BDC334
Biogeography & Global Ecology

Topic 3
Concepts of diversity

α-diversity

- alpha (α) diversity is the diversity of a community, and it captures the diversity within a site, plot, transect, or quadrat
- often used to represent the diversity of the smallest sampling unit
- can be seen as representing the local scale
- usually represented as
  - species richness,
  - a univariate index, such as Shannon's H' or Simpson's λ, or
  - if many samples are being compared, a **synthetic diversity index** (a.k.a. *dissimilarity index)* such as Bray-Curtis, Sørensen, Jaccard

β-diversity

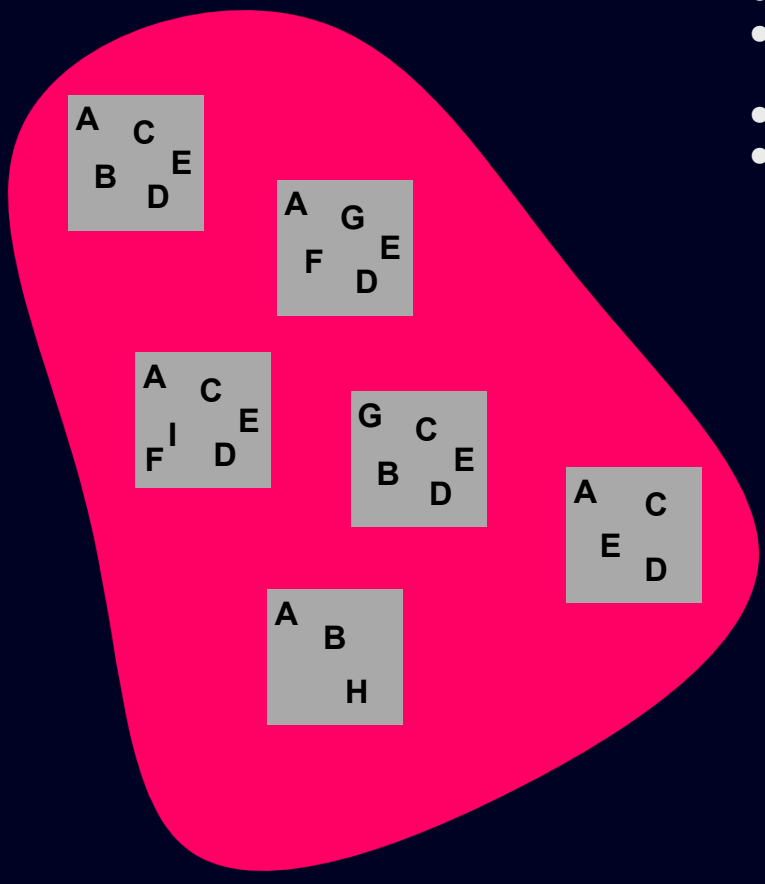
- beta (β) diversity is also known as '**species turnover**', and represents the rate of change in species composition from one community to another
- usually applied along **gradients**
- **not a univariate measure of diversity**

γ-diversity

- gamma (γ) diversity is the **total diversity** of a region or landscape
- can represent the diversity of all samples combined
- same metric as *α*-diversity (*i.e.* one of the dissimilarity indices)

