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marbena

Electronic conference on 'European Heritage under Threat: Marine Biodiversity in Mediterranean Ecosystems'

April 22 to May 3, 2002

Summary of discussions

An activity of:

MARS **BIOMARE**

Organized by:

IMEDEA **CEMO** **VLIZ**

Supported by the European Commission under the Fifth Framework Programme and contributing to the implementation of the key action 'Sustainable Marine Ecosystems' within 'Energy, Environment and Sustainable Development'

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General Introduction to the Marbena Project

GENERAL INTRODUCTION TO THE MARBENA PROJECT

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Context

Ten years ago, in 1992, the Earth Summit was held in Rio de Janeiro. Rio produced the Convention on Biological Diversity that has now been signed by nearly all European countries and the European Union. Since 1992 many initiatives for research on biodiversity issues have been launched, the majority of them local, short term and terrestrial. Marine biodiversity research was long considered less urgent because the main problems were thought to occur on land. Long-term biodiversity research, i.e. for more than 3 years, is very difficult to implement, even at the national level. Some of the major obstacles are the national and European funding systems and also the lack of an internationally agreed methodology for the measurement of marine biodiversity and the choice of indicators for biodiversity.

In 1994, the European Network of Marine Stations (MARS, http://www.marsnet.nl), a non-profit foundation incorporated in the Netherlands, was founded to cope with these obstacles. In 2000, the MARS-related initiative BIOMARE (Implementation and Networking of large-scale long-term Marine Biodiversity research in Europe, http://www.biomareweb.org), started. This concerted action, supported by the Fifth Framework Programme, aims at achieving a European consensus on the selection and implementation of a network of reference sites as the basis for long-term and large-scale marine biodiversity research in Europe, internationally agreed standardized and normalized measures and indicators for biodiversity, and facilities for capacity building, dissemination and networking of marine biodiversity research. Twenty-one institutes co-operate in the concerted action.

The BIOMARE concerted action is an important first step and will provide a framework for the implementation of marine biodiversity research on spatial and temporal scales that cannot be covered by traditional funding schemes. The next steps are of course the research itself and the subsequent transfer of its results to society. The rapidly growing interest in biodiversity, with Rio +10 (the Johannesburg UN meeting) and the next framework programme approaching, require a directed effort from the scientific community. What is needed as well is a broadening of the discussion to a wider range of subjects and to a wider audience by not only including more scientists of other disciplines (e.g. terrestrial biodiversity and biogeochemistry), but science managers and end users as well.

To define the issues at stake an electronic conference on marine biodiversity in Europe (M@RBLE, http://www.vliz.be/marble) was organized in October 2001. The objectives of the M@RBLE e-conference were to discuss the bottlenecks and their solutions in producing relevant knowledge and the implementation of this

knowledge in policy, management and conservation; therefore contributing to the development of a network for (marine) biodiversity research in Europe. The results of the e-conference were presented at the meeting of the European Platform for Biodiversity Research Strategy EPBRS in Brussels, December 2-4 2001, and published as Vanden Berghe, E.; van Avesaath, P.H.; Heip, C.H.R.; Mees, J. (2001): Electronic conference on MARine biodiversity in Europe (M@rble): summary of discussions, 8-26 October 2001. Flanders Marine Institute (VLIZ): Oostende, Belgium. iii, 43 pp.

We believe that the present efforts, BIOMARE and M@RBLE, are an important start. However, more will be needed to support development and application of marine biodiversity research over a sufficient period of time to make the field mature and active on a truly European scale. The discussion on the issues at stake should not stop with the presentation of the results at one single meeting. Instead, the discussion should become a continuous process for at least as long as the EPBRS meetings are held, so that each EPBRS meeting receives a specific input from the field responding to the specific topic of that meeting. Starting from BIOMARE - that will produce a recommendation for a network of flagship and reference sites and a review of indicators - and M@RBLE - that produced through the e-conference and the link to EPBRS the first appearance of marine biodiversity on the EU policy scene - the next series of activities should be used to create a lasting network for marine biodiversity research in Europe. Such a network must adequately prepare and exploit the possibilities of the next framework programme and the European Research Area, must improve the infrastructure for marine (biodiversity) research and its accessibility and utilization by European scientists, and must increase the visibility of marine biodiversity issues for science managers, politicians and other end users, including the public at large.

