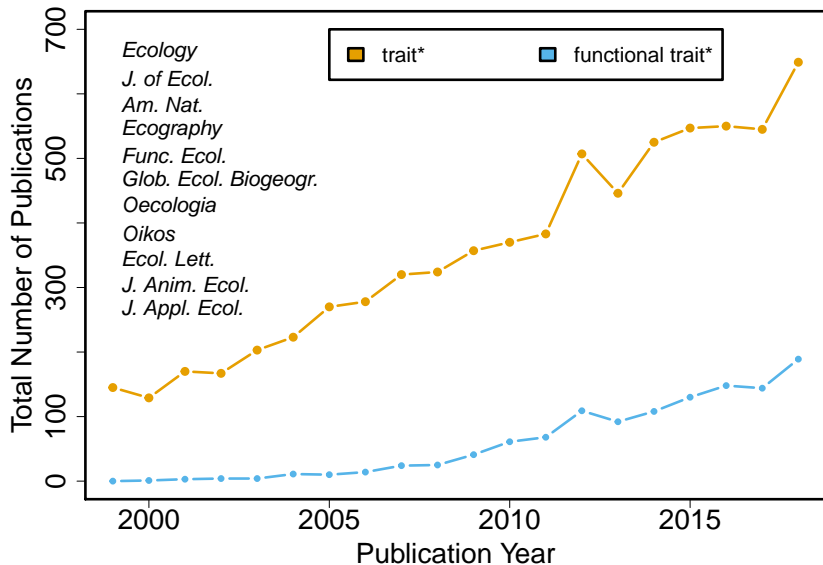


# A survey on the interpretation and application of the terms 'trait' and 'functional trait' among ecologists

Samantha Dawson, **Brad Duthie**, Manuela Gonzalez-Suarez, Mari Jönsson, Carlos Pérez Carmona, Filipe Chichorro de Carvalho, Max Mallen-Cooper, Yolanda Melero, Helen Moor, and John Simaika

University of Stirling

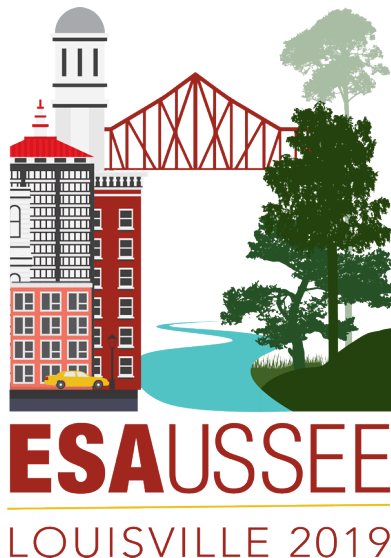
# Use of 'trait' and 'functional trait' in the ecology literature



# Use of 'functional trait' at ESA 2019

**Search for 'functional traits' in  
ESA 2019 abstracts:**

- ▶ Talks: 28
- ▶ Posters: 13
- ▶ Symposia: 2



# From flies to fungi: functional traits in conservation

**Evaluate the scope and merits of a trait-based framework for conservation in the Anthropocene that can be broadly applied across taxa.**

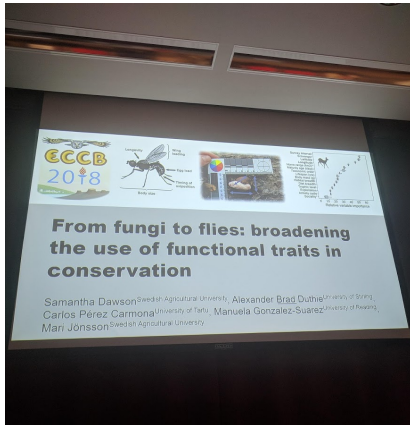
1. In what conservation contexts could functional traits provide more insights than species identities?
2. How can functional traits be used when investigating ecosystems functions and services to maximise human and ecosystem wellbeing?
3. How can recent advances in community ecology, grounded in plant functional traits, be more broadly applied to non-plants to inform conservation goals?

**European Congress of Conservation Biology 2018 Workshop**

# From flies to fungi: functional traits in conservation

## Summary of ECCB 2018 discussion group:

- Over 25 participants researching across multiple taxa and biomes



# From flies to fungi: functional traits in conservation

## Summary of ECCB 2018 discussion group:



- ▶ Over 25 participants researching across multiple taxa and biomes
- ▶ No clear consensus on what constitutes a 'trait' or 'functional trait'

# From flies to fungi: functional traits in conservation

## Summary of ECCB 2018 discussion group:



- ▶ Over 25 participants researching across multiple taxa and biomes
- ▶ No clear consensus on what constitutes a 'trait' or 'functional trait'
- ▶ Terms appeared to be used differently by different researchers

# Survey on trait terminology use and interpretation

Section 2 of 12

The following are acceptable categories of biological "trait" measurements (check all that apply)

Description (optional)

Question

- ☐ Genetic (e.g. locus heterozygosity)
- ☐ Morphological (e.g. organism size)
- ☐ Physiological (e.g. respiration rate)
- ☐ Phenological (e.g. fruiting duration)
- ☐ Behavioural (e.g. activity time)
- ☐ Cultural (e.g. bird song dialect)
- ☐ Geographic (e.g. population density)

After section 2 [Continue to next section](#)

**Hypothesis:** Researcher use of 'trait' and 'functional trait' depends on taxa and biome of study, and experience

- ▶ Developed a 16 question survey



# Survey on trait terminology use and interpretation

Section 2 of 12

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- ▶ Developed a 16 question survey
- ▶ Advertised on social media and email lists (e.g., ECOLOG-L, evoldir)

