Implementation and Networking of large-scale long-term Marine Biodiversity research in Europe

BIOMARE

Report of the First Workshop

Instituto Mediterraneo de Estudios Avanzados (IMEDEA)
Palma de Mallorca, Spain
November 2001

BIOMARE

Implementation and Networking of large-scale long-term Marine Biodiversity research in Europe

Day 1: Present state of the BIOMARE Project

Chair: Herman Hummel

Work Package 1: Primary and Reference sites

INTRODUCTION: PRESENTATION OF CANDIDATE SITES – RICHARD WARWICK

Within BIOMARE a nested approach is used to represent marine biodiversity within different regions. Intensive studies should be made at a small number of Intensive Flagship Sites (IFS – formerly referred to as 'primary' sites) and more limited studies undertaken at a larger number of Extensive Flagship Sites (EFS – formerly referred to as 'reference' sites) in each region. The IFSs should be areas with a mosaic of habitats that are relatively pristine (unimpacted) when compared with similar areas elsewhere and which are therefore expected to have comparatively high diversity. These IFSs will be studied in great detail and will provide a baseline ('reference conditions') against which the status of degraded or impacted sites can be assessed, and subsequent changes monitored. EFSs will be used for less comprehensive studies at a much larger number of sites (approximately 30 sites per region) using rapid assessment techniques developed and calibrated at the IFSs and focussing on a restricted number of key species. They will be selected to cover a range of impacted and non-impacted areas.

A database with candidate IFSs and EFSs is now available on-line. In the database, hyperlinks are included to detailed information on each candidate IFS. At the workshop, two aspects of site selection were put forward for discussion – (a) research objectives to be pursued at the different types of site and (b) criteria for selecting Intensive Flagship Sites.

(a) Research Objectives

(i) Intensive Flagship Sites

1. To make an exhaustive inventory of the biodiversity present – a so-called All Taxon Biodiversity Inventory (ATBI), including, for example, as complete a range of taxa as possible, the genetic diversity of target species and habitat diversity (rocky versus soft / sandy shores, tidal versus subtidal).
2. To establish the underlying phylogenetic pattern of biodiversity (e.g. the apportionment of species among higher taxa) and whether this varies along latitudinal, longitudinal and environmental (e.g. salinity) gradients.
3. To develop rapid assessment techniques. A major challenge in marine biodiversity studies within Europe is the need to further develop firmer estimates of species numbers and better estimation procedures. One important approach to richness estimation is extrapolation from taxon to taxon, focal groups to inclusive groups, site to site and sample to inventory, across spatial scales. To calibrate the basis for such an approach requires the establishment of sites with an ATBI. To date this has not been achieved, certainly for marine taxa, at any site in the world. Yet surrogacy methods, based on extrapolating information from intensively studied sites, will become the norm in site assessment, because of the impracticality of routinely attempting comprehensive surveys.
4. To develop and calibrate biodiversity measures based on relatively coarse data appropriate to the large scales of observation, and produce indices which, unlike species richness, are not strongly dependent on standardised sampling effort. Such indices may include information on trophic groups, distribution of body size, endemicity etc. as well as phylogenetic structure.
5. To serve as a benchmark for the standardization of procedures.
6. To initiate long-term monitoring in order to establish patterns of temporal change.

(ii) Extensive Flagship Sites

1. To map the distribution patterns of biodiversity on a relatively fine scale.
2. To assess man's impact on biodiversity
3. To undertake long term monitoring using rapid assessment techniques or biodiversity indicators.

(b) Criteria

(i) Intensive Flagship Sites

The current criteria for the selection of IFSs are:

- The sites should be pristine, (relatively) free from anthropogenic disturbance, and also free from natural stressors if these are atypical of the region which the site represents.
- They should comprise a mosaic of representative habitats within a well-defined area.
- Some background information should already be available
- They should be in areas that are afforded protection by their conservation status, which will ensure the perpetuation of their pristine status.
- There should be an appropriate infrastructure for biodiversity research.

There are still too many candidate IFSs proposed. The clustering of sites did not solve the problem. Now a committee of scientists that have no affiliation to any of the candidate IFSs will be formed and will select the IFSs based on a revised set of criteria. For this reason consensus should be reached on the new set of criteria during the workshop.

(ii) Extensive Flagship Sites

The criteria for the selection of these sites are not so strict but comparable habitats should cover a wide geographic range. Each site could comprise only a singe habitat type. There should be background information available and an infrastructure for research.

DISCUSSION BY REGIONAL GROUPS

After this introduction, the research objectives and selection criteria for IFSs were discussed by groups of delegates representing the different regions.

Discussion items:
ATBI: which taxa should be covered?
Genetic diversity: research focused on which taxa?
How to define habitat diversity and which classification system should we use?
Phylogenetic patterns: which indices should we use and how do we standardise the taxonomic and phylogenetic classification systems?
Which rapid assessment techniques might be tested at the flagship sites.
What kinds of biodiversity measures are applicable for large-scale observation programmes?
Are there additional objectives?

Another focus of the discussion should be the selection criteria for the primary flagship sites.

Reports from each of the regional groups are presented below.

1. Atlantic-Arctic region – Sabine Cochrane

This group mainly focussed on the discussion of the research objectives at the IFS.
The ATBI's should focus on metazoa and macrophytes. The group was not sure whether to include plankton in the surveys as they are not site specific. Genetic research should be based on a suite of taxa for which appropriate direct or indirect markers exist, or are in development. Existing habitat classification systems should be used. Phylogeny and rapid assessment techniques should focus on the complexity of the fauna present. The objective should be standardization of techniques and methods. At the moment it is not possible yet to link with ATBI. Large-scale observations should emphasise on linking with ATBI and inter-site comparisons. Various levels of analyses are possible. Monitoring could be focussed on long-term processes, like climate change etc.
Additional items: Maps, like habitat maps or biozonation maps. Geographical Information Systems should be used to produce the maps.

Criteria for the selection of the IFS's
Pristiness should not be used. The term is not adequate for the selection. It was suggested to use an alternative term: naturalness.

Additional criteria:
Commitment: commitment of the institute that proposes a site should become a selection criterion. This is linked with Information available.
Biogeographic representativeness: Since 5-6 sites are selected in different regions biogeographic representativeness should also be part of the selection criteria.

The selection criteria for the EFS were not discussed.
M. Costello: The EFSs could be linked with the water framework and habitat directives.

2. North Sea Baltic region – Friedrich Buchholz

After clustering of the sites, 6 candidate IFSs remained on the list. Gaps were reported for the northern Baltic and the Kattegat areas. Here no sites were proposed.

Criteria for the selection of the IFS's
In general the concept of the IFS and EFS (satellites) requires diversification. There should be a good connection between the different types of sites.
The term 'Pristiness' should not be used. It was suggested to use 'the best of ….'. [1]. The ATBI's were considered feasible and even present for Sylt. Within this respect it was suggested to organise funding for young scientists to fill in gaps in the geographic coverage of difficult taxa. The engagement of young scientist in this process is important for the continuation and maintenance of taxonomic knowledge. Genetic research should focus on gene flow between the Baltic and the North Sea. *Mytilus edulis* and *Fucus* were suggested as important species for this kind of research. Existing habitat classification methods should be used. As additional research objective was suggested bio-climatology.

