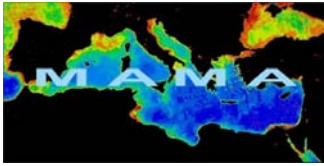# Biological Benthic Monitoring

Paolo Magni

(IMC International Marine Centre - Italy, p.magni@imc-it.org)

• **This presentation is relevant to WP2 - Observing System and Task 2.6 Evaluation of biological benthic tools of the MAMA project.**

• **It is considered that the benthos and its biological components are closely linked to the processes occurring in the water column and may represent a complementary tool in the assessment and implementation of existing observing systems.**
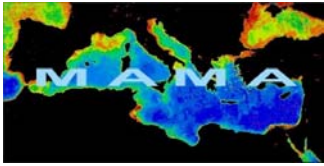
Biological Benthic Monitoring

Paolo Magni

(IMC International Marine Centre - Italy, p.magni@imc-it.org)

• A large number of research programs on benthos have produced substantial data-sets with information on marine benthic fauna, environmental conditions and the contaminant levels.

• The value of existing data-sets can be highly increased by combining them into a common data-set to determine large scale relationships between the benthic communities and selected environmental variables. This may serve to identify indicators of high versus low impacts of stress at a global level.
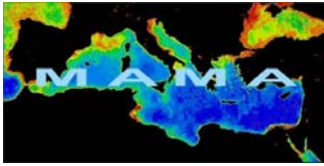
Biological Benthic Monitoring

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• **To perform this exercise, the IOC of UNESCO has formed the *Ad hoc* Study Group on Benthic Indicators (www.unesco.ioc.org/benthicindicators) with the aim to develop indicators of benthic health.**

• **This initiative is relevant to MAMA and relates to the development of methodologies for the GOOS, by providing environmental criteria and indices that can serve as early warning signals of change in the quality of the ocean environment.**
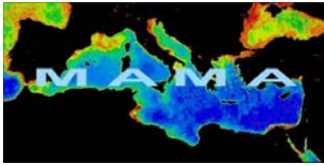
Biological Benthic Monitoring

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An important goal of this initiative is to develop recommendations for indicators of benthic health that are:

1. Reliable in their ability to detect stress (e.g. due to high contaminants levels);

2. Powerful in their ability to discriminate between anthropogenic *vs*. natural sources of stress;

3. Easy to use and broadly applicable in different parts of the world.

Organic Carbon Content of Sediment as an Indicator of Stress in the Marine Benthos

Jeffrey **HYLAND** [†]
W. Leonard **BALTHIS** [†]
Ioannis **KARAKASSIS** [§]
Paolo **MAGNI** [£]
Alexei **PETROV** [¥]
James **SHINE** [#]
Ole **VESTERGAARD** [‡]
Richard **WARWICK** [Ψ]

[†] *NOAA, National Ocean Service, Charleston, South Carolina, USA.*
[§] *Institute of Marine Biology of Crete, Heraklion Crete, Greece*
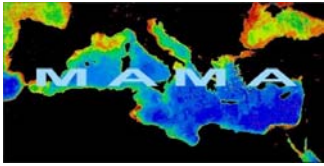[£] *IMC - International Marine Centre, Oristano, Italy*
[¥] *National Academy of Sciences of Ukraine, Sevastopol, Ukraine*
[#] *Harvard University, Boston, Massachusetts, USA*
[‡] *Intergovernmental Oceanographic Commission (IOC), UNESCO, Paris, France*
[Ψ] *Center for Coastal and Marine Sciences, Plymouth Marine Laboratory, UK*

