Methods and results of transitional/ coastal water assessment (Module 4)

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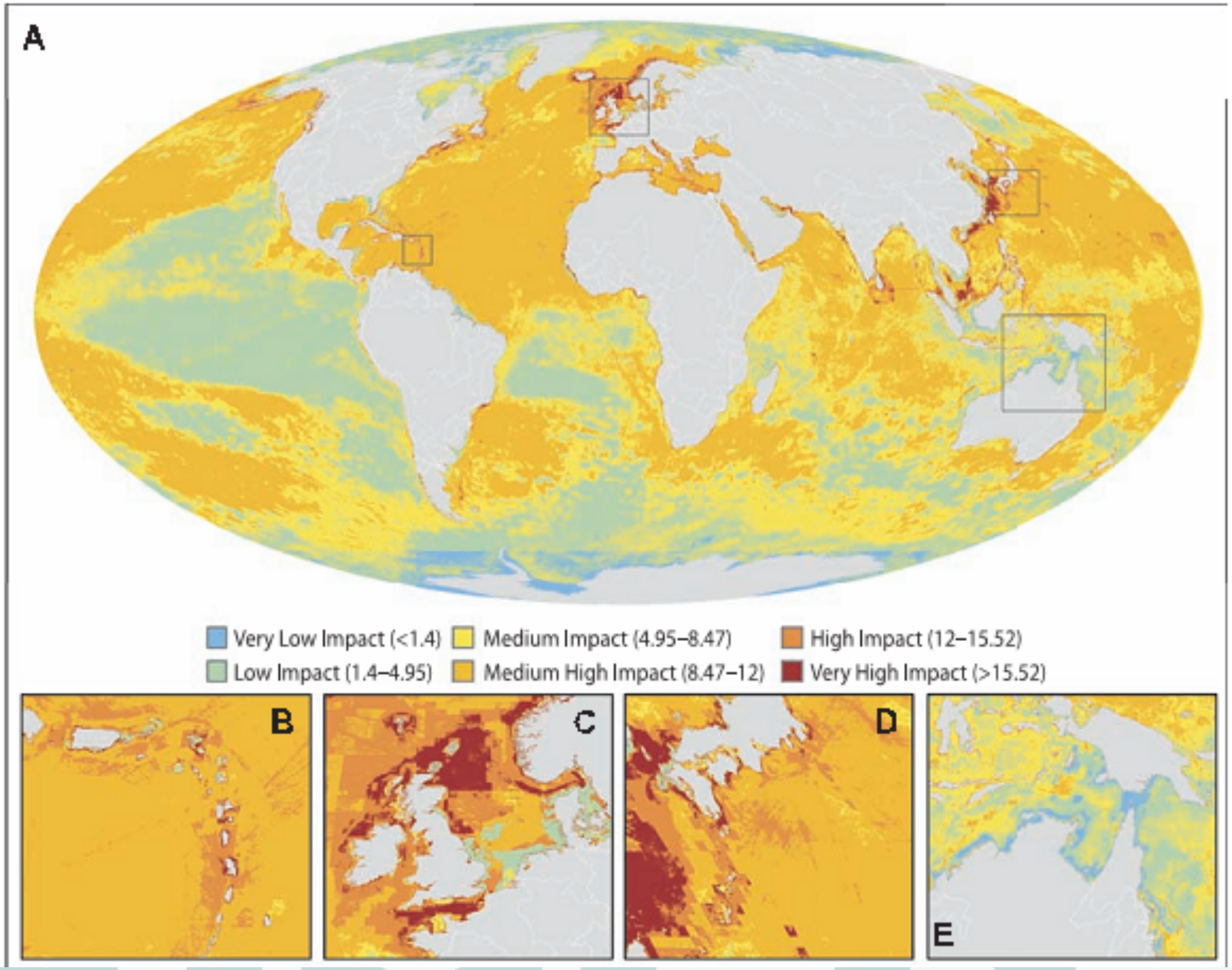
WISER

Tallinn, January 2012

Introduction

Fig. 1. Global map (**A**) of cumulative human impact across 20 ocean ecosystem types. (Insets) Highly impacted regions in the Eastern Caribbean (**B**), the North Sea (**C**), and the Japanese waters (**D**) and one of the least impacted regions, in northern Australia and the Torres Strait (**E**).

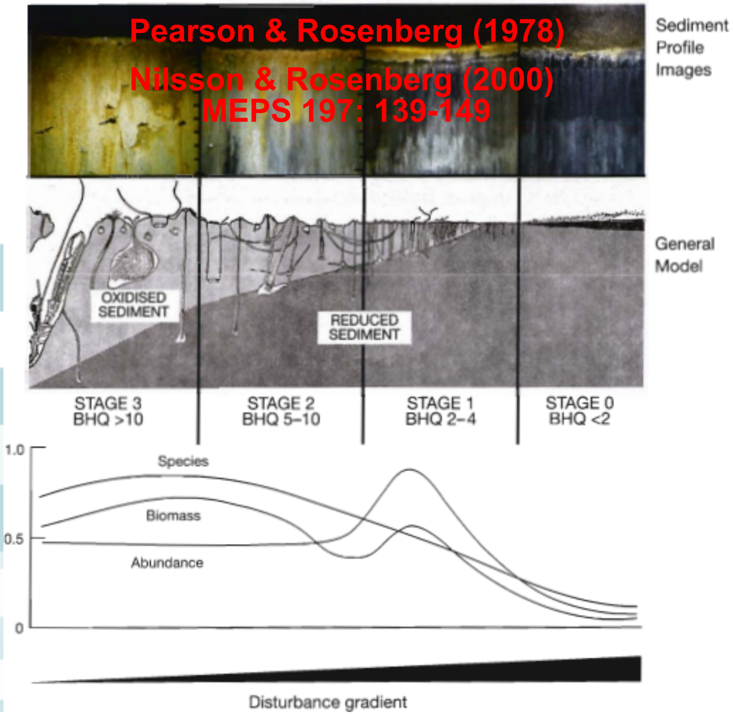


Science AAAS

A Global Map of Human Impact on Marine Ecosystems
Benjamin S. Halpern, *et al.*
Science **319**, 948 (2008);
DOI: 10.1126/science.1149345

Introduction

1. **Human pressures** must be assessed (quantitatively, whenever possible)
2. Sites with the absence of human pressures (or least disturbed locations) provide information to determine **reference conditions**
3. Methods to **assess the ecological status** in biological elements and aquatic ecosystems must be validated **against human pressures**, to determine the management responses

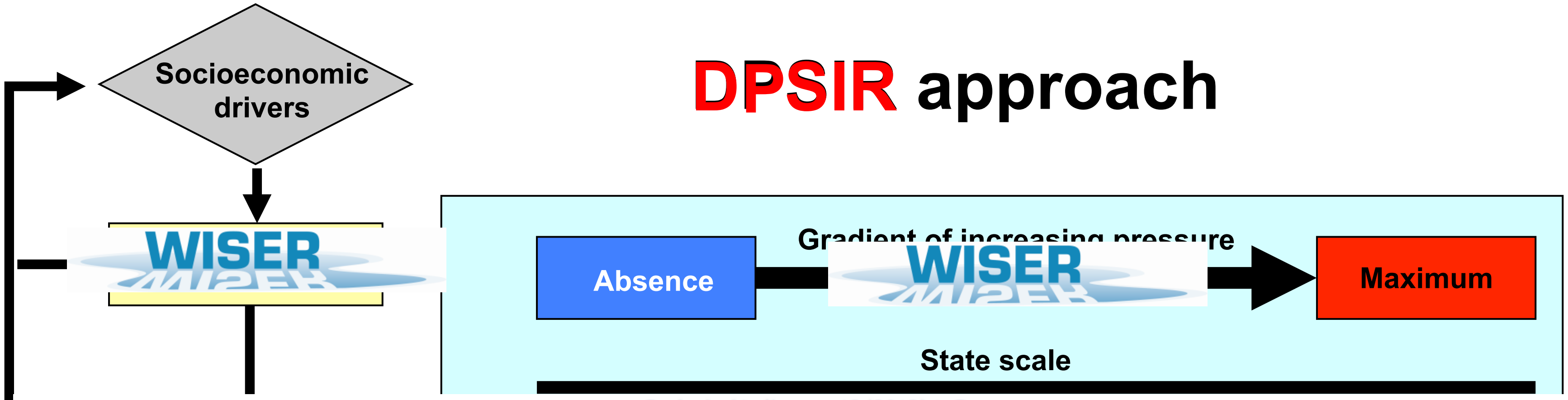


Pearson & Rosenberg (1978)

