“First training school for the promotion and application of EU Marine Environmental Policy Frameworks in non-EU Mediterranean and Black Sea countries”

SESSION 5: Theory and training on existing indicators- future development in the frame of MSFD

"The implementation of the Water Framework Directive in Eastern Mediterranean, state of the art on benthic indicators (Phytobenthos & benthic macroinvertebrates”

Nomiki Simboura

EU FP7 project PERSEUS and the Greek General Secretariat for Research and Technology.

Common Implementation Strategy for the Water Framework Directive (2000/60/EC)

Guidance document n.° 5

Transitional and Coastal Waters

Typology, Reference Conditions and Classification Systems

Common Implementation Strategy participation working groups participation (2000-2012)

1. **CIS Working Group 2.4. COAST: Coastal and Transitional expert network, Common Implementation Strategy of the Water Framework Directive, European Commisssion**
2. **CIS Working Group 2.A. on ecological status (ECOSTAT), Common Implementation Strategy of the Water Framework Directive, European Commisssion.**
3. **CIS Working Group 2.5. Intercalibration excersice (IC). Coastal and Transitional Intercalibration expert network-WFD-MED-GIG.**

The innovative character and significance of WFD

✓The WFD, or Water Framework Directive (EU Directive 2000/60/EC) is the actual legal framework for the EU's water policy.

✓Its overall objective is that all EU member states should achieve good ecological and chemical status for all water bodies by December 2015.

✓Sets standards,objectives and deadlines.

✓Ecological status/quality is to be evaluated in EU waters by using biological communities as Quality Elements.

✓Integrates all former Directives related to water.

Surface Water Categories

(coastal, transitional, inland)

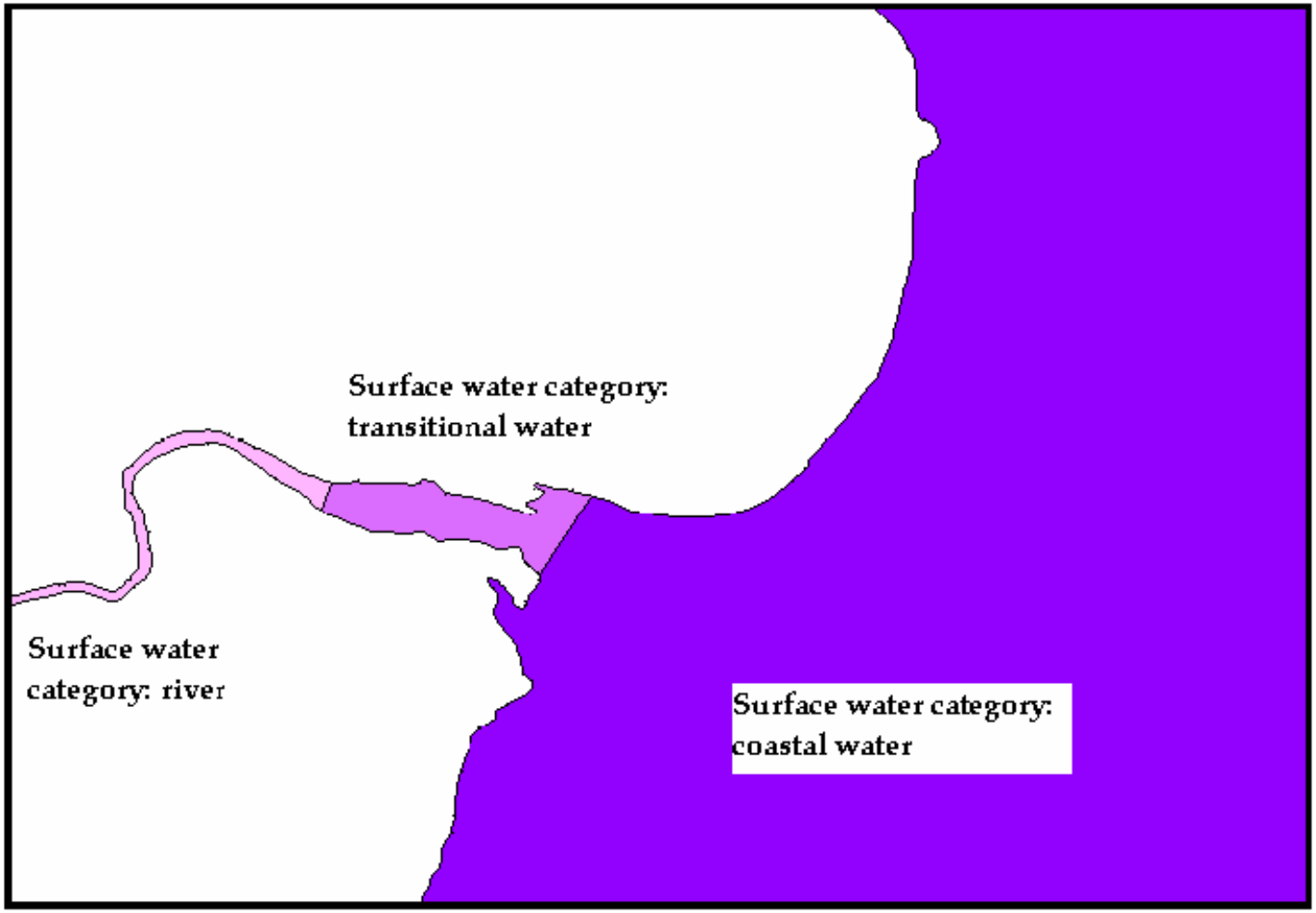


Figure 2.2. Surface Water Categories.

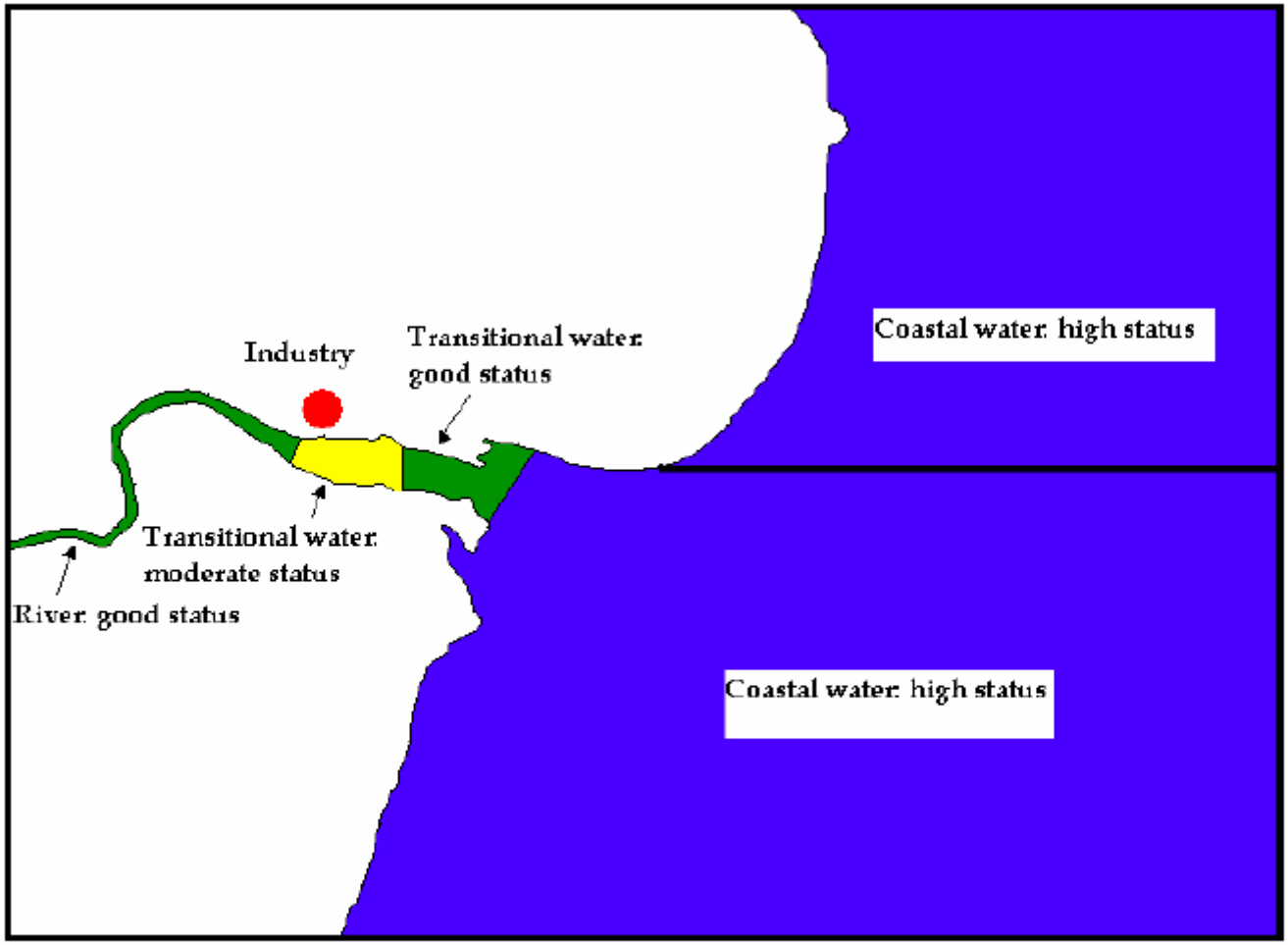


Figure 2.4. Surface water bodies. The colours used relate to those stated in Annex V 1.4.2 for reporting.

WATER FRAMEWORK DIRECTIVE

A. TYPOLOGY & REFERENCE CONDITIONS

B. CLASSIFICATION OF ECOLOGICAL QUALITY (DEVELOPMENT OF INDICES)

C. INTERCALIBRATION EXERCISE (finalised for coastal macroinvertebrates & macroalgae indices)

D. MONITORING NETWORK DESIGN

DEFINITIONS

WATER BODY: The basic management units for WFD.

ECOREGION: Large biogeographical European Units.

TYPOLOGY: Physicochemical and Hydromorphological factors that shape the biological elements.

CLASSIFICATION: Classification of ecological quality status using a five step scale

REFERENCE CONDITIONS: The Description of the condition of the biological elements under undisturbed conditions.

INTERCALIBRATION: Exercise in order to harmonise and check different metrics and classification methods in relation to critical boundaries

TYPING THE EUROPEAN SEAS

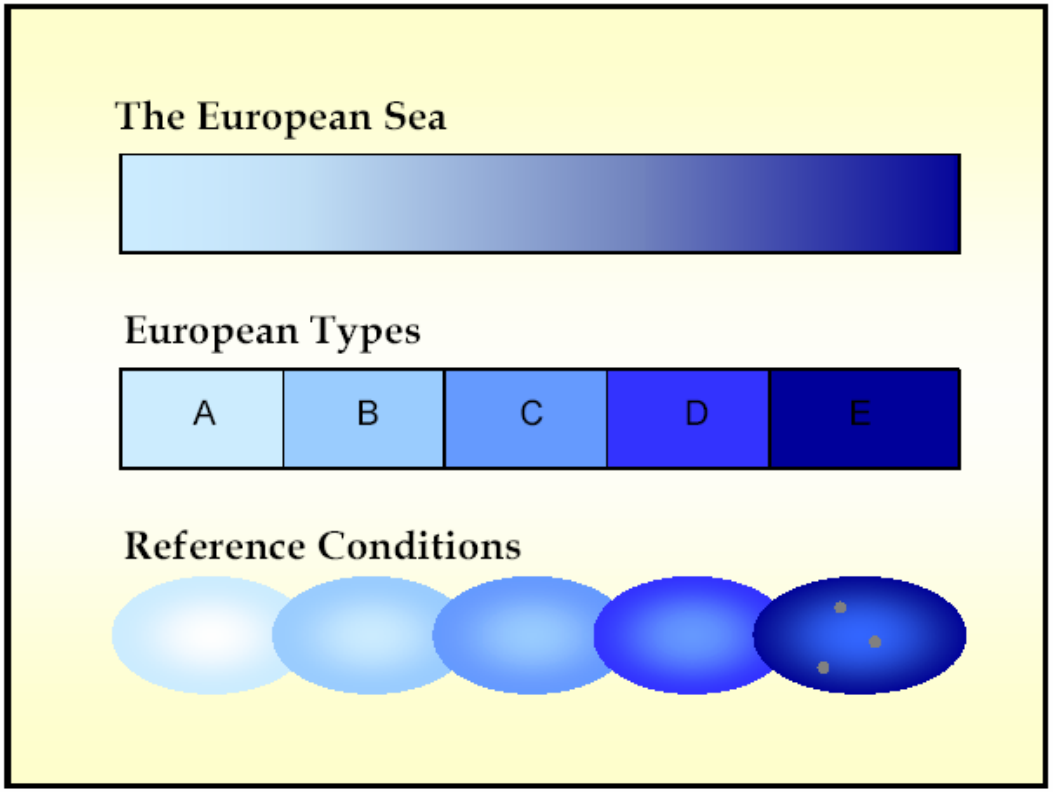


Figure 4.1. The relationship between all the seas in Europe (the European Sea), typology and type-specific reference conditions. The European sea is a continuum. Typology falsely compartmentalises this continuum into a number of physical types. The reference conditions for a specific water body type must then describe all possible natural variation within that type. In type E, sites are shown. This shows how sites within a type may be used to establish the natural variability within the type.

TYPOLOGY SYSTEM B COASTAL & TRANSITIONAL

Salinity	f.w. ≤ 0.5 0.5 ≤ 5-6 5-6 ≤ 18-20 18-20 ≤ 30 > 30 *
Tidal range (m)	< 1 * 1-5 >5
Wave exposure	Exposed Moderately exposed Sheltered
Mixing characteristics	Fully mixed Partially stratified Permanently stratified
Residence time	days weeks month-year
Mean substratum composition (percentages)	Hard (rock, boulders) sand/gravel silt mixed sediment
Depth	shallow< 30 m moderate depth 30 m to 50 (40) m *deep> 50 (40)m- depthn limit of Posidonia oceanica*
Current velocity (kn)	<1 * 1-3 >3

1. INITIAL TYPOLOGY FOR MEDITERRANEAN

Different RC for every type

COASTAL WATERS

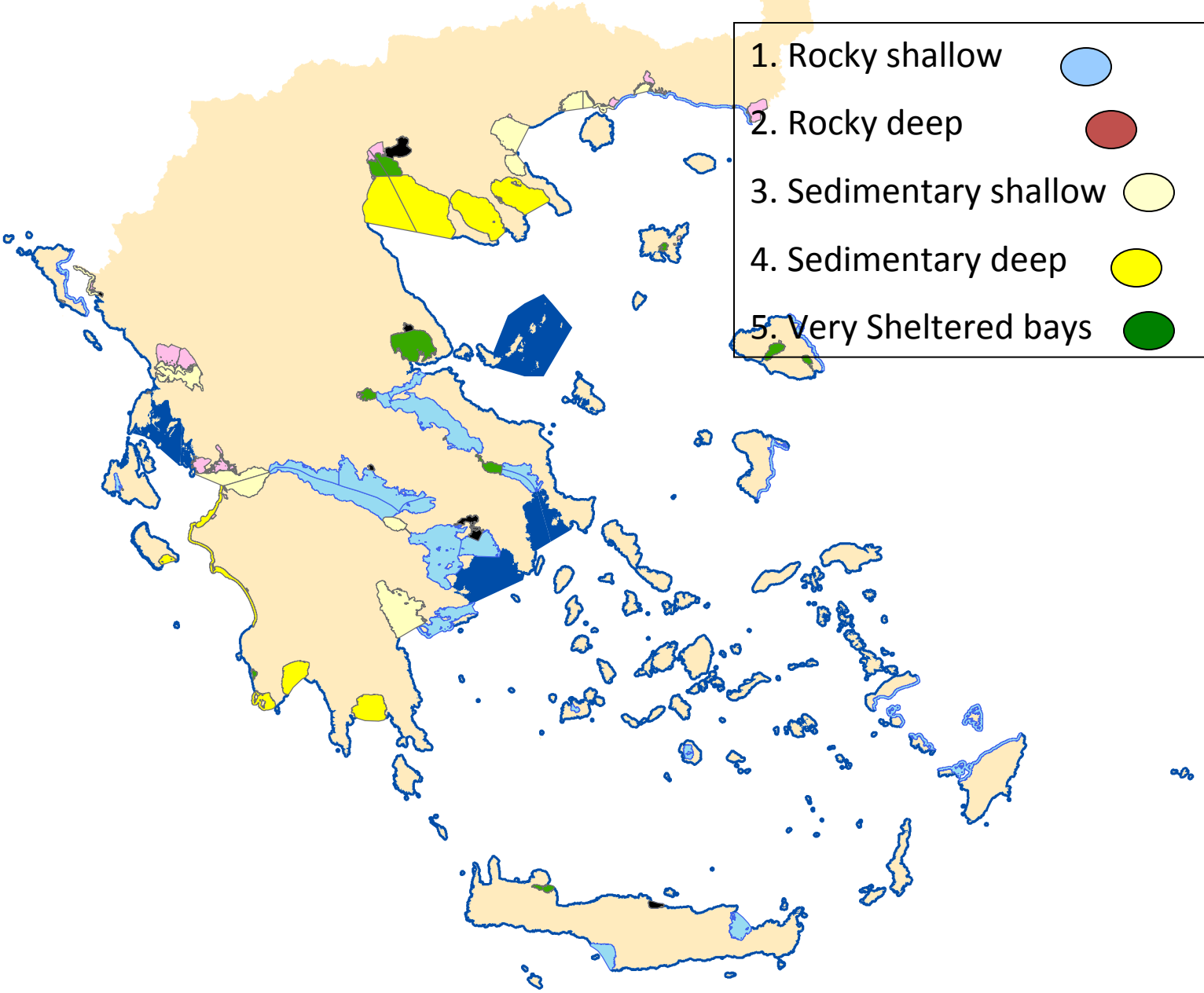
1. Rocky shallow
2. Rocky deep
3. Sedimentary shallow
4. Sedimentary deep
5. very sheltered bays

** This typology for CW was abandoned during Phase II of IC*

TRANSITIONAL WATERS

1. coastal lagoons
2. estuaries, deltas

TYPOLOGY-COASTAL WATERS (Αρθρο ΟΠΥ 5).



TYPES ONLY FOR PHYTOPLANKTON

Biological Quality Element	Phytoplankton

Description of types for coastal waters that have been intercalibrated (applicable for phytoplankton only)

Type	Description	Density (kg/m³)	Annual mean Salinity (psu)
Type I	Highly influenced by freshwater input	<25	<34.5
Type IIA	Moderately influenced by freshwater input (continent influence)	25-27	34.5-37.5
Type IIAdriatic			
Type IIIW	Continental coast, not influenced by freshwater input (Western Basin).	>27	>37.5
Type IIIE	Not influenced by freshwater input (Eastern Basin)	>27	>37.5
Type Island-W			

Countries sharing the types that have been intercalibrated

Type I: France, Italy
Type IIA: France, Spain, Italy
Type IIAdriatic: Italy, Slovenia
Type Island-W: France, Spain, Italy
Type IIIW: France, Spain, Italy
Type IIIE: Greece, Cyprus

THE ECOLOGICAL QUALITY ELEMENTS & INDICATOR PARAMETERS-COASTAL

Biological Quality Elements	**Indicator parameters**
Phytoplankton	Composition and abundance of phytoplanktonic taxa, phtyplankton biomass, planktonic blooms
Macroalgae and Angiosperms	disturbance-sensitive macroalgal and angiosperm taxa,the levels of macroalgal cover and angiosperm abundance
Benthic Invertebrate fauna	diversity and abundance of invertebrate taxa, disturbance-sensitive taxa
Fishfauna (only for transitional waters)	Species composition and abundance
Hydromorphological Quality Elements supporting the biological quality elements	Tidal regime (dominant currents, wave exposure and freshwater flow for TW). Depth variation, substrate conditions and both the structure and condition of the intertidal zones
Chemical & Physicochemical elements supporting the biological quality elements	General physicochemical characteristics (physicochemical parameters and nutrient status) and specific pollutants (priority substances and other pollutants)

THE REFERENCE CONDITIONS

Element	High Status
Biological Quality Elements	
Phytoplankton	*The composition and abundance of the phytoplanktonic taxa are consistent with undisturbed conditions.* *The average phytoplankton biomass is consistent with the type-specific physico-chemical conditions and is not such as to significantly alter the type-specific transparency conditions.* *Planktonic blooms occur at a frequency and intensity which is consistent with the type specific physico-chemical conditions.*
Macroalgae and Angiosperms	*All disturbance-sensitive macroalgal and angiosperm taxa associated with undisturbed conditions are present.* *The levels of macroalgal cover and angiosperm abundance are consistent with undisturbed conditions.*
Benthic Invertebrate Fauna	*The level of diversity and abundance of invertebrate taxa is within the range normally associated with undisturbed conditions.* *All the disturbance-sensitive taxa associated with undisturbed conditions are present.*

4.4. BIOLOGICAL QUALITY ELEMENTS REQUIRING REFERENCE CONDITIONS

4.4.1. Reference conditions should be described according to the definitions of the biological quality elements at high status in Annex V Table 1.2.3 and Table 1.2.4.

Annex V Table 1.2. General definition for rivers, lakes, transitional waters and coastal waters

High status

"There are no, or only very minor, anthropogenic alterations to the values of the physicochemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions.

The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion.

These are the type specific conditions and communities."

Benthic Invertebrate Fauna	*The level of diversity and abundance of invertebrate taxa is within the range normally associated with undisturbed conditions.* *All the disturbance-sensitive taxa associated with undisturbed conditions are present.*

- *Composition and abundance of benthic invertebrate fauna*

From CIS 2.4 Guidance documents (EC, 2003)

➢Type specific conditions and communities

•Diversity

•Abundance

•Presence of Sensitive taxa

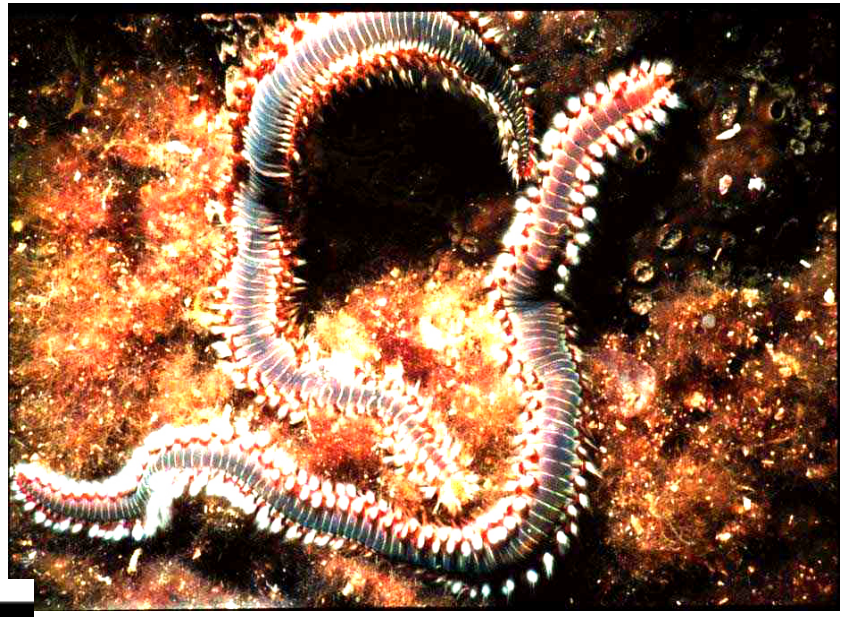
•Composition

Methods for Reference Conditions Setting

- ✓Historic data
- ✓Expert judgement
- ✓reference areas
- ✓modelling

MACRO-INVERTEBRATES QUALITY ELEMENT

BENTHIC MACROINVERTEBRATES-POLYCHAETES



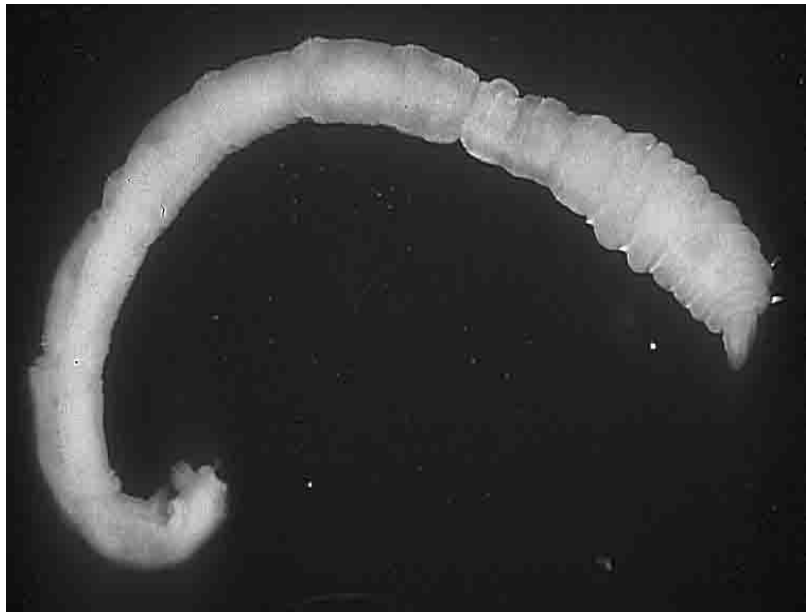


Photo 5.3: *Marsupenaeus japonicus*
Commercially important for fisheries in the Levant where it invaded via the Suez Canal (Balss, 1927). Cultured and wild population from aquaculture in the Aegean Sea, central and western Mediterranean (Galil *et al.*, 2002).

Source: Kosmas Kevrekides.

CRUSTACEA

ECHINODERMS

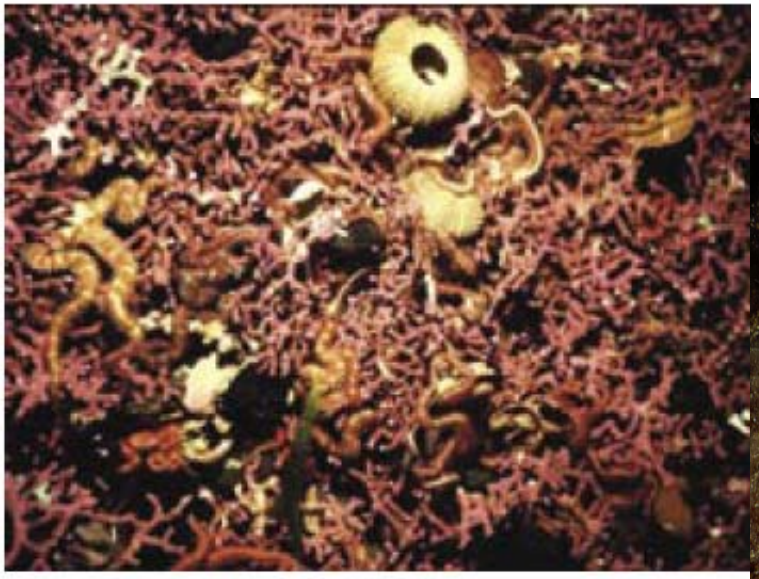
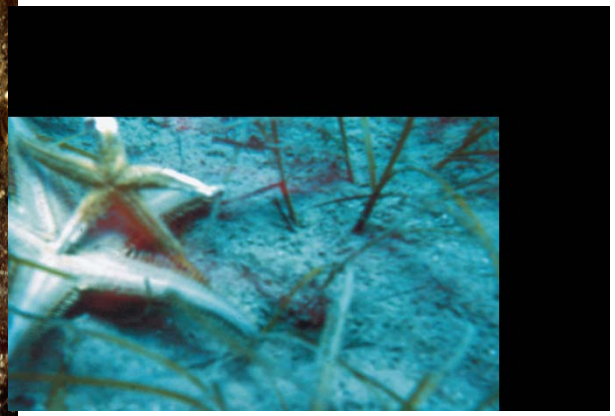
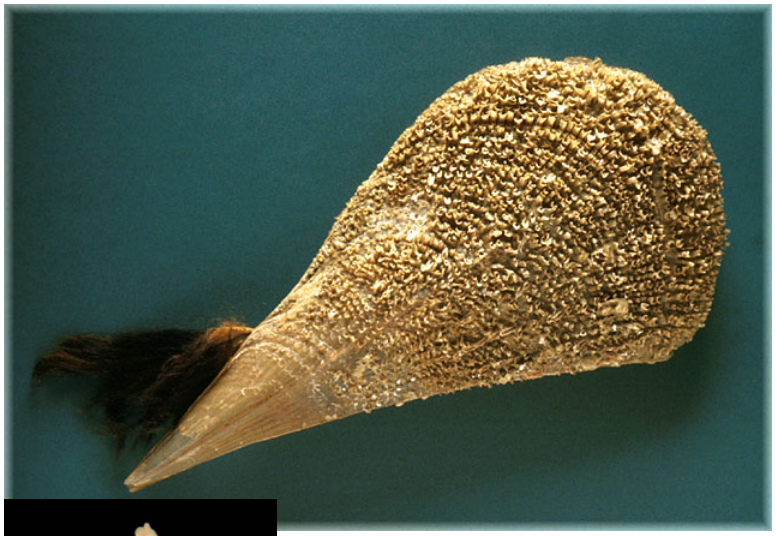


Photo 7.1: Maerl beds.

Source: http://www.marlin.ac.uk/baski/image_viewer asp?images=phycal&topic=Species.



- MOLLUSCS



Acanthocardia sp.

Loripes lacteus

Spisula subtruncata

Tellina fabula

Lucinella divaricata

GOVERN DE LES ILLES BALEARS
Conselleria de Medi Ambient

IMPLEMENTACIÓ DE LA DIRECTIVA MARC DE L'AIGUA A LES ILLES BALEARS: AVALUACIÓ DE LA QUALITAT AMBIENTAL DE LES MASSES D'AIGUA COSTANERES UTILITZANT LES MACROALGUES I ELS INVERTEBRATS BENTÒNICS COM A BIOINDICADORS (Maig 2005 - Març 2007)

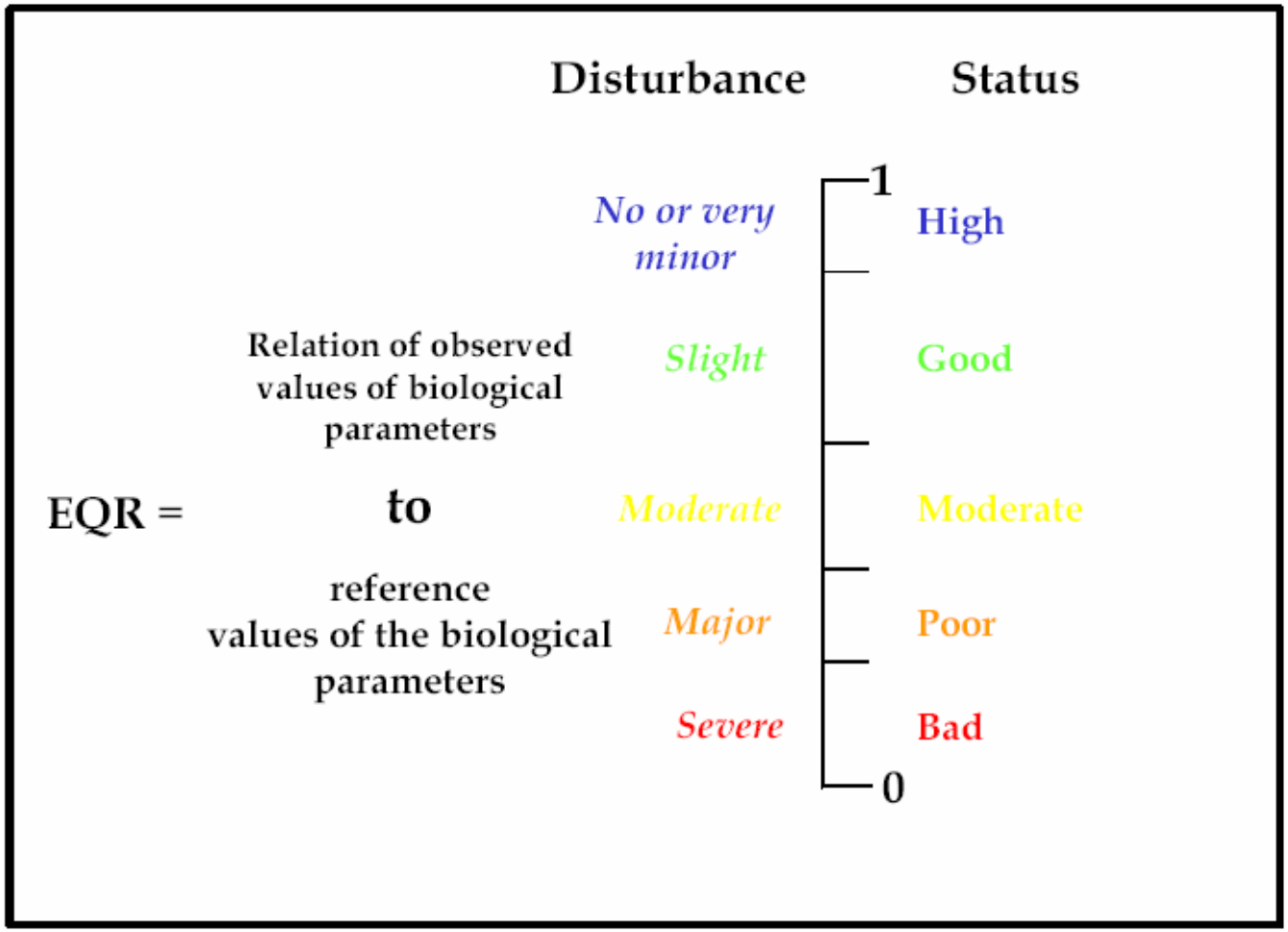
MACROINVERTEBRATES-CLASSIFICATION METHODS

- BIOTIC INDICES
- DIVERSITY MEASURES
- MULTIVARIATE OR MULTIMETRIC METHODS

CLASSIFICATION OF ECOLOGICAL STATUS

Ecological Status according to Deviation from RC

BIOLOGICAL ELEMENTS	HIGH	GOOD	MODERATE
Phytoplankton Macroalgae Angiosperms Benthic invertebrate fauna	All parameters are consistent with undisturbed conditions and show no, or only very minor, evidence of distortion.	Slight deviation from those normally associated with undisturbed conditions. low levels of distortion resulting from human activity	Moderate deviations from those normally associated with undisturbed conditions. In case of phytoplankton and macroalgae these may be such as to result in an undesirable disturbance to the balance of organisms present in the water body.


