

# 1. Measuring Biodiversity

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# 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?

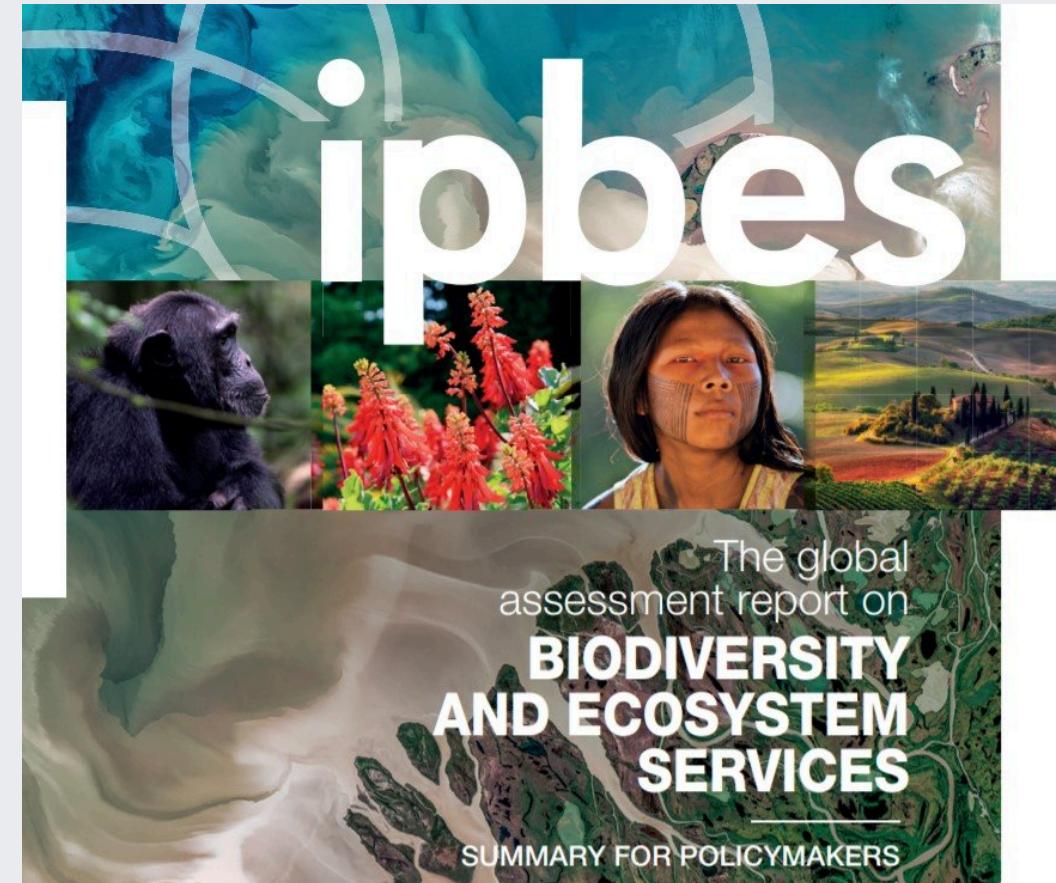
# What is biodiversity?

