E-conference on the 4 Working Groups (WG) within WP2 - Biodiversity Indicators

Four working groups were established following the discussion on WP2 “Biodiversity Indicators” in Palma, Mallorca.

Below we summarize shortly for each WG the discussion items and first results of the meeting in Palma, thereby presenting the basic items to be discussed in the e-conference (based on the report of Perez, Fourt & Feral, sent to you on 26 November 2001).

Each of you may respond and comment to any of the discussion items and first results, or formulate new questions. Yet, preferably concrete answers to the already formulated questions are awaited.
As indicated by Jean-Pierre, the chairs will have to animate the debate. We also expect them to make a short summary half-way and at the end of the discussions.

You may submit each contribution to the E-mail address indicators@biomareweb.org, whereby your message will be automatically forwarded to all BIOMARE members.

The time schedule is as follows :

- 16 January: Start of the e-conference
  - Indicate each time in your e-mail to which Working Group (WG) (and question) you refer.
  - Chairs structure the discussion whenever necessary, moderate the debate, and help to synthesise the discussions
- 15 February: End of e-conference
- 28 February: Integration and synthesis by Jean-Pierre Feral (assisted by the chairs)

- 14-16 March (Crete): discussion of results at Regional meetings for members of Baltic-North Sea and for Mediterranean region
- 18-20 April (Azores): discussion of results at Regional meeting for members of Arctic-Atlantic region

Working group 1 (WG1): Indicators of environmental changes

(Moderator: Sabine Cochrane, Rapporteur: Chris Emblow)

Discussion items *and results*:

- Give general indicators for the impact of environment changes

General indicators (surrogates) are (indicating system (dis)equilibrium):
- Taxonomic distinctness
- Structuring taxa
- Single taxa
- Functional groups
- Population dynamics
- Shifting taxa (temporal and spatial range change; exotics)
- Top predators

- Give indicators for specific impacts (climatic changes, toxicants, etc.). ?

Previous list is applicable
Take care that indicators are valid for long-term research and large scale (networking, uniform methods).

- Do indicators (taxa/groups) exist which by their geographic and bathymetric distribution could be used?

As suitable geographic & bathymetric indicators were mentioned: Mytilus, Calanus, limpets, barnacles, chaetognaths (Sagitta spp)

- Do indicators ofearly signs of biodiversity change/disturbance exist?

Early warning indicators are: taxon proportion (e.g. dominance of polychaetes), higher taxa diversity, seasonality, and selected single taxa.

- What is the usefulness of biomarkers?

There are direct & indirect links of biomarkers with biodiversity and environmental health. These links have to be explored further. Four types of biomarkers exist: reproduction, genotoxicity, immuno-depression,- pollution exposure:

Remaining questions:
- What is the link with biodiversity?
- What is the relation with environmental health?

- How to distinguish anthropogenic and natural impacts? *The distinction between anthropogenic and natural induced changes requires a good selection of a network of stations enabling inter-comparisons of sites to establish causes. The network should be selected at an appropriate scale (e.g. climate vs local impacts)*

- Indicate the major methods for the priority indicators?

- What indicators to use to predict a change in diversity (modelling)?

It is possible to predict changes in biodiversity for end users but it is important to carefully define boundary conditions and to be honest (with respect to both the input and the output). The input consists of combinations of assessment tools and the output could be models (GIS).
It is important to consider cascade effects: e.g. fisheries and natural changes result in changes of biodiversity (e.g. disappearance of 1 species) which on their turn will yield changes in other species and subsequently will have an impact on the food web and on habitats. For the end users it is important that the cause of these changes will be identified.

- New question: The biological effects of which precise environmental changes do we want to measure (temperature changes, changes in seasonal patterns, interaction of climate changes with other environmental changes)? Why and what to monitor (which target?)

- New question: Which taxa are appropriate to survey on long term at global scale and with which method:

Changes in biodiversity. Which habitats have to be covered? Spatial and temporal scale of the survey?
Key species population dynamics (possibly keystone, long-lived and sensible taxa)
Species at their limit of distribution (bathymetric and geographic)
Changes in the seasonal distribution (migration)
The effect on the physiology, reproduction, life cycles

Working group 2 (WG2): Invasive species (autochtone and allochtone)

(Moderator: Carlo Heip, Rapporteur: Ahmet Kideys)

Discussion items *and results*:

- What info do we need:
  - *lists of OSPAR, BERN conventions etc…*
  - *more pelagic taxa*

    To monitor the impact of global change, there is a need to monitor:
    - *stenotherm taxa,*
    - *homogenisations of communities,*
    - *loss of genetic variability (= this kind of biodiversity is lost for ever),*
    - *large-scale long-term loss,*
    - *loss of response option of the system*