# Survey on trait terminology use and interpretation

Section 2 of 12

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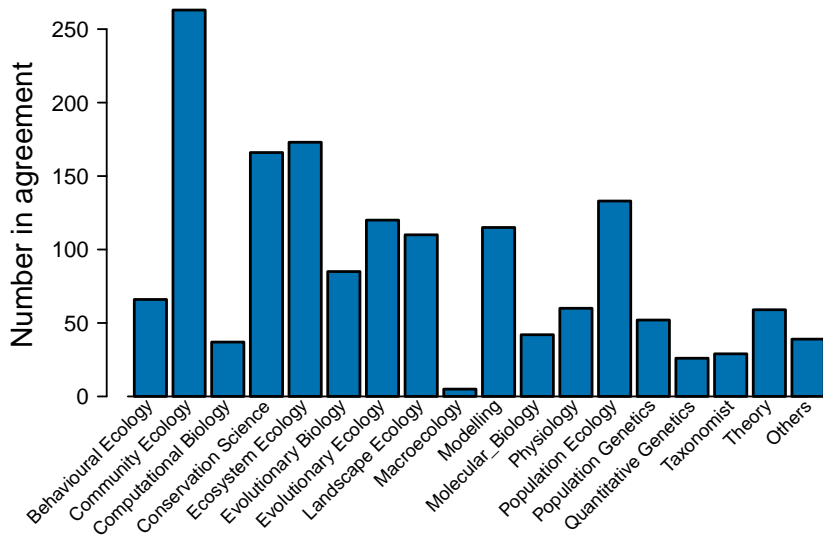
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After section 2 Continue to next section

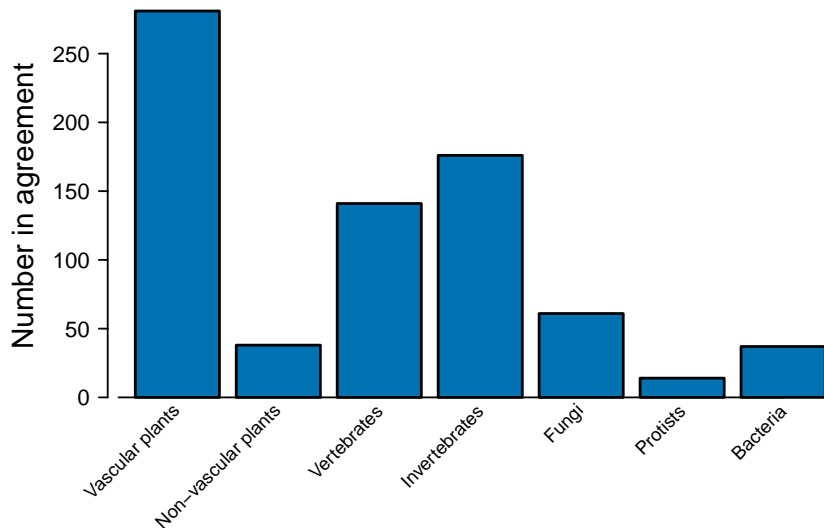
**Hypothesis:** Researcher use of 'trait' and 'functional trait' depends on taxa and biome of study, and experience

- ▶ Developed a 16 question survey
- ▶ Advertised on social media and email lists (e.g., ECOLOG-L, evoldir)
- ▶ Received 486 responses

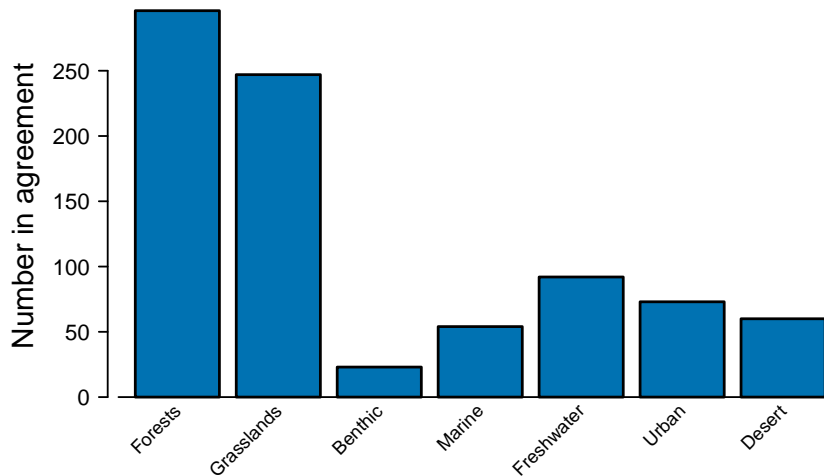
Which of the following terms describe your research?



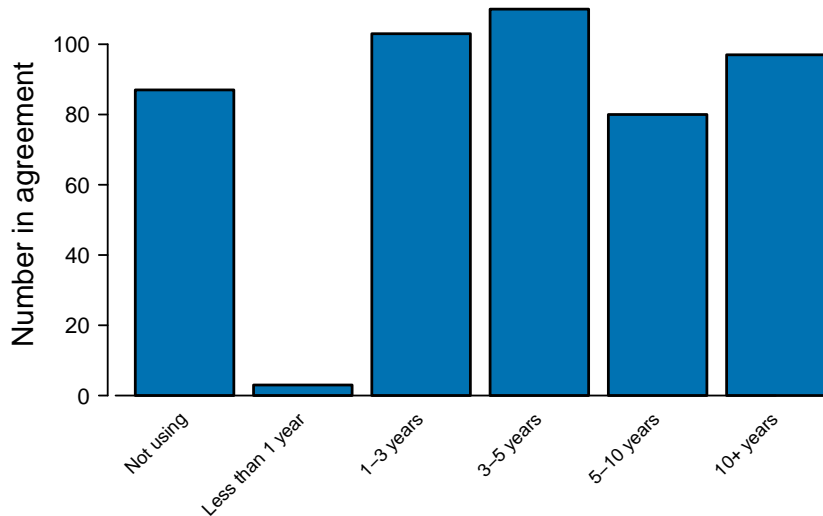
With which of the following taxa do you (mainly) work?