Disturbance
Status
EQR =
Relation of observed values of biological parameters
to
reference values of the biological parameters
No or very minor
Slight
Moderate
Major
Severe
1
0
High
Good
Moderate
Poor
Bad

DEVELOPMENT OF CLASSIFICATION METRICS

a)Use of paired metrics-discontinuities for boundary setting

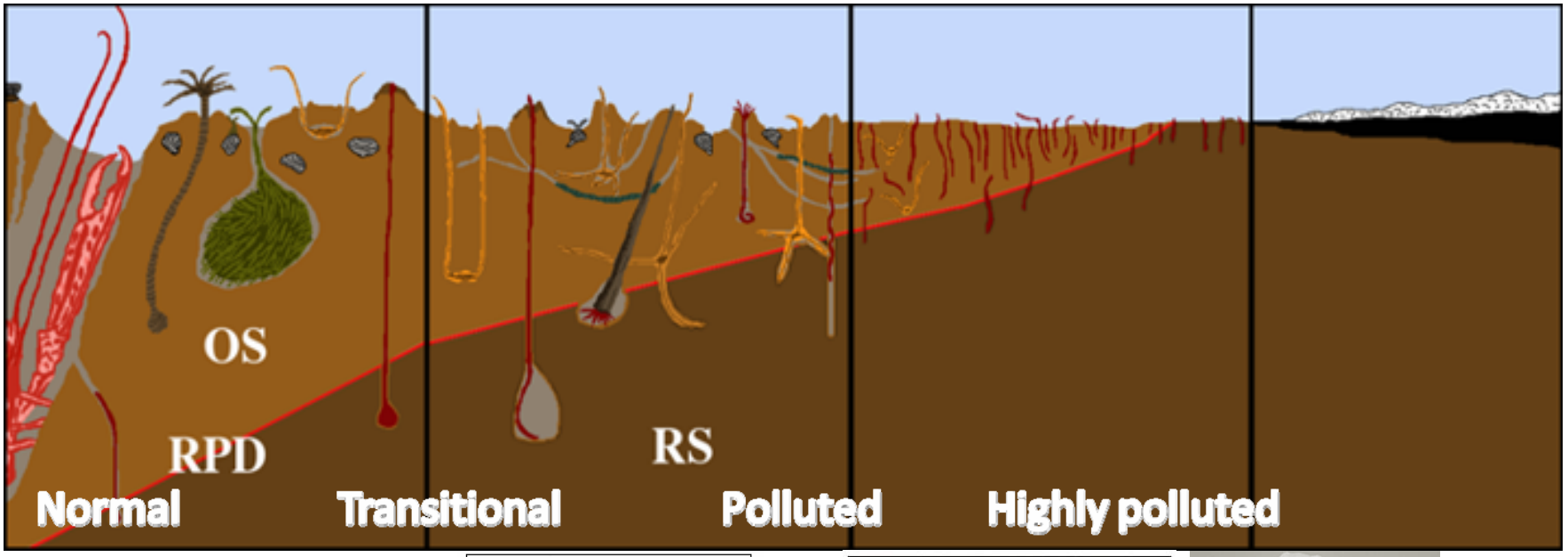
b)Following boundary setting protocol

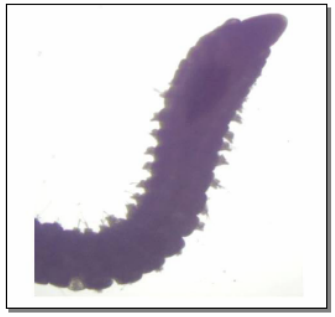
c)Boundaries according to normative definitions for Quality elements

d)Validation/demonstration of a pressure gradient

e)Significant correlation with pressure indicators

Pearson & Rosenberg, 1978 model





Ecological groupsHily, 1984; Grall & Glémarec 1986

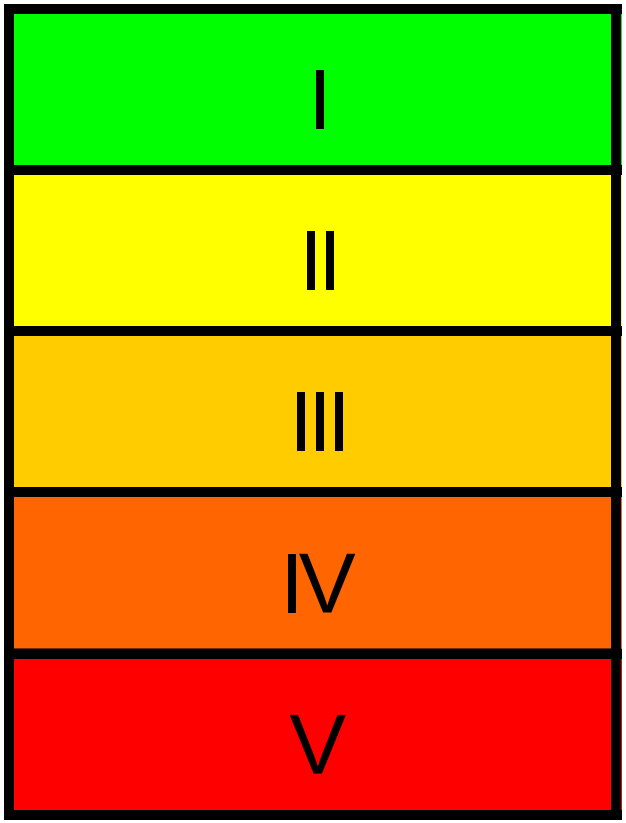
GI: *sensitive-*

GII: *indifferent-*

GIII*: tolerant-*

GIV: *second order opportunistic-*

GV: *first order opportunistic-*



INDICES ADOPTED & INTERCALIBRATED BY MEDITERRANEAN MS THROUGH IC EXERCISE

Country	National classification systems intercalibrated	Ecological Quality Ratios	
		High-Good boundary	*Good-Moderate boundary*
Methods including diversity parameter			
Italy	M-AMBI -	0.81	0.61
Slovenia	M-AMBI -	0.83	0.62
Methods not including diversity parameter			
France	AMBI -	0.83	0.58
Cyprus	Bentix -	0.75	0.58
Greece	Bentix -	0.75	0.58
Spain	BOPA -	0.95	0.54
Spain	MEDOCC index -	0.73	0.47

THE EXAMPLE OF THE BENTIX INDEX DEVELOPMENT

Recombination of Ecological groups and weight coefficients

GS } GI sensitive + GII indifferent

GIII tolerant

GT } GIV second order opportunists

GV first order opportunists

1 (sensitive=GS) : 3 (tolerant=GT)

6 : 2

BENTIX = [(6 x % GS + 2 x % GT)] / 100

where GS=GI+GII

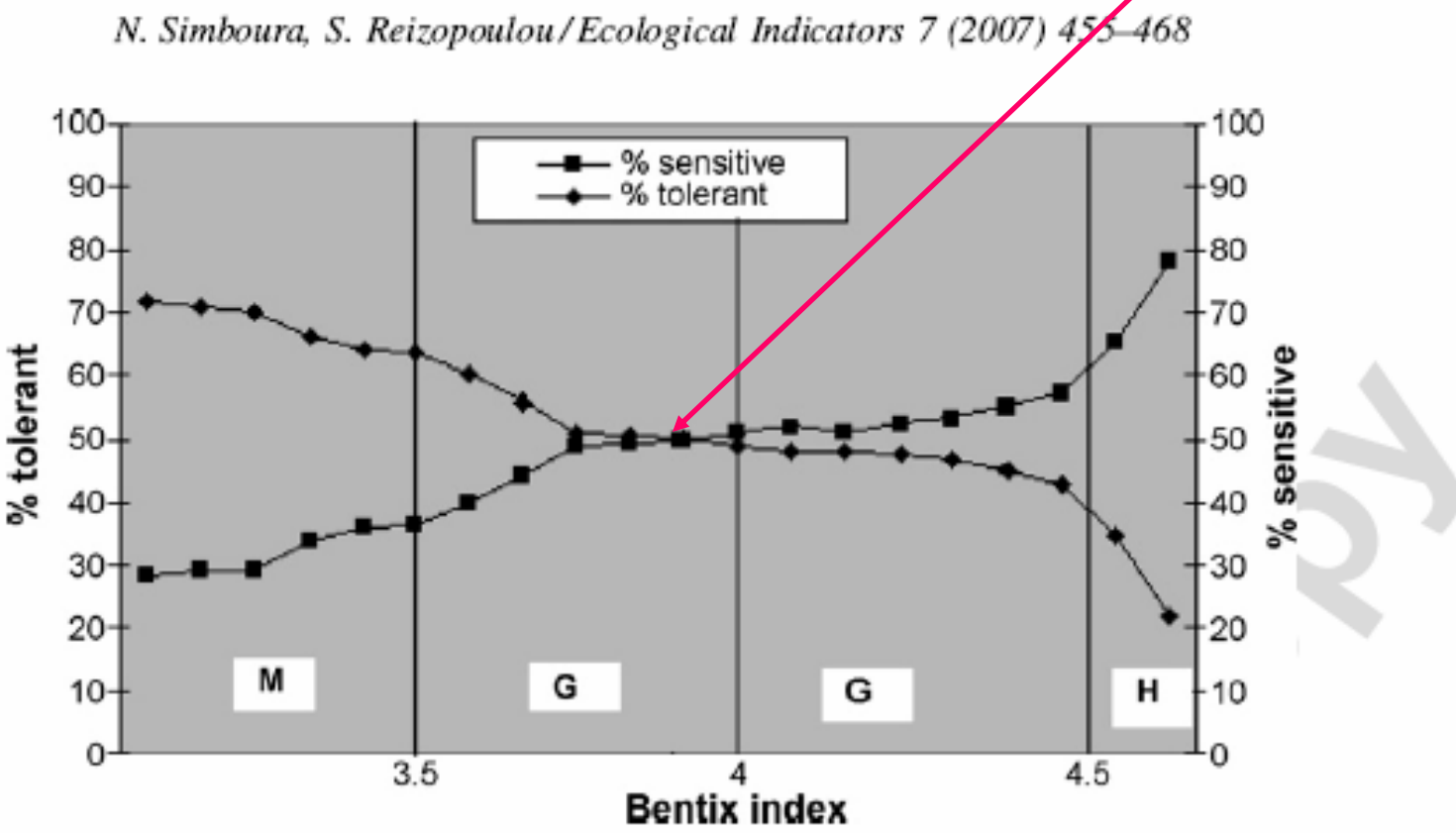
GT=GIII+GIV+GV

BOUNDARIES SETTING (paired metrics)

UNDER HIGH EQS

- SENSITIVE> 60%
- TOLERANT < 40 %

Ecotone point



Pressure gradient

BENTIX INDEX (Simboura & Zenetos, 2002)

Freeware calculation software available in http://bentix.ath.hcmr.gr

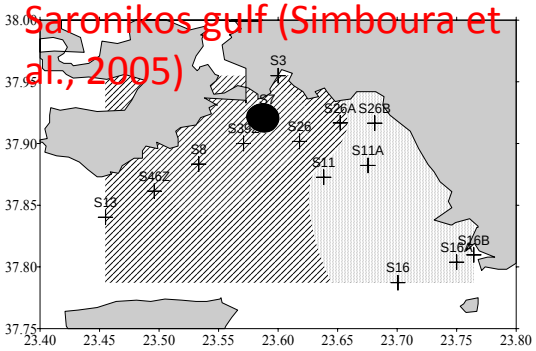
Bentix= { 6 X (% GS) + 2 X (% GT)}/100
GS=sensitive species GT=tolerant species

Ecological Status class	range of Bentix	Boundary limits	EQR	
High	4,5 ≤ Bentix < 6	6	1	>60% GS <40% GT
Good	3,5 ≤ Bentix < 4,5	4,5	0,75	
Moderate	2,5 ≤ Bentix < 3,5	3,5	0,58	>60% GT <40% GS
Poor	2,0 ≤ Bentix <2,5	2,5	0,42	
Bad	0	0	0	

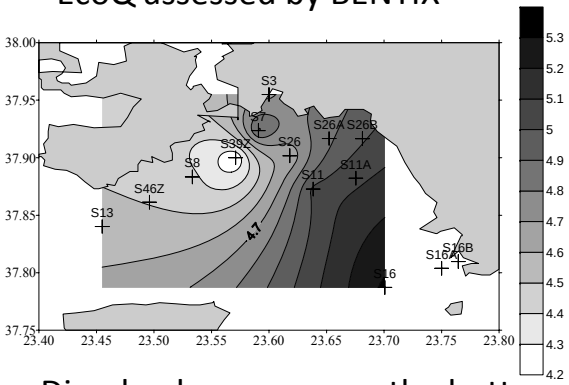
Boundaries and EQR valid for all former typologies, only specific habitat modification for muds (over 90%), 3,5=3, 4,5=4

Metric demonstrating pressure gradient

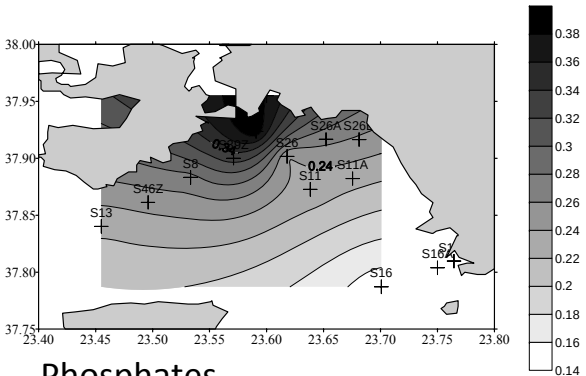
organic pollution Saronikos gulf (Simboura et al., 2005)



EcoQ assessed by BENTIX

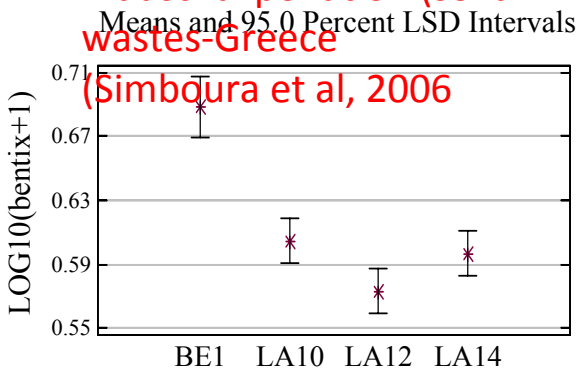


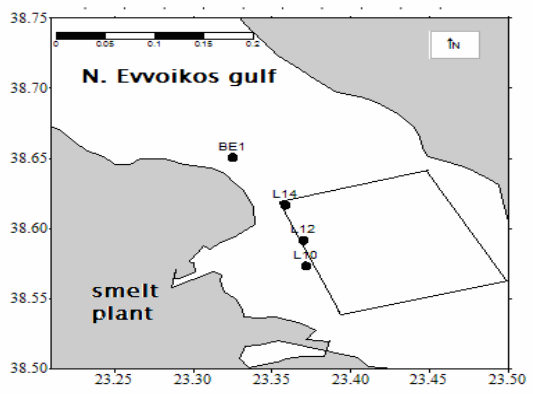
Dissolved oxygen near the bottom

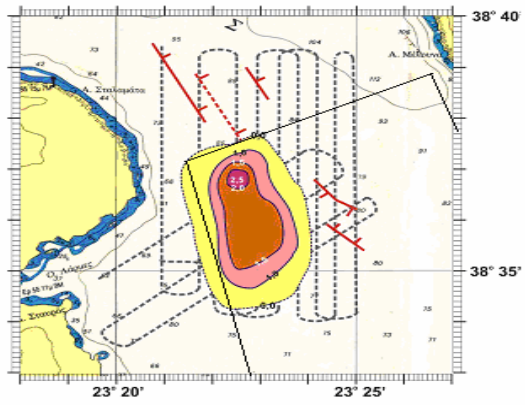


Phosphates

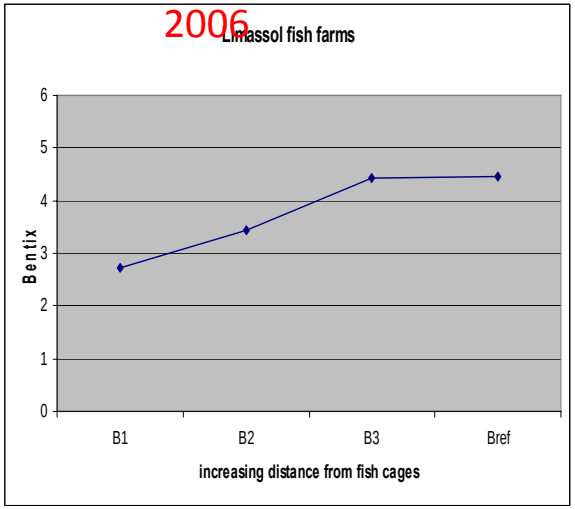
Industrial pollution (solid wastes-Greece (Simboura et al, 2006



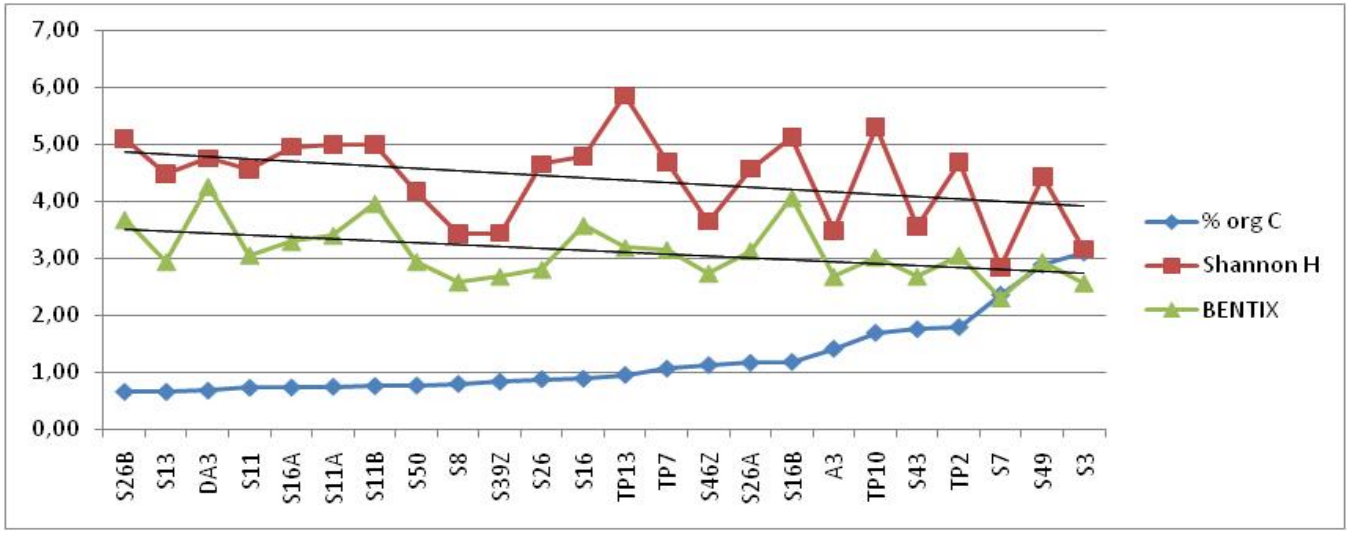


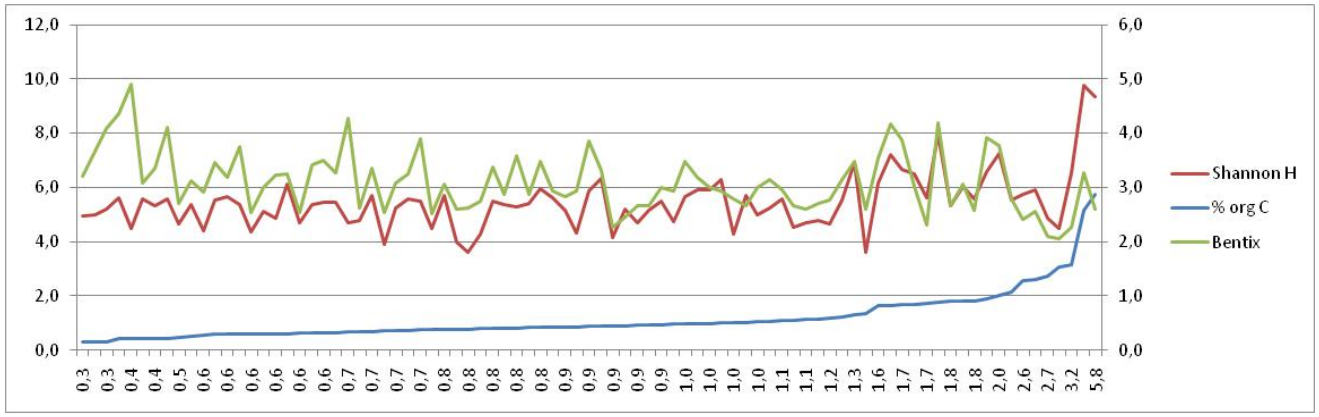


Fish farms, Cyprus Simboura & Argyrou, 2006

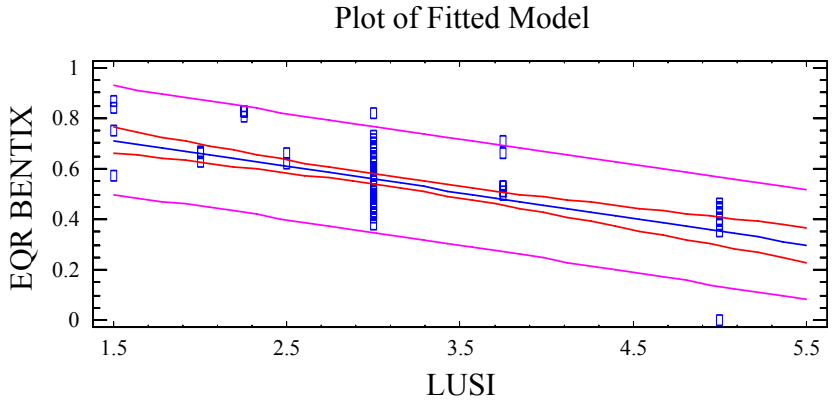


Correlation with OC% pressure gradient





Correlation with Land Use Pressure indices ex. LUSI index (Flo et al., 2008)



Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	0.610331	1	0.610331	55.14	0.0000
Residual	1.17324	106	0.0110683		
Total (Corr.)	1.78357	107			

Correlation Coefficient = -0.584976
R-squared = 34.2197 percent
Standard Error of Est. = 0.105206

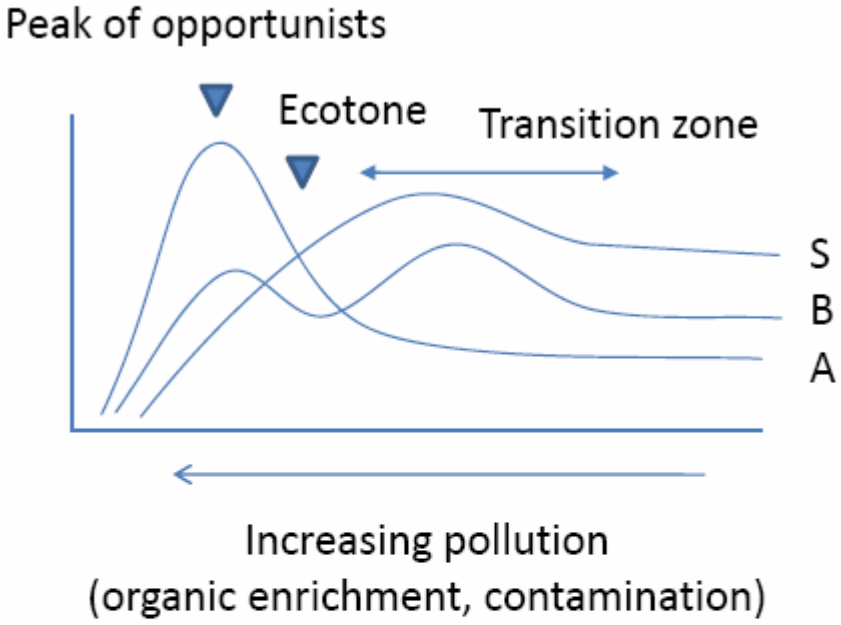
Classification of Pressures according to LUSI index

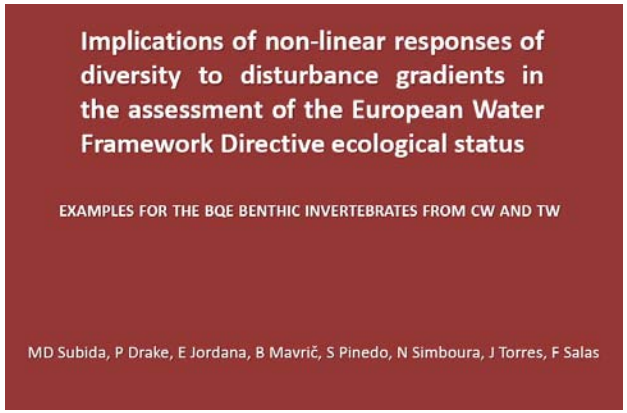
Urban	Agricultural	Industrial	Score
	<10%	<10%	0
<33%	10-40%	>10%	1
33-66%	>40%		2
>66%			3

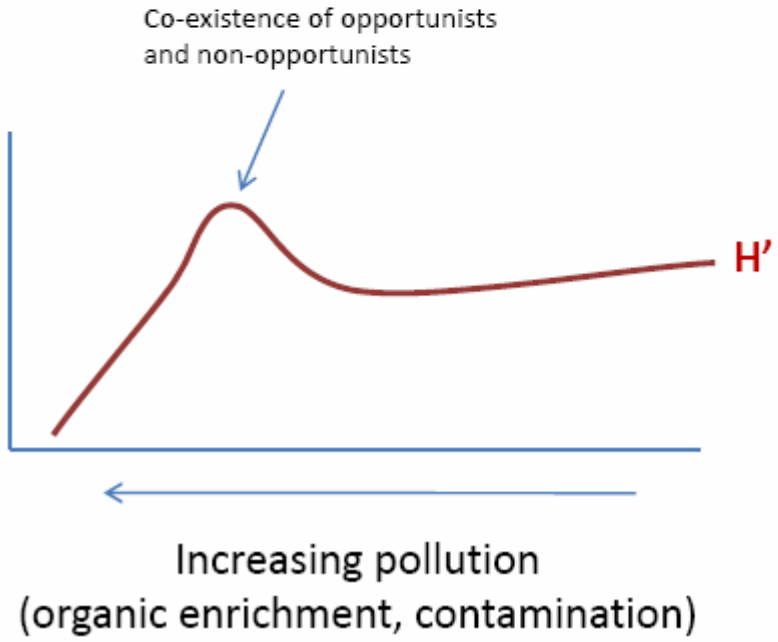
Confinement	Correction number
Concave	1.25
Convex	0.75
Straight	1.00

DIVERSITY MEASURES AND RELATION WITH PRESSURE

Most biotic indices are based on the model of Pearson and Rosenberg



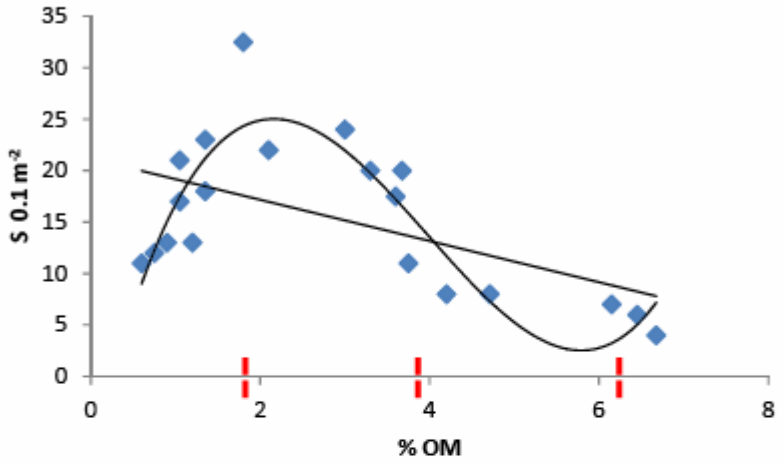




Source: Subida et al., 2010 ECSA

DIVERSITY RESPONDS NON-LINEARLY ALONG PRESSURE GRADIENTS

EXAMPLES FROM THE LITERATURE



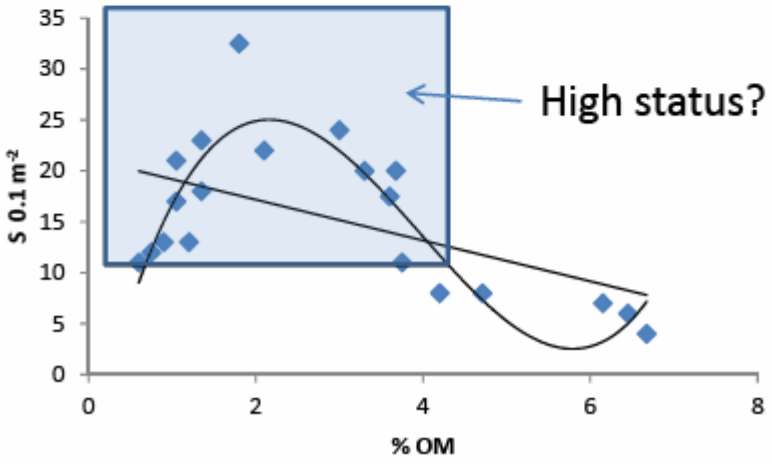
Adapted from Albayrak et al (2006)

S shows shifts at 3 OM critical points.
H' showed similar thresholds.
Depending on the criteria used to define class boundaries, and supposing that the full OM gradient is covered for the studied site, S in reference conditions could be 11, a 34% less than the maximum number of species attainable in the whole dataset.

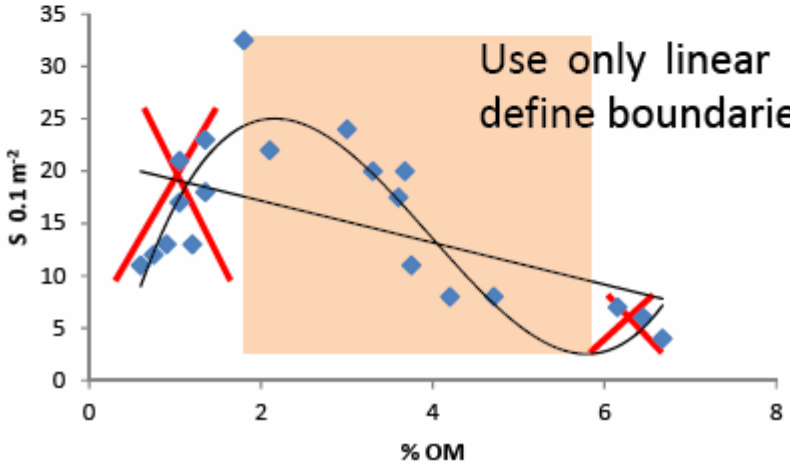
+

S =11 could also be found at OM ~ 4 %

?