# 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

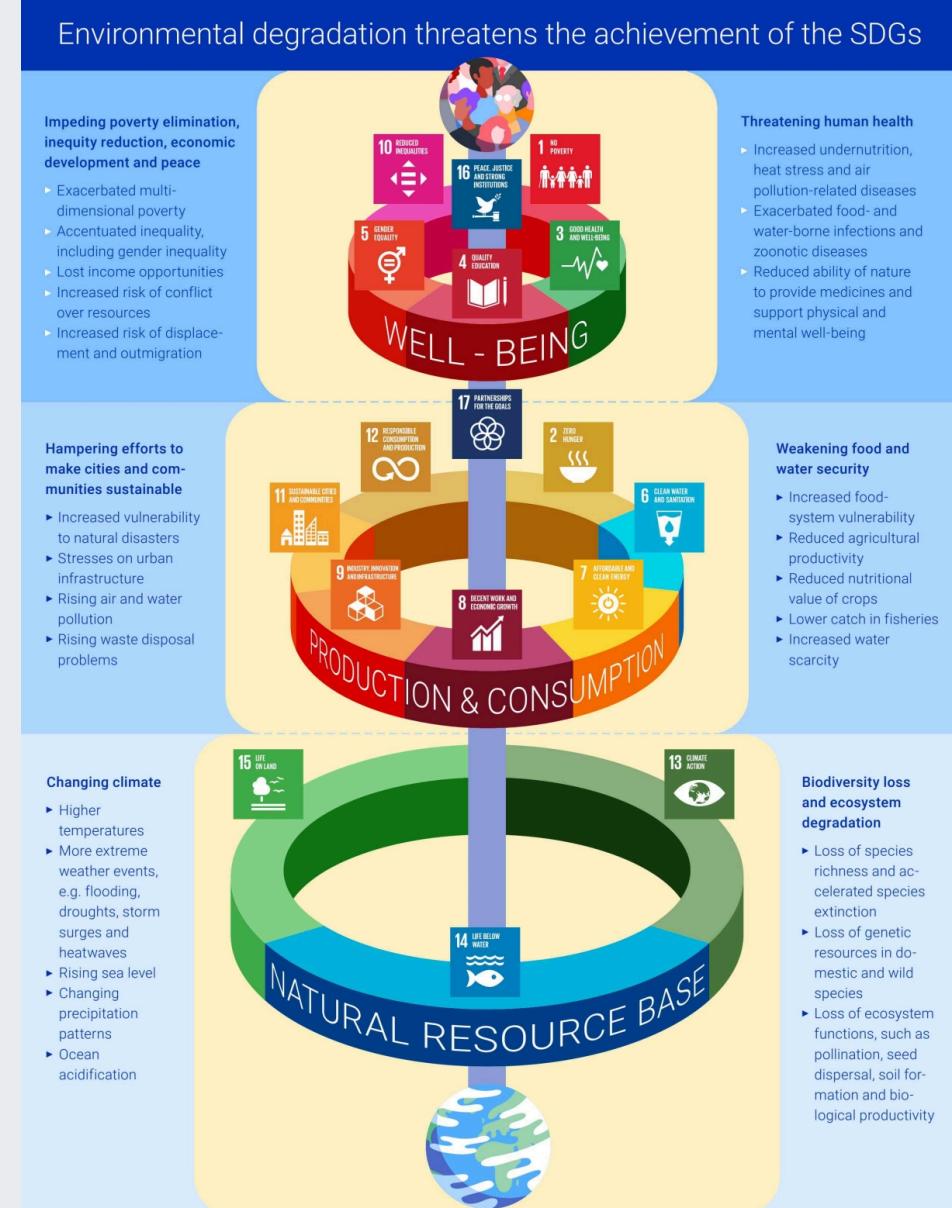


<https://ipbes.net/global-assessment>