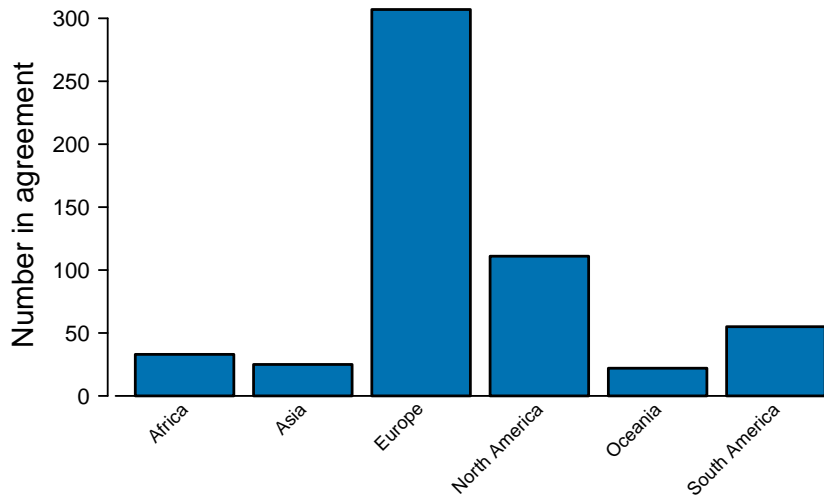
In which biomes do you (mainly) work?



How long have you been working with trait-based approaches?



If you use fieldwork to obtain your data, what continent do you primarily work on?



The following are acceptable categories of biological “trait” measurements (check all that apply)

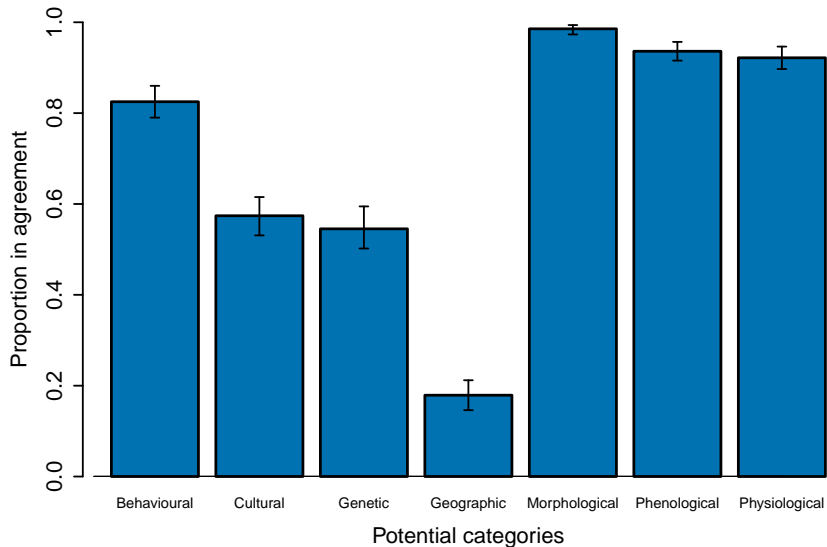
- ☐ Behavioural (e.g., activity time)
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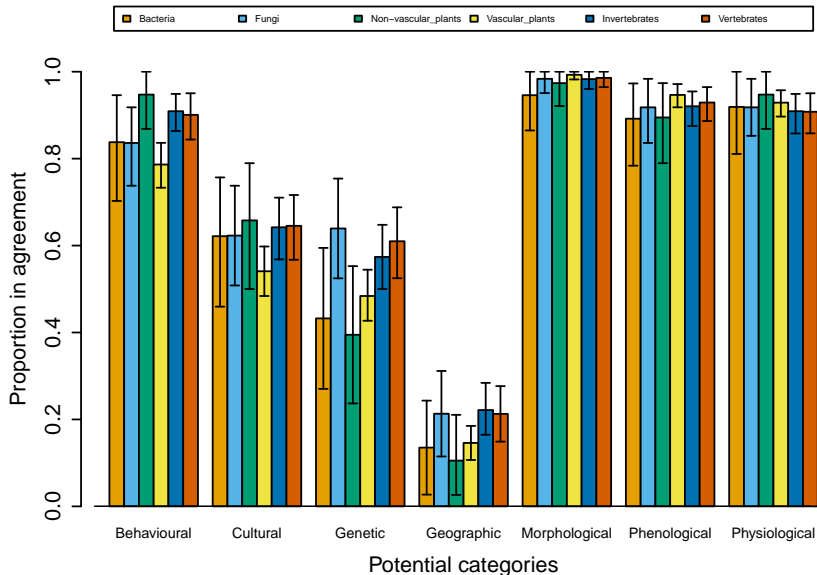
A biological “trait” can be defined at the following scales  
(check all that apply)

- ☐ Biochemical
- ☐ Cellular
- ☐ Organ system (within individual: e.g. multiple leaves from a single plant individual)
- ☐ Individual
- ☐ Clonal line (within individual: e.g. some fungi or clonal plants with identical genotypes)
- ☐ Group
- ☐ Population
- ☐ Community

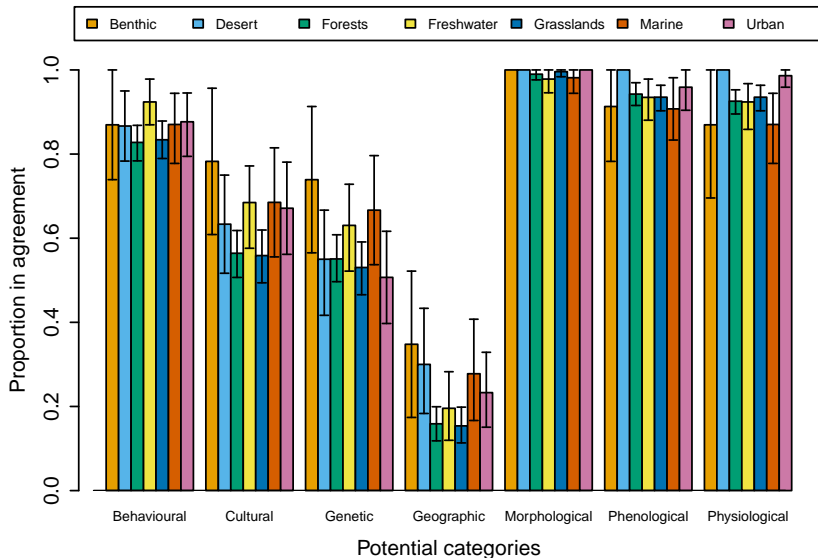
These are acceptable categories for a biological “trait”



