

1. Measuring Biodiversity

Jasper Slingsby, BIO3018F

2024-01-25

This module is about how you would measure biodiversity to address the different needs,

but first, a little *think-pair-share* activity:

Take 5 minutes and jot down your thoughts on the following 2 questions. Then you'll pair up with a classmate and share your thoughts with each other.

- What is biodiversity?
- Why would you want to measure biodiversity?

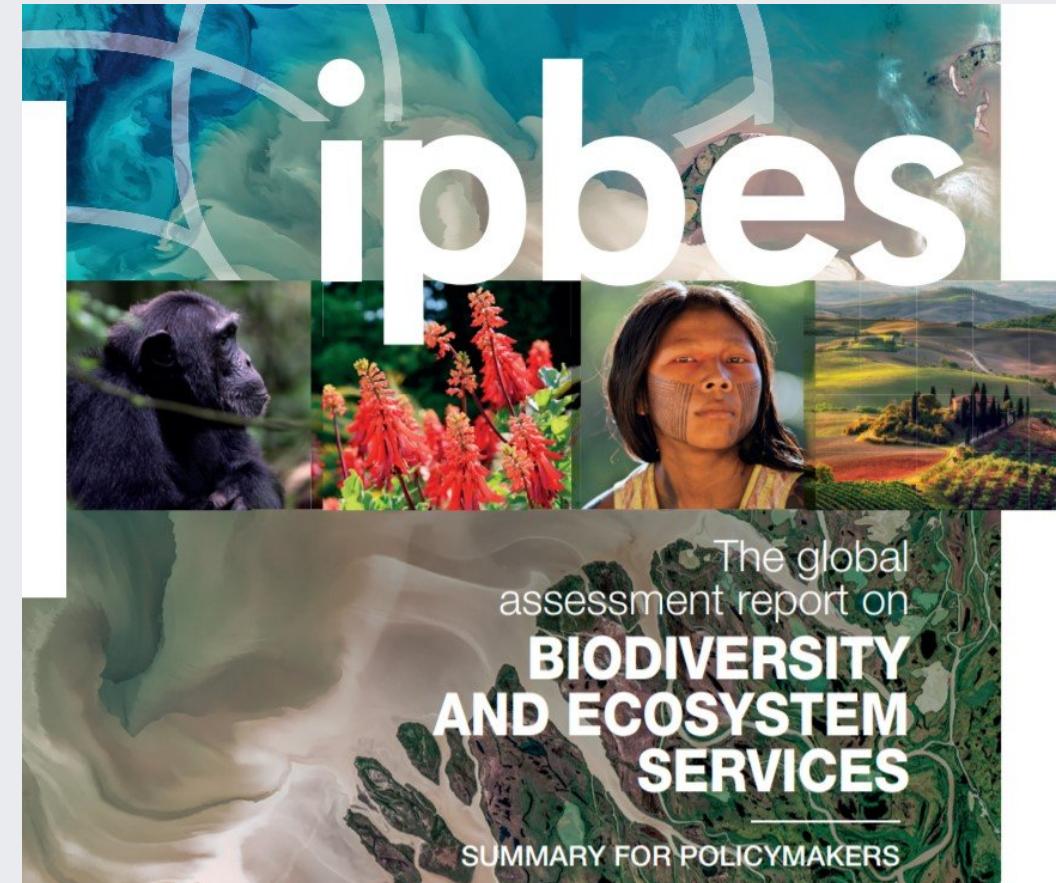
What is biodiversity?

Why would you want to measure biodiversity?

We depend on biodiversity...

There is growing focus on the importance of biodiversity for our survival

Large global initiatives like the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) focus on strengthening the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development