3. Mediterranean-Black Sea region – Anastasios Eleftheriou & Carlos Duarte

It appeared not possible to discuss the first two research objectives (ATBI and genetic research) without additional information. This type of discussion needs more time. No new habitat classification system should be developed. A core set of taxa should be included to ensure comparability across reference sites (notwithstanding possibilities to go beyond these). Indices should be independent of sampling size, like indices of taxon distinctiveness. They should be suited for large scale research. Most indices are biased and most probably are unsuitable for phylogenetic research. Rapid assessment techniques should be flexible enough to accommodate different habitats. Workshops are needed for the establishment and intercalibration of these techniques. The monitoring of the biodiversity in the Mediterranean should focus on invading and endemic species. The Mediterranean accommodates many endemic species. They are more vulnerable to changes. Also in the Mediterranean large numbers of immigrants occur. They create problems by replacing the native, and endemic species. Other species should be monitored as well, but the research should be focussed on the endemic species and the invaders. Target species should be species that are sensitive to aspects of global change, with emphasis (priority) on endemic species and long-lived species (e.g. molluscs, coelenterates or crustaceans). Preferably species with fossil records should be studied, which enable a very long time view. In this way e.g. climatic changes in the Mediterranean become visible. There has to be a consensus on the sites. For the EFS a large number is agreeable. For the IFS a strict adherence to the criteria is necessary. The candidate sites have to be screened by the independent committee.

Remarks
Plankton should be a part of the ATBI's. It is an important part of the ecosystem and lack of knowledge should not be a reason to exclude it from inventories or monitoring programmes. Also fish were lacking as target taxa in the ATBI's. The present approach is too benthic orientated. Sites that are covered by the Natura 2000 directive should be selected over sites that are not selected for Natura 2000.

[1] This concept is similar to the use of the term 'pristiness' during the regional meeting in Sopot. Here pristiness was related to the background levels of nutrients and contaminants of the region: as pristine as possible.

SYNTHESIS OF THE DISCUSSIONS – LED BY RICHARD WARWICK, WITH CONTRIBUTIONS FROM THE FLOOR

ATBI: which taxa should be covered?
The taxa covered in the ATBI seemed to be the biggest area of disagreement. Many delegates suggested we 'think big', aiming to be as inclusive of taxa as possible. Metazoa and macrophytes were definitely to be included, but several people recommended the inclusion of 'difficult' taxa such as microbes (using new molecular techniques) and of plankton, despite their lack of spatial and temporal specificity. It was suggested that an inventory could be made of the present knowledge of taxa present at the sites. This information could be translated to a table with a classification of the information available (e.g. adequate, updateable, workable, not feasible). There were several suggestions to recruit young scientists to fill gaps in knowledge.

Genetic diversity: research focused on which taxa?
The choice of taxa for genetic study should be based on pragmatism, with taxa selected for which expertise, markers, primers, etc already exist (e.g. fucoid algae).

How to define habitat diversity and which classification system should we use?
Most delegates agreed that we should use existing classification systems (e.g. EUNIS), but should perhaps discuss refinements and adaptations to these at a later date.

Phylogenetic patterns: which indices should we use and how do we standardise the taxonomic and phylogenetic classification systems?
The emphasis was on sampling-independent indices, such as Taxonomic Distinctness. For this to work well, standardisation of classification systems is essential. It is therefore necessary to support systematics research.

Which rapid assessment techniques might be tested at the flagship sites.
The techniques adopted need to flexible so that they can accommodate different habitats and taxa. Intercalibration Workshops will be important to ensure comparability.

What kinds of biodiversity measures / taxa are applicable for large-scale, long-term observation programmes?
This requires standardised collection and handling (database structure) of data from different sites. This will require well-developed communication (between participants). If standardisation is achieved, then valid comparisons can be made to some extent using traditional diversity indices. Endemic species are not suitable for large-scale comparisons, but should be prioritised for long term studies. Invasive species (species introduced by mariculture, ship transported species etc) should also be targeted as the consequences of a local introduction can be severe and long lasting. Long-lived species should also be targeted for long term monitoring. In this context, priority should also be given to species for which a fossil-record exists. Indicators of climate change should also be selected.

Are there additional objectives?
Mapping and bio-climatology (see Wulf Greve's presentation, below) were suggested as additional objectives.

Selection criteria for IFSs.
In general, the list of selection criteria for the IFSs was considered accurate and adequate. The available background information is linked with commitment of the institutes and has already been addressed in the additional questionnaire. A nearby institute should be committed to present information and to further studies on a proposed site. The additional criterion 'Biogeographic importance / representativeness' has also been addressed in the additional questionnaire. This criterion asks if the site is representative for a specific biogeographic region? Are all European biogeographic regions covered (see Habitats Directive, Water Framework Directive).

The term 'Pristiness' should be replaced by 'Naturalness' or 'the best of…'. The term has already been regarded as such during the regional meetings. Nevertheless there was persistent confusion. The placement of the criterion in a relative framework (related to the background levels of eutrophication and pollution) after the first inventory put the sites that were proposed by scientist that used 'pristiness' in a strict way, at a disadvantage. For instance, for the coast of Portugal, the proposer judged a number of sites on

bases of a strict use of the criterion ‘pristiness’. On basis of this criterion, the sites were proposed as EFSs. These sites are, however, more pristine than sites that are proposed as IFSs in other regions, e.g, in the Baltic, or Black Sea (even relative to the background levels of nutrients and pollution). If pristiness is not used in a strict way, this means that we have to allow the re-evaluation (and possible upgrade) of some EFSs. The committee that will select the IFS should consider this.

Until now the objectives of the EFS have not been discussed in detail, other than that commitment and data are required. Sites that are covered by the Natura 2000 directive should be selected over sites that are not selected for Natura 2000.

WORK PACKAGE 2: BIODIVERSITY INDICATORS

INTRODUCTION: THE FIRST RESULTS – Jean-Pierre Féral

Until 19 October 2001, 34 questionnaires have been submitted. Questionnaires that have been received later were not presented. The database will remain open for contributions until March 2002.

In summary, the first answers mentioned few rapid assessment methods (mapping, ROV, use of large erect species...). The methods need to be specified to enable standardization.

The geograpghical coverage by the questionnaires is quit well.

Many key-species were cited especially in the Mediterranean and in the Black sea (Table 1.). A special interest should be given to the protected species listed by the Berne Convention and in the OSPAR Convention.

Table1: Number of responses by biogeographic sector.

Sector	Number of questionnaires
Arctic	2
Baltic	4
Atlantic	12
Meditteranean and Black Sea	19

There is some overlap between the different regions (fig. 1).

