



# Marine ecosystem function: to the benthos and beyond

## Julie Bremner

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Centre for Environment  
Fisheries & Aquaculture  
Science

World Class Science for the Marine and  
Freshwater Environment

**CCSUS**

Collaborative Centre for  
Sustainable Use of the Seas

# Biological traits analysis for ecosystem functioning

A description of species/assemblages in terms of their ecological characteristics, rather than taxonomic identity

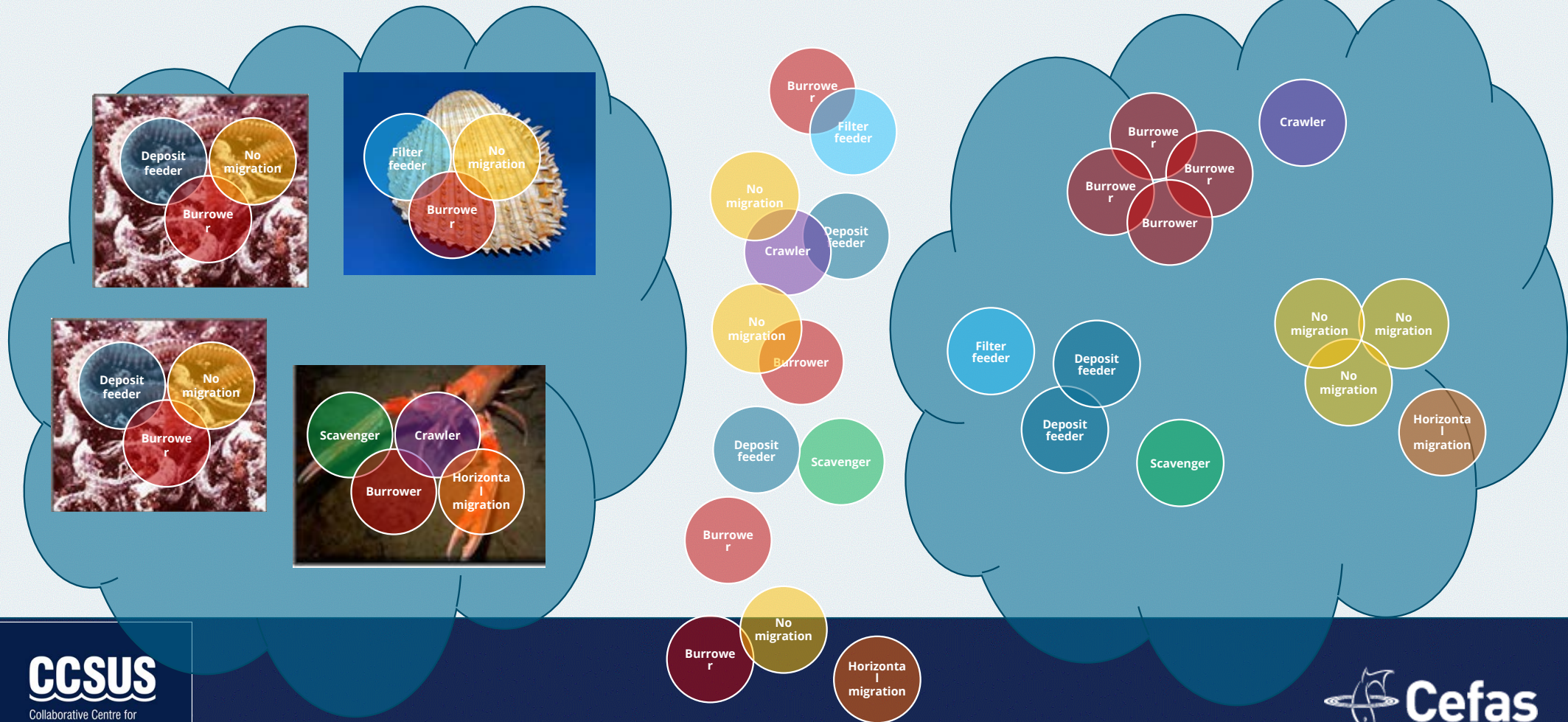
A different currency for ecological investigation, a 'package of traits'

Euarthropoda  
Crustacea  
Malacostraca  
Decapoda  
Nephropidae  
*Nephrops norvegicus*



Scavenger  
Burrower  
Crawler  
Non-migratory  
Moderately long-lived  
Large sized

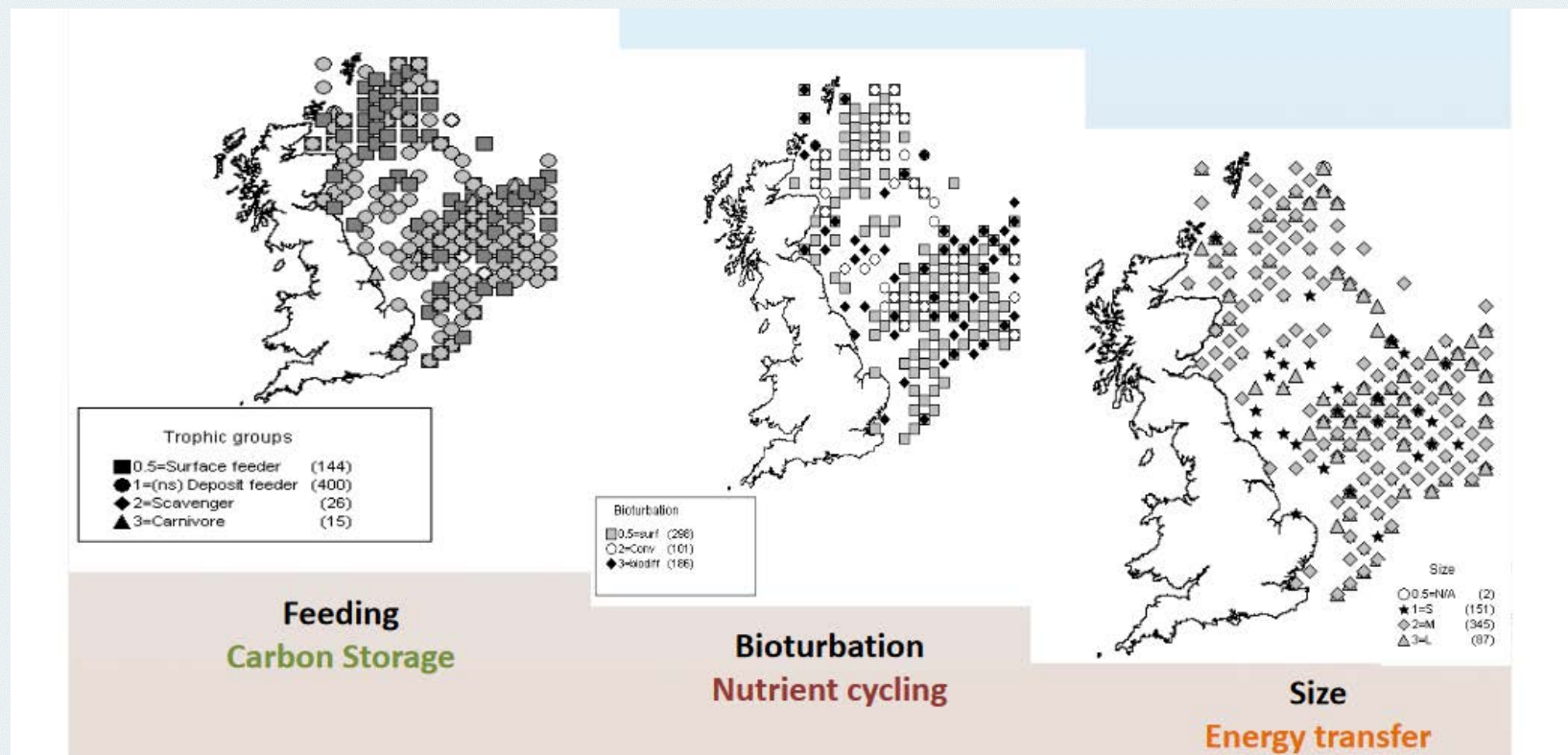
# Biological traits analysis for assemblage functioning