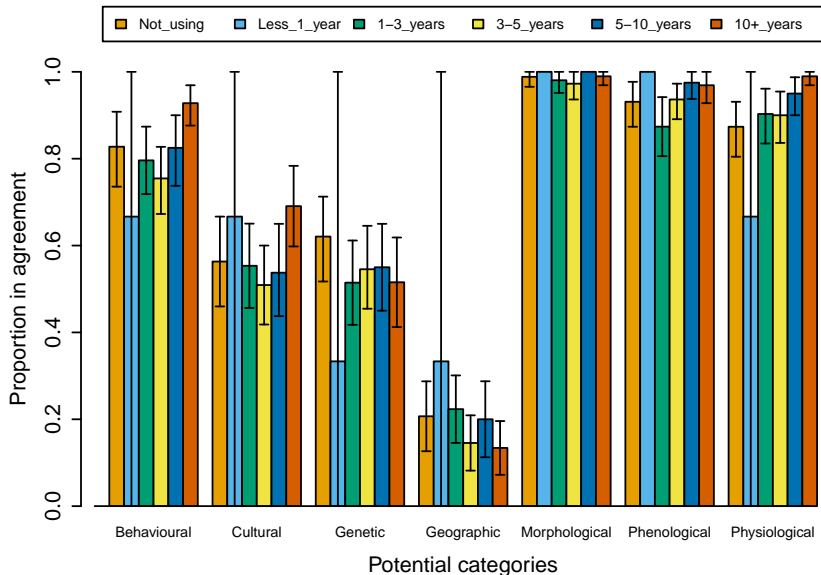
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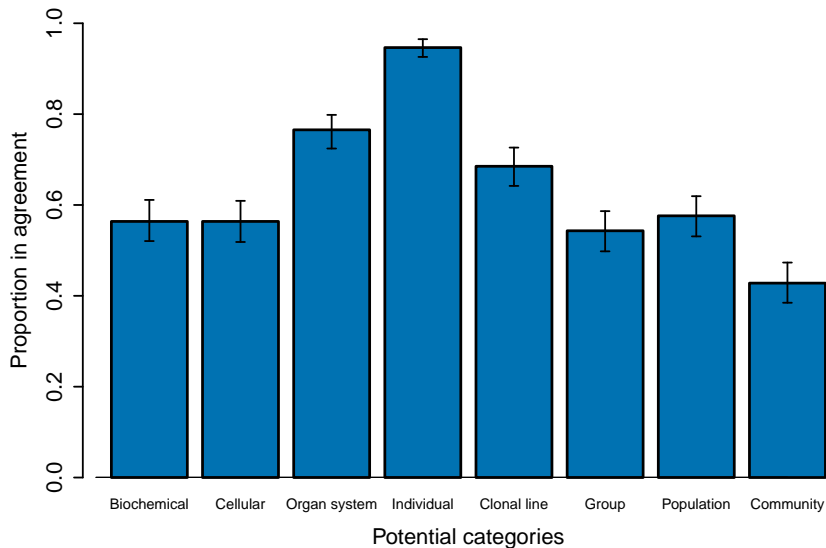
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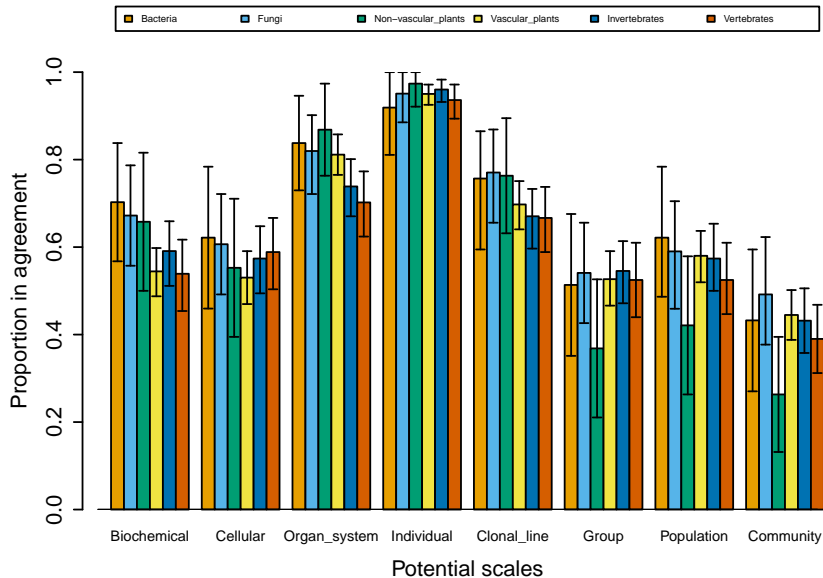
These are acceptable categories for a biological “trait”



