Dimensions of size structure in food webs and comparisons across ecosystems

Working Groups 2 & 3

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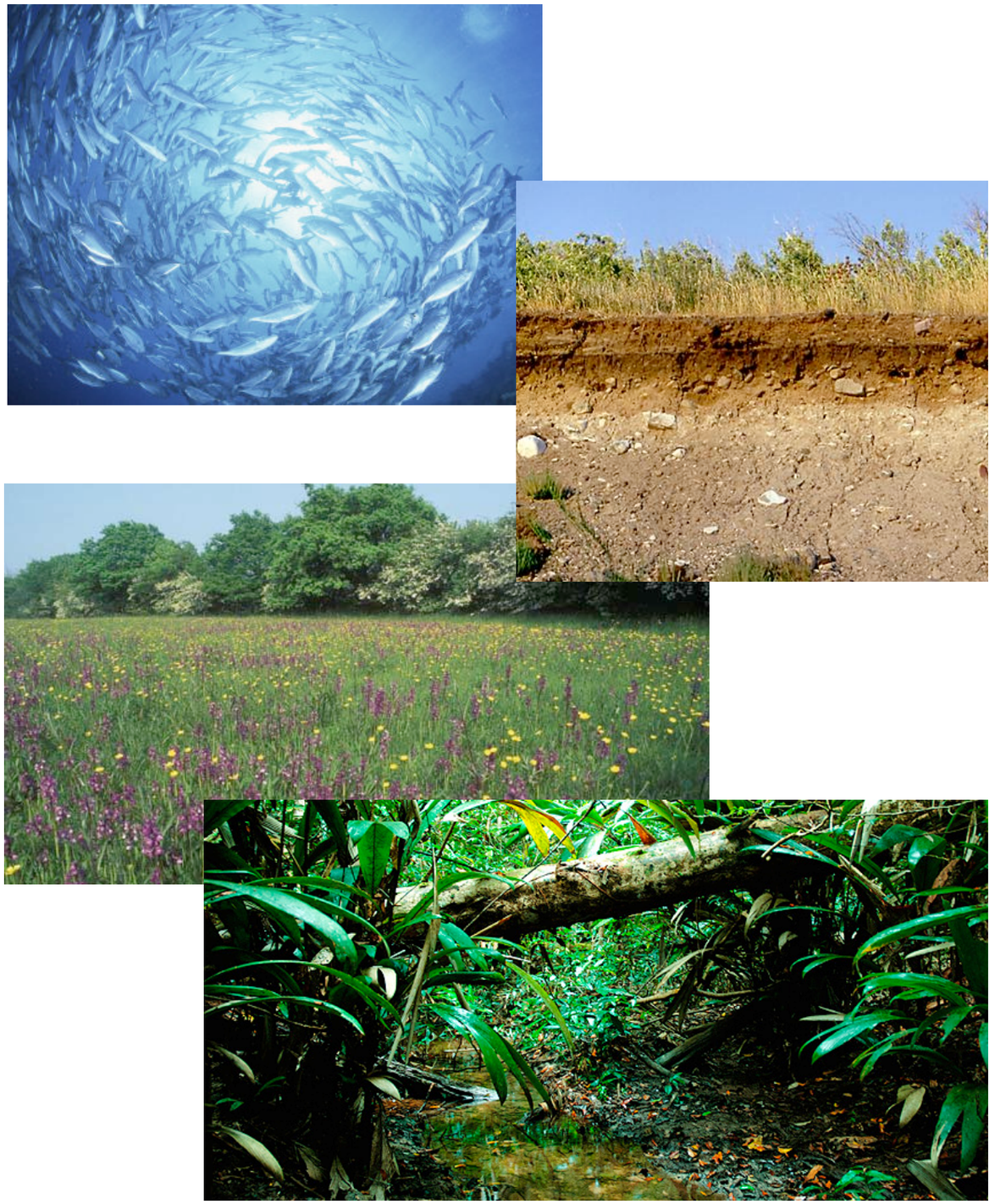
Size-structured or not?

An aquatic / terrestrial difference?

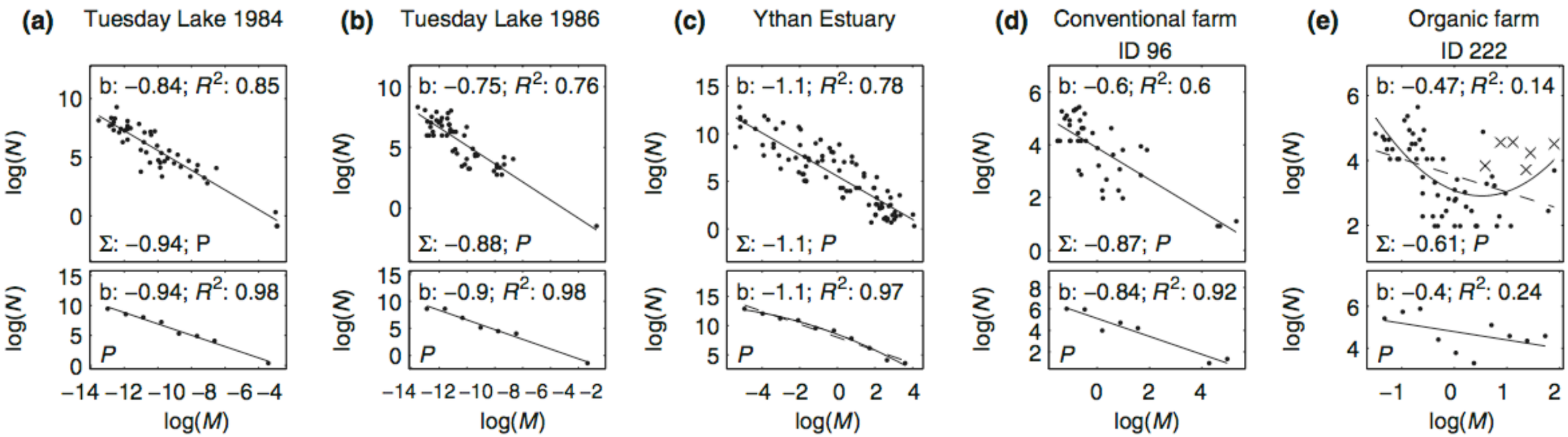
- Plankton food webs are strongly size structured
- Terrestrial (and benthic) food webs are not
- Driven by the growth, size, and nutritional quality of autotrophs