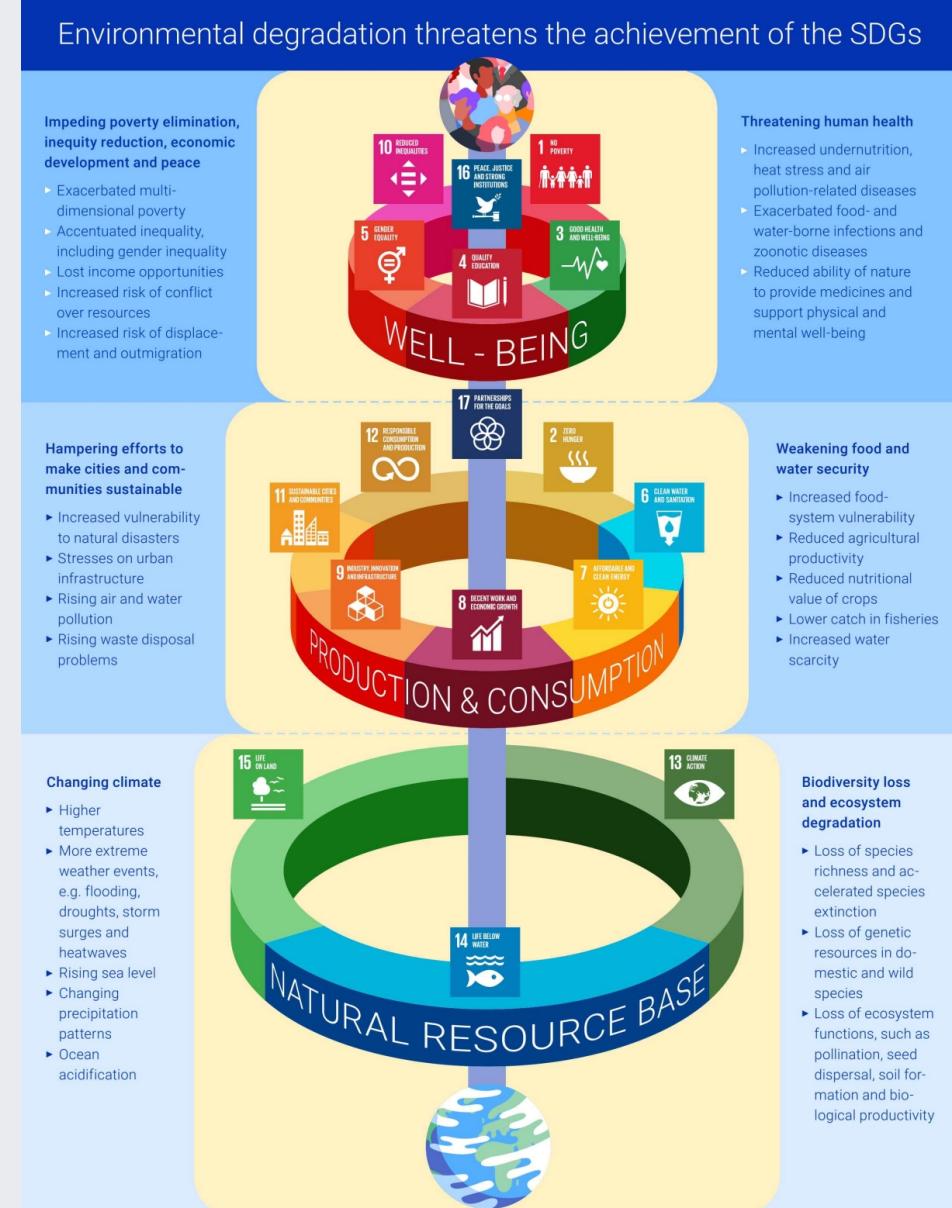


<https://ipbes.net/global-assessment>

We depend on biodiversity...

Attainment of the Sustainable Development Goals (SDGs) depends on the attainment of the goals relating to