# 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...

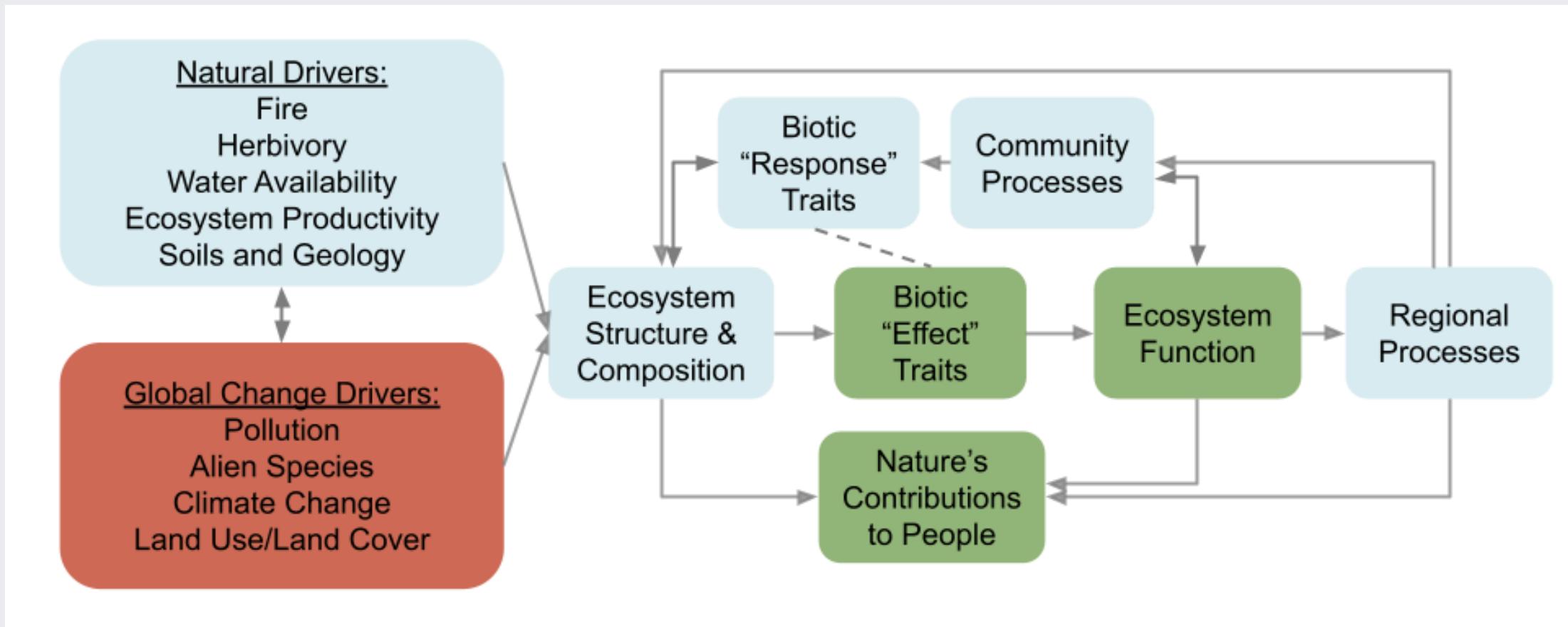
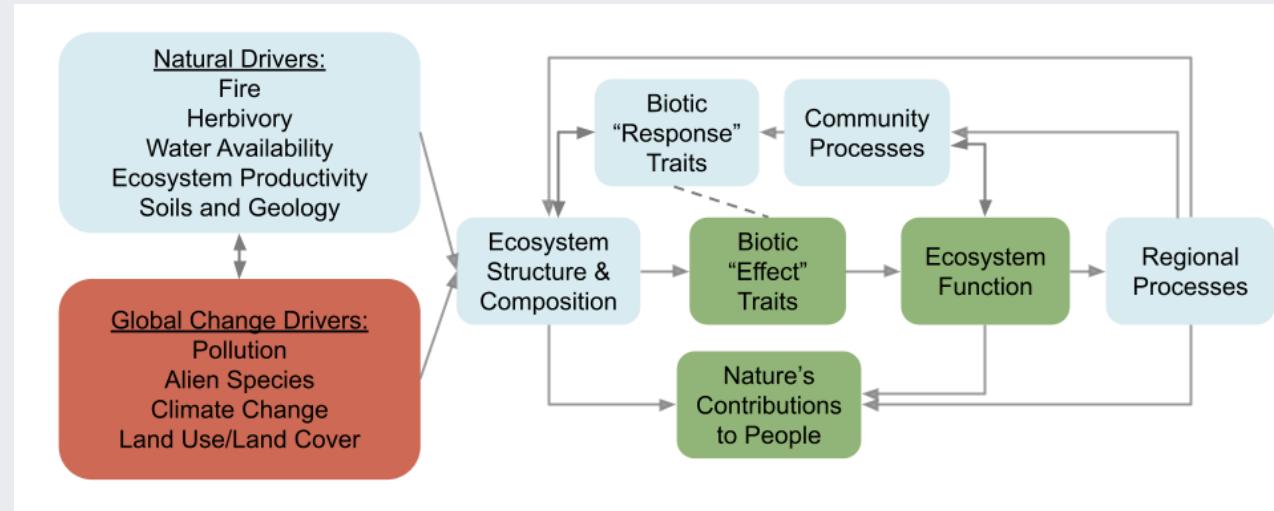