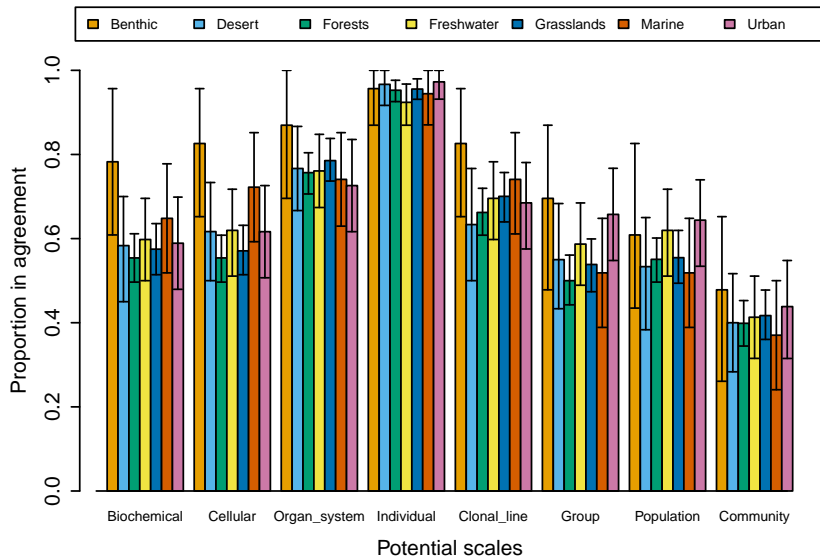
A “trait” can be defined at the following scales



# A “trait” can be defined at the following scales

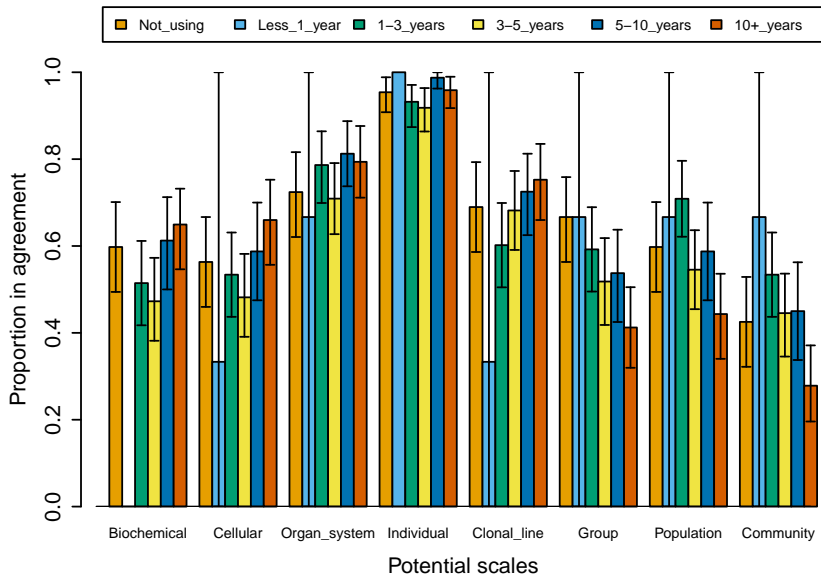


# A “trait” can be defined at the following scales





## A “trait” can be defined at the following scales



## A functional trait analysis on researcher functional traits

In the same way that community ecologists might look at functional trait diversity among species across sites, we looked at survey answer diversity among respondents across different groups.

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<sup>1</sup>Rao, CR. 1982. *Theor. Popul. Biol.* **21**: 24-43.

<sup>2</sup>Lepš et al. 2006. *Preslia* **78**:481-501.

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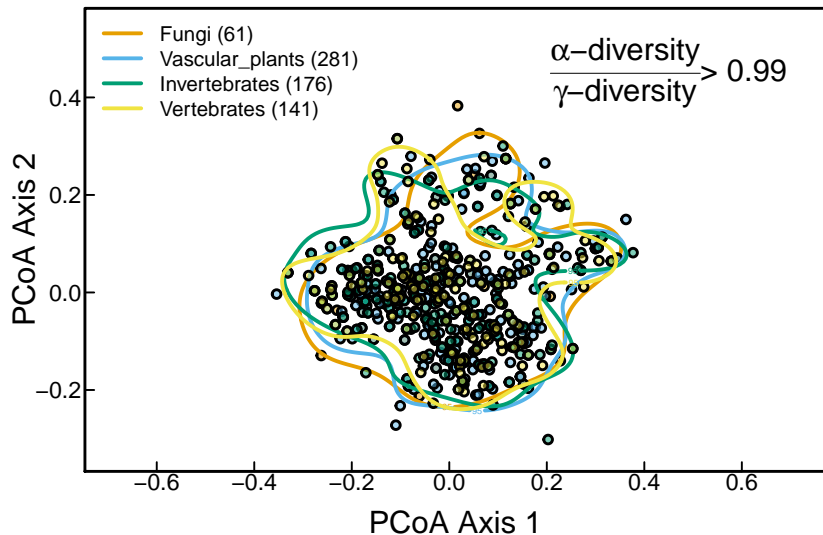
**Next figure is a principal coordinate analysis.**

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<sup>1</sup>Rao, CR. 1982. *Theor. Popul. Biol.* **21**: 24-43.

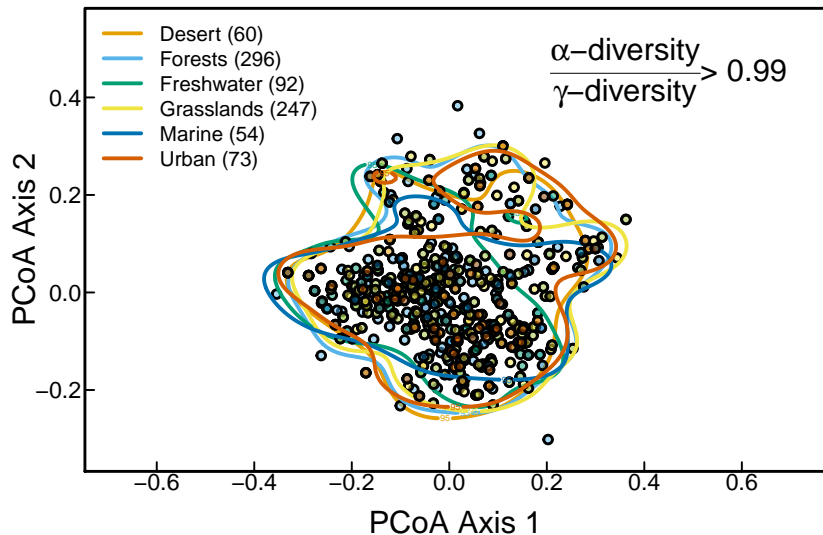
<sup>2</sup>Lepš et al. 2006. *Preslia* **78**:481-501.

