Linking functional traits to the MARLIN System to provide user-oriented products on ecosystem functioning

Authors: Dr. Alexa Wrede, Hendrik Pehlke, Paul Kloss, Dr. Jennifer Dannheim

(Technical report of the project ANsätze zur Kostenreduzierung bei der ERhebung von Monitoringdaten für Offshore Vorhaben (ANKER), Arbeitspaket BENTHOS; FKZ 0325921)

Last update: 23. May 2020

(1) Aim

The aim of linking functional biological characteristics to MARLIN is to optimize the provision and publication of automatically generated products on ecosystem functioning via MARLIN to meet the needs of stakeholders (e.g. governmental agencies, applicants for offshore windfarms) for purposes such as environmental impact assessments or marine spatial management.

(2) Introduction

Biological communities not only differ in their taxonomic, but also in their functional composition. Different species often possess different functional traits. These traits encompass all characteristics, which influence the functionality of an ecosystem or the presence of a species within a certain habitat (Díaz & Cabido 2001). Functional diversity thus has a stronger impact on ecosystem processes and cycling of matter, than taxonomic diversity (Díaz & Cabido 2001). The functional composition hence is a good indicator for reorganization in ecosystem processes and functioning, which is applied in environmental surveys and the Marine Strategy Framework Directive (MSFD Descriptor 6, Criteria D6C3, D6C5).

As the construction of offshore wind farms entails the introduction of hard substrate and fishery cessation, functional changes in the ecosystem are to be expected (Dannheim et al. 2019). Especially the latter may cause alterations in energy flow due to a shift from small predatory or scavenging species to a community of large long-lived ecosystem engineers (Dannheim et al. 2014).

Linking functional traits to MARLIN will thus enable the provision and publication of automatically generated products on ecosystem functioning via the MARLIN-System for stakeholders of environmental surveys and marine spatial management (e.g. governmental agencies, applicants for offshore windfarms).

(3) Technical development and implementation

The biological trait analysis (BTA) provides the basis for functional analyses and the provision of products which inform on ecosystem functioning. In a first step, traits have to be selected which are key to important ecosystem processes and functions (e.g. bioturbation for nutrient cycling) for the BTA. In cooperation, AWI and BSH have selected seven traits (Table 1) (for MARLIN template see document 47, TB8.zip).

Table 1: Functional traits which will are implemented in MARLIN with their respective attributes and units (for MARLIN template see document 69, TB11.zip)

Trait	Attributes	unit/remark
size	<10	mm
	11-100	mm
	101-200	mm
	>200	mm
Longevity	<1	years
	1-2	years
	3-10	years
	>10	years
Adult movement	Attached	
	Burrower	
	Crawler	
	Swimmer	
Feeding mode	Suspension	
	Selective deposit	
	Non selective deposit	
	Opportunistic	
	Predator	
	Grazer	
Bioturbation	Surficial modifiers	
	Upward conveyor	
	Downward conveyor	
	Biodiffusers	
	Regenerators	
Habitat forming	Reef builder (own body)	
	Bioengineering stabiliser (tube, mucus)	
	Bioengineering (destabiliser)	
	None	
Environmental position	Infauna	
	Epifauna	