Figure modified from Chapin et al. 1997, *Science*

# My research focuses on four questions...

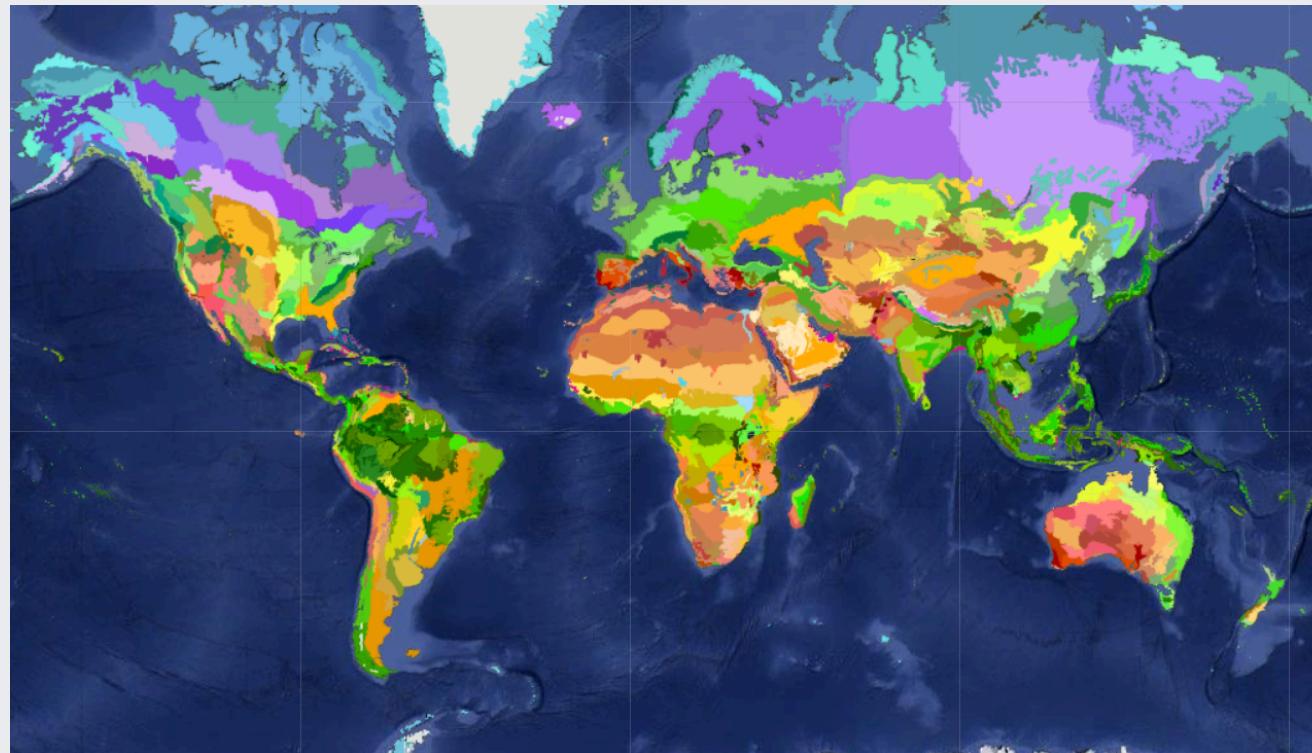


1. What determines the composition and diversity of communities and ecosystems at various scales?
2. What is the role of biodiversity in ecosystem function (and derived societal benefits)?
3. How is biodiversity changing and what are the impacts on ecosystem services?
4. How can we mitigate or adapt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

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

# This requires measuring biodiversity to...

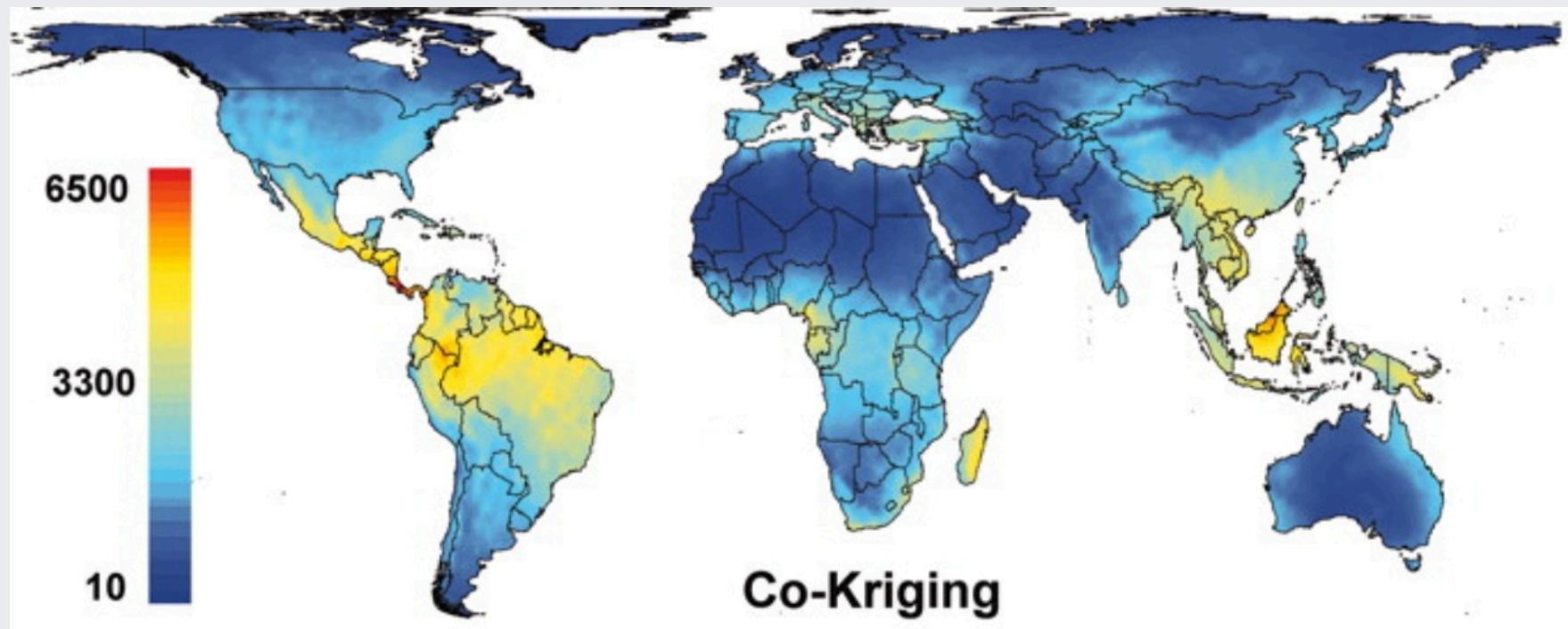
Map the distribution of species and ecosystems