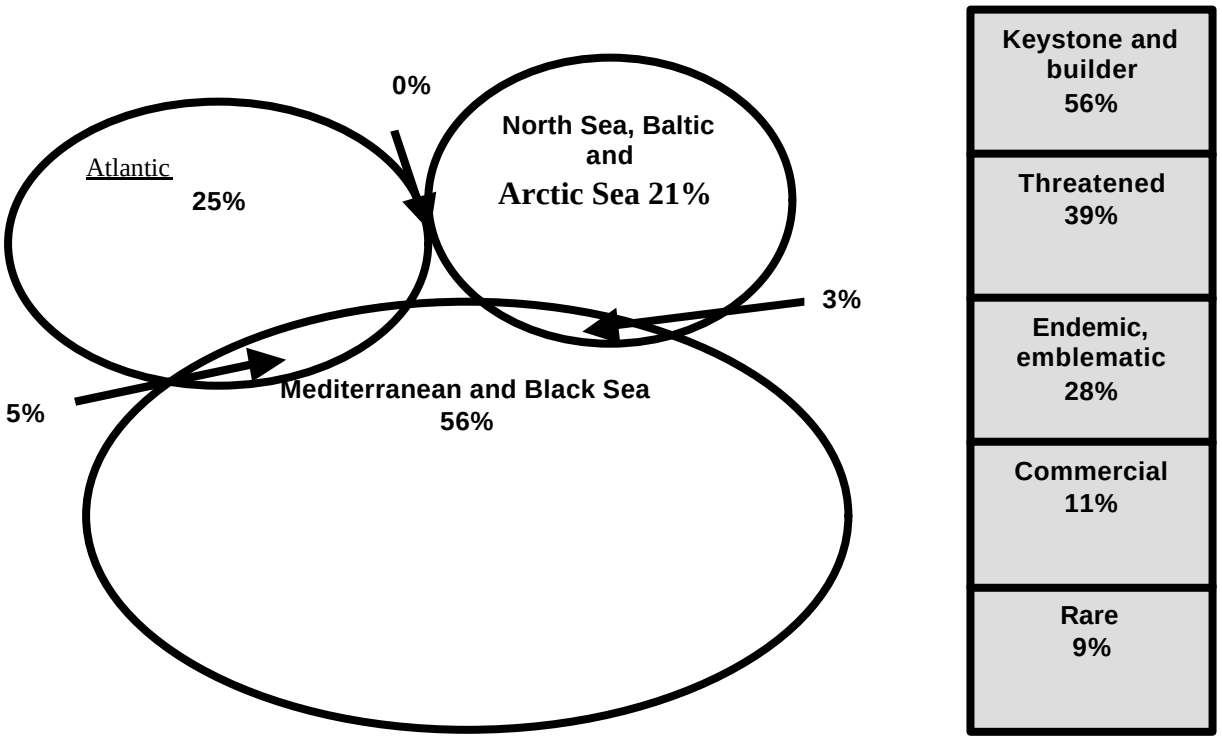

Figure 1: Percentage of key species cited so far.

As local causes of biodiversity degradation, “eutrophication” and “organic matter (OM) enrichment” were mentioned the most often. Chemical pollutants have been mentioned rarely. This, despite the fact that their deleterious effects on the fecundity, larval vitality, immunocompetence of organisms, and the increase of the virulence of pathogens or parasitic infections is generally acknowledged.

The most often cited causes of biodiversity change or loss are **alien species and climate change**. Both give cause of concern at various spatial scales. Thus global climate change or climatic event is probably the major cause of biodiversity change at a European level.

Ulva spp., *Enteromorpha* spp. and benthic invertebrates *Capitella* spp., *Malacoceros fuliginosa*, *Corbula gibba*, etc. were often cited as bioindicators. This type of bioindicator reflects the local problems of eutrophication and OM enrichment.
Species at their distribution limits (e.g. thermophilic species as bioindicators for global environmental modifications) have not yet been mentioned.
The usefulness of several biomarkers as early warning of biodiversity threat has been brought up in several answers. Among those listed, DNA damages, immuno-depression, effect of the reproduction may represent the most potential markers of future population perturbation because of their very crucial role in major ecological functions such as reproductive success and gene transmission.

It is becoming increasingly important to decide whether BIOMARE will focus solely on indicators for biodiversity, or include indicators for environmental (ecosytem) health as well. This will have large consequences for the approach of WP2.
Although there seemed to be a slight favour for focussing on biodiversity indicators at the workshop, the WP2 standpoint is that some indicators of environmental health (marine organism health) should be included in a marine biodiversity assessment protocol. It can reveal processes of biodiversity changes. Basic data, such as physical chemical parameters, pollutant bioavailabilities or stress level of organisms might be very useful in the case of drastic changes in biodiversity caused by a catastrophic event, e.g abnormal sea surface temperatures in the Mediterranean in 1999 or oil spills in "pristine" sites as observed in Brittany in 1999.

Several important items were not yet covered by the questionnaires:

- Standardisation of rapid assessment techniques,
- Indicators for global (climate) change,
- The need of a coordinated survey of invasive species,
- Plankton as indicators,
- The (relevance of the) use of biomarkers,
- Ways to include genetic diversity in the project, and
- The establishment of a link between ecology and ecotoxicology.

In order to have a better reflection on the items, the WP2 leader proposed to the steering committee to install four thematic working groups discussing the relevant items within each group (Table 2). The discussion started at the workshop but will continue afterwards. For this purpose, communication tools via the BIOMARE website will be developed by the WP3 leader.
A handout was produced to structure the discussion (annex 1)

Table 2. Main theme and chairs of the WP2 working groups

Group	Theme	Chairperson
1	Environmental changes	Sabine Cochrane
2	Keystone, Invasive, Engineer taxa	Carlo Heip
3	Genetic biodiversity	Herman Hummel
4	Methodologies	Fred Buchholz

At the workshop, the objectives of each working group were to answer the questions mentioned at the handout and to identify what is possible to accomplish and to set up at a short term or what are the needs for research. Except for working group 4. The items were discussed in two sessions.

RESULTS OF THE WORKING GROUP DISCUSSIONS

Working group 1 (WG1): Indicators of environmental changes
(Moderator: Sabine Cochrane, Rapporteur: Chris Emblow)

Discussion items

Give general indicators for the impact of environment changes.
Give indicators for specific impacts (climatic changes, toxicants, etc.). 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?
Do indicators ofearly signs of biodiversity change/disturbance exist?What is the usefulness of biomarkers?
link with biodiversity?

*Relations with the environmental health?*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)?

Two concepts were followed:

- 1. Impact of environmental change on biodiversity
- 2. Impact of biodiversity change on environment

1. Impact of Environmental change on biodiversity

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

This list is also applicable for general and / or specific impacts indicators (incl. climate change)
As suitable geographic & bathymetric indicators were mentioned: *Mytilus, Calanus*, limpets, barnacles, chaetognaths (*Sagitta* spp)
Early warning indicators are: Taxon proportion (dominance of polychaetes), higher taxa diversity, seasonality, and selected single taxa.

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

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).

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).

2. Biodiversity change on environment
It is important to consider cascade effects, i.e. changes in species diversity due to fisheries and natural changes with an impact on the food web and on habitats resulting in further changes of biodiversity.
For the end users it is important that the cause of these changes will be identified.