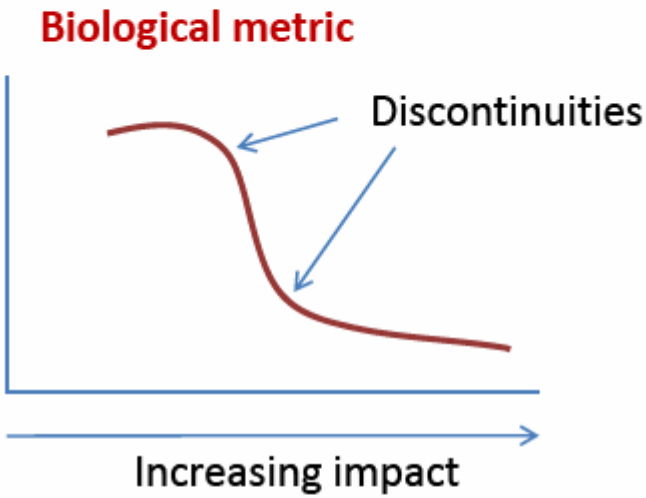
Or



DIVERSITY RESPONDS NON-LINEARLY ALONG PRESSURE GRADIENTS

IMPLICATIONS TO THE WFD

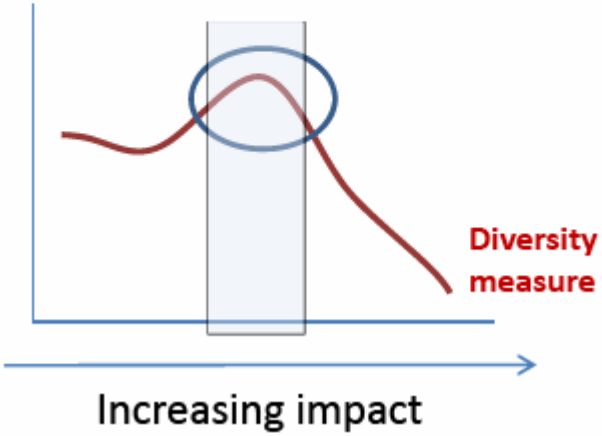
What does this mean in the context of the WFD?



Discontinuities in biological metrics are contemplated by CIS-Intercalibration guidances

Determine if the discontinuity relates to a class boundary or a class centre

What about polynomial responses? (recall the Pearson-Rosenberg model for diversity)



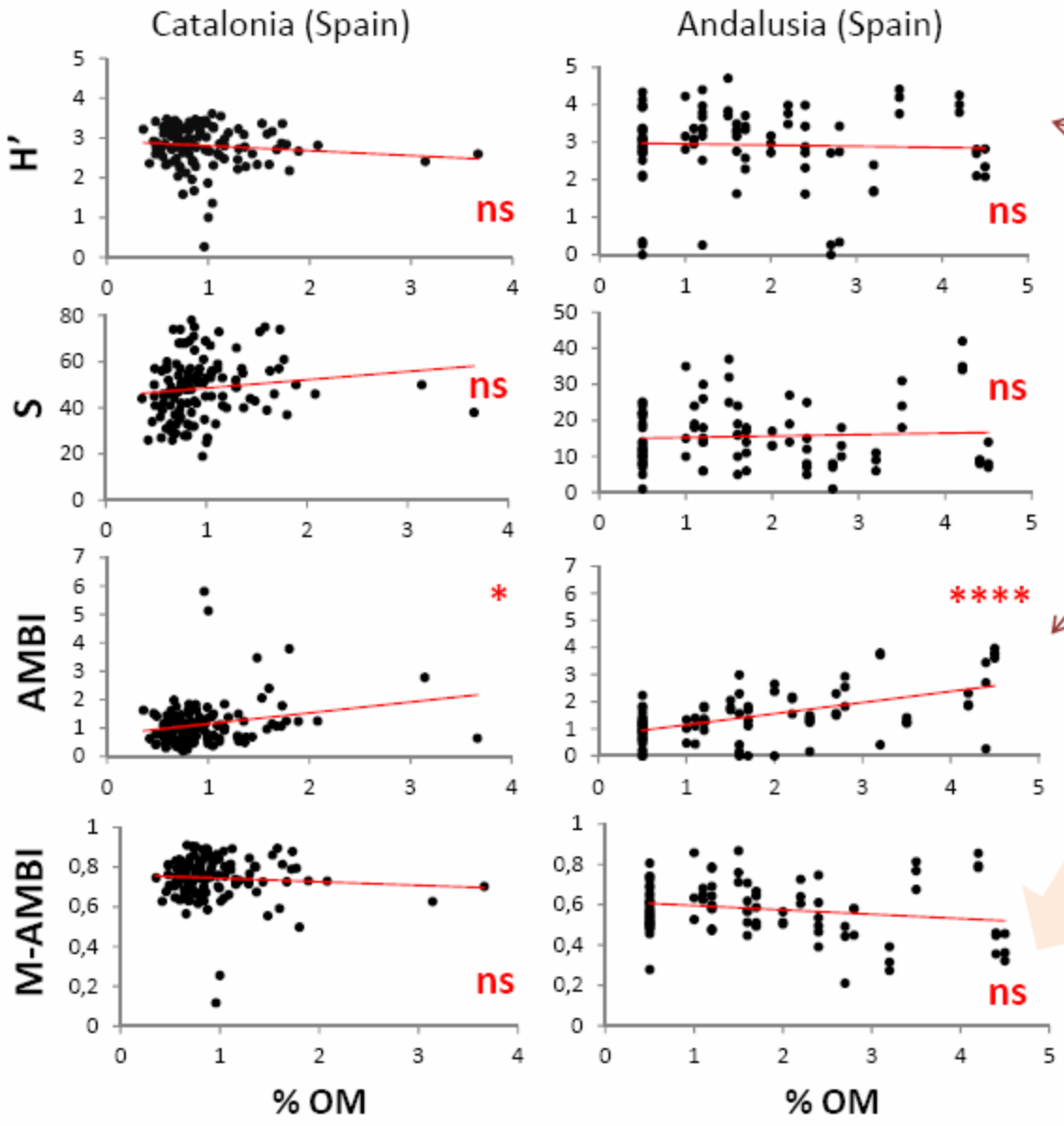
2 problems:

- Highest values of the biotic metric are not associated with the lowest impact situation

- The same value of the biotic metric may me measured in different degrees of impact

THE WEIGHT OF DIVERSITY'S NON LINEARITY ON MULTIMETRICS

EXAMPLES FROM THE MEDITERRANEAN CW INTERCALIBRATION EXERCISE



Diversity measures not correlated with % OM content

Metrics based on indicator species correlated with % OM content

	Catalonia	Andalusia
MEDOCC	*	****
BENTIX	*	****
BOPA	***	****

No correlation of M-AMBI with the pressure gradient

•CLASSIFICATION METRICS DEVELOPED NON TYPE DEPENDENT ONLY HABITAT TYPE DEPENDENT IN CASES.

•REFERENCE CONDITIONS FOR INDICES DEFINED BY EACH INDEX METHODOLOGY

•Typology for the Mediterranean only relevant for Phytoplankton QE

• Eastern Mediterranean belong to a single type not influenced by freshwater inputs

Description of Reference Conditions of benthic communities using an ecosystem based approach and based on the autoecology of species

Tool: EUNIS system

Linking of communities < habitats < water bodies

List of type specific species

Biological Quality Element	Phytoplankton

Description of types that have been intercalibrated (applicable for phytoplankton only)

Type	Description	Density (kg/m^3)	Annual mean Salinity (psu)
Type I	Highly influenced by freshwater input	<25	<34.5
Type IIA	Moderately influenced by freshwater input (continent influence)	25-27	34.5-37.5
Type IIIW	Continental coast, not influenced by freshwater input (Western Basin).	>27	>37.5
Type IIIE	Not influenced by freshwater input (Eastern Basin)	>27	>37.5

Countries sharing the types that have been intercalibrated

Type I: France, Italy

Type IIA: France, Spain, Italy, Slovenia

Type IIIW: France, Spain, Italy

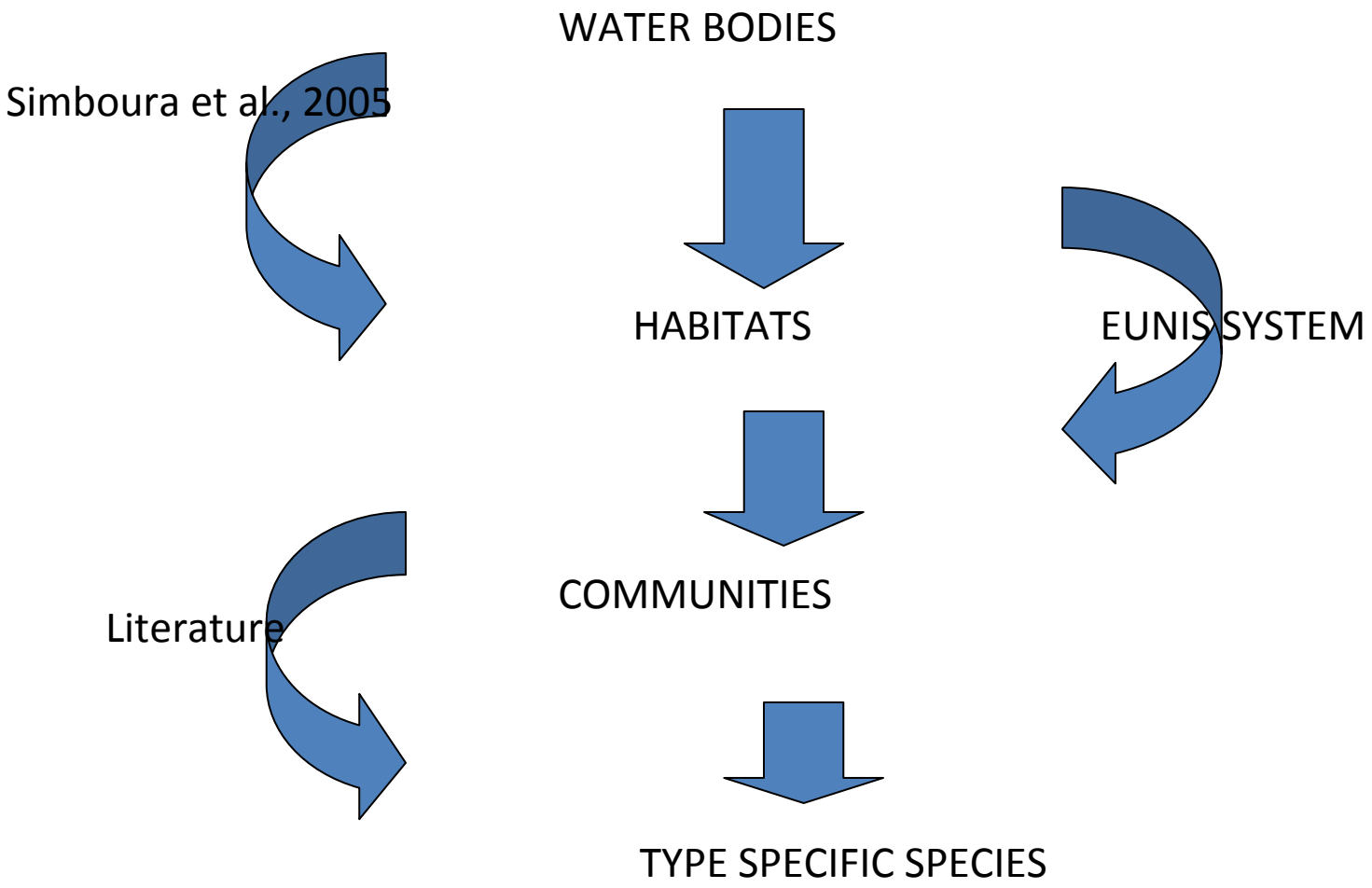
Type IIIE: Greece, Cyprus

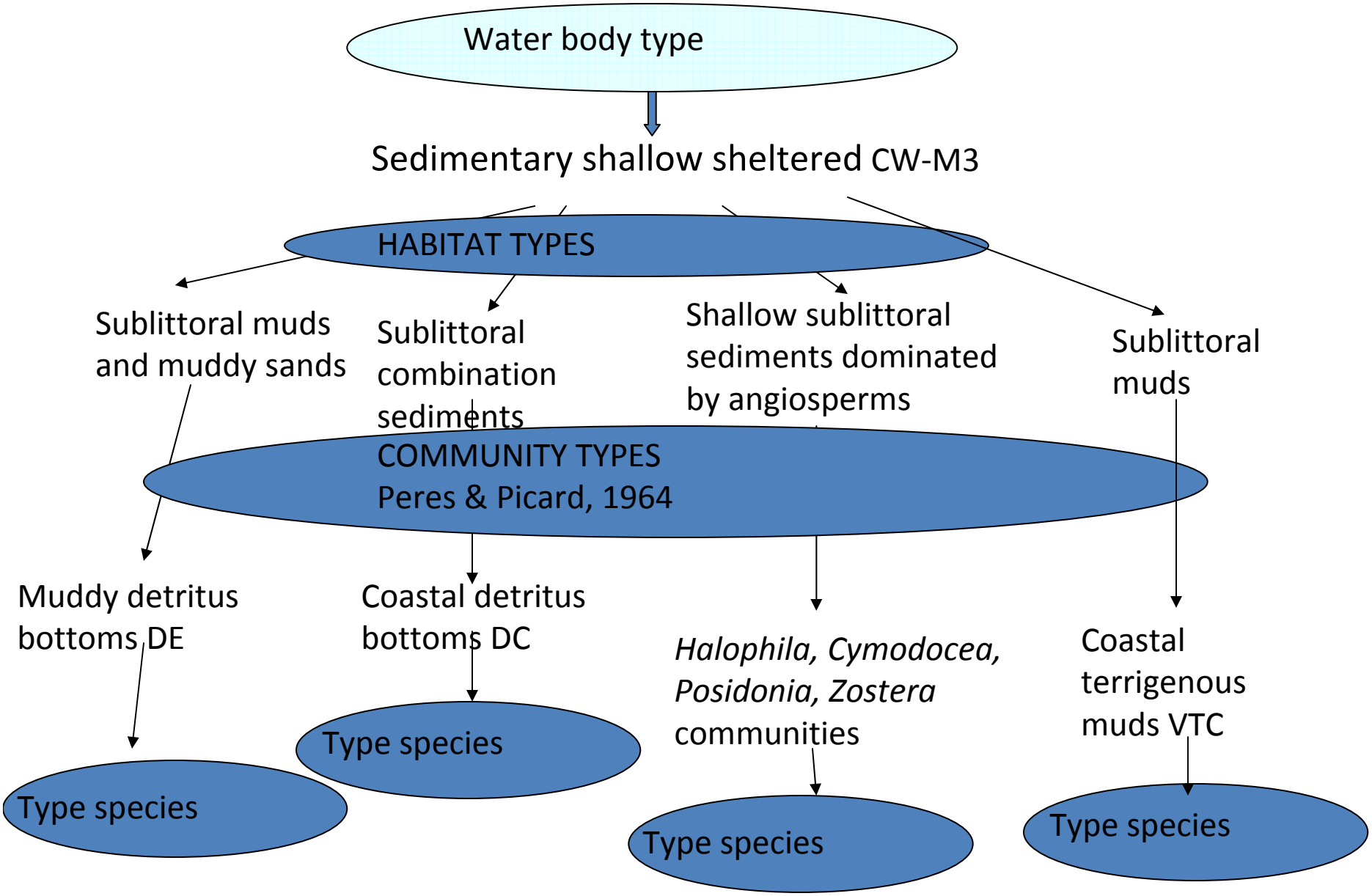
Phytoplankton: parameter indicative of biomass (Chlorophyll a)

STEP 1

Describing type specific communities-Ecosystem Based Approach

Classification scheme linking communities < habitats < water bodies

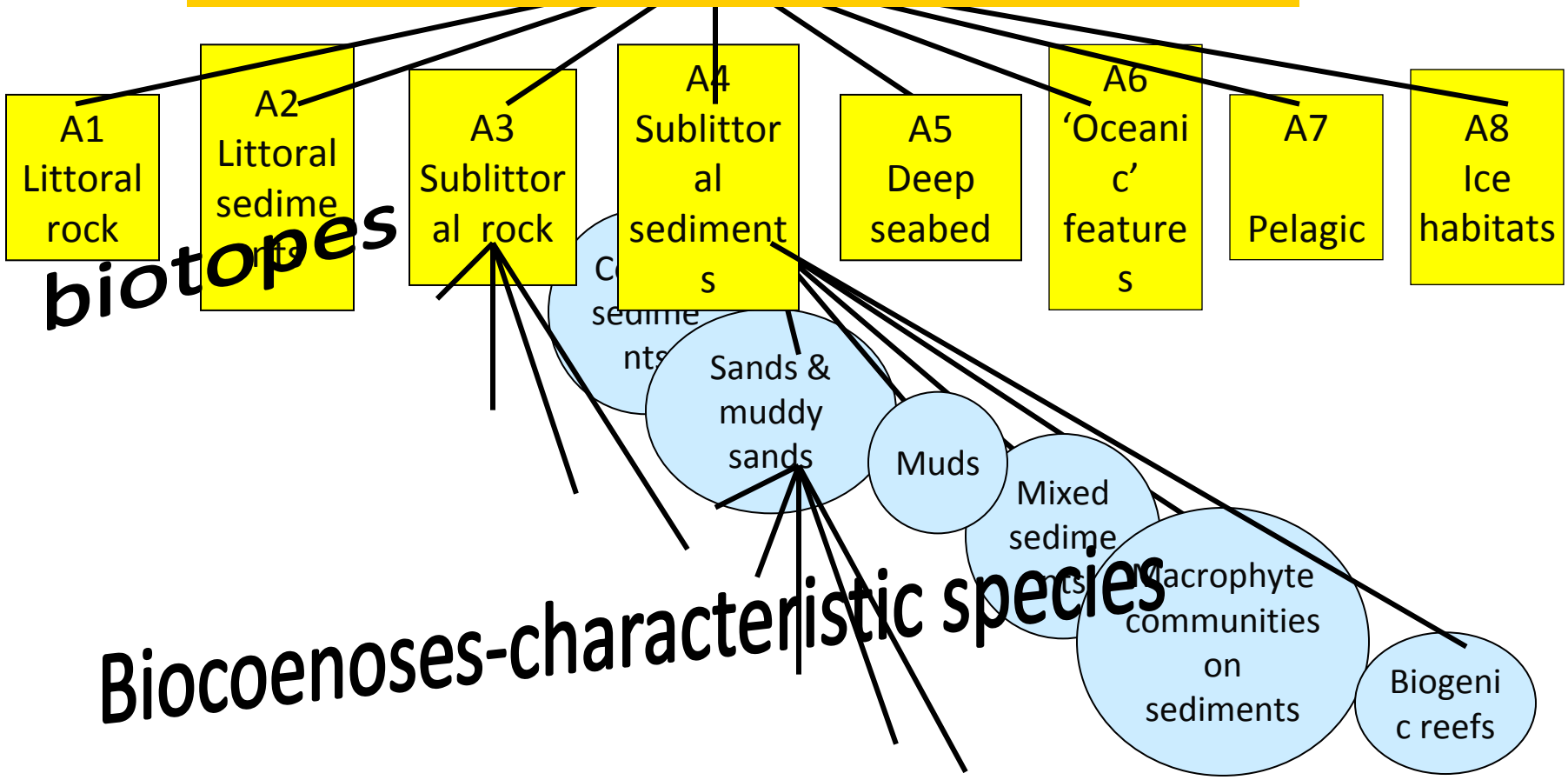




Classification scheme in Simboura et al., 2005

2. REFERENCE CONDITIONS - MACROINVERTEBRATES

They are not type specific for the Mediterranean (only habitat specific for some cases)

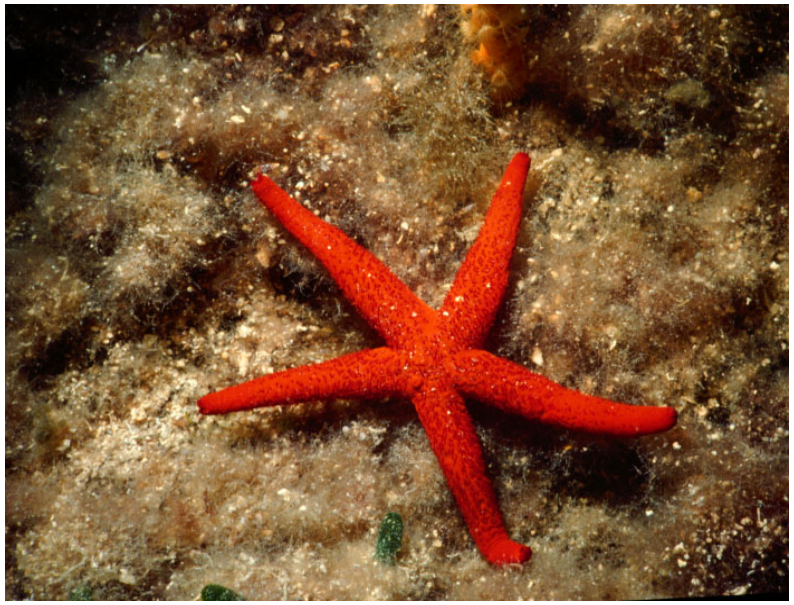


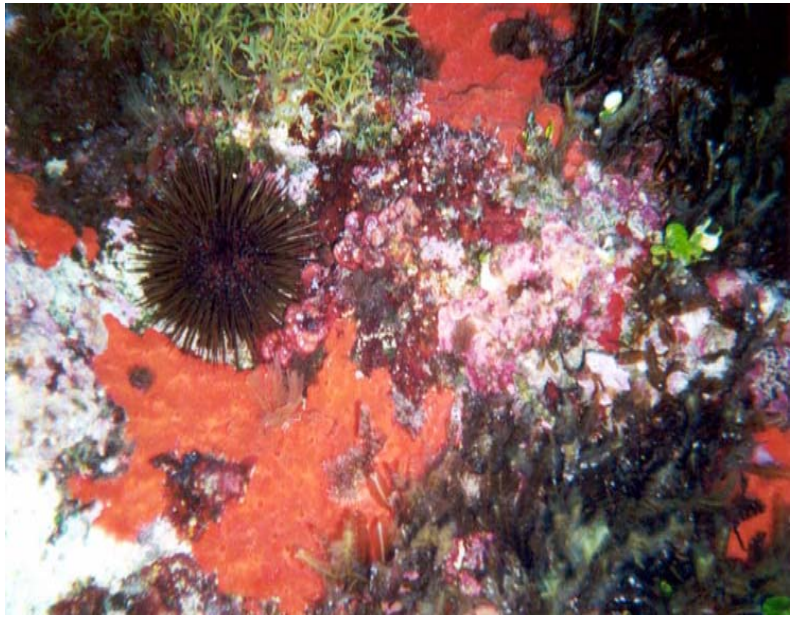
List of Characteristic species for every Biocoenosis
For use in RC Description based on autoecology

Sublittoral Muds-Coastal Terrigenous muds-VTC

CODE	SPECIES
Pol	*Ampharete acutifrons*
Pol	*Ancistrosyllis groenlandica*
Pol	*Ancistargis hamata*
Pol	*Aquilaspio sp. (Paraprionospio*
Pol	*Aricidea claudiae*
Pol	*Chaetozone setosa*
Pol	*Cossura coasta*
Pol	*Goniada maculata*
Pol	*Glycera rouxii*
Pol	*Glycera unicornis*
Pol	*Harmothoe lunulata*
Pol	*Laonice cirrata*
Pol	*Lepidasthenia maculata*
Pol	*Levinsenia gracilis*
Pol	*Lumbrineris latreilli*
Pol	*Maldane glebifex*
Pol	*Maldane sarsi*
Pol	*Marphysa bellii*
Pol	*Metasychis gotoi*
Pol	*Monticellina dorsobranchialis*
Pol	*Nephtys hystricis*
Pol	*Ninoe armoricana*

Macroinvertebrate communities under RC





EUNIS HABITAT CLASSIFICATION SYSTEM-LINK TO RC

ECOLOGICAL INDICATORS
www.elsevier.com/locate/ecolind

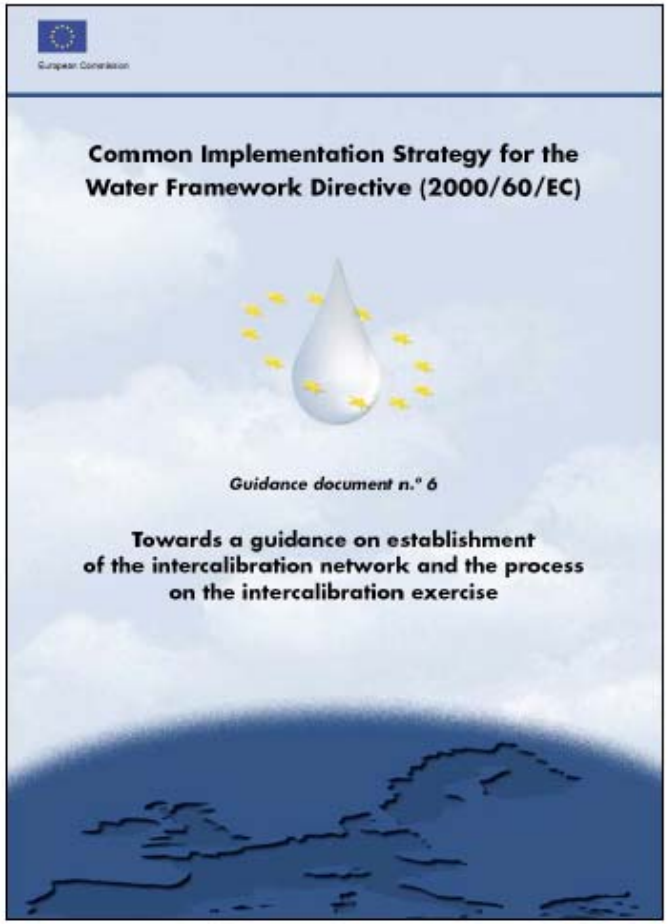
A synthesis of the biological quality elements for the implementation of the European Water Framework Directive in the Mediterranean ecoregion: The case of Saronikos Gulf

N. Simboura *, P. Panayotidis, E. Papathanassiou
Hellenic Centre for Marine Research, P.O. Box 712, Mavro Lithari, GR-19013 Anavissos, Greece

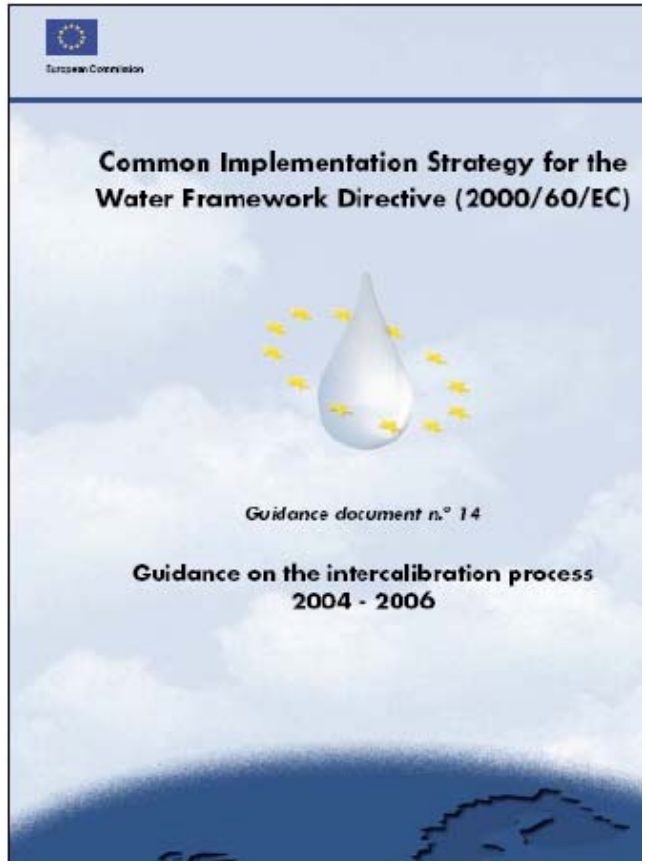
Accepted 29 March 2005

	nity types (EUNIS)
	oral rock moderately exposed to wave action and/or currents and tidal streams of infralittoral algae moderately exposed to wave action, association with *Cystoseira* spp., association with *Peyssonnelia* spp.) A4.5: shallow sublittoral sediments dominated by angiosperms (*Cymodocea*, *Halophila*, *Posidonia*) A4.2: sublittoral sands and muddy sands (DE) A4.4: sublittoral combination sediments (DC) A4.3: sublittoral muds (VTC) A4.7: deep shelf sediment habitats (animal communities of deep circalittoral bottoms, DL)
Rocky shallow sheltered	A3.3: infralittoral rock sheltered from wave action and currents and tidal streams (communities of infralittoral algae sheltered from wave action, association with *Cystoseira* spp.) A4.2: sublittoral sands and muddy sands (DE) A4.4: sublittoral combination sediments (animal communities in shallow water mixed sediments)
Sedimentary deep exposed	A4.2: sublittoral sands and muddy sands (SFHN, SFBC) A4.4: sublittoral combination sediments (DC) A4.6: biogenic structures over sublittoral sediments (association with rhodolithes in coarse sands and fine gravels under the influence of bottom currents-SGCF) A4.5: shallow sublittoral sediments dominated by angiosperms (*Cymodocea*, *Halophila*, *Posidonia*) A4.7: deep shelf sediment habitats (animal communities of deep circalittoral bottoms, DL)
Sedimentary shallow sheltered	A4.2: sublittoral sands and muddy sands (DE) A4.4: sublittoral combination sediments (animal communities in shallow water mixed sediments, DC) A4.5: shallow sublittoral sediments dominated by angiosperms (*Halophila*, *Cymodocea*, *Posidonia*, *Zostera*) A4.3: sublittoral muds (VTC)
Very sheltered bays	A4.3: sublittoral muds (SVMC, association with *Caulerpa prolifera* on superficial muddy sands in sheltered waters, VTC) A4.5: shallow sublittoral sediments dominated by angiosperms (*Halophila*, *Cymodocea*, *Zostera*) A4.2: sublittoral sands and muddy sands (SFHN)

