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On measuring traits

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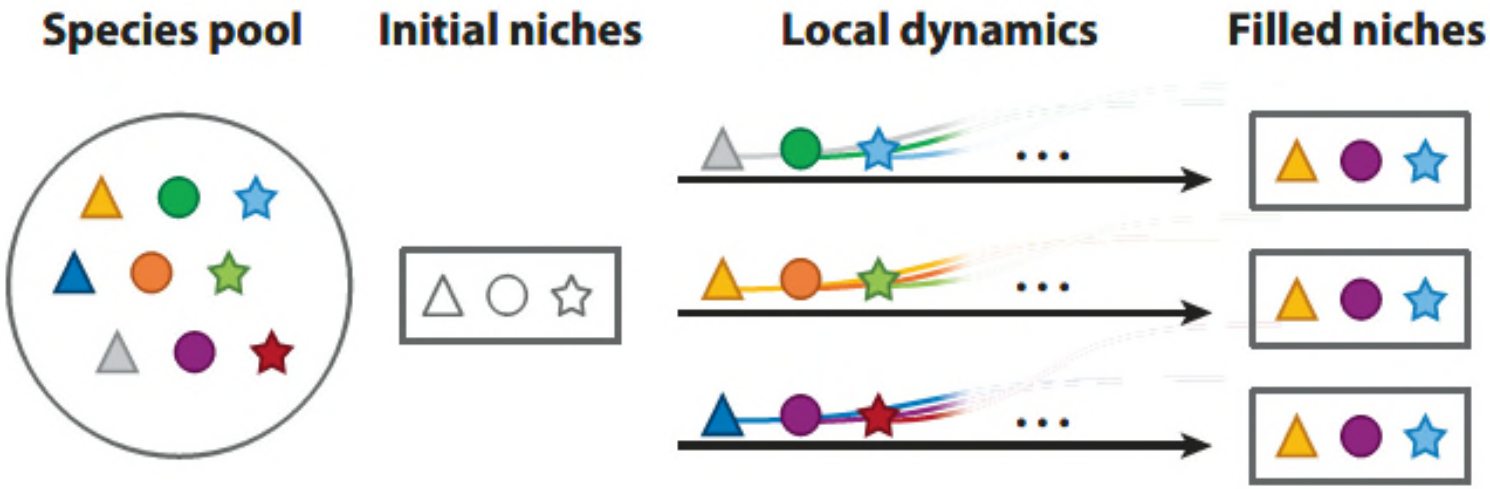
AWI ALFRED WEGENER INSTITUT

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

A „mechanistic Utopia“

Trait-based approaches promise to overcome the „taxonomy gap“ and to amend „who is there“ by „why are they there“.



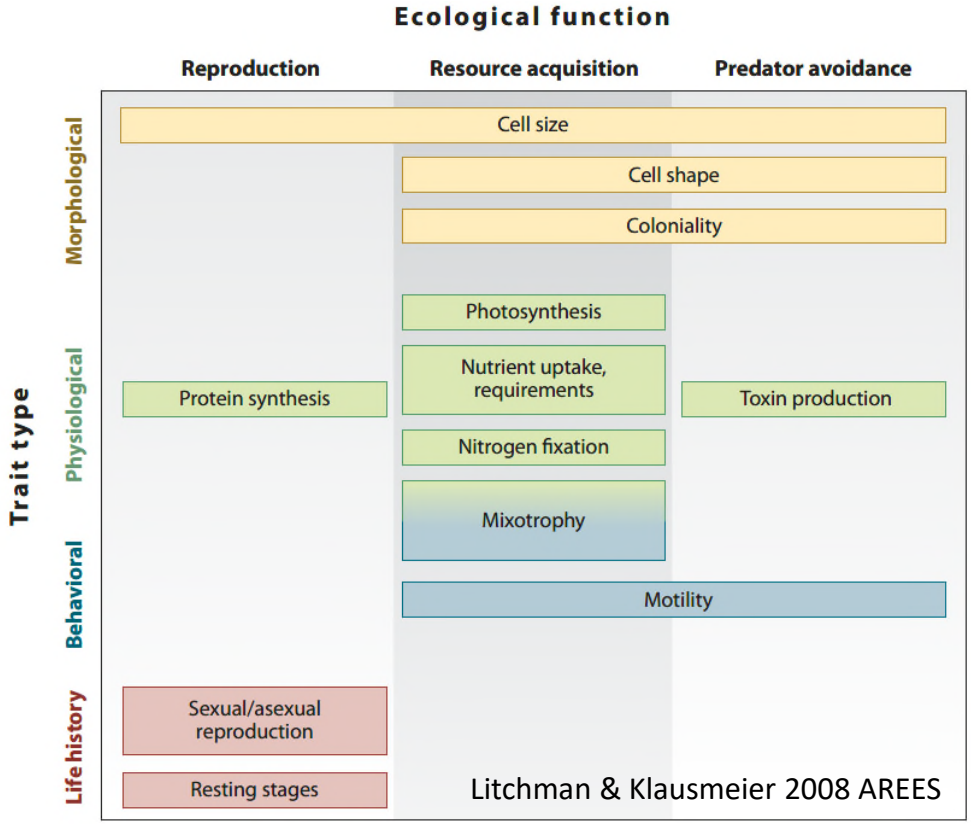
Schoener 1986 Am Zool, Fukami 2015 AREES

A „mechanistic Utopia“

Trait-based approaches promise to overcome the „taxonomy gap“ and to amend „who is there“ by „why are they there“.