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

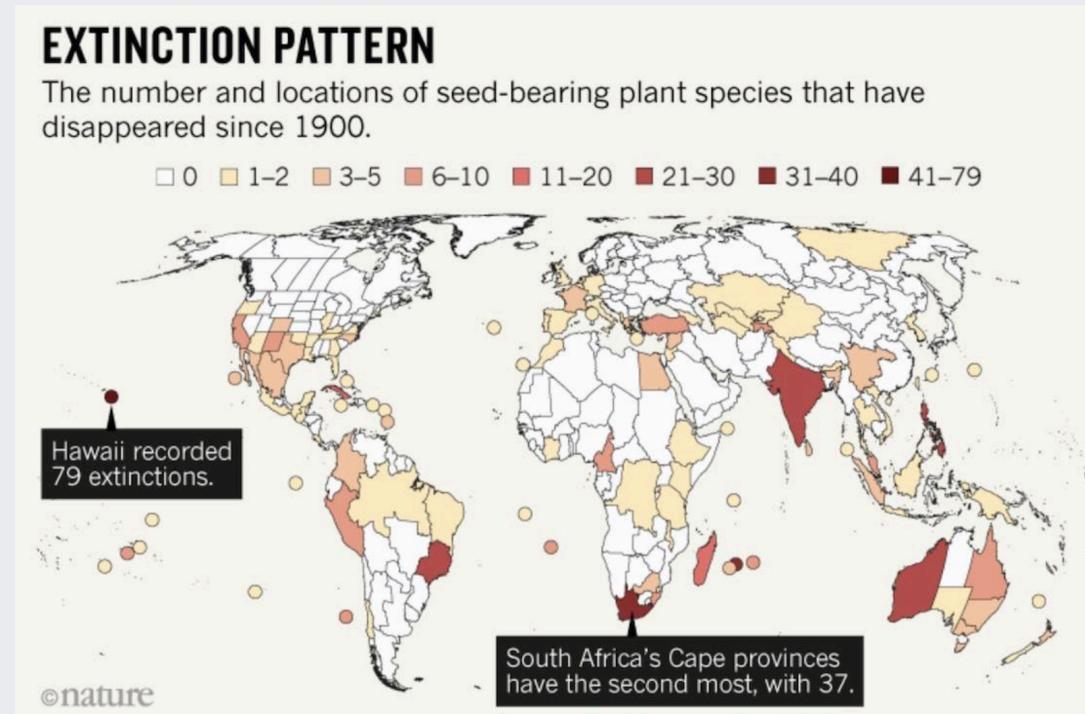
# This requires measuring biodiversity to...

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



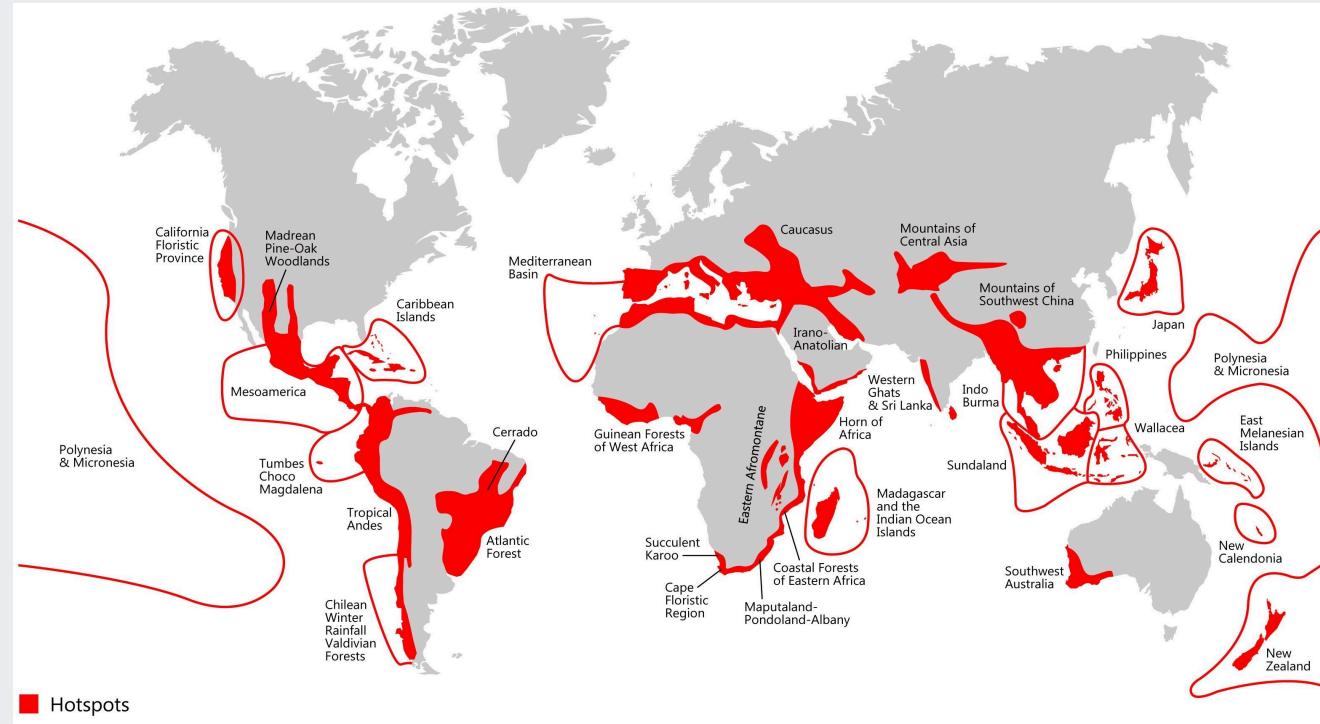
# This requires measuring biodiversity to...

