BenthoVAL Biotic Index:

Test of a new index based on the concept of the loss of abundance of species

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Coast Bordeaux 2017

Context and aim of the study

- **Context**

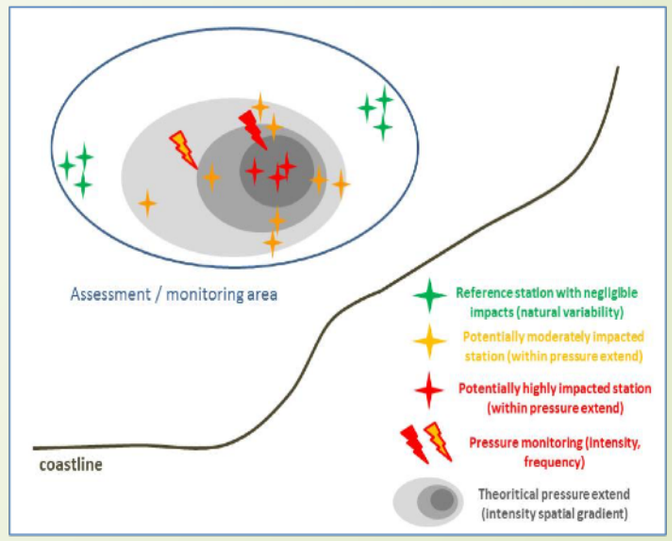
Most of the existing metrics currently used to infer the Ecological Quality Status of marine benthic habitats from benthic macrofauna composition are either based on :

(1) the sensitivity tolerance concept

(2) assessment of the deviation from a reference status

- **BI based on multidimensional deviation from a reference condition**

- Implies changes in community structure/composition
- Anthropogenic stress gradient
- Independent on lists of sensitivity of species
- The loss of species (or individuals) should have more weight than the gain of species in the detection of any impact

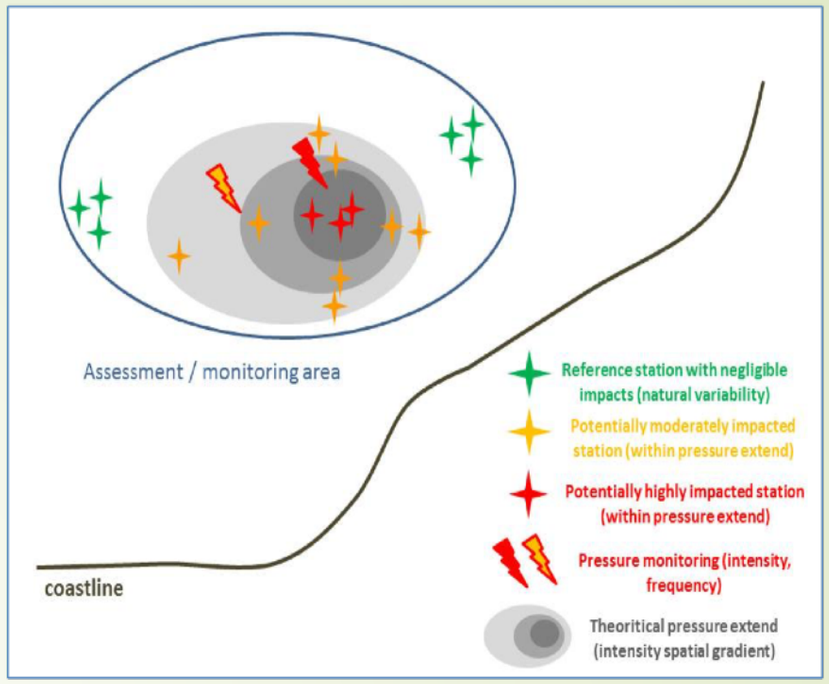


- **Reference site(s)**

- Community harbored by habitat under natural conditions
- Not necessarily pristine but outside of the pressure extend
- Monitored in parallel

The B_{Val} index

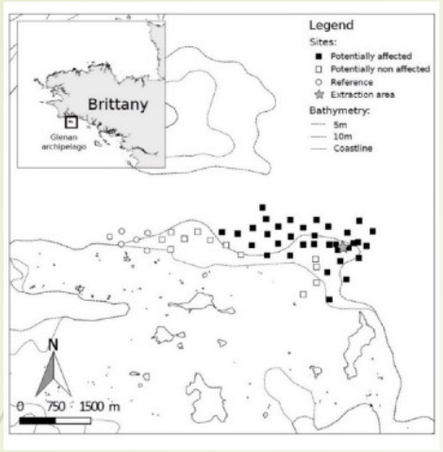
$$B_{Val} = 1 - \frac{\Sigma(r_i - x_i)}{\Sigma(r_i)} \qquad \text{if } r_i > x_i$$



- If $r_i >> xi$: $\frac{\Sigma(ri-xi)}{\Sigma(ri)} \simeq 1$ and $B_{Val} \simeq 0$ → Bad EcoQ
- If $ri \simeq xi$: $\frac{\Sigma(ri-xi)}{\Sigma(ri)} \simeq 0$ and $B_{Val} \simeq 1$ → Good EcoQ

- If all $r_i < x_i$: B_{Val}=NA and R is probably not a suitable reference

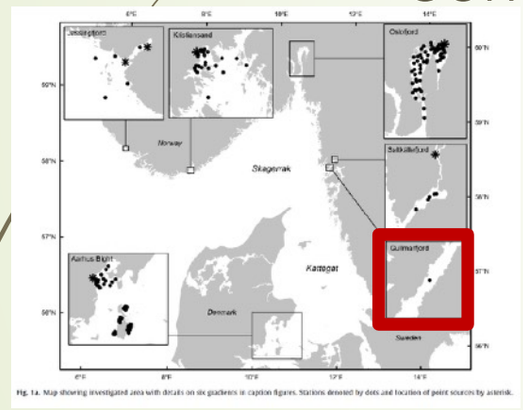
1. Present the results of B_{Val} tested on a physical disturbance context