Synthesis[2]
General impact indicators of environmental changes on biodiversity were given such as: taxonomic distinctness, structuring taxa, single taxa, functional groups, population dynamics, shifting taxa and top predators. Taxa such as *Mytilus, Calanus*, limpets, barnacles and chaetognaths can be used as geographic and bathymetric indicators. The taxon proportion can be used as early warning indicator as well as the four types of biomarkers (reproduction, genotoxicity, immuno-depression and pollution exposure) cited by Claude Amiard-Triquet. It has been said that we are able to predict changes in biodiversity but we must be careful. It has also been noted that biodiversity changes can also lead to environmental changes through a cascade effect.

[2] Jean-Pierre Féral

Working group 2 (WG2): Invasive species (autochtone and allochtone)
(Moderator: Carlo Heip, Rapporteur: Ahmet Kideys)

Discussion items

We need :
- lists of OSPAR, BERN conventions etc…
- more pelagic taxa

Do we need taxa or functional groups? Which species are the priority at local and European levels? How to distinguish anthropogenic and natural impact? The major methods for the priority indicators? What indicators to use to predict a change in diversity (modelling?) Usefulness of population (invasive species) dynamics studies? How to measure their effect (invasive species) on marine biodiversity (shifting taxa, disease outbreaks, etc.)?

The outcome of the discussion was presented in a table.

CONCEPT	**PROBLEM**	**NETWORK**
SPECIES		
Endemic, Rare, Extinct	Level of endemism	Historical info
	Changes in range	Red book, monitoring via surveys, preparing maps
Keystone	Fucoids, gastropods, sea urchins, top predators, reef-builders	Comparative exp. studies
Commercial		Explore fishery data, Encourage auto-ecol. stud
Emblamatic-Sentinel	Monk, seal, basking shark, turtles, mammals	Well-studied, surveys, publicity on alternative spp
Invader		Abundance survey, rate of spread, ecological impact Question: 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

Synthesis
Relating to the endemic, rare, extinct and keystone species it has been said that historical information should be used as much as possible, that a red book should be created and that the geographic distribution should be mapped.
The second discussion was reoriented towards invasive species and their impact on biodiversity:

Discussion items
Invasive species as indicators of global changes and Global change by invading species?
Infeasibility of European waters?
Effects of invaders on biodiversity and ecosystem functioning
Socio-economic consequences of marine biological invasions
Characteristics of invader species

Invasive species as indicator of decreased biodiversity
Can we use invasive species as early warning system?

It has been pointed out that there is a long list of invasive species and therefore a choice of species must be made.

Example of priority taxa: *Mnemiopsis,* Penaeid shrimps, *Rapana, Caulerpa,* Lessepsians, *Rhopilema,* Shellfish associates (parasites, pathogenes), *Eriocheir sinensis,* Pontocaspians (*Cercopagis*), *Neogobius*.
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

To assess the effects of biodiversity change on suceptibility 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.
The impact of invasive species can be important at the levels of homogenised 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.

Working group 3 (WG3): Genetic and molecular diversity
(Moderator: Herman Hummel, Rapporteur: Doris Schiedek)

Discussion items

How to :
assess the genetic biodiversity
• monitor the invasive taxa and aquaculture escapees
• link gene conservation and molecular ecology
• heterozygosity and demography at the sea? Is it useful?
Needed :
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?)

Assessment of genetic biodiversity
A high variety on the interpretation of this topic is possible due to the different background of the researchers, i.e. what organisms they work with (bacteria, benthic species, fish etc.). This variety in interpretation can be overcome if we distinguish between different scales:

- geographic (spatial)
    - local (one sampling site)
    - regional (e.g. the Baltic Sea)
    - global (e.g. pan-European)
- temporal
- size of organisms (bacteria >>>> mammals)

In order to cover all these scales different methods are needed. For example, with decreasing size more sophisticated methods have to be applied: in large organisms morphological studies may be sufficient to distinguish species, whereas allozymes, microsatellites, or conserved genes have to be used in smaller organisms.

It is important to understand 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 priority techniques to be used for genetic biodiversity are (dependent on the scale):

- morphology
- cytogenetics
- alloenzymes
- microsatellites, fingerprinting (e.g. RAPDs)

- conserved genes, mtDNA (for DNA microarrays "DNA-chips" at present no consistent protocol possible).

Some major research questions were formulated.

	Techniques				
Research question ⇓	Morphology	Cytogenetics	Alloenzymes	Microsatelites, Fingerprinting etc.	Conserved genes, mtDNA
Diversity of life					
Inventory	Larger organisms	Medium sized organisms	Medium sized organisms	Micro - organisms	Micro - organisms
Phylogenetic reconstruction					applicable
Evolutionary reconstruction of diversity					applicable
Population diversity of key taxa					
Comparison of diversity within taxon	Larger organisms	Medium sized organisms	Medium sized organisms	Micro - organisms	

Synthesis
The assessment of genetic biodiversity is especially useful for small-sized taxa either cryptic species or larvae. It can also be used for conservation of species. Heterozygosity can give information on the recruitment efficiency and help to give an order of priority in endangered species etc. But the study of genetic and molecular diversity is difficult therefore only a small number of indicators must be selected. Links can be made with WG2 concerning the monitoring of invasive taxa and aquaculture escapees.

Working group 4 (WG4): Methodologies
(Moderator: Fred Buchholz, Rapporteur: Ricardo Santos)

Discussion items
How to collect and use existing data?
How to use remote sensing/ habitat mapping/ side scan mapping, etc…How / for what modelling, scenarios, prediction?
Which indicators are the priorities at local and European levels?How to distinguish anthropogenic and natural impacts?The major methods for the priority indicators?

How to collect and use existing data?
To use available data on indicators is a priority! (Data mining)
Questions raised:
- 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?
- Should we include abiotic data/information (environmental data, nutrients, contaminants)? Measures of pollution? Sources of reference to access environmental quality data?

Questions addressed:
- Prioritise on existing species and habitat inventories as a basis to identify biodiversity indicators (abiotic data as meta-data only, contaminants etc. not our original task)! We need access to it. First of all, we need a good description of the methodology used to collect the data. (Who, How, Where and When)
- We need more detailed control of quality, however: 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.

How to use remote sensing / habitat mapping / side-scan mapping (habitat diversity)?
- Accoustics: multibeam sonar, side scan sonar, Roxanne, hydrophones

ADCP (Acoustic Doppler Current Profilers provide physical – chemical – biological data: biomass and migration speeds of spp.)
- Optical and spectrographic methods: satellite oceanography, satellite telemetry, laser techniques – Lidar and Codar -
- Visual: photography, video, holography
- Chemical and molecular methodology: pheromones, DNA-markers

Limitation of all of the above is the quality of ground-truthing.
At the same time all these techniques benefit from collaboration with physical oceanographers, engineers, chemists, geologists, statisticians, environmental agencies.

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

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

Synthesis
Each region should perhaps establish an inventory of "data sources". It has been said that we need inventories before methodologies.Acoustic methods seem very useful for inventories of habitats (cf. Port-Cros map). These methods should be more detailed in order to choose a certain number of them.
Are predictions to be considered at this stage of BIOMARE?