# Uses of biological traits analysis

Differences in function  
over space and time:

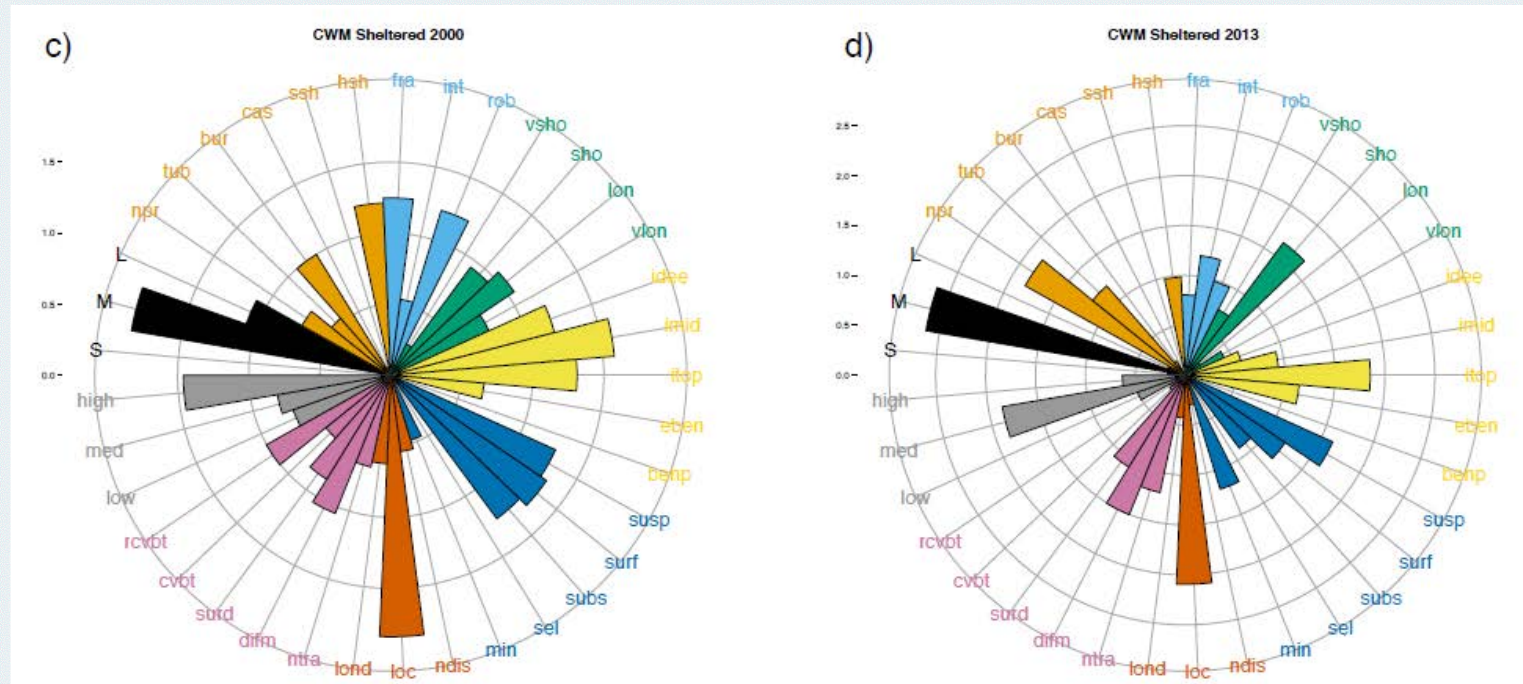
Individual traits



# Uses of biological traits analysis

Differences in function  
over space and time:

Assemblages



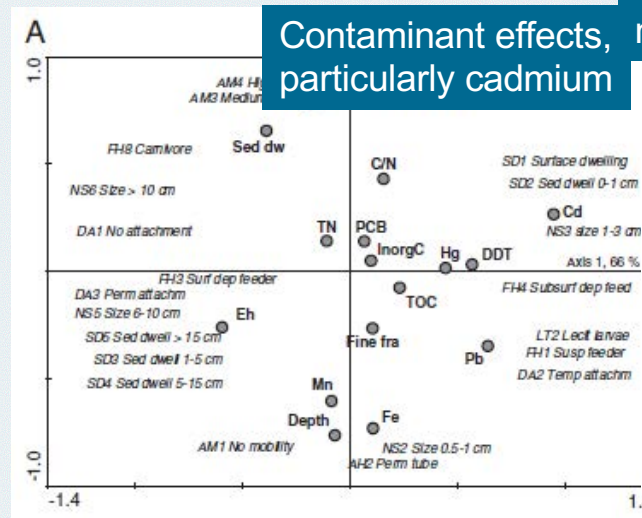
Weigel et al. (2015) Maintained functional diversity in benthic communities in spite of diverging functional identities. *Oikos*.