In a next step, information on these traits are compiled in a "species-trait table" from literature for the species within the MARLIN database. The workflow thereby follows a procedure of priority (i.e. species are processed according to their relative frequency) to balance between work effort and resolution (i.e. usually 80 % – 95 % of the species in a dataset are addressed). A "species-trait table" was compiled which encompasses the benthic species, which contribute 90% to macrozoobenthos abundance and biomass in MARLIN (see document 69, TB11.zip and BSH_Trait_Table).
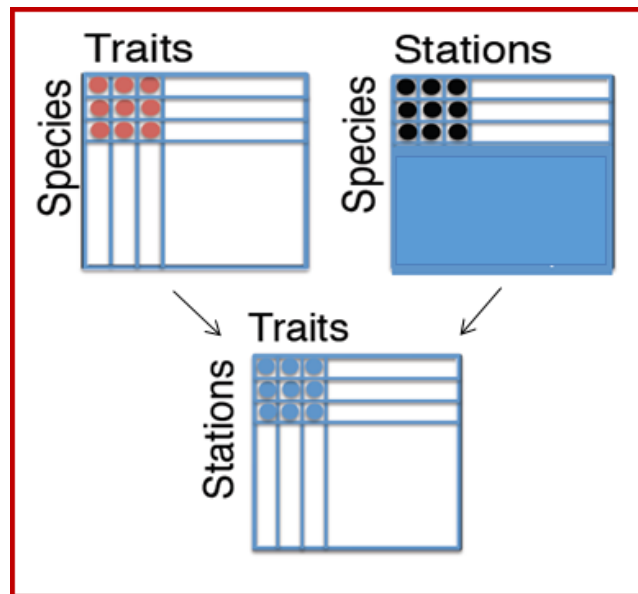
Figure 1: Conceptual graphic of the biological trait analysis procedure

In a third step the "species-trait table" is linked to the "species-stations table" (Figure 1). This link then provides the basis for the automated analysis of functional effects (for a detailed description of the analysis and the linking see digital Appendix: Produktsteckbrief B_109). While the "species-station table" can already be extracted from MARLIN the "species-trait table" is still under construction and needs to be tied to MARLIN. Using the Funct_Clean-R-Script (see digital Appendix) informative graphics may be created.

(4) Results

An analysis of the functional traits may provide insight whether ecosystem functioning changes with interferences such as offshore wind farm construction. In case of the Alpha Ventus project area no significant changes due to wind farm construction are visible in the relative abundance of the different feeding types (figure 2). However, irrespective of the wind farm construction, the reference area is continuously inhabited by higher percentage of suspension feeders compared to the wind farm area. This may indicate that there are general differences in the two areas for example in food availability.
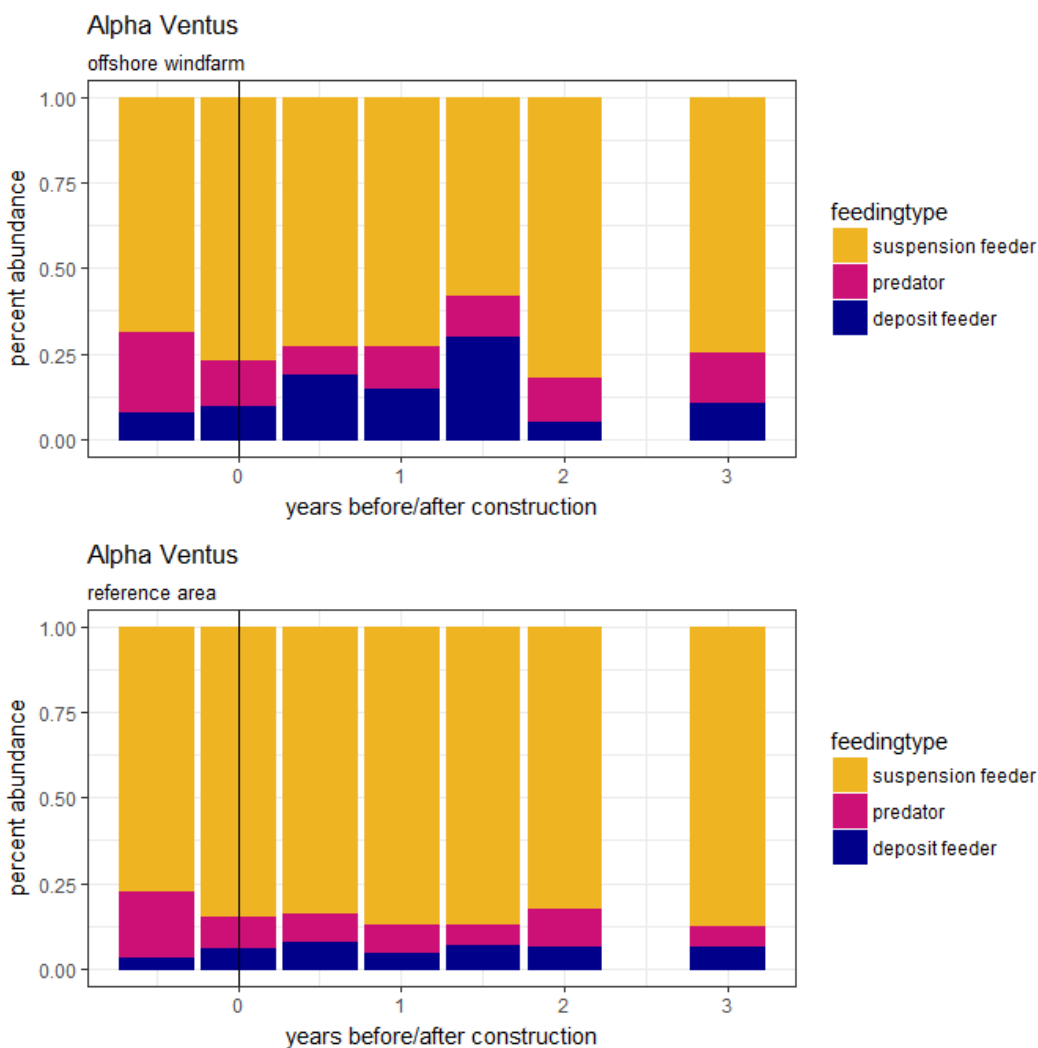
Figure 2: Percentage abundance of suspension feeders, deposit feeders and predators in the wind farm and reference area of the Alpha Ventus project before and after windfarm construction.