Key-Issue: EEA as enduser of biodiversity data - Anita Künitzer
Discussion
The EEA is interested in the marine biodiversity indicators for their reports if Biomare is going to produce any. The indicators should address EU-policies and conventions like COB, Natura 2000, AMAP, BSEP, HELCOM, OSPAR UNEP/MAP and the DPSIR framework. Thus the project should focus on policy related indicators. The indicators should be practical ones for the end users.
The EEA works with national contact points and there could also be a contact point from within BIOMARE.

Key Issue: System of global evaluation of the quality of the coastal milieu, with a particular attention to the biological aspects - Franck Bruchon

Day 2: General coordination, WP3 and future plans.

General Coordination

INTRODUCTION - Herman Hummel

Rapporteur: Doris Schiedek

Herman Hummel gave an overview of the project aims reached so far and the out-comes of the steering committee meeting in Mallorca on October 29 and 30.
After one-year duration the inventories and reviews for the three different Workpackages have been started and further developed. Two regional workshops have been held in Sopot (Poland) and Corinth (Greece). The second one was connected to the Euro Conference. Two further regional meetings are planned for 2002: North Sea/Baltic + Mediterranean: Heraklion, Greece - March 2002 (week 11) and Atlantic/Arctic: Azores - April 2002 (week 16). The second workshop will be held in Tromsø (Norway) or in Spitsbergen.
The management report will be due in November 2001. It should contain a brief summary of all activities conducted in the preceding period for each task. The actual state of advancement with respect to the timing foreseen in the DOW will be indicated. Furthermore, it will include the plans for the following 12 months detailed on the WP-level (including if necessary a proposal for adjustments), an updated list of publications submitted or published, of presentations of project-results made on scientific meetings, an updated list of personnel paid partially or fully from project funds for each partner, any other matter relevant to the assessment of the progress of the project, cost statement (annual).
Finances: Costs were calculated per member on basis of the expected participation to meetings.

Report from the last Steering Committee meeting
So far all steering committee meetings have been attended as agreed upon. Attendance at regional meetings and workshop was lower than calculated. Funds becoming available if one or both representatives of the member institutes are unable to attend the meeting are being used to invite external experts (by general co-ordinators) and to help members facing high costs of transport (Azores, Tromsø). Costs and available funds will be balanced with second and following payments.

Info regarding the work packages.
WP1: Gaps will be filled by sending the second questionnaire to some additional Marine Stations. Afterwards, a small committee of independent members and experts will decide on the final list of flagship sites.

WP2: a model-questionnaire (the one Chris Emblow has presented) will be sent to all regional leaders, who should send it to their colleagues, giving them an idea what kind of information is required and how to fill in the questionnaire (gaps will be filled in by consulting (phoning) personally the leading persons). This should motivate all partners to fill in the questionnaire and as such support the project.

WP 3: pictures for a special issue in Coastline are requested until November 2001.
Deadline for contributions for the next Newsletter is December 2001. In order to obtain information on existing (meta-) databases a filled-in list will be prepared which will be distributed. Gaps will be filled in by consulting (phoning) personally the leading persons.

Other items
BIOMARE related
It was agreed on including more NAS-countries to contribute to the extensive flagship sites and other items of WP1, WP2, WP3.
It is planned to extend BIOMARE for 4 months (end at 1 March 2003 = final payment). This requires the agreement of all partners. There was no objection, but there might be some later on. Members will be kept informed.

MARS related
Databases on facilities, training and research at marine institutes will be connected to BIOMARE.
It is proposed to organize summer schools in Slovenia (2003) and Poland (2004). The topic will be the comparison of marine biodiversity of the several European regions.

In the discussion after the presentation the question was raised how to include observers from other international organisations (e.g. EEA) or other agencies and associations, respectively.
One option might be to invite them to the regional meetings or to the workshops as being done for the Mallorca workshop.

It was suggested to think about how to include other scientific organisations. One option might be to formalize their contributions, as they become associated partners.
Finally, it was pointed out that BIOMARE was recognized as one of the projects of the International Year of Biodiversity (IBOY).

Key issue: An example of a protocol for bio-indicators - Herman Hummel and Chris Emblow

Discussion.
The protocol was considered too benthic orientated. Other criteria should be put in the water body system. Wulf Greve offered to help with this. Intermediate spatial (in between local and regional) and time (seasonal) scales were considered missing in the concept. Steve Hawkins offered his help to give an input in the development of the protocol. It was suggested to adopt the scales of the water framework directive. There is a working group of the WHD that can help. The database for this protocol will present metadata. The end users of the tool (the market) should be defined: mainly local or regional end users. Also there should be a clear dichotomy between the indicators for biodiversity and ecosystem/environmental health. The latter is outside the scope of the BIOMARE project. We should focus on biodiversity indicators. Different levels of organisation should also be addressed in the protocol. The habitat diversity could be quick and dirty.

WORK PACKAGE 3: DISSEMINATION OF THE RESULTS AND CAPACITY BUILDING
Rapporteur: Doris Schiedek

PRESENTATION OF RESULTS AND FUTURE PROSPECTS – Chris Emblow
Chris Emblow (WP leader) gave an overview of the progress being made in this work package and of the gaps, which have to be filled in. The main topics were the website, networking, newsletter, database and flyer/brochure:

1. Website
Over 2000 visits were counted so far compared with 900 until the last meeting. The links section was updated and contains reports from past meetings, progress reports, agenda and other details of forthcoming meetings, future additions, expansion of reference sites information, draft list of long term, large scale monitoring datasets and species inventories and training opportunities.
In the last months an additional section was added (Resources), offering i.e. biodiversity datasets and info on conferences or job vacancies.

2. Networking
Utilising the ERMS/BioMare database as a mailing list. Furthermore, Marine-B list server posted conference announcements and vacancies posted on listserver website.
In future the network should further expand through formal connections with organisations such as: ICES, OSPAR, HELCOM, EEA, CIESM, BARCOM, OBIS, national nature conservation/ environmental protection agencies. Chris Emblow asked the workshop participants to provide him with names of further potential organisations.

3. Newsletter
The newsletter will be used to inform the public about the progress of the BIOMARE. It will be published twice a year, put on the website in electronic (pdf) format, sent to the member institutes and to a broader audience identified through the MARS and ERMS network. Furthermore, it will be promoted through the news service. Issue 1 of the Newsletter is now available from the website. Contents: Overview of the project, report from Corinth workshop, article on regional biodiversity issues, article on young biodiversity researchers. The option to print in full colour is examined. The next issue is likely to be published by early next year, it will offer regional biodiversity issues and articles from young biodiversity researchers, information about the progress within the project, as well as a report from the Mallorca workshop. A further idea is to have a special edition on specific work packages, e.g. –Bioindicators or Reference Sites.
At present the following articles have been offered:

- Gorgonian mass mortalities in the Med.
- Black gobies in the Baltic
- Mapping of marine biodiversity in the Azores
- Environmental gradients in the Arctic
- Hyperbenthos in Crete
- Isopods in Helgoland

Any other offers should be sent to the leader of WP 3.