# Uses of biological traits analysis

Differences in function over space and time:

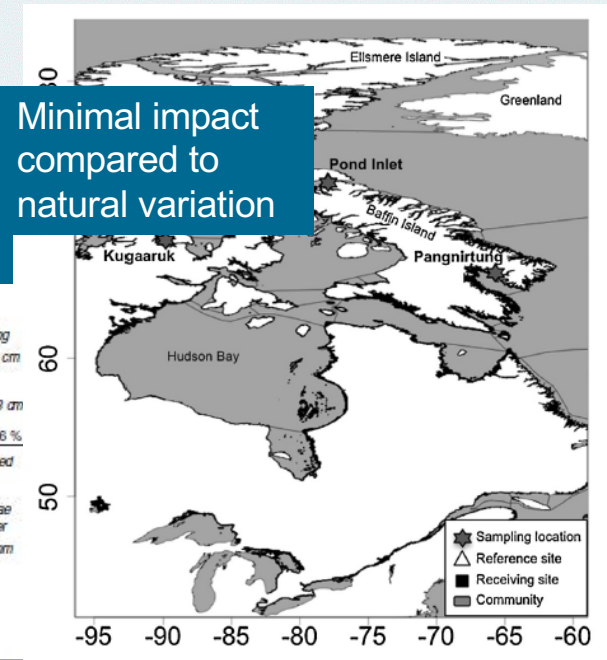
Describing human impacts

Aggregate extraction  
 Harbours  
 Environmental restoration  
 Pollution  
 Hypoxia  
 Fishing



Contaminant effects, particularly cadmium

Minimal impact compared to natural variation



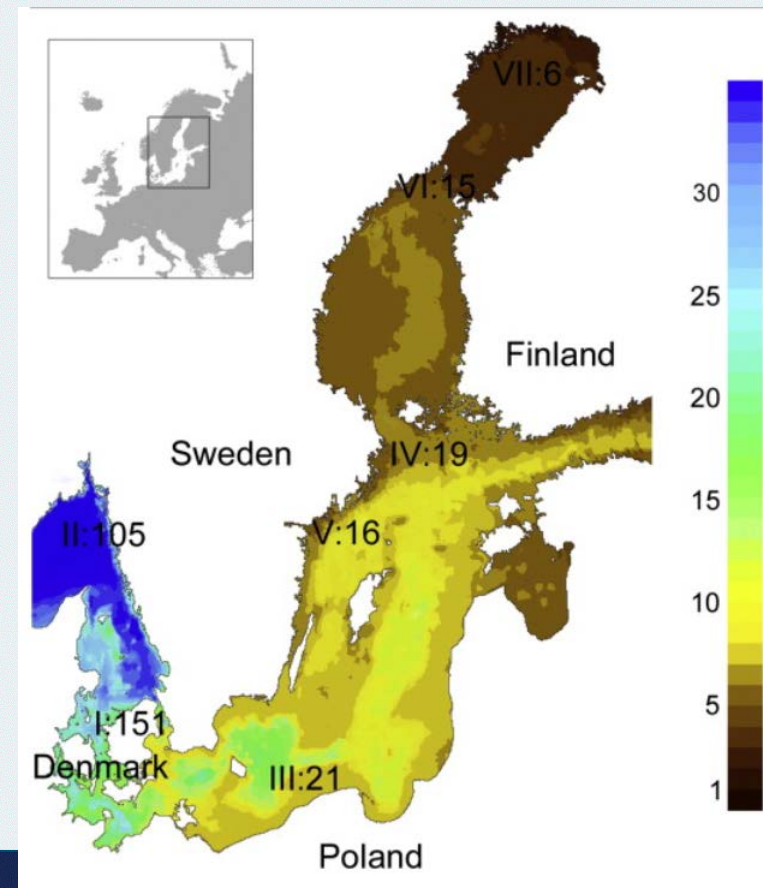
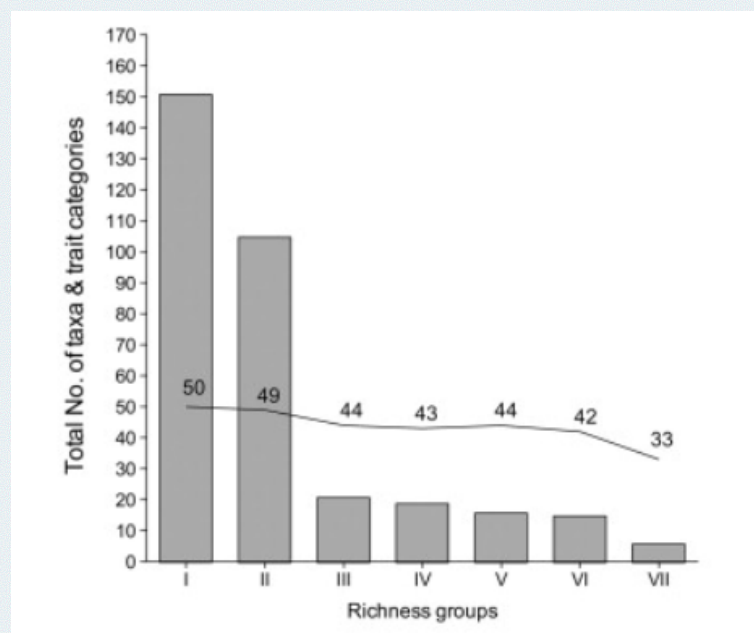
Oug et al. (2012) Biological traits analyses in the study of pollution gradients and ecological functioning of marine soft bottom species assemblages in a fjord ecosystem. *J. Exp. Mar. Bio. Ecol.*

Krumhansl et al. (2016) Using species traits to assess human impacts on near shore benthic ecosystems in the Canadian Arctic. *Ecological Indicators*,

# Uses of biological traits analysis

Biodiversity function relationships:

Redundancy




*Marine benthic ecological functioning over decreasing taxonomic richness.*  
*Tornroos et al. (2015). J. Sea. Research 98, 49-56*

# Data! Progress!

Individual datasets to online databases

**MarLIN** | The Marine Life Information Network for Britain & Ireland



 algaeBASE

The Arctic Traits Database

 polytraits

**Table 1.** List of marine trait databases or repositories. “Component” indicates the organism group targeted. “Access options” indicates in which forms the data can be accessed. References and web links are provided.