Nilsson & Rosenberg (2000) MEPS 197: 139-149

Introduction

DPSIR approach



Ecological Indicators 12 (2012) 1–7

Contents lists available at ScienceDirect

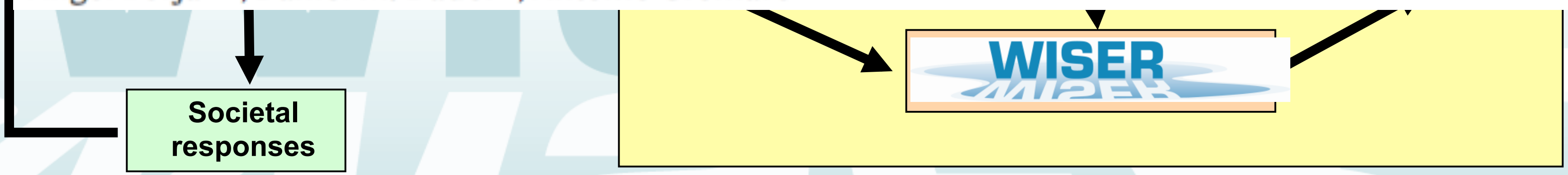
Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

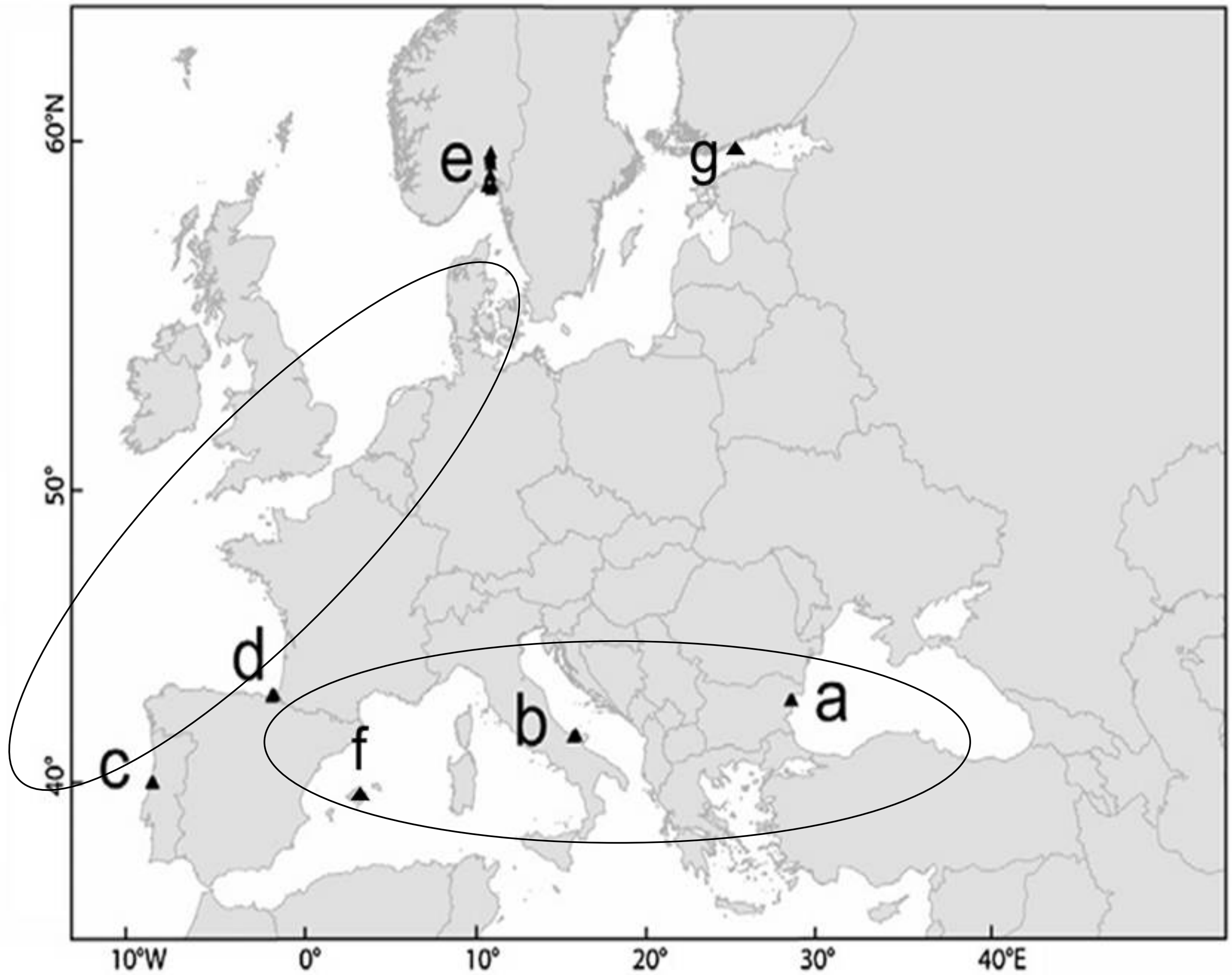
ELSEVIER

The importance of setting targets and reference conditions in assessing marine ecosystem quality

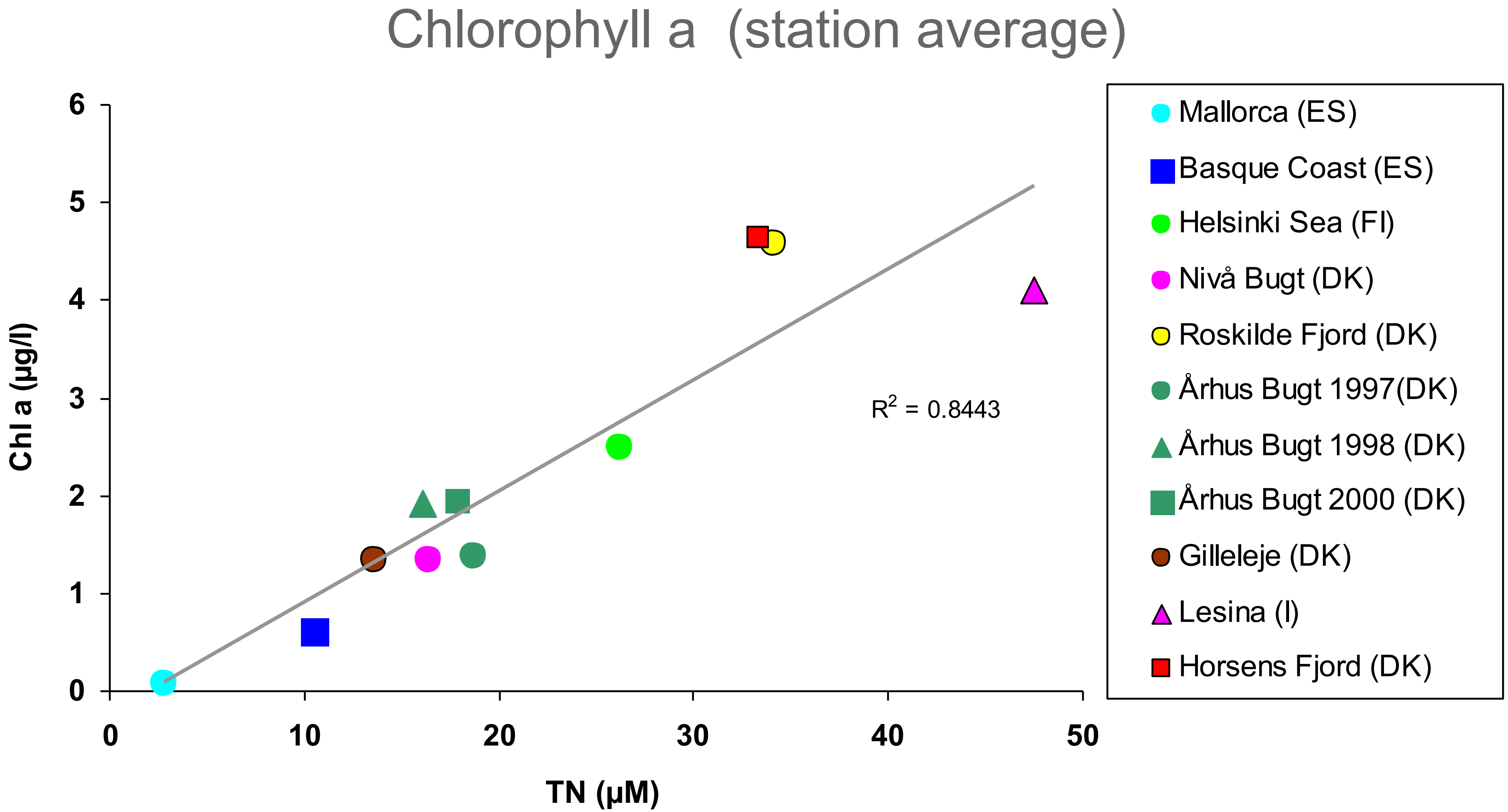
Ángel Borja[a,*], Daniel M. Dauer[b], Antoine Grémare[c]



