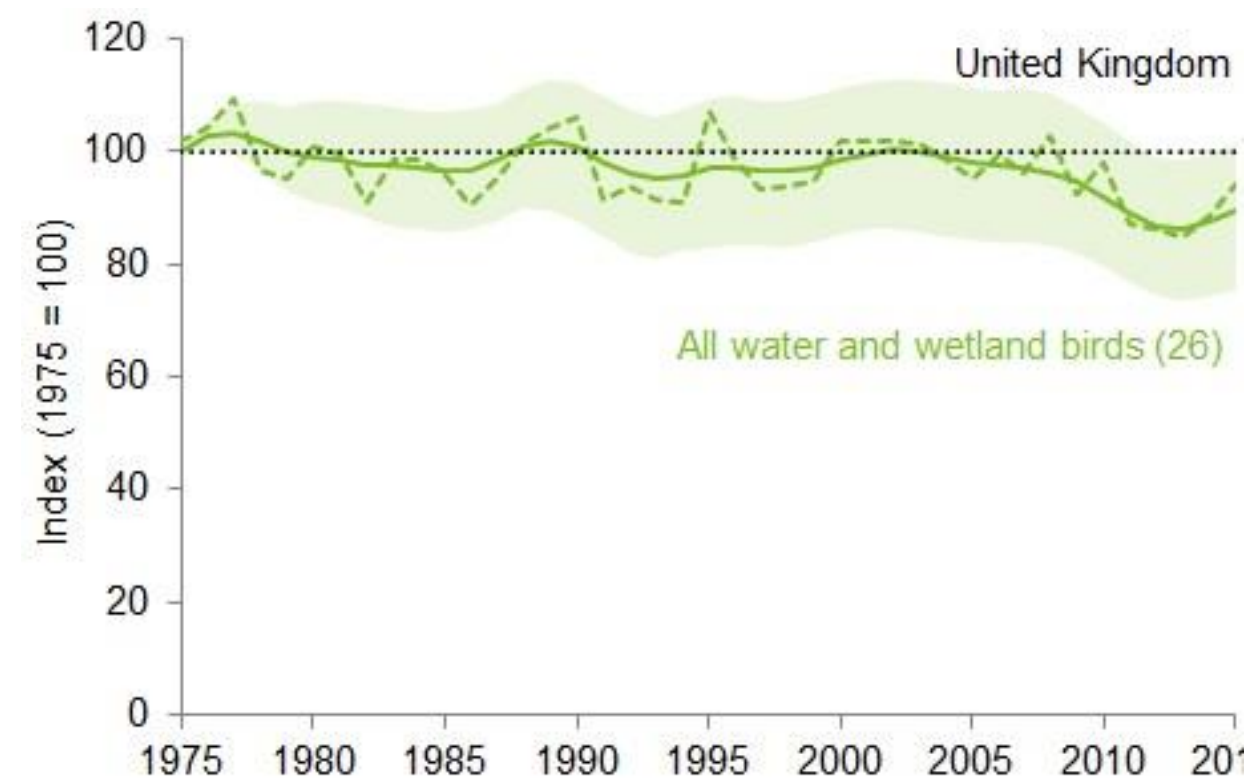
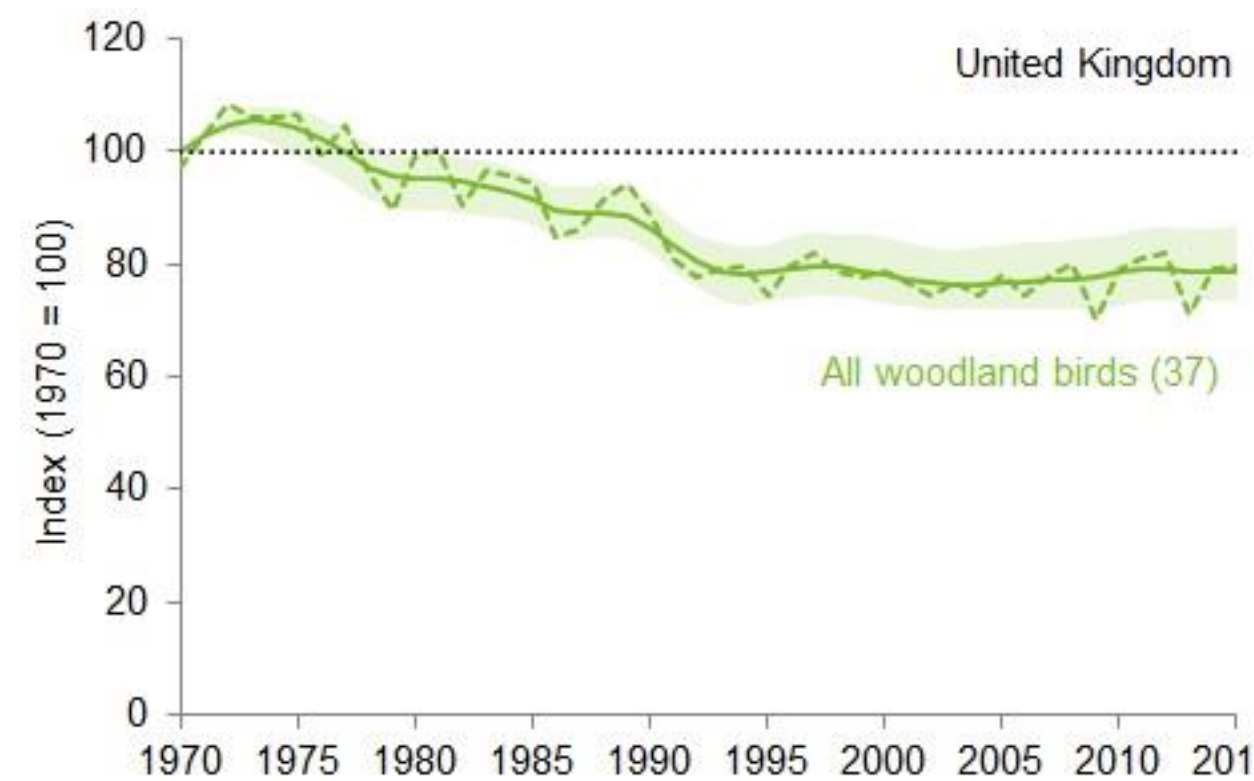
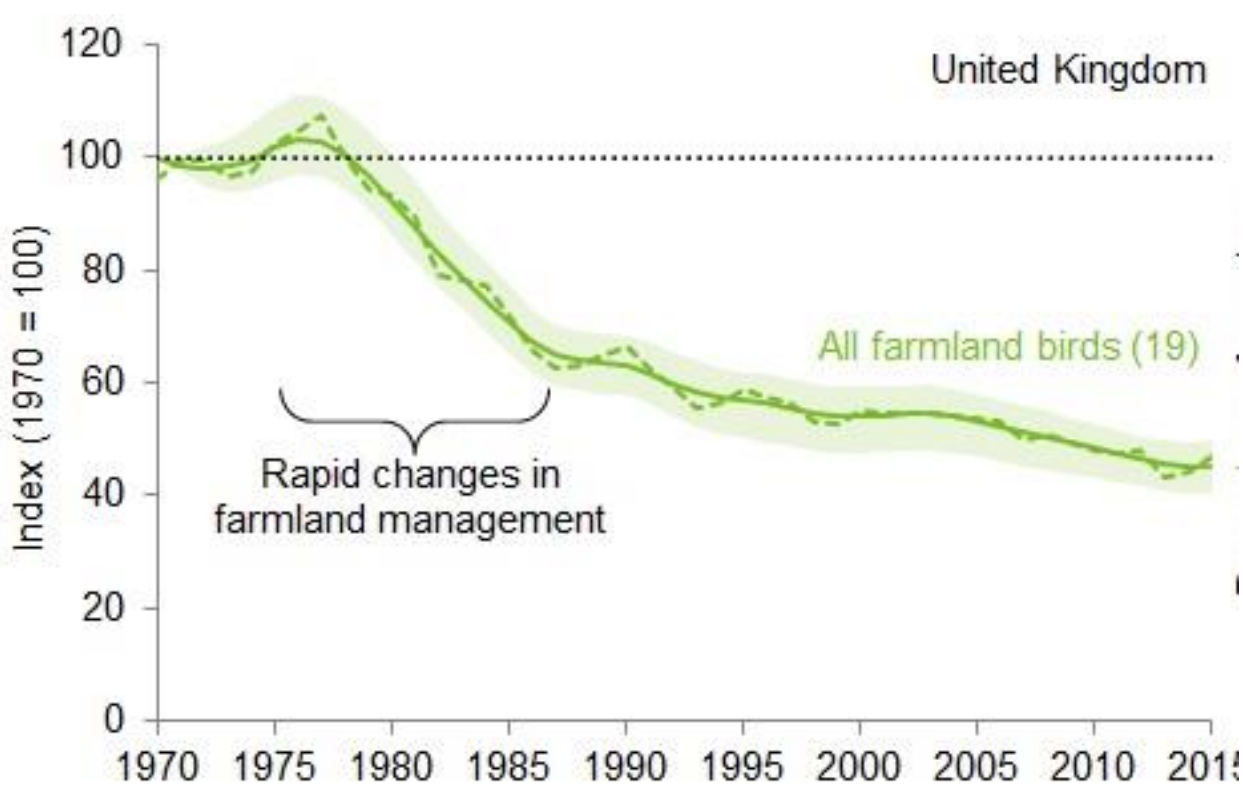
Monitoring Ecosystem Health using biological records data