- Do we need taxa or functional groups? *(see table)*
- How to distinguish anthropogenic and natural impact? *(see table)*

CONCEPT	**PROBLEM**	**NETWORK**
SPECIES		
Endemic, Rare, Extinct	Level of endemism	Historical info should be used
	Changes in range	Red book, monitoring via surveys, preparing maps
Keystone	Fucoids, gastropods, sea urchins, top predators, reef-builders	Comparative exp. Studies Historical info should be used
Commercial		Explore fishery data, Encourage auto-ecol. stud
Emblamatic-Sentinel	Monk, seal, basking shark, turtles, mammals	Well-studied, surveys, publicity on alternative spp
Invader	shifting taxa, disease outbreaks, ecosystem functioning	Abundance survey, rate of spread, ecological impact Question: What is susceptibility of system
USE		
Indicators	stability, temperature, water masses, pollution, eutrophication, overfishing	Is it possible to find true indicator sp? Comparative studies to assess impact. Group level comparisons. Existence of top predators, Imposex, remote sensing, *E. huxleyi*, jellyfish
Outreach		Jellyfish, red-tide, training school kids at shore, organising divers to gather info

- How to measure the effects (of invasive species) on marine biodiversity?

  It has been pointed out that there is a long list of invasive species and therefore a choice of species must be made. Examples of priority taxa: Mnemiopsis, Penaeid shrimps, Rapana, Caulerpa, Lessepsians, Rhopilema, Shellfish associates (parasites, pathogenes), Eriocheir sinensis, Pontocaspians (Cercopagis), Neogobius.

  The impact of invasive species can be important at the level of communities or habitats, but also at a socio-economic level. Indicators may be the amount of money lost, the amount of jobs lost, the fish protein decrease, damage to tourism industry or infrastructure. A network surveying the appearance of new (unknown) taxa in ports and mariculture areas would give an early warning concerning allochtone species.

  To assess the effects of biodiversity change on susceptibility of systems, there is a need to estimate the degree of openness and isolation of the systems, the environmental variability and the dynamics of previous invasions and recoveries.

New questions:

- Which species/taxa are the priority at local and European levels? Be precise on which, why, how and how much.
- What are well-know effects of invasive species on marine biodiversity? (shifting taxa, disease outbreaks)
- What are the major methods for the priority indicators? Be precise on which, why and how.
- What is the usefulness of population dynamic studies (of invasive species)?

Working group 3 (WG3): Genetic and molecular diversity

(Moderator: Herman Hummel, Rapporteur: Doris Schiedek)

Discussion items *and results*:

- How to :
  - assess the genetic biodiversity
  - monitor the invasive taxa and aquaculture escapees
  - link gene conservation and molecular ecology
  - assess heterozygosity and demography at the sea? Is it useful?
- Which indicators are the priority at local and European levels?
- How to distinguish anthropogenic and natural impacts?
- The major methods for the priority indicators?
- What indicators to use to predict a change in diversity (modelling?)

Before answering the questions it is important to understand on beforehand which aims should be achieved. Two major aims can be identified with regard to inventories of genetic biodiversity:

1. *Diversity of life (global inventory of the variety of taxa in a site/region)*
2. *Population diversity of key-taxa (comparison of different populations)*

Once these two types of genetic diversity have been assessed, the other questions listed above are secondary questions, relating to e.g. conservation, environmental health or impact of stressors.

The way to assess genetic biodiversity depends on a set of different scales:
- geographic (spatial): local (one site), regional (e.g. Baltic Sea), global (e.g. pan-European)
- temporal
- size of organisms (bacteria >>>> mammals)
In order to cover all these scales different methods are needed. E.g. with decreasing size more sophisticated methods have to be applied.

The priority techniques to be used for genetic biodiversity are (dependent on the scale):

- *morphology (e.g. for larger organisms as seals at global scale)*
- *cytogenetics*
- *alloenzymes (e.g. for medium-sized and larger organisms at regional or global scale)*
- *microsatellites, fingerprinting (e.g. RAPDs)*
- *conserved genes, mtDNA (for DNA microarrays "DNA-chips" at present no consistent protocol possible) (e.g. for micro-organisms at local scale)*

Since the study of genetic and molecular diversity is difficult, only a small number of indicators should be selected.