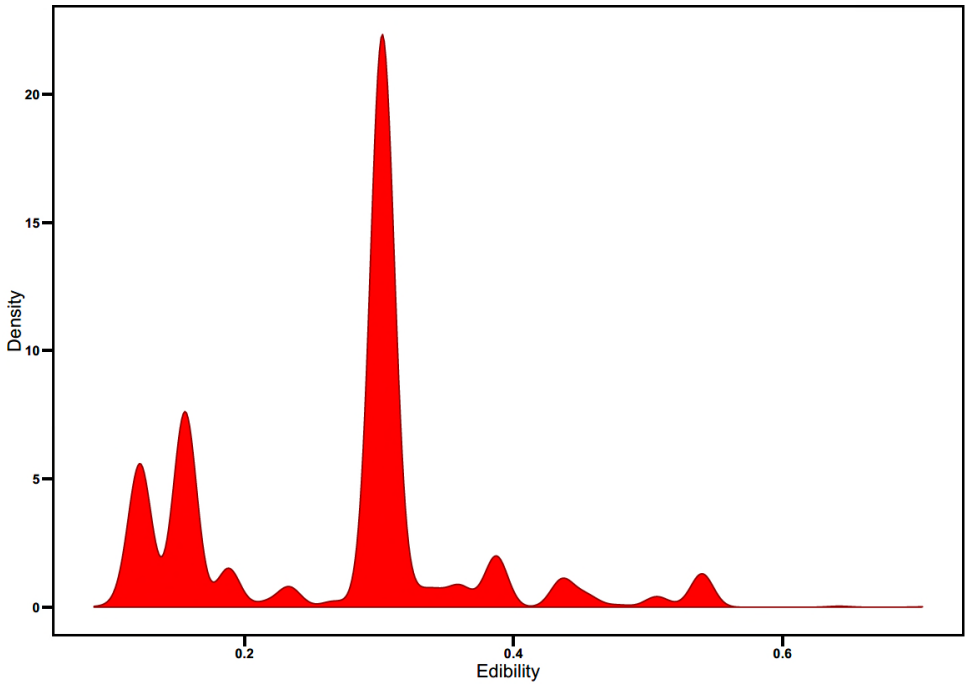
Trait-based approaches profit from

- knowing the link between a measured trait and a function (performance)
- being able to repeatable measure these traits across species in a organism group
- ability to reduce the dimensionality of the „community“
  - Using x_t traits instead of a much larger number of X_S species



Three warnings about functional groups

1) Grouping species into functional groups looses and distorts the information



How many groups? Often no objective criterion possible

All empirical examples from Interreg Water Quality project led by NLWKN, work by Josie Antonucci

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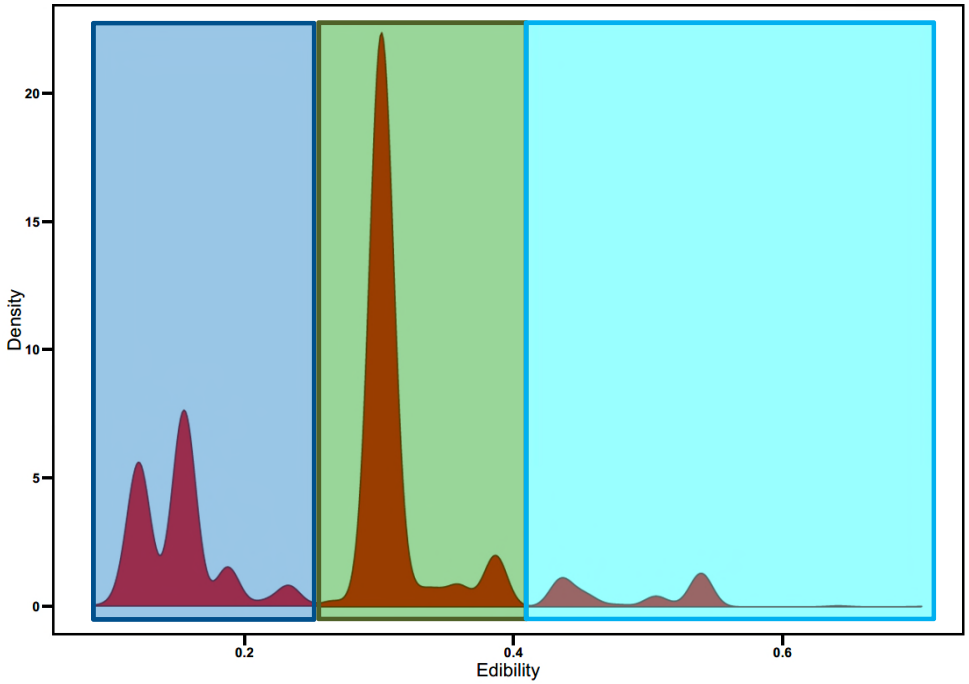