Objectives of M4 WISER project



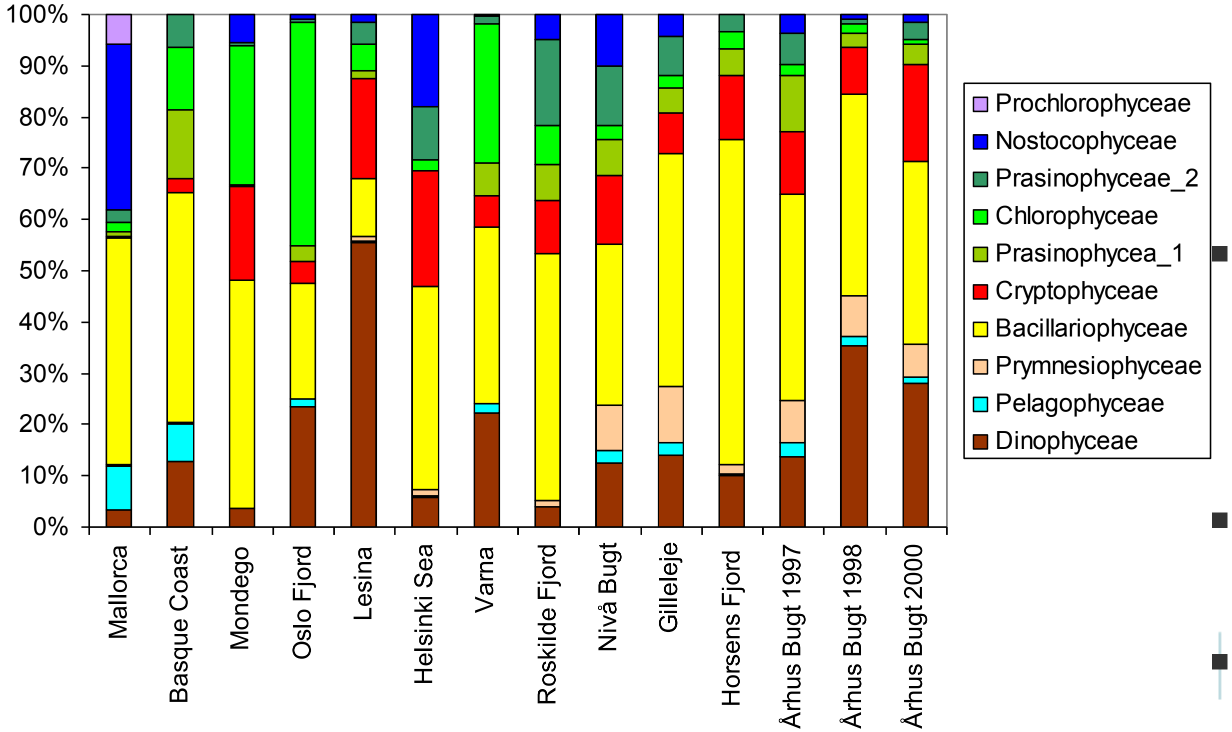
Ob1: To develop and validate indices: phytoplankton



- Chl a correlated with TN

Ob1: To develop and validate indices: phytoplankton

Phytoplankton composition

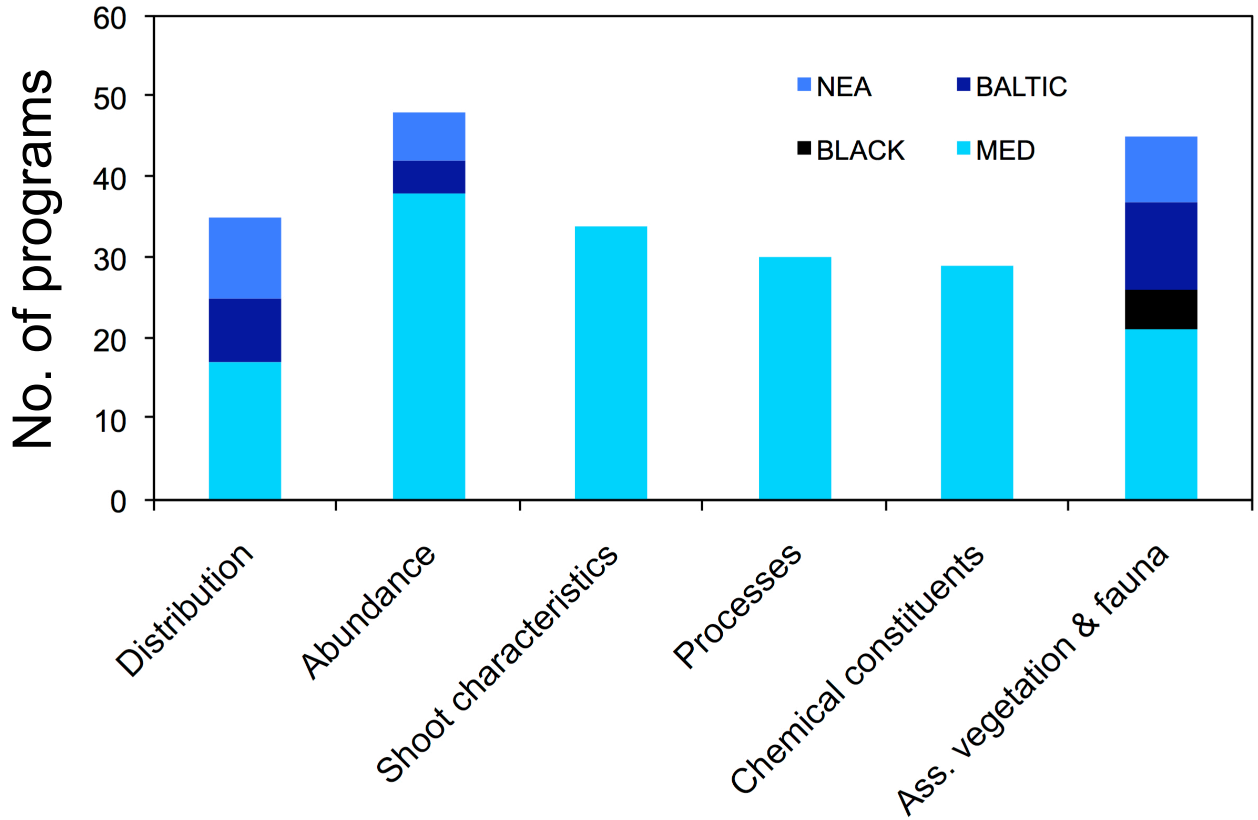


- Community patterns correlated with TN - ***but mainly with salinity and temperature***
- No clear correlations between single phytoplankton groups and TN
- Very large within-station variations
- Not possible to define reference communities