natural resource management, namely:

- SDG 13 Climate Action
- SDG 14 Life Below Water
- SDG 15 Life On Land



My research focuses on...

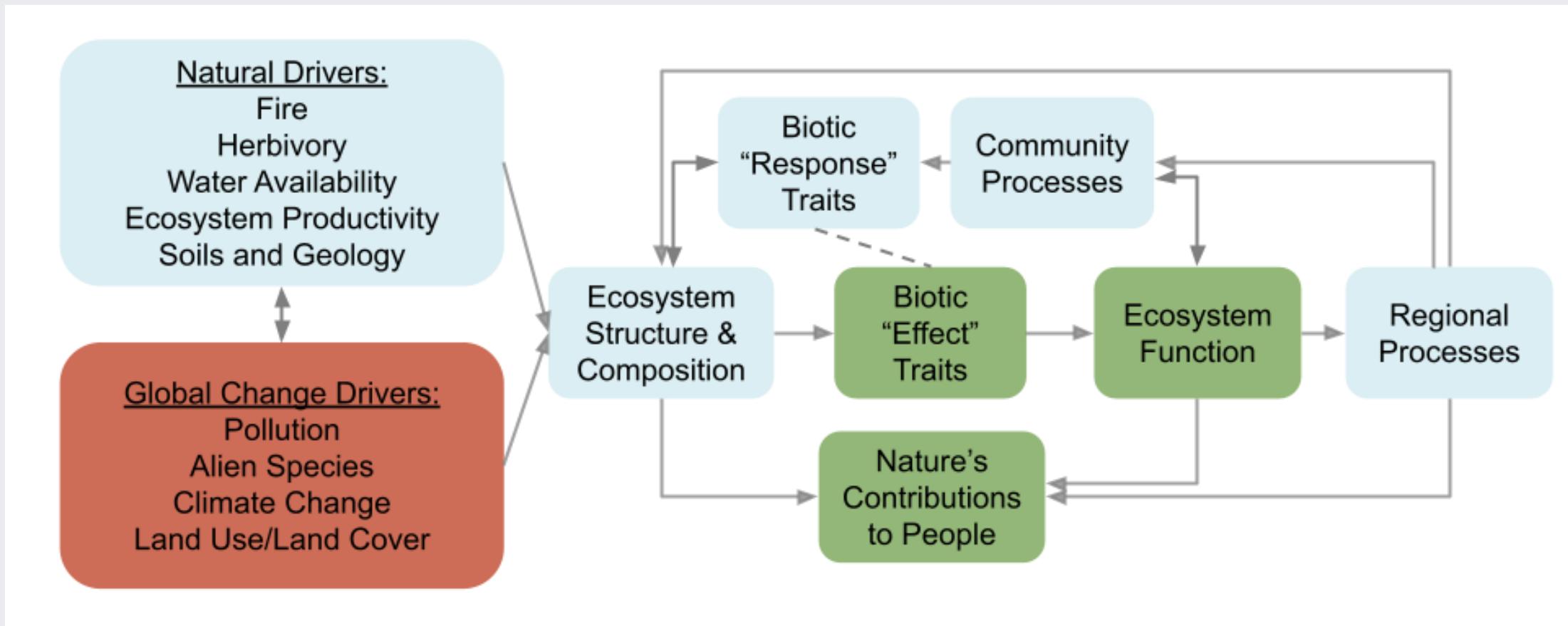
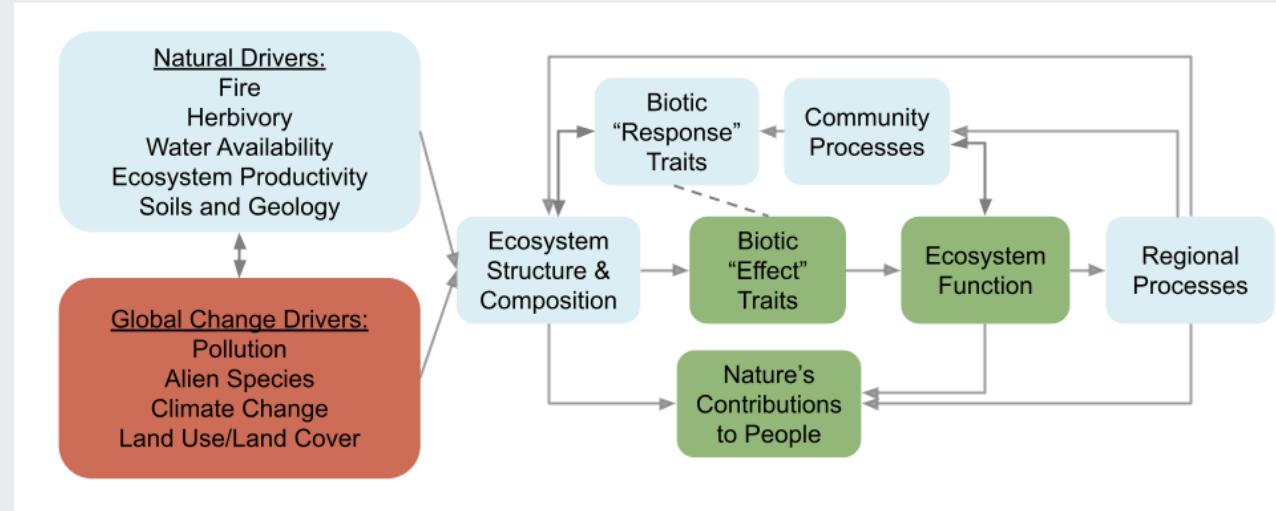