4. Database
At present, information concerning the current state of marine biodiversity research in Europe is available as well as existing long term or large-scale biodiversity monitoring datasets and species inventories. It is proposed to incorporate information via the MARS network concerning facilities for training of researchers and students and for marine biodiversity research at European institutes, respectively.
More data should be collected via a questionnaire but some problems of sourcing information have to be solved first. The regional co-ordinators will be responsible for the survey in their region. Overlap with work being completed through the MARS network will be examined. First attempts have been made to include institutions with relevance for biodiversity research, e.g. museums, universities and governmental laboratories outside the project.

5. Flyer/brochure
The brochure should include details of project aims and objectives and an overview of the work packages. The question was raised if it should also include results.
A draft of the brochure, which will be printed in full colour, will be distributed prior to the first regional workshop. At present it is not decided if it should contain summary sheets for intensive flagship sites.

At the end of the presentation different questions/problems were addressed and discussed:

Network: How to achieve the expansion? The Network is very much science related.
MARS members probably could be asked to join BIOMARE.

Website: Most of the people are happy with the present layout of the website. However, if possible some more pictures should be included to attract people. Links to Marine Journals were suggested but most of the participants thought that this is not necessary. A general section about biodiversity was considered missing. This could stimulate non scientist to browse the website also.

Database: Problem of sourcing information. It was pointed out that people are sometimes reluctant to give full access to their data, particularly if they are unpublished. If it is a meta databases, producers are very often not cited, this causes problems. A solution could be the mentioning of the owner of the data in the database.
A questionnaire was sent to the regional co-ordinator, but the response was not very satisfying. Chris Emblow pointed out that a template of the datasheet is available on the website.
It was also suggested to indicate those institutes, which already have on-line databases. It could be in the form of maps that link to the databases and link to institutes that already have contributed to the database (filled in the questionnaires). Helgoland data are now processed (PANGAEA). BIOMARE could link to that.
British data sets might be available, but certain rules have to be followed.
The relation of BIOMARE to SEA-SEARCH (intergovernmental organisation), an online gateway to European Marine data (www.sea-search.net), was discussed.

Distribution of the flyer:
Who should obtain it? General public, schools, universities, established researchers?
NGO's might be interested in it as well as MBA or other National Organisation for Marine Research. MBA offered to distribute the flyer to NGO's interested in the marine biodiversity issue. It could be joined together with the MBA newsletter which will be send to approximately 1300 people. Another idea was to write a contribution for the Elsevier Newsletter.

It was agreed that the co-ordinators would be provided with the necessary information about such organisations.
Other potential users were identified, such as: European Federation of Marine Science, WWF, EUCC, CIESM, Greenpeace, ECSA or Baltic Marine Biologists (BMB).
BIOMARE member institute will receive a given amount of flyers/brochures in order to distribute them to local/regional universities or other governmental bodies.

FUTURE PLANS

FUTURE PLANS for WORK PACKAGE 1: PRIMARY AND REFERENCE SITES
Vice-chair and minutes: Stephen Hawkins

Intensive (Flagship) Sites

The Chair summarised the reports from the regional sections from Friday. These were very congruent and thus the criteria and programme of research at these sites were agreed.
Carlo Heip suggested that there was a feeling in some quarters that biomarkers would be useful to judge pristineness. It was agreed that cross-calibration between indicators/biomarkers from W.P. 2 would occur at these Flagship Sites as well as others.

International and other initiatives

EUROCORES
Carlo Heip called for volunteers for help in commenting on the proposal for a EUROCORES proposal. Hawkins, Somerfield, Buchholz and Warwick agreed to do this.
A possibility of greater integration of activities stemmed from the powers under the Maastricht Treaty for the European Commission to co-ordinate national programmes, thereby improving competitiveness of the EU and supporting policy development. Carlo Heip agreed to explore this avenue.
The link between BIOMARE and DIVERSITAS.
Mechanisms to incorporate projects in DIVERSITAS have not been developed yet. It could be something like a stamp of approval by DIVERSITAS.
BIOMARE and the Newly Associated States (NAS).
NAS could develop proposals for projects themselves that could be adopted by BIOMARE.
BIODAQUA is an ERASMUS like student exchange programme between Canadian and European Universities and institutes. Contact persons: Mark Costello, or Margareth Eleftheriou.
OBIS and EUROBIS.
OBIS is an initiative to save orphaned datasets: dataset that are not are accessible to the public at the moment. Mark Costello intends to develop a European counterpart of this project: EUROBIS. The project aims at saving database with the main goals to provide species distribution maps. A EU proposal has to be developed for this. If an institute wants to be the general coordinator of this project, they can contact Mark Costello. The deadline for the proposal is 15 February 2002.
CoML
The Vice-chairman (Hawkins) mentioned a pilot proposal to COML to undertake work on updating regional marine station based fauna and flora lists (Plymouth Marine Fauna, etc). This proposal was a scoping study with a view to taking a larger proposal forward via the MARS network. This would be taken up again, but with the view of expanding the pilot to 4 or 5 regional floras or faunas. Volunteers were sought to contact S J Hawkins. Suggestions were Naples, Roscoff, Crete (Eleftheriou), Scarborough (Ducrotoy)
GLOBALLAST
Other initiatives mentioned were GLOBALLAST of IMO on species in ballast water. This would benefit from databases/atlases and BIOMARE had a role.
EEA
The EAA is also compiling a list of biodiversity monitoring sites, which could include an inventory of monitoring activities at the IFS's.

Funding strategy for the future

Richard Warwick envisaged a Framework Programme 6 proposal, encompassing many partners to undertake ATB1 at Flagship sites and with other research questions at the extensive sites. Without knowing the substance of the next call it was difficult to predict the exact field, although some influence on the content of the call could be exerted ahead of its formulation. S J Hawkins suggested that functional aspects of biodiversity could be addressed at the extensive sites using them as a nested network of study areas.

Presentation of information on Intensive Flagship Sites

It was proposed by the Chair and accepted that a succinct but glossy summary book/report of the sites be produced supplemented by web-based detailed information. This publication would include 2-3 pages plus illustrations summarising the nature of the 14-16 sites selected by the independent commission, plus briefer accounts of the extensive sites. An A4 book published by a suitable agency (preferably EC) was considered appropriate. MARS and UNESCO were mentioned as possibilities for the application for funds.

The role of Extensive Sites

It was agreed that the next round of regional workshops would develop a list of extensive sites, where soliciting or nominating locations providing a range of habitats, crucial biogeographic locations, and also

suitable for incorporation into long-term observational or experimental networks. Where possible, these sites (and the Flagship Intensive sites) should overlap with a subset of Natura 2000 sites or areas with statutory (or candidate statutory) status. Clearly the criteria for selection of such sites/stretches of coast/areas of sea depended on the scientific questions being addressed. These would include a range of replicated impacted and unimpacted sites/recovering sites. The need to distinguish local impacts on biodiversity from more global pressures (climate change, habitat loss, broadscale overfishing) was emphasised. The need to have a grid of sites to enable mapping was also noted. It was agreed that the extensive sites could be single stations (e.g. for plankton) or more extensive areas of coast, estuarine complexes etc.

