How determining a small set of indicator species useful in environmental monitoring?
A case study of intertidal boulder fields macrofauna (Northern Basque coast) using the R package "indicspecies".

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Introduction

Ecological indicators are useful to monitor environmental changes and assess ecological management and conservation. They provide information to understand the environment and its health status while also highlighting changes in the environment by giving early warning signals. Among them, the identification of indicator species add ecological meaning to studied sites and their use is an alternative to sampling the entire biodiversity.

The northern Basque coast (located in the South of the Bay of Biscay marine sub-area - France) is dominated by remarkable rocky habitats as stable platforms and mobile boulder fields exposed to swells and freshwater incomes. Since 2008, intertidal macroalgal communities living on platforms are well known and used as bioindicators to assess ecological quality status for the European Water Framework Directory. More recently, the context of the Marine Strategy Framework Directive emphasized significant deficiencies regarding rocky fauna communities. As it is observed for other sub-areas, boulder fields present a high benthic fauna diversity, but surprisingly, no previous studies had been conducted locally to consider and identify benthic fauna indicator in this habitat. This is the study aim.
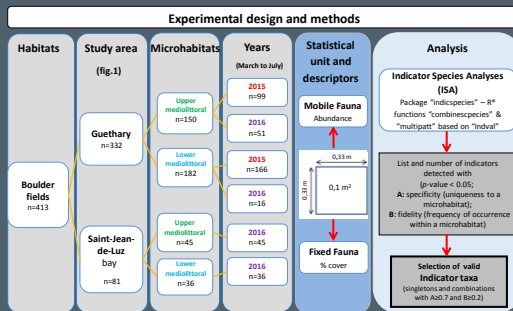
Material & Methods

Fig. 1. Location of the two sampling stations.

Fig. 2. Experimental design and methods. n: number of quadrats

Benthic fauna was sampled at two sites using a spatially stratified random sampling design from 2015 to 2016 (Fig. 1 & 2). Prior to analysis, the percentage cover matrix (fixed fauna) was converted into presence/absence and the abundance matrix (mobile fauna) was Hellinger-transformed.

Two independent Indicator Species Analyses (ISA) were carried out on two taxa matrix (mobile and fixed fauna) using the R package "indicspecies". It provides a set of functions to assess the strength and statistical significance of the relationship between species occurrence/abundance and groups of sites (microhabitats).

❑ New matrix to highlight single and/or combination species ("combine species" function).

❑ Significance association species pattern/microhabitats assessed with a permutation test ("multipatt" function).

❑ Selection of significant species (Indicator Value index) by ordering them through the two components values (A: the specificity; B: fidelity) ("IndVal" function).

Results

	Mobile fauna			Fixed fauna		
	Guéthary 2015	Guéthary 2016*	St J. de Luz 2016*	Guéthary 2015	Guéthary 2016*	St J. de Luz 2016*
Candidate taxa	62	41	44	18	15	16
Final valid combinations (/total relevant combinations)	LM=23 (/155) UM=9 (/32)	LM=7 (/87) UM=6 (/7)	LM=8 (/28) UM=1 (/15)	LM=7 (/31) UM=6 (/54)	LM=1 (/43) UM=0 (/1)	LM=1 (/21) UM=0 (/2)
Final valid singletons (/total relevant singletons)	LM=5 (/14) UM=4 (/4)	LM=3 (/9) UM=2 (/2)	LM=2 (/4) UM=2 (/2)	LM=3 (/6) UM=2 (/3)	LM=1 (/3) UM=1 (/1)	LM=2 (/3) UM=1 (/2)

Tab. 1. Results of ISA for single and taxa combinations for mobile and fixed fauna in the two study sites. LM: Lower Mediolittoral; UM: Upper Mediolittoral. Only common valid species are listed for sites and years.

❑ More than 78 taxa were identified during the study .

❑ Among them, we suggest a list with the properties of several related indices measuring the association between indicator taxa for mobile and fixed fauna in the lower and upper mediolittoral boulder fields. The whole list is available in A4 paper.

Mobile fauna

Fig. 3. Indicators taxa for lower mediolittoral zone. 1: *Porcellana platycheles*; 2: *Xantho spp.*; 3: *Lepadogaster lepadogaster*; 4: *Clibanarius erythropus* ; 5: *Ophioderma longicauda*

Fig. 4. Indicators taxa for upper mediolittoral zone. 1: *Eriphia verrucosa*; 2: *Patella spp.*; 3: *Phorcus lineatus*; 4: *Pachygrapsus marmoratus*
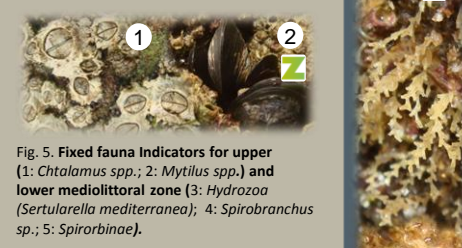
Fixed fauna

Fig. 5. **Fixed fauna Indicators for upper (**1: *Chtalamus spp.*; 2: *Mytilus spp.***) and lower mediolittoral zone (**3: *Hydrozoa (Sertularella mediterranea)*; 4: *Spirobranchus sp.*; 5: *Spirorbinae***).**

Z : ZNIEFF determinant species

Discussion/Conclusion

❑ Based on a probabilistic approach, ISA revealed valid single and combination taxa indicators for the lower and upper mediolittoral zones.
❑ A new challenge is to select (with ecological approach) the best taxa or species groups to describe and monitor boulder fields.
These indicators could be used to evaluate boulder fields integrity, as an alternative to sampling the entire local biodiversity. These various analysis improve our knowledge for monitoring the Basque intertidal rocky shore in a sustainable way. Finally, these results support the several Marine Strategy Framework Directive descriptors as the D1 "Biodiversity" and D6 "Seafloor integrity".

References:
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