Objectives of MARBENA

The objectives of the MARBENA project are:

- To create the infrastructure for marine biodiversity research in Europe by creating a pan-European network of marine scientists, with strong links to the different stakeholders in Marine Biodiversity Issues, from the EU-EEA and the Newly Associated Nations, and that covers the European seas from the Arctic to the Atlantic, the Mediterranean and the Black Sea. This network must improve the science by cataloguing the existing expertise and infrastructure, by defining and prioritizing the issues at stake in terms of scientific knowledge, technological requirements and application to societal problems. It must provide an intellectually attractive environment for young scientists and a discussion forum for all. It must promote the European presence and the organization of international research programmes, and promote the discussion of their results and their application. It must provide the links between scientists and industrial companies willing to aid in technological development, between scientists and science managers and

politicians and lead to better integration of research and a better insight in the 'market' of supply and demand of marine biodiversity information.

- To create awareness on the issues at stake and enlarge the visibility of marine biodiversity research in Europe, the network must make the issues – the scientific questions and the relevance of the outcome of the scientific research – clear to a non-scientific audience, it must communicate with EU policy makers and politicians (presentation of marine biodiversity issues at the European Platform for Biodiversity Research Strategy meetings, presentation to the European Commission and European Parliament when requested), with global organizations and programmes such as several IGBP programmes (GLOBEC, LOICZ, perhaps SOLAS), DIVERSITAS and the Census of Marine Life initiative, national and other EU biodiversity platforms (e.g. the BioPlatform thematic network) and dissemination of information to the public at large.

Hereby, the project contributes to the European Research Area (ERA) initiative. Special effort will be undertaken to involve the stakeholders from the Newly Associated States (NAS) in the network.

For more information on the project and for the partners involved see http://www.vliz.be/marbena.

Overview of planned project activities

To achieve these objectives, MARBENA performs the following main activities:

A. To create a long-term infrastructure for marine biodiversity research

1. To develop a European Marine Biodiversity Network
    - MARBENA will start by using existing information (e.g. the ESF and Diversitas Science Plan and the results from BIOMARE and M@RBLE amongst others) and by cooperating with existing European organizations, including the European Marine Research Stations Network MARS that through its member institutes has already played an active role in the development of marine biodiversity science.
    - MARBENA will open its activities and actively engage cooperation with any interested partner, including museums of natural history, universities and government laboratories.
    - MARBENA will establish a structural link with the BioPlatform.
    - One of the most important tasks will be integration with scientists of the Newly Associated States and a sufficient coverage of the marine areas at the periphery: the Arctic Sea, the Black Sea and – when possible – the Southern Mediterranean Sea.

2. To build a long term research infrastructure for the network MARBENA will provide the information and mechanisms for creating a solid basis on which the network can build:
    - By discussing research priorities and their implementation and coordination for the next five (or even ten) years and the ways of financing European-level research where needed, taking advantage of the new possibilities of the next framework programme and the European Research Area e.g. through complementation of national research.
    - By describing the market of 'supply and demand' of marine biodiversity information: who are the stakeholders and what is the information available and needed? Where are the gaps and what can we do about them?
    - By describing and publishing a catalogue of the research infrastructure existing and required (vessels, instrumentation, experimental facilities) and of taxonomic literature (floras and faunas, keys for identification), studying their accessibility to European researchers and prioritizing their development where necessary.
    - By promoting regional cooperation between different EEA and NAS countries focusing on regional problems and involving the regional end-users.
    - By promoting the possibilities for discussion between scientists, management and policy makers.

B. To create visibility for marine biodiversity issues in Europe

To enlarge the visibility of the marine biodiversity issues and therefore marine biodiversity research in Europe, MARBENA will work on publicizing these issues with the stakeholders and the public. This will be done by maintaining an active web site, by regular press releases, and by the publication of a newsletter, CD-ROM's and folders. MARBENA will link to other programmes of interest (DIVERSITAS, relevant IGBP-programmes, Census of Marine Life CoML etc.), to EU policy makers requiring information and support for implementation of e.g. the Water and Habitat Directives, the European Environment Agency and to the ESF Marine Board as a representative of the national funding agencies.