Research at Extensive Sites

It was emphasised that the main thrust of BIOMARE and successor projects was long-term and broadscale research on biodiversity. Whilst ecotoxicological and compliance monitoring would use these sites or provide contextual information for study of these sites – the aim was long-term research not monitoring. Regional workshops and follow-up sessions need to clarify the questions to be addressed at these sites. Many compliance monitoring programmes covered coastal waters. It was essential that open water sites were covered. Research at these sites would inform and provide context for compliance monitoring.

The distinction between compliance monitoring and long-term research under BIOMARE was considered as being essential, although synergies exist.

Molecular Biology and Marine Biodiversity Research - Ramon Rossello-Mora
Discussion
Molecular techniques should not be used as an end itself.
Prokaryotes do exists and rule important ecological (biodiversity?) issues that we are dealing with.
3?
An ATBI is feasible for bacteria. Certainly if the survey focuses on the most dominant groups. It is likely that there are bacteria groups with a global distribution.

FUTURE PLANS for WORK PACKAGE 2: INDICATORS

Conclusions of the subgroup discussion

Working group 1 (WG1): Indicators of environmental changes
Only a few concrete answers were given, probably due to the fact that the questions provided mentioned at the handout, were not precise enough and because the interactions between biodiversity changes and environmental changes is not clear. A new series of questions (not limitative) is necessary during the electronic conference.

Working group 2 (WG2): Invasive species (autochtone and allochtone)
This group was reoriented and new questions were submitted for the second session. Links are made between this group and WG1 because the appearance and development of invasive species may be a consequence of global change. There is also a need to link with WG3 because of the usefulness of molecular markers to assess and monitor aliens and farm escapees and microbes as well.

Working group 3 (WG3): Genetic and molecular diversity
The assessment of genetic biodiversity is especially useful for small-sized taxa either cryptic species or larvae. It can also be used for conservation of species. Heterozygosity can give information on the recruitment efficiency and help to give an order of priority in endangered species etc. But the study of genetic and molecular diversity is difficult therefore only a small number of indicators must be selected. Links can be made with WG2 concerning the monitoring of invasive taxa and aquaculture escapees.

Working group 4 (WG4): Methodologies
We need more information concerning the methods to use as well as the scale at which they must be applied. We must be able to propose detailed protocols (including frequency at which they must be applies, special scale, their limits…) on e.g.:

Side-scanning
Remote censing
Photo and video recording..

We need more information concerning the methods to use as well as the scale at which they must be applied. We must be able to propose detailed protocols (including frequency at which they must be applies, special scale, their limits…) on e.g.:

Side-scanning
Remote censing
Photo and video recording..

There is a need of basic information. The existing data concerning biodiversity must be located. A special effort must be done to collect interesting data all ready existing.
Concerning the methodology used for genetic diversity it should be given by WG3 as for biomarkers by WG1. Comparable assessment methodology MUST be applied for example in the flagship sites. Which ones? Methods NEED to be standardized especially for rapid assessment methods.

Remarks on the discussion:

A list of methods was set up, however we have to go further. Each method must be discussed in relation (qualitative and quantitative) with its object. It does not seem necessary to continue to discuss methods apart from their geographical and temporal context, on the one hand, and of the target and the level of biodiversity chosen, on the other hand. The WP2 thus suggests keeping in mind methodologies in each other discussion. If it is proven that BIOMARE does not have the expertise of a given method, and if this method is necessary e.g. to the definition of a base line or a monitoring, it is important to define where competence is. We must, within one year only, being able to propose extremely concrete things.
There is also to concretely think about the quality control of the data, not only those that will result from future programs, but also those of the existing data. It is certain that such thoughts already took place in several European countries. It is thus important to make the synthesis of it (link with WP3).

In general

In general it can be concluded that the working groups did not give concrete answers to fill in the gaps. It is necessary to continue the discussion in the near future. The best way to achieve this is via an E-conference like discussion via the BIOMARE web site. A communication tool will be developed to discuss the four items via the Internet. The discussion will end 15 December 2001.
Another problem is the mixing up of different scales/levels and definitions. It is important to reach understanding in the meaning of important terms before we start the discussion at the Internet. Therefore Jean-Pierre will make an introduction to the discussions of the working groups containing summary and synthesis of the of the working group discussions, indications for the direction of the several discussions and a glossary of important terms.

It is important that the already filled in WP2 questionnaires will be updated, and that new-ones will be submitted. Therefore the database will remain accessible until further notice. The Members were kindly requested to use this opportunity to add information.

Key-issue: Marine benthic biodiversity - invaders and other challenges. - Sabine Cochrane
Discussion
A concerted action would be required to study the problems of the introduction of foreign species via the ballast water of large ships. Although the problem is generally accepted, until now no research aiming at this was funded by the EU. The private sector contacted Sabine Cochrane for advises in low risk regions for the dumping of the ballast water with respect to th epossibleintroduction of foreign species. Sabine Cochrane volunteered to explore links and ways to participate in these actions as a representative of BIOMARE.

Annex 1. Handout with discussion items for the Working Group discussions of WP2: Indicators

1. Indicators of environmental change (Sabine Cochrane)

- give general indicators for the impact of environmental changes
- give indicators for specific impacts (Climatic changes, toxicants)

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
- do indicators of early signs of biodiversity change/disturbance exist
- what is the usefulness of biomarkers:
    - what is the link with biodiversity
    - which relations with the health of the environment
- how to distinguish anthropogenic from natural impact
- give the major methods for the priority indicators
- what indicators to use to predict a change in diversity (modelling)

2. Keystone, invasive and engineer species (Carlo Heip)

We need:
- lists of OSPAR, Bern convention, etc. Others ??
- more pelagic taxa

About priorities:
- do we need taxa or functional groups?
- which species are the priority ones a) at local level, b) at European level
- how to distinguish anthropogenic from natural impact
- give the major methods for the priority indicators
- what indicators to use to predict a change in diversity (modelling)

3. Genetic (and molecular) biodiversity (Herman Hummel)

Solve gaps (how to do/measure) :
- assessment of biodiversity
- monitoring of invasive taxa and aquaculture escapes
- gene conservation and molecular ecology
- heterozygosity and demography at sea? Is it useful?

Needed:
- which indicators are the priority ones a) at local level, b) at European level
- how to distinguish anthropogenic from natural impact
- give the major methods for the priority indicators
- what indicators to use to predict a change in diversity (modelling)

4. Methodology (Fred Buchholz)

- how to collect and use existing data
- how to use remote sensing / habitat mapping / side-scan mapping (habitat diversity)
- how / for what modelling, scenarios, prediction
- which indicators are the priority ones a) at local level, b) at European level
- how to distinguish anthropogenic from natural impact
- give the major methods for the priority indicators

Annex 2 List of the responses of the WP2 questionnaire (14/11/2001)
Responses are available on-line at: http://194.167.19.106/biomare/viewR.php4