Lindeman (1942) Ecology, 23, 399-418
Shurin et al. (2006) PRSB, 273, 1-9

Destroying the dichotomy

Local size-density relationship



Individual size distribution
(size spectra)

Reuman, Mulder, Raffaelli, and Cohen (2008)
Ecology Letters, 11, 1216-1228

Size-structure as a continuum

Grassland

Forest

Soil

Benthic

Reef

Pelagic

Terrestrial

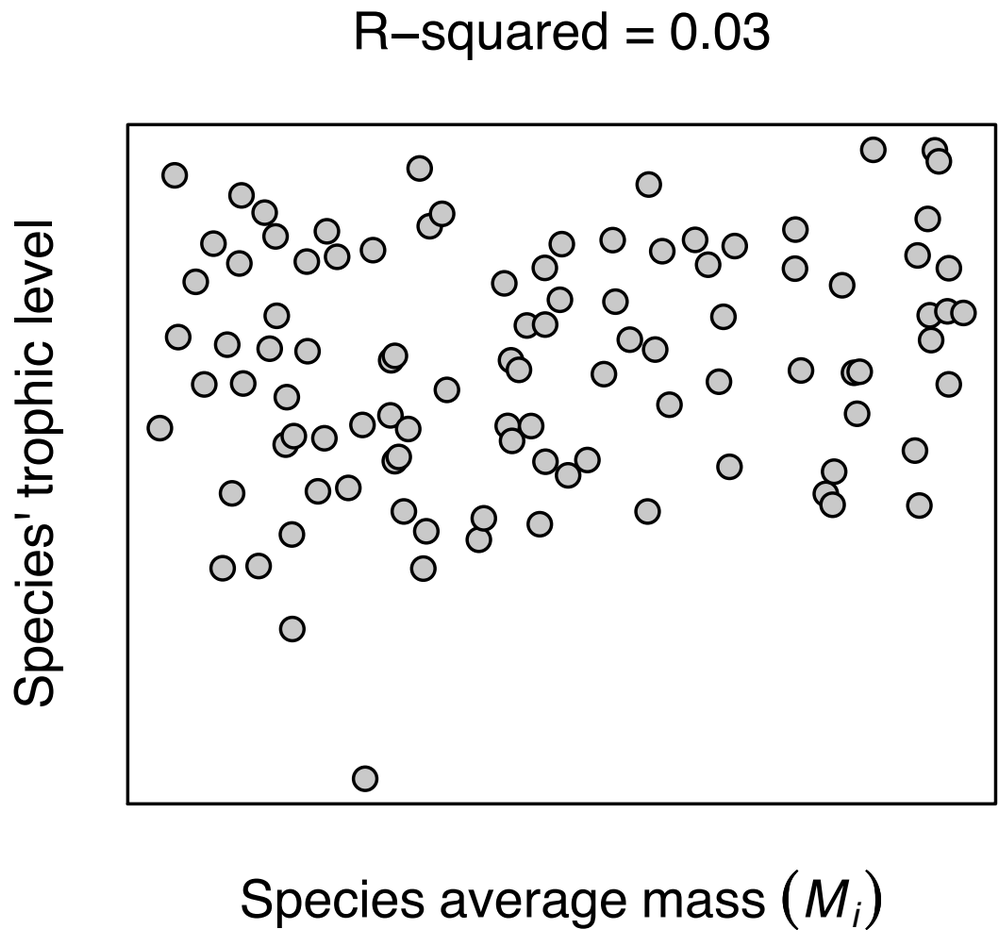
Aquatic

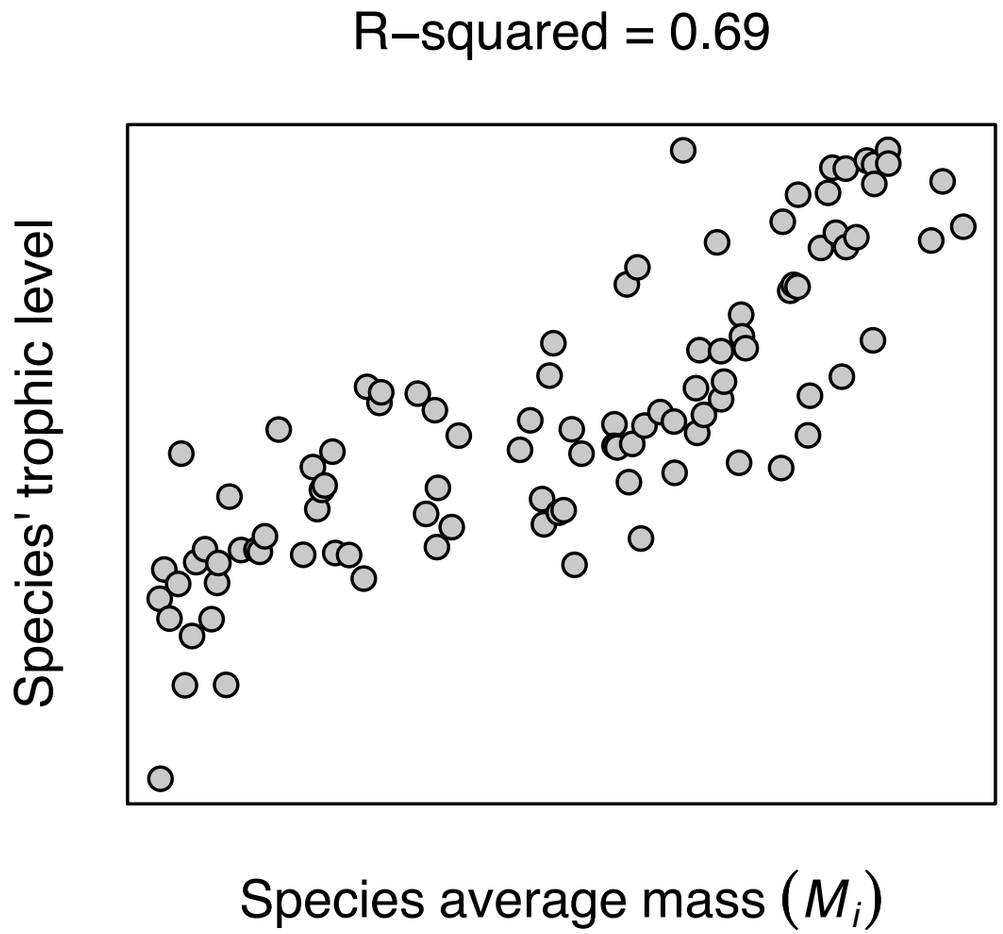
Less

More

An axis of size-structure

What axis?