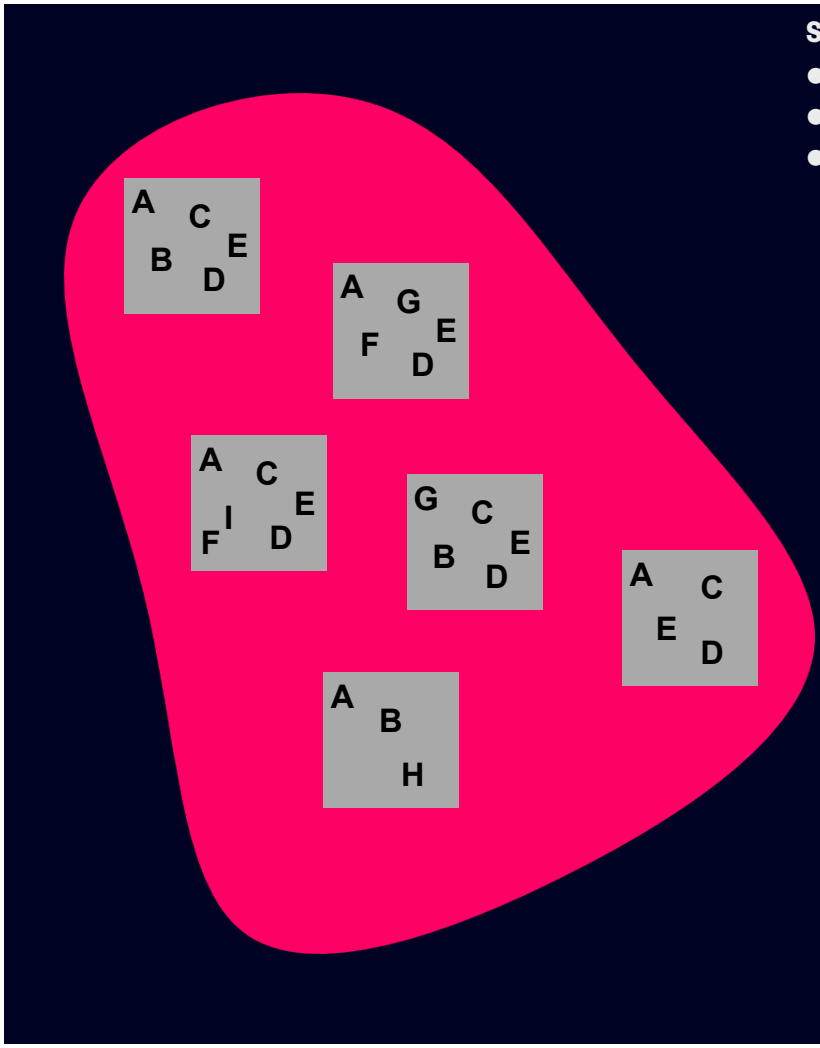
Species richness

- simply the number of species present, sometimes called a species list
  - *α*- or *γ*-diversity (depends on scale)—see later the concepts of ‘grain’ and ‘extent’



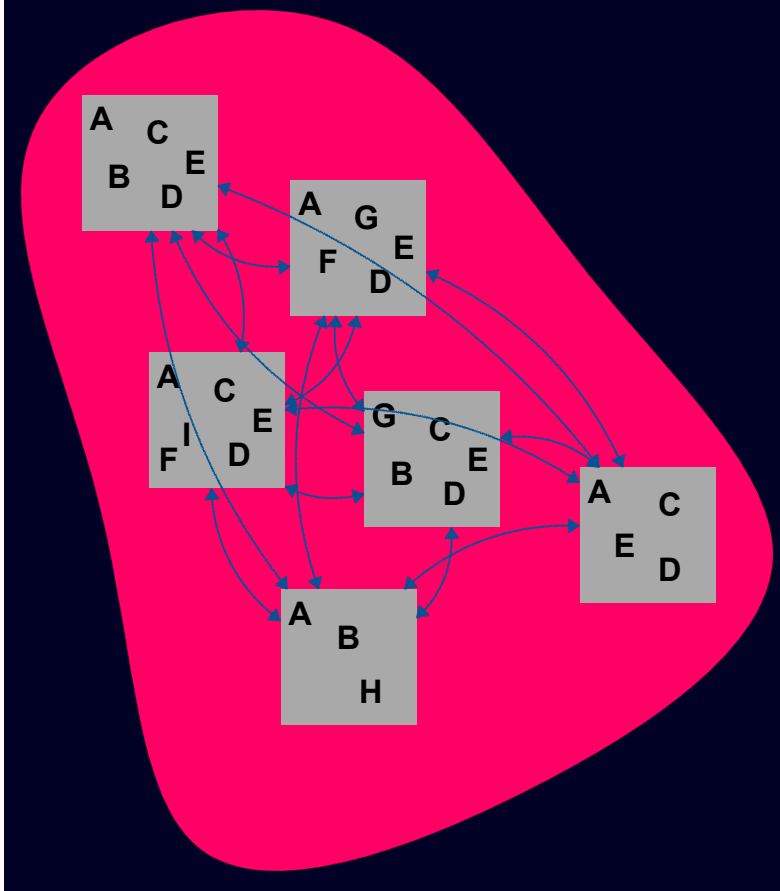
Species richness (α-diversity)

- simply the number of species (S)
- as mean of all subunits, or quadrats as in this example
- (5 + 5 + 6 + 5 + 4 + 3) / 6 = 4.667
- can be calculated from presence-absence or abundance data (but in the case of the latter, this info is not used)