N°	Biogeographic sector	Country	Contact
1	Artic Sea, Atlantic	United Kingdom	S. Hawkins
2	Artic Sea	Norway	S. Cochrane
3	Atlantic	France	G. Bachelet
4	Atlantic	France	A. Toulmond
5	Atlantic	France	C. Amiard-Triquet
6	Atlantic	France	G. Boucher
7	Atlantic	Netherlands	H. Hummel
8	Atlantic	Norway	S. Cochrane
9	Atlantic, North Sea	United Kingdom	P. Ducrotoy
10	Atlantic	Belgium	S. Degraer
11	Atlantic	Ireland	C.Emblow
12	Atlantic	Portugal	R. Santos
13	Baltic Sea	Finland	E. Bonsdorff
14	Baltic Sea	Finland	E. Sandberg-Kilpi
15	Baltic Sea	Poland	J.M. Weslawaski
16	Baltic Sea	Germany	D. Schiedek
17	Black Sea	Turkey	A. Kideys
18	Black Sea	Ukraine	N. Milchakova
19	Black Sea	Greece	C. Arvantidis
20	Mediterranean	Slovenia	L. Lipej
21	Mediterranean	Israel	B. Galil
22	Mediterranean	France	C. Amiard-Triquet
23	Mediterranean	France	T. Perez & J. Vacelet
24	Mediterranean	France	A. Gremare
25	Mediterranean	Italy	V. Zupo
26	Mediterranean	Greece	N. Simboura
27	Mediterranean	Greece	C. Arvanitidis
28	Mediterranean	Greece	C. Arvanitidis
29	Mediterranean	Greece	C. Arvanitidis
30	Mediterranean	Greece	C. Arvanitidis
31	Mediterranean	Greece	C. Arvanitidis
32	Mediterranean	Greece	S. Orfanidis
33	Mediterranean	Turkey	M. Ertan Cinar

Annex 3. Participants of the Workshop

Federico ALVAREZ
Centro Oceanográfico de Baleares (IEO)
(SPAIN)

José F. AMENGUAL
Parque Nacional de Cabrera
(SPAIN)

Claude AMIARD-TRIQUET
Université de Nantes
ISOMer, SMAB
Service d'Écotoxicologie (FRANCE)

Christos ARVANITIDIS
Institute of Marine Biology of Crete
(GREECE)

Franck BRUCHON
Agence de l'Eau Seine-Normandie
Délégation au Littoral et à la Mer
(FRANCE)

Friedrich BUCHHOLZ
Biologische Anstalt Helgoland - AWI
(GERMANY)

Sabine COCHRANE
Polar Environmental Centre
Akvaplan-NIVA
(NORWAY)

Mark COSTELLO
Ecological Consultancy Services Ltd (ECS)
(IRELAND)

Tasman CROWE
Dept of Zoology
University College Dublin
(IRELAND)

Steven DEGRAER
Dept. of Biology, University of Gent
(BELGIUM)

Carlos M. DUARTE
IMEDEA (CSIC-UIB)
(SPAIN)

Jean-Paul DUCROTOY
The University of Hull
Scarborough Centre for Coastal Studies
(UNITED KINGDOM)

Anastasios ELEFTHERIOU
Institute of Marine Biology of Crete
(GREECE)

Chris EMBLOW
Ecological Consultancy Services Ltd (ECS)
(IRELAND)

Jean-Pierre FERAL
Observatoire Oceanologique de Banyuls, CNRS
(FRANCE)

Mariluz FERNANDEZ DE PUELLES
Centro Oceanográfico de Baleares (IEO)
(SPAIN)

Maia FOURT
Observatoire océanologique de Banyuls, CNRS
(FRANCE)

Bella GALIL
National Institute of Oceanography
(ISRAEL)

Philippe GARRIGUES
University Bordeaux I, UMR 5472 CNRS
Environmental and Toxicological Laboratory
(FRANCE)

José M. GOMEZ
Conselleria de Medi Ambient
C.A.I.B.
(SPAIN)

Raquel GOÑI
Centro Oceanográfico de Baleares (IEO)
(SPAIN)

Antoni GRAU
Conselleria d'Agricultura i Pesca
C.A.I.B.
(SPAIN)

Wulf GREVE
German Centre for Marine Biodiversity
(GERMANY)

Åke HAGSTRÖM
University of Kalmar
Dept. of Biology
(SWEDEN)

Stephen J. HAWKINS
Marine Biological Association of the UK
(UNITED KINGDOM)

Carlo HEIP
Netherlands Institute of Ecology
(THE NETHERLANDS)

Susan HULL
The University of Hull
Scarborough Centre for Coastal Studies
(UNITED KINGDOM)

Herman HUMMEL
Netherlands Institute of Ecology
(THE NETHERLANDS)

Damià JAUME
IMEDEA (CSIC-UIB)
(SPAIN)

Ahmet KIDEYS
Institute of Marine Sciences
Middle East Technical University (IMS)
(TURKEY)

Drosos KOUTSOUBAS
Aegean University
(GREECE)

Anita KÜNITZER
European Environment Agency
(DENMARK)

Harri KUOSA
Tvärminnen Zoological Station
(FINLAND)

Catalina MASSUTÍ
Conselleria de Medi Ambient
C.A.I.B.
(SPAIN)

Isabel MORENO
IMEDEA (CSIC-UIB)
(SPAIN)

Jorge MORENO
Parque Nacional de Cabrera
(SPAIN)

Gabriel MOYÀ
IMEDEA (CSIC-UIB)
(SPAIN)

Sergej OLENIN
Coastal Research and Planning Institute
Klaipeda University
(LITHUANIA)

Frode OLSGARD
Norwegian Institute for Water Research (NIVA)
(NORWAY)

Thierry PEREZ
Centre d'Océanologie de Marseille
UMR 6540 DIMAR
(FRANCE)

José ROMERO
Parque Nacional de Cabrera
(SPAIN)

Ramón ROSSELLO-MORA
IMEDEA (CSIC-UIB)
(SPAIN)

Sonja SALOVIUS
Environmental & Marine Biology
Åbo Akademi University
(FINLAND)

Eva SANDBERG-KILPI
Tvärminne Zoological Station
(FINLAND)

Doris SCHIEDEK
Baltic Sea Research Institute
(GERMANY)

Ricardo SERRÃO SANTOS
Dept. de Oceanografia e Pescas
Universidade dos Açores
(PORTUGAL)

Paul J. SOMERFIELD
Plymouth Marine Laboratory
(UNITED KINGDOM)

José TEMPLADO
Dept. de Biodiversidad y Biol. Evolutiva
Museo Nacional de Ciencias Naturales (CSIC)
(SPAIN)

Joaquín TINTORÉ
IMEDEA (CSIC-UIB)
(SPAIN)

Piia TUOMISTO
European Commission
DG Research
Brussels (BELGIUM)

Jean VACELET
Centre d'Océanologie de Marseille
CNRS-Univ. de la Mediterranée, UMR 6540
Station Marine d'Endoume
(FRANCE)

Pim VAN AVESAATH
Netherlands Institute of Ecology
(THE NETHERLANDS)

Richard WARWICK
Plymouth Marine Laboratory
(UNITED KINGDOM)

Jan Marcin WESLAWSKI
Institute of Oceanology
Polish Academy of Sciences
(POLAND)

Maciej WOLOWICZ
Institute of Oceanography
University of Gdansk
(POLAND)

Valerio ZUPO
Stazione Zoologica "A. Dohrn"
(ITALY)

Ulla L. ZWEIFEL
Dept. of Biology and Environ. Science
University of Kalmar
(SWEDEN)