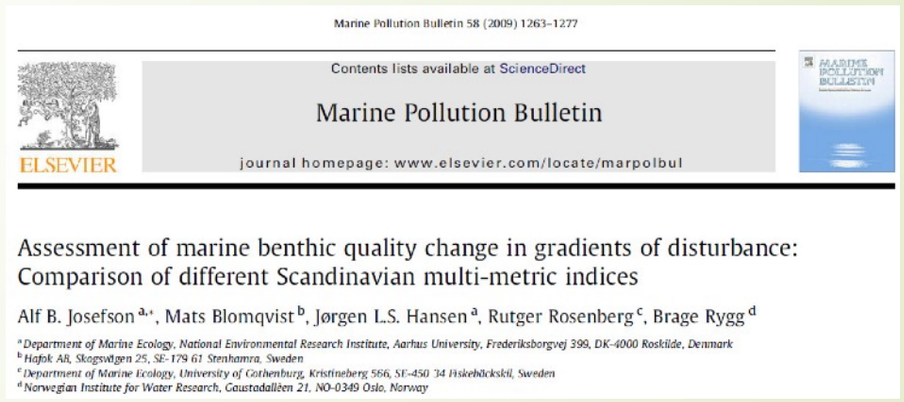


-Macrofauna maerl beds french dataset

-Pressure: maerl extraction

2. Present the results of B_{Val} tested on a chemical disturbance context and compared with the Scandinavian indices

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Assessment of marine benthic quality change in gradients of disturbance: Comparison of different Scandinavian multi-metric indices

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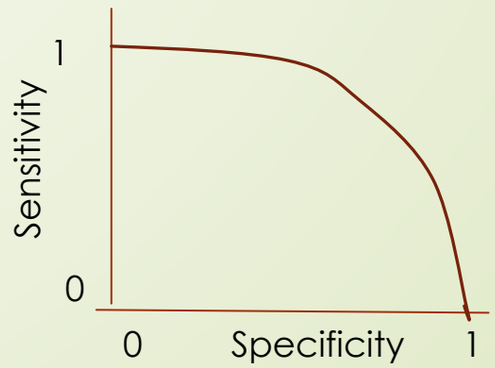
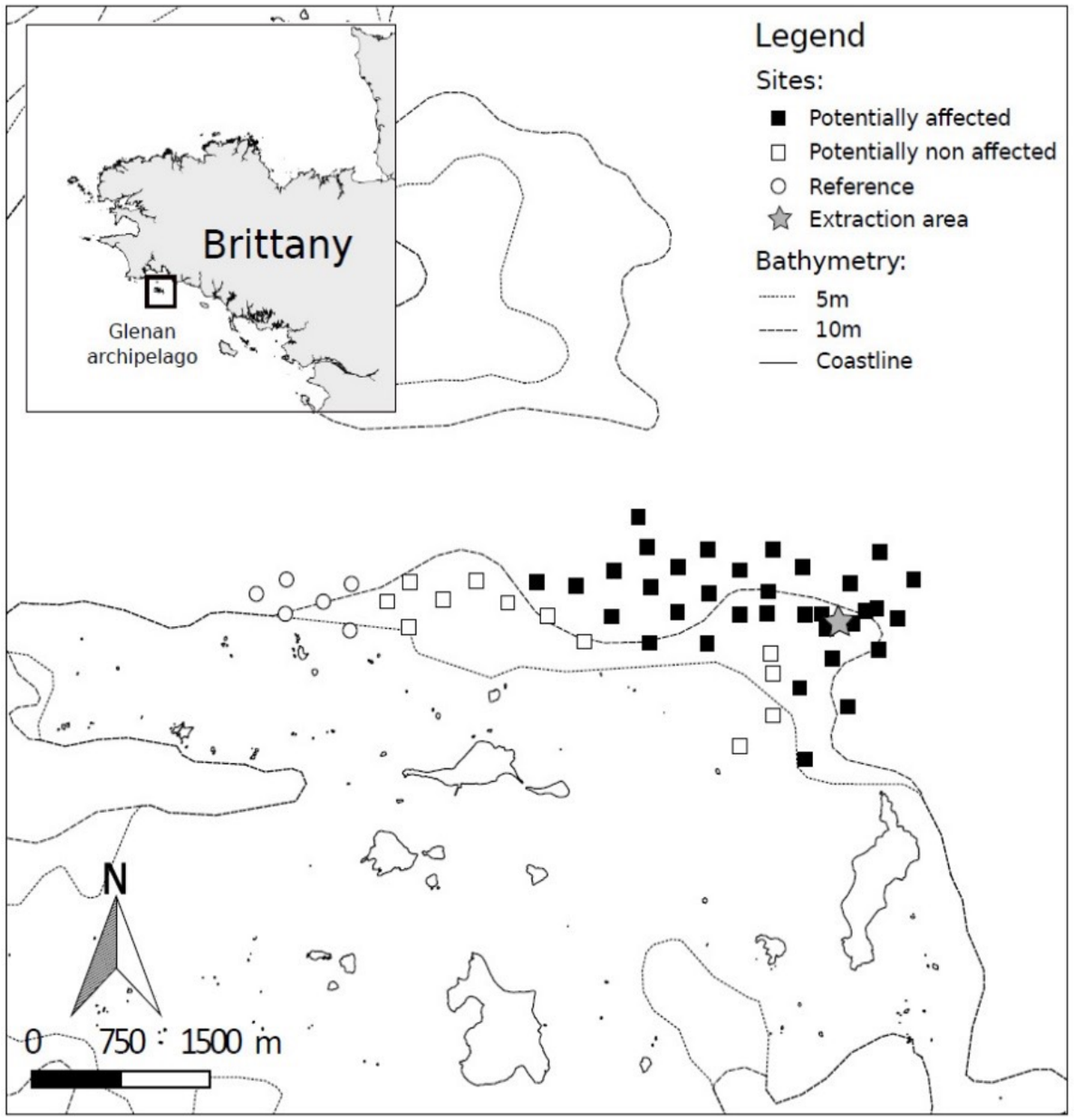
3. Propose an approach to define a G/M border of EcoQ