Nick Isaac



UK Centre for
Ecology & Hydrology





What is Nature Conservation?



[nature.com](https://www.nature.com)



[awf.org](https://www.awf.org)



[ensia.com](https://www.ensia.com)



[freepik.com](https://www.freepik.com)



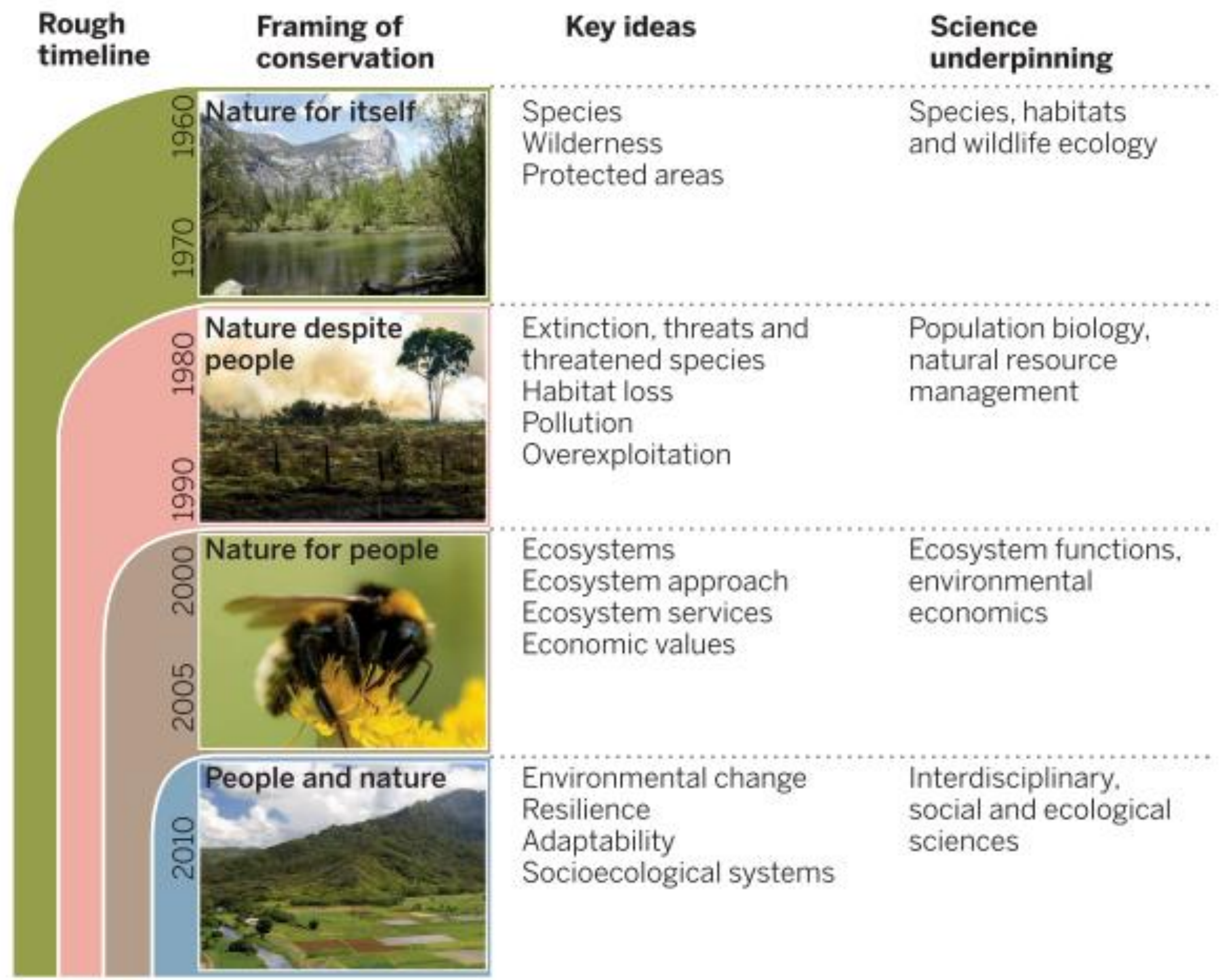
openaccessgovernment.org

Nature Conservation: An evolving narrative

Mace (2014) identified four phases in the development of the nature conservation movement:

1. Nature for itself (1960s, 1970s)
2. Nature despite people (1980s, 1990s)
3. Nature for people (2000s)
4. People and Nature (2010s)

Mace (2014) *Whose conservation?* Science 354: 1558



Changing views of nature and conservation. Over the past 50 years, the prevailing view of conservation has changed several times, resulting, for example, in a shift in emphasis from species to ecosystems. None of the framings has been eclipsed as new ones have emerged, resulting in multiple framings in use today.

Agencies want more from data

Functional diversity
Functional connectivity
Ecosystem Services
Resilience
Natural Capital
Adaptability
Human Wellbeing
Ecosystem Health



Devolved authority and agency



Scottish Indicators of Ecosystem Health

Condition indicators

1. Land cover

2. Protected nature sites

3. Forests

4. Farming and nature

5. Species diversity - Bird populations

6. Freshwater

7. Soil carbon

Function indicators

8. Connectivity

9. Acid and nitrogen pollution

Resilience indicators

10. Habitat restoration

11. Invasive non-native species

12. Climate change adaptation

13. Soil sealing

What is a healthy ecosystem?