Component	Access options	Publication, web links
Copepoda	Download of Excel workbook via PANGAEA, traits provided as original values or binary code (0/1), references per trait provided.	Brun et al. (2017); <a href="https://doi.pangaea.de/10.1594/PANGAEA.862968">https://doi.pangaea.de/10.1594/PANGAEA.862968</a>
Polychaeta	Download of full database or specified subsets in various formats (references and partly original quote and page number provided), online via browsing the Polychaetes Scratchpad	Faulwetter et al. (2014); <a href="http://polytraits.lifewatchgreece.eu">http://polytraits.lifewatchgreece.eu</a> (last access: 20 February 2019) <a href="http://polychaetes.lifewatchgreece.eu">http://polychaetes.lifewatchgreece.eu</a> (last access: 20 February 2019)
Benthos	Download of trait information in several matrix formats: as text and for certain traits as binary (0/1) code, also browsing online	Biological Traits Information Catalogue (BIOTIC); MarLIN (2018), <a href="http://www.marlin.ac.uk/biotic">http://www.marlin.ac.uk/biotic</a> (last access: 20 February 2019)
Fish	Browse online, programmatically via an application programming interface (API) and R package rfishbase	Froese and Pauly (2018) <a href="http://www.fishbase.org">http://www.fishbase.org</a> , version (02/2018) last access: 20 February 2019
Benthos	Browse online	Marine Macrofauna Genus Trait Handbook; <a href="http://www.genustraithandbook.org.uk">http://www.genustraithandbook.org.uk</a> (last access: 27 June 2018)
Corals	Browse online, download as *.csv file, traits provided as original values or text information, references provided.	<a href="https://coraltraits.org/">https://coraltraits.org/</a> (last access: 20 February 2019)
Phytoplankton (coastal)	Download of Excel workbook, traits provided as original values or binary code (0/1).	Klais et al. (2017); <a href="https://www.riinaklais.com/phytotraits">https://www.riinaklais.com/phytotraits</a> (last access: 20 February 2019)
All marine	Browse online	Marine Species Traits; <a href="http://www.marinespecies.org/traits">http://www.marinespecies.org/traits</a> (last access: 27 June 2018)
All marine	Browse online	SeaLifeBase; <a href="http://www.sealifebase.org">http://www.sealifebase.org</a> (last access: 29 June 2018)
Fossil groups	Browse online	Neogene Marine Biota of Tropical America (NMiTA); <a href="http://eusmilia.geology.uiowa.edu">http://eusmilia.geology.uiowa.edu</a> (last access: 29 June 2018)
All biota	Browse online, programmatically via an API	Encyclopedia of Life (EoL); <a href="http://www.eol.org">http://www.eol.org</a> (last access: 29 June 2018)



# Where are we?

Time to ask whether this is worthwhile  
Systematic review?

Biological traits & analysis & marine  
Biological traits & analysis & benthic  
n = 212

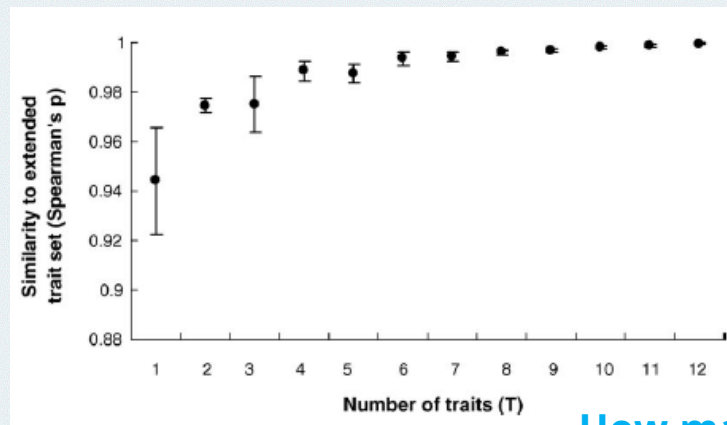


# 1. Does biological traits analysis work?

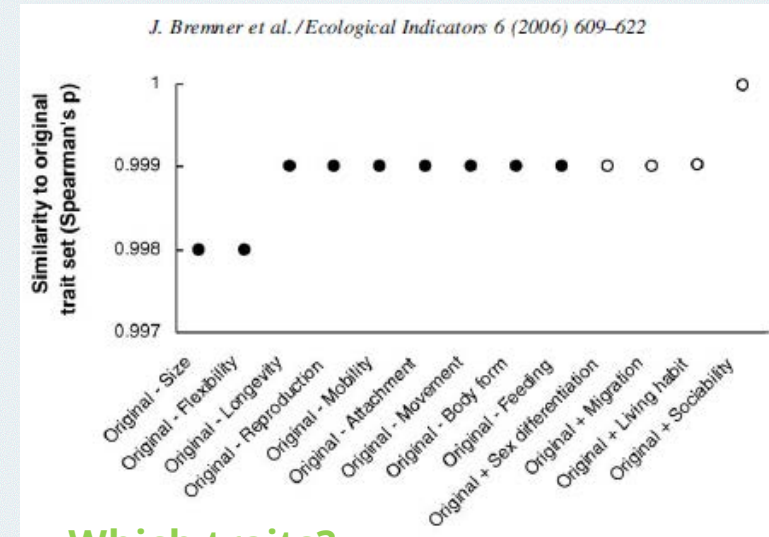
Do we have the right biological traits information?

Number and type of traits – what's enough?

LifeWatch database queries?