Based on the Signal Detection Theory, illustrated by ROC curves, from which AUC can be used as a measure of the indicator response



1: The Glenan Archipelago dataset



- Macrofauna maerl beds dataset

- Pressure: maerl extraction

- 52 stations

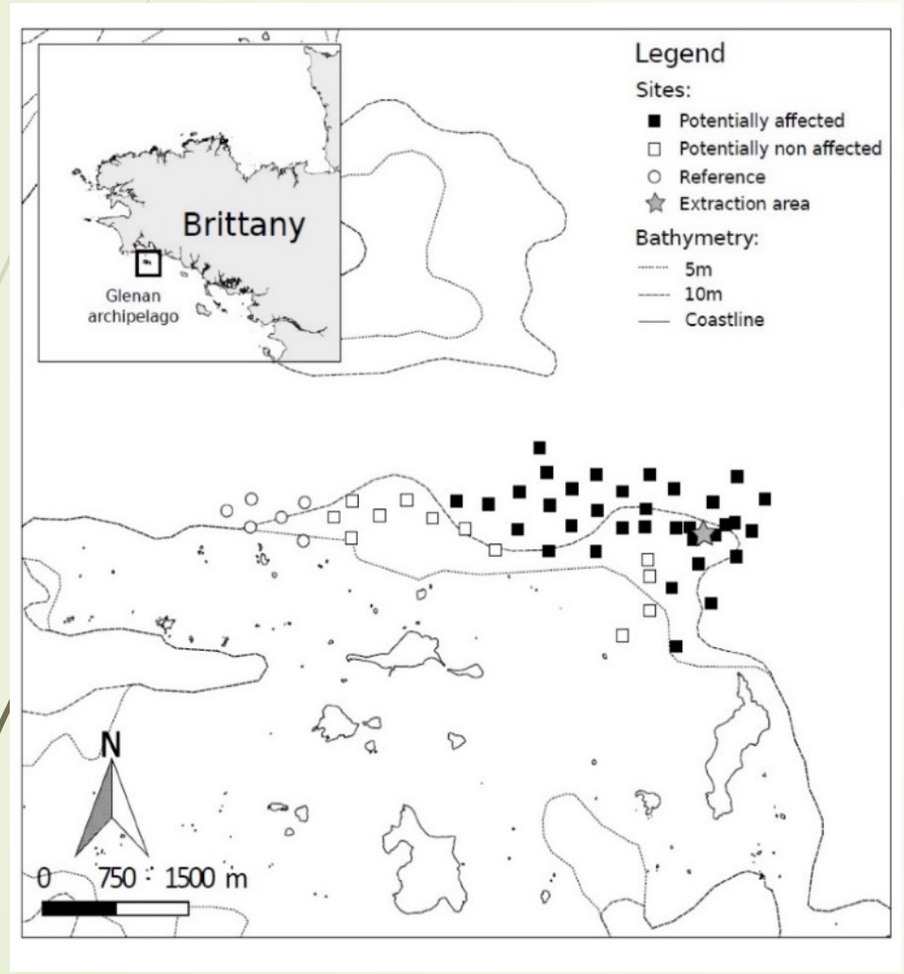
- Three 0.1m² Van Veen grab samples were collected at each station