In MARLIN the traits from the BSH_Trait_Table (see digital appendix) are already implemented and accessible via the Benthos Catalogue, the Data Analyses for benthos and the Dashboard. This is only possible for the species where information is already available i.e. species that account for 90% abundance, biomass and frequency within the MARLIN benthos data.

In the Benthos Catalogue the user can see for each species to which category of the selected traits the species belongs. Additionally the user is presented with the reference. In the example below (figure 3, marked in red and grey) we can see that *Abra alba* is sorted

into the category "epifauna or internal irrigation" for the trait "burrow type". The reference for this is "Maire et al. 2006".

Figure 3: Screenshot from the MARLIN benthos catalogue. The above discussed example is marked in red and grey

The Data Analysis framework provides an in-depth view of the distribution of certain trait categories. In a first step the user has to select a "use case" and a" calculation method" i.e. a unit that shall be investigated such as abundance per m² (figure 4: marked in dark red). Then the user selects a "subject". This means a trait and category of interest (in the example the trait feeding type (figure 4: marked in red) and the category predator (figure 4: marked in light red)

Figure 4: Screenshot from the MARLIN data analysis framework for benthos – selection of subject. The selected use case and calculation method are marked in dark red (i.e. abundance in ind./m²); the exemplary trait (i.e. feeding type) feeding type is marked in red, the selected category (i.e. predator) is marked in blue.