How many groups? Often no objective criterion possible

Boundaries arbitrary

Difference close to boundary exaggerated

Difference within functional groups ignored

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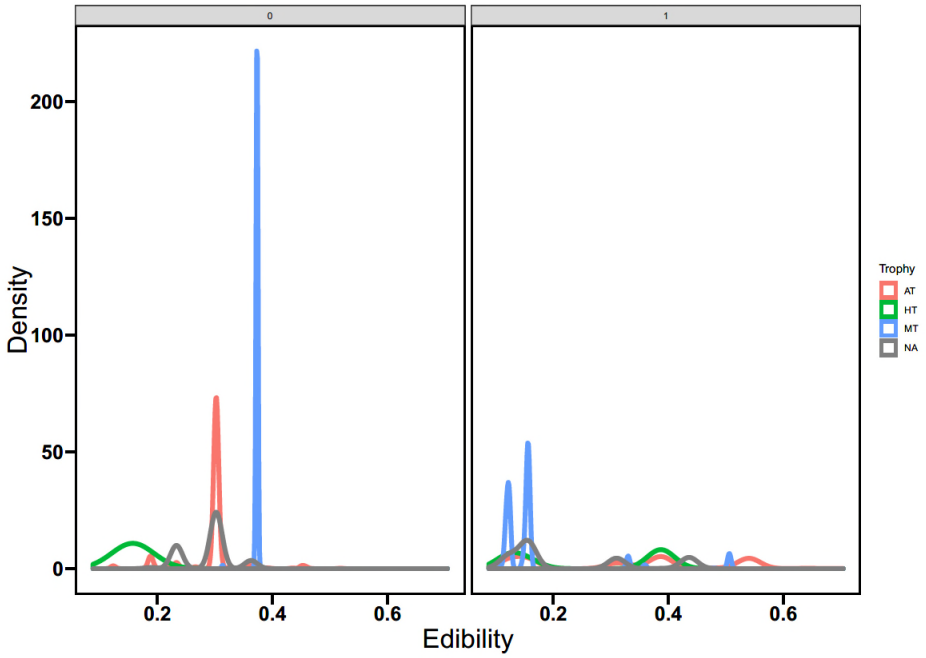

Same trait (edibility) split between immobile (left) and mobile (right) algae and 4 trophic groups (colors)

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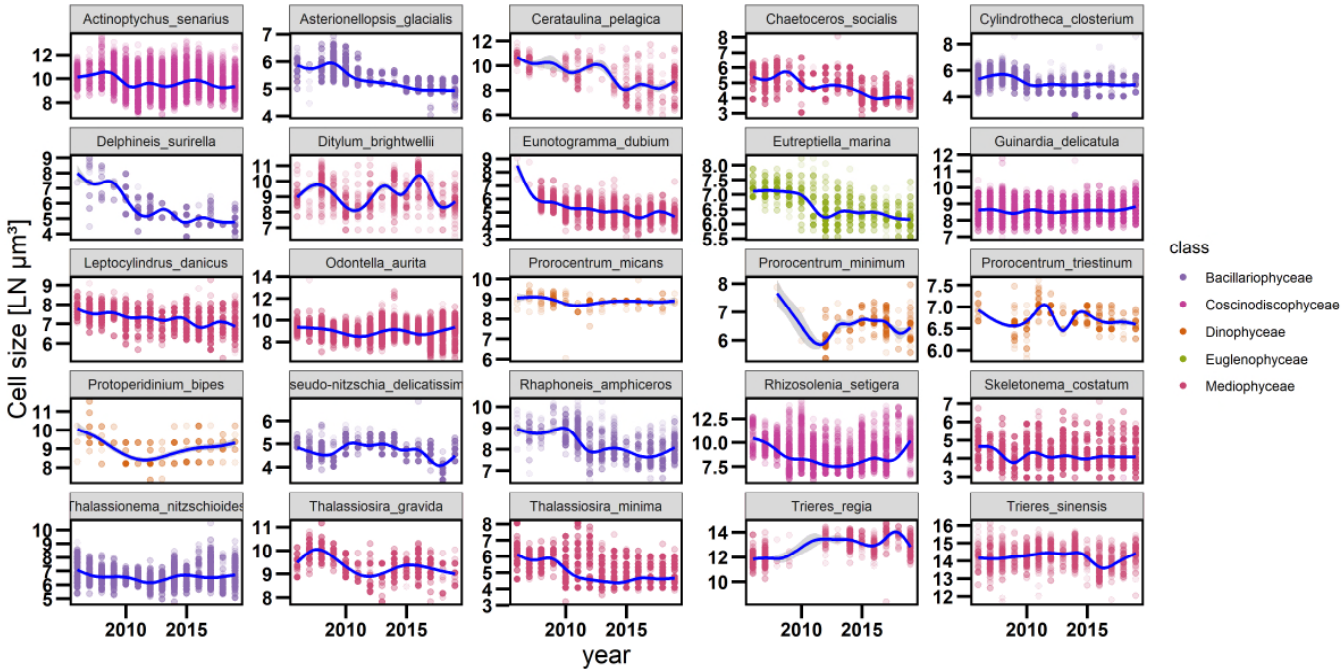
Three warnings about functional groups

1) Grouping species into functional groups looses and distorts the information

2) The number of functional groups increases with each new taits considered: No reduction in complexity

3) Groupings occur (almost) always at the species level and across time, which ignores intraspecific variance



All empirical examples from Interreg Water Quality project

Does fuzzy coding help?