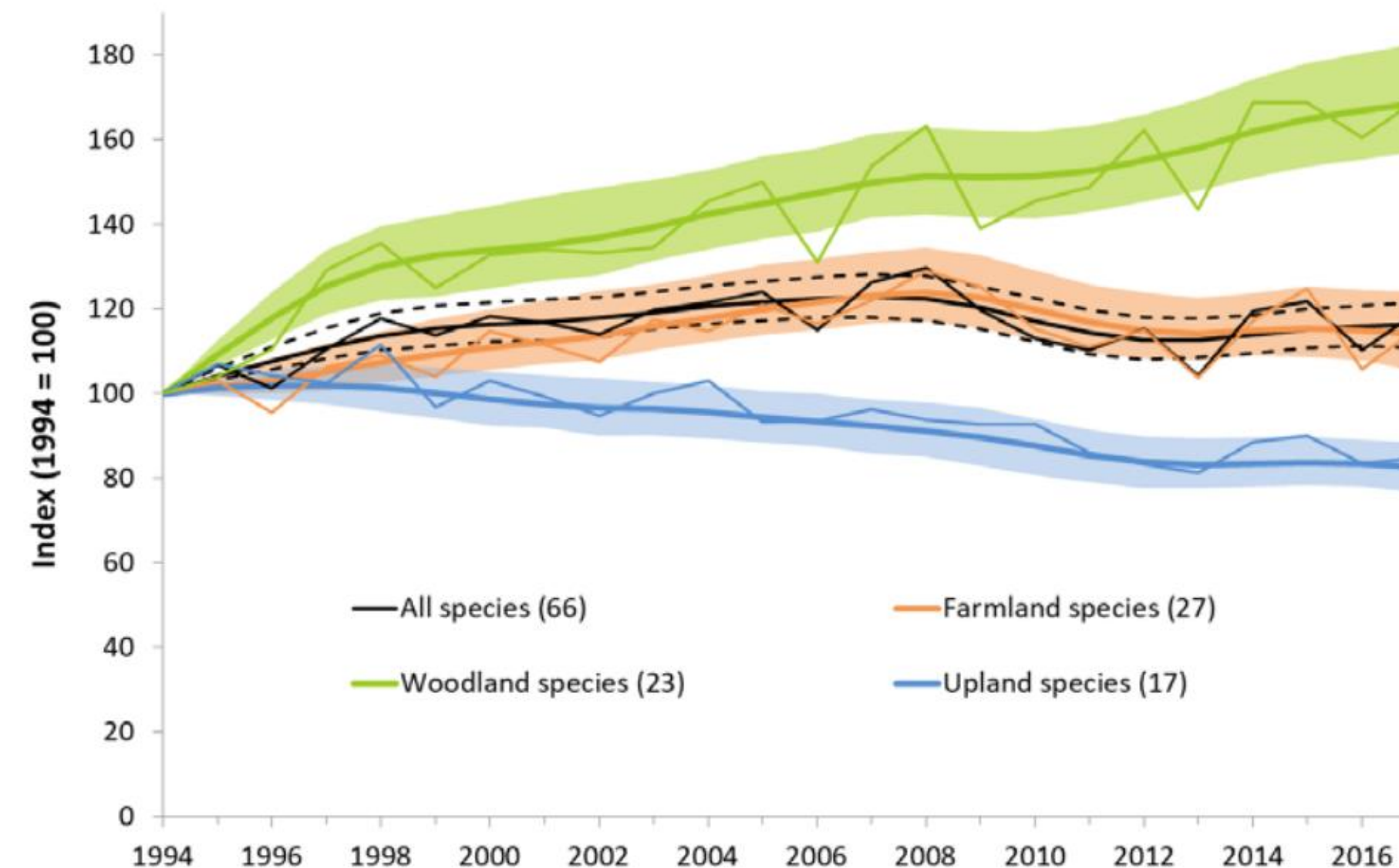
- Habitat in good ‘condition’
- Abundant wildlife populations
- Resilient to change
- A healthy ecosystem “delivers multiple benefits”
 - Clean water
 - Captures carbon
 - Not polluted
 - Attractive for recreation
 - Biodiversity is “intact”

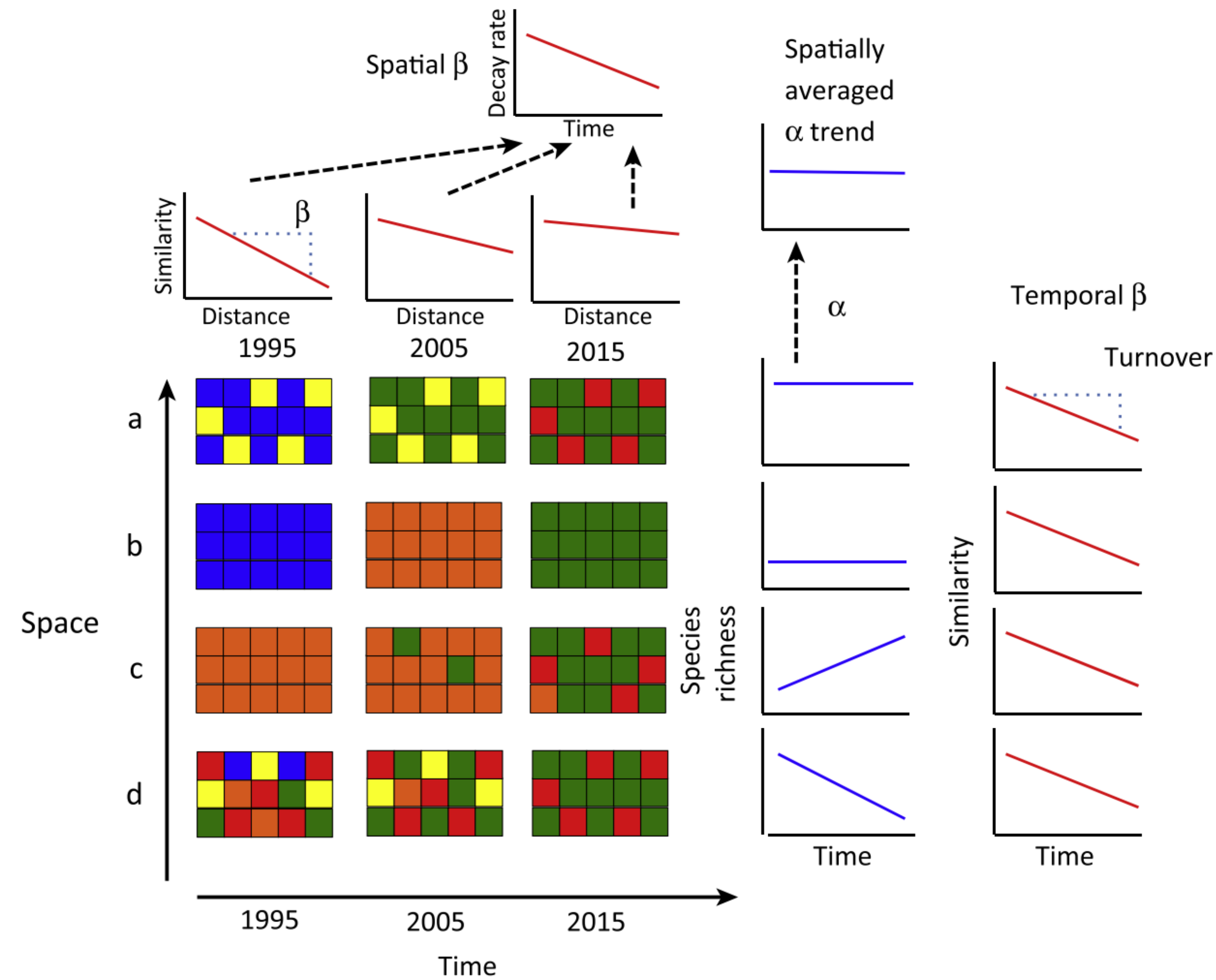
How might we measure ecosystem health using scheme data?

- A Scottish Govt indicator of Ecosystem Health
- Measures trends in average bird abundance
- Does this really reflect ecosystem properties?

Index of Abundance for Scottish Terrestrial Breeding Birds, 1994 to 2017

Thick and thin lines are smoothed and unsmoothed trends, respectively. Dashed lines (for all species trend) and shaded areas (for habitat specific trends) illustrate 95% confidence intervals.