Main steps of intercalibration

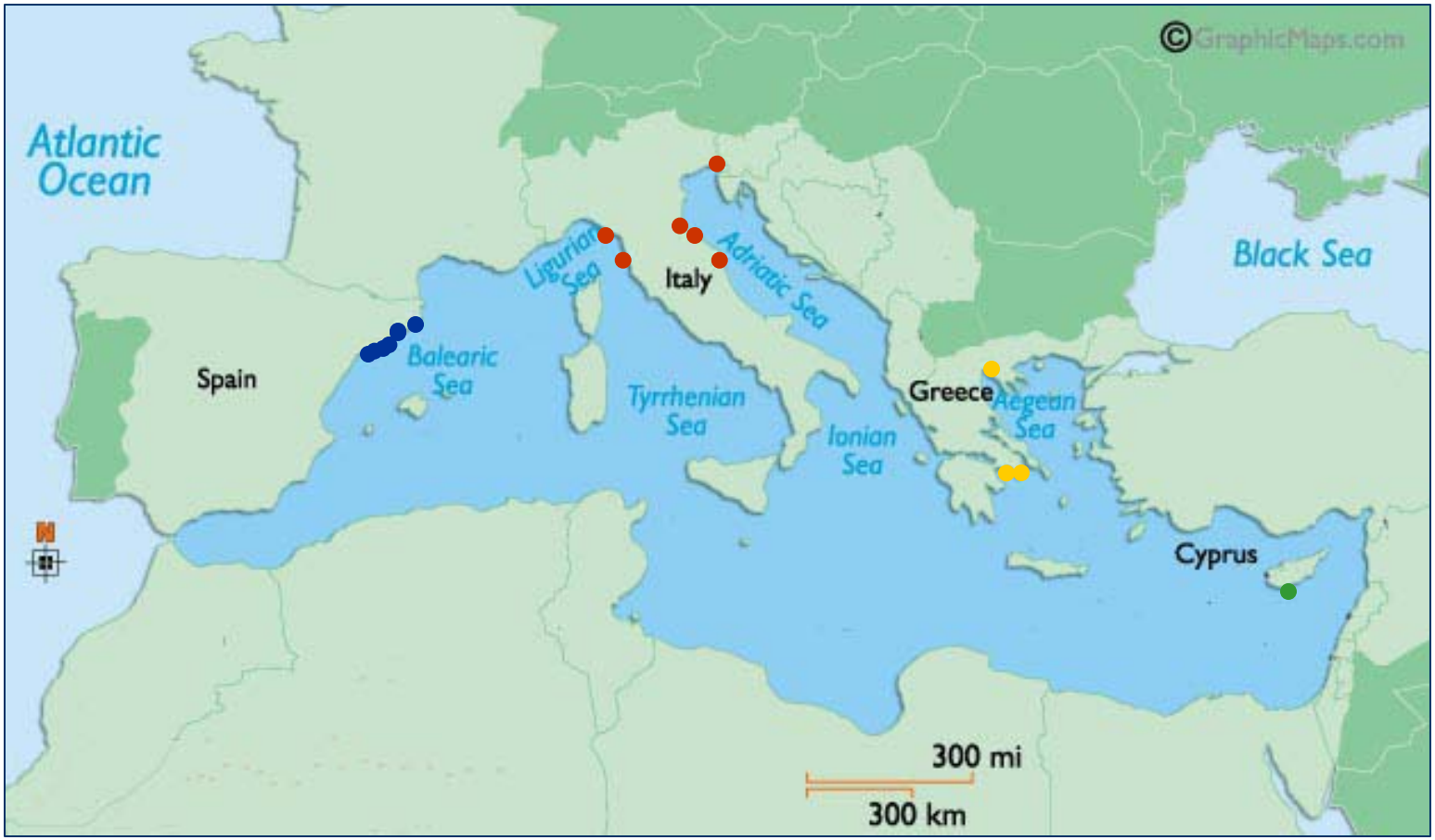


1. Intercalibration register (200 2004): 1500 sites selected and published in the Official Journal 2005

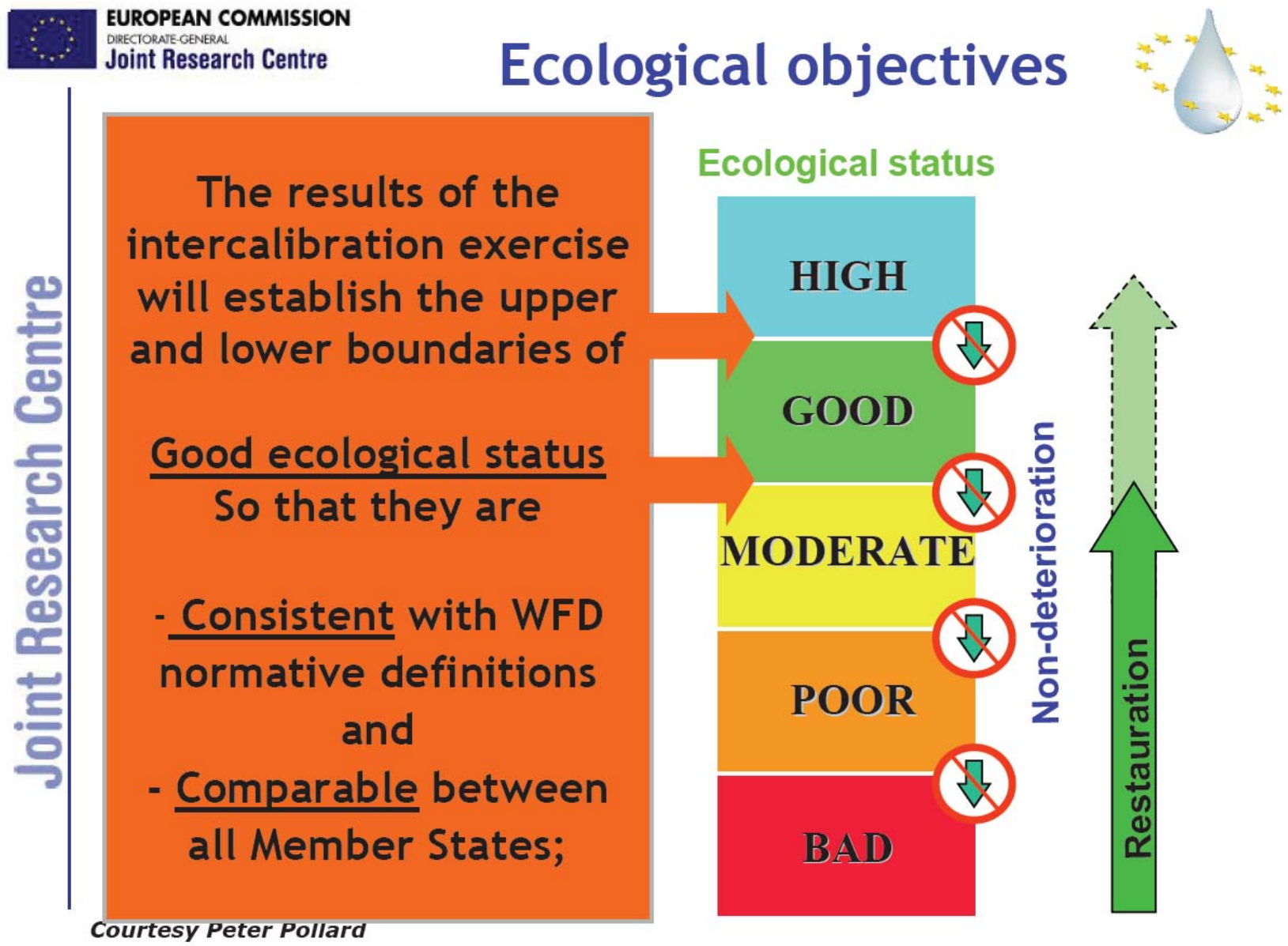


2. Intercalibration process (2004-2006)

The intercalibration sites



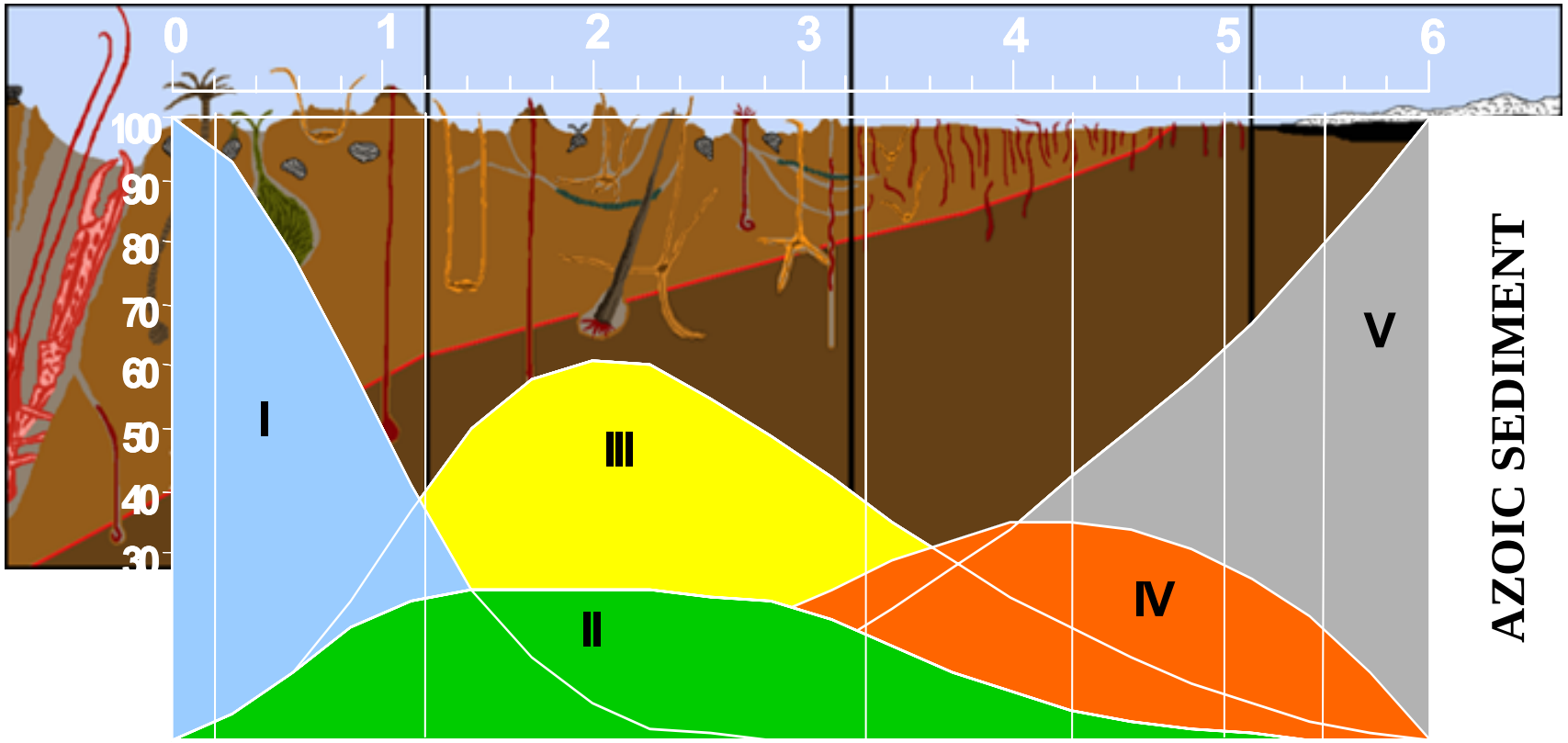
Six countries participated: Italy, Spain, France, Greece, Cyprus, Slovenia. One MS (Malta was missing).



FROM: Heiskanen & Jowett

DESCRIPTION OF MEDITERRANEAN INDICES AND COMPARISON AMONG THEM

AMBI index (Borja et al., 2000)
software in: http://www.azti.es



AMBI index (Borja et al., 2000) classification scheme

AMBI	Dominating Ecological Group	Benthic Community Health	Site Disturbance Classification	Ecological Sta
$0.0 < AMBI \leq 0.2$	I	Normal	Undisturbed	High Status
$0.2 < AMBI \leq 1.2$		Impoverished		
$1.2 < AMBI \leq 3.3$	III	Unbalanced	Slightly disturbed	Good Statu
$3.3 < AMBI \leq 4.3$		Transitional to pollution	Meanly disturbed	Moderate Sta
$4.3 < AMBI \leq 5.0$	IV-V	Polluted		Poor Status
$5.0 < AMBI \leq 5.5$		Transitional to heavy pollution	Heavily disturbed	
$5.5 < AMBI \leq 6.0$	V	Heavy polluted		Bad Status
Azoic	Azoic	Azoic	Extremely disturbed	

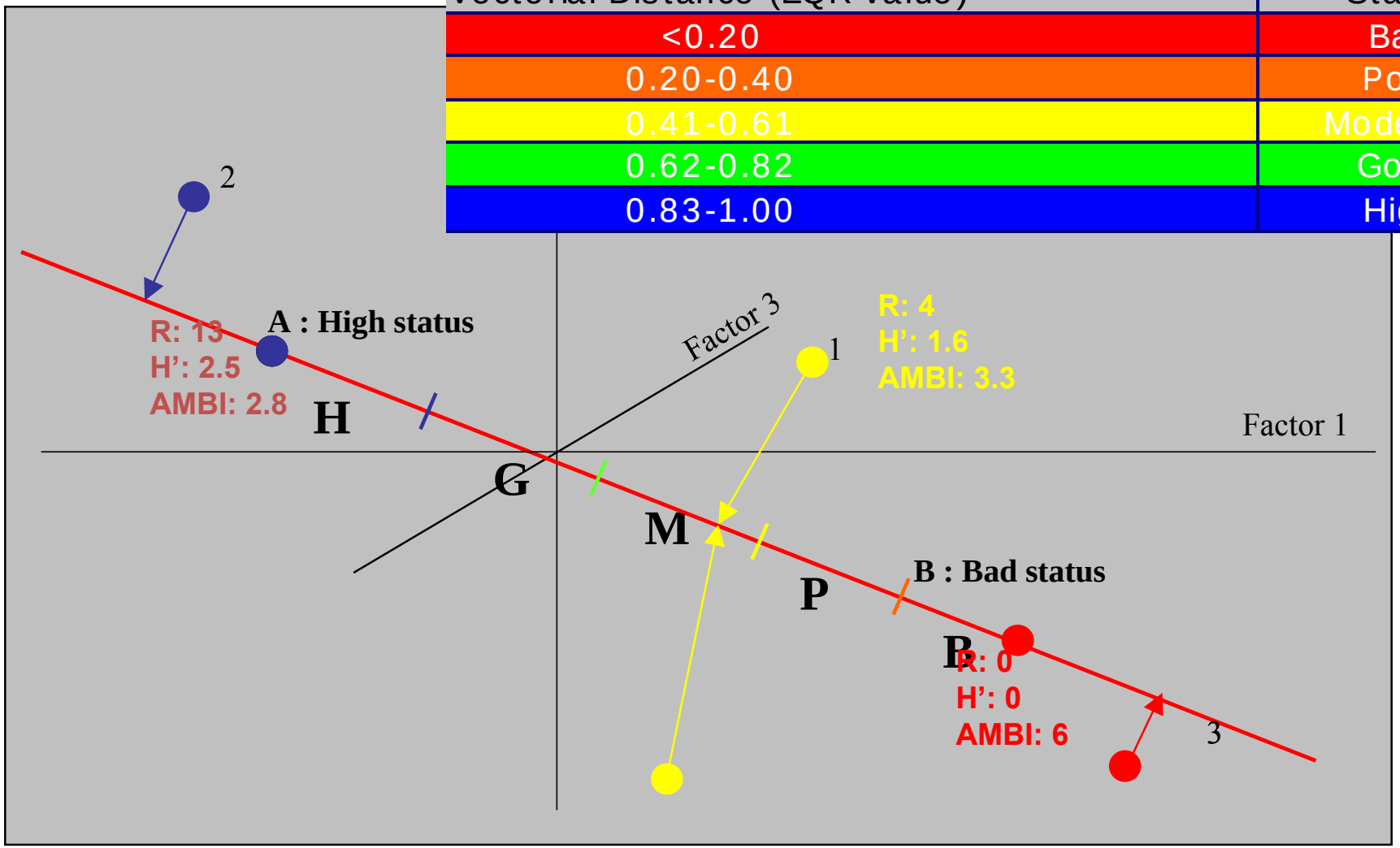
Biotic Coefficient (□orja et al., 2000)

{(0 x % **GI**) + (1.5 X % **GII**) + (3 x % **GIII**) + (4.5 X % **GIV**) + (6 X % **GV**)}/100

Classification	AMBI index	EQR value
High	1.2<AMBI<0	>0.83-1
Good	1.2<AMBI<3.3	>0.53-0.83
Moderate	3.3<AMBI<5	>0.39-0.53
Poor	5<AMBI<6	>0.21-0.39
Bad	>6	<0.21

Multivariate Factorial analysis combining AMBI with Shannon Diversity and Species richness (M-AMBI EQR) Muxica et al., 2007, Borja et al., 2004

Vectorial Distance (EQR value)	Status
<0.20	Bad
0.20-0.40	Poor
0.41-0.61	Moderate
0.62-0.82	Good
0.83-1.00	High



M-AMBI boundaries-ITALY

Classification	EQR value
High	>0.96-1.17
Good	>0.72-0.9
Moderate	>0.49-0.72
Poor	>0.24-0.49
Bad	<0.2

M-AMBI boundaries-SLOVENIA

Classification	EQR value
High	>0.83-1.00
Good	>0.62-0.83
Moderate	>0.41-0.62
Poor	>0.20-0.41
Bad	<0.20

GIV+GV

MEDOCC= [(0 x %EGI + 2 x %EGII + 4 x %EGIII +6 x %E GIV)]/100

Ecological Status	MEDOCC values (6-0)	EQR
High	(0<MEDOCC<1.6)	0.73
Good	(1.6<MEDOCC<3.2)	0.47
Moderate	(3.2<MEDOCC<4.77)	0.20
Poor	(4.77<MEDOCC<5.5)	0.08
Bad	(5.5<MEDOCC>6)	0

Catalunya & Balearic islands

The values of the BOPA are calculated from the benthic data series, using the following algorithm:

BOPA= log ((fp/(fa +1)) +1)

where *fp* is opportunistic polychaete frequency, and *fa* is amphipod (excluding G. *Jassa*) frequency. BOPA index varies between 0 (when *fp* = 0) and 0.30103 (when *fa* = 0).

Classification	**BOPA index**	**EQR value**
High	0<BOPA<0.045	>0.83-1
Good	0.06<BOPA<0.139	>0.53-0.83
Moderate	0.139<BOPA<0.193	>0.39-0.53
Poor	0.193<BOPA<0.261	>0.21-0.39
Bad	0.261<BOPA<0.301	<0.21

BOPA index Dauvin & Ruellet, 2007

ELSEVIER

Available online at www.sciencedirect.com
ScienceDirect
Marine Pollution Bulletin 55 (2007) 215–224

MARINE POLLUTION BULLETIN
www.elsevier.com/locate/marpolbul

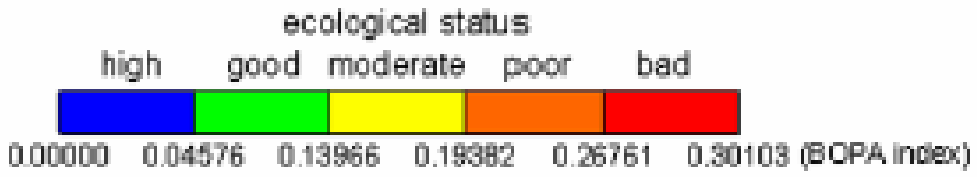
Polychaete/amphipod ratio revisited

J.C. Dauvin *, T. Ruellet

Station Marine de Wimereux, Université des Sciences et Technologies de Lille, FRE CNRS 2816 ELICO, 28 Avenue Foch, BP 80, 62930 Wimereux, France
GIP Seine-Aval, 12 Avenue Aristide Briand, 76000 Rouen, France

$$\text{BOPA index} = \log\left(\frac{f_P}{f_A + 1} + 1\right)$$

where f_P is the opportunistic polychaete frequency (ratio of the total number of opportunistic polychaete individuals to the total number of individuals in the sample); f_A, the amphipod frequency (ratio of the total number of amphipod individuals excluding the opportunistic *Jassa* amphipods to the total number of individuals in the sample); and $f_P + f_A \leqslant 1$.



FRANCE-PHASE I

Table 1. EcoQ values for the Shannon, AMBI, BQI and Trophic indices.

EcoQ	H'	AMBI	BQI		
			Depth < 20m	Depth. > 20m	
High	H' > 4	AMBI ≤ 1.2	BQI > 18.8	BQI > 26.4	IT > 80
Good	3 < H' ≤ 4	1.2 < AMBI ≤ 3.3	14.1 < BQI ≤ 18.8	19.8 < BQI ≤ 26.4	60 < IT ≤ 80
Moderate	2 < H' ≤ 3	3.3 < AMBI ≤ 4.3	9.4 < BQI ≤ 14.1	13.2 < BQI ≤ 19.8	50 < IT ≤ 60
Poor	1 < H' ≤ 2	4.3 < AMBI ≤ 5.5	4.7 < BQI ≤ 9.4	6.6 < BQI ≤ 13.2	30 < IT ≤ 50
Bad	H' < 1	5.5 < AMBI ≤ 6	BQI ≤ 4.7	BQI ≤ 6.6	IT ≤ 30

SHANNON DIVERSITY INDEX USED AS CLASSIFICATION METRIC

Table 27

Classification diversity (H) of soft-bottom fauna (EEA, 2001)

	Classes				
	I	II	III	IV	V
Parameters	Very Good	Good	Fair	poor	Bad
Shannon-Wiener index (H) (Norway)	>4	4-3	3-2	2-1	<1

Box 2: Ecological quality classes according to community diversity in closed gulfs (sandy/muddy community types).

bad:	H≤1,5: Azoic to very highly polluted –examples from Elefsis Bay, Thessaloniki
poor:	1.5<H≤3: highly polluted – examples from Saronikos, Thermaikos
moderate:	3<H≤4: moderately polluted
good:	4<H≤5: for transitional zones
high:	H>5: reference sites

Source: UNEP-MAP, 2004, Simboura & Zenetos, 2002

Table 1
Classification of EcoQS according to ranges of H', BENTI

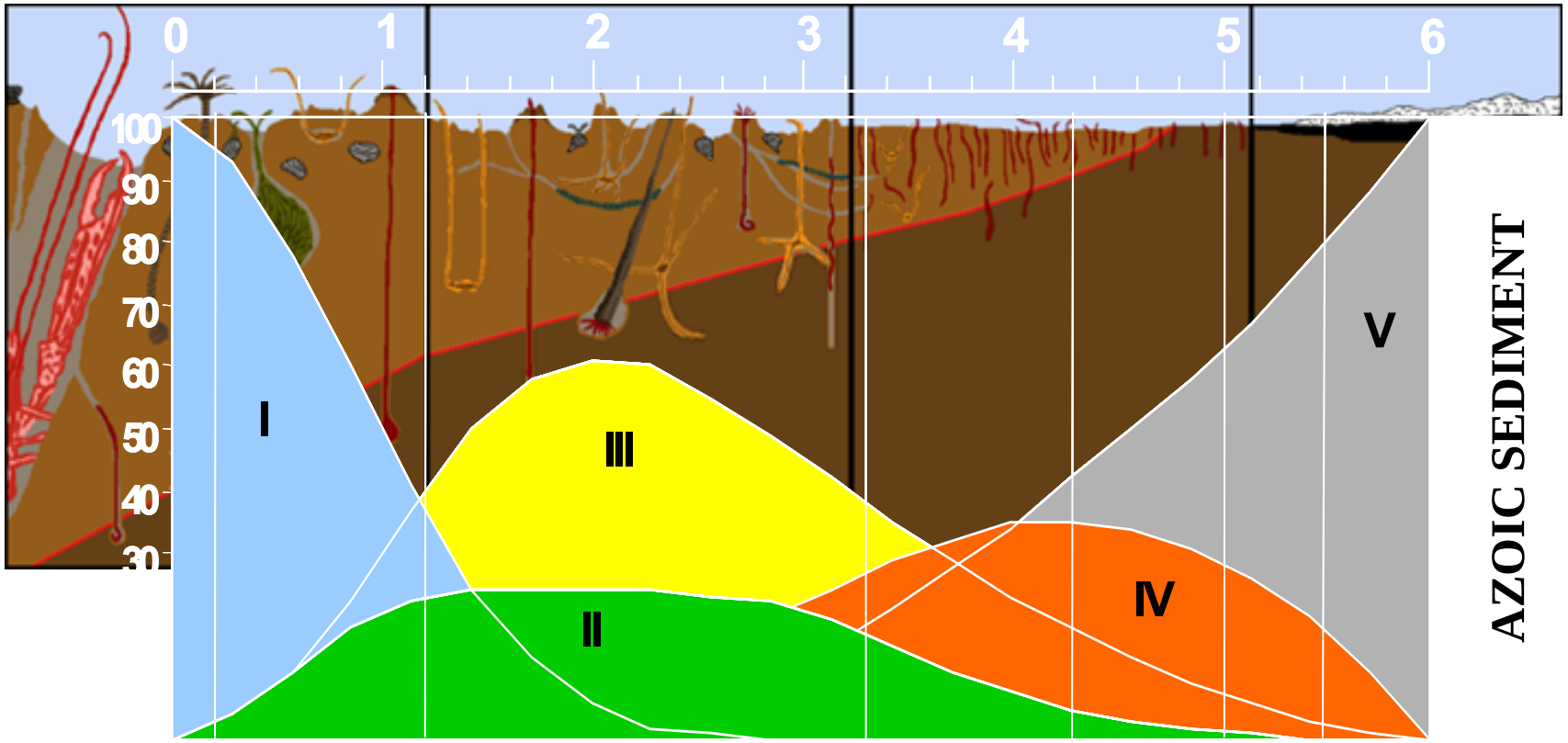
Pollution classification	H' (UNEP/MAP, 2004)
Unpolluted/normal	$H' > 4.6–5.0$
Slightly polluted	$4 < H' \leqslant 4.6–5.0$
Moderately polluted	$3 < H' \leqslant 4$
Heavily polluted	$1.5 < H' \leqslant 3$
Extremely polluted/Azoic	$H' \leqslant 1.5$

Note: Lower limits of indices apply in physically stressed m

Source: UNEP/MAP, 2004, Albayrak et al., 2006

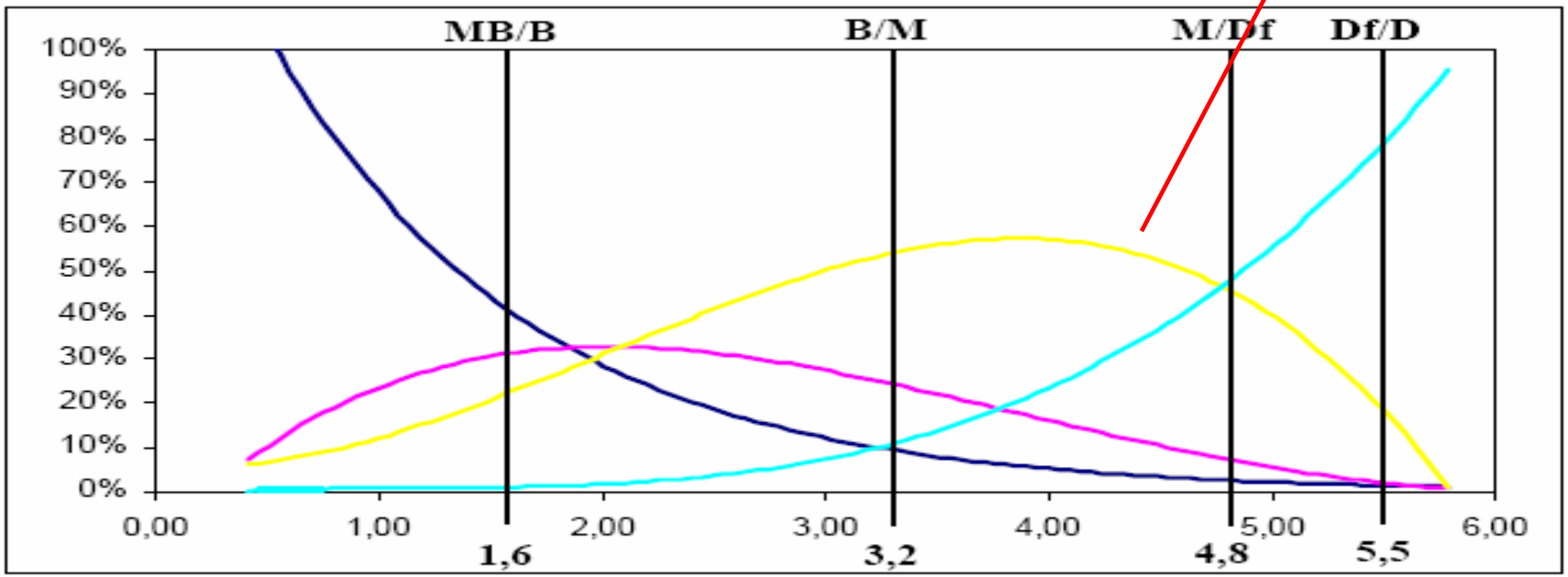
INDICES COMPARISON

AMBI index (Borja et al., 2000)
software in: http://www.azti.es



MEDOCC index (Pinedo & Jordana 2008)

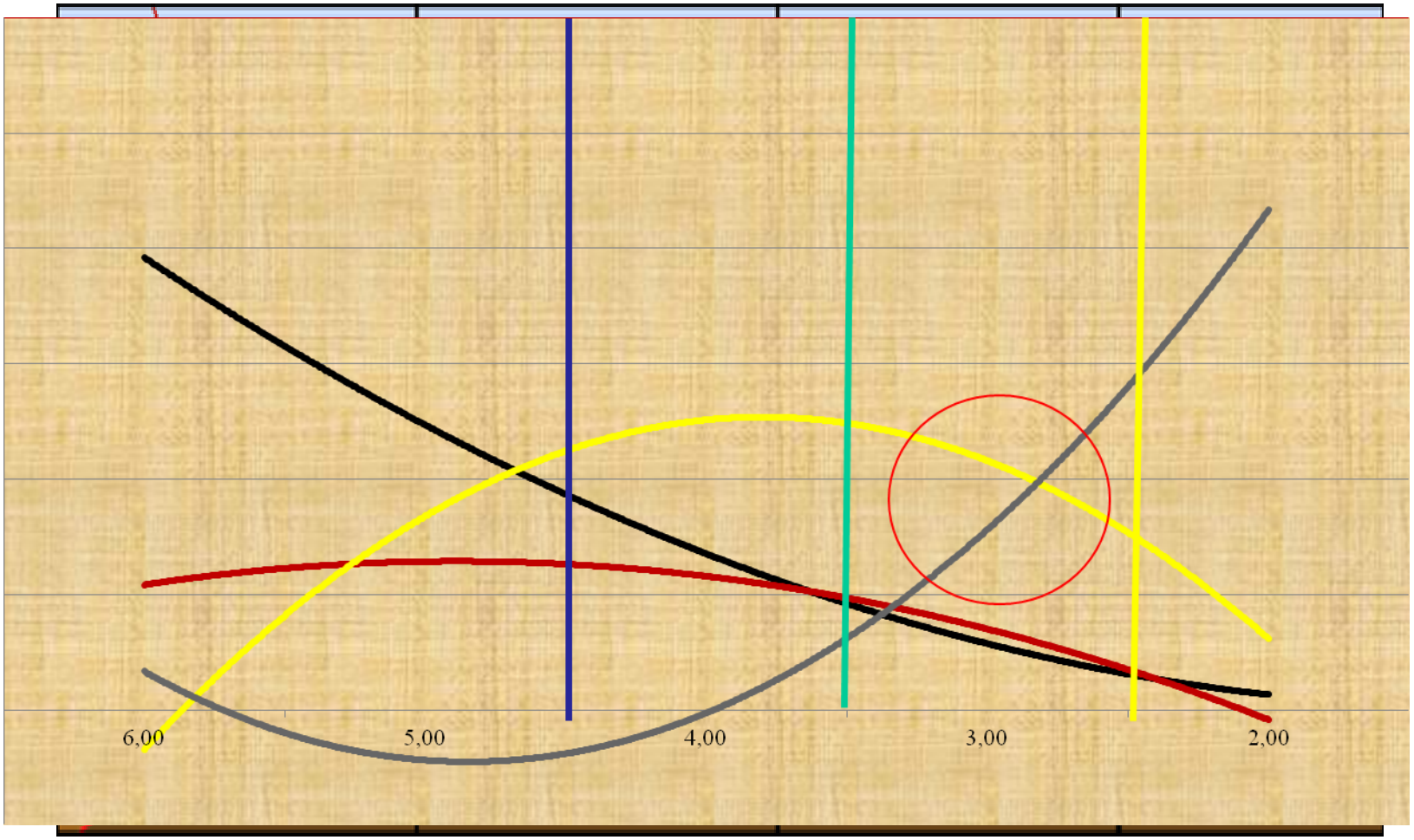
MEDOCC= [(0 x %EGI + 2 x %EGII + 4 x %EGIII +6 x %E GIV)]/100



Spain (Catalonia and Balearic Islands)

BENTIX index (Simboura & Zenetos, 2002)

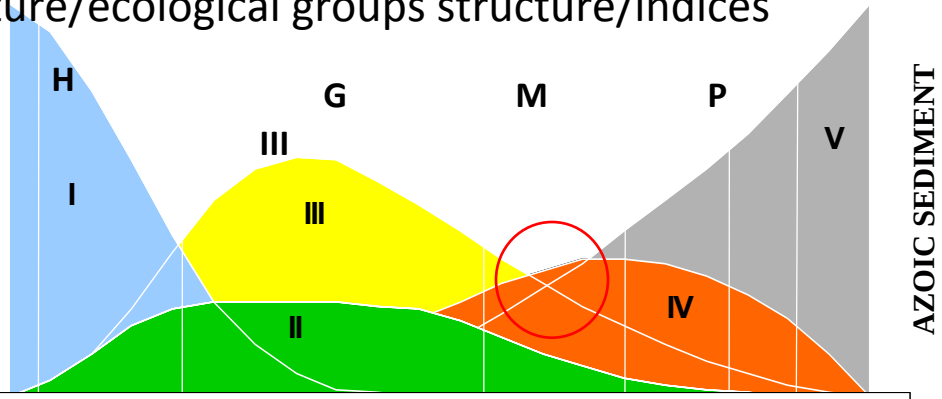
BENTIX = (6 X %GS + 2 X %GT)/100



Greece=Cyprus (Eastern Mediterranean)