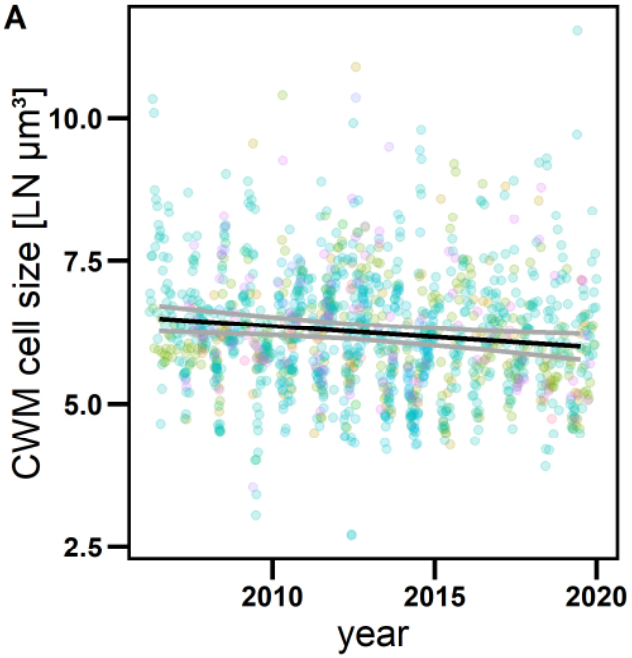
- Yes
  - Allows more differentiation in binary traits by more discrete categories
  - Allows integrating intraspecific trait variance
  - Allows continuous emerging properties
- No
  - Potential subjectivity of code categories
  - Discrete data often do not meet assumptions of statistical procedures

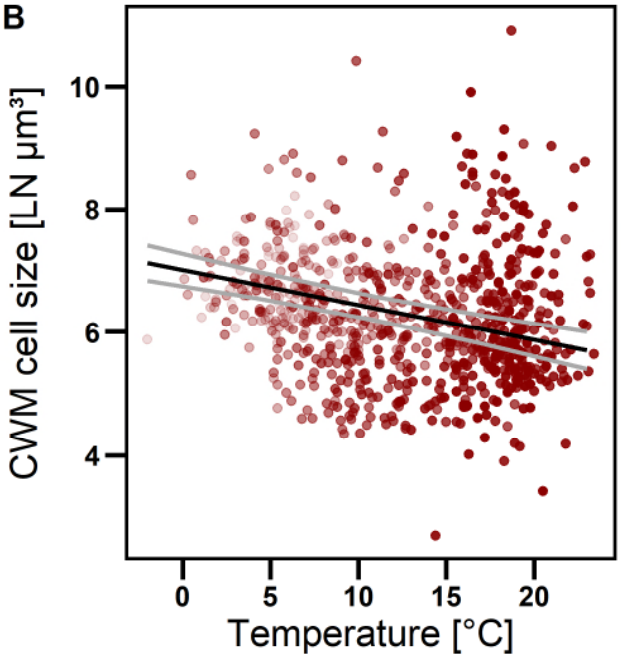
Explanation of fuzzy codes

3	Taxon has total and exclusive affinity for a certain trait category.
2	Taxon has a high affinity for a certain trait category, but other categories can occur with equal (2) or lower (1) affinity.
1	Taxon has a low affinity for a certain trait category.
0	Taxon has no affinity for a certain trait category.

If you can stick to continuous, do so

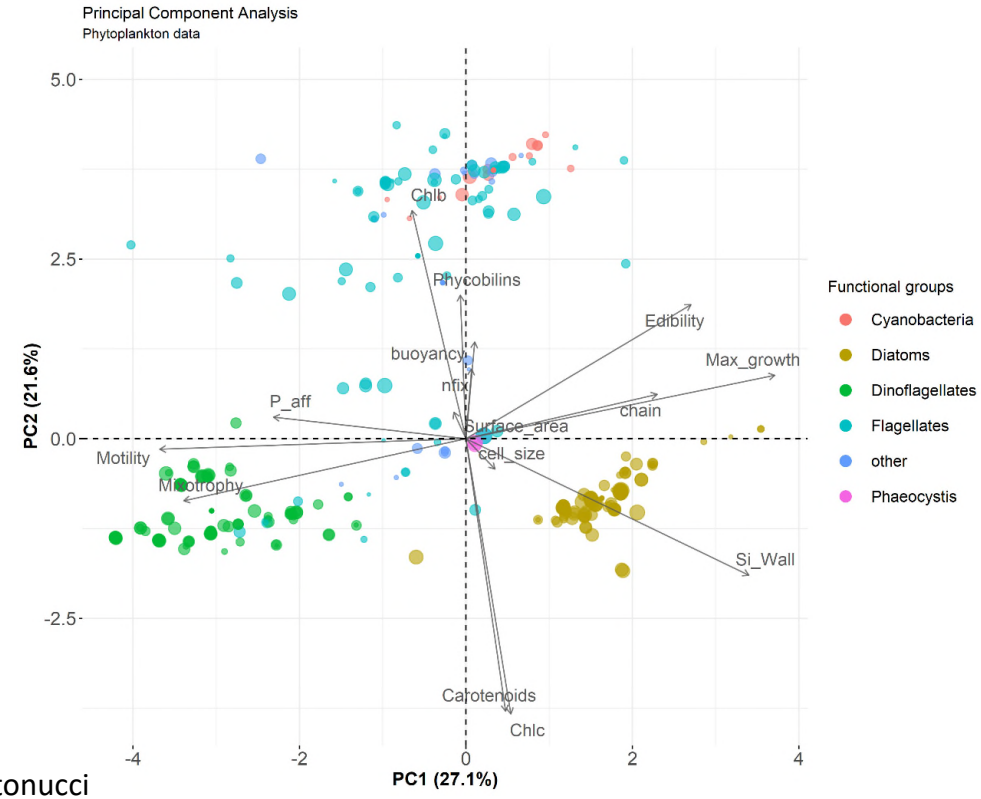
- For single traits allows to understand changes at the species and community level