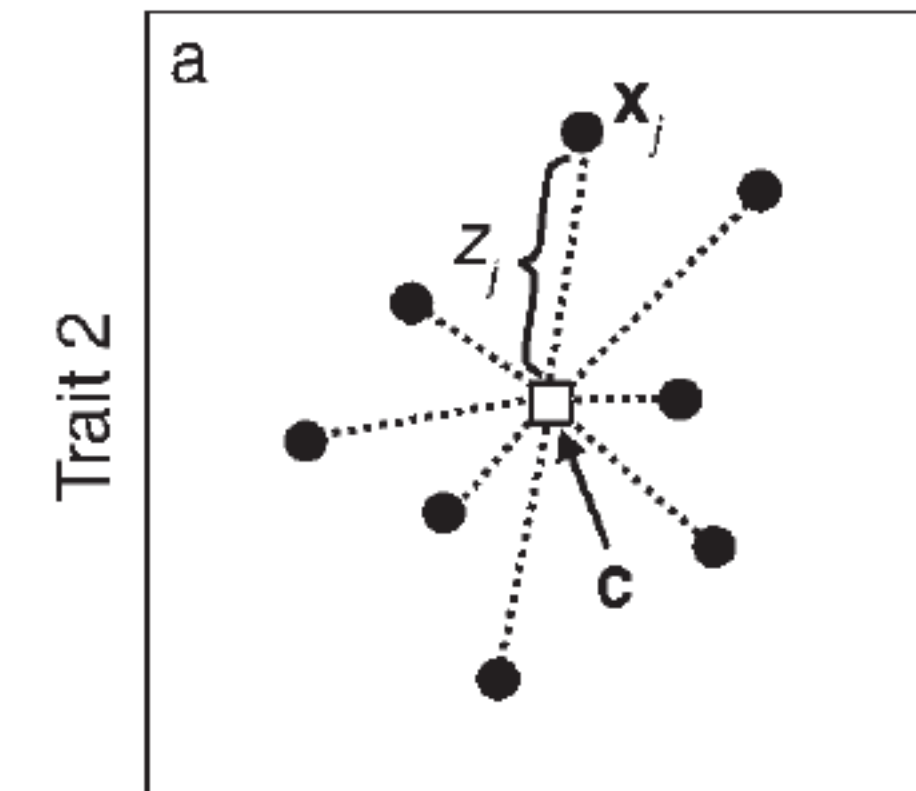
TRENDS in Ecology & Evolution

Figure I. Illustration of key types of biodiversity that can be measured. This figure follows four hypothetical communities (a–d) through three time periods (1995, 2005, 2015) (community abundance is constant, colors represent distinct species) demonstrating all of the major types of trends of α and β diversity.



How might we measure ecosystem health using scheme data?

- Membership-based indices
 - Average trends per site/species
 - Species richness trends per site
 - Diversity metrics (e.g. Shannon's entropy)
 - Community composition
- Trait-weighted indices
 - Functional diversity
 - Community-weighted trait values
 - Diversity profiles