## Track change in biodiversity



# This requires measuring biodiversity to...

## Set conservation priorities

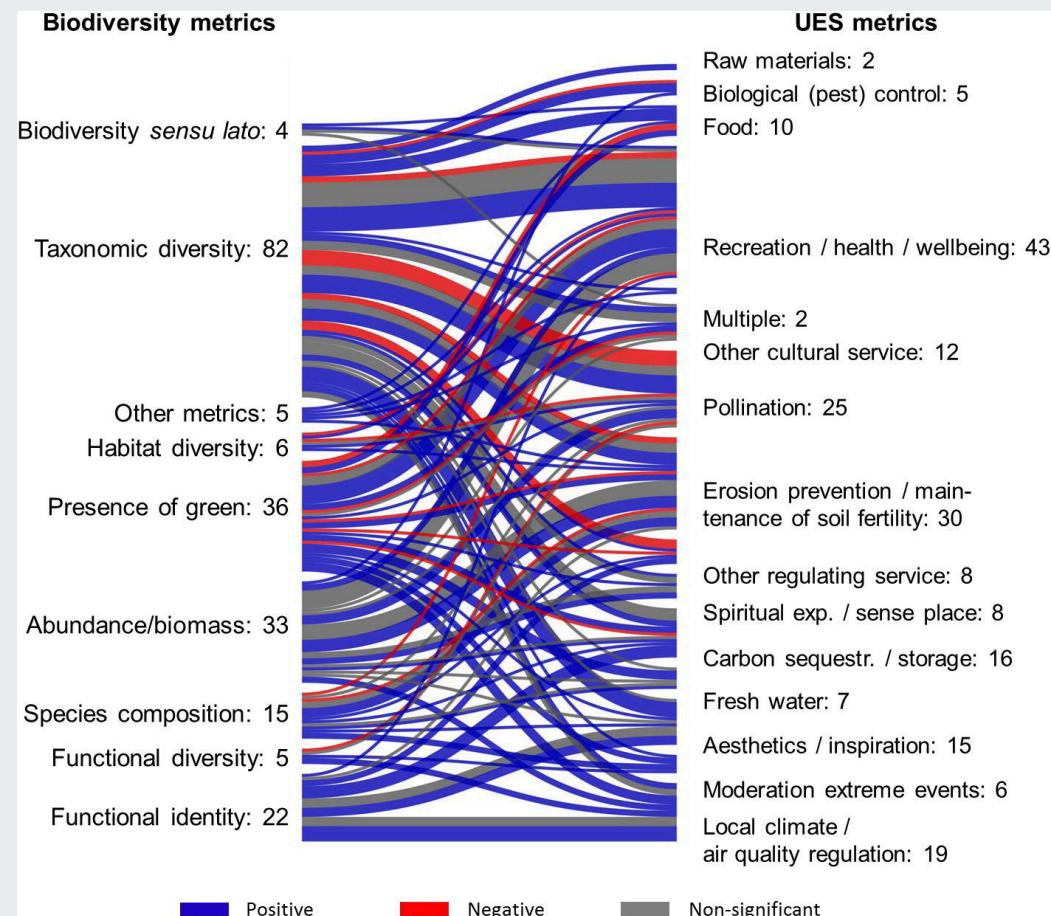


<https://www.conservation.org/priorities/biodiversity-hotspots>

# This requires measuring biodiversity to...

## Understand the role of biodiversity

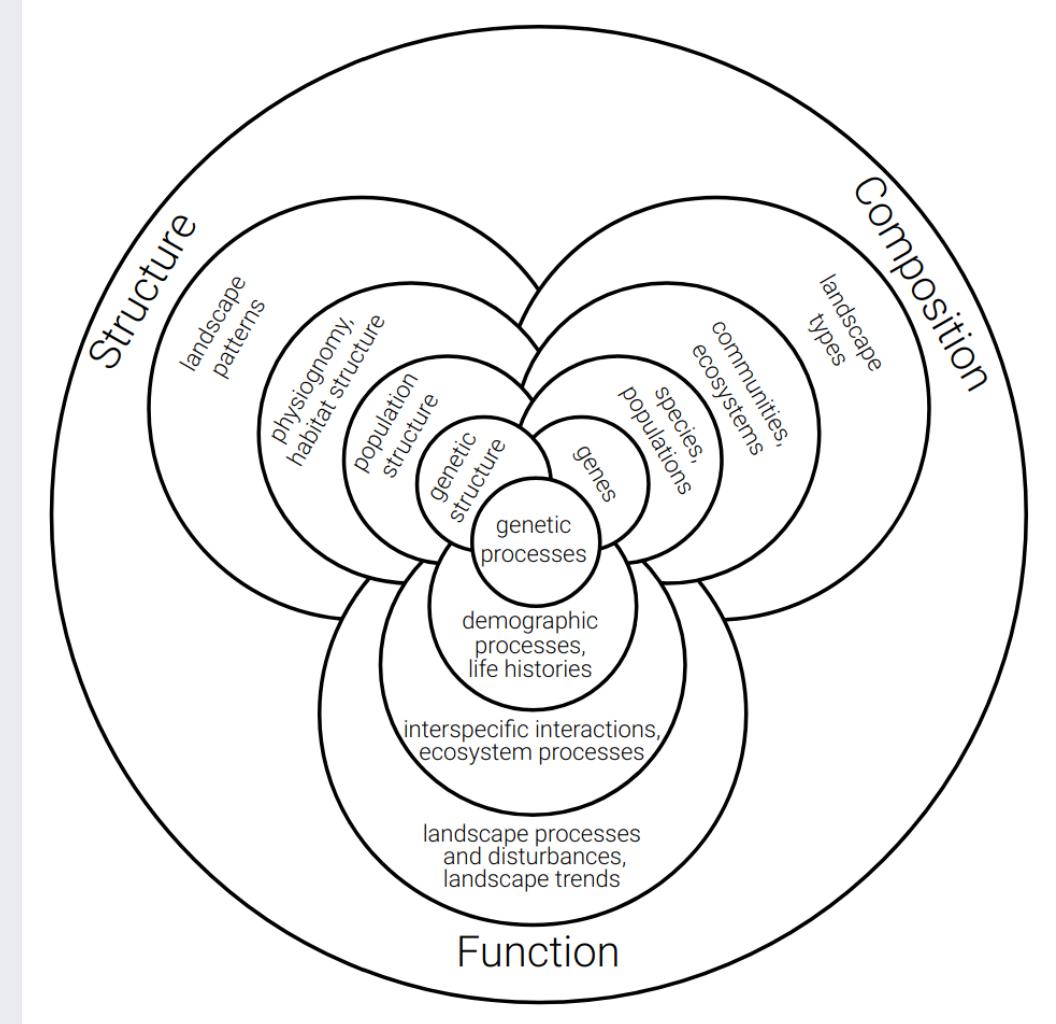
Here we see relationships between biodiversity metrics and urban ecosystem services (UES) that have been tested empirically (from Schwartz et al. 2017).



# 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*

"A definition of biodiversity that is altogether