1. To develop and maintain a web site where information and issues produced by the Marine Biodiversity Network will be easily accessible to stakeholders involved in marine biodiversity as well as the public at large. The website will be the main communication structure for the network of marine biodiversity stakeholder. The web site will have links to the MARS Web Site and to other web sites (BioPlatform, ESF Marine Board, EU Directorate of Research)

2. To organize Electronic conferences on selected themes

- To provide relevant information on the Marine Biodiversity issue for use in the meetings of the "European Platform for Biodiversity Research Strategy" (EPBRS) connected with the EU presidencies. For this a close cooperation will be established with BioPlatform.
- To discuss issues important for the establishment and maintenance of the Marine Biodiversity Network and the long term infrastructure for marine biodiversity research and the communication between researchers, management and policy makers.

3. To organize workshops, conferences and case studies
   MARBENA will organize together with other partners a series of workshops on selected topics, discussion of four case studies on selected priority issues for four regions in Europe involving scientists, policy makers, industry and the public (including the press) and a major conference to finalize the project and create the conditions for the future existence of the network.

C. Involving the Newly Associated States

In this project special effort will be undertaken to include the scientists and through them the other stakeholders of the marine biodiversity research from the Newly Associated States in the network. For this we propose the concept of MARBENA Ambassadors, well known and respected scientists who are residents of the NAS, who will actively extend the network in these countries. Furthermore the 'Ambassadors' will discuss relevant biodiversity issues at the Electronic conferences.

The MARBENA electronic conferences

The MARBENA-project will organize a series of five e-conferences on selected themes.

Four electronic conferences will be held before each of four European Platform for Biodiversity Research Strategy (EPBRS - see the BioPlatform website at http://www.bioplatform.info) meetings with the following objectives:

- To raise a dialogue on the themes selected for the EPBRS meetings, involving a wide range of participants. These themes will be determined ad hoc in relation to the EU Minister Conference.
- To prepare for the EPBRS meetings through this dialogue, involving both the scientific community and policy makers, specifically:
  A. To identify current understanding on the selected themes.
  B. To identify areas of uncertainty ('biodiversity information needs') on the selected themes.

- To make provisional recommendations on research ('biodiversity research needs') on the selected themes for subsequent discussion at the EPBRS meetings.
- To provide background papers for the Platform meetings summarizing current understanding, areas of uncertainty and recommendations on research on the selected themes.

E-conference chairs are coupled with the EU presidency and organization of the EPBRS meeting: in order to reach participants form the nations that host the coming EPBRS meetings (Spain, Denmark, Greece, UK), the chair of the respective e-conferences is conveyed to a scientist resident of these countries.

The first of these conferences ran for two weeks, from 22 April to 3 May 2002. The theme was "European heritage under threat: marine biodiversity in Mediterranean ecosystems". The results of the conference are presented at the European Platform for Biodiversity Research Strategy (EPBRS) meeting under the Spanish EU Presidency, which is held in Almería from 11 to 13 May 2002.

The Electronic conferences will be held in preparation of the EPBRS meetings in Denmark (2002), Greece (2003) and the United Kingdom (2003). A special discussion item will be "Marine Biodiversity Issues in Newly Associated States".

One additional e-conference on "The Future of Marine Biodiversity Research in Europe" will be organized independently of the platform meetings.

Summary and conclusions

SUMMARY AND CONCLUSIONS

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Introduction

Because of events that occurred during its formation and subsequent history, the Mediterranean basin shows a rich marine biodiversity compared to other temperate seas. This biodiversity is still not totally disclosed, and yet there is concern that it is already being lost. The perceived erosion of Mediterranean marine biodiversity, which affects species within a broad range of taxa, and also the two other levels of biodiversity, ecological communities and genetic heritage, has been linked to increasing human pressure, derived from local (point and diffuse) and regional/global changes. Indeed, the Mediterranean coastline has experienced rapid change during the past century, including – among others – constructions along the coastline, increased boat traffic, exploitation of marine resources (wild and cultured), alterations of the hydrological regime of the basin and its connection to other basins (e.g. the Suez Canal), and the delivery of materials from the watersheds, as well as beach management. In addition, evidence for warming of the Mediterranean Sea has been linked to changes in the abundance of species as well as expansions of alien species. There is, therefore, the perception that Mediterranean marine biodiversity is presently under threat, but the rates and causes of these changes require further verification. The development of management strategies to monitor and conserve Mediterranean marine biodiversity should be, therefore, an important priority in the future. The e-conference *"European heritage under threat: marine biodiversity in Mediterranean ecosystems"* was aimed at providing a forum to exchange views and perspectives on this issue to help devise an agenda to confront and eventually revert the perceived problem.