If you can stick to continuous, do so

- For single traits allows to understand changes at the species and community level
- For multiple traits allows describing communities



Trait space of Wadden Sea phytoplankton
Two first PCs show strong impact by binary traits

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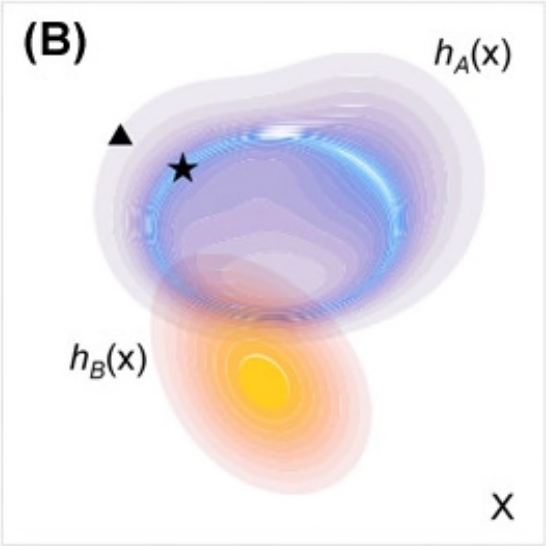
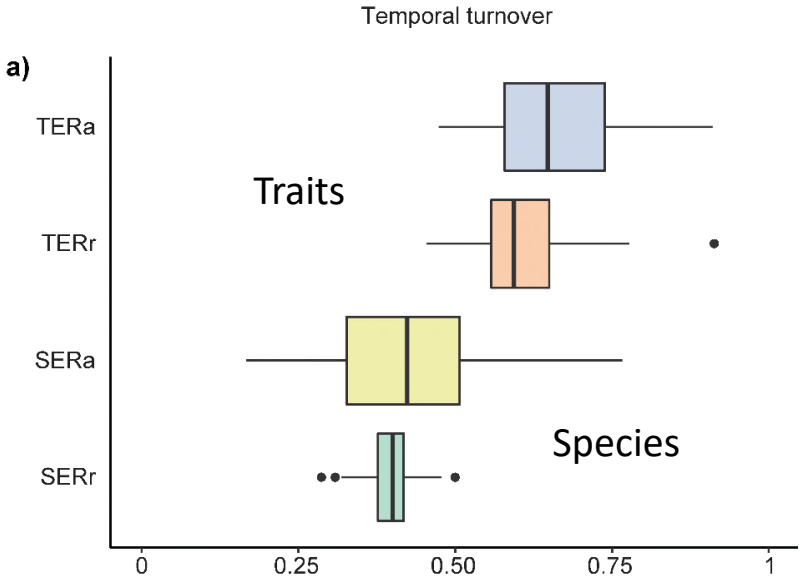
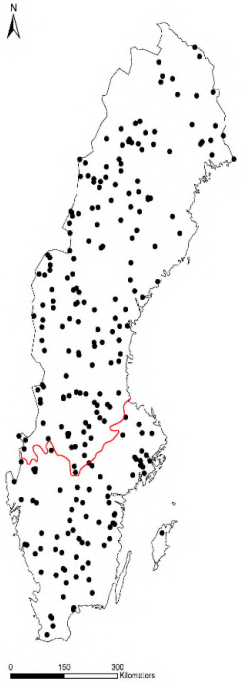
If you can stick to continuous, do so

- For single traits allows to understand changes at the species and community level
- For multiple traits allows describing communities
- For communities allows quantifying changes in trait space, e.g. hypervolumes



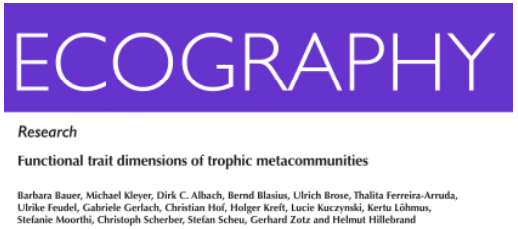




^Blonder 2018; > Truchy et al. in prep., Swedish freshwater macroinvertebrate monitoring