In a next step the user can select an area or time of interest (see figure 5 for an example of selecting a time).
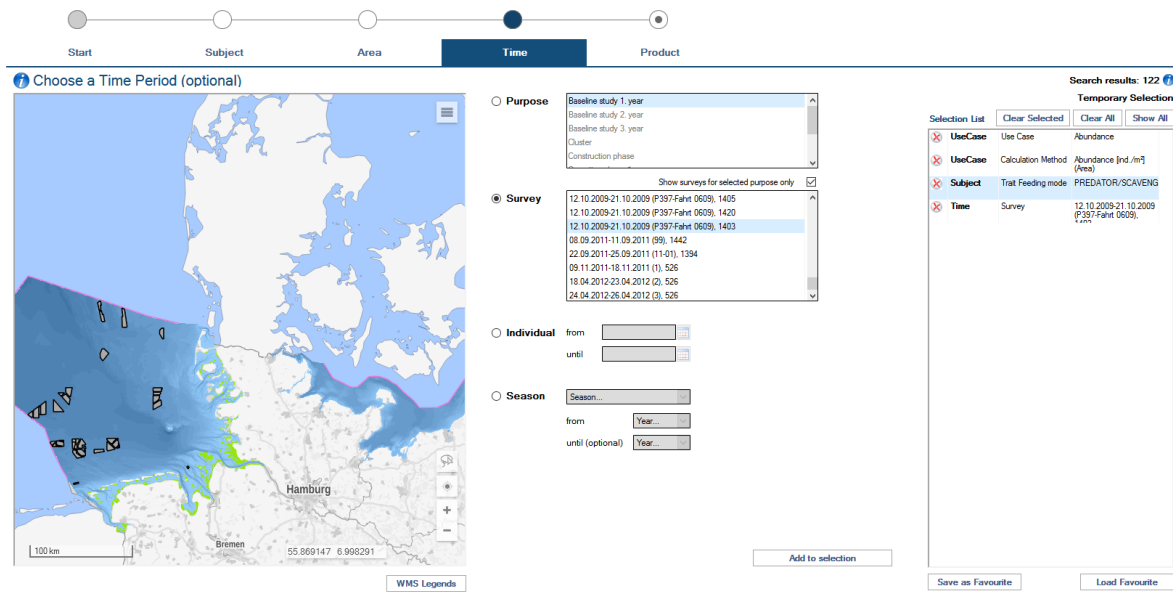
Figure 5: Screenshot from the MARLIN data analysis framework for benthos – selection of time. The selected survey is marked in red.

In a next step a product is generated. The user may choose between Box Whisker plot, gridded maps and a standardized table (figure 5: red marking). Concurrently a map shows all sampling locations where our selected category occurred within the selected time and area
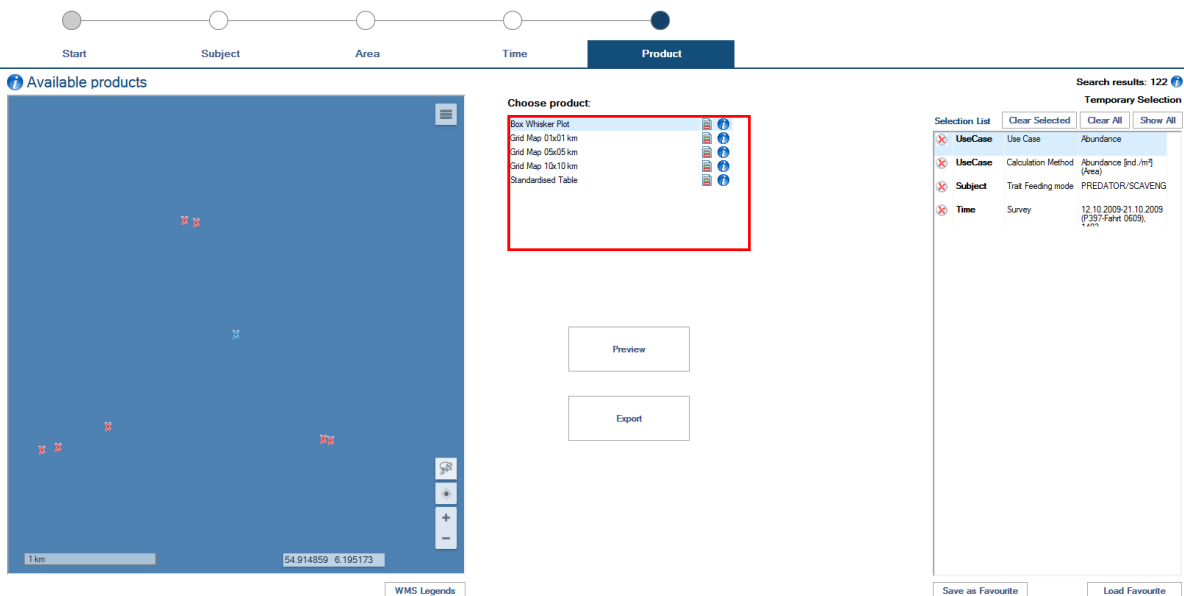

Figure 5: Screenshot from the MARLIN data analysis framework for benthos – selection of product. The products wicht may be selected are marked in red. The map shows all sampling locations where our selected category (i.e. predators) maybe found in the selected time and area.