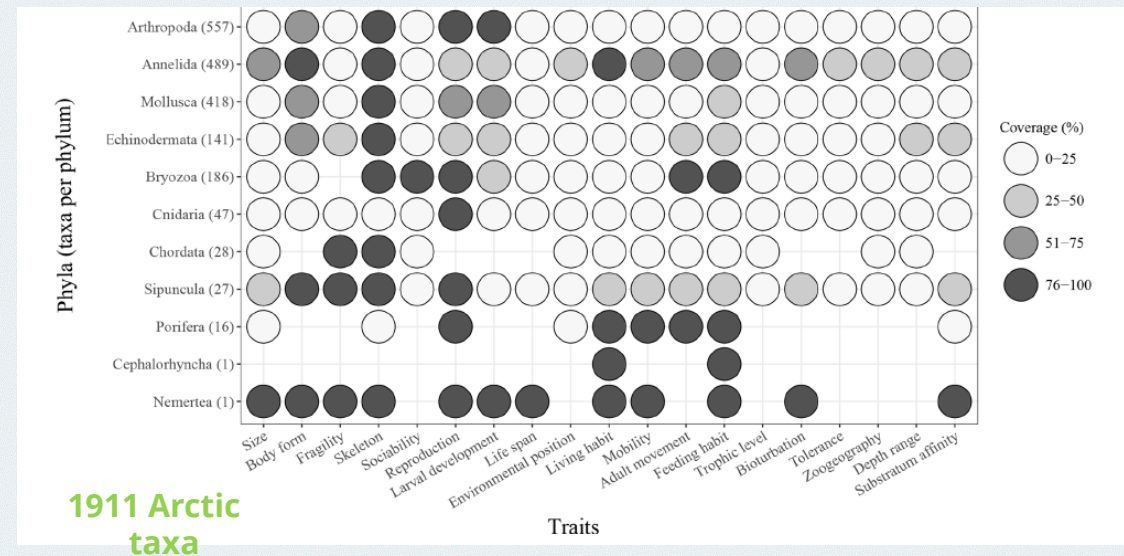
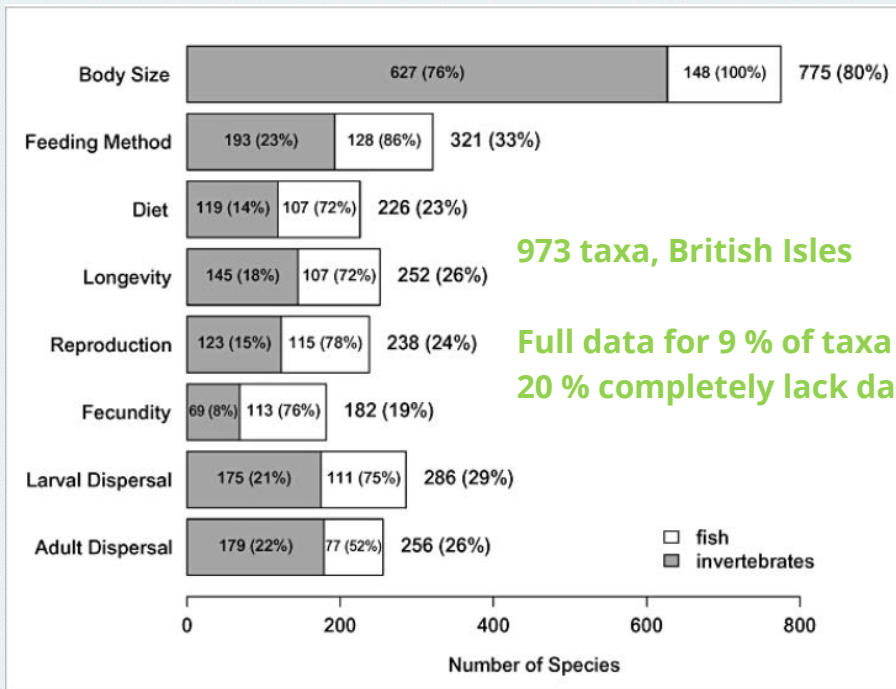
How many traits?



Which traits?

# 1. Does biological traits analysis work?

Do we have the right biological traits information? **Missing information**



Degen & Faultwetter (2019) The Arctic Traits Database – a repository of Arctic benthic invertebrate traits. Earth System Science Data, Feb 2019