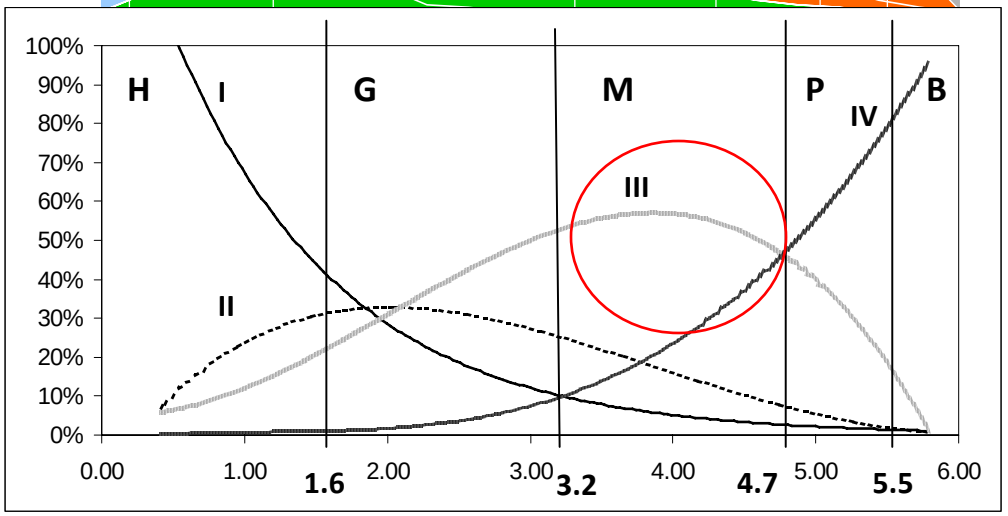
Community structure/ecological groups structure/indices

AMBI



ATLANTIC

MEDOCC

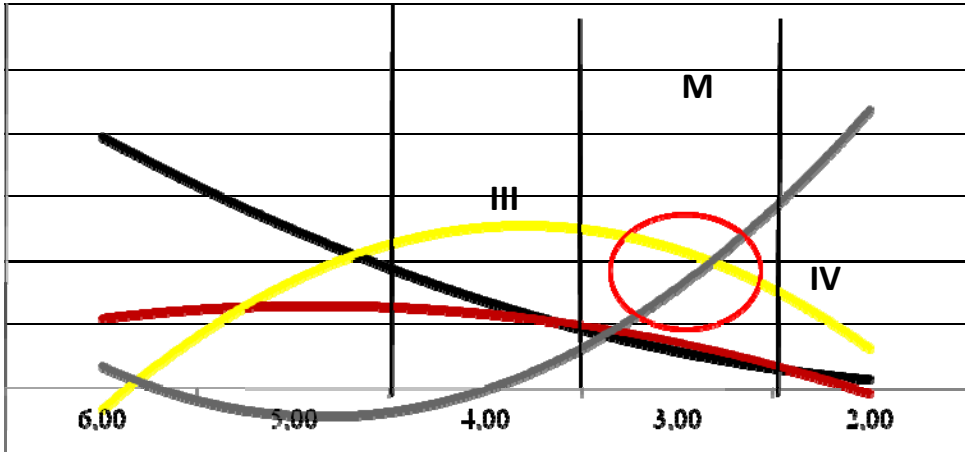


IV=opportunistics 1st and 2nd order

WESTERN MED

Tolerant & opportunistis equally important in in the moderate to poor area

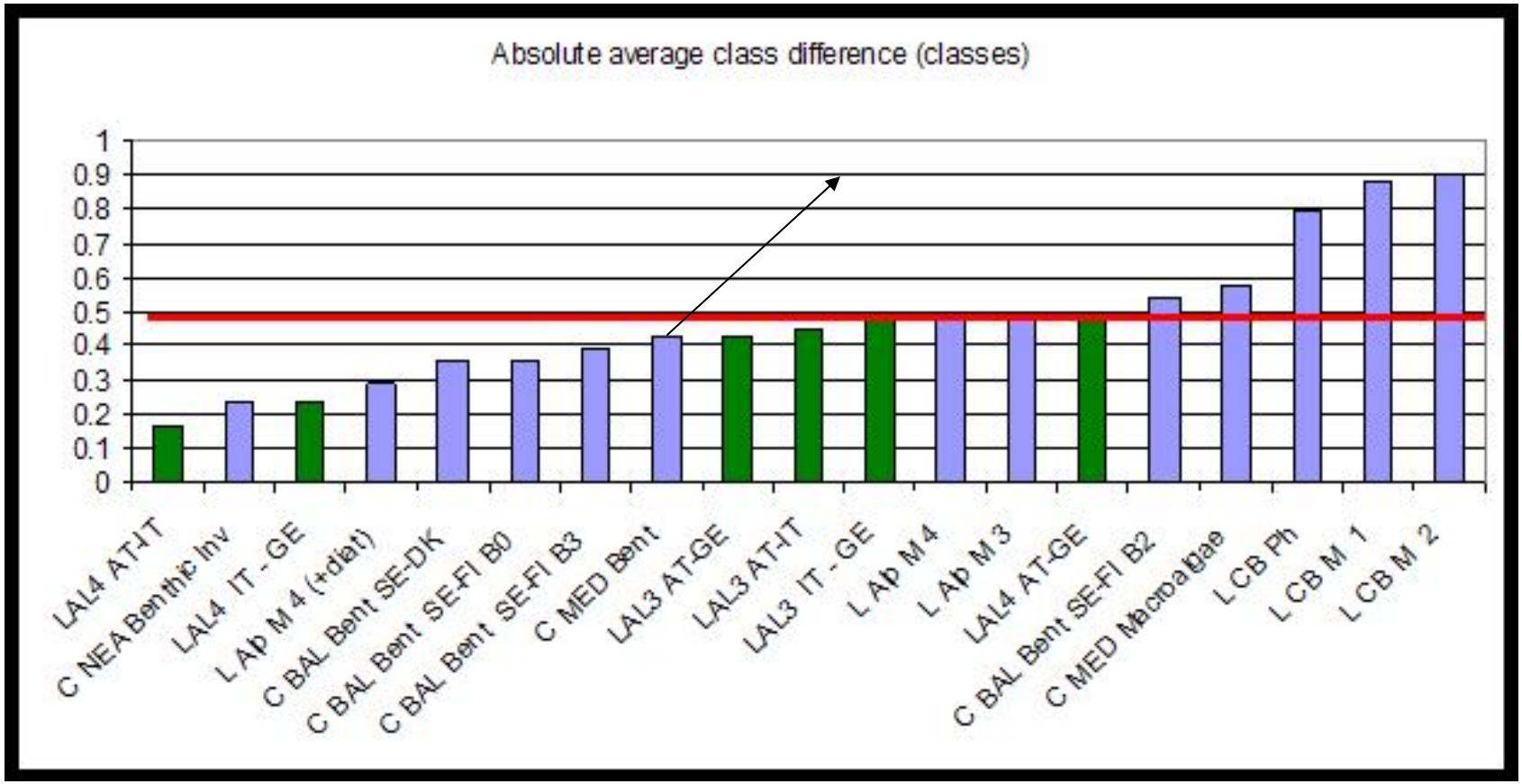
BENTIX



EASTERN MED

Tolerant & opportunistis equally important in the moderate class

PHASE I: OVERALL AGREEMENT-DISAGREEMENT



Agreement on 5 classes OVER ALL 6 MS

BENTIX vs MEDOCC: 66.67

M-AMBI vs BENTIX: 62.12

MEDOCC vs M-AMBI: 44.96

OVERALL M-AMBI-MEDOCC-BENTIX agreement: 57.92 % ACCEPTABLE

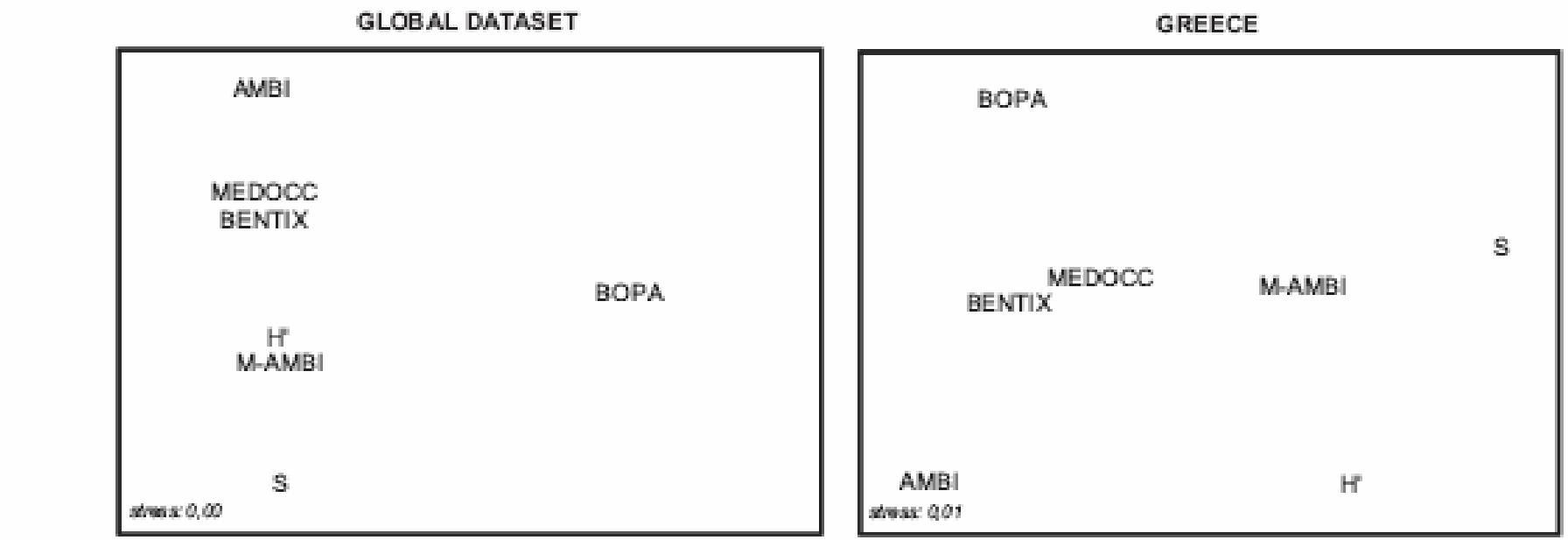
OVERALL M-AMBI-MEDOCC-BENTIX difference: 43 %

IC-PHASE II RESULTS FOR MACROINVERTEBRATES. Boundary EQR values established for the type/quality element/pressure combination for the common metric (where applicable) and each national WFD assessment method

Member State	Classification	Ecological Quality Ratios	
	Method	High-good boundary	Good-moderate boundary
	Common metric		
France	AMBI	0,83	0,58
Greece	BENTIX	0,75	0,58
Cyprus	BENTIX	0,75	0,58
SpaIn (Catalonia-Balearic islands)	MEDOCC	0,73	0,47
Spain (Murcia-Valencia-Andalusia regions)	BOPA	0,95	0,54
Italy	MAMBI	0.81	0.61
Slovenia	MAMBI	0.83	0.62

Kappa analyses indicated an acceptable agreement (>0.4) between AMBI, MEDOCC, BOPA and BENTIX, when MAMBI index is included in the analysis, the agreement is low (0.29). This result is coherent with the results obtained along the IC exercise, and it is suggested that the diversity parameter is the main responsible of the low relation between MAMBI and the rest of the methods.

COMPARISON OF INDICES OVER WHOLE MEDITERRANEAN



Ecological Indicators xxx (2011) xxx

Contents lists available at ScienceDirect

Ecological Indicators

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

Response of different biotic indices to gradients of organic enrichment in Mediterranean coastal waters: Implications of non-monotonic responses of diversity measures

M.D. Subida[a,*], P. Drake[a], E. Jordana[b], B. Mavrič[c], S. Pinedo[b], N. Simboura[d], J. Torres[e], F. Salas[f,g]

[a] Instituto de Ciencias Marinas de Andalucía (CSIC) Av. República Saharaui s/n 11510 Puerto Real, Cádiz, Spain

COMPARISON OF INDICES EQRs OVER EASTERN MEDITERRANEAN (GREECE-CYPRUS)

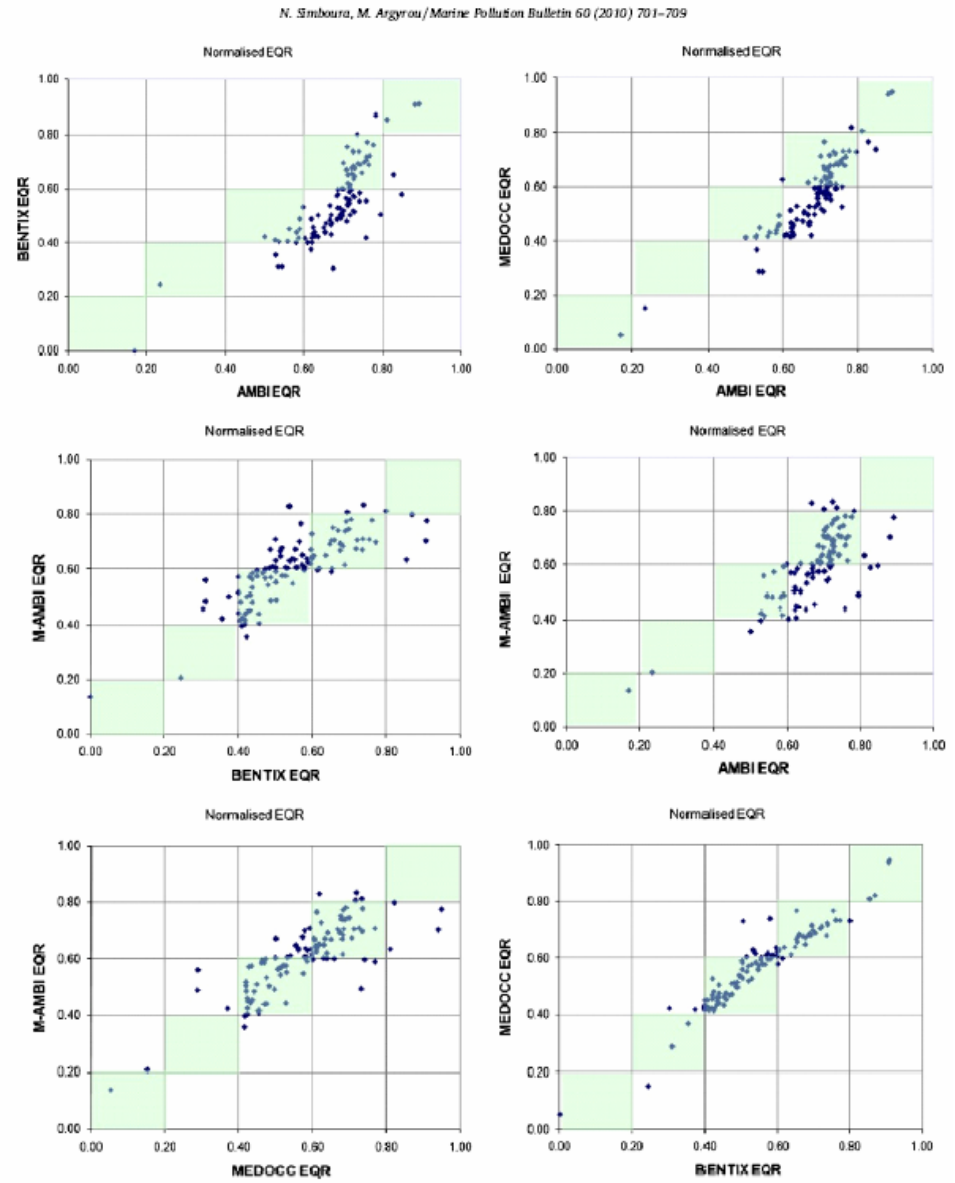


Fig. 3. Comparison of the EQRs of the four methods.

Contents lists available at ScienceDirect

Marine Pollution Bulletin

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

An insight into the performance of benthic classification indices tested in Eastern Mediterranean coastal waters

N. Simboura [a,*], M. Argyrou [b]

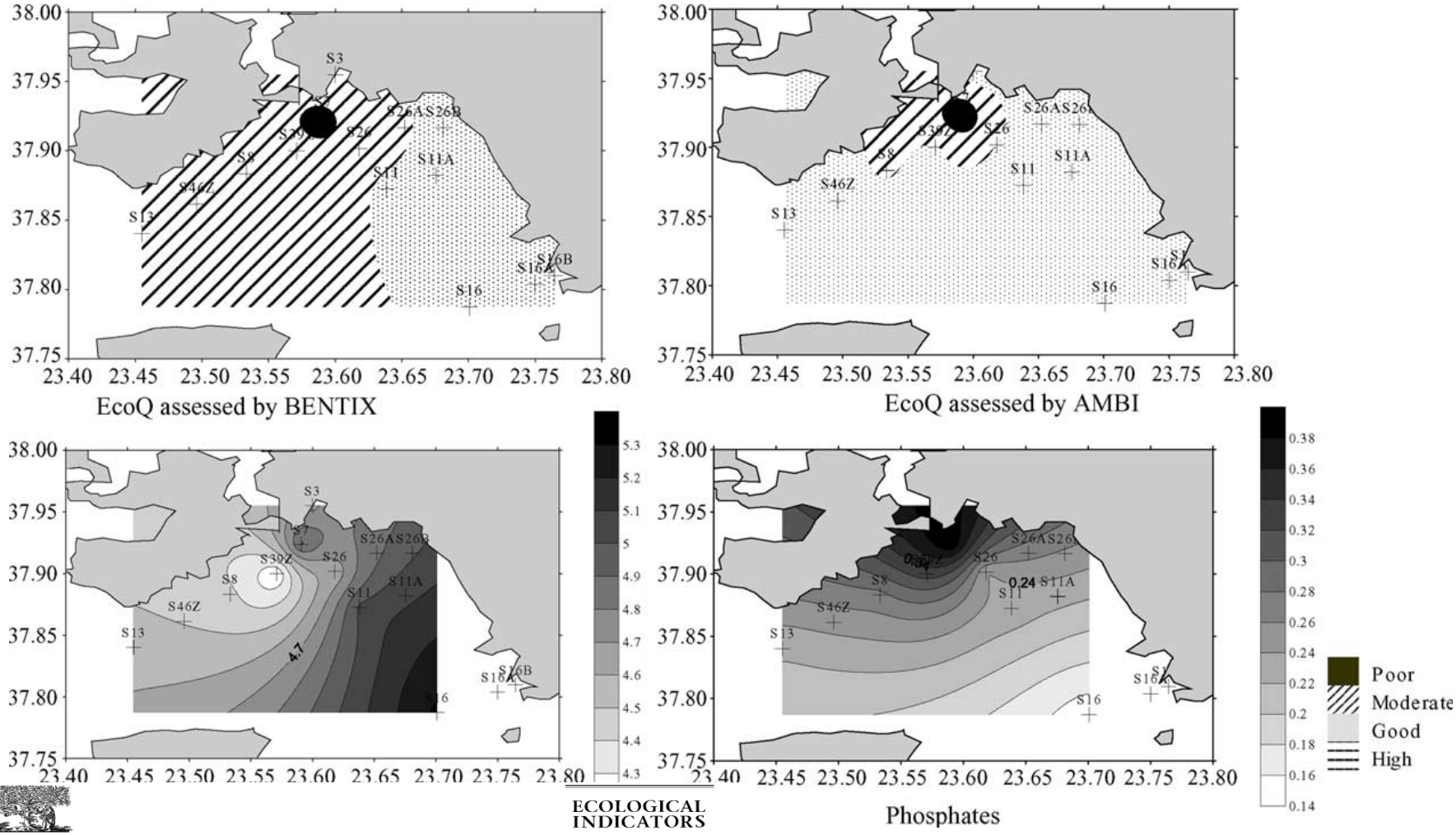
[a] Hellenic Centre for Marine Research, P.O. Box 712, Mavro Lithari, GR-19013 Anavissos, Greece

Table 2
Percentage of agreement of indices on a five classes scale with no 0.05 deviation of EQR over the data set (108 cases).

Index comparison	Agreement %
BENTIX-AMBI	41.67
AMBI-MEDOCC	50
M-AMBI-BENTIX	57.41
AMBI-M-AMBI	62.04
M-AMBI-MEDOCC	67.59
MEDOCC-BENTIX	83.33

BENTIX INDEX APPLICATION

Application in Saronikos gulf



ELSEVIER

Ecological Indicators 5 (2005) 253–266

ECOLOGICAL INDICATORS

This article is also available online at: www.elsevier.com/locate/ecolind

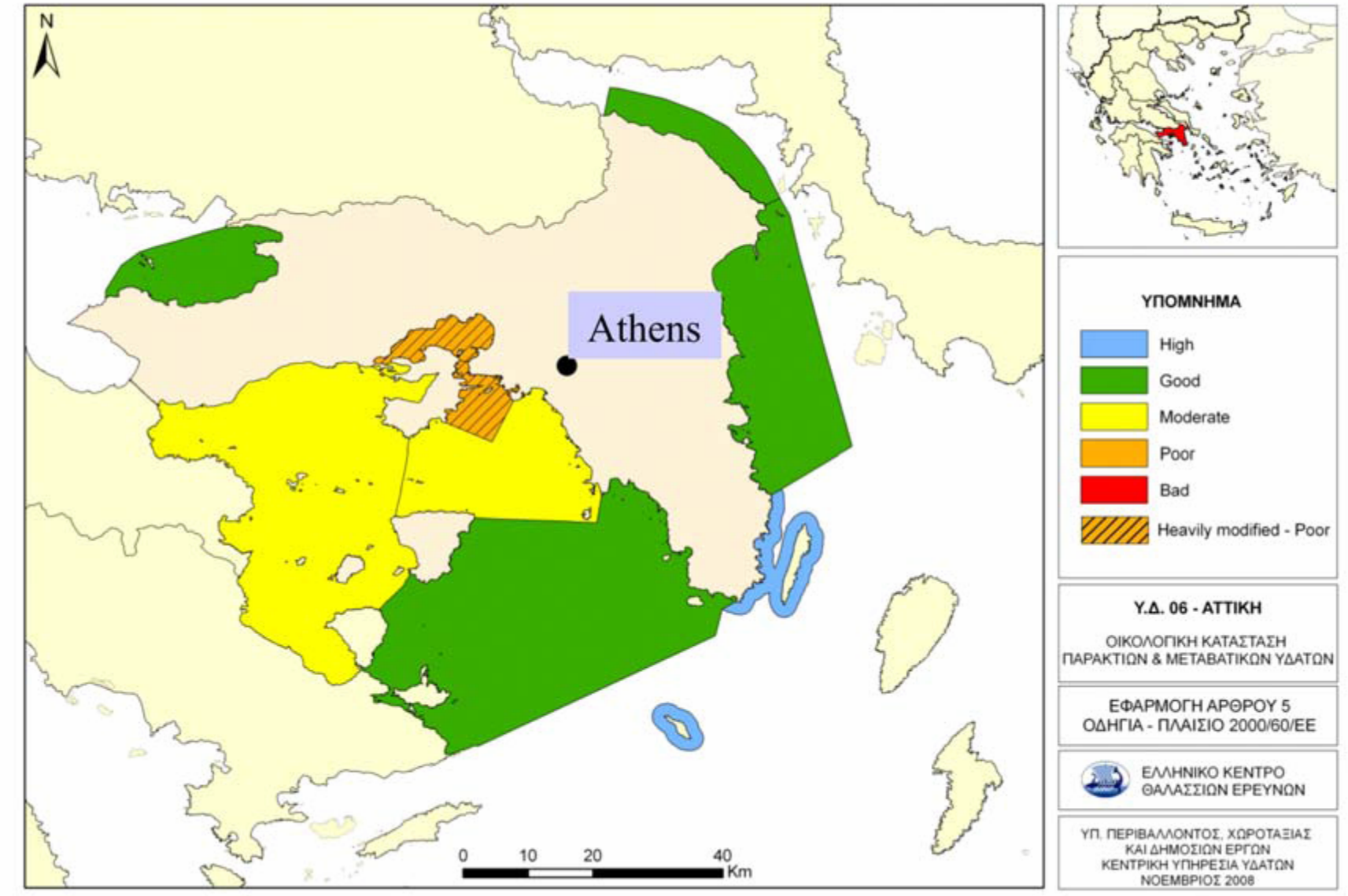
A synthesis of the biological quality elements for the implementation of the European Water Framework Directive in the Mediterranean ecoregion: The case of Saronikos Gulf

N. Simboura *, P. Panayotidis, E. Papathanassiou

Hellenic Centre for Marine Research, P.O. Box 712, Mavro Lithari, GR-19013 Anavissos, Greece

Accepted 29 March 2005

CLASSIFICATION OF ECOLOGICAL QUALITY: The case of Saronikos gulf



•Metallourgical solid wastes discharge (Evvoikos)

•Aquaculture-Cyprus

ELSEVIER

Ecological Indicators 7 (2007) 164–180

ECOLOGICAL INDICATORS

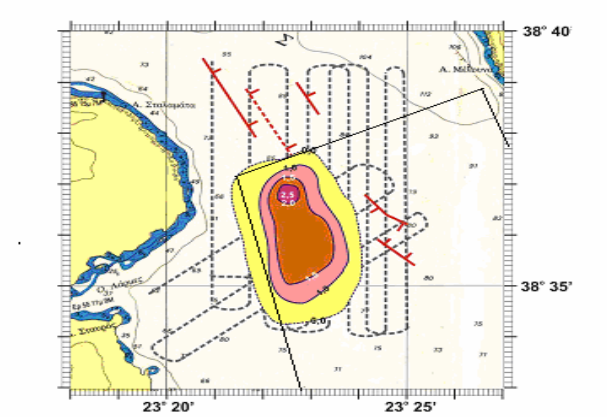
This article is also available online at: www.elsevier.com/locate/ecolind

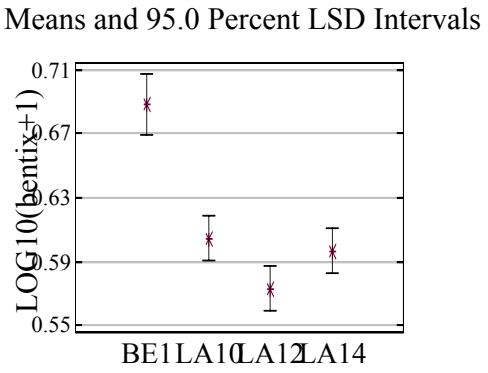
The use of a biotic index (Bentix) in assessing long-term effects of dumping coarse metalliferous waste on soft bottom benthic communities

N. Simboura *, E. Papathanassiou, D. Sakellariou

Hellenic Centre for Marine Research, P.O. Box 712, Mavro Lithari, GR-19013 Anavissos, Greece

Received 18 July 2005; received in revised form 25 November 2005; accepted 29 November 2005





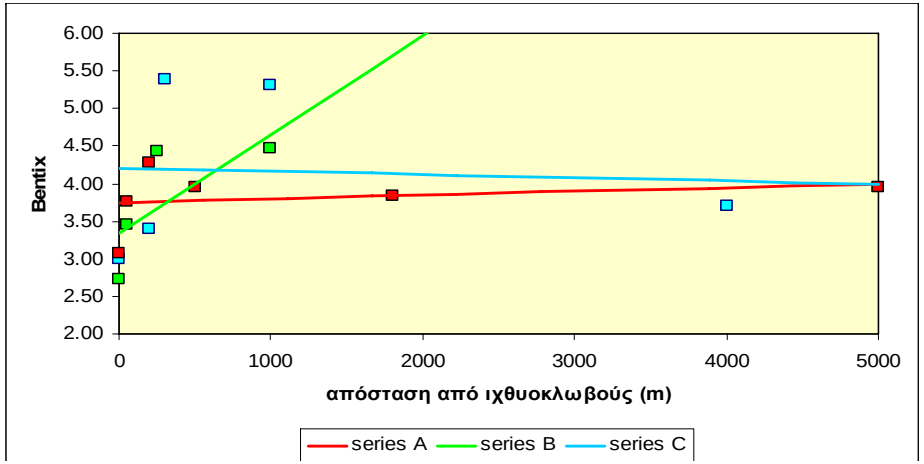
Εφαρμογή της Οδηγίας Πλαίσιο γιά τα Υδατα στην Κύπρο: Εφαρμογή του δείκτη Bentix στον κόλπο της Λεμεσού.

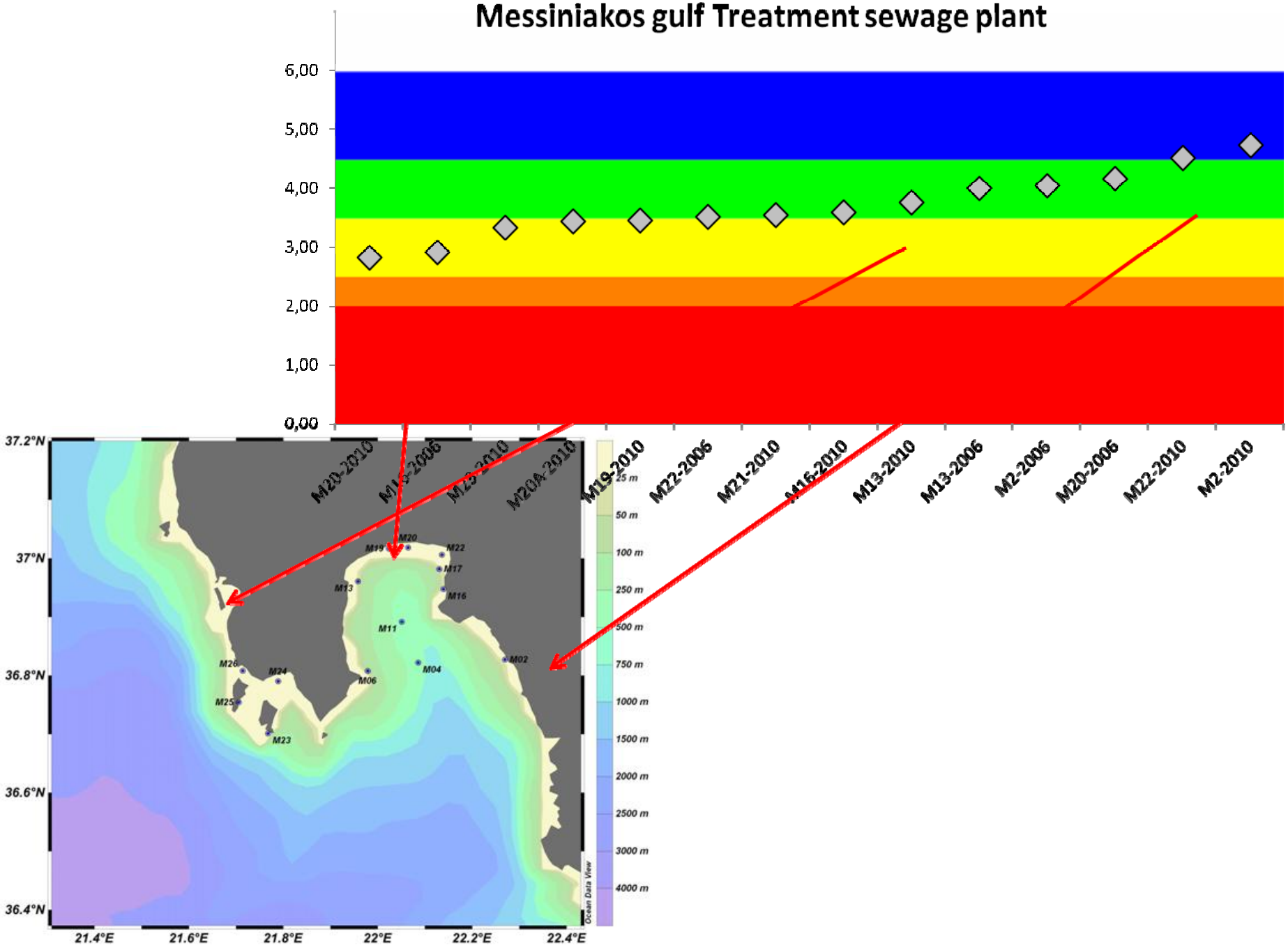
Ν. Σύμπουρα[1] & Μ. Αργυρού[2]

[1] Ελληνικό Κέντρο Θαλασσίων Ερευνών, 46,7 χλμ. Λεωφ. Αθηνών-Σουνίου, τ.θ. 712, 19013, Ανάβυσσος Αττικής.