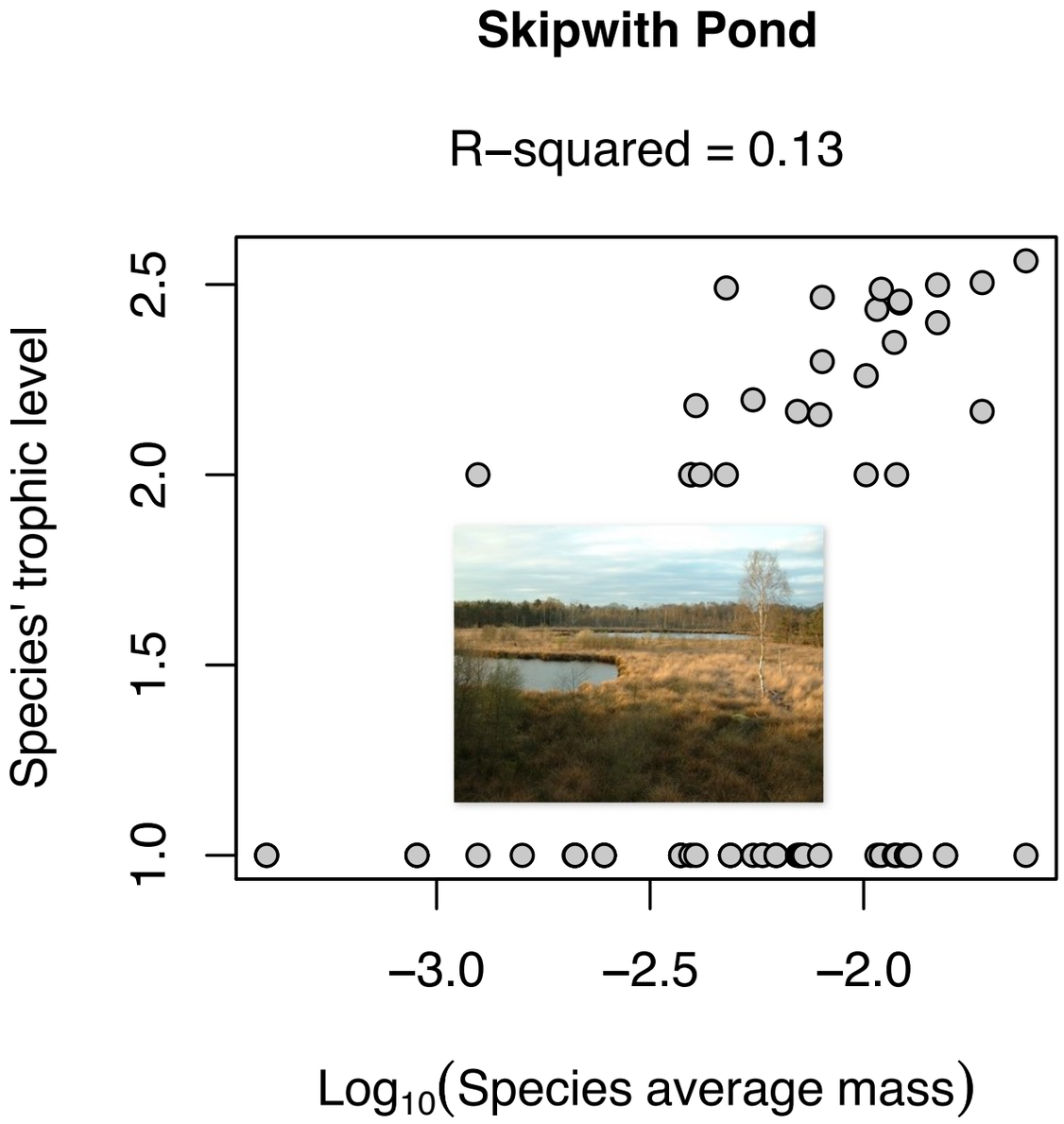


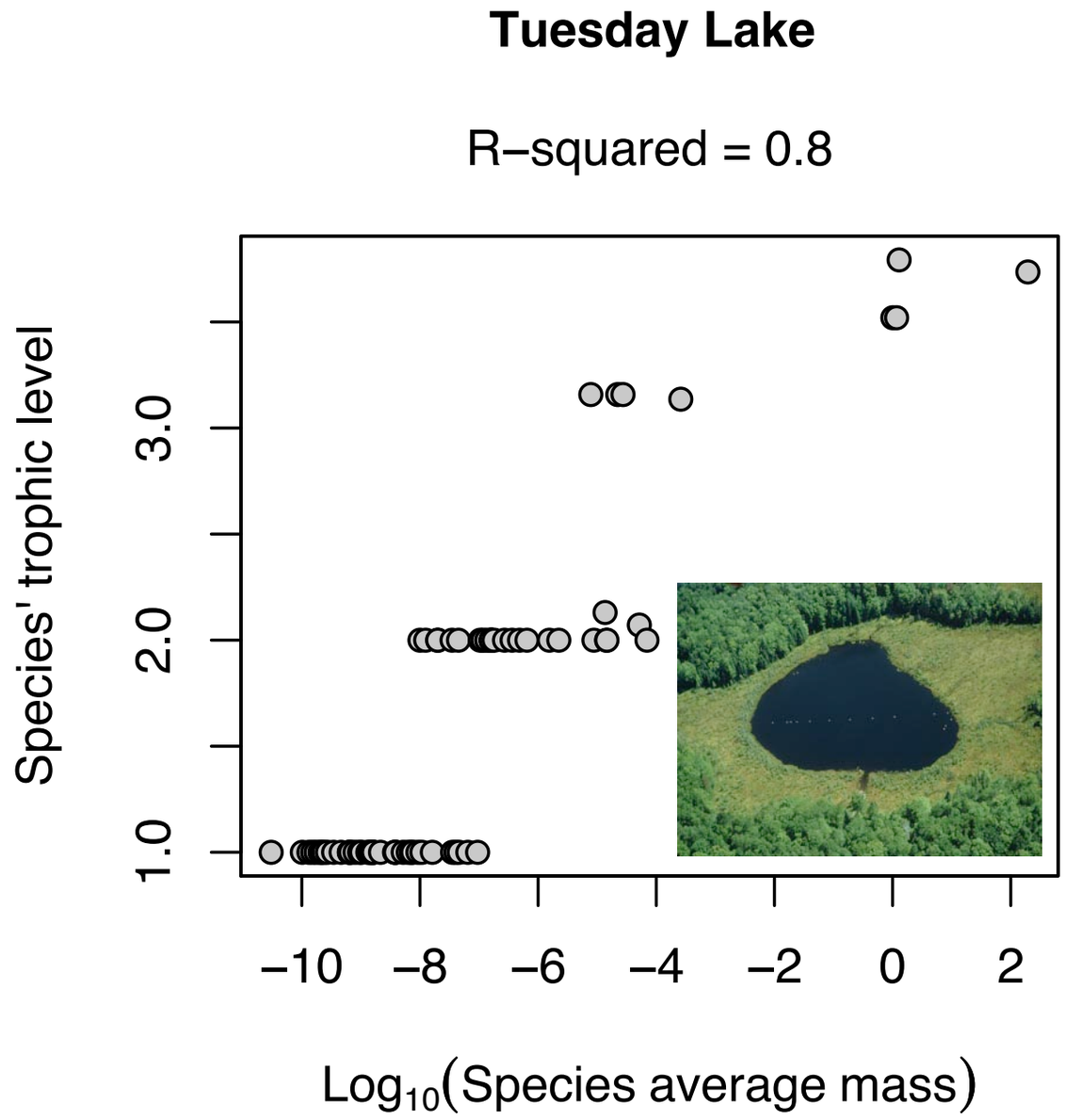
Less

More

R^2 of trophic level-mass relationship

What axis?