High

Biotic Response

NH_3, H_2S, chemical contaminants

Oxygen

Low

Low →→→ High
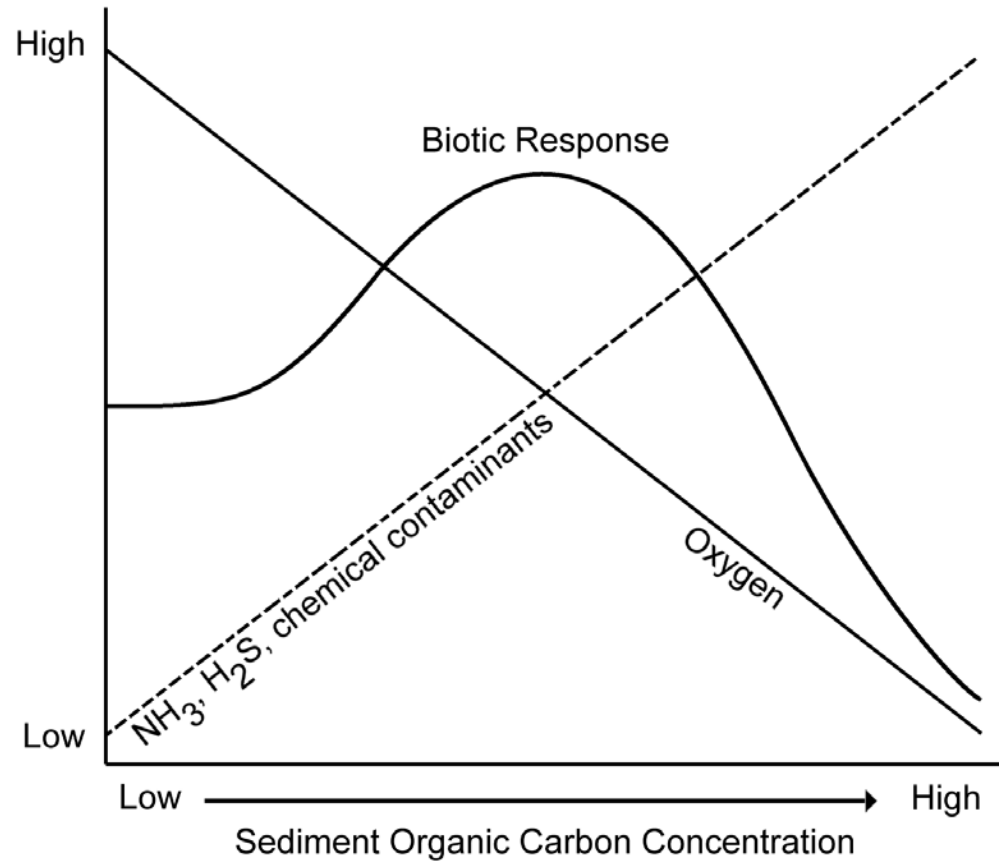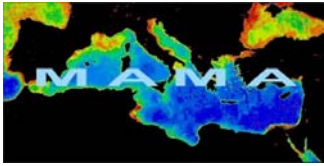
Sediment Organic Carbon Concentration