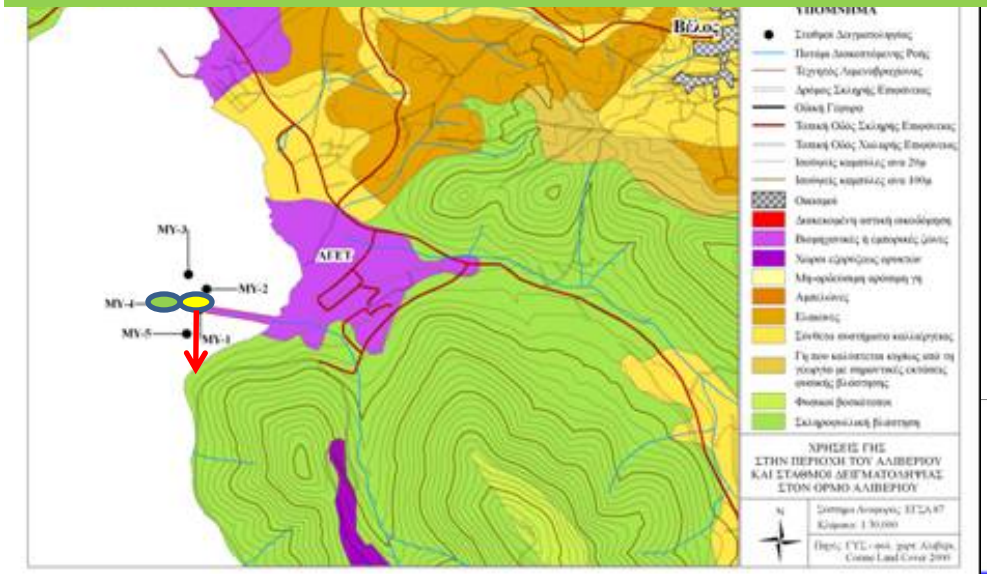
[2] Τμήμα Αλιείας και Θαλασσίων Ερευνών, Υπουργείο Γεωργίας, Φυσικών Πόρων και Περιβάλλοντος, Αιόλου 13, 1416 Λευκωσία, Κύπρος.

8ο Πανελλ. Συμπ. Ωκεανογρ. & Αλιείας, Θεσσαλονίκη 4-8 Ιουνίου 2006

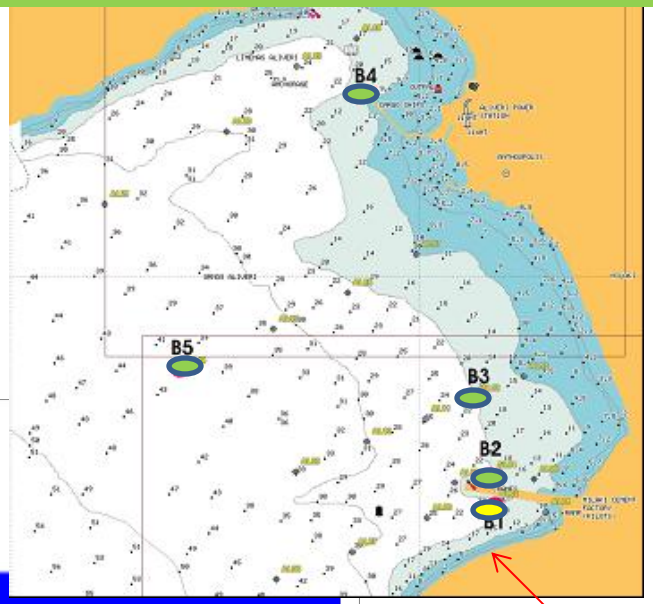


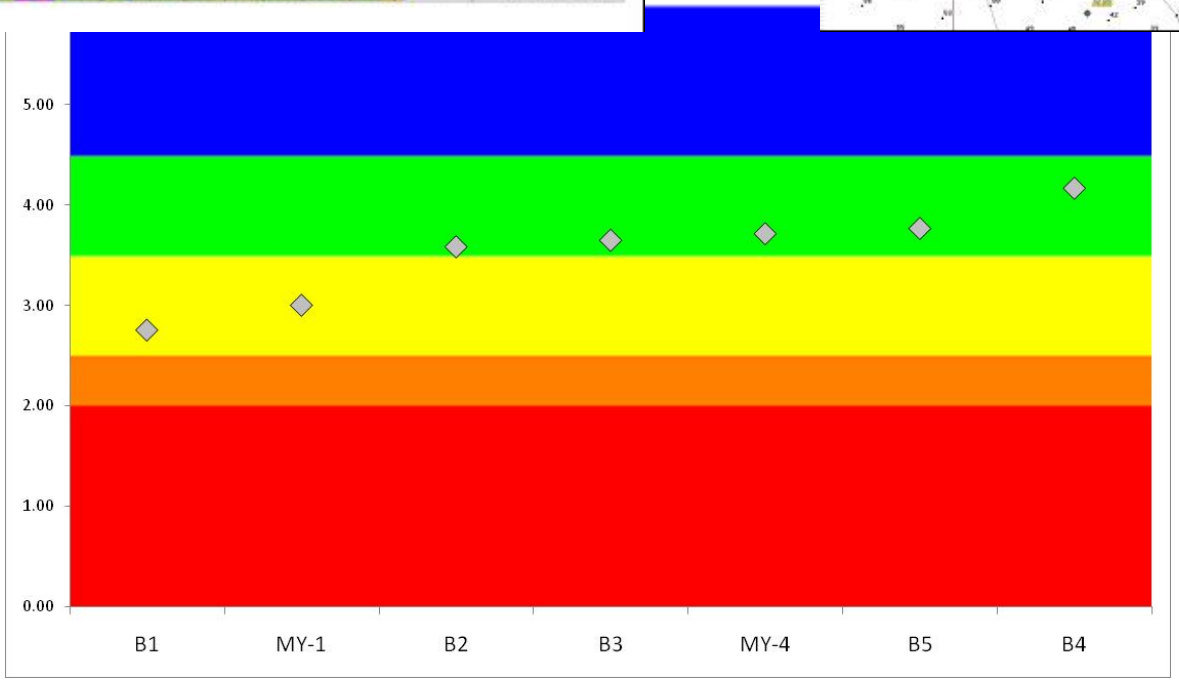

Messiniakos gulf Treatment sewage plant
6,00
5,00
4,00
3,00
2,00
1,00
0,00
M20-2010
M19-2010
M22-2006
M21-2010
M13-2010
M13-2006
M2-2006
M20-2006
M22-2010
M2-2010
37.2°N
37°N
36.8°N
36.6°N
36.4°N
21.4°E
21.6°E
21.8°E
22°E
22.2°E
22.4°E
M20
M19
M22
M17
M13
M16
M11
M02
M04
M06
M24
M26
M25
M23
25 m
50 m
100 m
250 m
500 m
750 m
1000 m
1500 m
2000 m
2500 m
3000 m
4000 m
Ocean Data View

Effects of a desalination plant

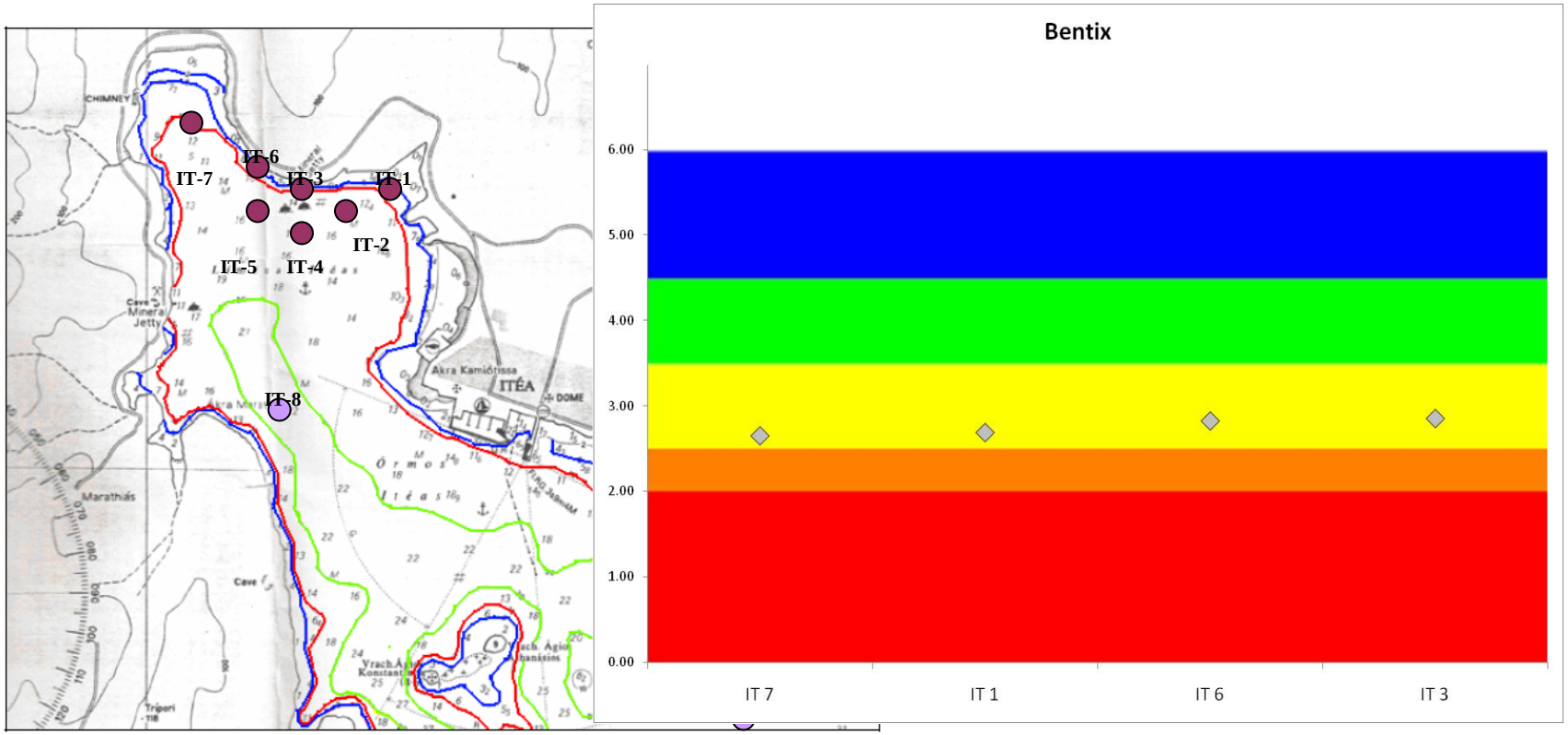


Effects of a cement industry



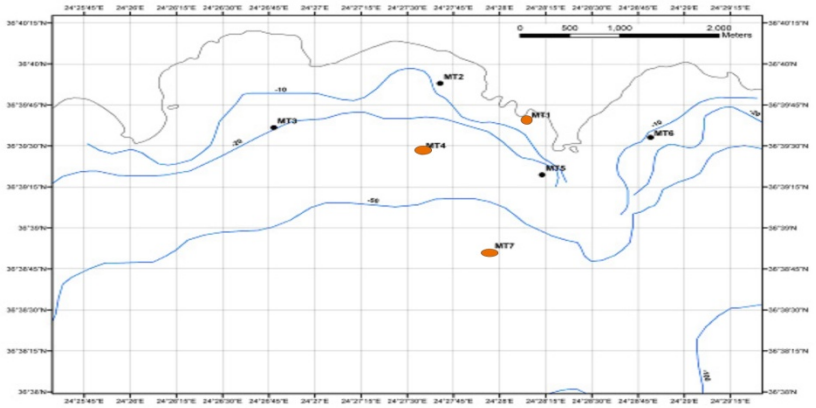


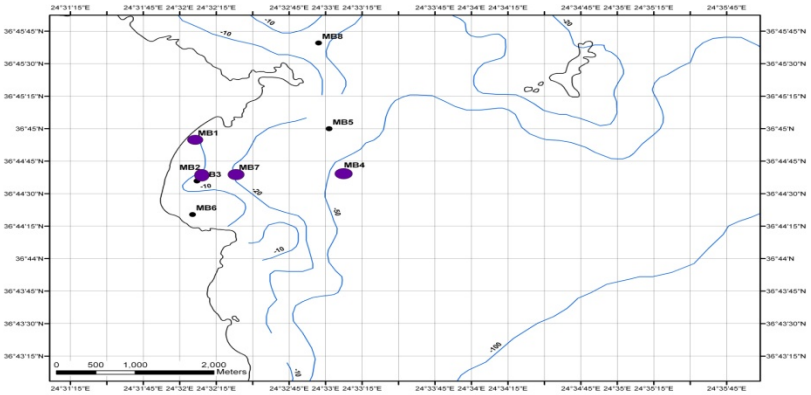
Variation of BENTIX Index in the area

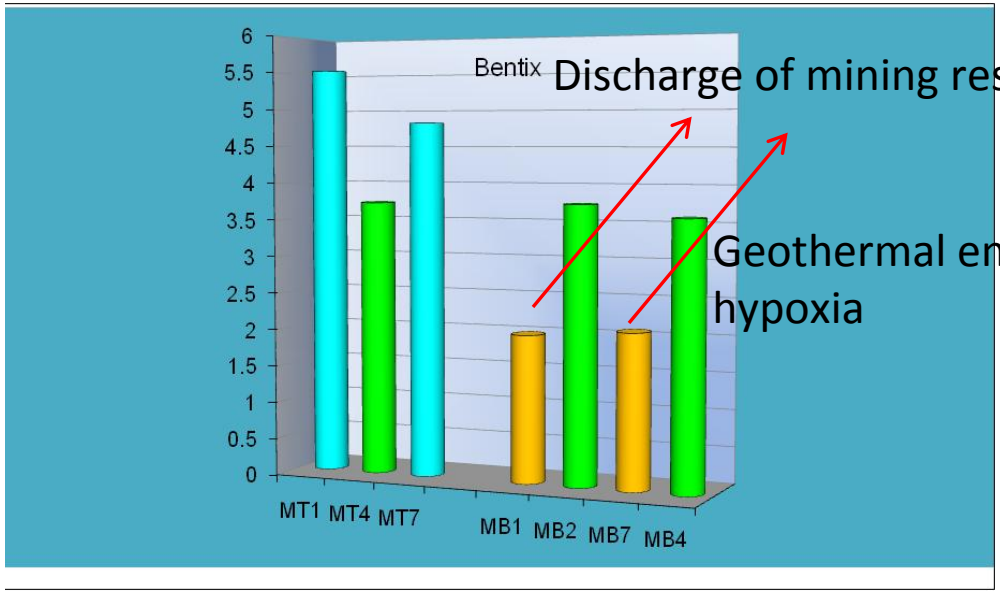


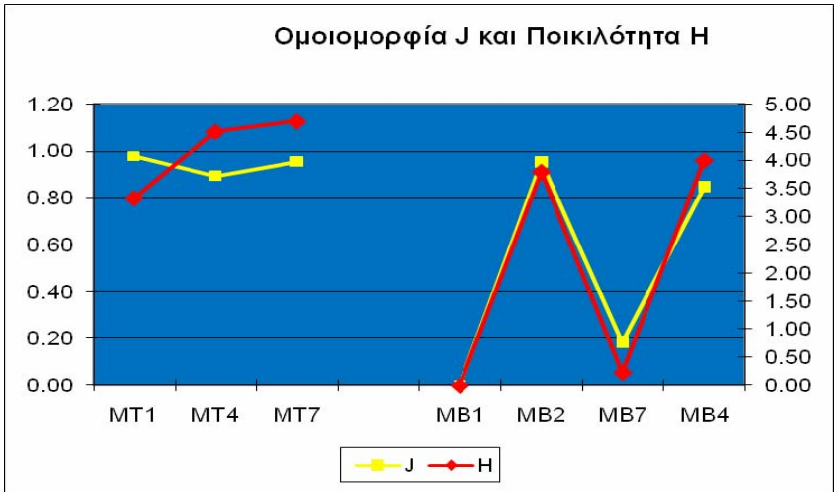
Application of BENTIX in bauxite mining area

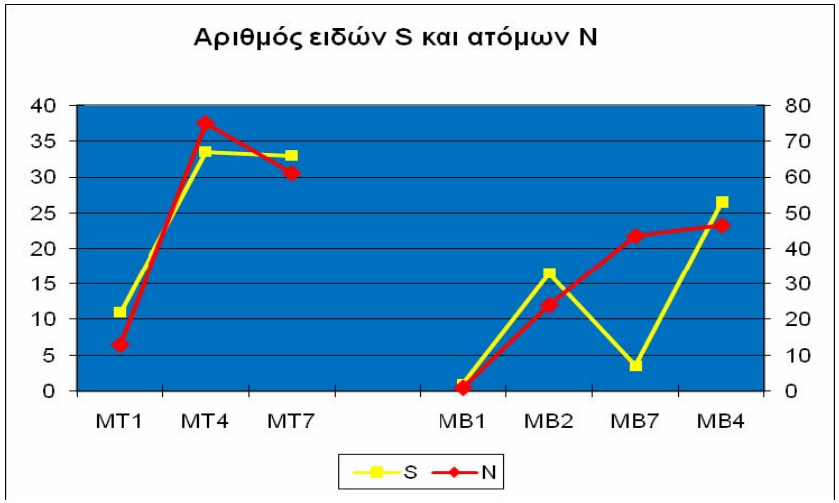
Application of Bentix in industrial mining area of Milos island



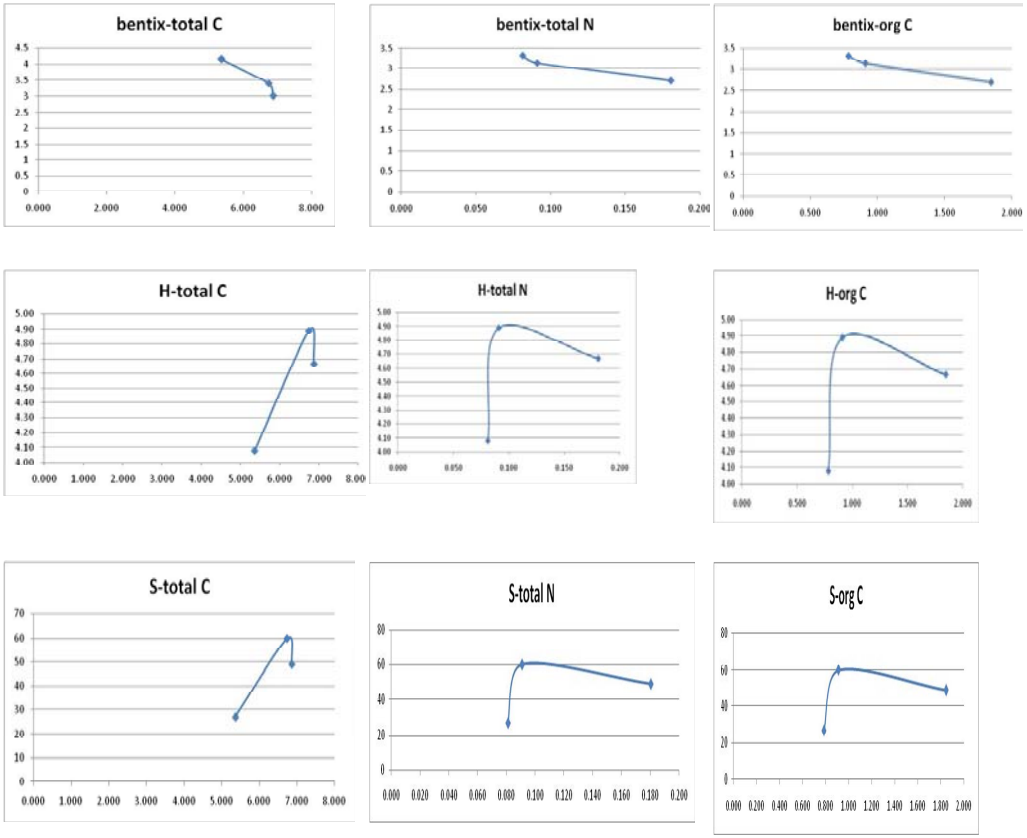


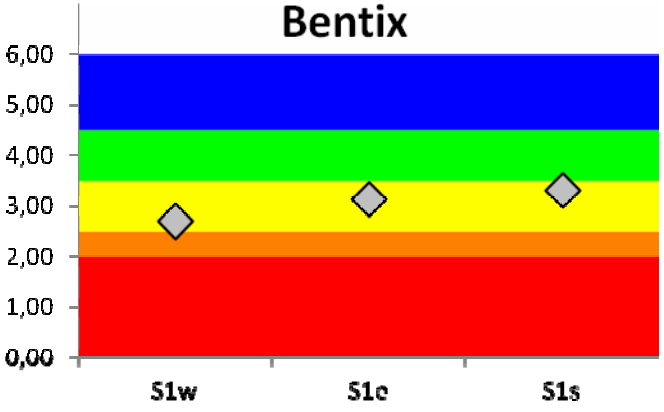






EFFECTS OF TREATMENT PLANT EFFLUENTS IN ELEFSIS BAY





Significant negative correlations among BENTIX and OC% in sediments (r=-1.000, p=0.000). On the contrary H' Shannon and species richness S did not correlate or were positive and mostly related to sediment composition (r=0.5000, p=0.4795).

FUTURE DEVELOPMENT IN THE FRAME OF MSFD

Descriptor 6: Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.		
LEVELS/ ATTRIBUTES	**CRITERIA**	**INDICATORS**
Substrate	Change in natural 3-dimensional structure	Spatial extent of benthic habitats
	Degree of alteration of original substrate composition/types	% area with benthic invertebrates known to be associated with particular substrates
	Size of area exposed to pressures known to alter substrate	biomass/production above a given % of undisturbed areas
	Changes in ecological functions provided by substrate features	1-% of area exposed to pressure X above level Y, where X and Y are location specific an take account of different backgrounds
Bio-engineers	Change in number and/or spatial extent of bio-engineers	Abundance of bio-engineer species
	Change in availability of functions served by bioengineers	Extent of habitats used by or provided by bio-engineers
	Size of area exposed to pressures known to alter substrate or harm bio-engineers directly	1-% of area exposed to pressure X above level Y, where X and Y are location specific an take account of different backgrounds
Oxygen	Changing oxygen concentration of bottom water and/or upper sediment layer	Extent of area with spatial and temporal hypoxia
		Ratios of oxygen / hydrogen sulphide concentrations
		Presence of benthic communities associated with low oxygen conditions
Contaminants	See TG 8	See TG 8
	Accumulation of contaminants in sediment and biota	
Species composition of benthos	The number of species in the benthic community	Diversity and richness indices taking in account also species/area relationships
	The relative abundances of species in the benthic community	Shape of cumulative abundance curves of numbers of individuals by species
	The presence of species know to be particularly sensitive or particularly tolerant to various pressures or to general disturbance regimes	Position of samples in multivariate representations community composition
		Presence of diagnostic species
	Changing proportion of the community comprised of small and large individuals	Proportion of number or biomass above some specified length
		Biomass size spectrum
		Shape of cumulative abundance curves of numbers of individuals by size group
Tropho-dynamics	Rates of Nutrient supply, mobilisation, regeneration in the benthos and sediments	See TG4
	Levels of secondary production in the benthos	
	Changes in carrying capacity	
Life-history traits	Changes in functional diversity	Opportunistic-sensitive species proportion
	Changes in relative abundance of traits associated with opportunistic and sensitive species	(e.g.AMBI)
		Biological traits analysis
		Conceptually possible to apply for changing life history traits within a species (population over time

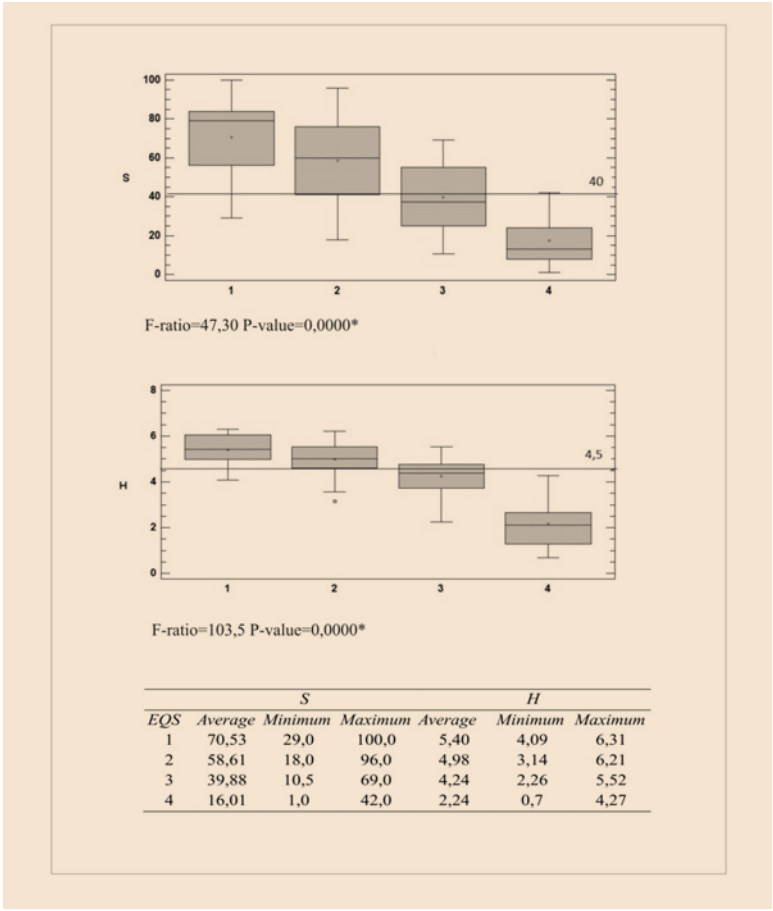
COMMISSION DECISION
of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (2010/477/EU)

Descriptor 6: Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

6.1. Physical damage, having regard to substrate characteristics
— Type, abundance, biomass and areal extent of relevant biogenic substrate (6.1.1)
— Extent of the seabed significantly affected by human activities for the different substrate types (6.1.2).

6.2. Condition of benthic community
— Presence of particularly sensitive and/or tolerant species (6.2.1)
— Multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species (6.2.2)
— Proportion of biomass or number of individuals in the macrobenthos above some specified length/size (6.2.3)
— Parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community (6.2.4).


The Mediterranean Marine Science Journal -HCMR- - Mozilla Firefox
File Edit View History Bookmarks Tools Help
The Mediterranean Marine Science Journal -...
www.medit-mar-sc.net/articleview2.php?id=651
Most Visited Getting Started Latest Headlines 657-663.pdf (applicati... Αρχική σελίδα του Mo...
HCMR
MEDITERRANEAN MARINE SCIENC
HCMR Library Contact Us
Search
Home
About the Journal
Instructions to Authors
Monographs and Other Special Publications
Hellenic Seas indicators for Sea-floor integrity unde the European Marine Strategy Framework Directive setting the thresholds and standards for Good Environmental Status
N. SIMBOURA, A. ZENETOS, M.A. PANCUCCI-PAPADOPOULOU, S. REIZOPOULC and N. STREFTARIS
Medit. Mar. Sci. 13 (1): xx-xx
Research Article
Abstract
A dataset of 625 samples of benthic macroinvertebrates collected from the Hellenic seas (Ionian and Aegean) w used to set thresholds and reference standards for two of the indicators addressing the Descriptors of Sea-fl integrity under the Marine Strategy Framework Directive (MSFD): species diversity and richness and proportio sensitive to tolerant species. The dataset was categorized according to the baseline ecological status assessm of the respective water bodies under the Water Framework Directive (WFD). Regarding the species diversity richness, the indices of Shannon Diversity and Species richness were analysed for three pre-defined substr types, three depth zones and three sample-size categories and significant categories were statistically validat



	S			H		
EQS	*Average*	*Minimum*	*Maximum*	*Average*	*Minimum*	*Maximum*
1	70,53	29,0	100,0	5,40	4,09	6,31
2	58,61	18,0	96,0	4,98	3,14	6,21
3	39,88	10,5	69,0	4,24	2,26	5,52
4	16,01	1,0	42,0	2,24	0,7	4,27

Figure 1. Boxplots and results of an analysis of variance of S and H across ecological quality classes for standard sample size, coastal zone and heterogeneous substrata (ecotype B).

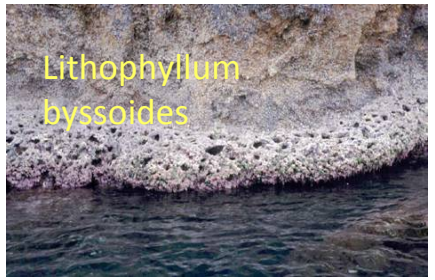
PHYTOBENTHOS

MACROALGAE

+pollution

Pollution gradient

-pollution



-sensitivity

Sensitivity gradient

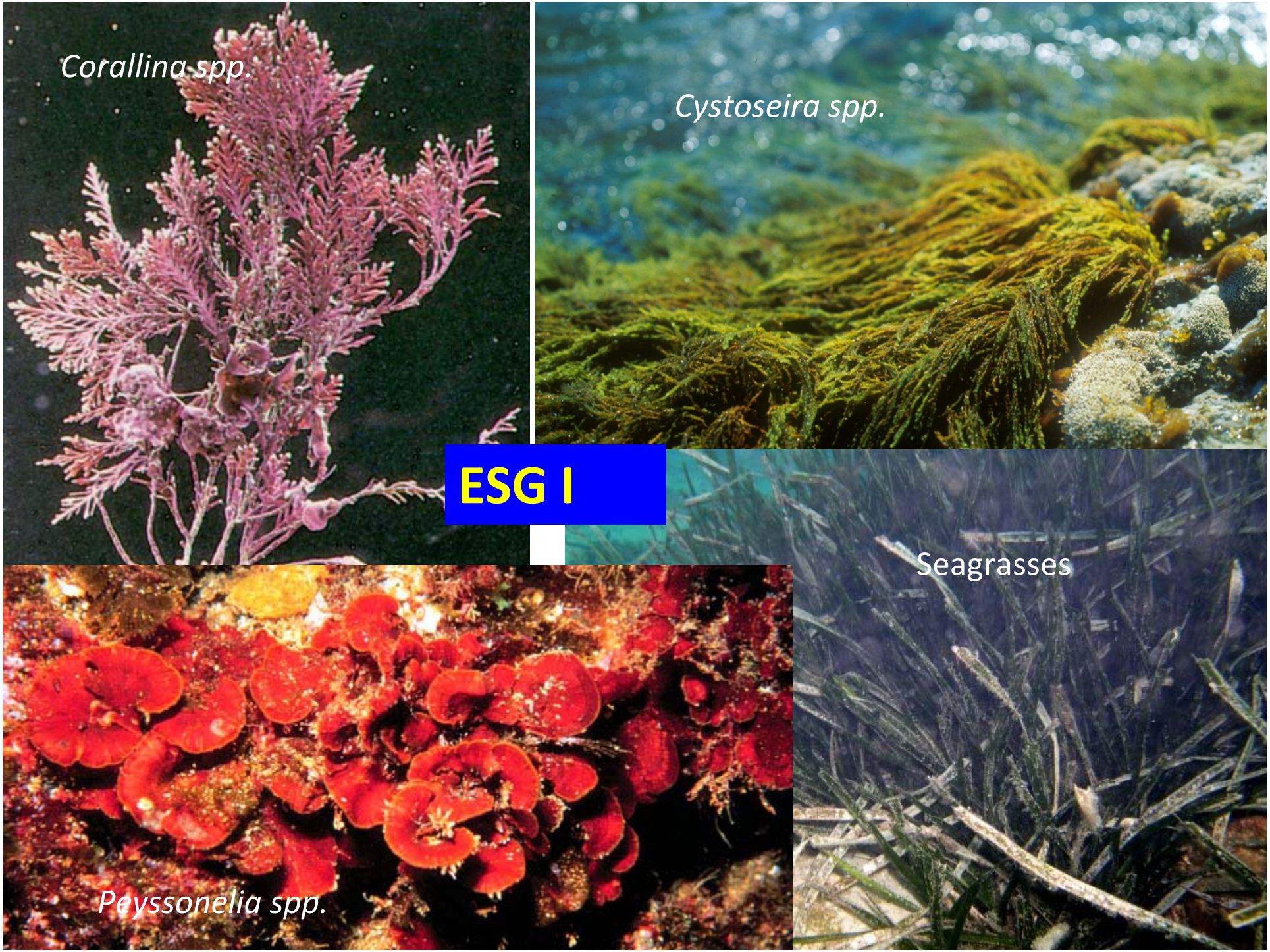
+sensitivity

Benthic communities reflect the environmental changes of littoral waters quality

ECOLOGICAL EVALUATION INDEX-EEI

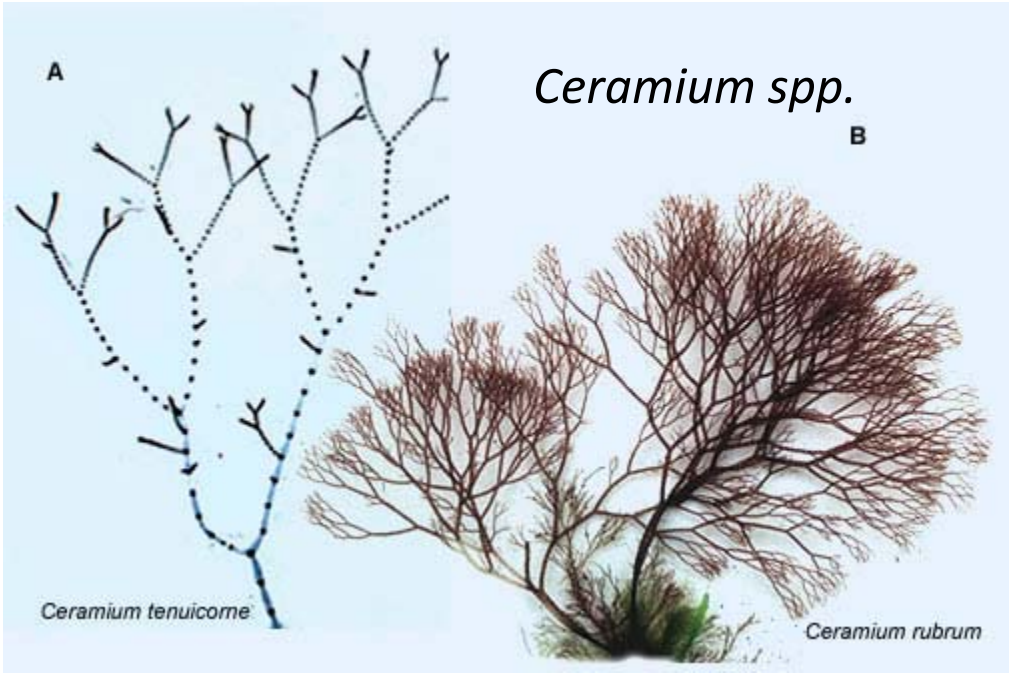
Orfanidis S., Panayotidis P. & Stamatis N., 2001 Ecological evaluation of transitional and coastal waters: a marine benthic macrophytes-based model, Med. Mar. Science 2(2) 45-65.