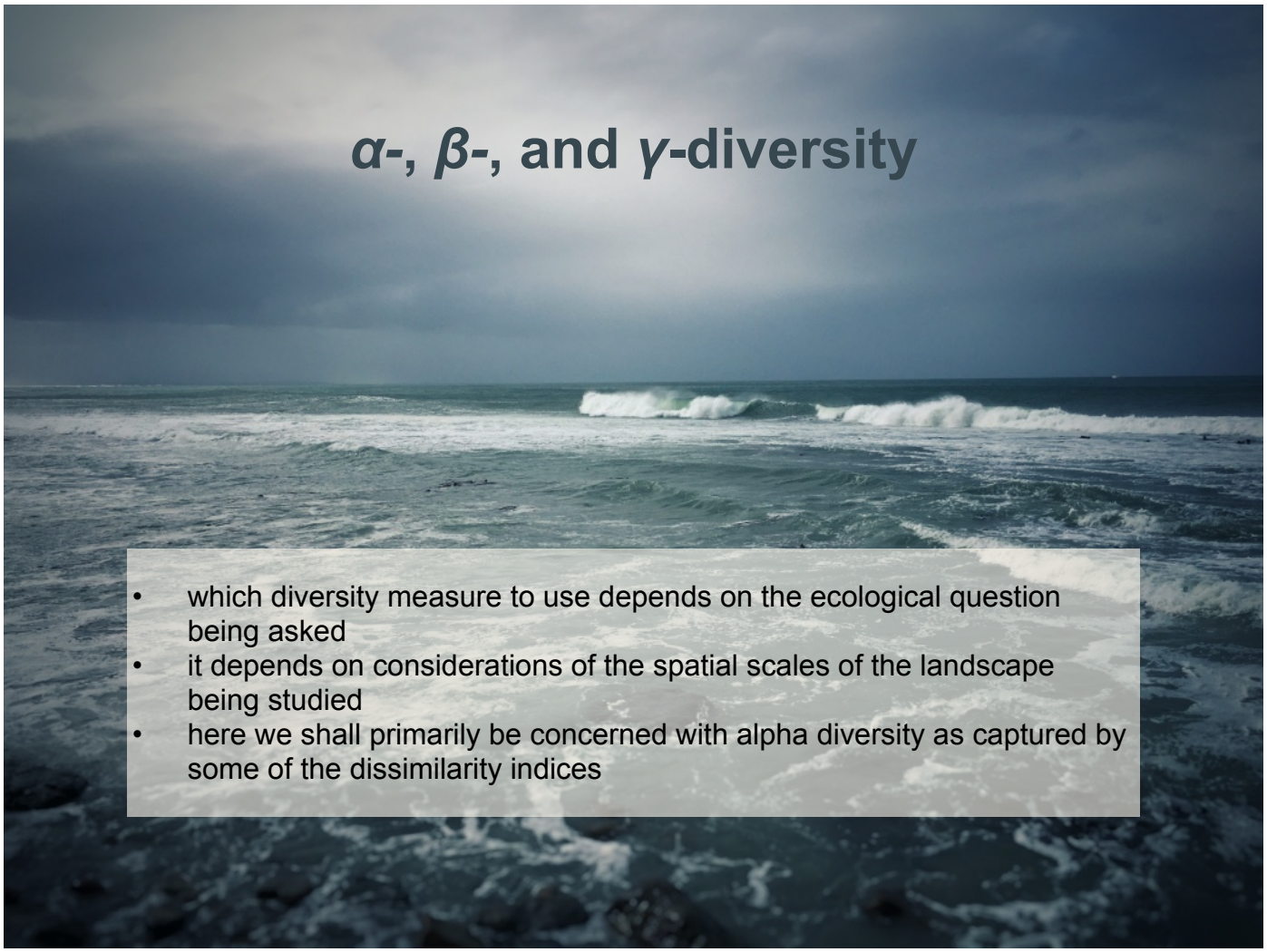
Species richness (γ-diversity)

- these species are present in the ecosystem:
- A, B, C, D, E, F, G, H, I
- i.e. 9



β-diversity based on pairwise comparisons

- These are also dissimilarity indices, so we will return to this in Topic 6.