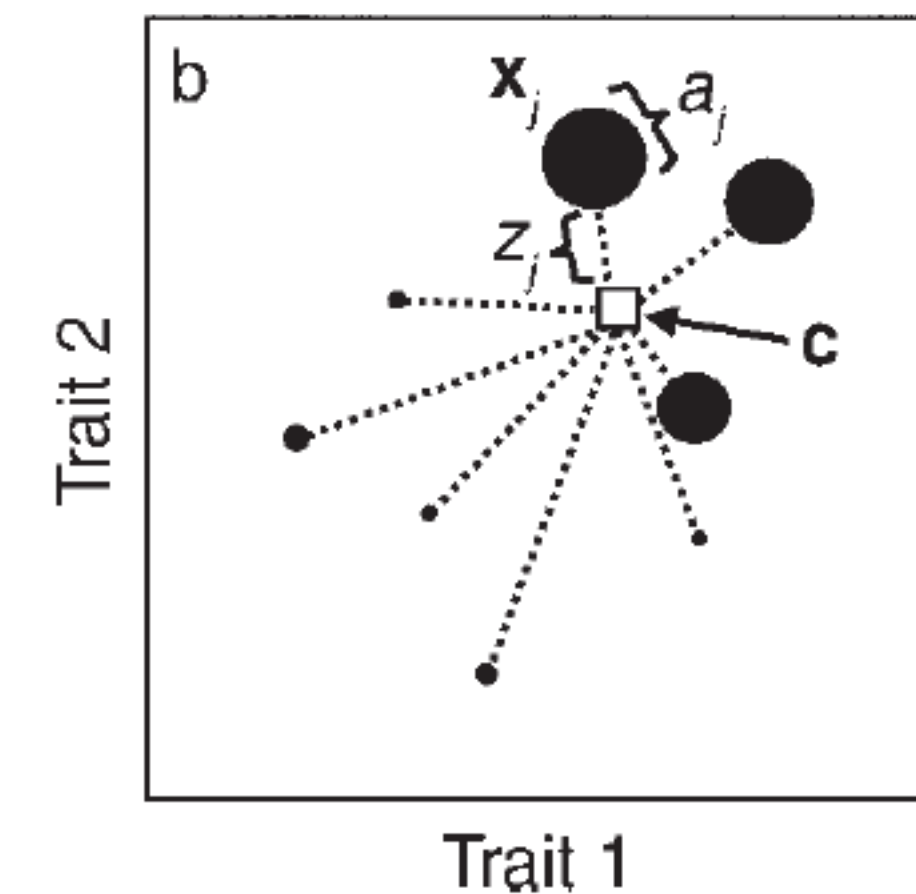


Centroid

$$\mathbf{c} = [c_i] = \frac{\sum x_{ij}}{n}$$

Functional dispersion

$$\text{FDis} = \frac{\sum z_j}{n}$$



Centroid

$$\mathbf{c} = [c_i] = \frac{\sum a_j x_{ij}}{\sum a_j}$$

Functional dispersion

$$\text{FDis} = \frac{\sum a_j z_j}{\sum a_j}$$

Community composition/integrity

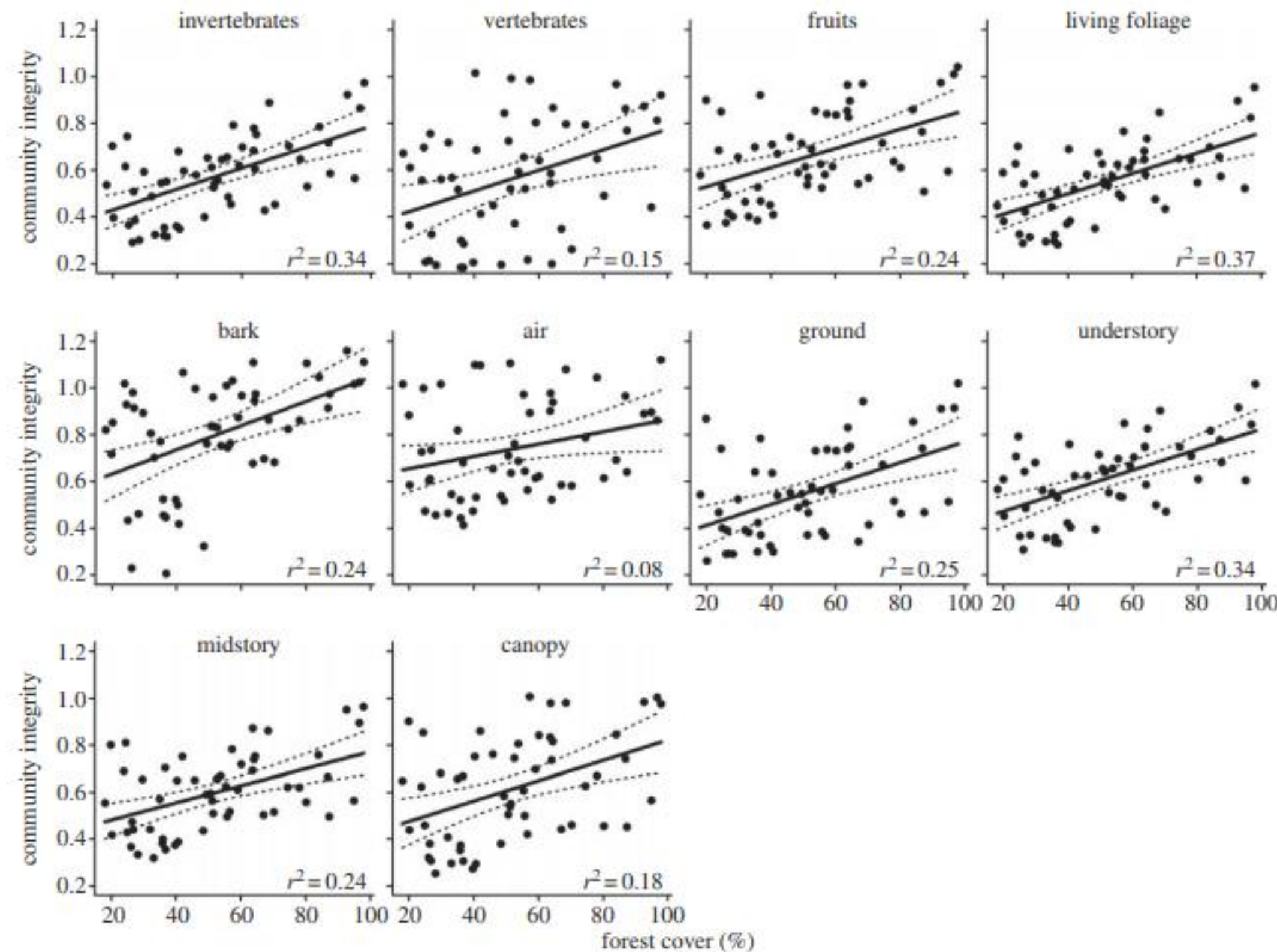
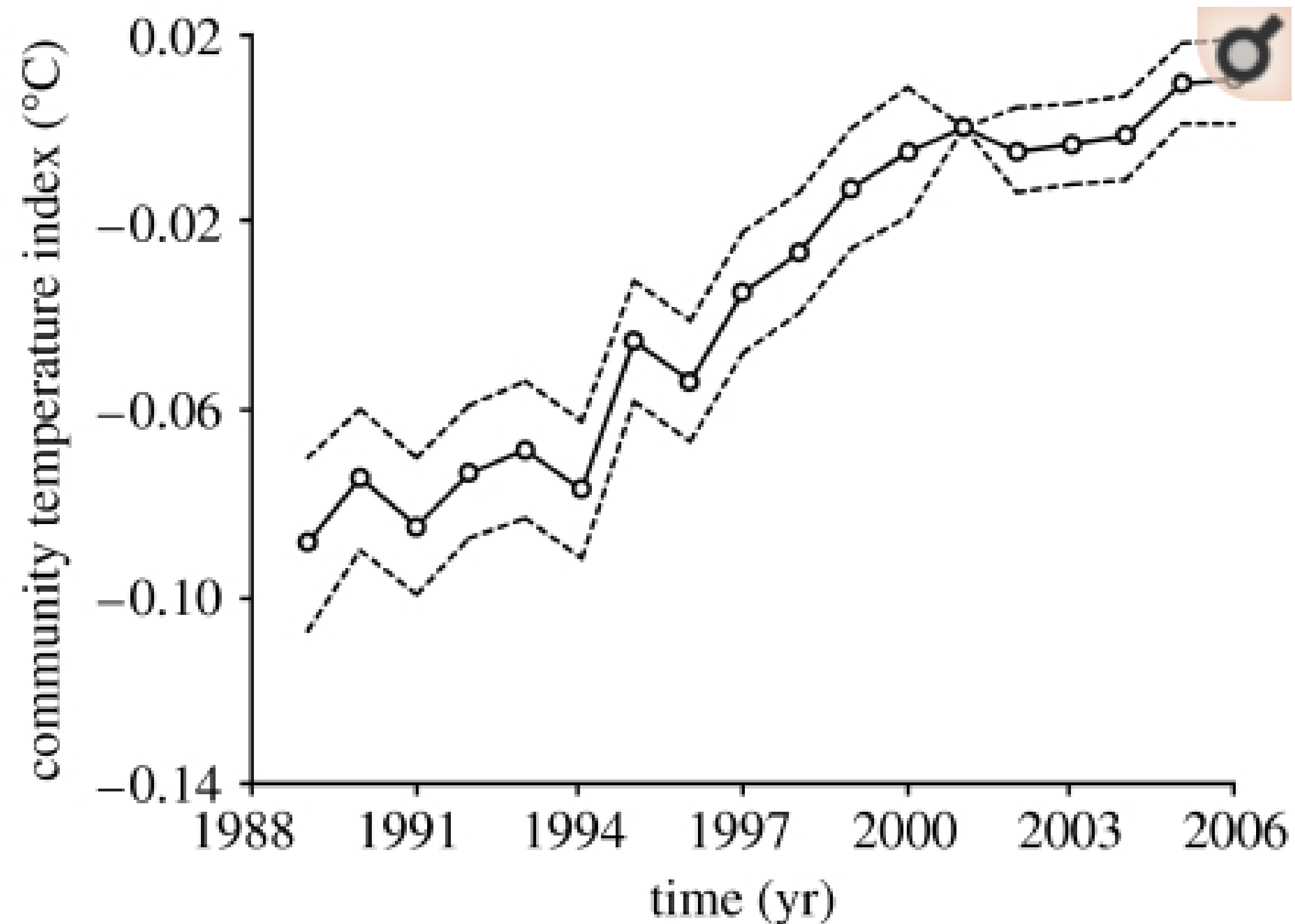


Figure 4. Species composition, measured as community integrity for different ecological groups, per site in relation to forest cover. Fitted values (solid lines), 95% confidence limits (dotted lines) and coefficients of determination r^2 are shown (all $p < 0.05$).

- Membership-based
- Conceptually difficult
- Sensitive to sampling effort
- Flexible for comparisons