ESG II	ESG I
Sheet filamentous coarsely branched groups	Thick leathery, jointed calcareous crustose
High productivity	groups
Annuals	Low productivity
Ruderals	Perennials
e.g. Ulva, Cladophora, Enteromorpha	Competitors
	e.g. Cystoseira, Corralina, Hydolithon


Corallina spp.
Cystoseira spp.
ESG I
Seagrasses
Peyssonelia spp.

ESG II

Ulva spp.



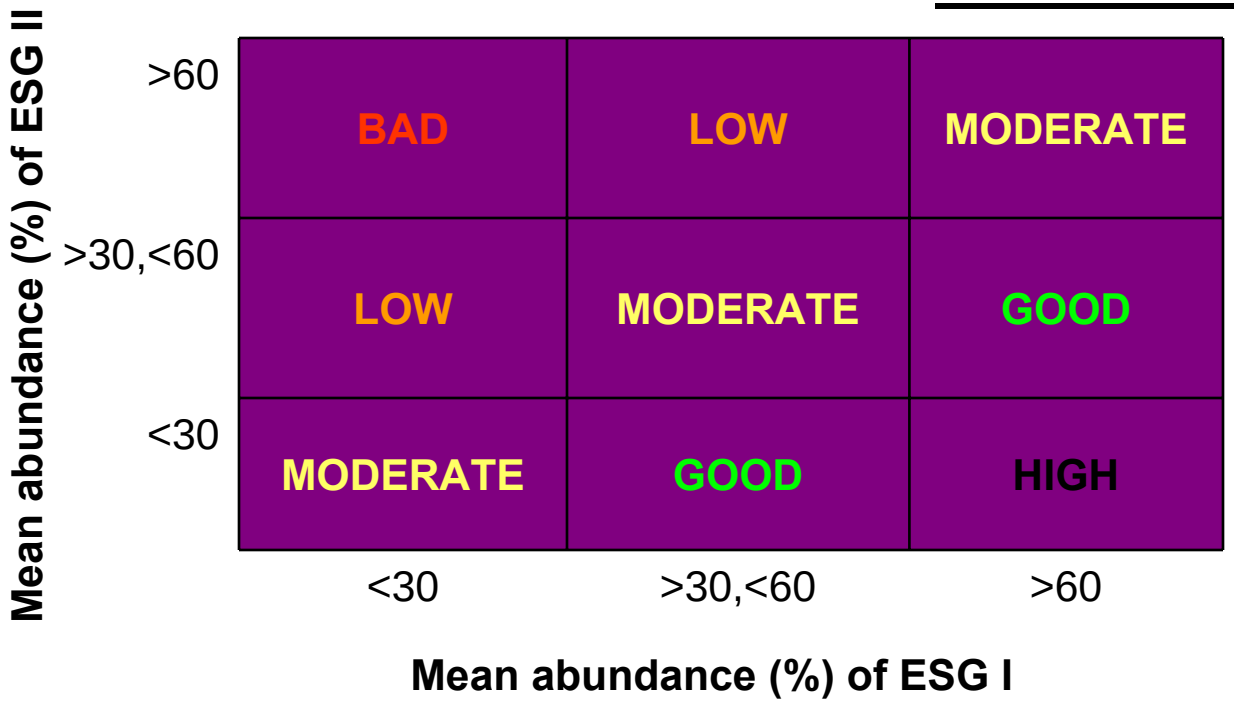
Ceramium spp.

EEI
Ecological Evaluation Index

(Orfanidis et al. 2001)

Ecological State Groups

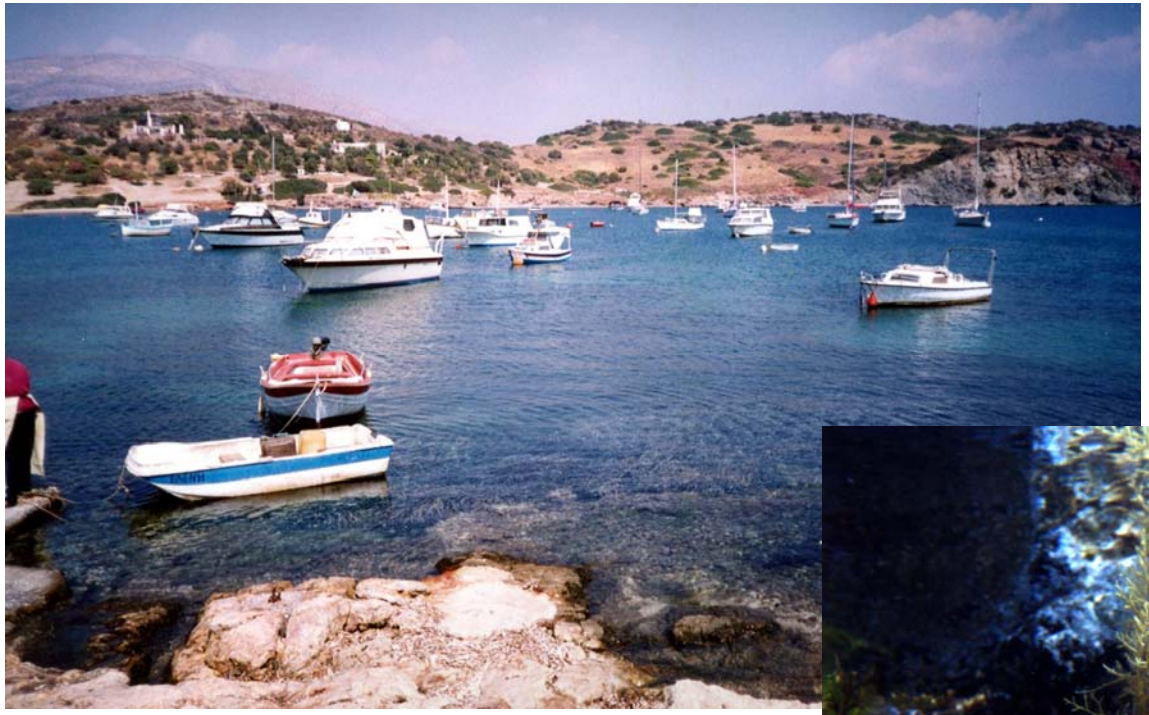
ESG II	ESG I
- Sheet filamentous coarsely branched groups - High productivity - Annuals - Ruderals *e.g. Ulva, Cladophora, Enteromorpha*	- Thick leathery, jointed calcareous, crustose groups - Low productivity - Perennials - Competitors *e.g. Cystoseira, Corralina, Hydolithon*



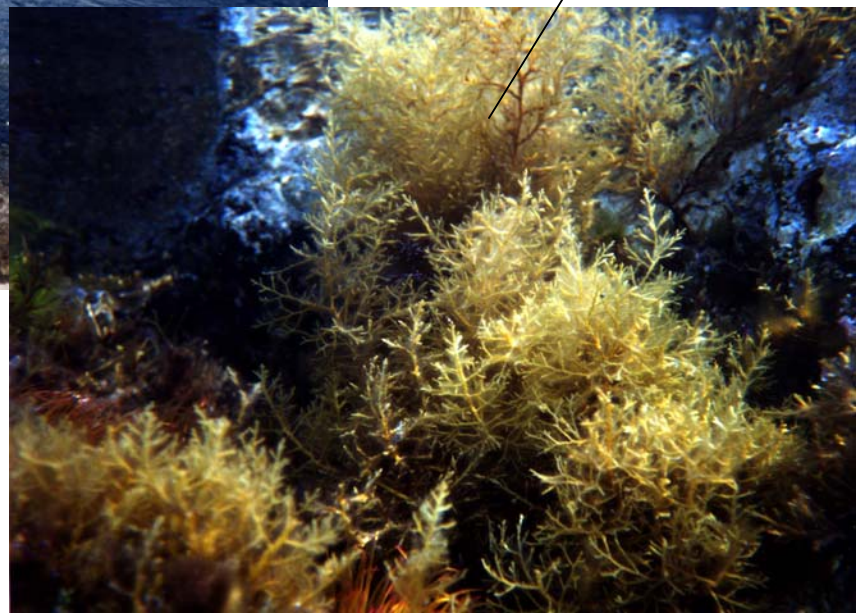
Ecological Evaluation Index (Orfanidis, Panayotidis & Stamatis, 2001

Ecological Status	**EEI range**	**Boundary limits**	**EQR 1,25XEEI-0,25**
High	$10 \leq EEI < 8$	10	1
Good	$8 \leq EEI < 6$	8	0,76
Moderate	$6 \leq EEI < 4$	6	0,48
Poor	$4 \leq EEI < 2$	4	0,25
Bad	2	2	0

Aghios Nikolaos-Reference site-High status



Cystoseira

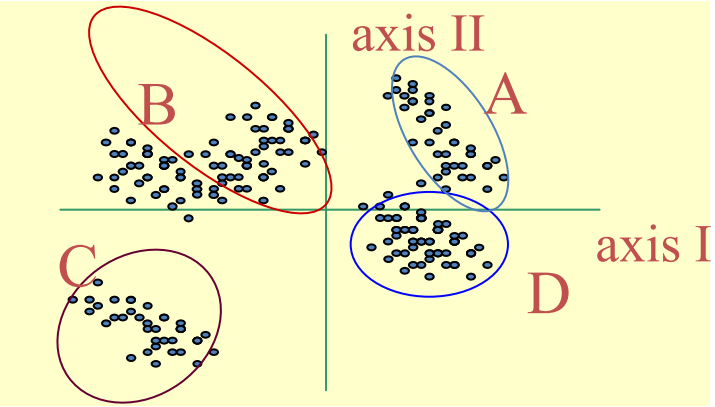


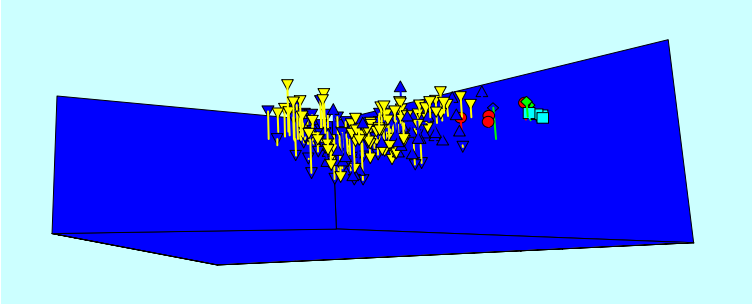
Salamina-Moderate ecological status

Ulva sp.

BENTHOS - CARLIT

Pinedo *et al*, 2006 **Ballesteros *et al*, 2006**





"Sensitivity level (SL)" is quoted from 1 to 20 for every community (worst to the best) based on "expert" judgement

Description	Code	Sensitivity Level
Cystoseira 5	Cs5	20
Cystoseira 5 withTrottoir	Cs5+T	20
Cystoseira 4-5	Cs4-5	19
Cystoseira 4 with Trottoir	Cs4+T	19
Cystoseira 4	Cs4	18
"Trottoir"	T	18
Cystoseira 3 with "Trottoir"	Cs3+T	18
Cystoseira 5 with Ulvacean algae	Cs5+U	18
Cystos		
Cystos		
Cystos		
Cystos		
Cystos		
Cystos		
Cysto		
Cystos		
"Trottoir" with *Corallina elongata*	T+Co	12
Cystoseira 1-2	Cs1-2	11
Cystoseira 1	Cs1	10
Cystoseira 2 with Ulvacean algae	Cs2+U	10
Corallina elongata	Co	8
Cystoseira 1 with Ulvacean algae	Cs1+U	8
Corallina with Mytilus	Co+M	7
Mytilus	M	6
Lithophyllum incrustans	L	6
Ulvacean algae	U	3
Blue-green algae	Cy	1

$$EQV = \frac{\sum (l_i * SL_i)}{\sum l_i}$$

Data analysis

-Species x stations

-Multivariate methods (DCA, CA, MDS)

Environmental and biological variables: Pearson correlations, ANOVAs, DCCA, CCA

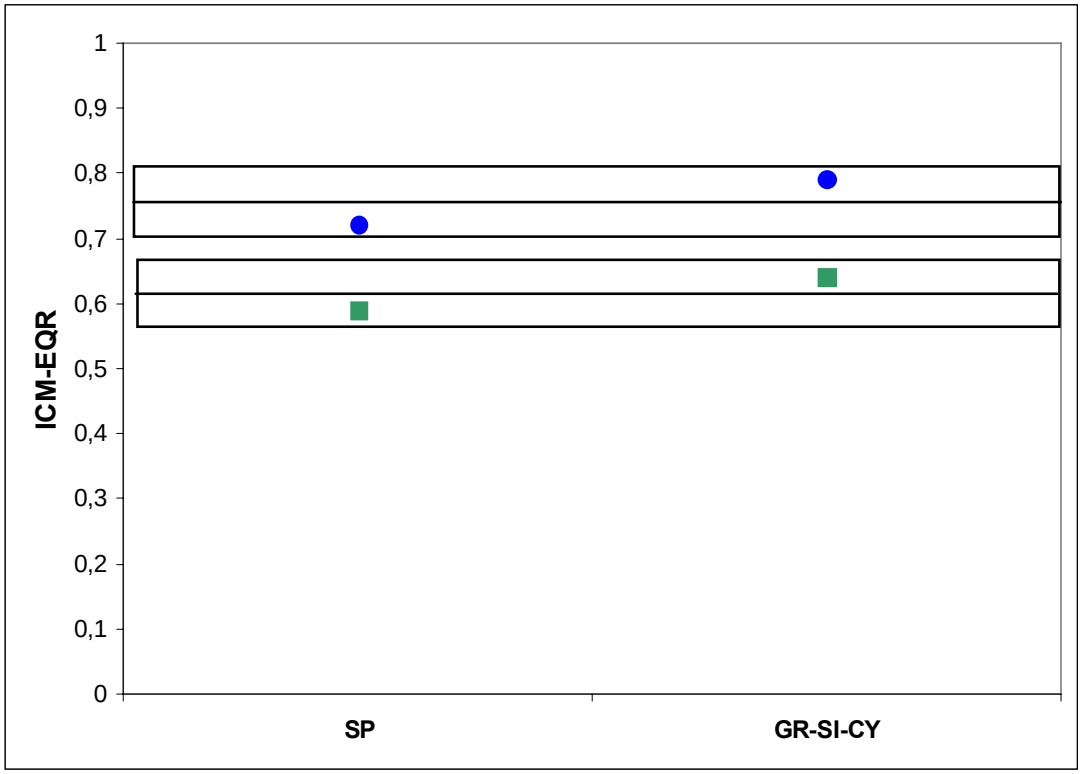
Biological Quality Element	Macroalgae

Results coastal waters: Ecological quality ratios of national classification systems

The following results apply to the upper infralittoral zone (3.5 – 0.2 m depth) in rocky coasts:

Country	National classification systems intercalibrated	Ecological Quality Ratios	
		High-Good boundary	Good-Moderate boundary
Cyprus	EEI-c - Ecological Evaluation Index	0.76	0.48
France	CARLIT - Cartography of Littoral and upper-sublittoral rocky-shore communities	0.75	0.60
Greece	EEI-c - Ecological Evaluation Index	0.76	0.48
Italy	CARLIT - Cartography of Littoral and upper-sublittoral rocky-shore communities	0.75	0.60
Slovenia	EEI-c - Ecological Evaluation Index	0.76	0.48
Spain	CARLIT - Cartography of Littoral and upper-sublittoral rocky-shore communities	0.75	0.60

BENTHOS was used as a common metric (Option 2 of the ECOSTAT WG Guidance) to fulfil the purposes of the intercalibration exercise



Compatibility (±5%) of CARLIT (Spain) and EEI (Greece, Slovenia and Cyprus) EQR High/Good and Good/Moderate values.

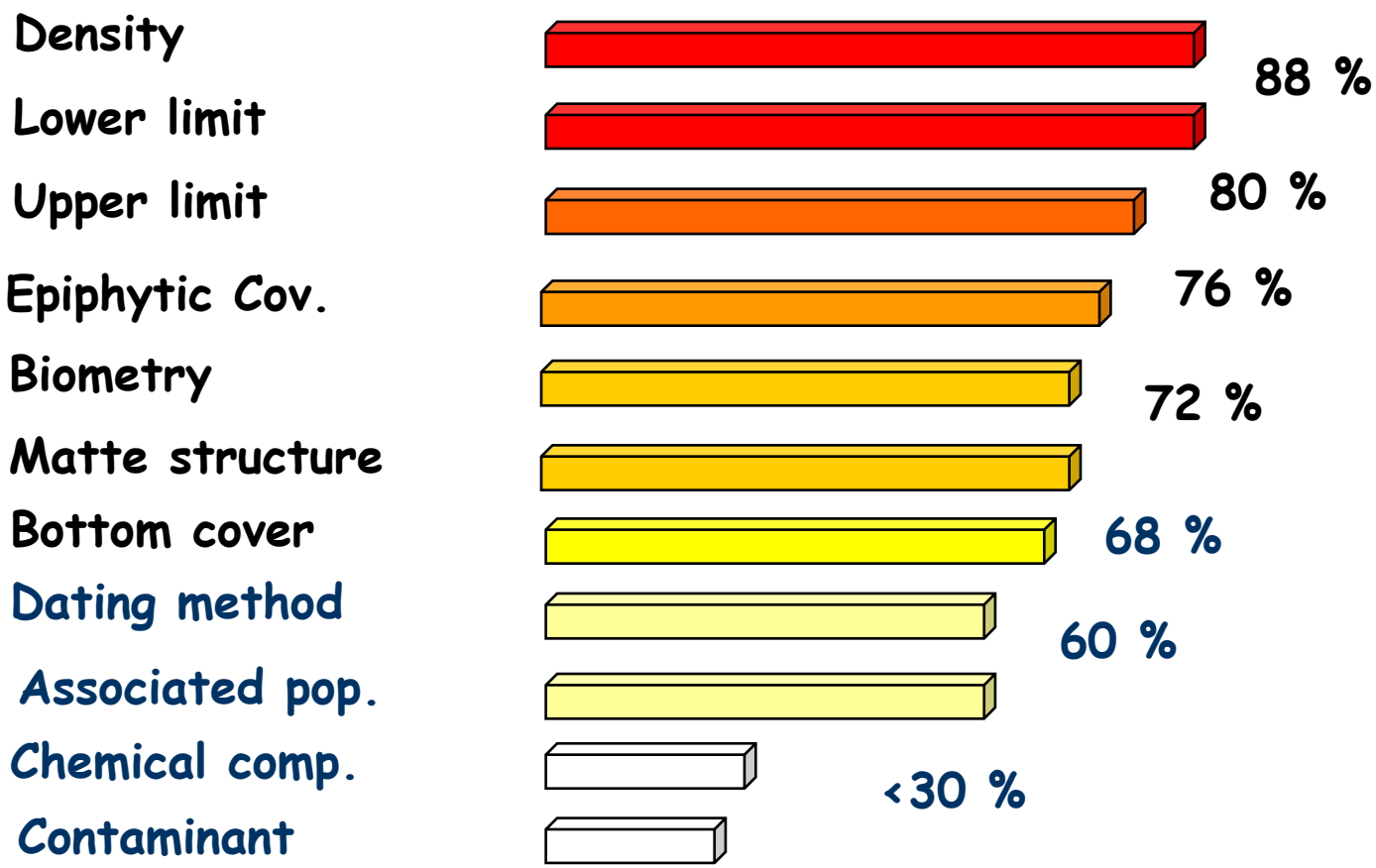
Both CARLIT (Spain) and EEI (Greece, Slovenia and Cyprus) EQR High/Good and Good/Moderate values were inside the +5% interval thus fulfilling the comparability criteria set by ECOSTAT

ANGIOSPERMS

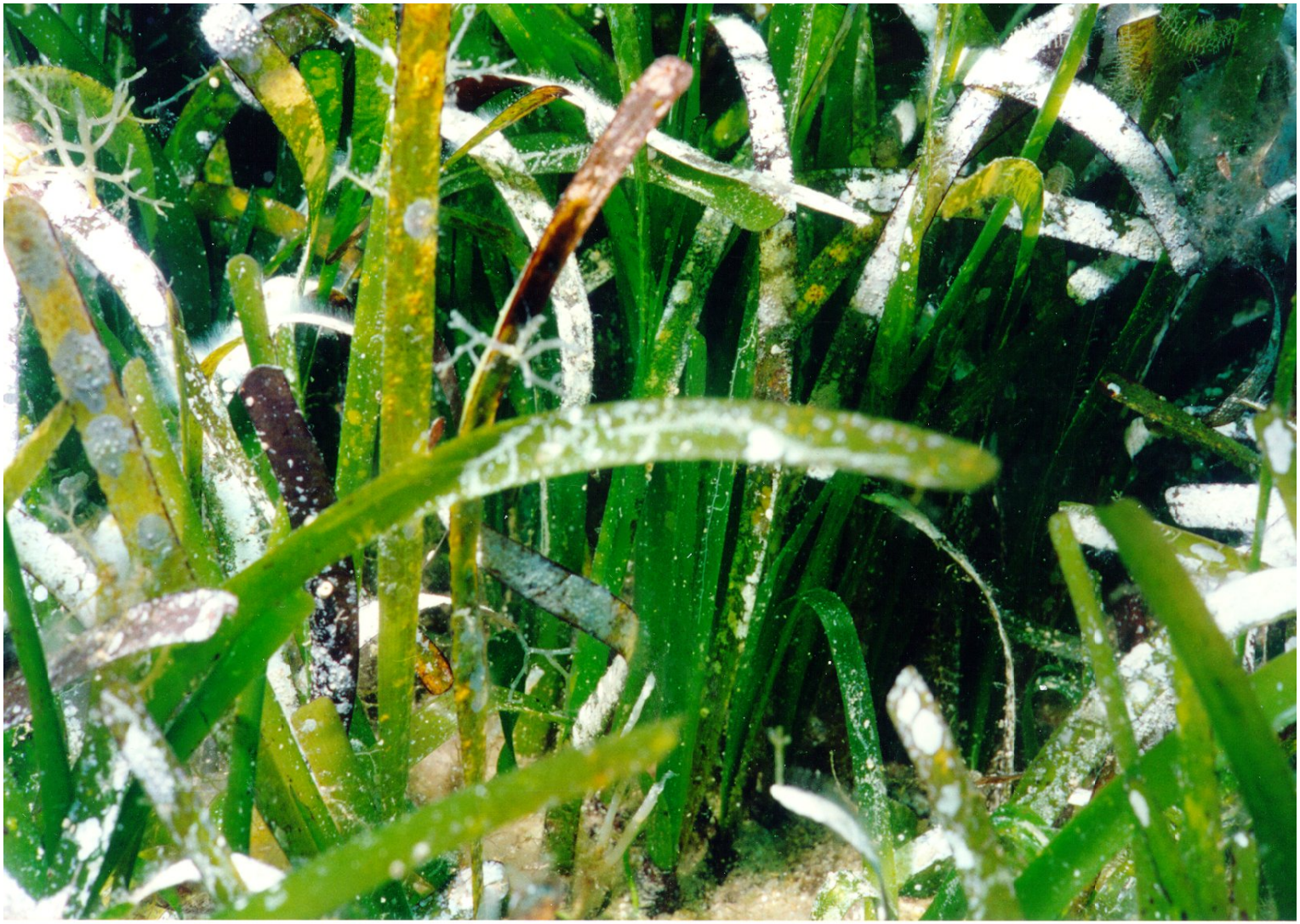

Posidonia oceanica

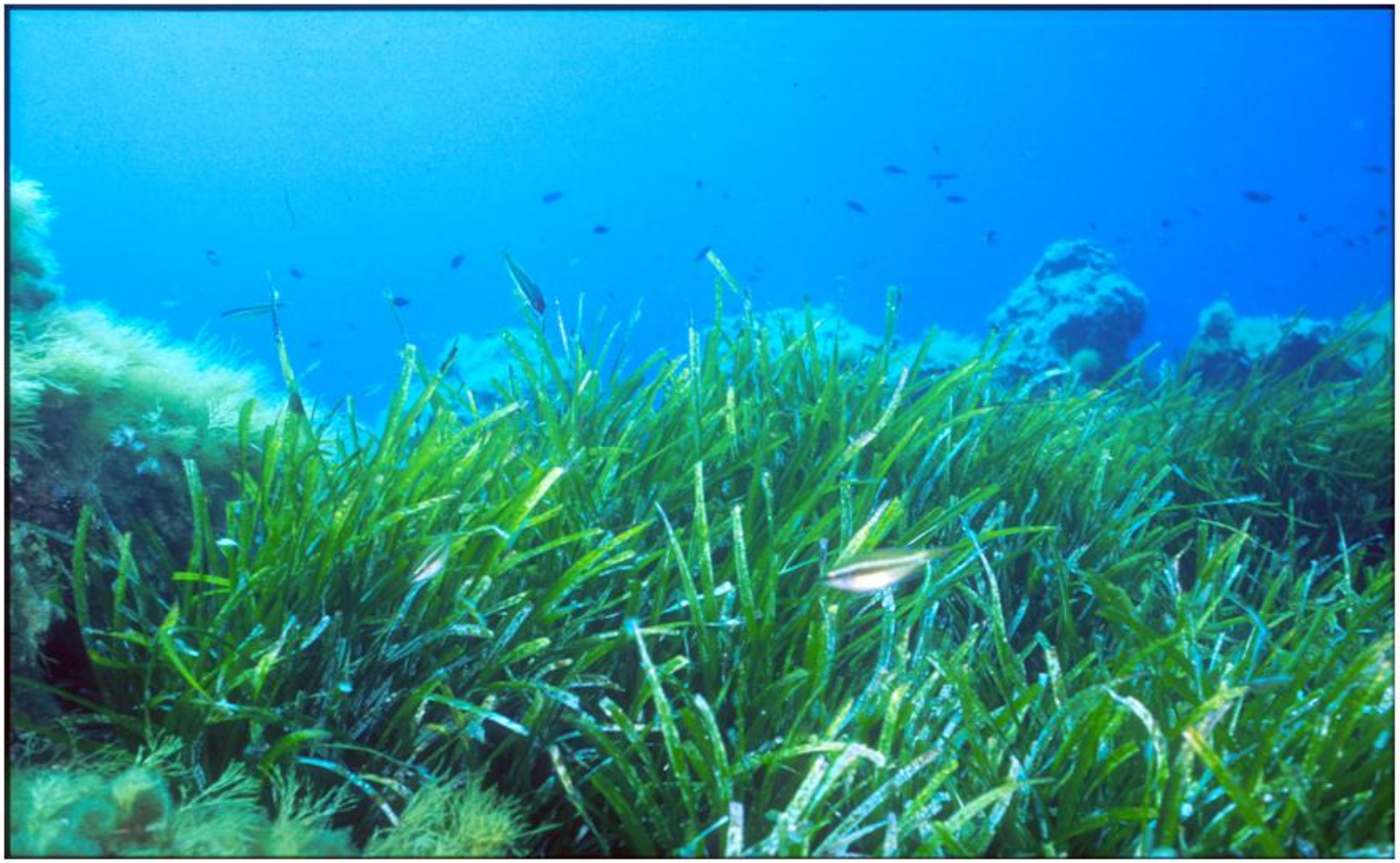
Identification of suitable descriptors

65 % of replies (10 nations, 25 centers) & general agreement



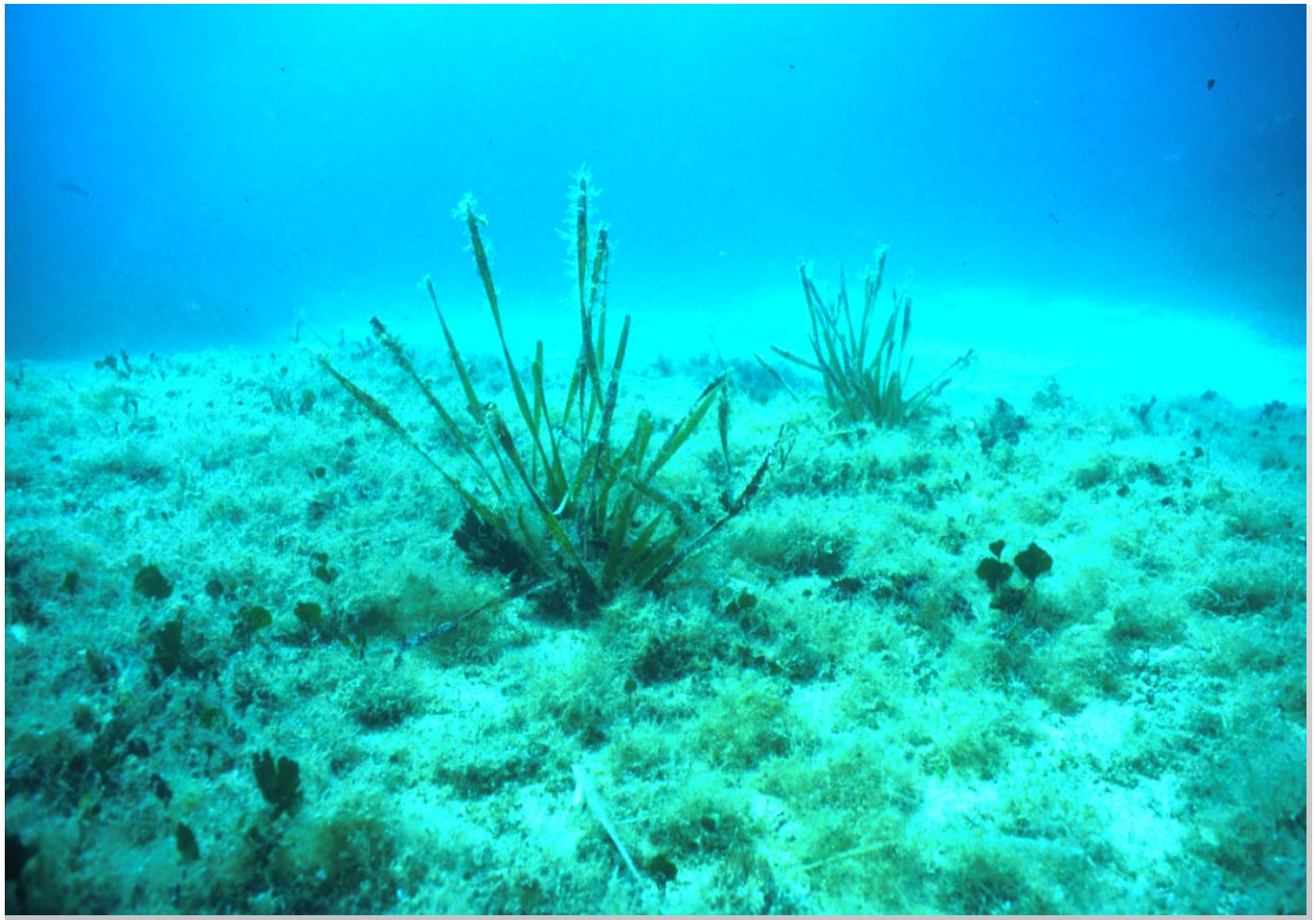
Posidonia *high status*





Non or slightly disturbed

Posidonia-*Degraded meadow*

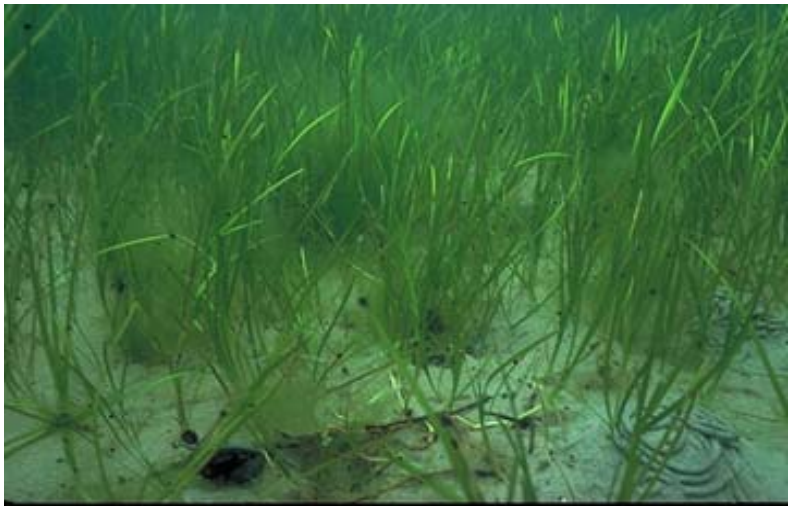


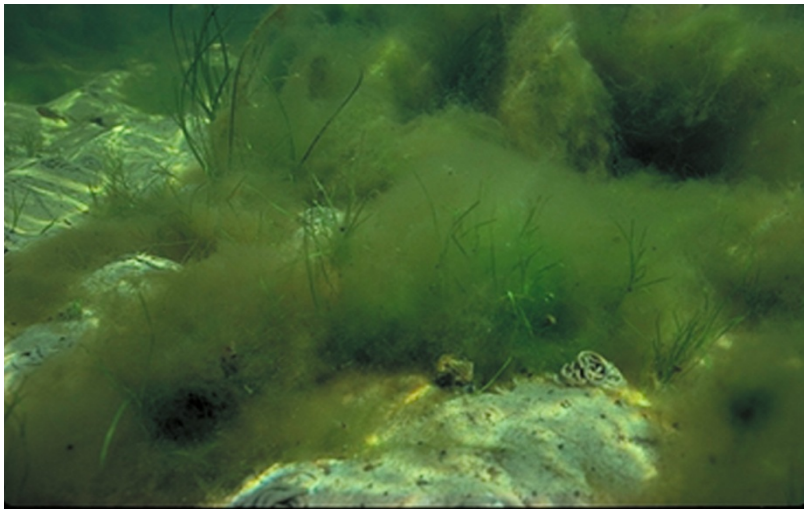
Heavily disturbed

Depth limit of Zostera- Ecological (Danish-fjords)