α-, *β*-, and *γ*-diversity

- which diversity measure to use depends on the ecological question being asked
- it depends on considerations of the spatial scales of the landscape being studied
- here we shall primarily be concerned with alpha diversity as captured by some of the dissimilarity indices

Diversity indices

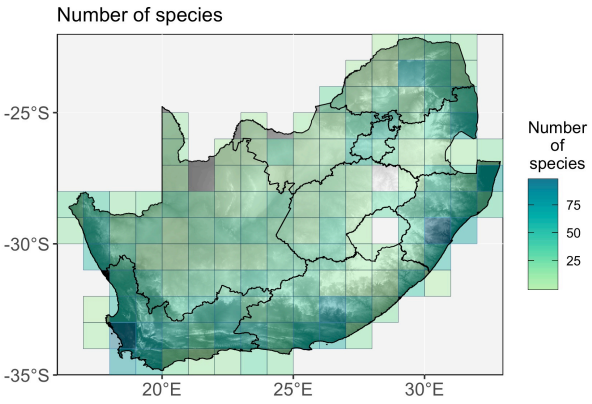
- a way of representing α-diversity
- diversity index: a mathematical measure of species diversity in a community
- species richness: simply the number of species
- diversity indices also take into account the relative abundances of the species, *e.g.*,
    - community A—10 individuals of each of 10 species (total of 100 individuals across all species)
    - community B—9 species has 1 individual each, and the 10th has 91 individuals (total of 100 individuals across all species)
        - which community is more diverse?
- a diversity index takes into account both richness and evenness
- species richness (already seen)
- Shannon diversity index
- Simpson's diversity index

Shannon and Simpson's diversity indices

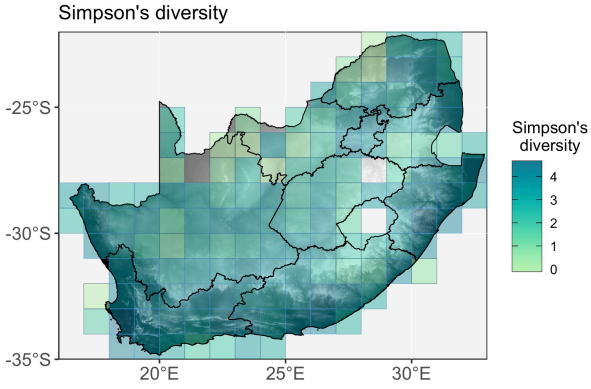
site	sp_A	sp_B	sp_C	sp_D	sp_E	sp_F
site_A	1	1	1	2	1	10
site_B	1	2	1	1	2	1
site_C	4	4	5	4	5	4
site_D	10	11	10	10	10	11
site_E	0	0	0	0	1	1
site_F	0	0	0	0	1	10
site_G	1	1	1	1	1	1
site_H	10	10	10	10	10	10

```
> specnumber(species[, 2:9], MARGIN = 2)
site_A site_B site_C site_D site_E site_F site_G site_H
     6      6      6      6      2      2      6      6
> round(diversity(species[, 2:9], MARGIN = 2, index = "shannon"), 2)
site_A site_B site_C site_D site_E site_F site_G site_H
  1.25   1.73   1.79   1.79   0.69   0.30   1.79   1.79
> round(diversity(species[, 2:9], MARGIN = 2, index = "simpson"), 2)
site_A site_B site_C site_D site_E site_F site_G site_H
  0.58   0.81   0.83   0.83   0.50   0.17   0.83   0.83
```