Community-weighted means

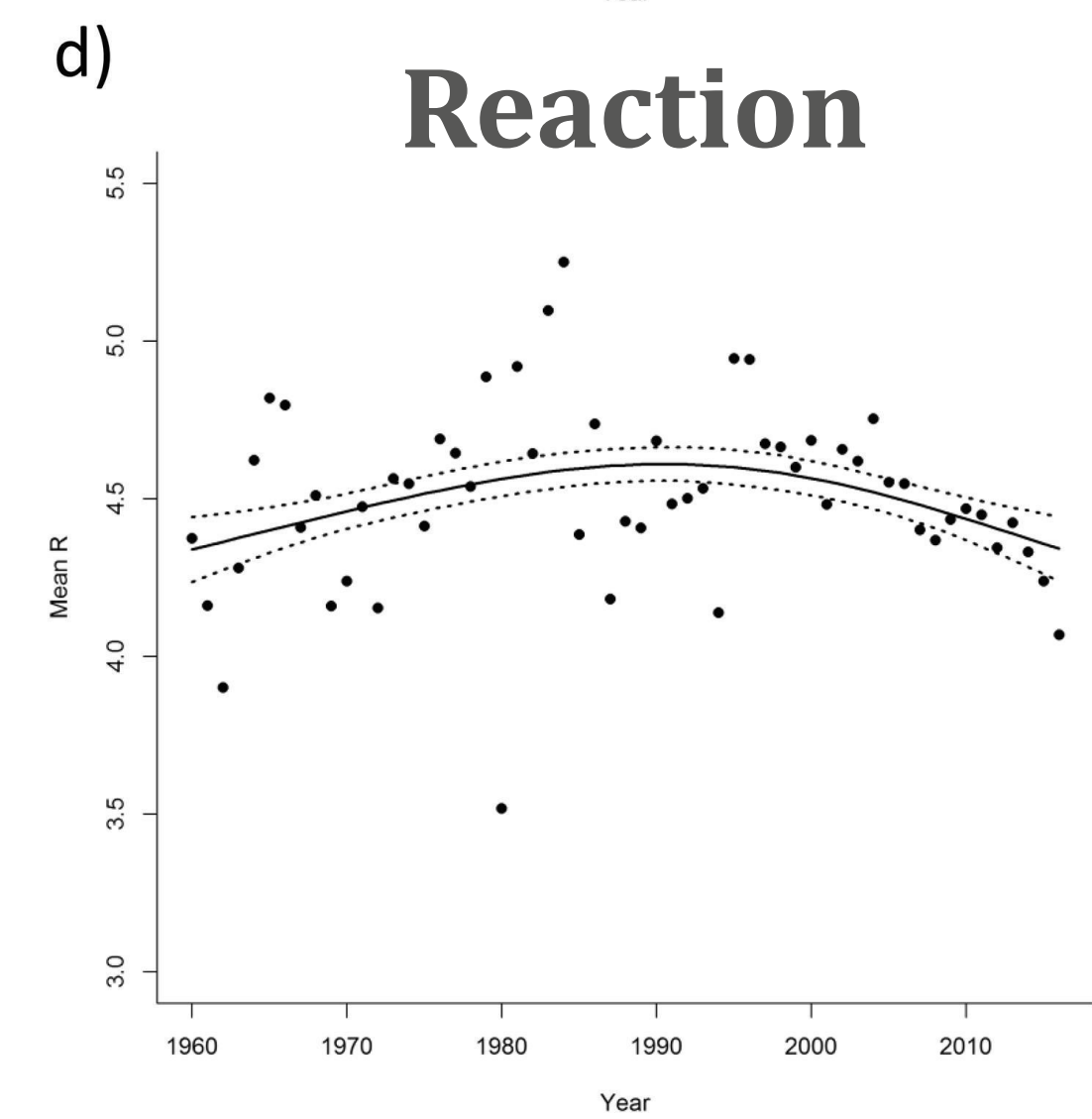
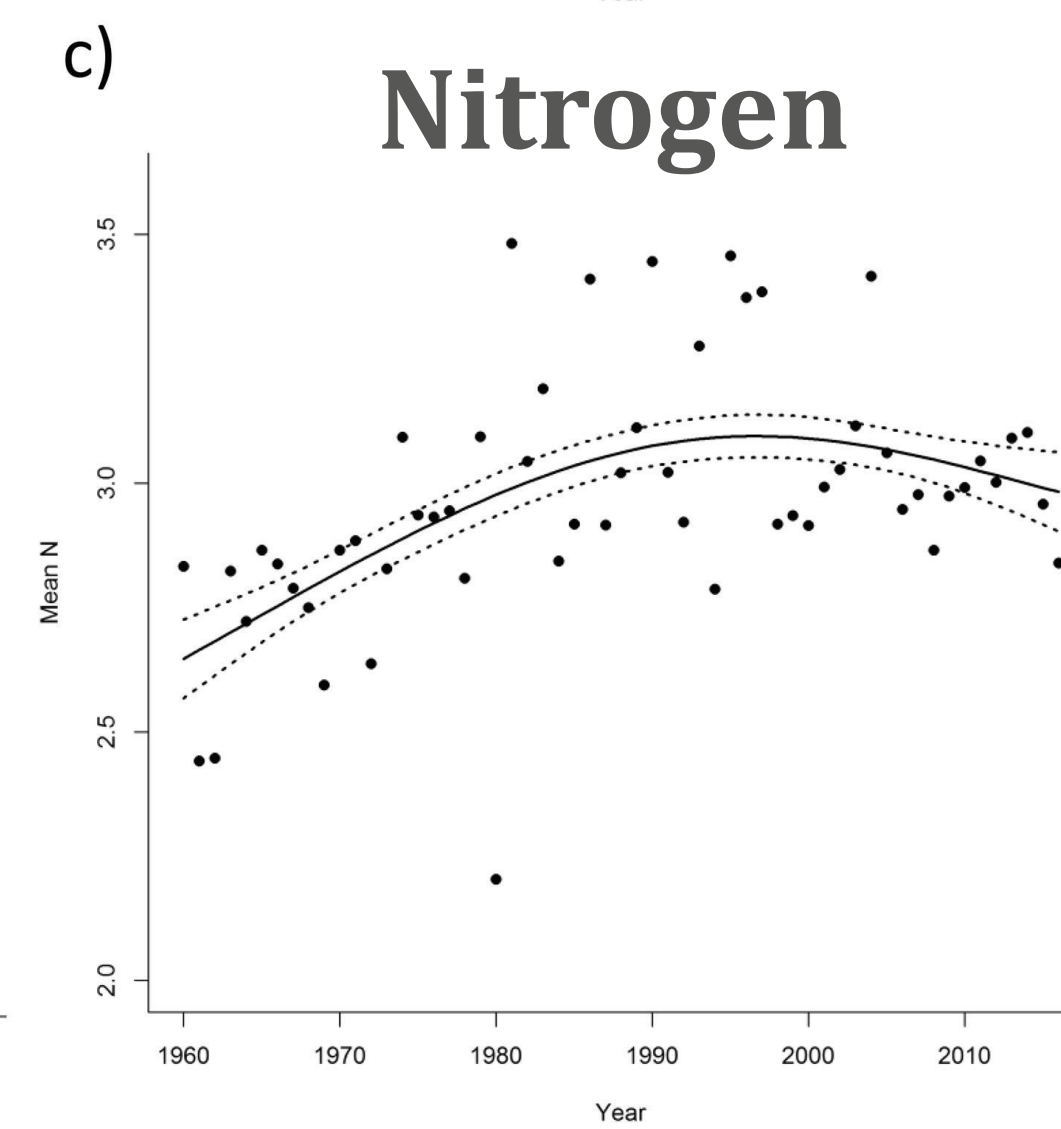
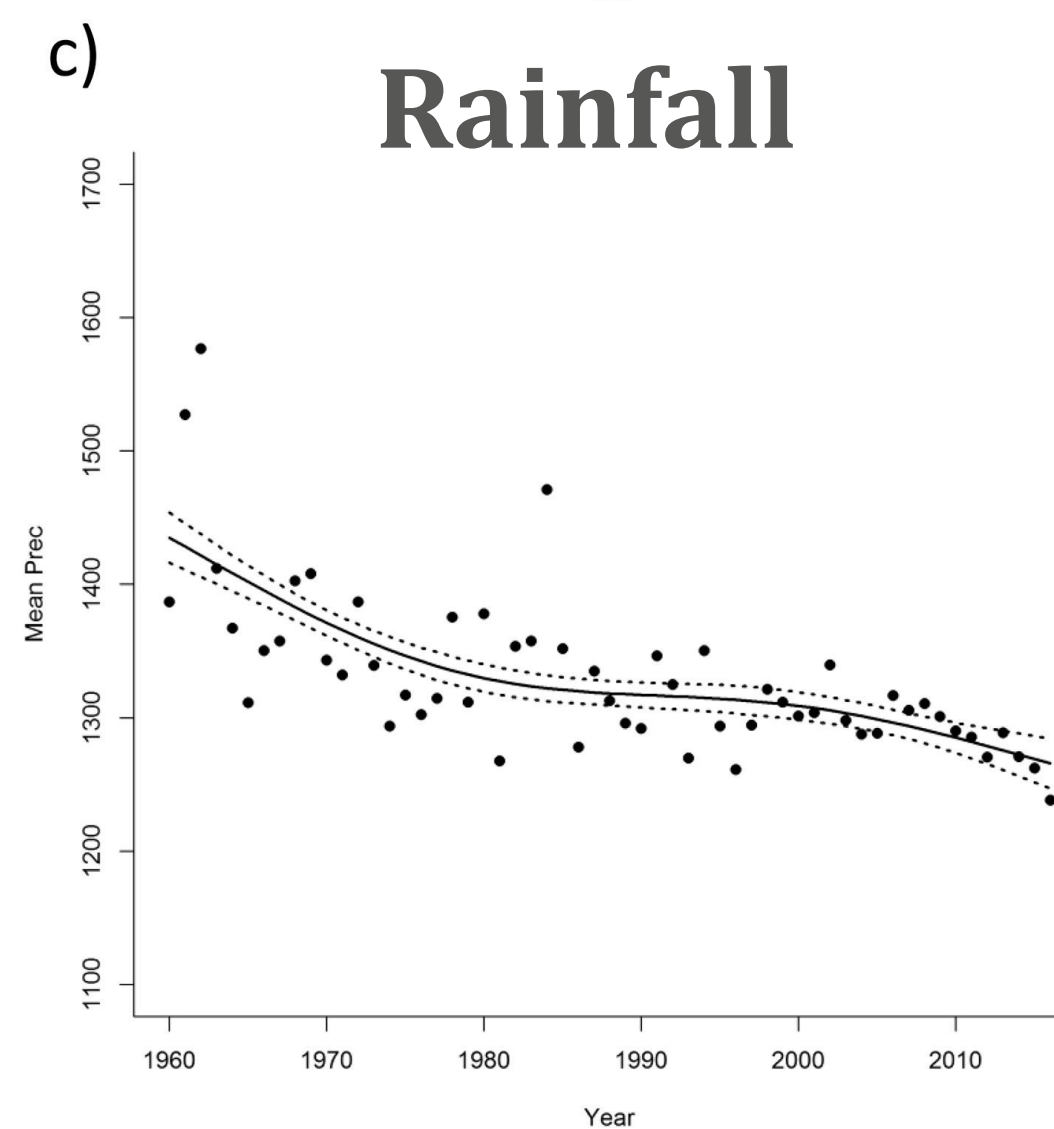