## The PCoA on research taxa used

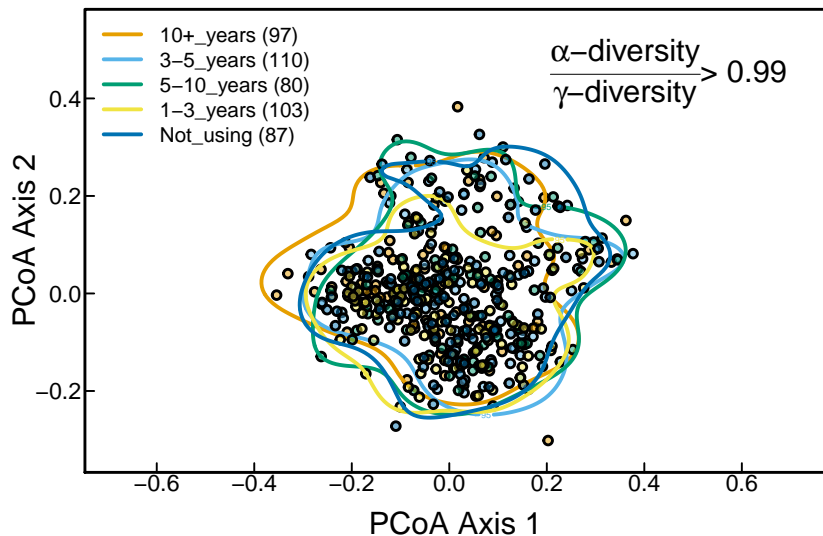




## The PCoA on research biome used



## The PCoA on research experience with functional traits



## No evidence that terms are used differently among groups

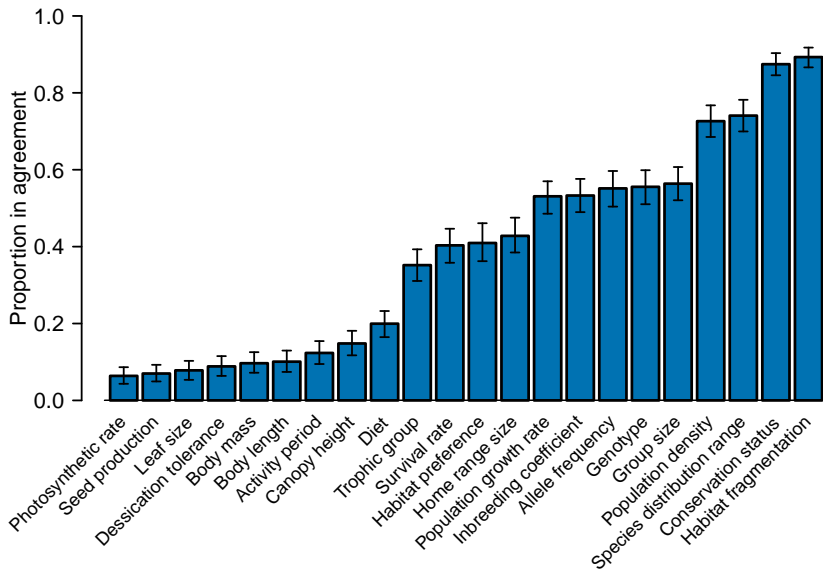
- ▶ Taxa of focus ✓
- ▶ Biome of focus ✓
- ▶ Experience with trait-based approaches ✓

# No evidence that terms are used differently among groups

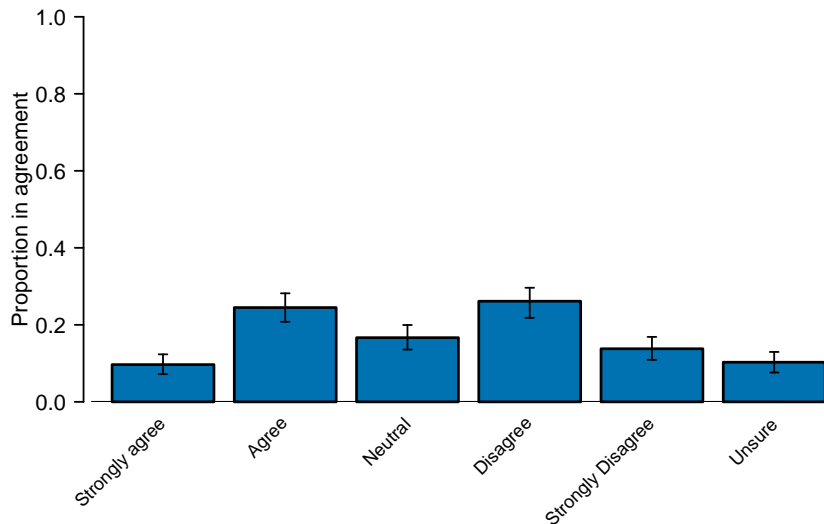
- ▶ Taxa of focus ✓
- ▶ Biome of focus ✓
- ▶ Experience with trait-based approaches ✓
- ▶ **Sub-discipline(s) of the researcher**
- ▶ Continent of field work focus
- ▶ Age of the researcher
- ▶ Gender of the researcher

- ▶ Behavioural Ecology (66)
- ▶ Community Ecology (263)
- ▶ Computational Biology (37)
- ▶ Conservation Science (166)
- ▶ Ecosystem Ecology (173)
- ▶ Evolutionary Biology (85)
- ▶ Evolutionary Ecology (120)
- ▶ Landscape Ecology (110)
- ▶ Macroecology (5)
- ▶ Modelling (115)
- ▶ Molecular Biology (42)
- ▶ Physiology (60)
- ▶ Population Ecology (133)
- ▶ Population Genetics (52)
- ▶ Quantitative Genetics (26)
- ▶ Taxonomy (29)
- ▶ Theory (59)