Figure modified from Chapin et al. 1997, *Science*

My research focuses on four questions...

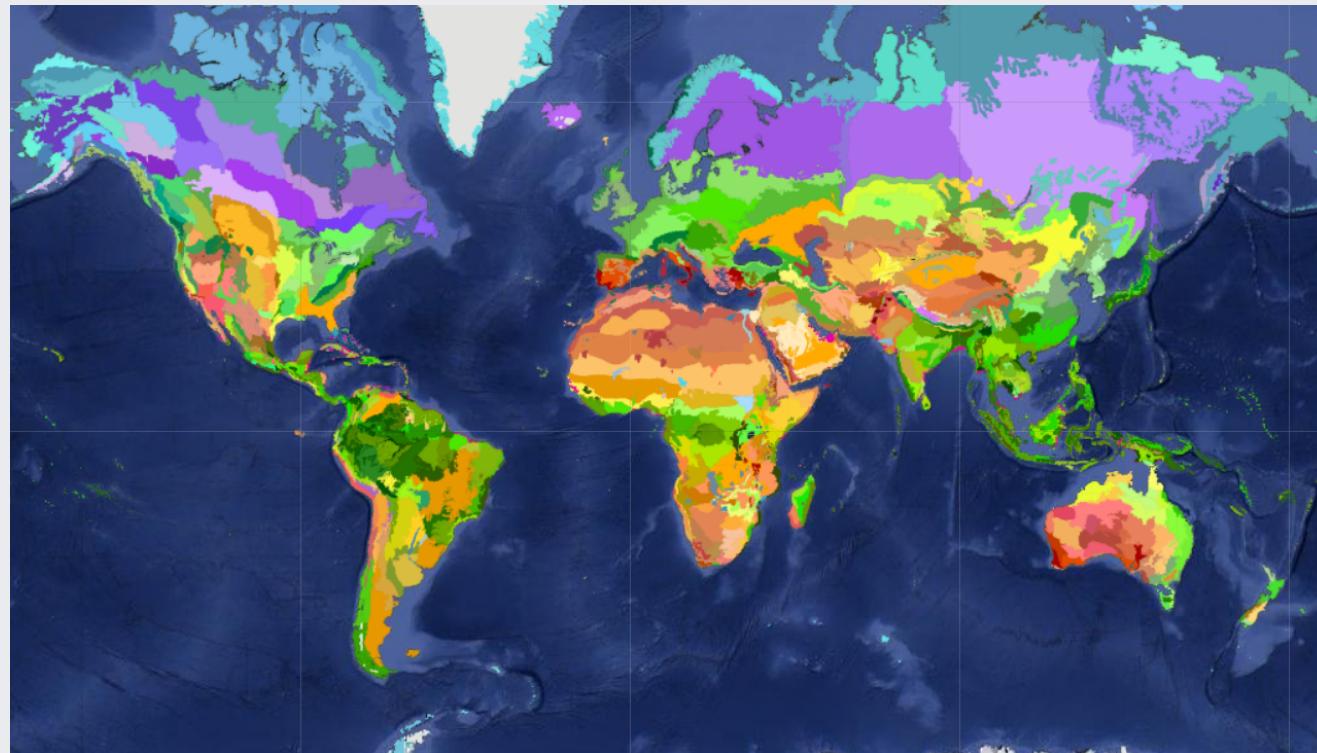


1. What determines the composition and diversity of communities and ecosystems at various scales?
2. What is the role of biodiversity in ecosystem function (and derived societal benefits)?
3. How is biodiversity changing and what are the impacts on ecosystem services?
4. How can we mitigate or adapt to changing biodiversity and ecosystem services?

Figure modified from Chapin et al. 1997, *Science*

This requires measuring biodiversity to...

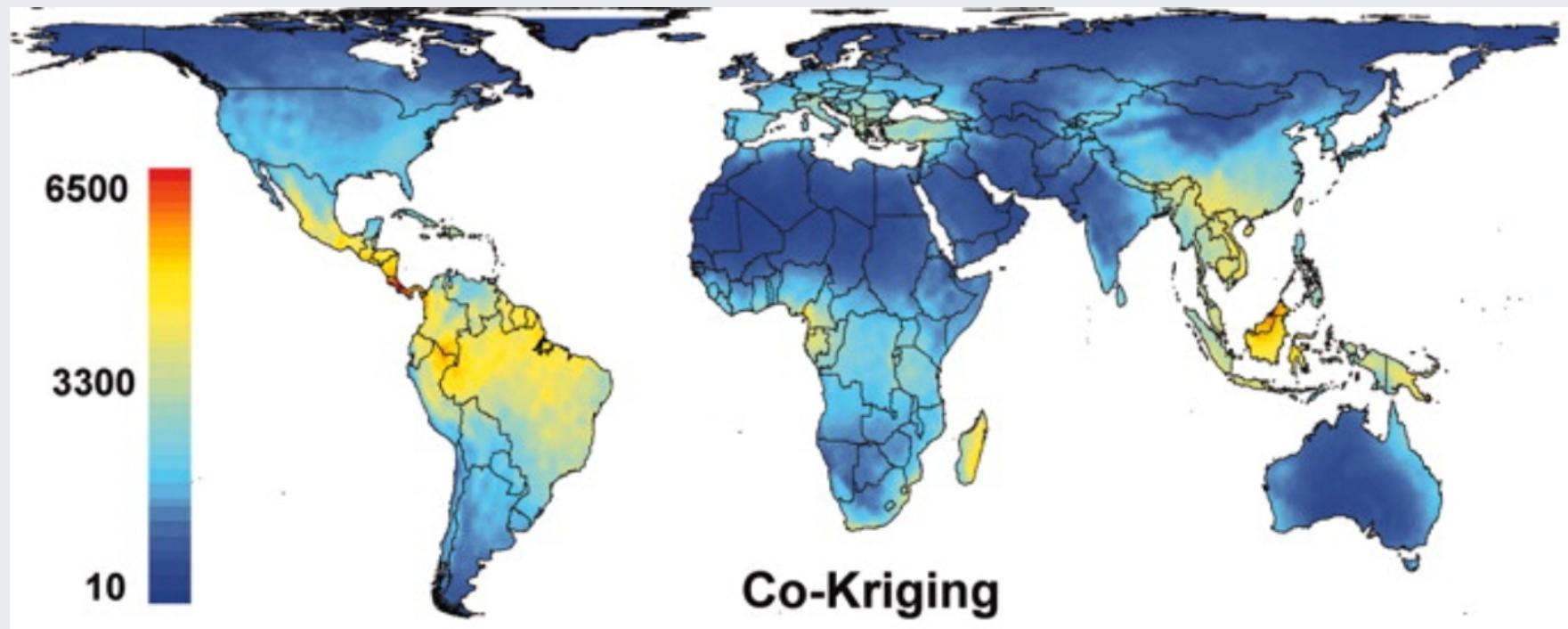
Map the distribution of species and ecosystems