Lower depth limit: 4µ-Reference state

Gradual degradation of Zostera bed. Lower depth limit, 3m, 25% max deviation from Ref cond. –boundary of good/moderate status





ANGIOSPERMS

BQE 4: Angiosperm	*Assessment Method*	*Status*	*Reference*
France	PREI	Finalised	Gobert et al ., 2007
Italy	Posware	Finalised	Buia et al., 2005
Spain – Catalonia	POMI	Officially accepted	Romero et al., 2007
Spain - Valencia	Valencian CS	Finalised	Fernandez Torquemada et al., 2008

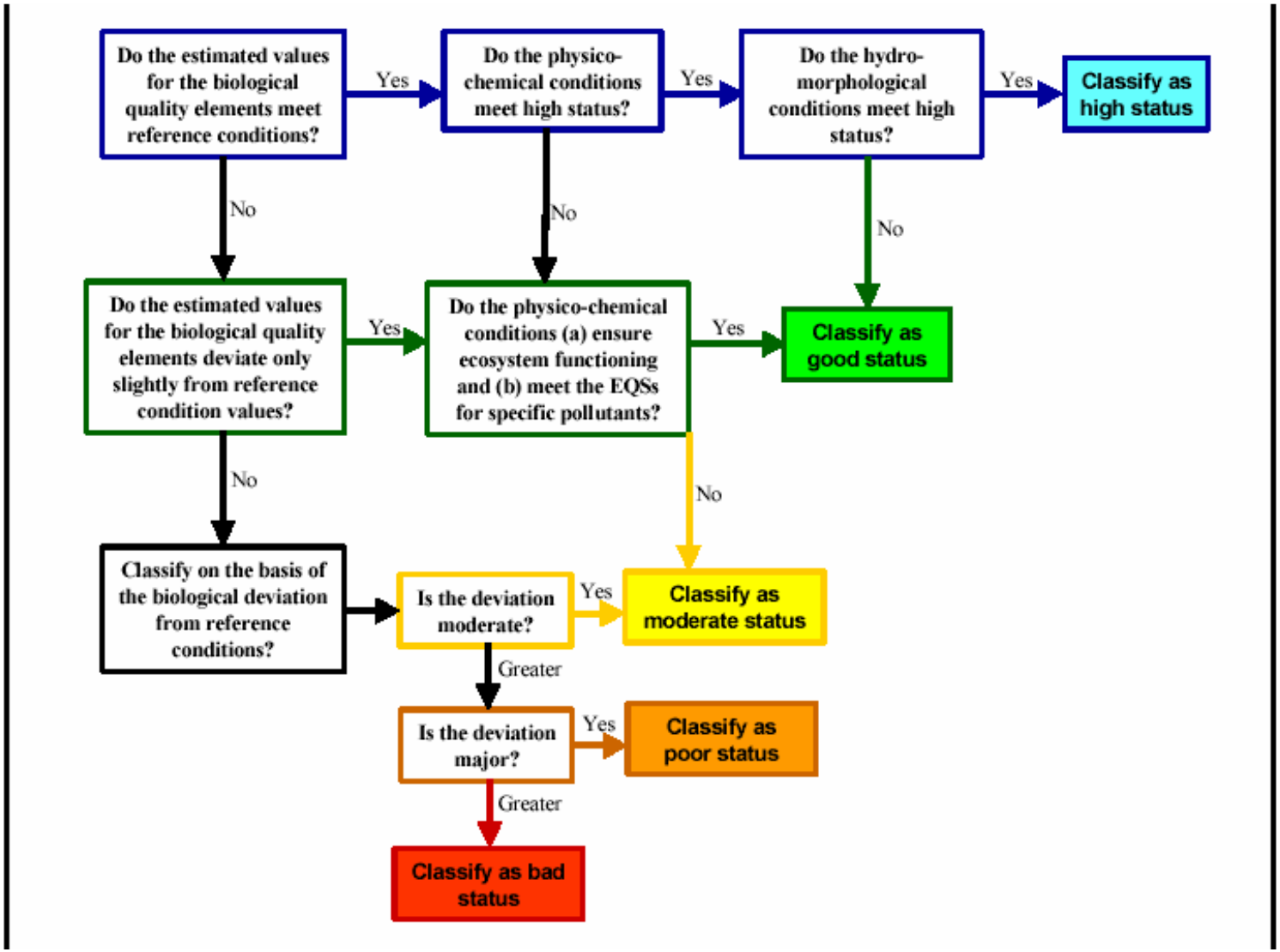
Table 1. National Classification systems intercalibrated for the angiosperms QE.

BiPo index (Lopez y Royo et al.,) 2008 based on
- Lower limit depth (m)
- Type of limit
- Shoot density
- Shoot leaf density

Results coastal waters: Ecological quality ratios of national classification systems

Country	National classification systems intercalibrated	Ecological Quality Ratios	
		High-Good boundary	Good-Moderate boundary
Cyprus	PREI - Posidonia oceanica Rapid Easy Index	0.775	0.55
France	PREI - Posidonia oceanica Rapid Easy Index	0.775	0.55
Italy	PREI - Posidonia oceanica Rapid Easy Index	0.775	0.55
Spain (Catalonia, Balearic Islands, Murcia, Andalucia)	POMI - Posidonia oceanica Multivariate Index	0.775	0.55
Spain (Valencia)	Valencian-CS	0.775	0.55

Ecological status following One-out All-out principle for the biological elements
Global classification of ecological and physico-chemical and hydromorphological status



Assessing the integrative ecological status

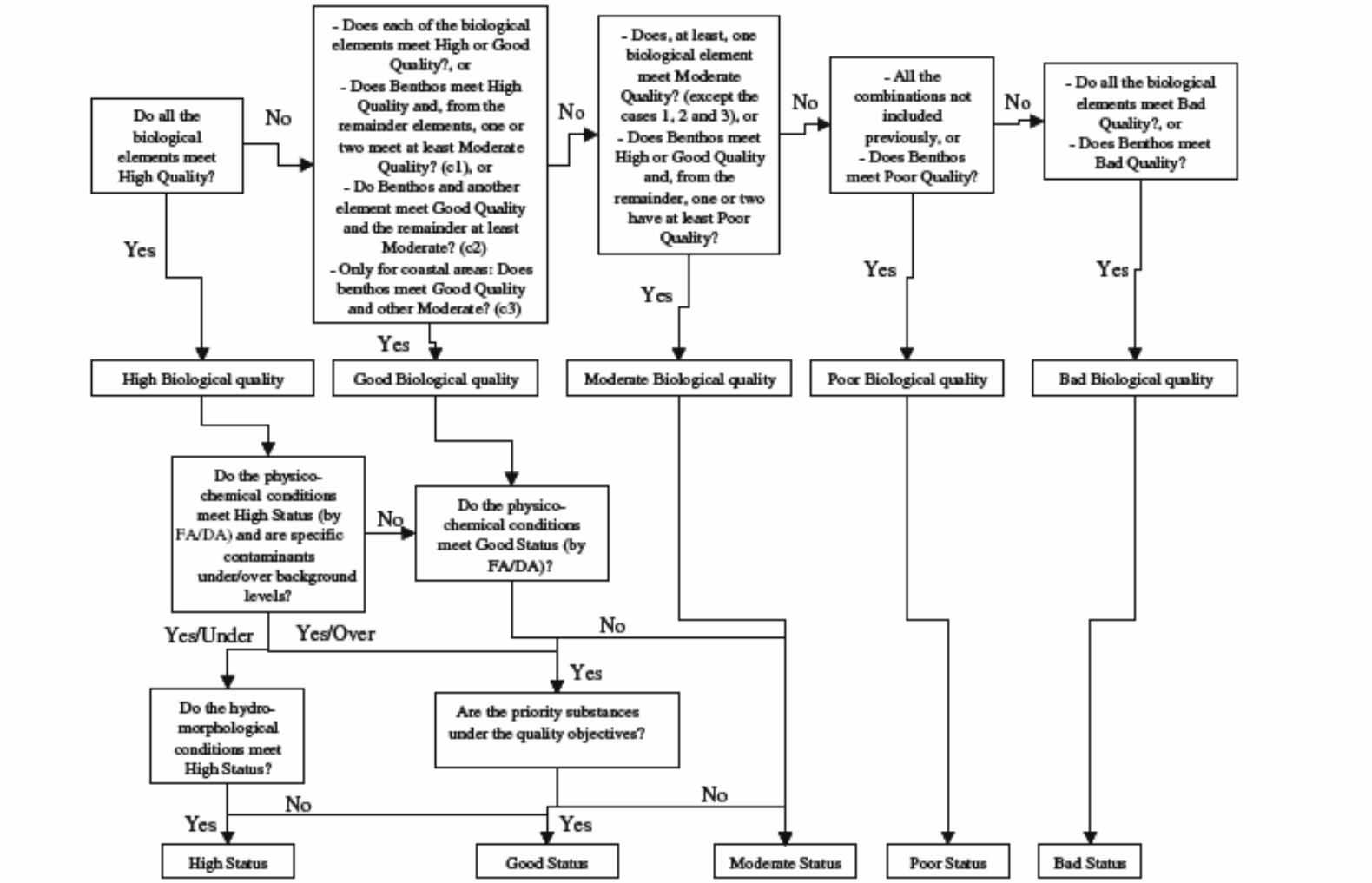
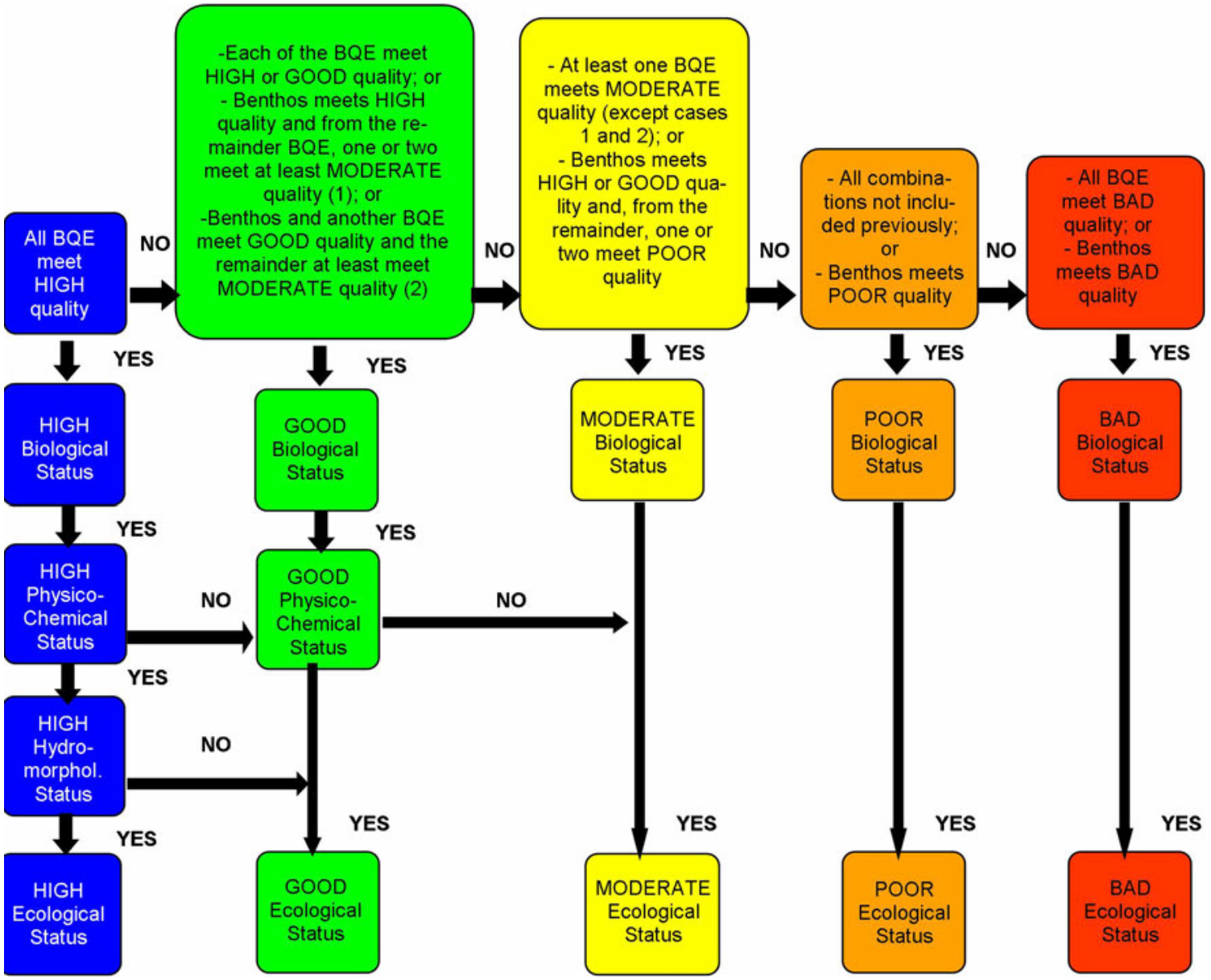


Fig. 2. 'Decision-tree' used in assessing the integrative ecological status, within the Water Framework Directive (modified from Borja et al. (2004a)). *Key*: FA/DA – factor analysis/discriminant analysis; c-cases.

Decision tree From: Borja et al., 2009, MPB



"Decision-tree" used in assessing the ecological status (based only on eutrophication related quality elements), within the Water Framework Directive (adapted from Borja et al. 2009a, b). BQE: Biological Quality Elements. From Garmendia et al., 2012. Estuaries &

Integration of water, sediment and biomonitors in assessing chemical status under the WFD

Using criteria and scorin

Table 2
Criteria when integrating water and sediments into the assessment of the chemical status, within the Water Framework Directive (WFD) (adapted from Borja et al., 2008b). Note: a variable achieves the chemical status, when the concentration is less than the quality objectives established by the WFD.

Water	Sediment	Status
All variables meet	All variables meet	Achieves
	1 variable does not meet	Achieves
	⩾2 variables do not meet	Fails
1 variable does not meet	All variables meet	Achieves
	1 variable does not meet	Achieves
	⩾2 variables do not meet	Fails

Marine Pollution Bulletin 58 (2009) 1389–1400

Contents lists available at ScienceDirect

Marine Pollution Bulletin

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

ELSEVIER

Integrating long-term water and sediment pollution data, in assessing chemical status within the European Water Framework Directive

Itziar Tueros [a,*], Ángel Borja [a], Joana Larreta [a], J. Germán Rodríguez [a], Victoriano Valencia [a], Esmeralda Millán [b]

[a] AZTI-Tecnalia Foundation, Marine Research Division, Herrera Kaia, Portualdea, s/n, 20110 Pasaia, Spain
[b] Departamento de Química Aplicada (Química Analítica), Facultad de Química, Universidad del País Vasco, Apartado 1072, 20080 San Sebastián, Spain

Table 1
Example of the calculation of the integrative index of quality (IIQ) for two locations, based upon different variables and matrices (modified from Franco et al., 2004)

Matrix	Variables	Location 1		Location 2	
		Classification	Score	Classification	Score
Case a: without weighting					
Water	Basic variables	Moderate	3	Good	4
	Heavy metals	Poor	2	Good	4
	Organic compounds	Good	4	Bad	1
Sediment	Heavy metals	Moderate	3	Bad	1
	Organic compounds	High	5	Poor	2
Biomonitors	Heavy metals	Poor	2	Bad	1
	Organic compounds	High	5	Bad	1
Total scores for water only			9		9
Classification over 15 scores for water only			Moderate		Moderate
Total scores (IIQ)			24		14
Classification over 35 scores:			Moderate		Poor
Case b: weighting sediment and biomonitors					
Water	Basic variables	Moderate	3	Good	4
	Heavy metals	Poor	2	Good	4
	Organic compounds	Good	4	Bad	1
Sediment	Heavy metals	Moderate	3×3 = 9	Bad	1×3 = 3
	Organic compounds	High	5×3 = 15	Poor	2×3 = 6
Biomonitors	Heavy metals	Poor	2×2 = 4	Bad	1×2 = 2
	Organic compounds	High	5×2 = 10	Bad	1×2 = 2
Total scores (IIQ)			47		22
Classification over 65 scores:			Good		Bad

Case 'a' was derived without weighting the scores, in Case 'b', sediment was weighted×3 and biomonitors×2. Basic variables can include: Secchi disc, nutrients, dissolved oxygen, etc.; heavy metals (the authors include 10); organic compounds, which can include PCB, DDT, PAH, HCH, HCB, etc. Classification key: Case 'a': high—31–35 scores; good—25–30; moderate—19–24; poor—13–18; bad—7–12; Case 'b': high—57–65 scores; good—46–56; moderate—35–45; poor—24–34; and bad—13–23.

ELSEVIER

Available online at www.sciencedirect.com
SCIENCE DIRECT®
Marine Pollution Bulletin 49 (2004) 8–11
MARINE POLLUTION BULLETIN
www.elsevier.com/locate/marpolbu

Viewpoint

The water framework directive: water alone, or in association with sediment and biota, in determining quality standards?

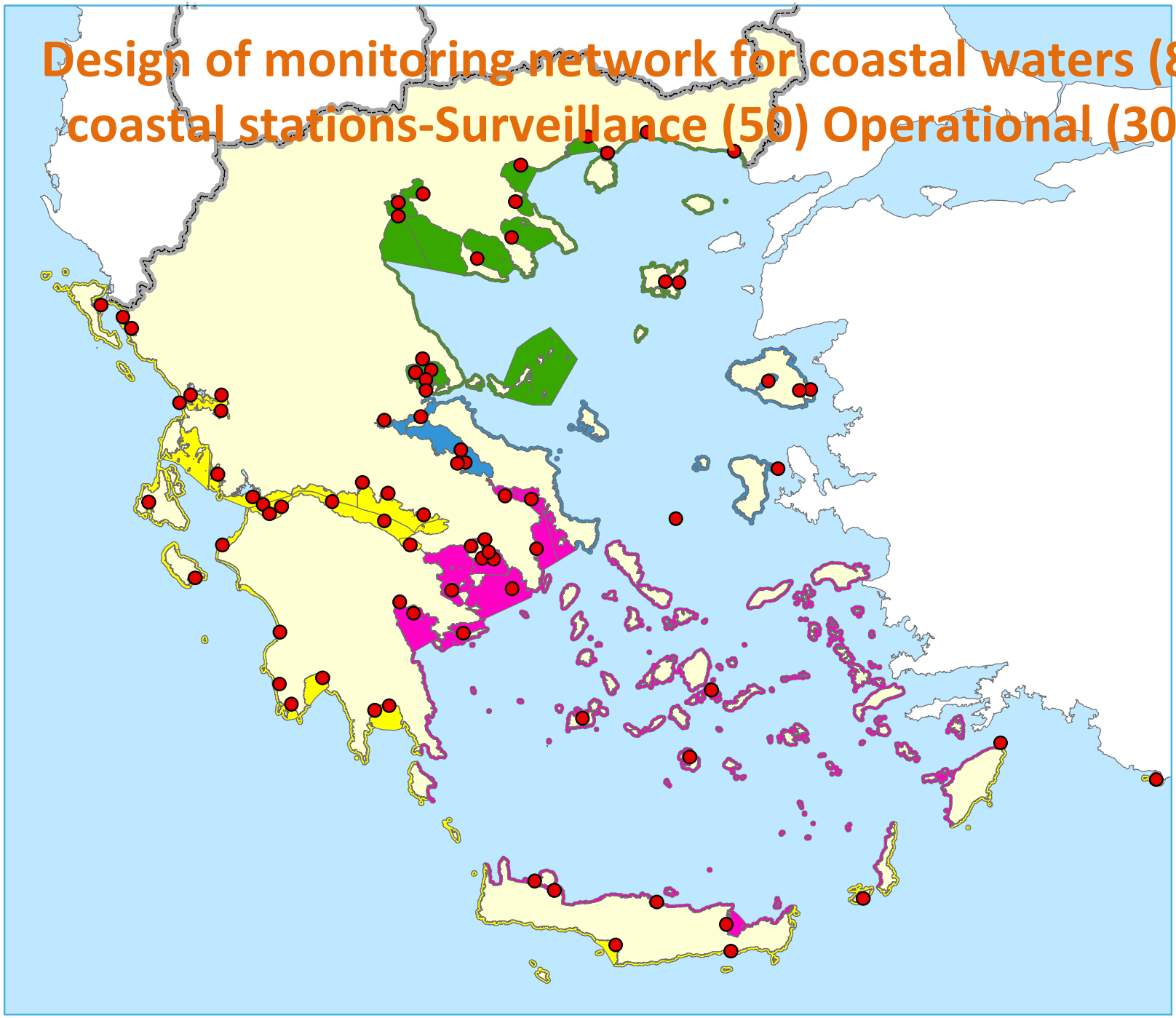
A. Borja *, V. Valencia, J. Franco, I. Muxika, J. Bald, M.J. Belzunce, O. Solaun

AZTI, AZTImar Unit (AZTI Marine Research), Herrera Kaia, Portualdea s/n, 20110 Pasaia, Spain

THE MONITORING

Definition of coastal water bodies in Greece

Design of monitoring network for coastal waters (80 coastal stations-Surveillance (50) Operational (30)



Basic Elements of the Network

- ✓the MEDPOL project monitoring network
- ✓ the WFD Intercalibration network
- ✓the Natura project reference network
- ✓existing research and monitoring projects

Criteria for the selection of the monitoring sites

✓One site per water body is mainly selected in within the known or predicted zone of impact.

✓In areas where a number of site source pressures or diffuse source pressures exist more than one site maybe selected per water body.

✓Types of Monitoring: Operational (stations at risk, visited every year)

✓Surveillance: Stations non at risk visited every 3 years or twice per river basin management plan period (6 years)

Monitoring frequencies (coastal) for both types of monitoring

✓Twice a year (2/y) for phytoplankton

✓Once every 3 years (3y) for phytobenthos and macroinvertebrates

✓Once every 6 years (6y) for hydromorphological elements

✓4 times per year (4/y) for general physicochemical elements

✓4 times per year (4/y) for priority substances and other pollutants with the possibility of future reconsideration of these frequencies depending on the results of this initial monitoring.

Related literature

Ballesteros, E., Torras, X., Pinedo, S., García, M., Mangialajo and L., de Torres, M., 2007. A new methodology based on littoral community cartography dominated by macroalgae for the implementation of the European Water Framework Directive. Marine Pollution Bulletin. 55, 172-180.

Borja, A., Franco J., Perez. V., 2000. Marine Biotic Index to establish the ecological quality of soft bottom benthos within European estuarine and coastal environments. *Mar. Poll. Bull*., 40 (12): 1100-1114.

Borja, A., J. Franco and V. Perez. 2000. Marine Biotic Index to establish the ecological quality of soft bottom benthos within European estuarine and coastal environments. *Mar. Poll. Bull*., 40 (12): 1100-1114.

Borja, A., J. Franco and V. Pérez. 2000. Marine Biotic Index to establish the ecological quality of soft bottom benthos within European estuarine and coastal environments. *Mar. Poll. Bull*., 40 (12): 1100-1114.

EC, 2000. Directive of the European parliament and of the Council 2000/60/EC establishing a framework for community action in the field of Water Policy. PE-CONS 3639/1/00.

EC, 2003. Guidance on typology, reference conditions and classification systems for transitional and coastal waters. Guidance document no5. Produced by: CIS Working Group 2.4. (Coast), Common Implementation Strategy of the Water Framework Directive, European Commisssion, p. 116. http://forum.europa.eu.int/Public/irc/env/wfd/library.

EC (2008). "Commission Decision of 30. October 2008, establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise (notified under document number C(2008) 6016) (2008/915/EC)." Official Journal of the European Union **L332**: 20–44.

GIG (2008). "WFD intercalibration technical report. Part 3 – Coastal and Transitional Waters. Sect. 2 – Benthic invertebrates. Four parts: Mediterranean GIG; Black Sea GIG; North East Atlantic GIG; and Baltic GIG.".

Glémarec, M. and C. Hily. 1981. Perturbations apportées à la macrofaune benthique de la baie de Concarneau. *Acta Œcologica*, 2: 139-150.

Grall, J. and M. Glémarec. 1997. Using biotic indices to estimate macrobenthic community perturbations in the Bay of Brest. *Estuar. Coast. Shelf Sci*., 44: 43-53.

HCMR/EKBY 2008. Network development and monitoring of the inner, transitional and coastal waters of Greece-assessment/classification of their ecological status. MINISTRY OF THE ENVIRONMENT/OPERATIONAL PROJECT “ENVIRONMENT”. Project Coordinator: Dr. P. Pamayotidis.

Ignatiades l., Vounatsou P. & Karydis M., 1992. A possible method for evaluating oligotrophy and eutrophication based on nutrient concentration scales. *Mar. Poll. Bull*.. 24: 238-243.

Muxika I., Borja A., Bald J., 2007. Using historical data, expert judgement and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European water framework Directive. *Mar. Poll. Bull*., 55: 16-29.

Orfanidis S, Panayotidis P, Stamatis N (2003) An insight to the ecological evaluation index (EEI). Ecological Indicators 3: 27-33.

Panayotidis P, Stamatis N (2001) Ecological evaluation of transitional and coastal waters: a marine benthic macrophytes model. Marine Mediterranean Science 2 (2): 46-65 Pearson, T. H. and R. Rosenberg. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. *Ocean. Mar. Biol. Ann. Rev.*, 16: 229-311.

Pinedo, S., Jordana, E., 2008. Spain (Catalonia and Balearic Islands). In: Carletti, A.,Heiskanen, A.-S. (Eds.), Water Framework Directive Intercalibration Technical Report. Part 3: Coastal and Transitional Waters. JRC Scientific and Technical Reports: 62–70. JRC & ies.

Pagou K., 2000. Assessment of the trophic conditions in the Inner Thermaikos Gulf. Technical Report for the Ministry of Environment, Planning and Public Works, NCMR, Athens, December 2000, 11p

Panayotidis, P., Montesanto, B., Orfanidis, S., 2004. Use of low-budget monitoring of macroalgae to implement the European Water Framework Directive. Journal of Applied Phycology 16: 49-59)

Pinedo, S. García, M., Satta, M.P., de Torres, M. and Ballesteros, E., 2007. Rocky-shore communities as indicators of water quality: A case study in the Northwestern Mediterranean. Marine Pollution Bulletin. 55, 126-135.

Primpas, I., Tsirtsis, G., Karydis, M., Kokkoris, G.D. 2010. Principal component analysis: Development of a multivariate index for assessing eutrophication according to the European water framework directive. Ecological Indicators, Volume 10, Issue 2, March 2010, Pages 178-183.

Rosenberg, R., M. Blomqvist, H. C. Nilsson, H. Cederwall and A. Dimming. 2004. Marine quality assessment by use of benthic species-abundance distributions: a proposed new protocol within the European Union Water Framework Directive. *Mar. Poll. Bull*., 49: 728-739.

Simboura, N. & A. Zenetos, 2002. Benthic indicators to use in ecological quality classification of Mediterranean soft bottom marine ecosystems, including a new Biotic index. *Mediterranean Marine Science*, 3/2:77-111.

Simboura N, Panayotidis P, Papathanassiou E., 2005. A synthesis of the Biological Quality Elements for the implementation of the European Water Framework Directive in the Mediterranean Ecoregion: the case of Saronikos Gulf. Ecological Indicators, 5: 253-266.

Simboura, N. & M. Argyrou, 2006. Implementation of the Water Framework Directive in Cyprus: application of the Bentix index in Limassol Bay. Proceed. 8th Hell. Symp. Oceanogr. & Fisheries Thessaloniki p. 77.

Simboura, N. & S. Reizopoulou, 2008. An intercalibration of classification metrics of benthic macroinvertebrates in coastal and transitional ecosystems of the Eastern Mediterranean ecoregion (Greece). *Marine Pollution Bulletin, 56:116-126*.

Simboura, N. & Argyrou, M. 2010. An insight into the function of benthic classification indices tested in Eastern Mediterranean coastal waters. *Marine Pollution Bulletin*, 60(5): 701-709.

Siokou-Frangou I. & Pagou K., 2000. *Assessment of the trophic conditions and ecological status in the Inner Saronikos Gulf.* Technical Report for the Ministry of Environment, Planning and Public Works, NCMR, Athens, March 2000,43pp. (in greek and english edition)

Spatharis, S. & G. Tsirtsis, 2010. Ecological quality scales based on phytoplankton for the implementation of Water Framework Directive in the Eastern Mediterranean. *Ecological Indicators*, *Volume 10, Issue 4*, *840-847*