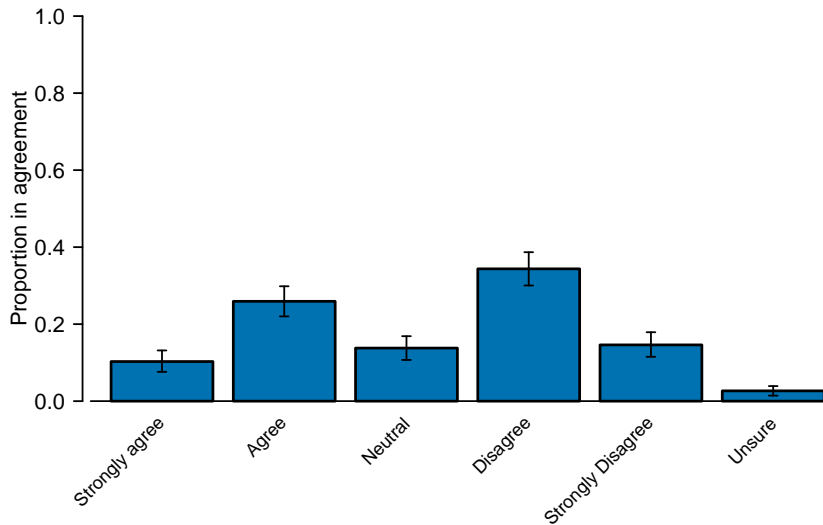
The following **are not** examples of functional traits



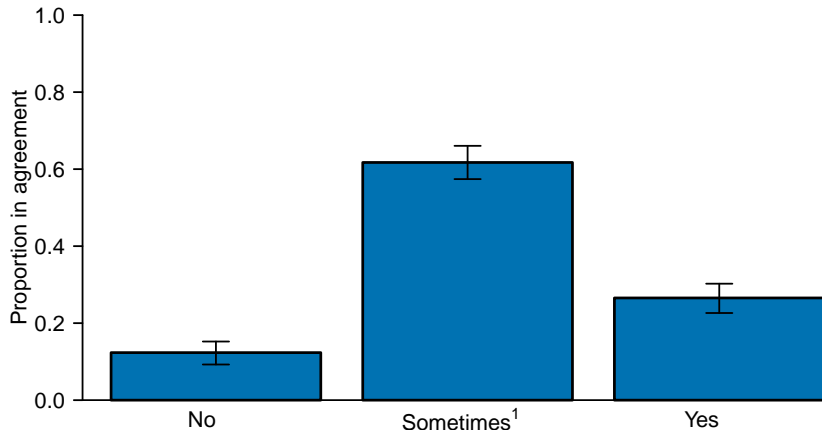
A biological “trait” must be defined independently from its relation to the environment



## A biological “trait” must be heritable



## Definition of “trait” is flexible depending on study organism



---

<sup>1</sup>Provided a definition is clearly stated and motivated by knowledge about the organism



# Acknowledgements (general conclusions to follow)

LEVERHULME  
TRUST

UNIVERSITY of  
STIRLING



Sveriges lantbruksuniversitet  
Swedish University of Agricultural Sciences

ArtDatabanken



Eesti Teadusagentuur  
Estonian Research Council



CNPq

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES



## Conclusions: agreements and disagreements about traits

Agreement	Disagreement
Individual measurements are traits (e.g., leaf size, body mass)	Unrelated to researcher sub-discipline, taxa of study, biome of study, or experience with using traits
Larger scale patterns are not traits (e.g., conservation status, habitat fragmentation)	Must be independent from relation to the environment
Terminology is, at least sometimes, dependent upon on study organism	Must be heritable

## Literature review

# Traits and functional traits: a small literature review

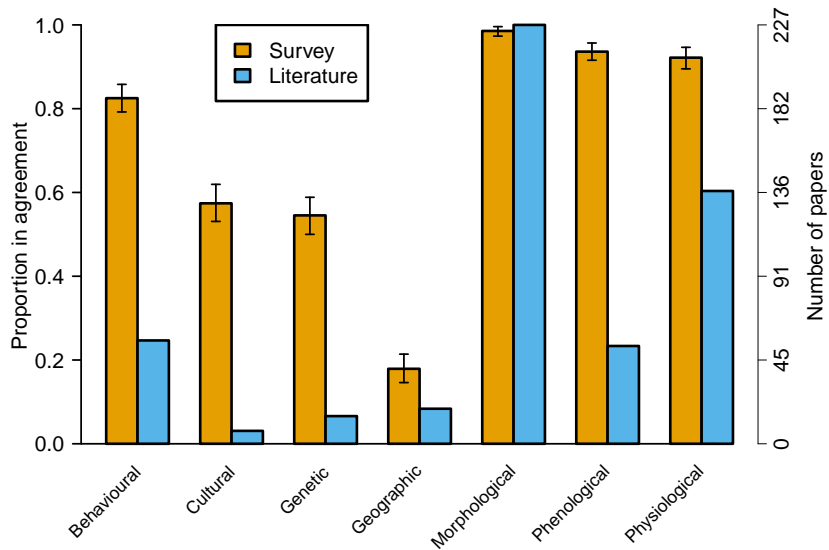
- ▶ **Are survey results reflected in the literature?**
- ▶ Reviewed articles with 'trait\*' in title, abstract, or key words

# Traits and functional traits: a small literature review

- ▶ **Are survey results reflected in the literature?**
- ▶ Reviewed articles with 'trait\*' in title, abstract, or key words
- ▶ Articles from 2018 in selected ecology journals
- ▶ 760 total articles reviewed (in progress)
- ▶ Articles randomly assigned to co-authors

*Ecology*  
*J. of Ecol.*  
*Am. Nat.*  
*Ecography*  
*Func. Ecol.*  
*Glob. Ecol. Biogeogr.*  
*Oecologia*  
*Oikos*  
*Ecol. Lett.*  
*J. Anim. Ecol.*  
*J. Appl. Ecol.*

## Traits and functional traits: a small literature review



# Traits and functional traits: a small literature review

**Total papers reviewed: 318**

- ▶ 22 provide a definition of 'trait', 'functional trait', or both

---

<sup>1</sup>Violle, C et al. 2007. *Oikos*, **116**: 882-892.