The e-conference consisted of seven main discussion topics. Each topical discussion was opened by a statement from the co-chairs and with a Spanish scientist acting as opponent to stimulate the debate. Opponents have also contributed to generate this report. The topics and the corresponding opponents were:

1. Monday 22 April, *"Is marine biodiversity under threat in the Mediterranean?"* (Opponent: Enrique Macpherson)

2. Tuesday 23 April, *"What are the rates and causes of the erosion of Mediterranean marine biodiversity?"* (Opponent: Miquel Alcaraz)

3. Wednesday 24 April, *"Is invasion by alien species a major problem?"* (Opponent: Francesc Pagès)

4. Thursday 25 April, *"How to incorporate Mediterranean marine biodiversity into sustainable management strategies? How to incorporate this into cost/benefit analyses?"* (Opponent: Pere Oliver)

5. Friday 26 April, *"How should Mediterranean marine biodiversity be monitored? How to develop and use early warning indicators?"* (Opponent: Joandomènec Ros)

6. Monday 29 April, *"Ecosystem-oriented protection and management vs. species-specific strategies"* (Opponent: Raquel Goñi)

7. Tuesday 30 April, *"Hot topics in the management of the Mediterranean littoral zone. Beach management, development, and marine ecosystems under-threat: the case of* Posidonia oceanica *meadows"* (Opponent: Jorge Terrados)

The discussions engaged a large number of scientists throughout the Mediterranean, which contributed to a lively discussion in all these issues (cf. conference statistics below). These discussions were summarized, and used to produce the conclusions of the conference, all of which follow below.

Topic 1 – Is marine biodiversity under threat in the Mediterranean?

The importance of the biological richness of the Mediterranean basin is recognized by all participants and it is considered as one of the 25 hotspots in biodiversity in the Earth. This status is due to the high number of species (plants and animals) and the elevated number of endemics. These endemics belong to many taxa, and comprise around 18% of the total Mediterranean species. The necessity of an interdisciplinary approach, from descriptive to molecular taxonomy and from small-scale to landscape processes, was emphasized. Considering that this area is the most seriously affected by anthropic activities, the Mediterranean should be considered as one of the conservation priorities in Europe. The contributions to this electronic conference come from different countries and different specialities. The key points addressed were:

1. Is this a local or a basin-wide problem?

Evidence of diversity degradation is not fragmentary and there are too many data showing a general degradation of the Mediterranean ecosystems (e.g. fishing statistics, habitat losses, changes in the coastal landscapes). However, it was recognized that there is a lot of loss that may remain hidden because of poor knowledge in particular habitats, regions or taxa, and that some of the fluctuations detected may not be considered a threat. Nevertheless, some losses in traditional fisheries and slow-growing organisms (e.g. corals or *Posidonia oceanica* meadows) may require centuries to recover. There was also discussion on possible evidence of diversity losses in deep-water communities. Nevertheless, the absence of long-term records (before the 80's) makes this evidence speculative. However, some examples of changes and local extinctions in the fisheries of the red shrimps (caught deeper than 800m) provide support for this suggestion. These loss/variations could be induced mainly by fishing activities (and perhaps by supplementary anthropic actions, e.g. eutrophication, natural variations in environmental conditions). The importance of eutrophication-pollution and overfishing as the main causes in the biodiversity decrease was emphasized. This was supported by interesting data on the pollution of the Eastern Mediterranean basin.