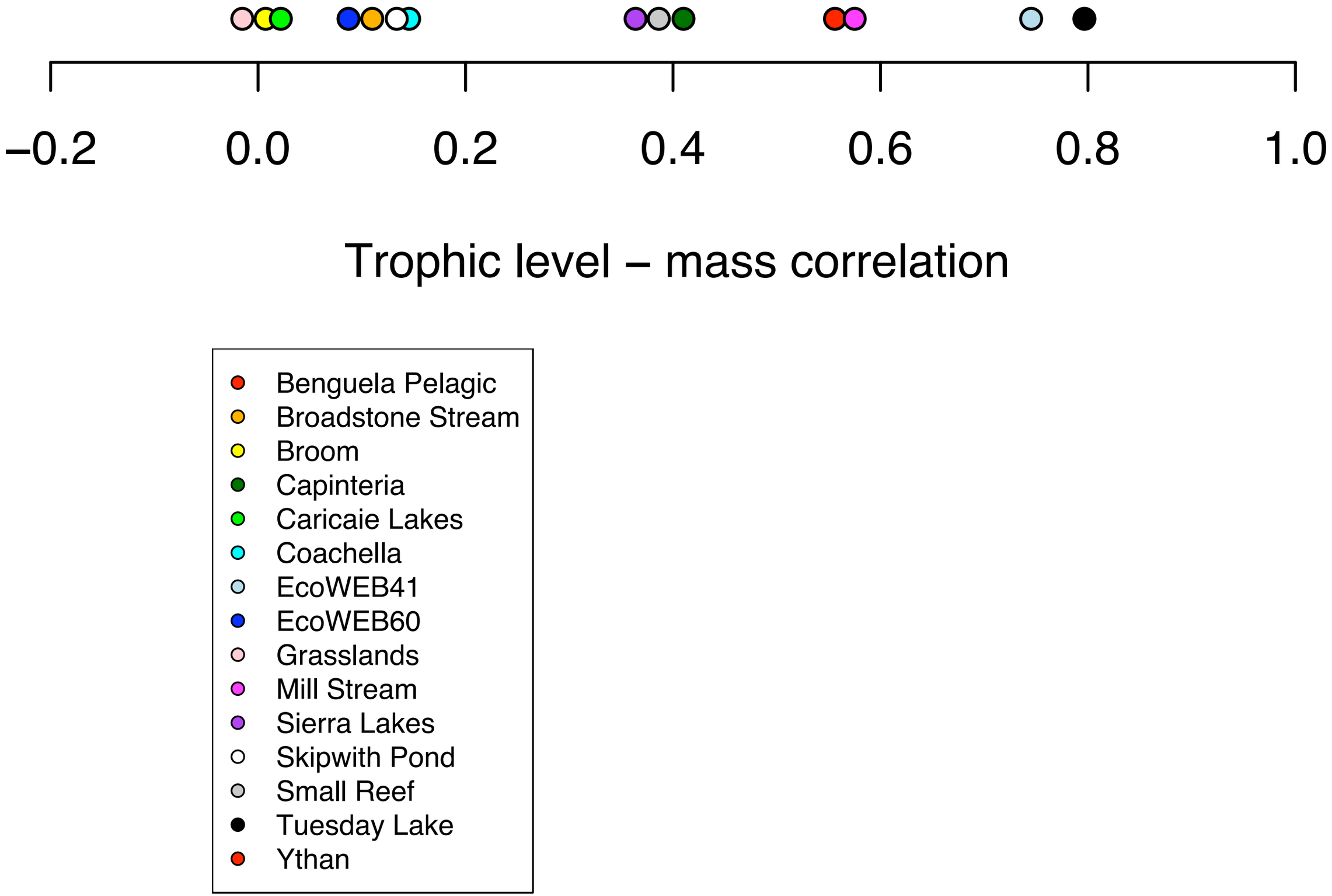


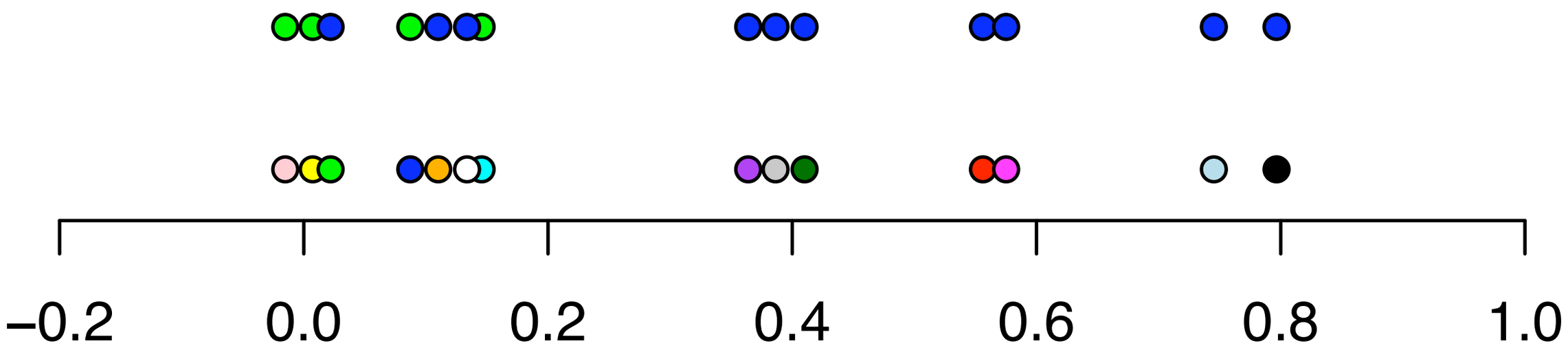


Less

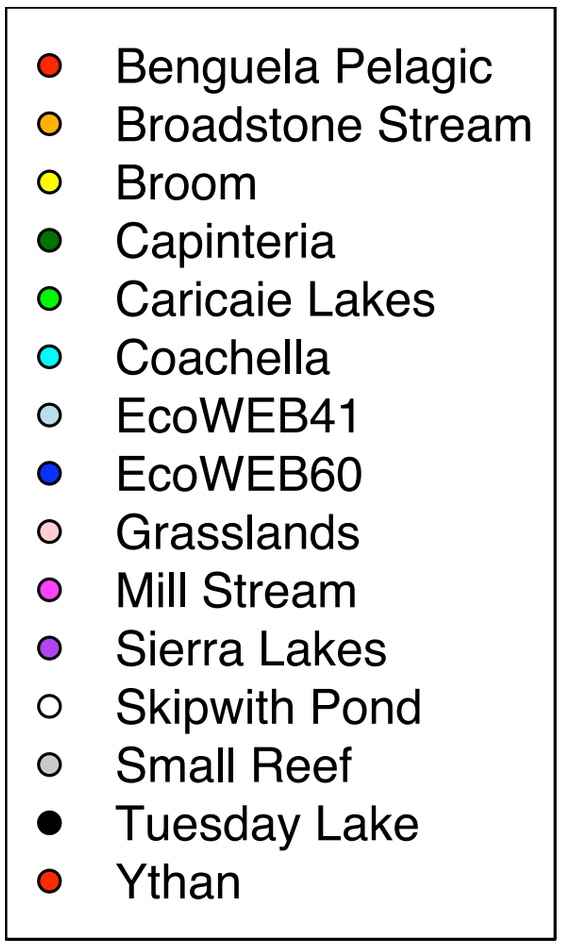
More

R^2 of trophic level-mass relationship

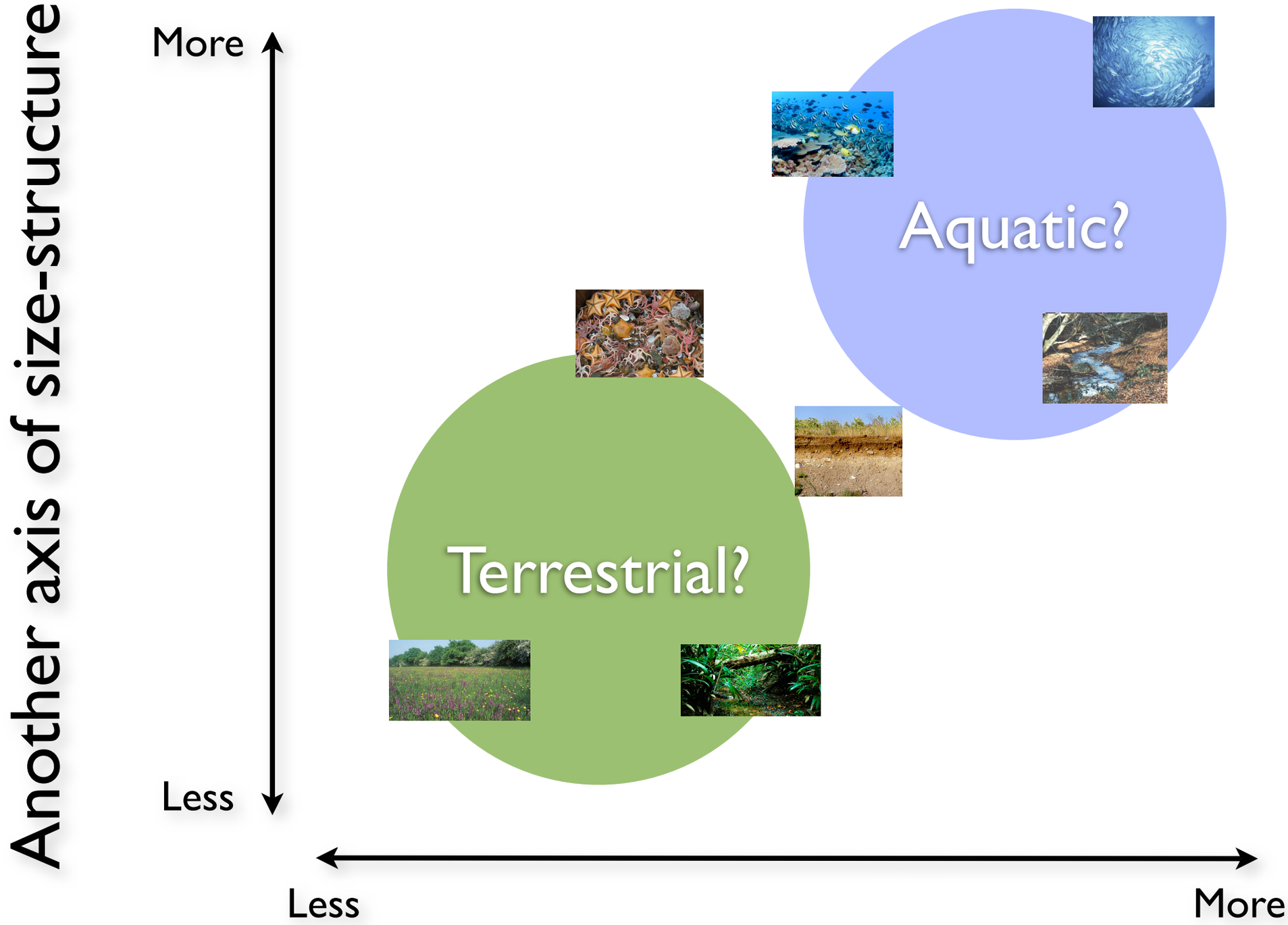

–0.2
0.0
0.2
0.4
0.6
0.8
1.0
Trophic level – mass correlation
Benguela Pelagic
Broadstone Stream
Broom
Capinteria
Caricaie Lakes
Coachella
EcoWEB41
EcoWEB60
Grasslands
Mill Stream
Sierra Lakes
Skipwith Pond
Small Reef
Tuesday Lake
Ythan



Trophic level – mass correlation



Size-structure in two dimensions



Size-structure in n-dimensions

- Provides a continuum along which to ask about variation in size structure
- Recognises multiple dimensions of size structure
- Gives a general framework within which to study variation in size structure among communities and ecosystems

What axes?

Less

More

???

What axes?

Level of organisation	Mass scaling with:
Individual	Metabolic rate, growth rate, life span, movement rate, RNA content, metabolic type, chemical composition, day and home range, scale of movement
Population	Abundance, occupancy, range size, stability, persistence, extinction risk
Interaction	Mass of competitors / prey / predator / host / parasitoid / mutualist Strength of interaction, attack rate, handling time, maximum ingestion rate
Community	Trophic level, generalism, vulnerability, degree, position in hierarchy

Data...

- Need more data about individual communities
- And more communities for which we have data
- Echo's Joel Cohen's call for multivariate community data

Taxonomy or size?

- Very much changes how size structure appears

- Strong size structure or lack of size structure

- Can change the appearance of macroecological patterns (e.g., Tom Webb yesterday)

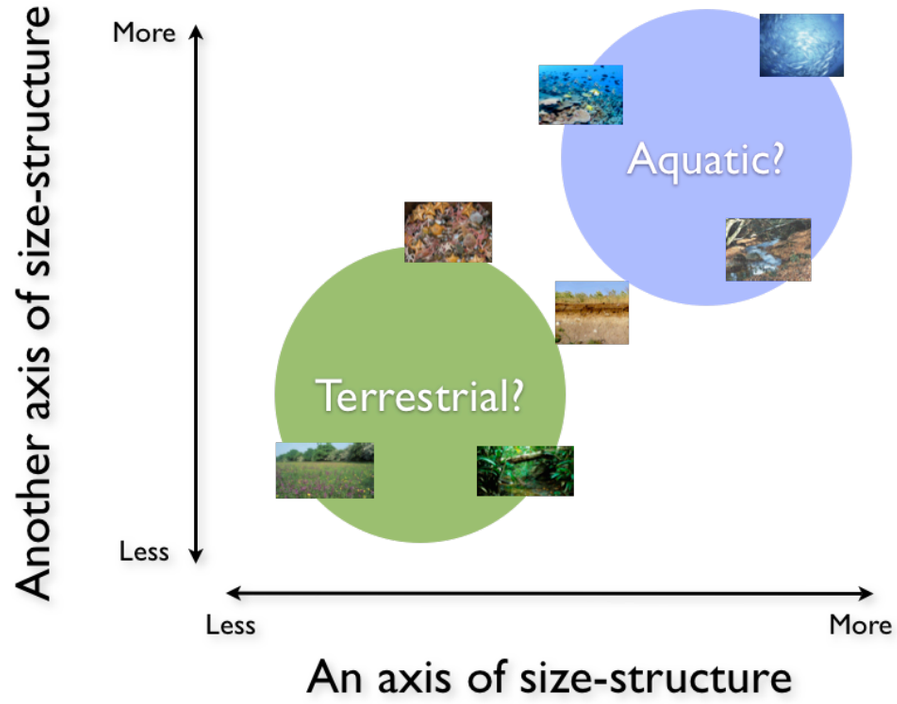
Data...

- Need more data about individuals in individual communities

- We don’t have a lot of this!

Can models help us?

- Exploration of hypotheses about the determinants of size structure
- What kinds of mechanisms can explain the variation in size structure among communities?



Ecology Letters, (2008) **11**: 1216–1228 doi: 10.1111/j.1461-0248.2008.01236.x

LETTER

Three allometric relations of population density to body mass: theoretical integration and empirical tests in 149 food webs

Daniel C. Reuman,[1*†] Christian Mulder,[2] Dave Raffaelli[3] and Joel E. Cohen[1]

Abstract

Predicting species population density–body mass scaling in community food webs (henceforth *webs*) is important for conservation and to understand community structure. Very different types of scaling have been studied, based on either individuals or species.