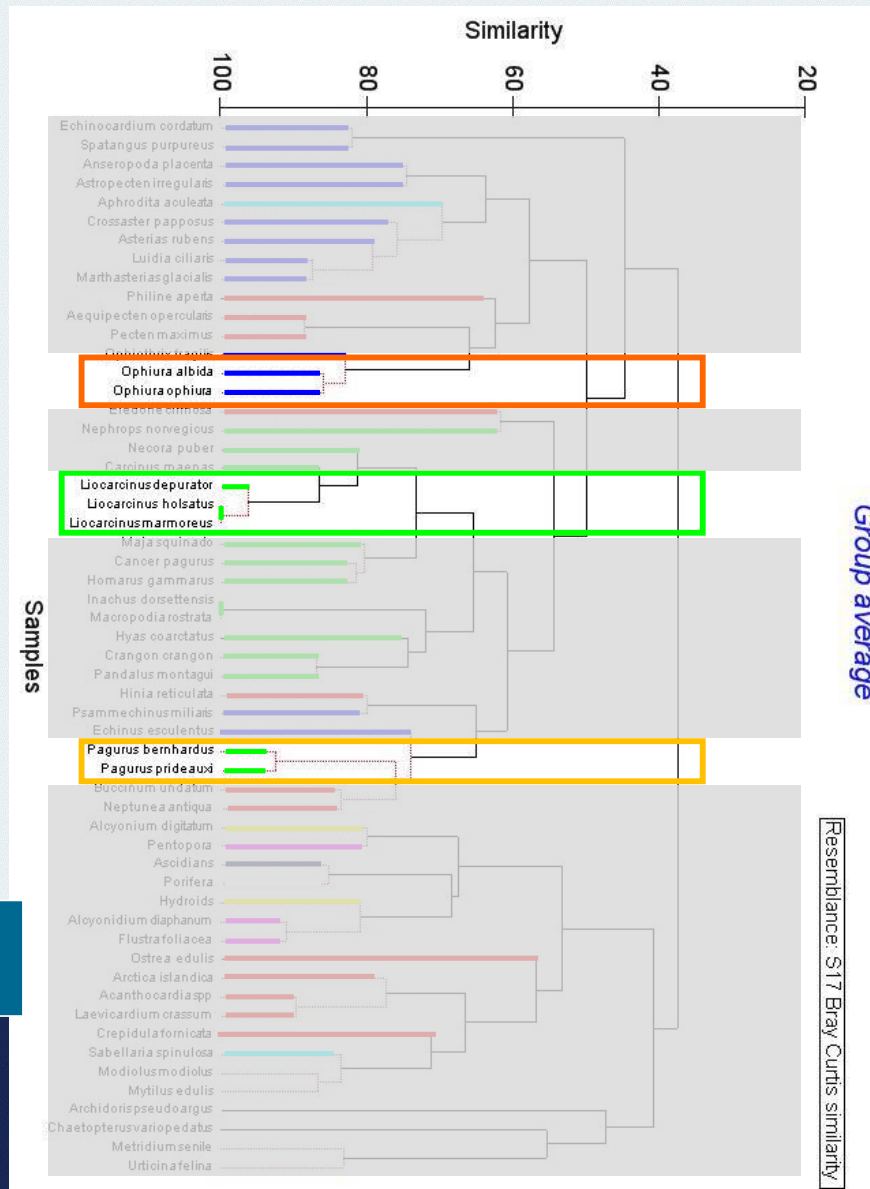
# Missing information

- Leave traits blank
- 'Borrow' from other species

What are the implications?  
 \*\*\*\* in, \*\*\*\* out

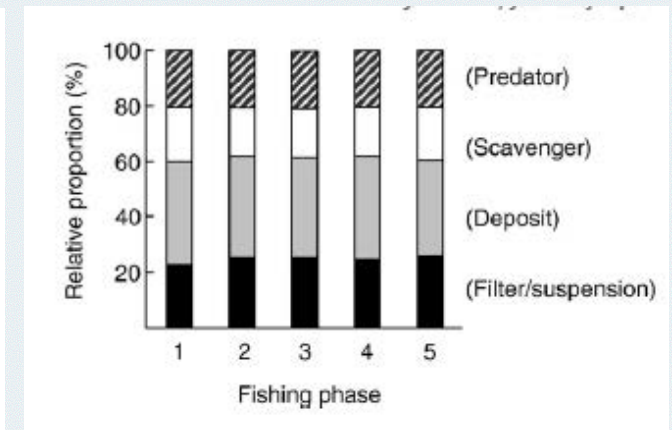
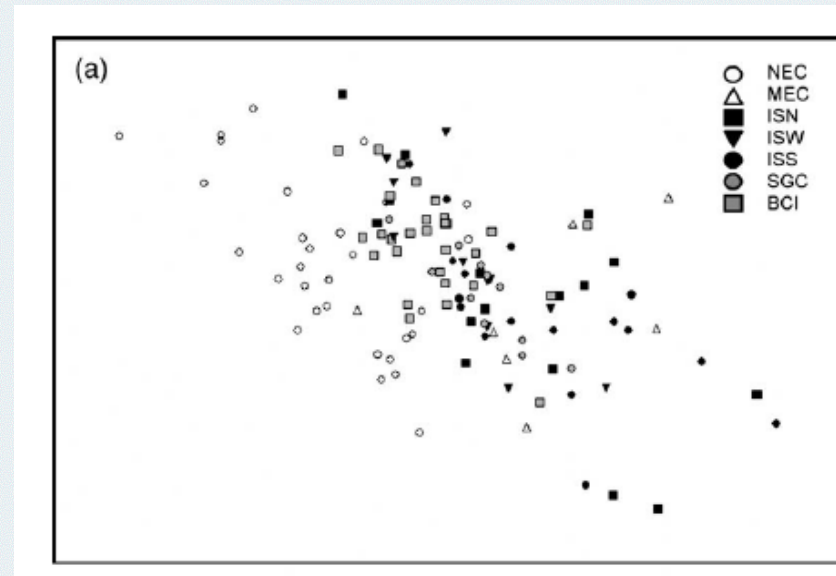
Pragmatism *versus* scientific rigour  
 LifeWatch databases.....

Can we use species' relatives?  
 How far up the tree?



## 2. What does BTA tell us about function?

Nothing is happening!

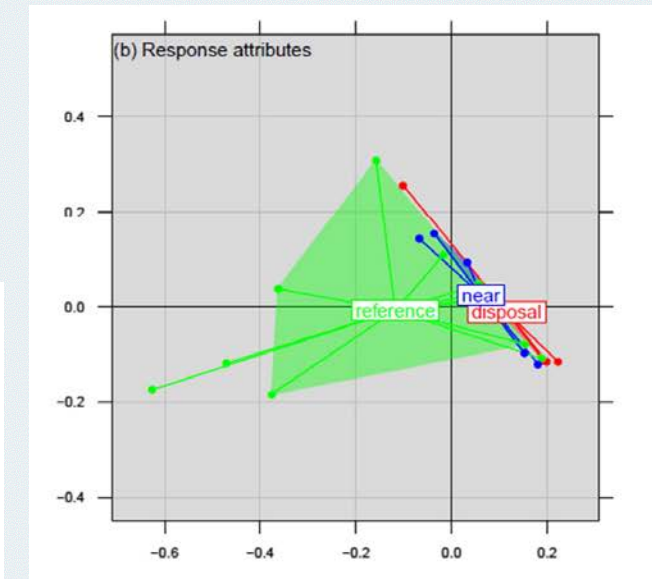
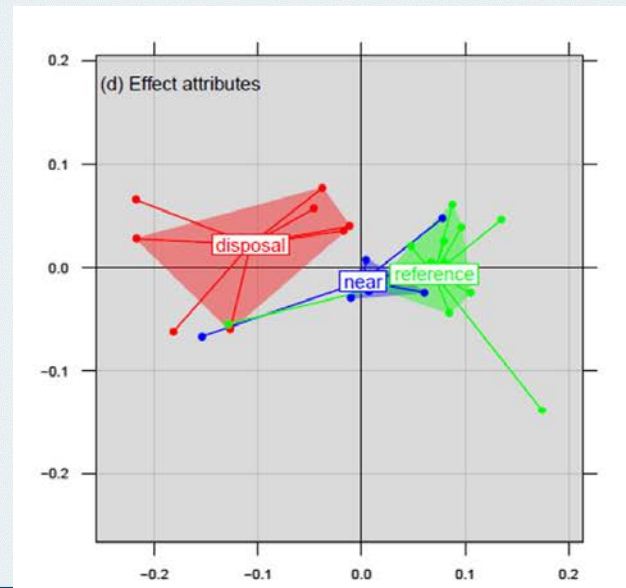


## 2. What does BTA tell us about function?

Something is happening but is it a change in functioning?

Response traits: morphology, egg development, living habit, sediment position and mobility.

Effect traits: size, longevity, larval development, feeding mode, bioturbation and productivity



Dredged material (FCA).  
Clément Garcia, Cefas

## 2. What does BTA tell us about function?

Does it really describe function?

Pragmatism again

		ECOSYSTEM FUNCTIONS AND PROPERTIES			
		Energy & nutrient cycling	Secondary production	Stability / Vulnerability	Heterogeneity
TRAITS	Morphology	Body size	Body size	Body size	Body size
		Body form		Body form	Body form
		Protection / Fragility		Protection / Fragility	
		Sociability		Sociability	Sociability
	Life history	Reproduction	Reproduction	Reproduction	
		Fecundity	Fecundity	Fecundity	
		Larval development		Larval development	
		Dispersal / Migration		Dispersal / Migration	
		Life span	Life span	Life span	
	Behavior	Environmental position		Environmental position	Environmental position
		Living habit		Living habit	Living habit
		Mobility / Movement		Mobility / Movement	
Feeding habit / Diet		Feeding habit / Diet	Feeding habit / Diet	Feeding habit / Diet	
Bioturbation / Irrigation			Bioturbation / Irrigation	Bioturbation / Irrigation	
Ecosystem engineering			Ecosystem engineering	Ecosystem engineering	

Degen et al. (2018) Trait-based approaches in rapidly changing ecosystems: a roadmap to the future polar oceans. Ecological Indicators 91, 722-736

## 2. What does BTA tell us about function?

Something functional is happening, but what?