Ob1: To develop and validate indices: seagrasses

Overview of indicators used

- 42 monitoring programs
- 49 seagrass indicators in use (25 in *P. oceanica*, 19 in *Z. marina*, 12 in *Z. noltii*, 3 in *C. nodosa*)
- 51 seagrass metrics assessed



Marbà et al (submitted)

Ob1: To develop and validate indices: macroalgae

Ecological Indicators 12 (2012) 58–71

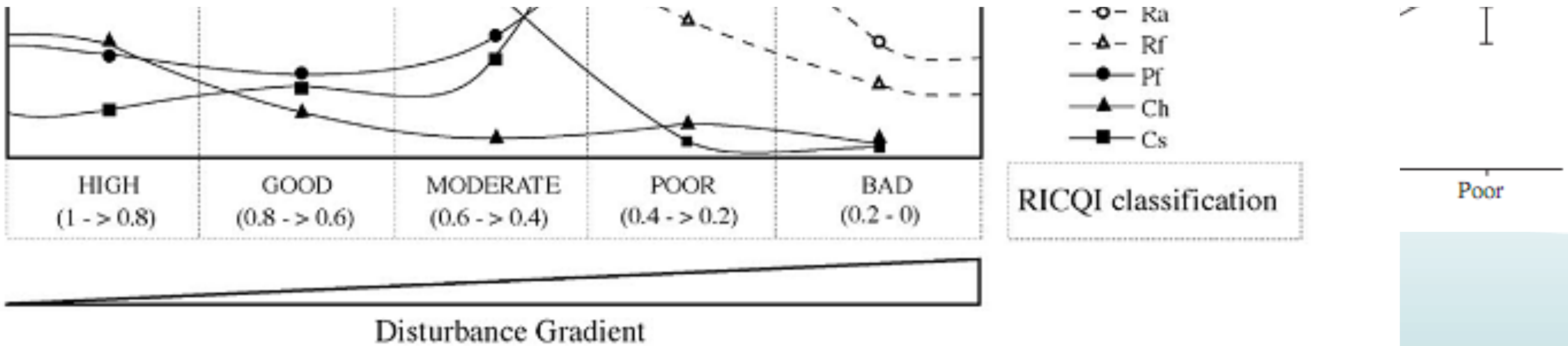
Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Development of a tool for assessing the ecological quality status of intertidal coastal rocky assemblages, within Atlantic Iberian coasts

I. Díez[a,*], M. Bustamante[b], A. Santolaria[a], J. Tajadura[b], N. Muguerza[a], A. Borja[c], I. Muxika[c], J.I. Saiz-Salinas[b], J.M. Gorostiaga[a]



Ob1: key messages from indices

- We have critically reviewed indices from several BQEs: Everyone has their own (many) metrics and some are site/ group specific
- Metrics are based on structure but also on functional attributes (taxonomic, size-biomass spectra, traits analysis) are useful and reliable for the assessment
- Developing common metrics was difficult, due to the plethora of MSs methods; but a common pressure index has been used in fish IC to bring very different indices to a common scale
- We have developed methods and indicators for phytoplankton, macroalgae and benthos. Some of them are in use by countries

Ob2: Pressure-response relationships: macroflora

• Correlative analyses across regional and/or local scales (6 case studies)

a) Single observations: Indicators (and metrics) vs pressures analyzed:
- POMI (*Posidonia oceanica*, MED) vs nutrient concentration, coastal defence, shipping traffic, extent of urban areas, and total pressures
- EEI (macroflora, MED & Black) vs total pressures (agriculture, urban industry waste water discharges; extension of land-uses; fisheries; turbidity)+ temperature and salinity
- MarMAT(macroalgae, NEA) vs human population size, extend of industrial land use, agriculture and fishing area and total pressures

b) Time series available and indicators analyzed:
- Macroalgal cover (Baltic) vs salinity, temperature, nutrient concentrations, Secchi depth, Chla
- *Zostera marina* depth limit (Baltic) vs nutrient concentrations, salinity, temperature
- *Zostera noltii* extent and biomass (NEA) vs hydromorphological change, resource use change, nutrient concentrations, turbidity

Ob2: Pressure-response relationships: macroflora

- All 6 case studies show significant macroflora responses to pressures

- Relationships showed considerable variability, explaining a limited part (5-20 %) of the total variance of the indicator except for EEI (90%) and MarMAT (67%)

- The lack of strong relationships reveals that macroflora indicators are markedly influenced by other non-tested environmental parameters, and/or complex interactions between ecological processes and anthropogenic pressures affecting the metrics

- Macroflora indicators (e.g. macroalgal cover, eelgrass depth limit) respond to the interaction between natural environmental parameters (e.g. temperature, salinity) and anthropogenic pressures

- Variability in sampling methods, local traits, differences in spatial scale of pressures and vegetation quantification may contribute to the variability observed in pressure-response relationships

Ob2: Pressure-response relationships: benthos

Table 1
Pressures determined at each location and sampling station (see Fig. 1), showing the pressure gradient in the total value and a pressure index, calculated as an average value of the pressures (see Section 2). Values: 1 – low pressure; 2 – moder...

Marine Pollution Bulletin 62 (2011) 499–513

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

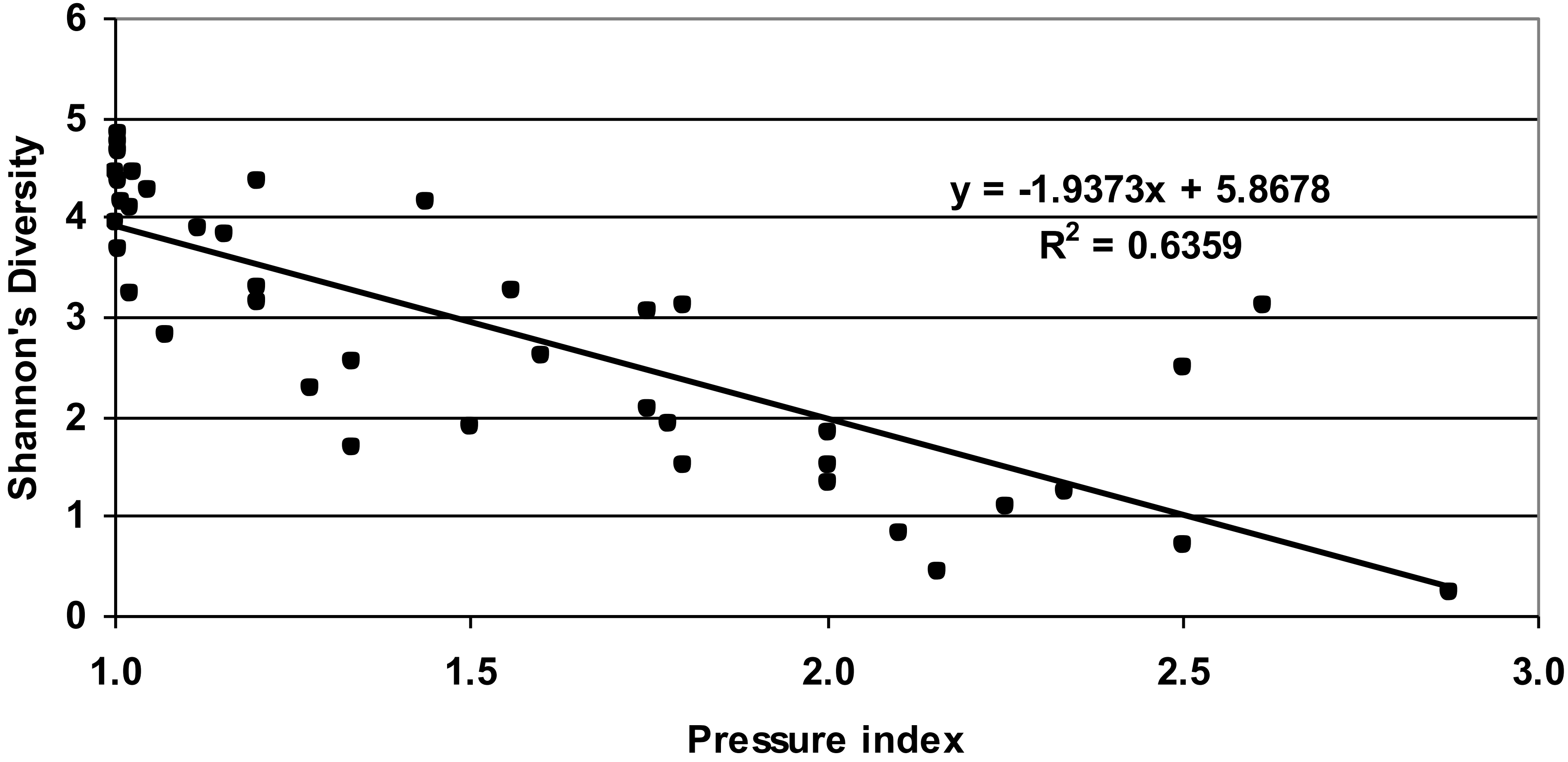
Response of single benthic metrics and multi-metric methods to anthropogenic pressure gradients, in five distinct European coastal and transitional ecosystems