Some major research questions were formulated.
A) Inventory of the diversity of life: Are there hot-spots of diversity at flagship sites (or along a gradient e.g. salinity)?
B) Inventory of the diversity of life: Phylogenetic reconstructions
C) Inventory of the diversity of life: Evolutionary reconstruction of the diversity of key-taxa in Europe
d) Population diversity of key-taxa (comparison of different populations): Comparison of diversity within a taxon along European gradients (this has to include both intensive and extensive sites)

Research question A: Global inventory of life: Are there hot-spots Research question D: Population diversity within a taxon along European gradients						
Technique to be used	for larger organisms		for medium sized organisms		for micro -organisms	
Morphology						
Cytogenetics						
Alloenzymes						
Microsatelites, fingerprinting						
Conserved genes, mtDNA						
Research questions B: Diversity of life: Phylogenetic reconstruction Research questions C: Diversity of life: Evolutionary reconstruction of diversity of key taxa						
Conserved genes, mtDNA						

New questions:
- Which indicator to use (abstracted from the techniques used: be specific for each method)?
- Is microbial diversity a reliable indicator of general biodiversity?
- Do we have to take into account protection and conservation (e.g. genetic erosion)

Working group 4 (WG4): Methodologies

(Moderator: Fred Buchholz, Rapporteur: Ricardo Santos)

Discussion items *and results***:**

- How to collect and use existing data?

- To use available data on indicators is a priority! (Data mining)

We need to know where the data are. What resolution? For which indicators? Which species inventories exist? What habitat inventories there are? Data versus meta-data? Each region should perhaps establish an inventory of "data sources".

- Should we include abiotic data/information (environmental data, nutrients, contaminants)? Measures of pollution? Sources of reference to access environmental quality data?

Prioritise on existing species and habitat inventories as a basis to identify biodiversity indicators. Abiotic data, contaminants etc as meta-data only (is not our original task). We need access to it. We need a good description of the methodology used to collect the data (who, how, where, when)

- We need more detailed control of quality, however this has to be further developed within BIOMARE.

- We should try to integrate all sources of information: Marine Stations, Museum- collections, MPA.

- Identify problematic taxa, and convene in workshops with specialists.

- If it is clear that BIOMARE does not have the expertise on a given method, and if this method is necessary e.g. to the definition of a base line or monitoring, it is important to define where competence can be obtrained.

- How to use remote sensing/ habitat mapping/ side scan mapping, etc…

- Accoustics: multibeam sonar, side scan sonar, Roxanne, hydrophones, ADCP (Acoustic Doppler Current Profilers provide physical – chemical – biological data: biomass and migration speeds of spp.). Acoustic methods seem very useful for inventories of habitats (cf. Port-Cros map).

- Optical and spectrographic methods: satellite oceanography, satellite telemetry, laser techniques – Lidar and Codar -

- Visual: photography, video, holography

- Chemical and molecular methodology: pheromones, DNA-markers

Platforms: AUVs, ROVs, Ships/ boats, Moored stations, Divers, etc, etc, etc

Limitation of all of the above is the quality of ground-truthing.

- How / for what modelling, scenarios, prediction?

The analysis of multi-factorial data sets needs modelling. Biodiversity indicators are important inputs into models. A multi-step approach is necessary, although each step could stand for itself: Hypothesis formulation >> development of conceptual models >> transposition into numerical modelling >> prediction/prognosis (of e.g. changes in species composition in specific ecosystems).

New questions:

- Which methods to apply at which scale? We must be able to propose detailed protocols (including frequency at which they must be applied, scale, their limits…) on e.g. side-scanning, remote sensing, photo and video recording. (see also addendum)

- How to standardize methods (especially for rapid assessment methods)? (see also addendum)

Addendum :

During the discussion please use the terms mentioned below in the specified context.

Established species: a species with a self-sustaining population outside of its native range.
Indigenous species: a species found within its native range.
Invasive species: a non-indigenous species that spreads from the point of introduction and becomes abundant.
Non-indigenous species: a species introduced to areas beyond its native range by human activity.
Non-invasive species: a non-indigenous species that remains localised within its new environment.
Transition: one step in the invasion sequence (e.g. transportation, release and establishment).

Explanations and discussions of methods (especially of RAM) could follow the model below:

1 - Name
2 - Origin (basic literature, first article which described it, … if available)
3 - Brief, but informative, summary of technique
4 - Geographic scale(s) that are compatible
5 - Possible targets (what is the goal of such an inventory)
6 - Data needed
7 - Assessment of likely availability of data
8 - Cost involved (by action, by year, …)
9 - Human resources involved
10 - Human resources required
11 - Data generated (are they real, hypothetical, modelled?)
12 - Time frame
13 - Examples of implementation, … if existing
14 - Points in favor (e.g. *fast, cheap, maps, accurate predictions, accurate estimation of population size, assign categories of threat to individual species, provides a manual for biodiversity managers, provide data compatible for collating information, …*)
15 - Points against (e.g. *[hugely] expensive, time consuming, invasive sampling, never used or used only in particular conditions, not applicable for all seas in Europe, data are only directly comparable with other sites assessed by precisely the same method, the relationships between biodiversity in different groups of sampled invertebrates and the others are not well understood, …*)
16 - Appraisals
17 - Literature (reports on the application of the method, … if available).