If you can stick to continuous, do so

- For single traits allows to understand changes at the species and community level
- For multiple traits allows describing communities
- For communities allows quantifying changes in trait space, e.g. hypervolumes
- Correlations between traits allows i) functional insights and ii) identification of trait dimensions that can be compared beweetn organism groups



Functional trait dimensions of trophic metacommunities

Barbara Bauer, Michael Kleyer, Dirk C. Albach, Bernd Blasius, Ulrich Brose, Thalita Ferreira-Arruda, Ulrike Feudel, Gabriele Gerlach, Christian Hof, Holger Kreft, Lucie Kuczynski, Kertu Lõhmus, Stefanie Moorthi, Christoph Scherber, Stefan Scheu, Gerhard Zotz and Helmut Hillebrand

Bauer et al 2021 Ecography

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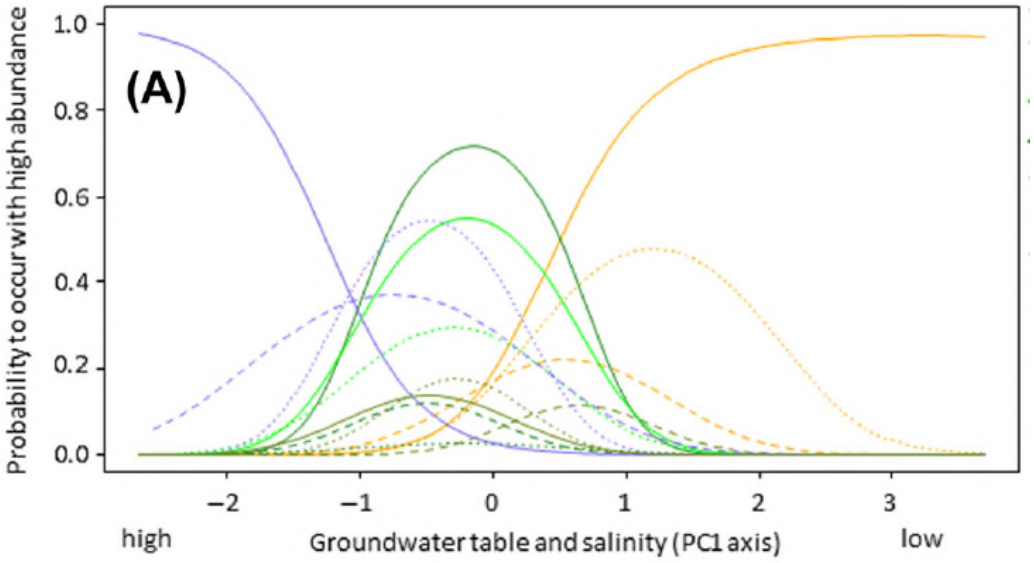
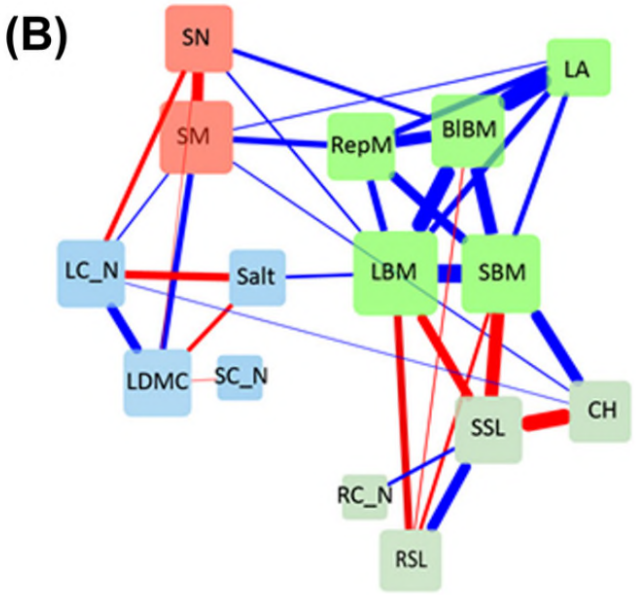
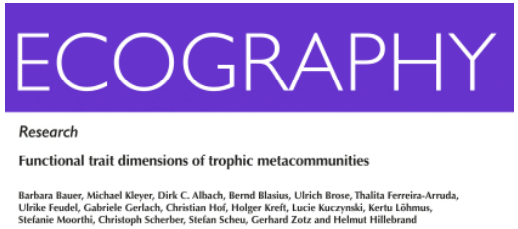
Trait dimensions





Seed number	SN
Seed mass	SM
Reproductive mass	RepM
Leaf area	LA
Leaf dry matter content	LDMC
Stem specific length	SSL
Root specific length	RSL
Plant vegetative height	CH
Plant leaf dry mass	LBM
Plant stem dry mass	SBM
Plant belowground dry mass	BlBM
Leaf C:N ratio	LC_N
Stem C:N ratio	SC_N
Root C:N ratio	RC_N
#Salt tolerance mechanisms	Salt