If a Box Whisker plot is chosen as product, it will show the abundance distribution of predators in the selected area and time (figure 6A). The created graphic may now be exported. If another category (e.g. suspension feeder) is selected within the trait "feeding type" by the above described procedure we can now compare the abundance distribution of the predators (figure 6A) with the abundance distribution of suspension feeders (figure 6B).

In our example we see that the community in our selected area contained, at the time of the selected sampling, on average thrice the number of suspension feeders than predators.
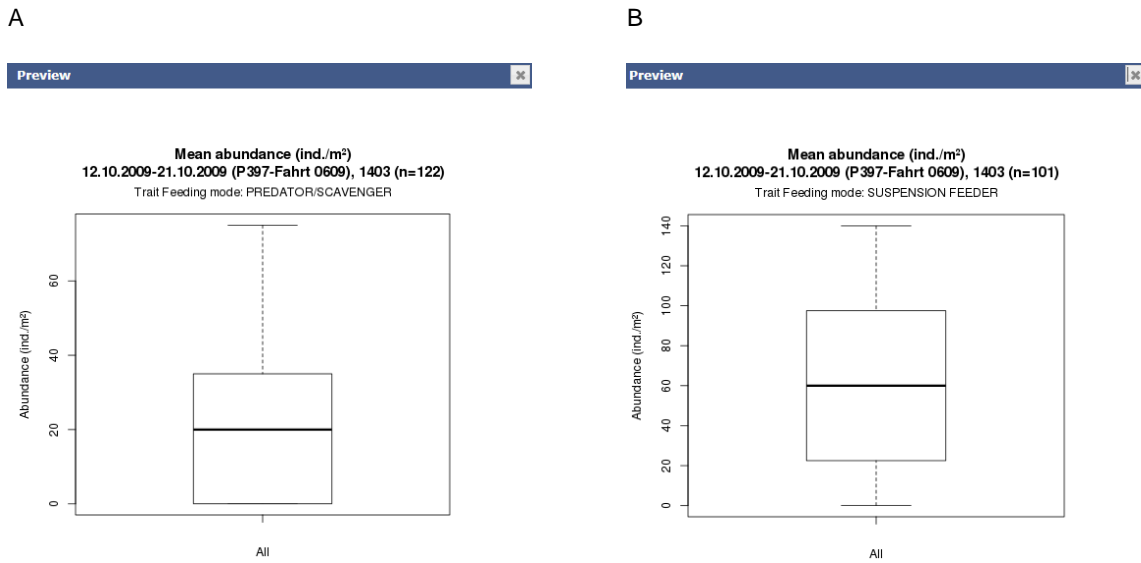
A

B

Figure 6: Screenshot from the product previews produced by MARLIN data analysis framework for benthos – Box Whisker plots of the abundance distribution (ind./m²) of predators (A) and suspension feeders (B). The wiskers show the upper and lower quartile while the line indicates the median.