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ECOLOGICAL COMPLEXITY

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An explanatory model for food-web structure and evolution

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PNAS

Evolutionary emergence of size-structured food webs

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Edited by Simon A. Levin, Princeton University, Princeton, NJ, and approved March 10, 2005 (received for review November 12, 2004)

Explaining the structure of terrestrial and aquatic food webs remains one of the most important challenges of ecological theory. Most existing models use emergent properties of food webs, such as diversity and connectance as parameters, to determine other food-web descriptors. Lower-level processes, in particular adaptation (whether by behavioral, developmental, or evolutionary mechanisms), are usually not considered. Here, we show that

metabolism is measured per unit mass (mass-specific metabolic rate) (13). Because of this allometric relation, it is possible to correlate body size and a number of life-history traits of organisms, thereby making a link between organismic and community scales (13, 14). We modeled the population dynamics of species i with biomass N_i and body size x_i by

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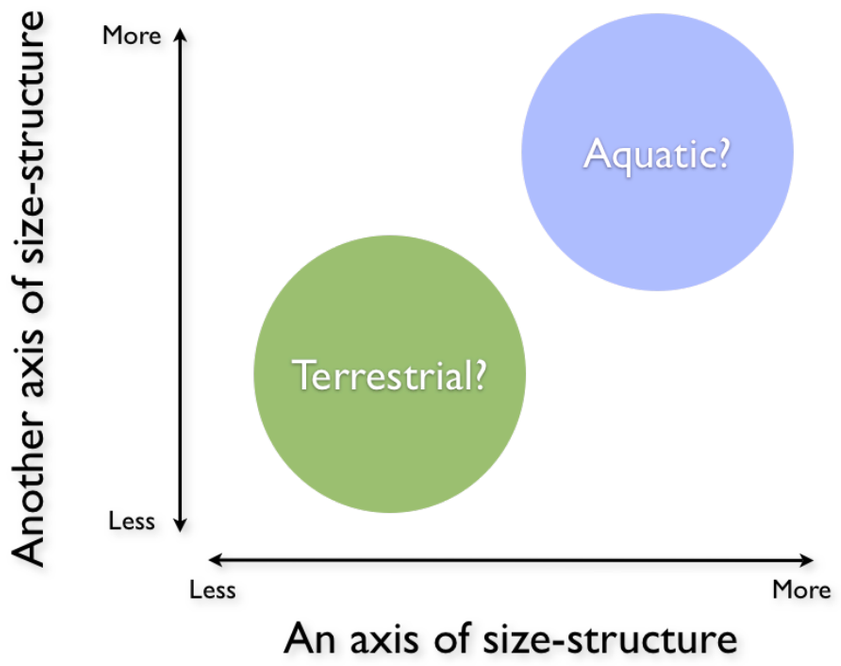
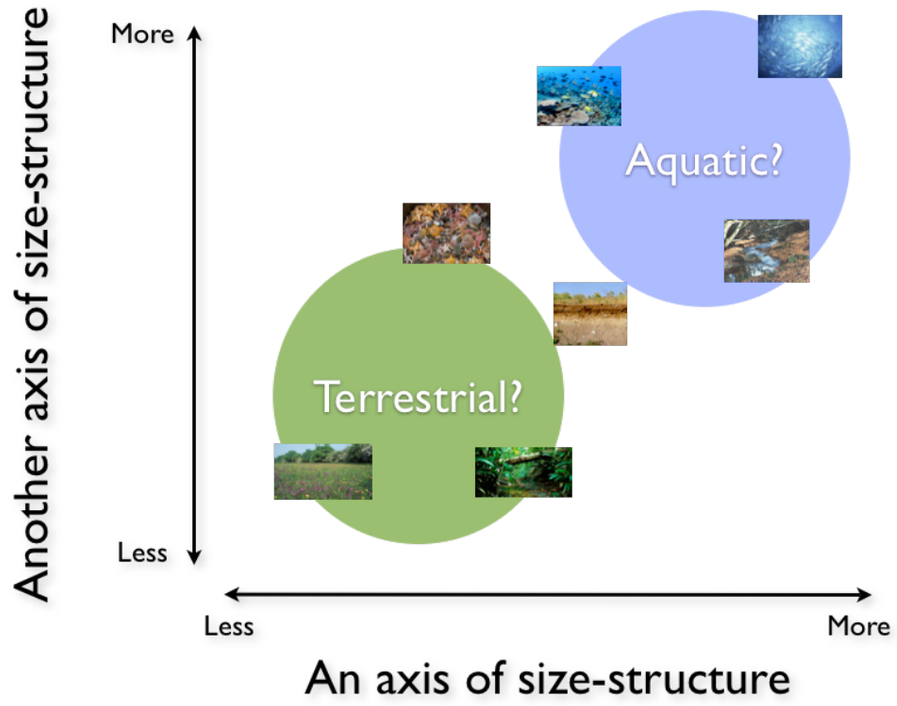
How does abundance scale with body size in coupled size-structured food webs?

Julia L. Blanchard[1,2]*, Simon Jennings[1], Richard Law[2], Matthew D. Castle[1,2]†, Paul McCloghrie[1], Marie-Joëlle Rochet[3] and Eric Benoît[4]



Dimensions of size structure in food webs and comparisons across ecosystems

- Size structure as a continuous multidimensional property of communities
- We need more data from more ecosystems for more individuals
- Models can help us understand links between allometries and know what to look for in empirical data



Thanks...

- Data collectors and contributors
- WG 2 & 3 and all SIZEMIC participants
- Julia Reiss (WG2 Leader), Ute Jacob (WG3 leader)
- Gabriel Yvon-Durocher (Size-structure in n-dimensions)
- Guy Woodward and Julia Blanchard (Size or taxonomy)
- Aaron Thierry (Exploring determinants of size structure)
- Funders include...