# Traits and functional traits: a small literature review

**Total papers reviewed: 318**

- ▶ 22 provide a definition of 'trait', 'functional trait', or both
- ▶ 9 cite Voille et al. (2007)<sup>1</sup> for definitions (below)

***Trait:*** [A]ny morphological, physiological or phenological feature measurable at the individual level, from the cell to the whole-organism level, without reference to the environment or any other level of organization.

***Functional trait:*** Any trait which impacts fitness indirectly via its effects on growth, reproduction and survival.

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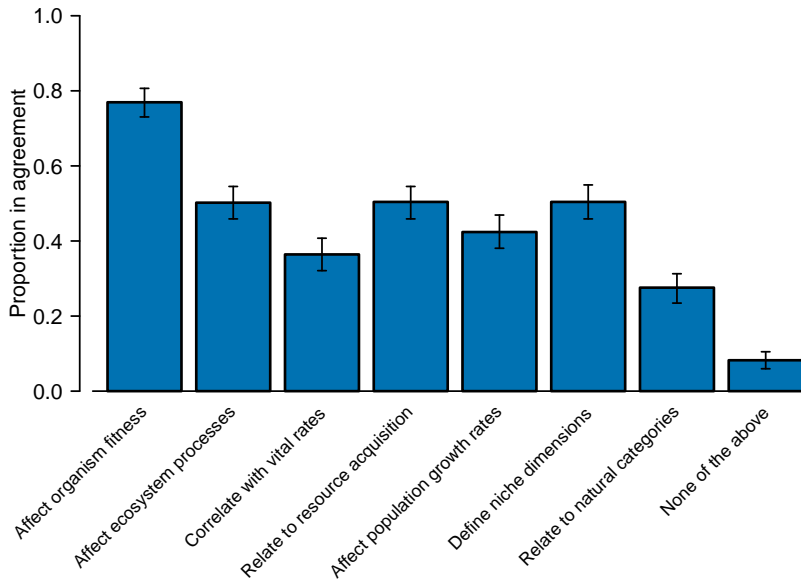
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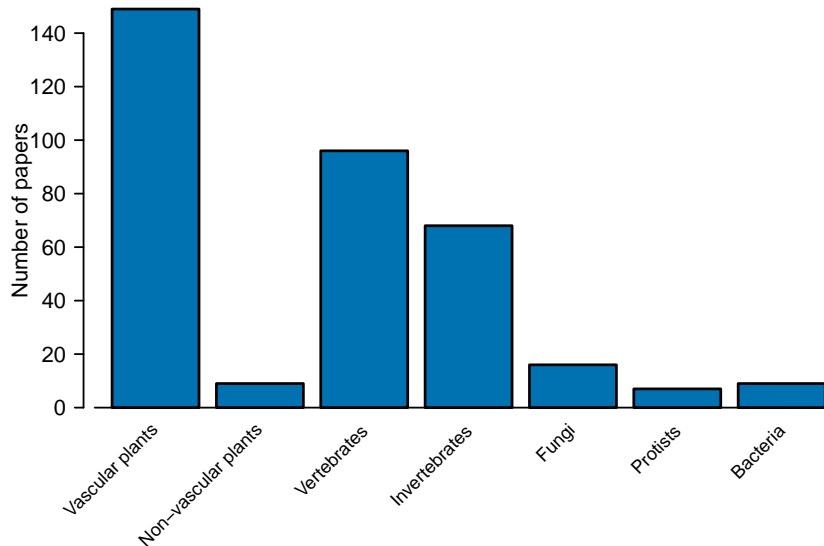
A biological trait must fulfil at least some of the following conditions to be considered a functional trait (check all that apply)

- ☐ Affect organism fitness
- ☐ Affect ecosystem processes
- ☐ Correlate with vital rates
- ☐ Relate to resource acquisition
- ☐ Affect population growth rate(s)
- ☐ Define important niche dimensions
- ☐ Relate to natural categories (i.e., excluding unambiguously human-designated categories such as provenance or conservation status)
- ☐ None of the above

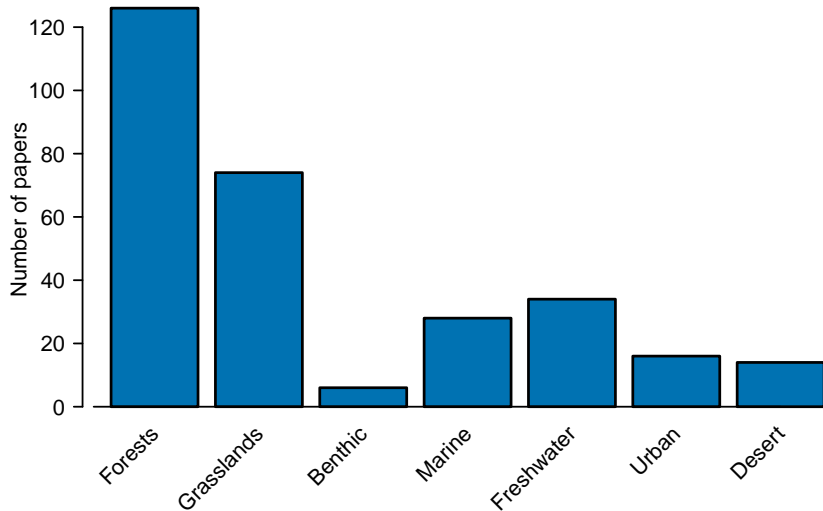
A biological “trait” must fulfil at least some of the following conditions to be considered a functional trait



## Taxa for trait based research



## Biomes for trait based research



## Continents for trait based research

