Marine ecosystem function: to the benthos and beyond

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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

Uses of biological traits analysis

Differences in function over space and time:

Describing human impacts

Aggregate extraction
Harbours
Hypoxia
Environmental restoration
Pollution
Fishing

Contaminant effects, particularly cadmium

Minimal impact compared to natural variation


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

### 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.

<table>
<thead>
<tr>
<th>Component</th>
<th>Access options</th>
<th>References and Web links</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copepoda</td>
<td>Download of Excel workbook via PANGAEA, traits provided as original values or binary code (0/1), references per trait provided.</td>
<td>Brun et al. (2017); <a href="https://doi.org/10.1594/PANGAEA.869368">https://doi.org/10.1594/PANGAEA.869368</a></td>
</tr>
<tr>
<td>Polychaeta</td>
<td>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</td>
<td>Faulwetter et al. (2014); <a href="http://polytraits.lifewatchgreece.eu">http://polytraits.lifewatchgreece.eu</a> (last access: 20 February 2019)</td>
</tr>
<tr>
<td>Benthos</td>
<td>Download of trait information in several matrix formats as text and for certain traits as binary (0/1) code, also browsing online</td>
<td>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)</td>
</tr>
<tr>
<td>Fish</td>
<td>Browse online, programmatically via an application programming interface (API) and R package fishbase</td>
<td>Freese and Pauly (2018); <a href="http://www.fishbase.org">http://www.fishbase.org</a>, version (02/2018) last access: 20 February 2019</td>
</tr>
<tr>
<td>Benthos</td>
<td>Browse online</td>
<td>Marine Macrofauna Genus Trait Handbook; <a href="http://www.genustraitshandbook.org.uk">http://www.genustraitshandbook.org.uk</a> (last access: 27 June 2018)</td>
</tr>
<tr>
<td>Corals</td>
<td>Browse online, download as *.csv file, traits provided as original values or text information, references provided.</td>
<td><a href="https://coraltraits.org/">https://coraltraits.org/</a> (last access: 20 February 2019)</td>
</tr>
<tr>
<td>Phytoplankton (coastal)</td>
<td>Download of Excel workbook, traits provided as original values or binary code (0/1).</td>
<td>Klais et al. (2017); <a href="https://www.riianaklais.com/phytostraits">https://www.riianaklais.com/phytostraits</a> (last access: 20 February 2019)</td>
</tr>
<tr>
<td>All marine</td>
<td>Browse online</td>
<td>Marine Species Traits; <a href="http://www.marinespecies.org/traits">http://www.marinespecies.org/traits</a> (last access: 27 June 2018)</td>
</tr>
<tr>
<td>All marine</td>
<td>Browse online</td>
<td>SealifeBase; <a href="http://www.sealifebase.org">http://www.sealifebase.org</a> (last access: 29 June 2018)</td>
</tr>
<tr>
<td>Fossil groups</td>
<td>Browse online</td>
<td>Neogene Marine Biota of Tropical America (NMITA); <a href="http://eumolp.geology.uiowa.edu">http://eumolp.geology.uiowa.edu</a> (last access: 29 June 2018)</td>
</tr>
<tr>
<td>All biota</td>
<td>Browse online, programmatically via an API</td>
<td>Encyclopedia of Life (EdL); <a href="http://www.eol.org">http://www.eol.org</a> (last access: 29 June 2018)</td>
</tr>
</tbody>
</table>
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?

Which traits?
How many traits?
1. Does biological traits analysis work?

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

Tyler et al. 2011. Extensive gaps and biases in our knowledge of a well-known fauna: implications for integrating biological traits into macroecology. Global Ecology and Biogeography. 21 (9) 922-934

• 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

<table>
<thead>
<tr>
<th>TRAITS</th>
<th>Morphology</th>
<th>Life history</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Body size</td>
<td>Reproduction</td>
<td>Environmental position</td>
</tr>
<tr>
<td>Energy &amp; nutrient cycling</td>
<td>Body size</td>
<td>Reproduction</td>
<td>Environmental position</td>
</tr>
<tr>
<td>Secondary production</td>
<td>Body size</td>
<td>Reproduction</td>
<td>Environmental position</td>
</tr>
<tr>
<td>Stability / Vulnerability</td>
<td>Body form</td>
<td>Larval development</td>
<td>Environmental position</td>
</tr>
<tr>
<td>Heterogeneity</td>
<td>Body form</td>
<td>Larval development</td>
<td>Environmental position</td>
</tr>
<tr>
<td></td>
<td>Protection / Fragility</td>
<td>Dispersal / Migration</td>
<td>Environmental position</td>
</tr>
<tr>
<td></td>
<td>Sociability</td>
<td>Life span</td>
<td>Environmental position</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Living habit</td>
</tr>
<tr>
<td></td>
<td>Reproduction</td>
<td></td>
<td>Mobility / Movement</td>
</tr>
<tr>
<td></td>
<td>Fasciality</td>
<td></td>
<td>Feeding habit / Diet</td>
</tr>
<tr>
<td></td>
<td>Larval development</td>
<td></td>
<td>Bioturbation / Irrigation</td>
</tr>
<tr>
<td></td>
<td>Dispersal / Migration</td>
<td></td>
<td>Ecosystem engineering</td>
</tr>
<tr>
<td></td>
<td>Life span</td>
<td></td>
<td></td>
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</tbody>
</table>

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

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
- CaCO₃ cycling
- Stability
- Habitat provision
- Primary production
- Secondary production

Ecosystem services:
- Food
- Genetic material
- Recreation
- Coastal protection
- Carbon storage

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