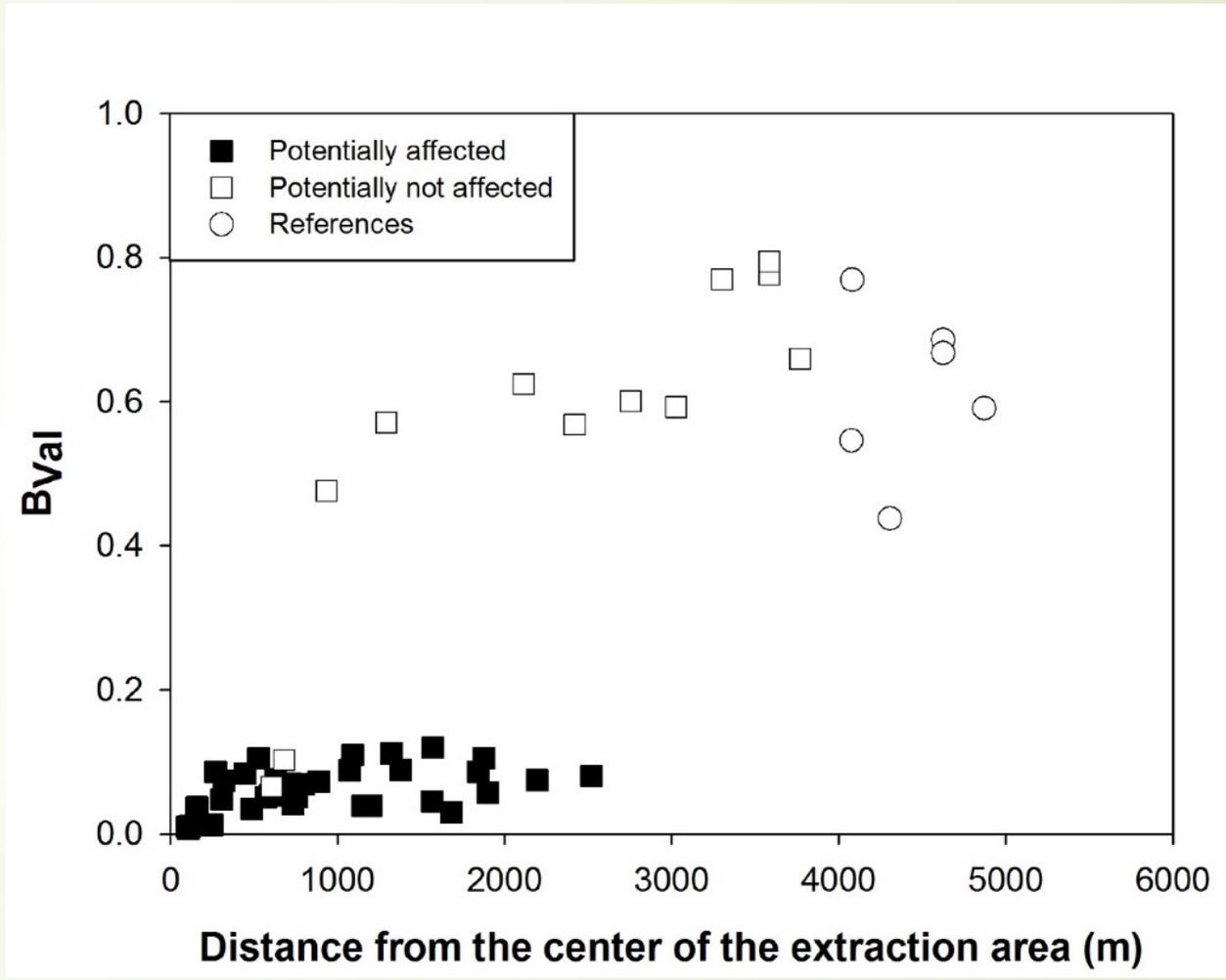
- Sieved on a 1mm mesh size

Stations were *a priori* classified based on the Telemac-2D hydro-sedimentary model taking into account :