2. Is it evident throughout the basin?

The necessity of a historical perspective of the biodiversity loss was stressed. Historical data exist, although they are not easy to summarize (and will be indirect evidence in many cases). There are some archaeological studies demonstrating historical changes. This perspective should be addressed from joint work by historians and ecologists. It was suggested that, at least for some invertebrate groups, we have explored only a small portion of the basin and their occurrence and abundance data are unfortunately scarce. This aspect avoids a general perspective of their fluctuations and extinction rates. Additionally, there is a scarcity of knowledge of the interactions between some abundant species (e.g. some commercial fishes) and poorly known or unknown species (e.g. gelatinous predators). Likewise, the effects on communities (seagrass meadows, coralligenous communities and so on) show regional differences.

3. Has it affected larger organisms only?

There are interesting examples of small species losses. Some intertidal hydrozoans have disappeared during the last decades, although these possible extinctions and changes need be better documented. Unfortunately, current knowledge is insufficient to realize whether an invertebrate is disappearing, unless it is a particularly conspicuous one, such as the bivalve *Pinna nobilis*, now protected by law in many Mediterranean countries. There is, therefore, the need to develop the capacity to detect threats in conspicuous and inconspicuous species, considering the importance of most species in this complex ecosystem, which requires also the existence of a pool of highly specialized experts in the taxonomy of the various groups, which is not guaranteed at present. Although in several groups the knowledge is still partial, in general we have an acceptable level of taxonomic knowledge for most groups. This knowledge has the potential, if properly articulated around long-term observational efforts, to deliver the trends on the increase or decrease in species richness after several decades of ecosystem degradation.

In addition to losses at the population level, there is evidence of biodiversity loss at genetic level in brackish water species, which is a far more 'cryptic' component of biodiversity loss, but with important implications for the evolution of the population (in some instances of the species). This calls for the development of a genetic monitoring of species, mainly in those species with low dispersal capabilities and restricted geographical ranges. However, these multiple targets will require the development of some tools to be used in risk assessment, such as the capacity to predict the sensitivity of particular taxa to disturbance. Such predictions would need a complex approach (e.g. genetic, species or community) and would be most necessary when studying long-lived organisms.

4. *Is the erosion of marine biodiversity generalized as to require a concerted effort and action from all countries?*

Biodiversity is not simply the number of species in an area; it is a complex aggregate including genetic variability, species interactions and landscape/ecosystem processes. Hence, biodiversity losses may occur at different levels. Whereas total extinctions are few, dramatic declines in the population size of several species represent a real threat (both for these species and for the whole community, given the possibility of cascade effects) which has been reported in various cases, and which evaluation requires interdisciplinary efforts and concerted actions from many countries.

Topic 2 – What are the rates and causes of the erosion of Mediterranean marine biodiversity?

In more than 30 posted comments, the participants have almost unanimously declared the existence of identifiable changes in the Mediterranean biota that may represent a serious threat. Overfishing, industrial and urban growth and pollution, and incorporation of alien biota, either man-enhanced or as a natural process, appear as the main causes responsible for the observed changes. However, the lack of historical perspective (extreme scarcity of long-term studies except for exploited species) preclude to isolate natural (i.e., controlled by climatic oscillations) from human-induced changes. For the same reasons, it is very difficult to quantify the rates of alteration.

The lack of adequate studies (long series of descriptors at appropriate time and space scales, including amongst other climatic, hydrographic and taxonomy data) preclude a clear distinction between natural, climate-controlled cyclic changes and irreversible, human-derived alterations. Fishery statistics are probably the only existing long-term data that can give some insights about the rate of ecosystem transformation in the Mediterranean. However, the data are fragmentary, focused on some exploited species, refer mainly to biomass, and don't inform about the accompanying fauna. Hence, despite evidence that Mediterranean marine biodiversity is declining, we ignore, to a large extent, the rates at which this decline takes place as well as whether this decline occurs as a step or gradual phenomenon.

The change of trophic structure of deep ecosystems, either by increased loads of organic matter, or by overexploitation of top predators, has been suggested to account for part of the diversity loss. The incorporation of alien species (Atlantic, via the Gibraltar Strait, or from the Red Sea) is also considered a threat. A possible compensation for the losses of Mediterranean species by exotic invasions cannot be considered as a gain, given the above-mentioned cascading effects on the ecosystem. Indeed, invasions by alien species have been often observed to act as an additional agent of further loss of the local biodiversity, as the incorporation of alien species further erodes, rather than compensates, Mediterranean marine biodiversity.