<https://ecoregions.appspot.com/>

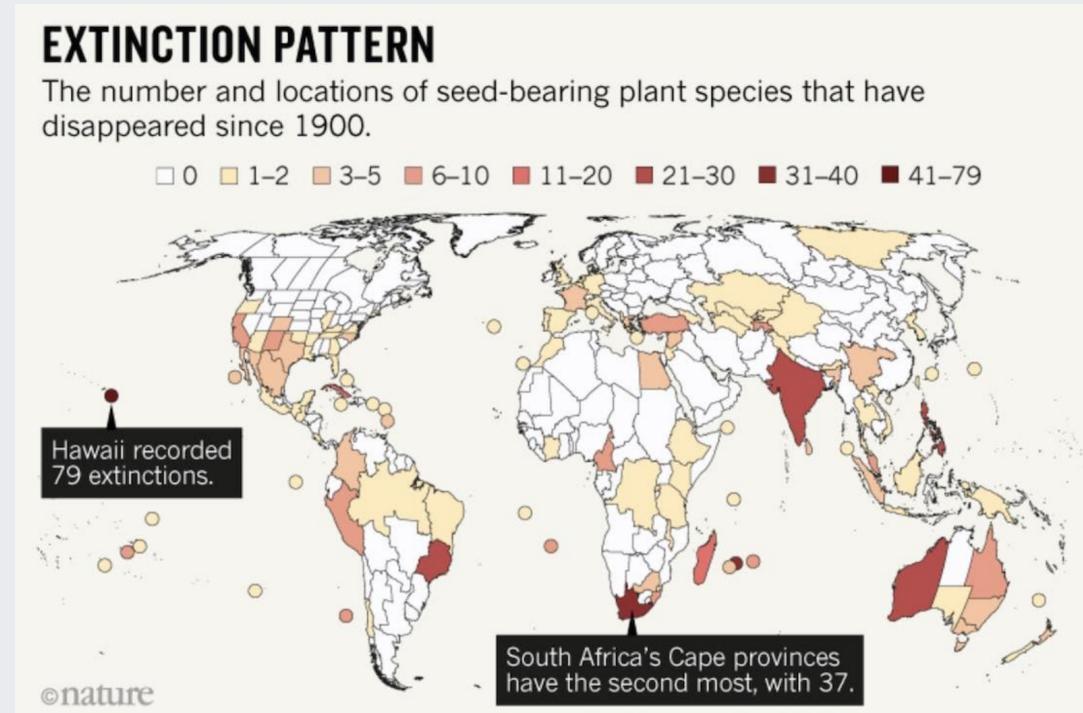
This requires measuring biodiversity to...

Develop and test theory - e.g. What determines species richness?



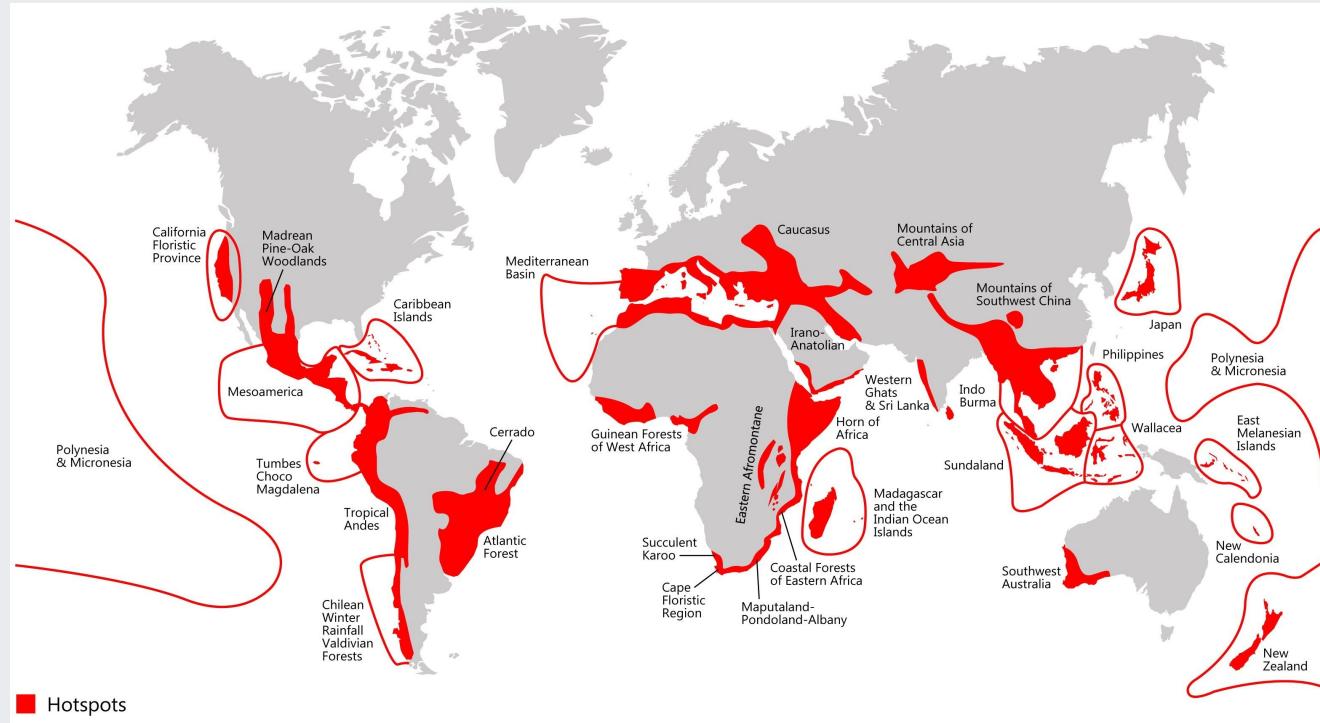
This requires measuring biodiversity to...

Track change in biodiversity



This requires measuring biodiversity to...