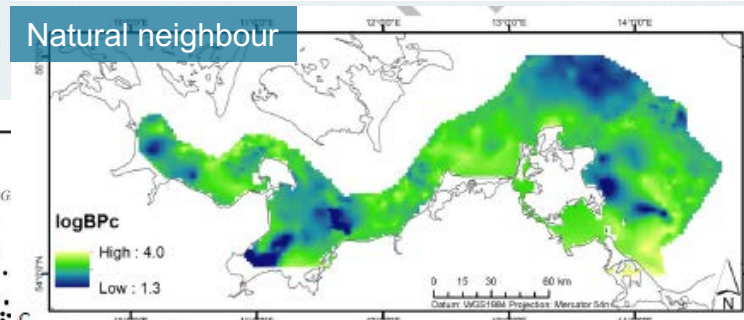
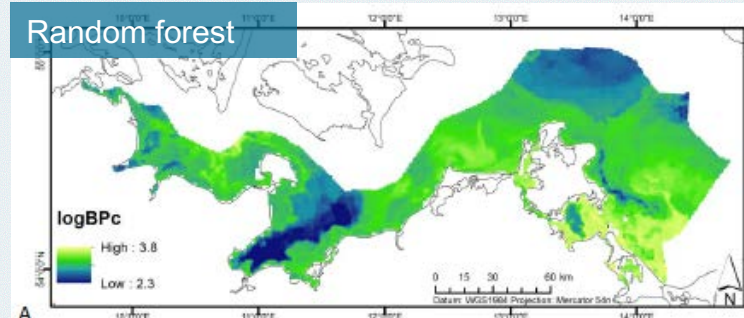
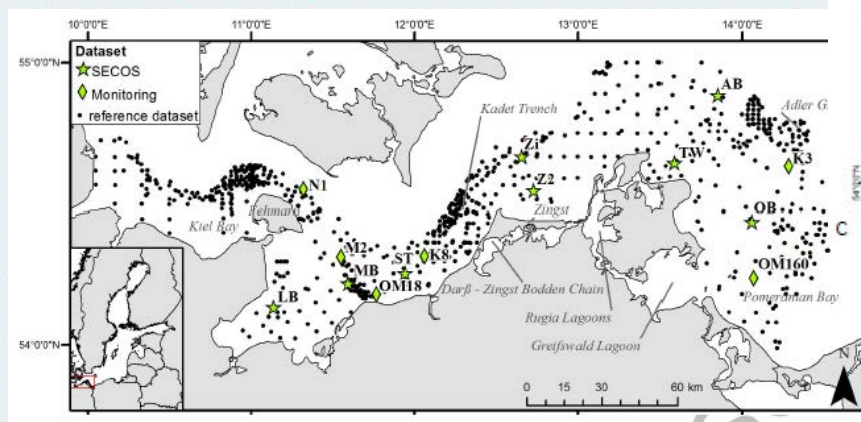
There were reductions in filter feeders, large organisms and burrow dwellers between the impacted and the reference sites, indicating a change in function.



# 3. What is the bigger picture?

Making predictions over space or time

Maps from patchy data  
Spatial interpolation

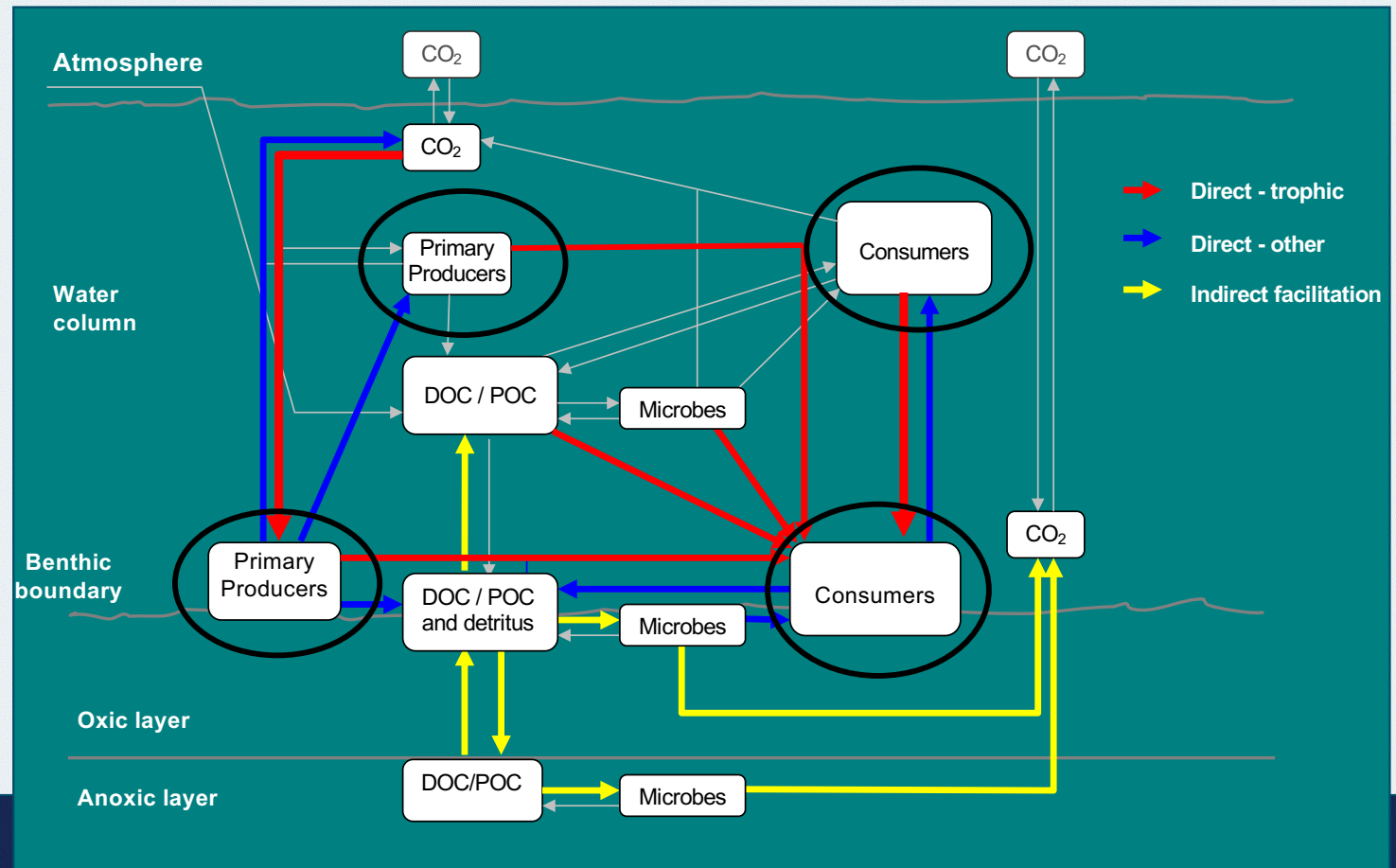


Gogina et al. (2016) Towards benthic ecosystem functioning maps: quantifying bioturbation potential in the German part of the Baltic Sea. *Ecol. Indicators*.