The scientific importance of taxonomic studies has been emphasized as a necessary step to detect any structural and functional change in Mediterranean ecosystems. At the same time, the absence of an adequate historical perspective must be corrected, and the collection of selected data for uninterrupted long time-series must be encouraged.

Topic 3 – Is invasion by alien species a major problem?

In general, alien or immigrant species have not caused significant impacts on the Mediterranean marine ecosystems, although a fraction of the species invading the Mediterranean have caused considerable damage to local biodiversity; the Eastern Mediterranean can be an exception, with its scores of Lessepsian migrants. However, the increasing record of non-indigenous species in the Mediterranean, whose ecological role and effect on biodiversity conservation is unknown, is a major concern. Participants argued about the main historic and recent anthropogenic factors that resulted in a high number of exotic species (not fully recorded yet) in the Mediterranean. Present knowledge and reliable data on species identity, introduction date, geographic origin, dispersal vectors and distribution ranges are very limited. The ecological impact of invasive species is poorly known because it is rarely investigated. Planktonic and benthic communities appear to be equally affected by invasive events. More joint research is necessary for obtaining a better knowledge of the present and future impacts caused by immigrant species.

Invasion affects biodiversity by adding species that may outcompete and displace indigenous ones. Most exotic species that establish reproducing populations within the Mediterranean constitute neither a nuisance nor have commercial value. Most exotic species do not undergo outbreaks that would turn even an innocuous species into a 'pest'. However, some of the invasive species have a heavy economic, if not ecological, impact, and the number of exotic species that develop stable populations is increasing. The special vulnerability of the Mediterranean Sea to invasion by exotic species stems from its position between the Atlantic, Pontic and Erythrean regions, its history, and heavy anthropogenic impact.

It is believed that impoverished biotas are more prone to invasions. The Levantine Sea has less than half the number of benthic species found in the Mediterranean Sea. This faunal impoverishment has been attributed to its comparatively late recolonization following the Messinian crisis, to Pleistocenic climatic fluctuations and to the basin's extreme oligotrophy. The prevailing high temperature and salinity may prevent the arrival of Atlantic species. When tropical organisms arrive, few ecological obstacles prevent their successful establishment. Increased pollution (from agricultural run-offs to industrial wastes), unsustainable fishing practices and engineering projects (dams, landfills, etc.) have caused widespread disruption of the littoral ecosystem and decimation of the Mediterranean biota.

It is difficult to provide conclusive data on the possible scenarios on the consequences of the introduction of species in the Mediterranean for marine

biodiversity there. Not enough data are available to forecast the effect of invading species on marine communities. However, some previsions may be attempted based on the general ecological characters of invaders. Taking into account the main source of human-mediated invasions (ballast waters, aquaculture, etc.), invaders are apparently represented by resistant, fast growing, adaptable species to diverse conditions and stressed environments.

There are marked differences about the impact of invasive species between the Eastern and Western Mediterranean. The eastern basin is mainly invaded by Lessepsian immigrants. In the western basin the most important invader, the algae *Caulerpa taxifolia*, was apparently released from a public aquarium. *Sargassum muticum*, and some other species that were introduced by the cultivation of exotic commercial species, have a strong economic impact together with the ecological one. Considering that ship ballast water affects equally both basins, western countries are more prone to introductions through aquaculture. The cold seawater temperature of the western basin in winter is not a barrier for the arrival and settlement of some Lessepsian immigrants. Since the fifties *Caulerpa racemosa* has reached the Italian coast and Mallorca. The seagrass *Halophila stipulacea* has passed the Siculo-Tunisian sill as have other organisms like the fishes *Leiognathus klunzingeri* and *Pomadasys stridens*, the gastropod *Cerithium scabridum*, and the pearl oyster *Pinctada radiata*.

No taxonomic surveys are made in areas highly sensitive to alien species introductions, as harbours and aquaculture sites. No study on the transport of organisms in ballast water has been attempted in the Mediterranean. The coordination among scientists undertaking research in this field is poor.