Set conservation priorities

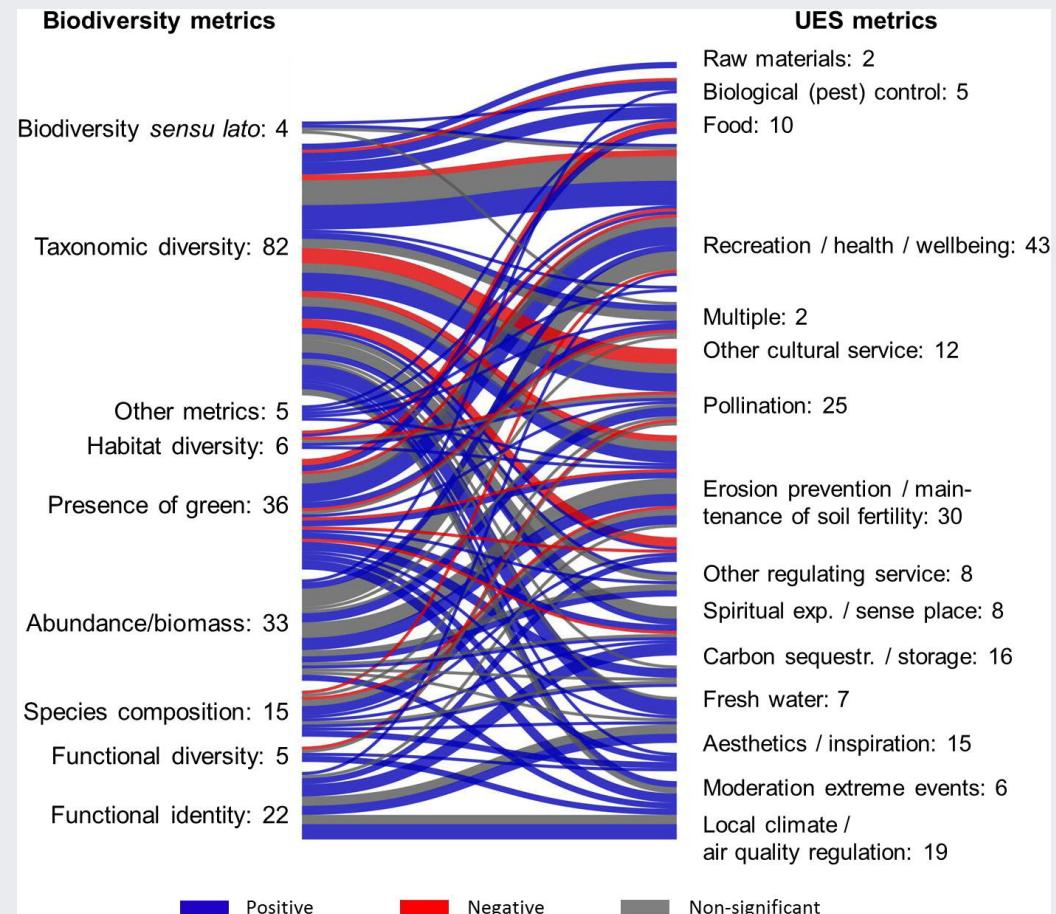


<https://www.conservation.org/priorities/biodiversity-hotspots>

This requires measuring biodiversity to...