- maerl extraction location,
- timing,
- volumes extracted
- tide currents

1. Glenan Archipelago

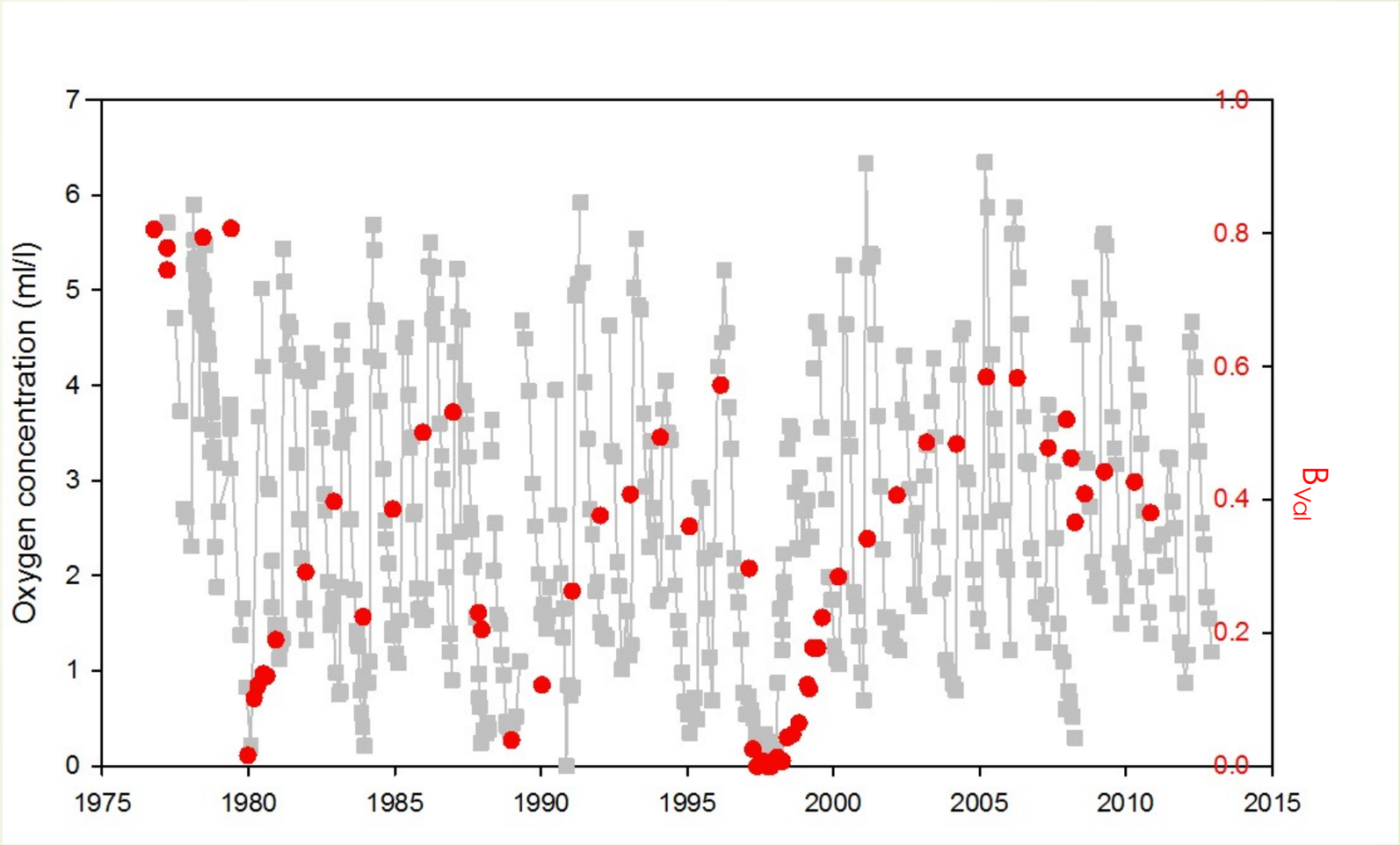




- B_{val} is able to detect a physical pressure

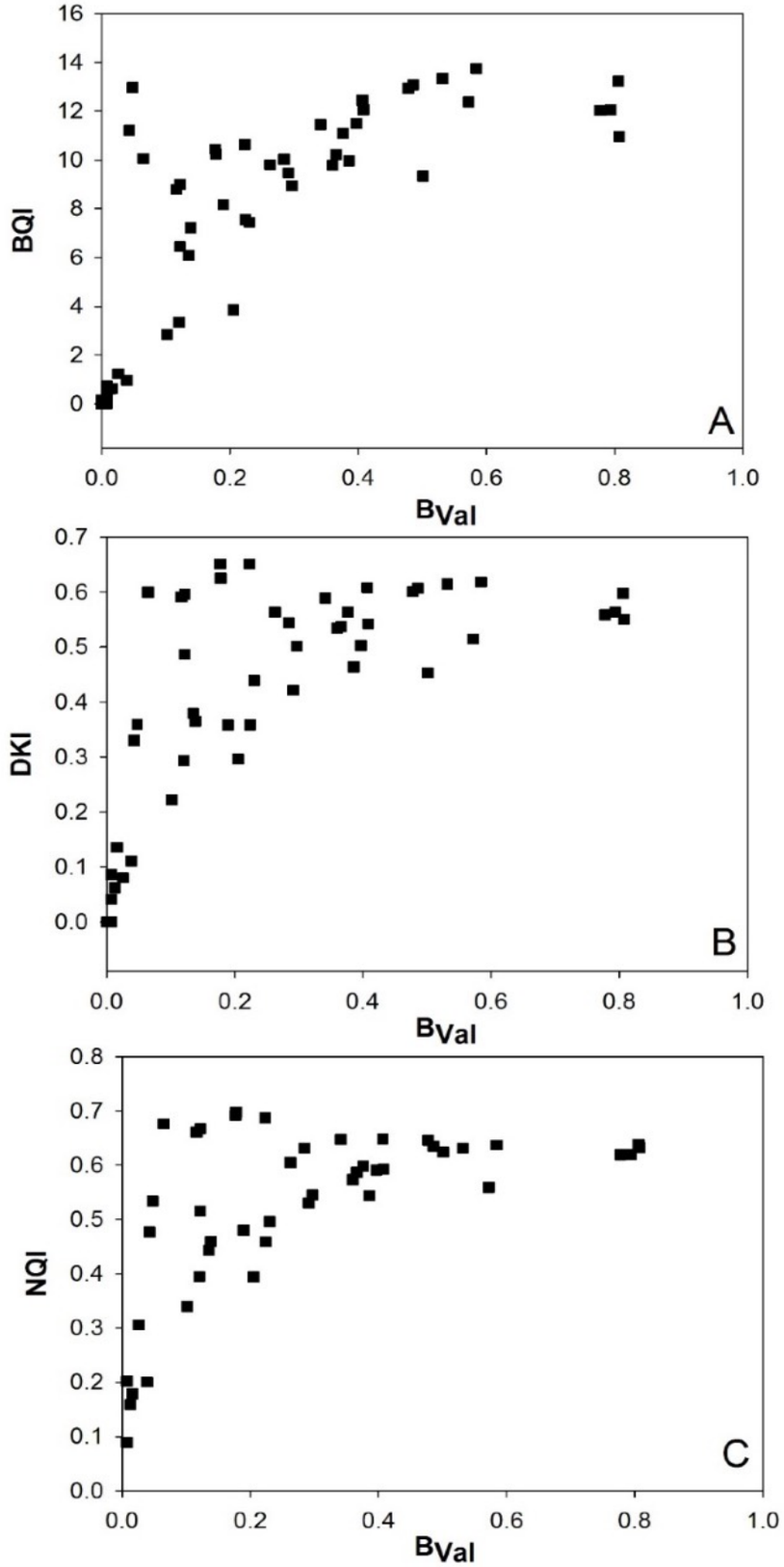
2. Gullmarfjord

This dataset consists in a 1 station long-term time series sampled between 1977 and 2010 in 56 occasions. The station is located 118m depth, the major disturbance is hypoxia and the pressure proxy is the near bottom O_2 concentration.



- B_{Val} correlated positively with the average O_2 concentration during the year preceding each sampling date (Spearman rank correlation; τ=0.48, p<0.001).