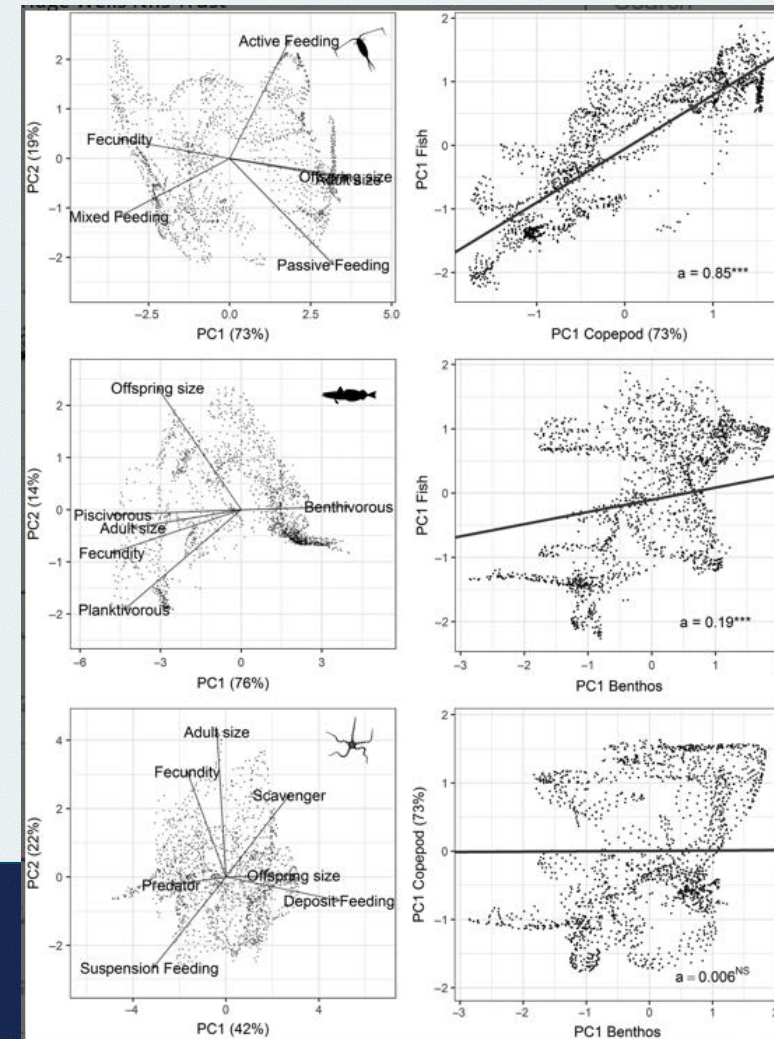
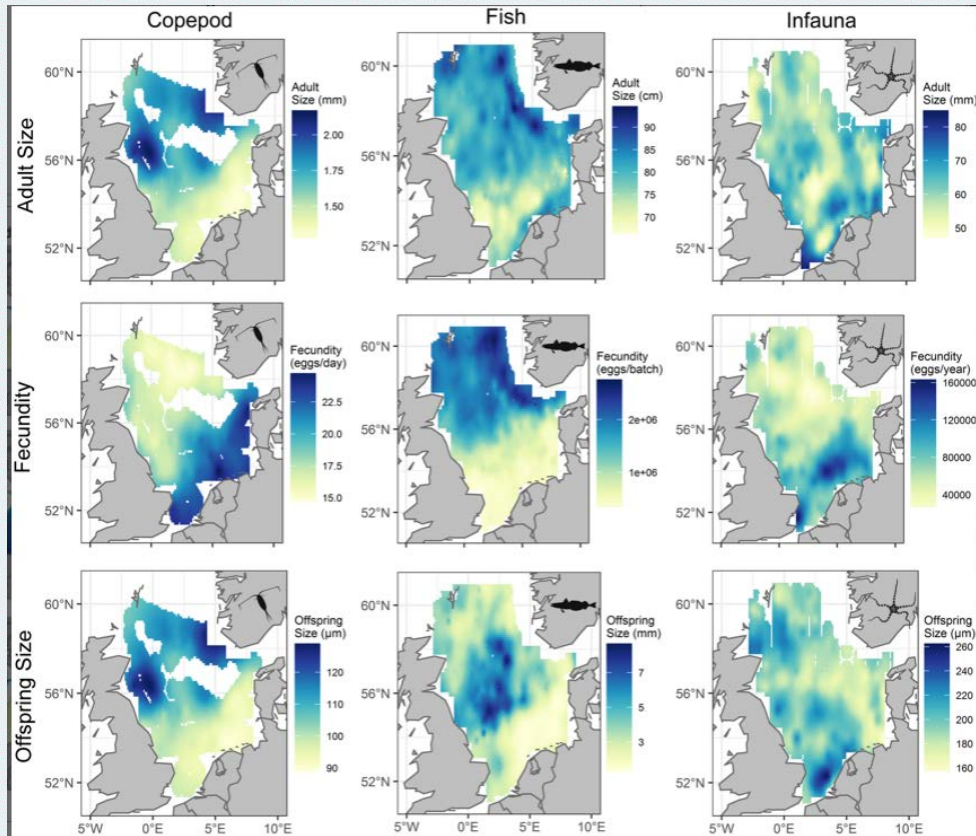
# 4. What about the whole ecosystem?

Connecting the marine biological compartments rather than inferring (benthic, pelagic).

Freshwater, terrestrial?



# 4. What about the whole ecosystem?

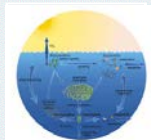


# 5. What does it all mean for society?



## Functional traits

- Body size
- Body form
- Sociability
- Reproduction
- Dispersal
- Lifespan
- Living habit
- Movement
- Migration
- Feeding type
- Bioturbation
- Engineering



## Ecosystem function

- Energy cycles
- Nutrient cycling
- CaCO<sub>3</sub> cycling
- Stability
- Habitat provision
- Primary production
- Secondary production



## Ecosystem services

- Food
- Genetic material
- Recreation
- Coastal protection
- Carbon storage



**julie.bremner@cefas.co.uk**

**@wormbotherer**

**[www.cefas.co.uk](http://www.cefas.co.uk)**  
**[www.uea.ac.uk/ccsus](http://www.uea.ac.uk/ccsus)**

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