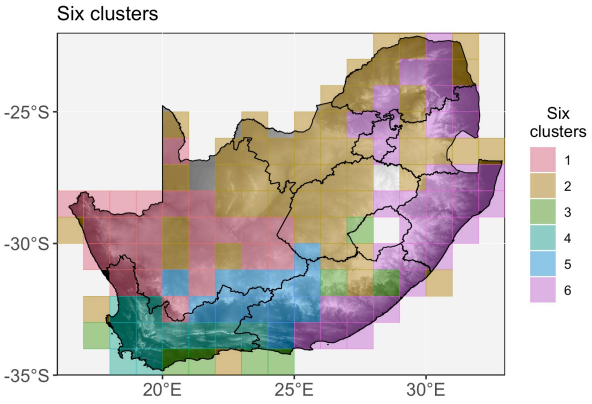
A



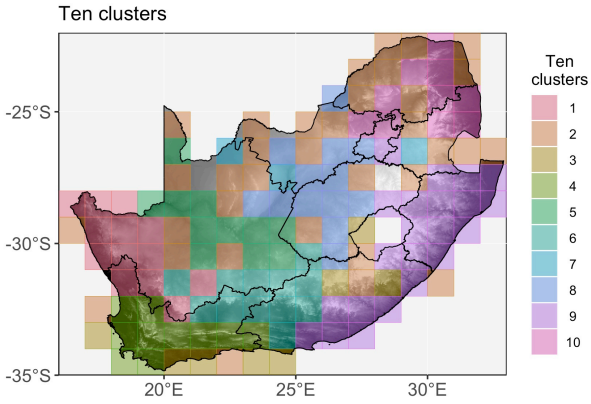
B



C



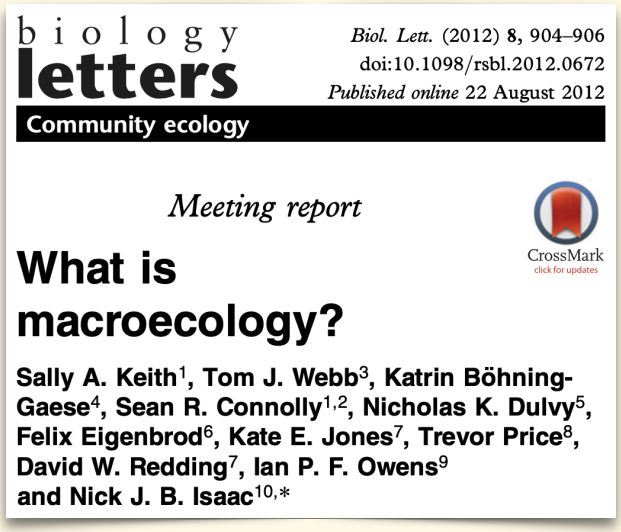
D



Shannon and Simpson's diversity indices

- take into account both richness and evenness
- supposedly the difference is…
  - Shannon more influenced by richness
  - Simpson's affected more by evenness
- …supposedly, because there seems to be some disagreement about what precisely it means, *e.g.* from the {vegan} help file by Jari Oksanen:

"*Better stories can be told about Simpson's index than about Shannon's index, and still grander narratives about rarefaction (Hurlbert 1971). However, these indices are all very closely related (Hill 1973), and there is no reason to despise one more than others (but if you are a graduate student, don't drag me in, but obey your Professor's orders). In particular, the exponent of the Shannon index is linearly related to inverse Simpson (Hill 1973) although the former may be more sensitive to rare species.*"


biology letters

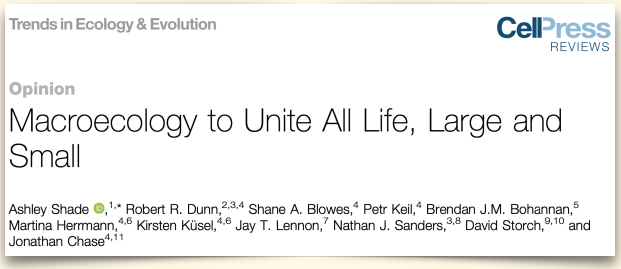
Community ecology

Biol. Lett. (2012) **8**, 904–906
doi:10.1098/rsbl.2012.0672
Published online 22 August 2012

Meeting report

What is macroecology?

Sally A. Keith[1], Tom J. Webb[3], Katrin Böhning-Gaese[4], Sean R. Connolly[1,2], Nicholas K. Dulvy[5], Felix Eigenbrod[6], Kate E. Jones[7], Trevor Price[8], David W. Redding[7], Ian P. F. Owens[9] and Nick J. B. Isaac[10,*]


Trends in Ecology & Evolution

CellPress REVIEWS

Opinion

Macroecology to Unite All Life, Large and Small

Ashley Shade,[1,*] Robert R. Dunn,[2,3,4] Shane A. Blowes,[4] Petr Keil,[4] Brendan J.M. Bohannan,[5] Martina Herrmann,[4,6] Kirsten Küsel,[4,6] Jay T. Lennon,[7] Nathan J. Sanders,[3,8] David Storch,[9,10] and Jonathan Chase[4,11]


Journal of Biogeography, **26**, 867–878

The distance decay of similarity in biogeography and ecology

Jeffrey C. Nekola* and Peter S. White *Curriculum in Ecology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27599, U.S.A.*


frontiers in Marine Science

ORIGINAL RESEARCH
published: 12 December 2017
doi: 10.3389/fmars.2017.00404

Seaweeds in Two Oceans: Beta-Diversity

Albertus J. Smit[1,2], John J. Bolton[3] and Robert J. Anderson[3,4]

Class Test 1: 17 August 2020, 14:00 -16:00
Class Test 2: 7 September 2020, 14:00 - 16:00