Angel Borja [a,*], Enrico Barbone [c], Alberto Basset [c], Gunhild Borgersen [b], Marijana Brkljacic [b], Michael Elliott [e], Joxe Mikel Garmendia [a], João Carlos Marques [d], Krysia Mazik [e], Iñigo Muxika [a], João Magalhães Neto [d], Karl Norling [b], J. Germán Rodríguez [a], Ilaria Rosati [c], Brage Rygg [b], Heliana Teixeira [d], Antoaneta Trayanova [f]

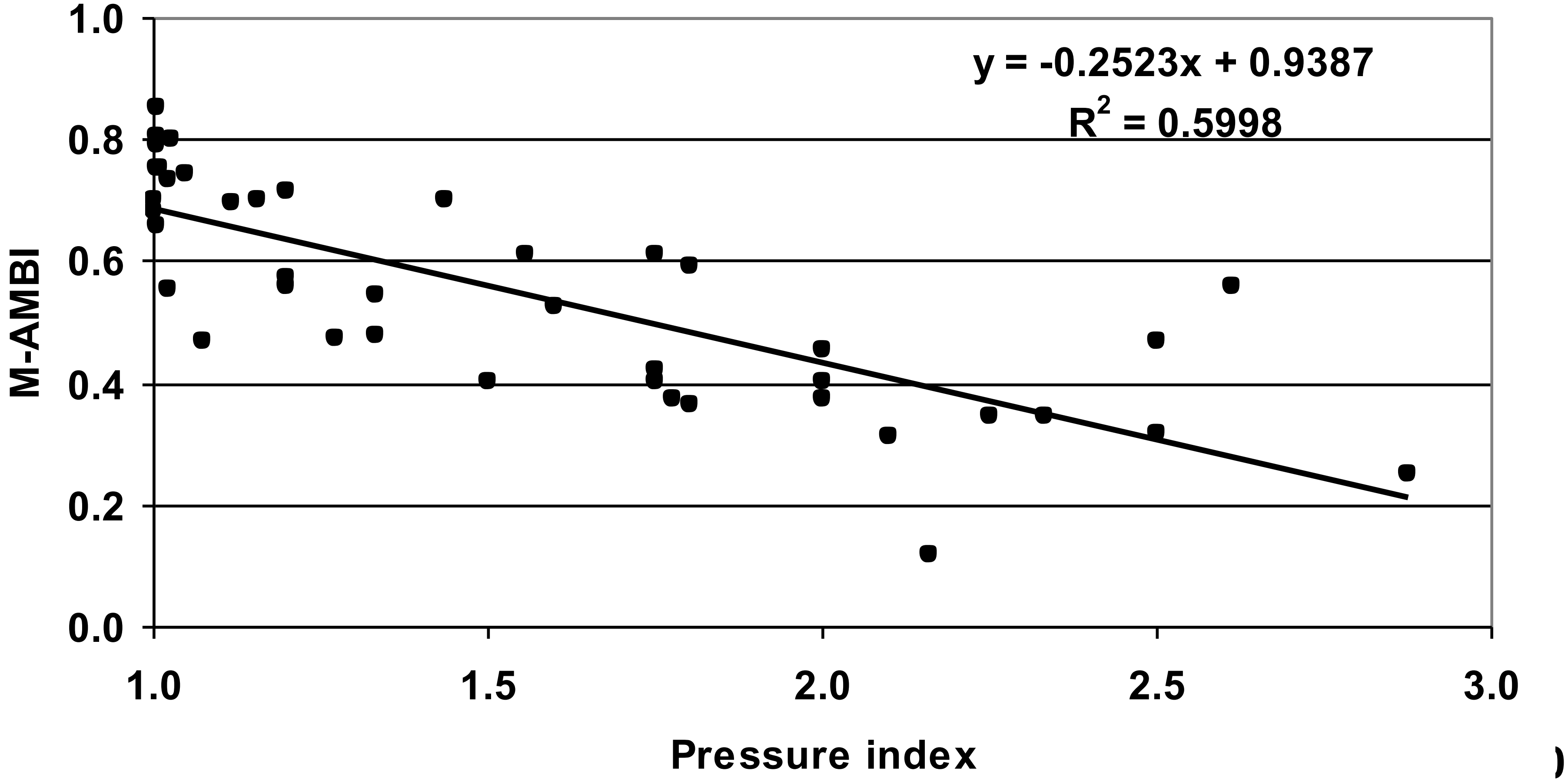
Ob2: Pressure-response relationships: benthos

- 13 single metrics
  - AMBI
  - Margalef and Shannon diversity
  - Ecological Groups I, II, III, IV, V
  - ES50, ES100
  - Abundance and Richness
  - SN
- 8 Multimetric methods
  - BAT (Portugal)
  - BEQI (Belgium, Netherlands)
  - BITS (Italy)
  - BQI (Sweden, Finland)
  - IQI (UK, Ireland)
  - ISS (Italy)
  - MAMBI (Spain, France, Germany, Italy, Romania, Bulgaria, Slovenia)
  - NQI (Norway)

Ob2: Pressure-response relationships: benthos



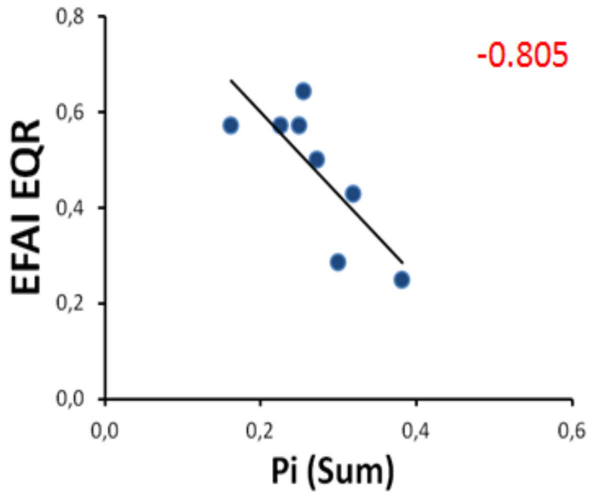
Ob2: Pressure-response relationships: benthos