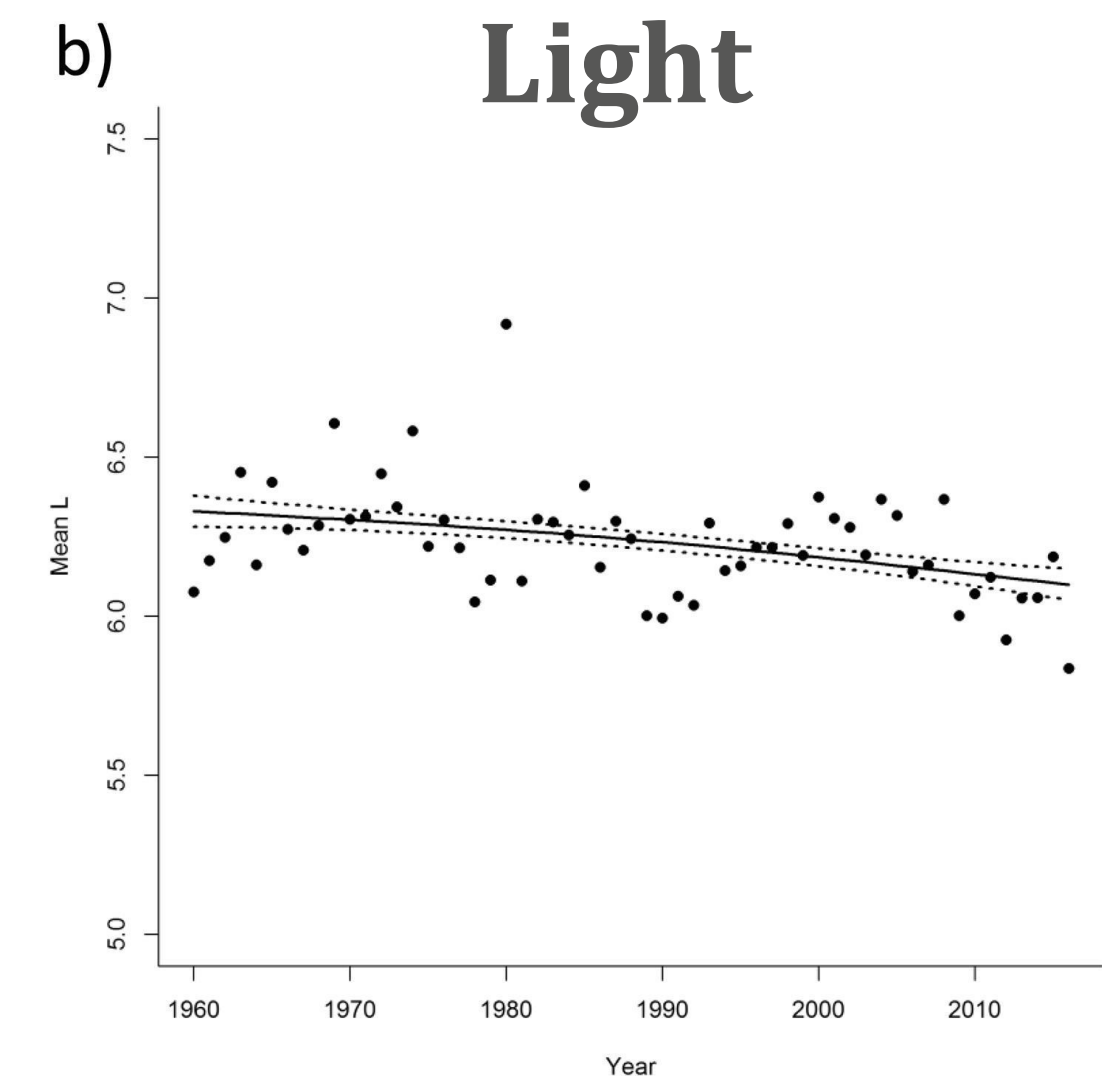
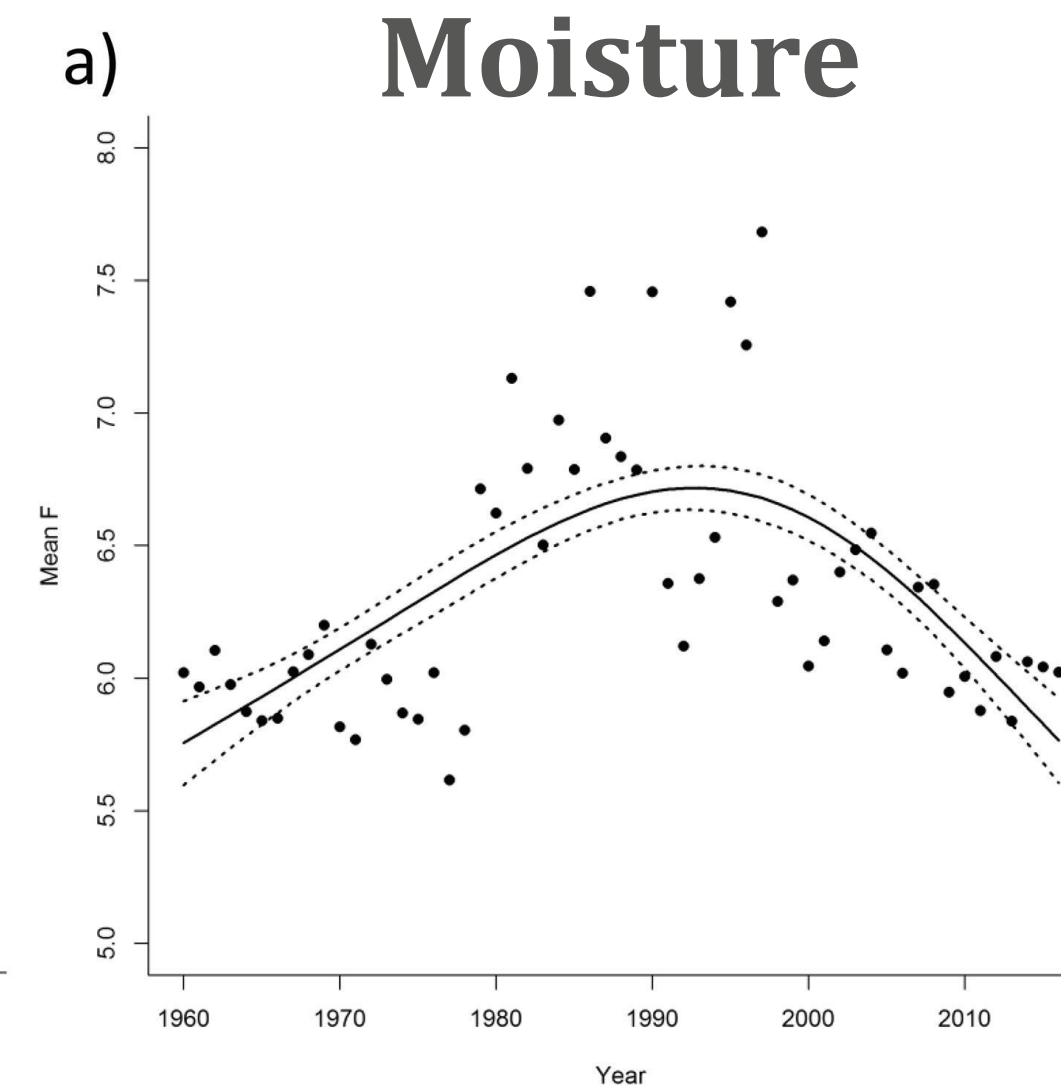
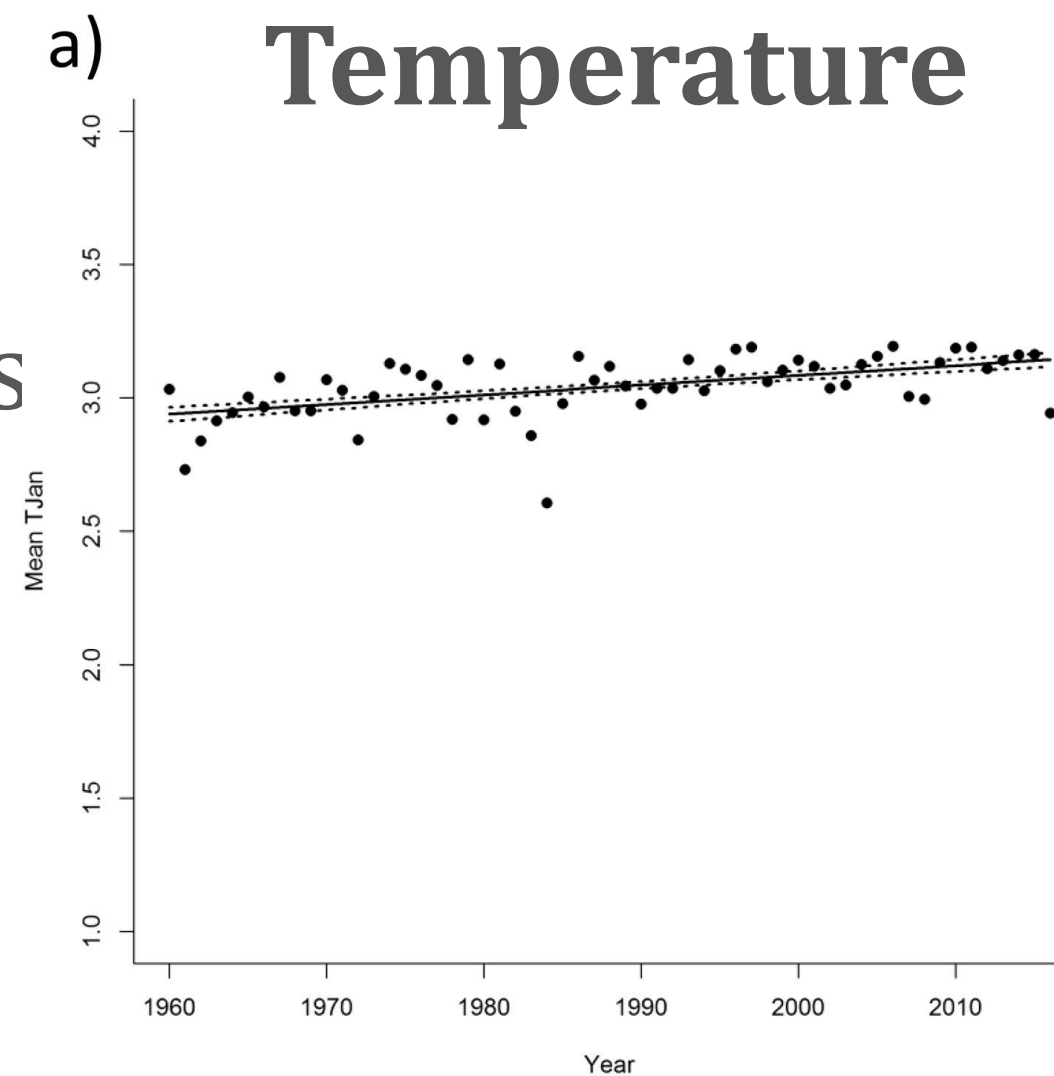