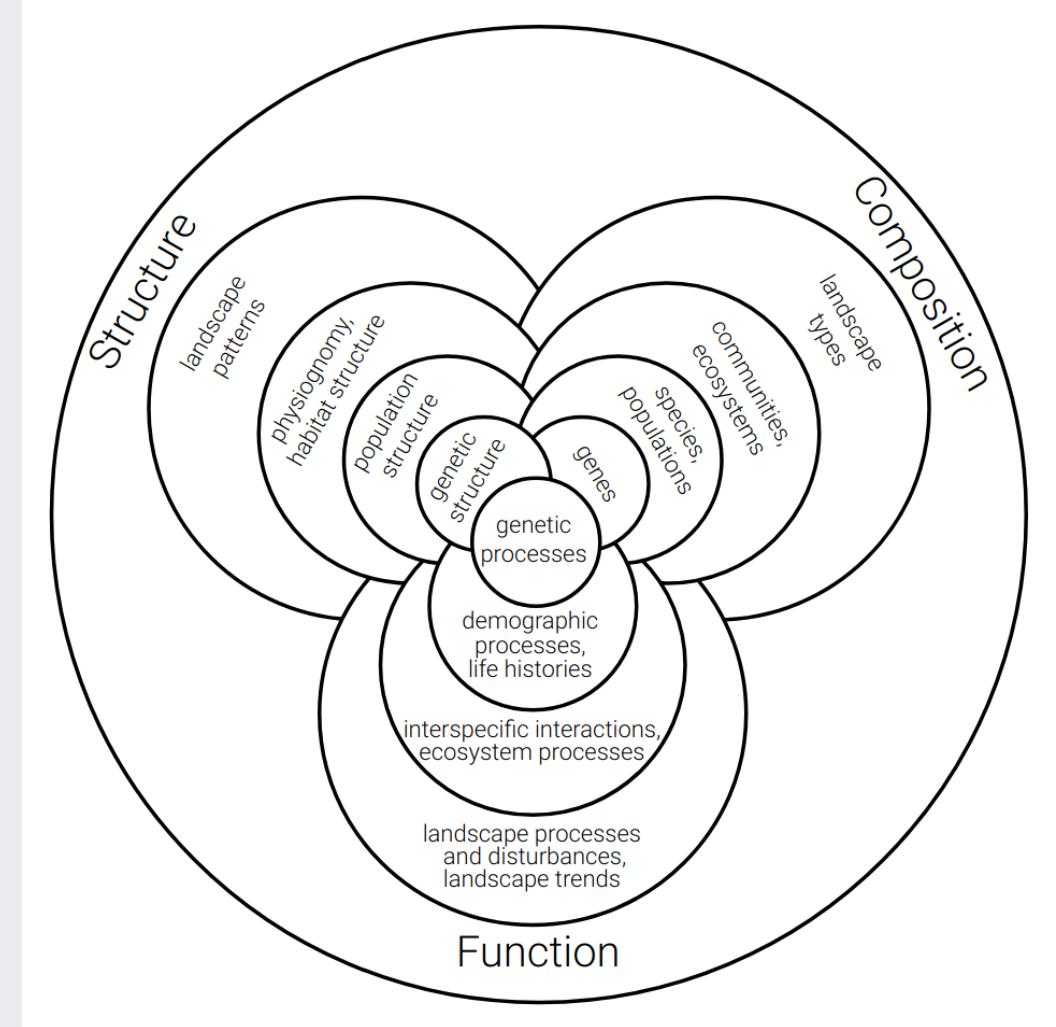
Understand the role of biodiversity

Here we see relationships between biodiversity metrics and urban ecosystem services (UES) that have been tested empirically (from Schwartz et al. 2017).



But there are many facets of biodiversity!

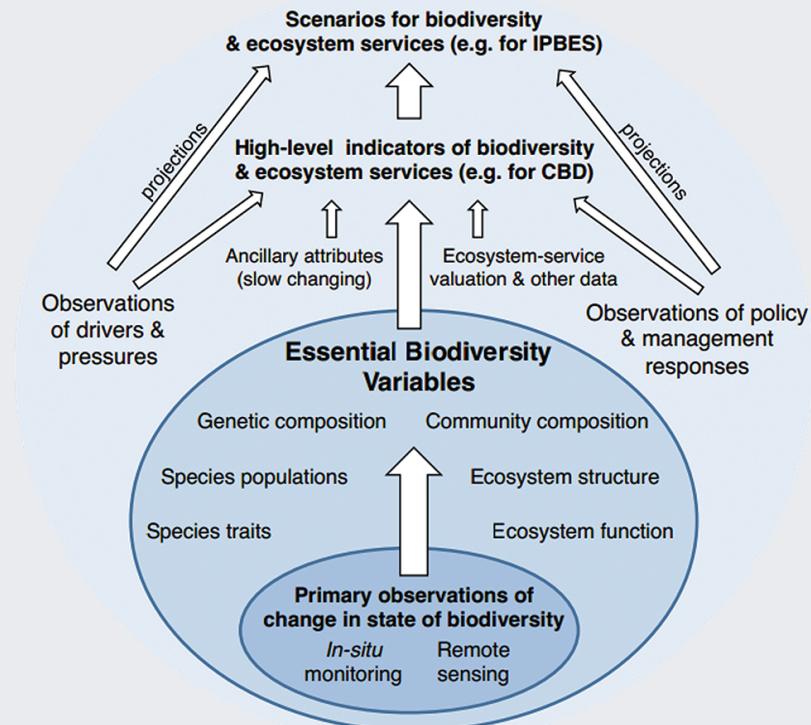
"biodiversity is the sum total of all biotic variation from the level of genes to ecosystems" - Purvis & Hector 2000, *Nature*



Noss 1990, *Conservation Biology*

With different aspects that can be measured!

Essential Biodiversity Variables (EBVs)