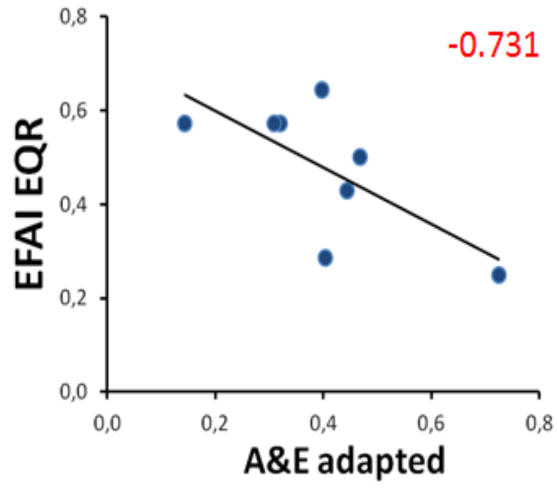


Pressure index

Ob2: Pressure-response relationships: fish

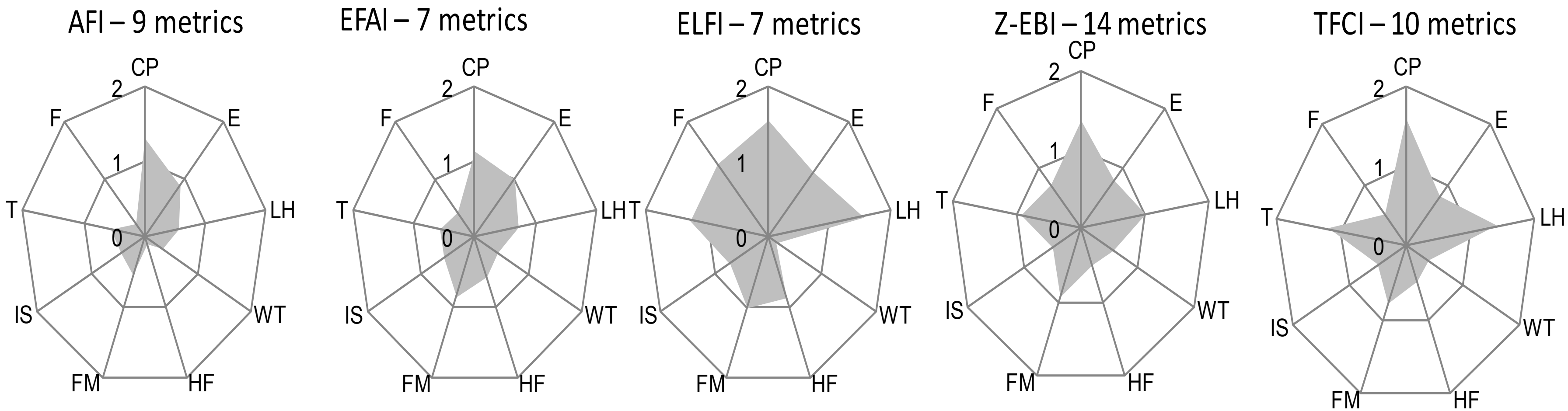
- Case study: Basque estuaries
  - AFI = 0.013 + 0.017(average estuary depth) – 0.003 (global pressure index) – 0.001(residence time) + 0.028 (dredged volume) – 0.007(percentage of channeling in ports) + 0.009(percentage of channeling out of ports).
- Case study: Portuguese estuaries





Ob2: Pressure-response relationships: fish

- Chemical pollution (CP), eutrophication (E), loss of habitat (LH), water turbidity (WT), habitat fragmentation (HF), fish mortalities (FM), invasive species (IS), temperature (T) and flow (F) changes. 0 (no relationship) and 2 (strong strength).



Ob2: key messages from pressure-response

- Multiple pressures in a dynamic system
- Heterogeneous system such that pressures may differ over km
- Determining time-lag in the system between stressor and response is a challenging task
- Problem of detecting anthropogenic stress in naturally-stressed system, such as in TW, for some BQEs
- Benthic invertebrates respond consistently to human pressure gradients across TW and CW, and also across geographies.

Ob3: Reference conditions investigation: benthos in lagoons

OBJECTIVES:

To analyse in 'reference lagoons' the sources of natural variability of the most common multimetric assessment tools;

To evaluate the effectiveness of the different approaches to lagoon typology to account for natural variability;

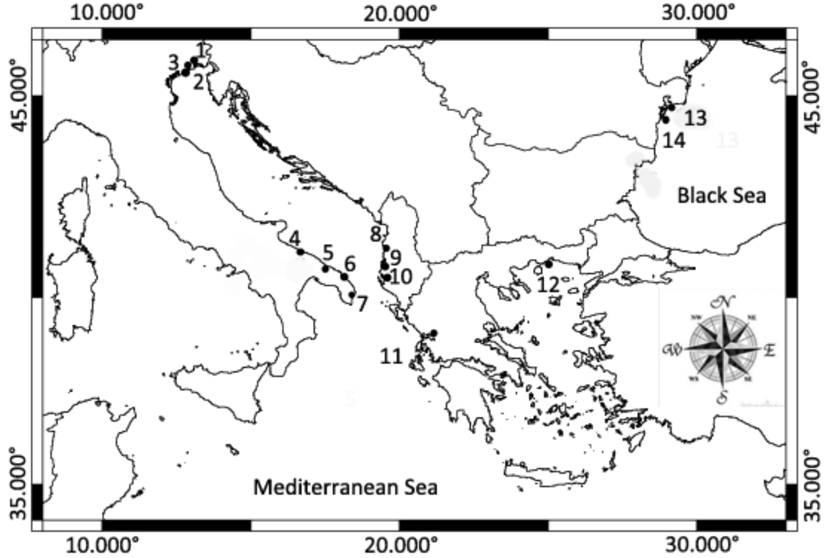
To compare the metric-specific variability within types;

To evaluate the accuracy of type specific reference conditions derived with the different approaches.

Ob3: Reference conditions investigation: benthos in lagoons

SAMPLING EFFORT AND DISTRIBUTION

- Lagoons/lagoon area (14)
- Seasons (2)
- Habitat types (2-3) (*within lagoon*)
- Sampling sites (2) (*within habitat type*)
- Replicates (5) (*within sampling site*)



VARIABILITY SOURCES

- Time (seasonality)
- Surface area
- Tidal range
- Salinity
- Degree of confinement
- Sediment type
- Vegetation type
- Depth
- Oxygen

MULTIMETRIC METHODS

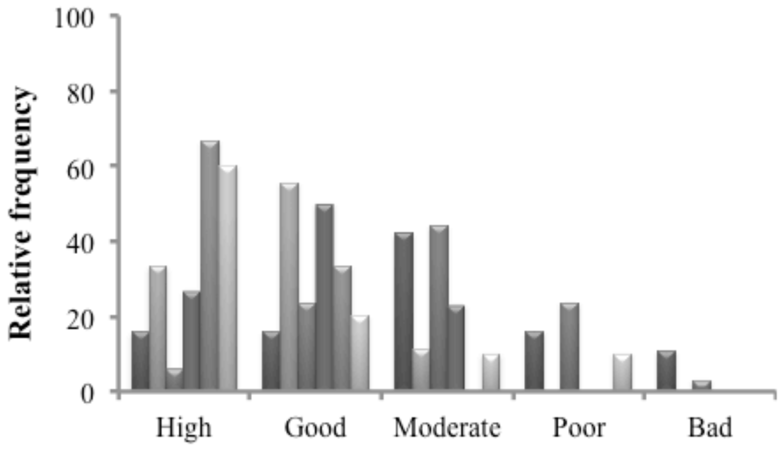
- Taxonomically based
  - M-AMBI
  - BAT
  - BITS
- Non taxonomically based
  - ISS

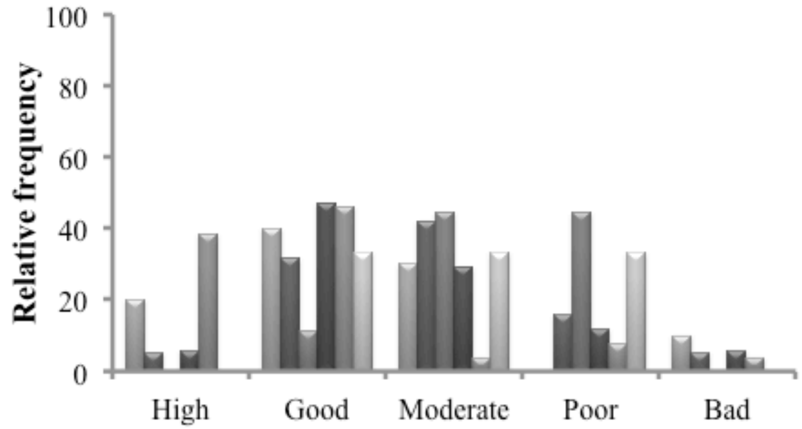
Ob3: Reference conditions investigation: benthos in lagoons