ECOGRAPHY

Research

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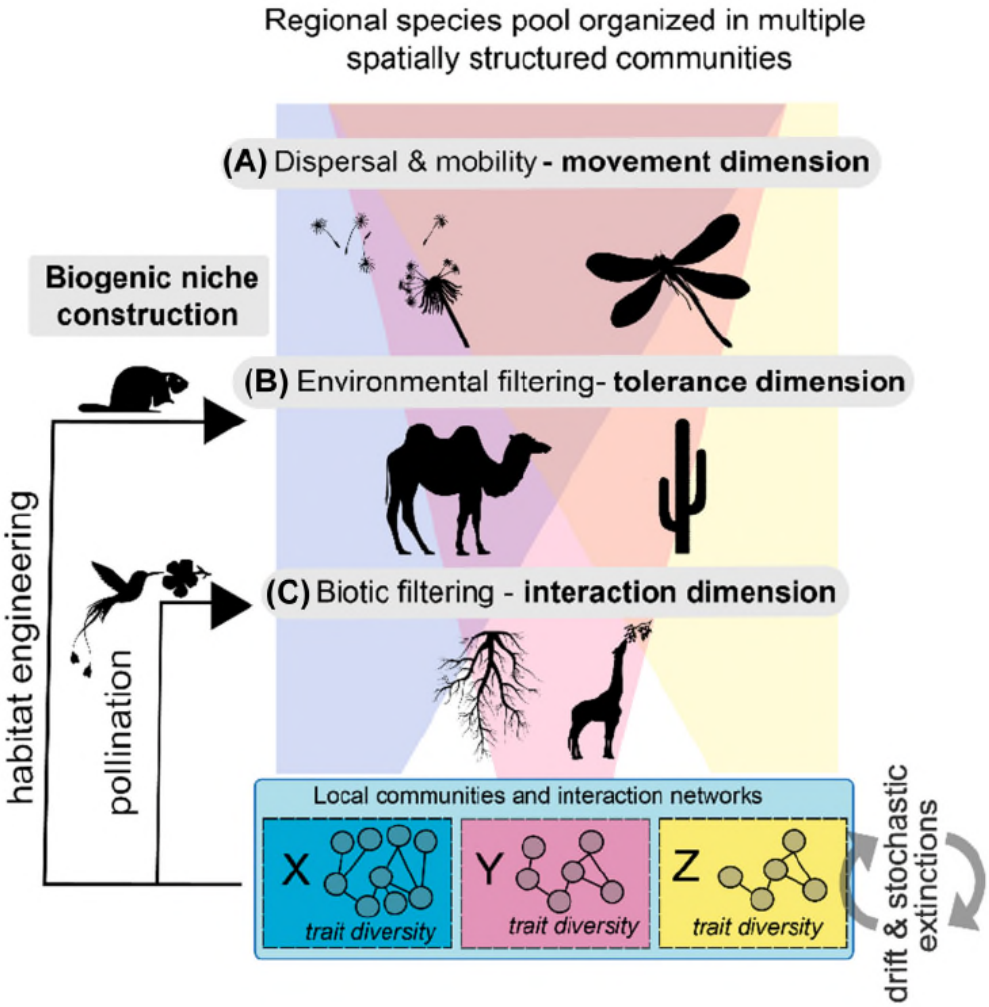