simple, comprehensive, and fully operational (i.e. responsive to real-life management and regulatory questions) is unlikely to be found. More useful than a definition, perhaps, would be a characterisation of biodiversity that identifies the major components at several levels of organization." - Noss 1990, *Conservation Biology*



Noss 1990, *Conservation Biology*

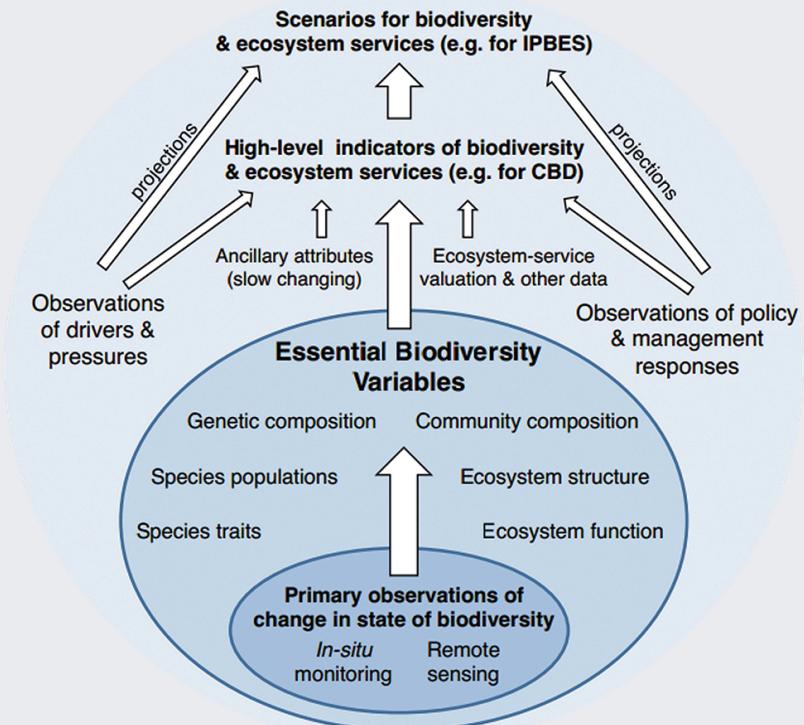
# Scenario

We are on a newly discovered island. We need to do a **quantitative** survey of the ecosystems on the island so as to describe their biodiversity and infer the key ecological processes that drive them.