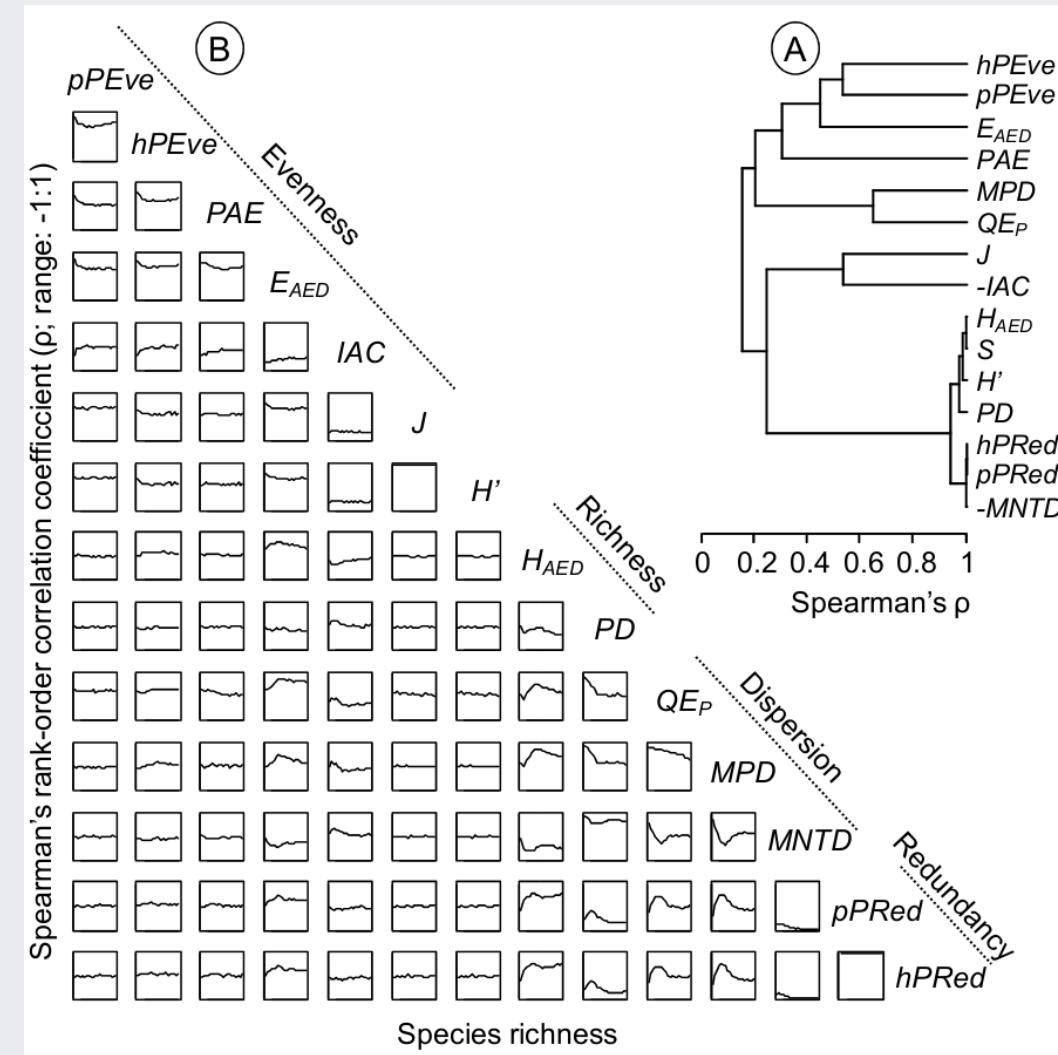
EBV.class	EBV.name
Genetic composition	Genetic diversity (richness and heterozygosity)
	Genetic differentiation (number of genetic units and genetic distance)
	Effective population size
	Inbreeding
Species populations	Species distributions
	Species abundances
Species traits	Morphology
	Physiology
	Phenology
	Movement
Community composition	Community abundance
	Taxonomic/phylogenetic diversity
	Trait diversity
	Interaction diversity
Ecosystem functioning	Primary productivity
	Ecosystem phenology
	Ecosystem disturbances
Ecosystem structure	Live cover fraction
	Ecosystem distribution
	Ecosystem Vertical Profile

And many ways of measuring them!

Many kinds of diversity

- Genetic diversity
- Taxonomic diversity
- Phylogenetic diversity
- Functional diversity
- Ecosystem diversity
- etc...

And many methods for measuring each of them!!!



A comparison of *some* phylogenetic diversity indices from Slingsby 2011, *PhD Thesis*

Problem!

We need to be able to measure biodiversity to develop questions, test hypotheses, map priorities, etc

"The use of different measures or analytical approaches on a single set of data can naturally result in quite different outcomes and interpretations." - Anderson et al. 2011

i.e., there is no one perfect measure of biodiversity.

Take home

Measures of biodiversity are hypotheses themselves! Most biodiversity-related hypotheses should be prefaced "*Assuming our measure of biodiversity is a reasonable approximation of reality, then...*"

It's crucial that we master the methods for measuring and analyzing biodiversity data, and explore the assumptions and implications of the measures we use for the questions and goals at hand...

References

- Anderson, M. J., T. O. Crist, J. M. Chase, et al. (2011). "Navigating the multiple meanings of beta-diversity: a roadmap for the practicing ecologist". En. In: *Ecology letters* 14.1, pp. 19-28. ISSN: 1461-023X, 1461-0248. DOI: 10.1111/j.1461-0248.2010.01552.x.
- Noss, R. F. (1990). "Indicators for monitoring biodiversity: A hierarchical approach". En. In: *Conservation biology: the journal of the Society for Conservation Biology* 4.4, pp. 355-364. ISSN: 0888-8892, 1523-1739. DOI: 10.1111/j.1523-1739.1990.tb00309.x.
- Purvis, A. and A. Hector (2000). "Getting the measure of biodiversity". En. In: *Nature* 405.6783, pp. 212-219. ISSN: 0028-0836. DOI: 10.1038/35012221.
- Schwarz, N., M. Moretti, M. N. Bugalho, et al. (2017). "Understanding biodiversity-ecosystem service relationships in urban areas: A comprehensive literature review". In: *Ecosystem Services* 27, pp. 161-171. ISSN: 2212-0416. DOI: 10.1016/j.ecoser.2017.08.014.
- Stuart Chapin III, F., B. H. Walker, R. J. Hobbs, et al. (1997). "Biotic Control over the Functioning of Ecosystems". En. In: *Science*. ISSN: 0036-8075. DOI: 10.1126/science.277.5325.500.

Thanks!

Slides created via the R packages:

xaringan
gadenbuie/xaringanthemer

The chakra comes from remark.js, **knitr**, and R Markdown.