EXAMPLE OF TYPE SPECIFIC CLASSIFICATION: ITALIAN TYPOLOGY

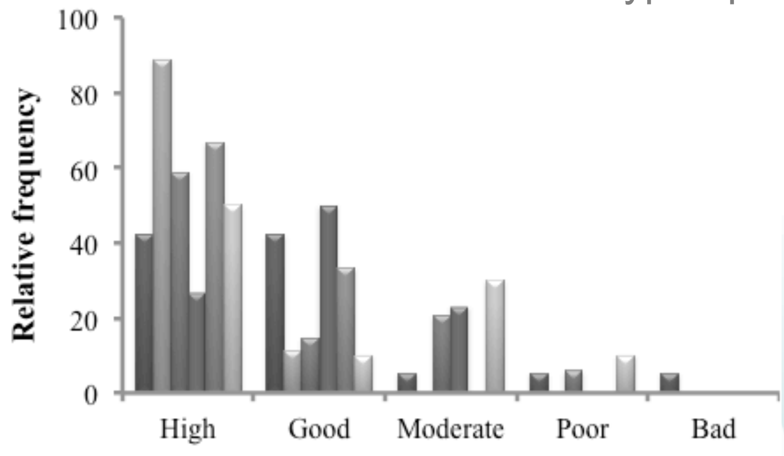
M-AMBI ISS

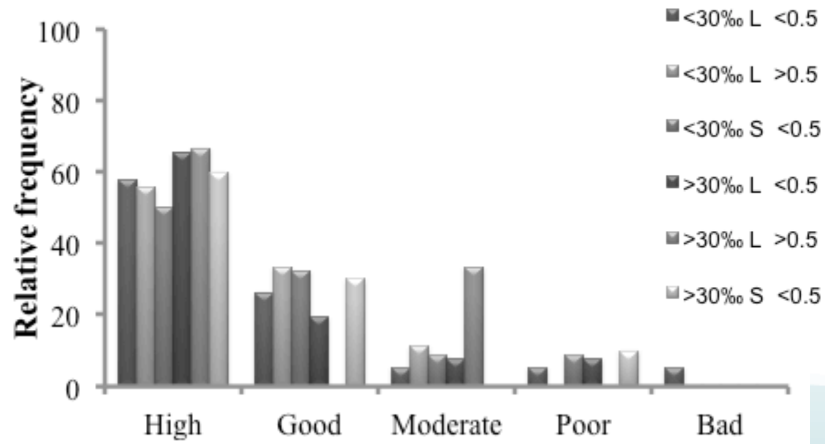
Standard boundaries



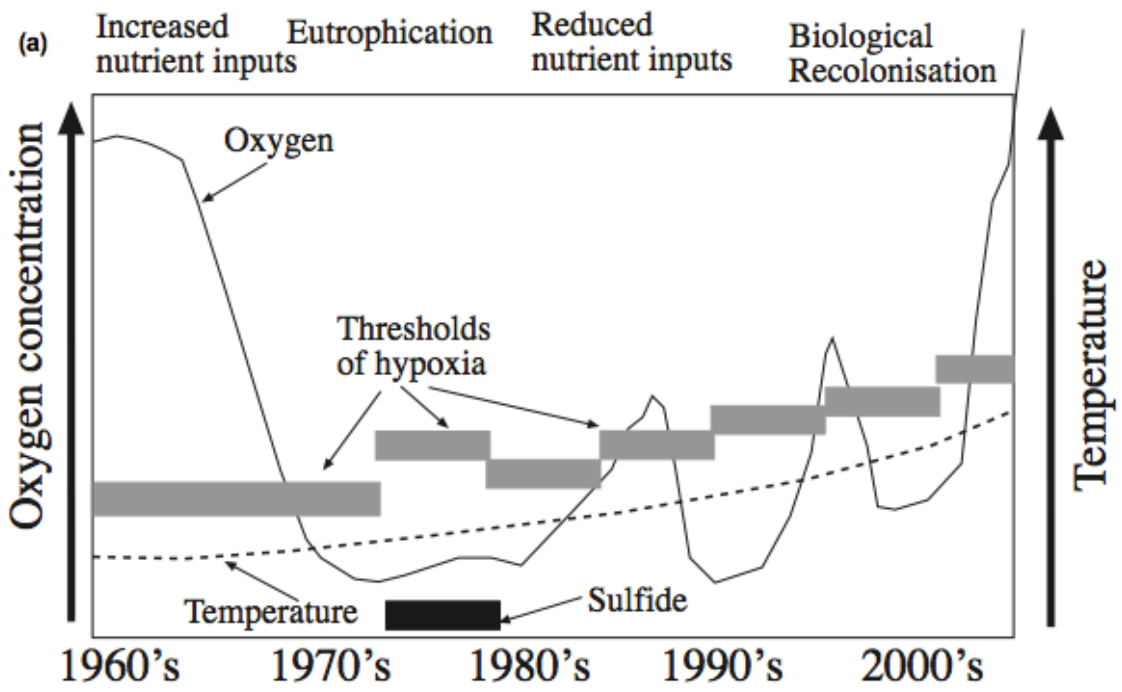


Type-specific boundaries





Ob3: Reference conditions investigation: benthos



Conceptual model of ecosystem recovery from hypoxia

Ob3: key messages from reference conditions

- Setting adequate reference conditions in assessing TraC quality is one of the most important tasks
- Defined as an absence of pressures or a presence of good ecology
- Look for underlying processes and if these occur then there is potential for deriving reference conditions
- Defining RC for TraC is not trivial, but required to minimize misclassification
- They should be type specific and BQE specific
- They should take into account that aquatic systems are dynamic and not static

Ob4: Estimating uncertainty: Phytoplankton

Sources of Uncertainty in Assessment of Phytoplankton Communities
Dromph KM, Agusti S, Basset A, Franco J, Henriksen P, Icely J, Lehtinen S, Moncheva S, Revilla M, Sørensen K (manuscript)

Statistical analysis

- Hierarchical mixed effect model
  - Only random effects considered (Water body, Station, Sample, Sub-sample).
  - A hierarchical structure was applied, taking into account that Stations are nested within Water body, Samples within Water body and Stations and so on.

Ob4: Estimating uncertainty: Phytoplankton

- Pigments: The main proportion of the variation is explained by the variation between stations followed by the variation between water bodies.
- Chlorophyll a: More than 90% of the variation was explained at the station level.
- Cell counts:
  - The main proportion of the variation between number of taxa recorded is explained by the variation between water bodies.
  - The main proportion of the variation between density of cells recorded is explained by the variation between the taxonomist counting the subsamples.

Ob4: Estimating uncertainty: seagrasses

To determine sources of variability associated with the sampling design influencing ecological status classifications in *Posidonia*.