Figure 1. Conceptual model showing a generalized pattern of response of benthic fauna in relation to TOC content of sediment and other potential co-varying environmental stressors in sediments
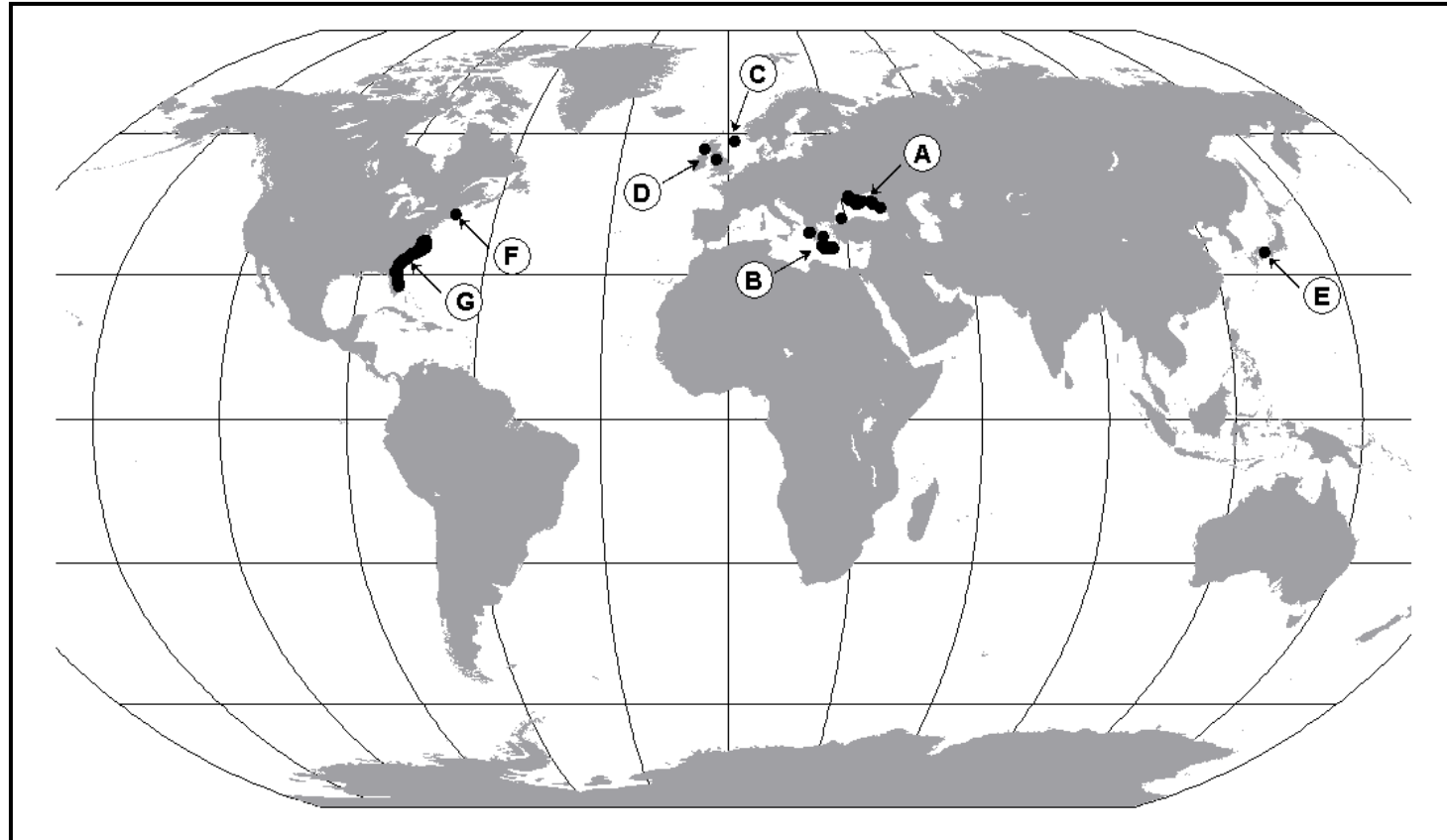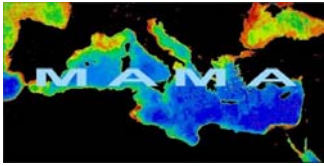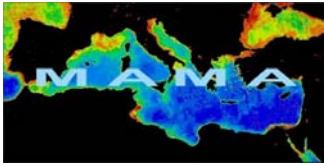
Figure 2. Study areas: northern Black Sea (A); eastern Mediterranean Sea (B); North Sea (C); Firth of Clyde and Liverpool Bay, UK (D); an estuary of the Seto Inland Sea, Japan (E); Boston Harbor and Massachusetts Bay, U.S.A. (F); estuaries along Southeastern U.S.A. (G)
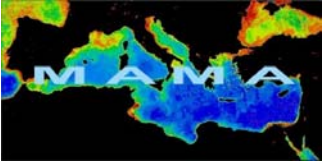
CONCLUSIVE REMARKS

1. Results suggest that the likelihood of such impairments will be relatively low at TOC concentrations below about 8 mg/g, high at concentrations in excess of about 36 mg/g, and intermediate at concentrations in-between.

2. The above response-to-stress framework should be applicable over broad coastal areas that are receiving organic wastes and other pollutants associated with human activities. However, it must be understood that the TOC critical points supporting this framework are to be used only as guidelines for assessing the likelihood of a bioeffect occurrence.

CONCLUSIVE REMARKS

3. Predictive ability within these ranges, though high, does not preclude the possibility that the observed bioeffects were due to other co-varying stressors (e.g., chemical contaminants).

4. Of particular importance is the need to differentiate between relative contributions of multiple stressors that may be co-varying in relation to common environmental factors.

5. Where co-occurrences of high TOC levels and benthic effects are observed, follow-up studies are recommended to determine exact causes and stressor sources.
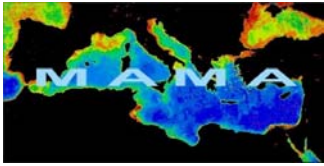
Potential tools for benthic monitoring
- Not Disturbed Environments -

Environmental characteristics:

- **Low Total Organic Carbon (<1%)**
- High RedOx potential (positive Eh values)
- Low porewater sulfide (<0.01 mg/l H_2S)
- Low porewater ammonia (<0.2 mg/l NH_3)
- High bottom water dissolved oxygen (>5 mg/l)
- Low measures of sediment contamination (e.g. low chloroform extractable bitumen, <1 mg/g)
- No sediment toxicity in standard bioassays with ambient amphipods
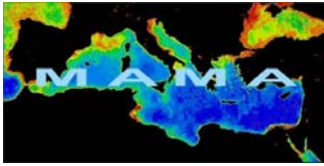
(www.unesco.ioc.org/benthicindicators)

Potential tools for benthic monitoring
- Not Disturbed Environments -

Biological Characteristics:

• High species diversity

• High number of pollution-sensitive species

• Low number of opportunistic & pollution-tolerant species

• Higher ratio of filter feeders to carnivores & deposit feeders

• Diverse age-class structure

• Higher ratio of crustaceans to polychaetes and molluscs

• Low abundance/biomass and abundance/species ratios
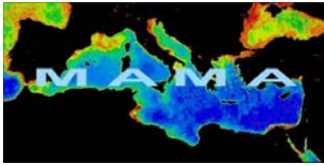
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WP2 MAMA-OBS - OBSERVING SYSTEM
Task 2.6 Evaluation of biological benthic tools

- Based on these initial recommendations on the use of biological benthic tools in monitoring and observing coastal ocean, Task 2.6 calls for a survey to be conducted among partners. The aim is to evaluate the extent of existing data relevant to the benthic environment. These data will be in the form of metadata (i.e. information on the existence of data and not the real values).
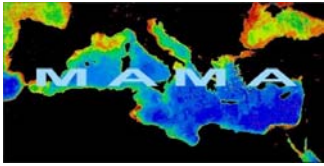
WP2 MAMA-OBS - OBSERVING SYSTEM
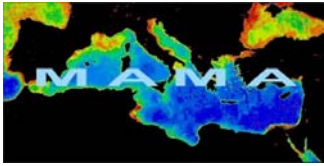## *Task 2.6 Evaluation of biological benthic tools*

- **The existence/availability of metadata on surveys coupling biological and geochemical sampling in the Mediterranean basin will be assessed by means of an exploratory questionnaire to be divulged among interested Partners/Institutions. The content of the questionnaire will include site characteristics, and environmental and biological characteristics of the benthic environment.**

Location Coordinates	Estuary, Shelf, Coastal, Fully Marine	Salinity range	Water Depth	Turbidity - Water clarity	Year - Season

Benthic Environmental characteristics

Sediment physical parameters	Organic matter in sediments	Porewat. nutrients	Sedim. RedOx	Chemical contamin.	Other

Benthic Biological characteristics

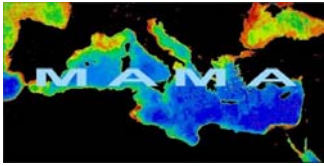| Existence benthic animal surveys	Macro-fauna metadata	Meio-f. metadata	Bio-diversity	Other	

WP2 MAMA-OBS - OBSERVING SYSTEM
Task 2.6 Evaluation of biological benthic tools

- These metadata will be available to the scientific community (by means of web/newsletter), with particular reference to the scientists in charge of the respective data sets.

- At a later stage, we will contact colleagues who are in charge of relevant data sets to ask them whether they would be interested in a joint analysis (and multi-author publication) of the data which would allow detection of trends in a pan-Mediterranean context.
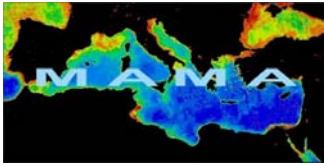
WP2 MAMA-OBS - OBSERVING SYSTEM
Task 2.6 Evaluation of biological benthic tools

- **Depending on the success of the first steps, we would like to attempt forming a network of scientists/institutes that could agree to adopt similar methods in different Mediterranean regions and to seek (at least partial) funding for a large-scale monitoring programme aiming at detecting environmental changes and the development of common indicators.**
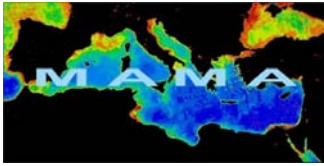
Potential indicators of benthic condition
- Heavily Disturbed Environments -

Environmental characteristics:

- **High Total Organic Carbon (>3%)**
- Low RedOx potential (negative Eh values)
- High porewater sulfide (>0.05 mg/l unionised H_2S)
- High porewater ammonia (>0.4 mg/l union. NH_3)
- Low bottom water dissolved oxygen (>2 mg/l)
- High measures of sediment contamination (e.g. high chloroform extractable bitumen, >10 mg/g)
- Significant sediment toxicity

(www.unesco.ioc.org/benthicindicators)

4th MAMA Meeting, Rome 3-6 June 2003

Potential indicators of benthic condition
- Heavily Disturbed Environments -

Biological characteristics:

- **Low species diversity**
- Low number of pollution-sensitive species
- High number of opportunistic species & pollution-tolerant species
- Lower ratio of filter feeders to carnivores and deposit feeders
- Higher incidence of younger forms
- Lower ratio of crustaceans to polychaetes and molluscs
- High abundance/biomass & abundance/species ratios

(www.unesco.ioc.org/benthicindicators)