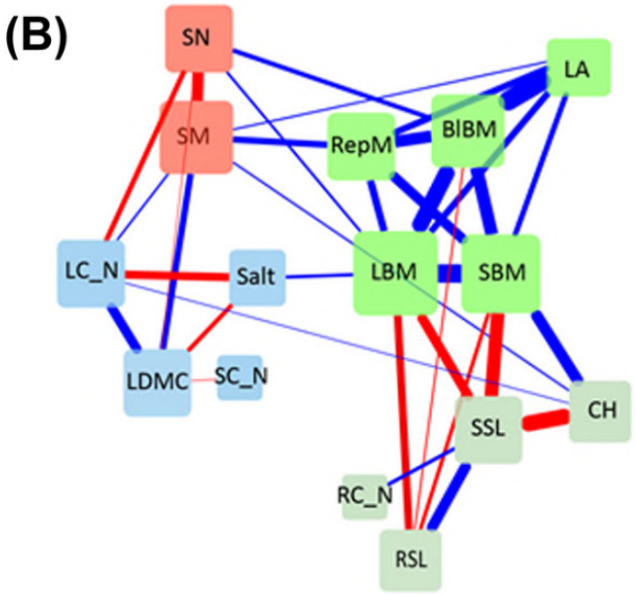

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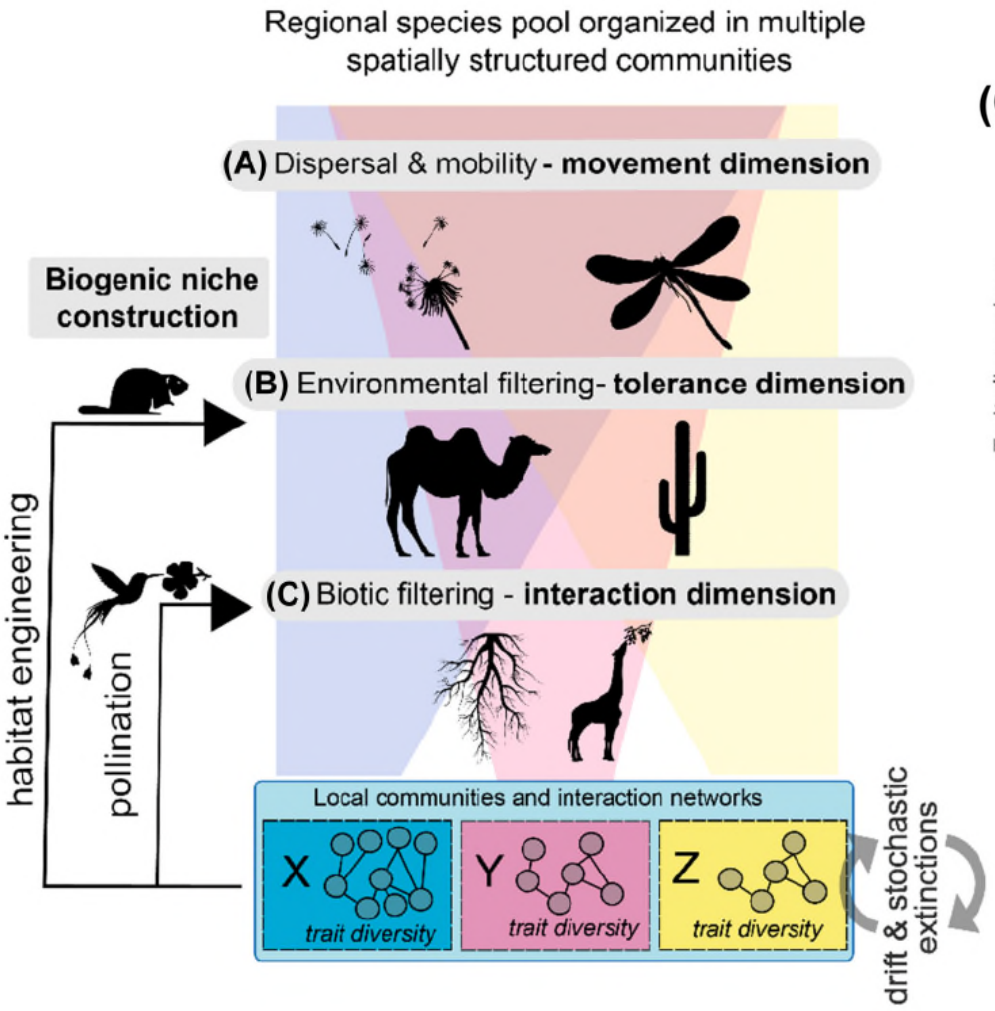

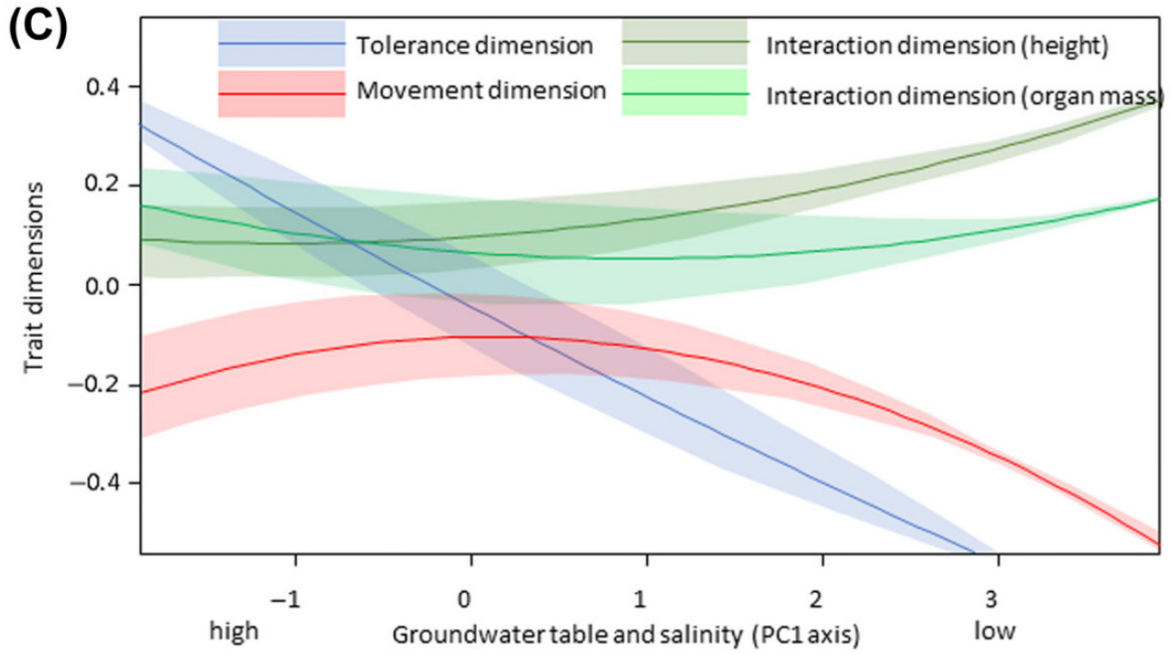

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Conclusion

- Traits are highly important and useful tool to link community composition to environment and functions
- Their usefulness is highest if used as measured characteristics (as in plant ecology) across a wide range of organisms without grouping

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