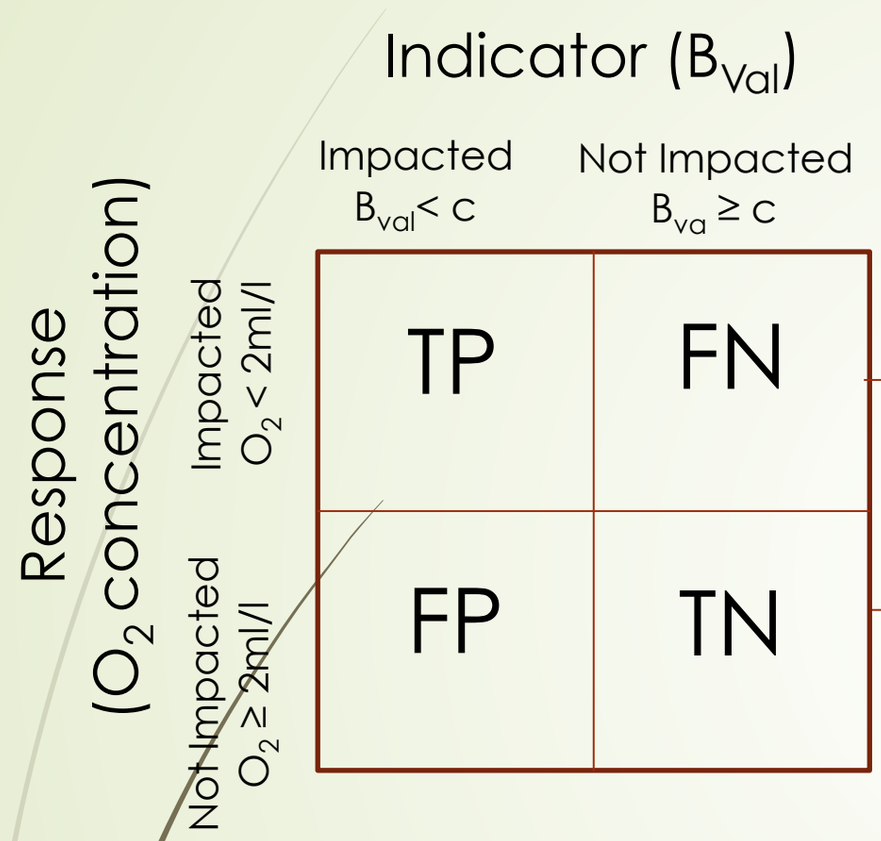
2. Gullmarfjord



B_{Val} correlated positively with BQI, DKI and NQI
(Spearman Rank Correlation test)
BQI : τ=0.806, p<0.001, N=49
DKI : τ=0.682, p<0.001, N=49
NQI: τ=0.534, p<0.001, N=45

➢ B_{val} is able to detect a hypoxia and correlate with the existing Scandinavian indices constructed for this area

3: Propose a G/M border of EcoQ



Ecological Applications, 6(1), 1996, pp. 132–139

THE STATISTICAL EVALUATION OF ECOLOGICAL INDICATORS[1]

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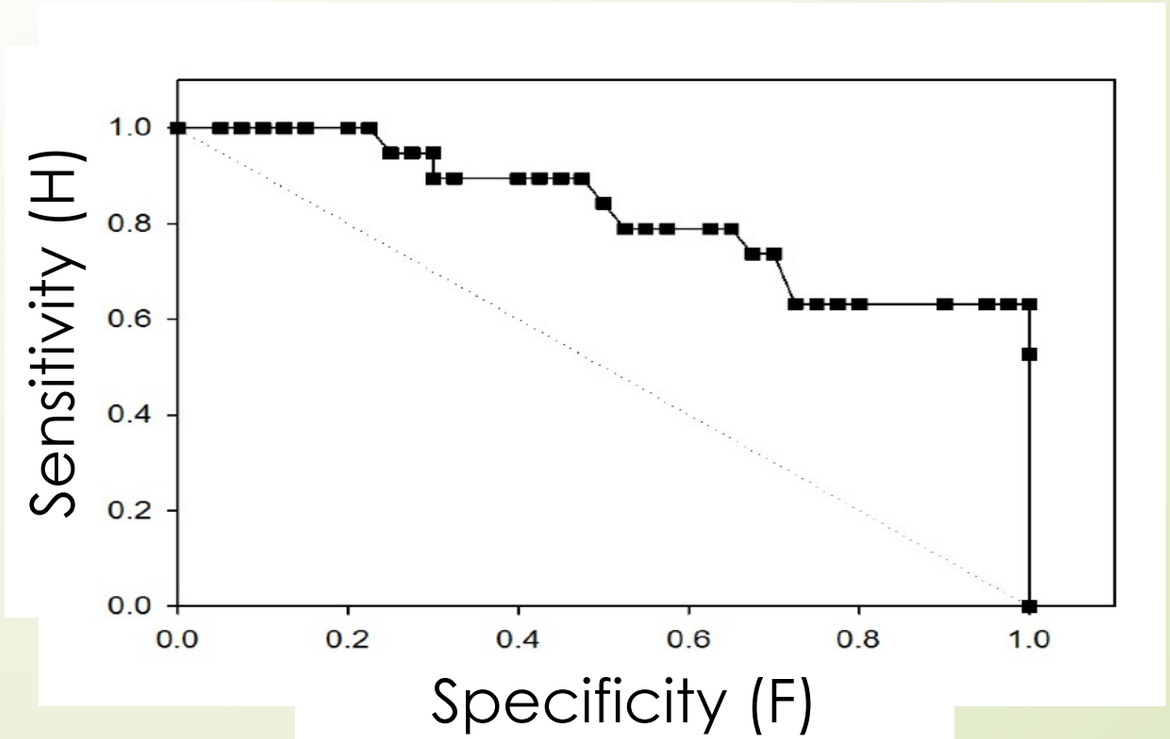
Department of Statistics, Oregon State University, Corvallis, Oregon 97331 USA