While the traits implementation within the benthos Catalogue and Data Analysis framework have already passed a conclusive inspection this still has to be done for the MARLIN Dashboard. Nonetheless the Dashboard can already provide an overview which species belongs to which category (figure 7: marked by different colors) of the selected trait (i.e. feeding mode see figure 7: grey marking) and in how many sampling species was found.
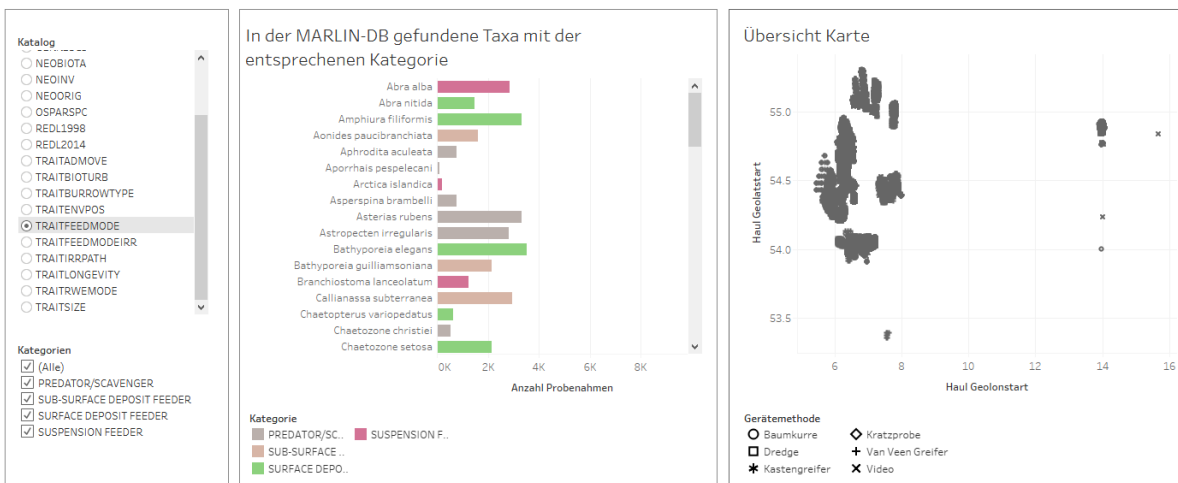

Figure 7: Screenshot from MARLIN Dashboard showing the association of the different species with the categories (taupe: predators/scavengers; rose: sub-surface deposit feeders; green: surface deposit feeder; pink: suspension feeders) of the trait feeding type (selection marked in grey). The map labeled "Übersicht Karte" shows the locations and sampling methods of the samples.

(5) Digital Appendix

- Produktsteckbrief B_109: percentaged abundance of functional groups of the infauna and epifauna in classified areas
- Funct_Clean-R-Script: converts the linked "species-station table" and "species-trait table" into a "station-trait table", may be used for simple plots of percentaged abundances
- BSH_Trait_Table: Excel table including the definitions of the functional traits, the "species-trait table" for the species which encompass 90% of the biomass and abundance and the short references for the original literature references for each trait
- References_BSH_Trait_Tabelle: Word document including the full references to short references in the BSH_Trait_Table

References

Díaz S, Cabido M (2001) Vive la difference: plant functional diversity matters to ecosystem processes. Trends in Ecology and Evolution 16: 646-655

Dannheim, J., Bergström, L., Birchenough, S. N. R., Brzana, R., Boon, A. R., Coolen, J. W. P., Dauvin, J.-C., De Mesel, I., Derweduwen, J., Gill, A. B., Hutchison, Z. L., Jackson, A. C., Janas, U., Martin, G., Raoux, A., Reubens, J., Rostin, L., Vanaverbeke, J., Wilding, T. A., Wilhelmsson, D., und S. Degraer (2019). Benthic effects of offshore renewables: identification of knowledge gaps and urgently needed research. – ICES Journal of MarineScience,doi:10.1093/icesjms/fsz018.

Dannheim J, Brey T, Schröder A, Mintenbeck K, Knust R, Arntz WE (2014) Trophic look at soft-bottom communities - short-term effects of trawling cessation on benthos. Journal of Sea Research 85: 18-28

European Commission (2017) Commission decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU. Official Journal of the European Union L125

European Commission (2010) Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (notified under document C (2010) 5956)(2010/477/EU). Official Journal of the European Union 232:12-24

European Union (2008) Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). Official Journal of the European Union, Book L164. European Union