- Trait-weighted
- Fairly simple
- Sensitive to abundance changes
- Sensitive to species turnover
- One trait at a time
- Calculable for sites or nationally

Scottish Bryophytes

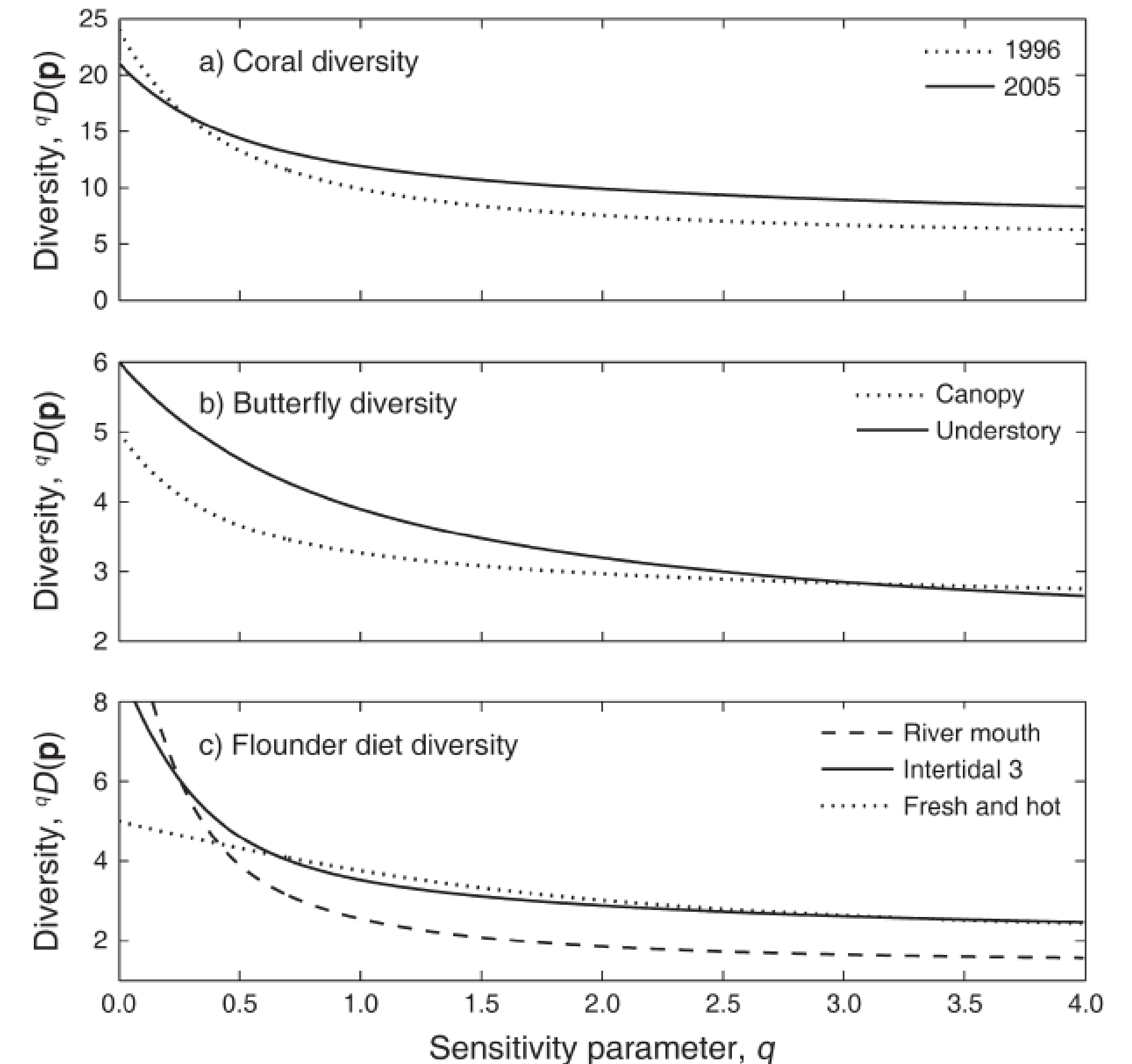
- Trait-weighted trends in Scottish Bryophytes
- Under consideration by Scottish Govt
- Are these trends interpretable?
- What do national trends tell us about ecosystems?

Pakeman *et al* (2019) *Ecological Indicators*



Diversity Profiles

- Expansion of functional diversity (trait-weighted)
- Accounts for similarity among species (e.g. phylogenetic)
- Accounts for abundance
- Not easy interpret!



Conclusions

- “Ecosystem Health” is gaining currency among agencies and policy-makers
- The latest buzzword?
 - Same message, different packaging?
- Encapsulates many existing terms
 - ecosystem services, natural capital
- Many biodiversity metrics could be provide useful indicators
 - Species richness, functional diversity, “biotic intactness”
- Scheme data has potential to provide data for policy

Acknowledgments

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