$$\hat{H}_{(c)} = \frac{TP_{(c)}}{TP_{(c)}+FN_{(c)}}$$

$$\hat{F}_{(c)} = \frac{TN_{(c)}}{TN_{(c)} + FP_{(c)}}$$



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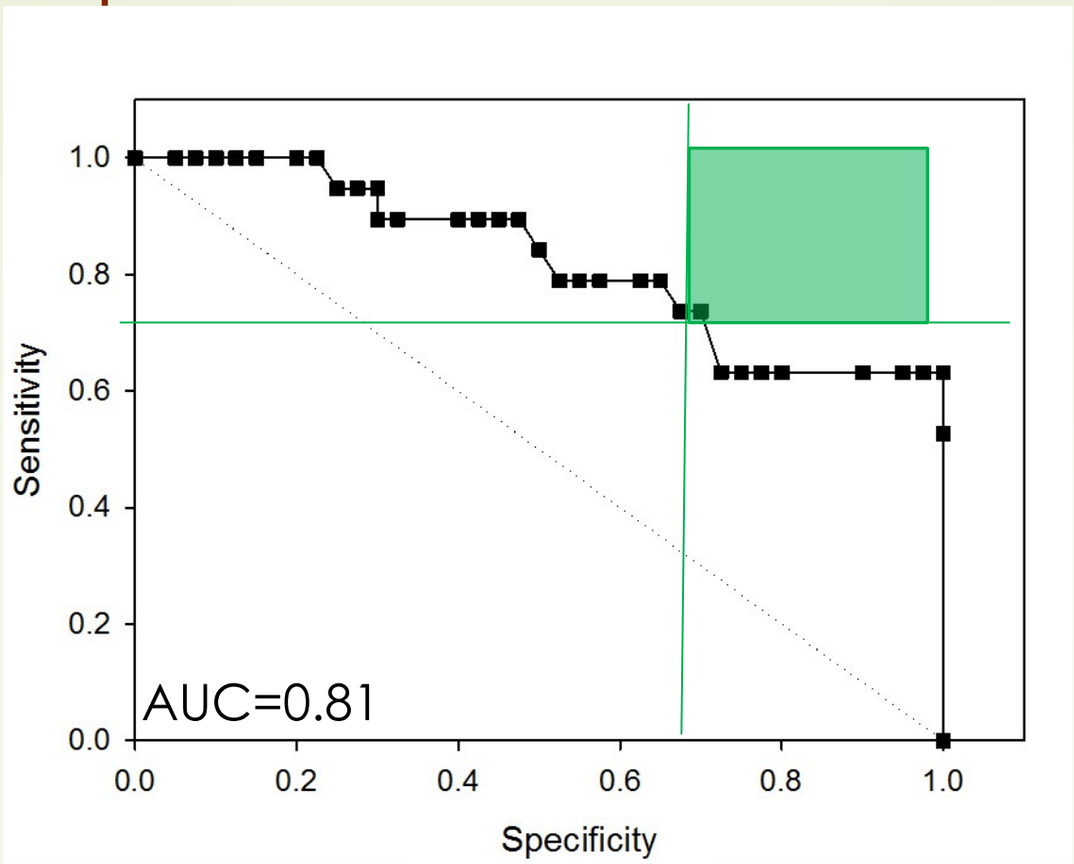
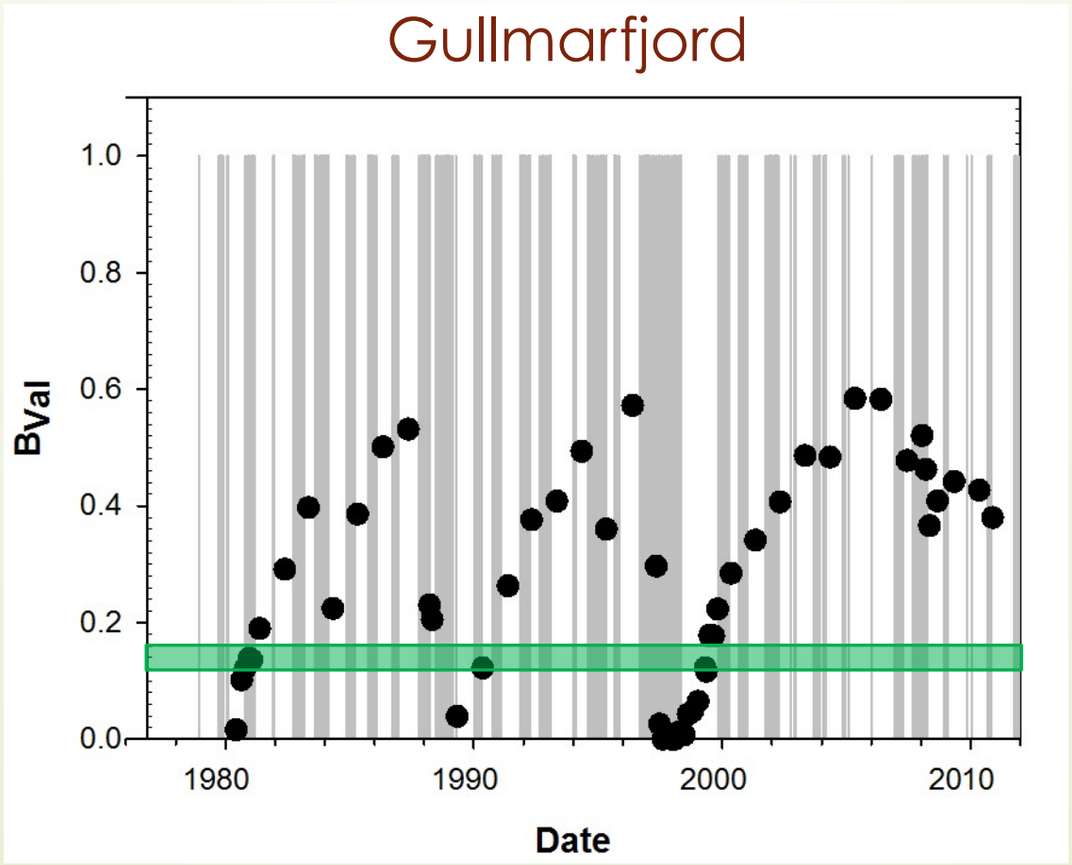