What are you going to measure?

# With different aspects that can be measured!

## Essential Biodiversity Variables (EBVs)



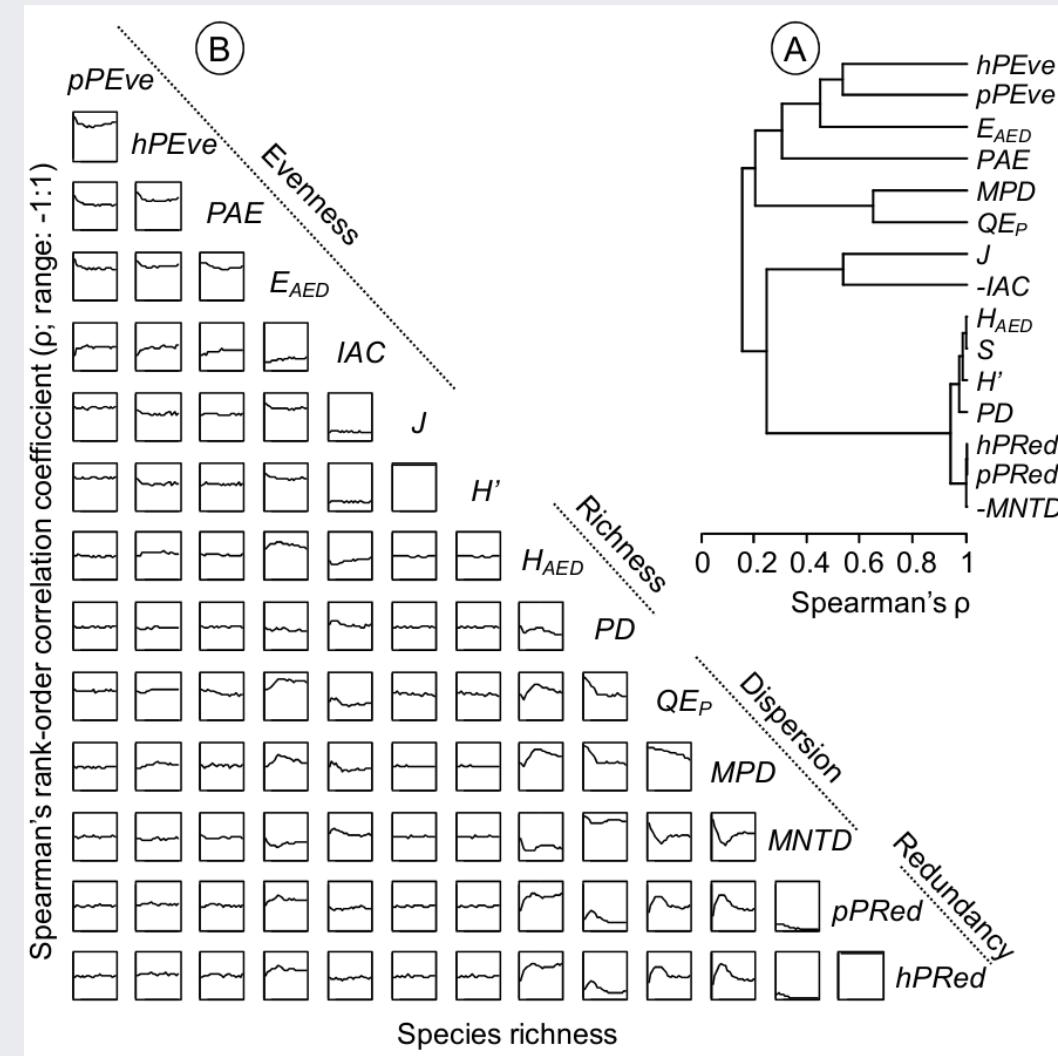
| EBV.class             | EBV.name   |
|-----------------------|--|
| Genetic composition   | Genetic diversity (richness and heterozygosity)                        |
|                       | Genetic differentiation (number of genetic units and genetic distance) |
|                       | Effective 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(which shouldn't be surprising given we don't have one perfect definition of biodiversity...)

## Take home

***Measures of biodiversity are hypotheses!*** 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.
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- 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.