Marine Pollution Bulletin 62 (2011) 1616–1621

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Marine Pollution Bulletin

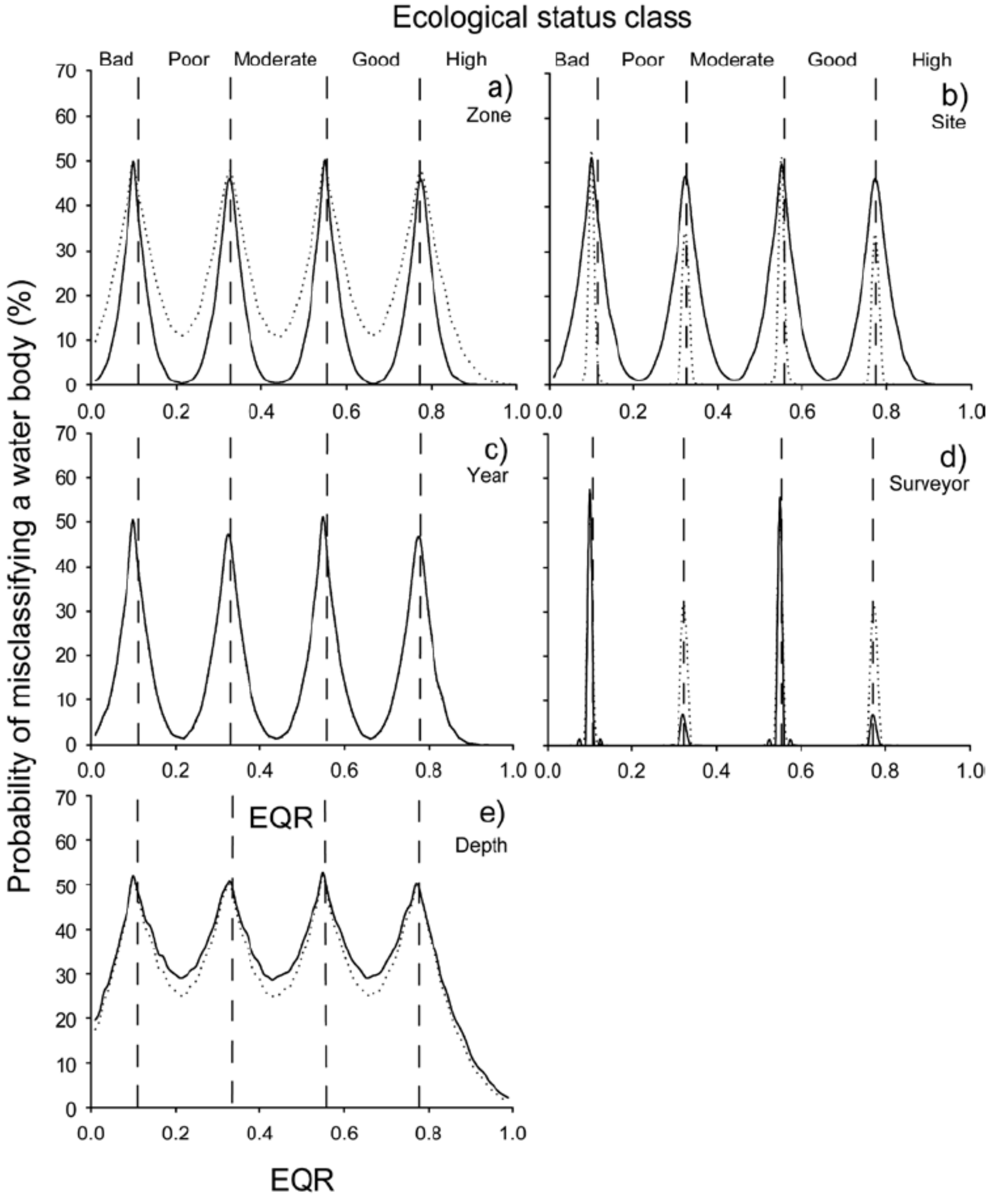
journal homepage: www.elsevier.com/locate/marpolbul

ELSEVIER

Ecological status of seagrass ecosystems: An uncertainty analysis of the meadow classification based on the *Posidonia oceanica* multivariate index (POMI)

Scott Bennett [a,*], Guillem Roca [a], Javier Romero [b], Teresa Alcoverro [a]

Ob4: Estimating uncertainty: seagrasses



Extracted from
Bennett et al., 2011

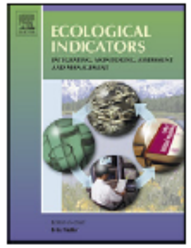
Ob4: Estimating uncertainty: fish

Probability distribution of Ecological Quality Status (EQS) in lagoons

H. Drouineau et al. / Ecological Indicators 13 (2012) 314–321

A Bayes... specific ...ing stressor

H. Drouin...
A. Courrat...



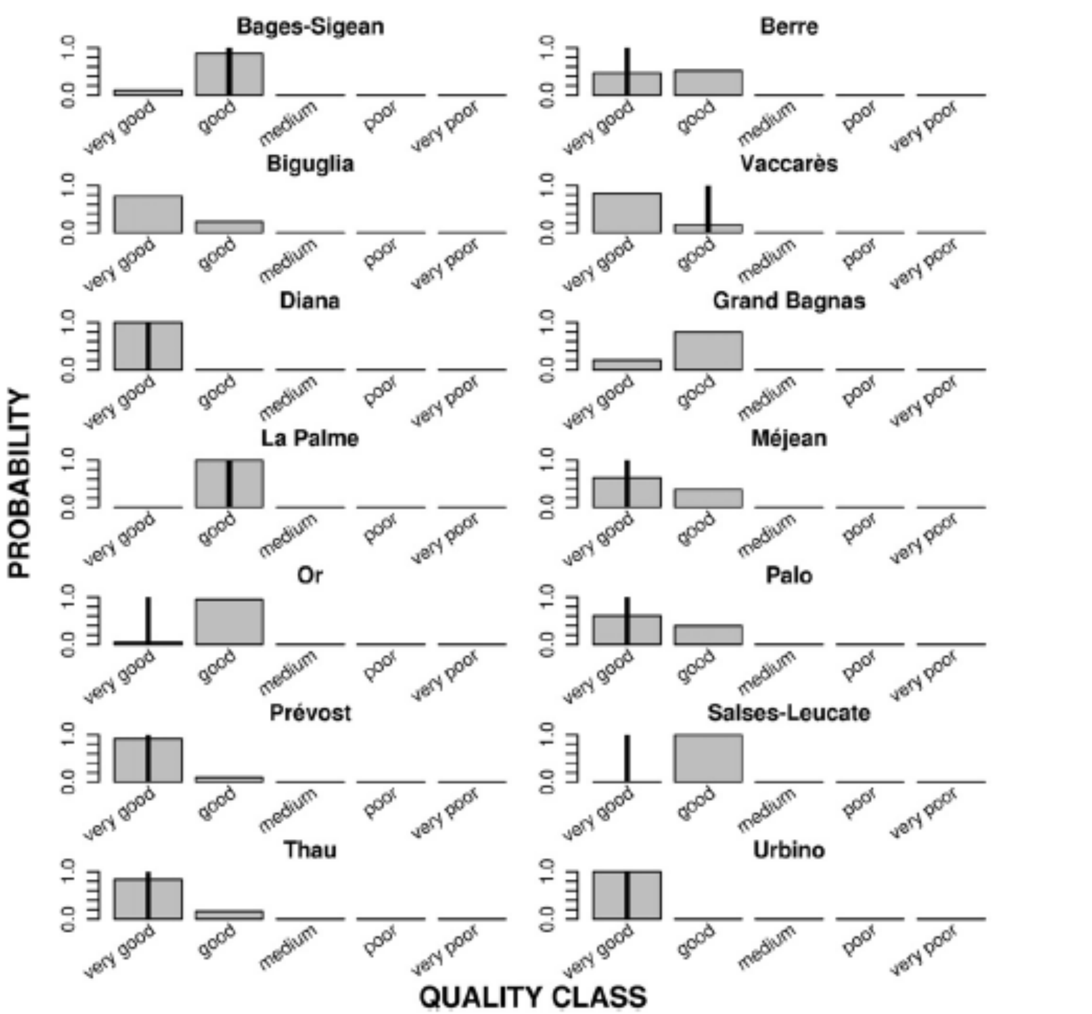


Fig. 3. Posterior probability to be in a quality class given the observations (barplot) and pressure index quality class (from RINBIO, vertical bold line).

Ob4: key messages from uncertainty

- Disentangling sources of variability (space, time, worker) is necessary
- Uncertainty should be also defined and tested across BQEs
- We have develop a method to derive confidence intervals in the assessment of fish, using a Bayesian approach
- Better information on habitat and physical characteristics will reduce uncertainty at the metric level leading to more robust assessments
- Uncertainty in the classification can be reduced by harmonizing (reducing?) methodologies across Europe

Conclusions

- Over 20 peer-review papers published (and many more coming!)
- Over 40 presentations in international conferences
- WISER has developed new methods, which have been intercalibrated within the GIGs (deep engagement of WISER in GIGs)
- Some of the methods here are being adopted (in discussion now) also in USA and China.
- These methods have been developed taking into account the definition of reference conditions, the pressure gradients and the validation with independent datasets
- Despite the variety in indices in EU, there is still common aspects. No magic bullet exists for phytoplankton
- WISER has demonstrated good pressure-indicator links for all BQEs
- WISER has highlighted the importance of good reference conditions for some indicators, BQEs and aquatic systems
- WISER has undertaken uncertainty analyses for the first time in TraC waters
- We think that some lessons learned in WISER are very important for the MSFD implementation

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Thanks to all partners!

WISER