Conclusions

- B_{Val} index discriminates impacted vs not impacted stations

- The advantages of the B_{Val} index:

  - Do not need a list of sensitivity (which is in general associated to a geographic area and a type of pressure)
  - It can be used for any type of pressure

- The limits of the B_{Val} index:

  - Gives information on degradation only → Need to be absolutely confident about the reference
  - Possibility to look at the gain of species and change of reference station if one better

- Importance of elaborate a sampling strategy adequate with this methodology

  - A minimum of 1 reference station /habitat
  - All stations sampled at the same time

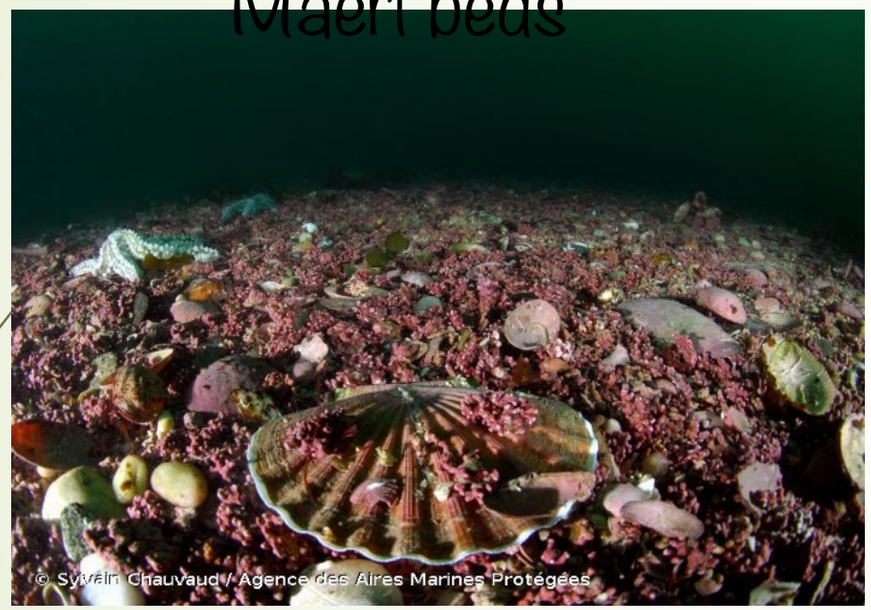
Perspectives

- Compare the values of B_{Val} with the values of different indices such as AMBI, BQI, NKI, DKI etc…on other datasets

- Test B_{Val} on other datasets with quantified pressure in order to adjust the G/M border

Thank you for your attention!

Maerl beds



Glénan Archipelago

Acknowledgment: Mats Bloomqvist and the swedish team

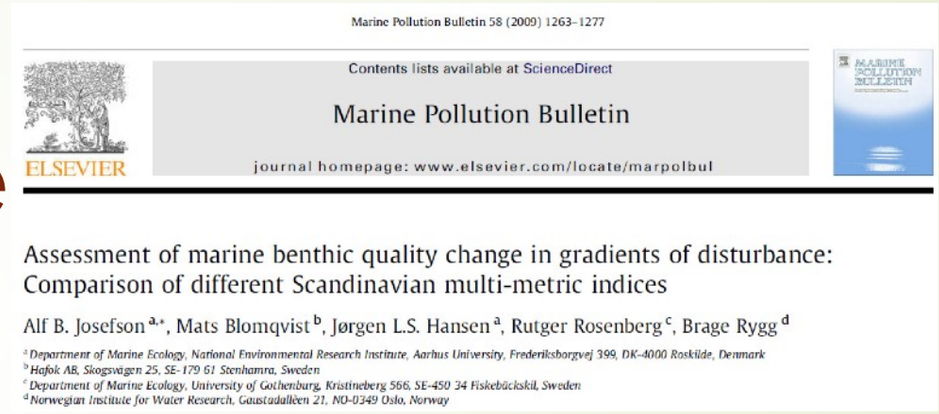
Protocol for assessment

- **Define habitat subsets** (depth, grain size …)
- **Define temporal subsets** within these subsets (if possible)
  - Keep years separate
  - Keep seasons/months/dates separate
- **Choose reference(s) within subsets**

The index proposed

$$B_{Val} = 1 - \frac{\Sigma(ri - xi)^{*}}{\Sigma(ri)} \qquad *: \text{if } r_i > xi$$

The scandinavian indice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$$DKI = \left(\frac{\left(1 - \frac{AMBI}{7}\right) + \left(\frac{H'}{H'_{max}}\right)}{2}\right) \times \left(\frac{(1 - \left(\frac{1}{N}\right) + (1 - \left(\frac{1}{S}\right)}{2}\right)$$

$$NQI = 0{,}5 \times \left(1 - \frac{AMBI}{7}\right) + \left(0{,}5 \times \frac{SN}{2{,}7} \times \frac{N_{tot}}{N_{tot} + 5}\right) \qquad where\ SN = \ln(S)\ /\ln(\ln(N))$$

$$BQI = \left(\sum_{i=1}^{Sclas}\left(\frac{Ni}{Nclas} \times ES500{,}05\right)\right) \times \log_{10}(S + 1) \times \left(\frac{N_{tot}}{N_{tot}+5}\right)$$