Very few scientific projects are investigating the occurrence of alien species and invasive events in the Mediterranean. The International Commission for the Scientific Exploration of the Mediterranean Sea (CIESM) is preparing an atlas of species that entered recently into the Mediterranean from either the Red Sea or the Atlantic Ocean. The list is very long. For most species there are just a few records and their impact is negligible. However, some species have an enormous impact along the Levantine coast (Egypt, Israel, Lebanon, Turkey) where 95% of total shrimp fisheries are Red Sea penaeid prawns, 50% of the volume of fish trawled is composed by Red Sea species and where large shoals of the scyphomedusa *Rhopilema nomadica* extend more than 100km in length. The ecological and functional role of most of these species is ignored.

To know the biological and socio-economic consequences caused by alien and immigrant species scientific research (taxonomy, ecology, environmental forecast) is required. The scientific cooperation would promote international regulations to prevent the arrival of exotic species and the control of their environmental impact.

Topic 4 – How to incorporate Mediterranean marine biodiversity into sustainable management strategies?

Ten posted comments discussed the lack of effective conservation measures in the development plans and their insufficient incorporation into developing initiatives on sustainable management. There was strong agreement regarding the need to face urgently the impact of human practices on marine ecosystems and biodiversity, mainly in the coastal zone, implementing effective management measures. The need to conduct a real Ecosystem-Based Management (EBM) based on indicators and limits of sustainability was stressed throughout the discussion.

Improved understanding of complex systems increasingly suggests that ecosystem state shifts can cause large losses of ecological and economic resources, and that restoring a desired state may require drastic and expensive intervention. In this case the challenge will be to sustain a large stability domain rather than to control fluctuations.

It was also indicated that changes over time cannot be meaningfully interpreted in relation to sustainable development considering only the ecosystem constraints/limits and that references corresponding to the socio-economic aspects of the human activity are also needed. It has been suggested that the huge economic pressures should be tempered down and in this context some initiatives to build a framework for protecting biodiversity and improve sustainability are relevant, such as 'The Earth Summit' in Rio de Janeiro in 1992 (UNCED Rio) and its Agenda 21. 'The Code of Conduct for Responsible Fisheries' adopted by FAO October 1995 should also be enforced. At the European level, the Habitats Directive 92/43/EEC aims at conserving the fauna, flora and natural habitats of EU importance. The Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean Sea entered into force in December 1999 within the framework of the Barcelona Convention. This new Protocol contains novelties regulating the protection and management of endangered and threatened species, and conservation and sustainable use of biodiversity.

The general opinion was that moral concerns on the loss of marine biodiversity have proved to be insufficient to effectively convince the managers about the need for a policy on resource management. Actually, economy tends to prevail over morals. A more promising venue would be the demonstration of the resources and services provided by marine ecosystems to the Mediterranean society, raising awareness on how the society is dependent on them, and how they are, in turn, dependent on biodiversity/ecosystem function. Moral concern is not enough and to convince the managers is our task.

Some events like the occurrence of red tide algae, the generation of mucilage and the proliferation of jellyfish has been quite detrimental for the tourism industry in the Adriatic. The invasion of *Caulerpa taxifolia* is harming both fisheries and tourism. Overfishing is the cause that only through subsidies the fishing fleets can maintain their activity and that more than 80% of fish consumption in the Mediterranean corresponds to products imported from other regions. It should be

possible to use such arguments to promote research into factors affecting the resilience of the Mediterranean ecosystem to invasive species, the likeliness of blooms of nuisance species or into how living marine resources can be exploited in a most responsible way. Also, the visit to marine protected areas (MPA) is a very important economic asset for the tourist industry, and many examples can be shown of a good symbiosis between protection and economic wealth to foster the creation of more of such MPAs around the Mediterranean.

Nevertheless, it has been also pointed out that at the same time that reliable scientific advice should be provided, management actions should be based on the Precautionary Approach; i.e. when evidence of a threat for sustainability exists the most conservative measure, based on the best scientific information available at that moment, should be implemented.

Topic 5 – How should Mediterranean marine biodiversity be monitored? How to develop and use early warning indicators?

There hasn't been an overwhelming participation on this topic, but all the participants made their points forcefully and a general agreement was evident. A summary of these contributions is as follows:

All opportunities are to be taken and used to monitor biodiversity changes, either through the use of individual species easy to survey (e.g. large macrofauna or macroflora species, charismatic or invasive species), indicator species, or communities. We should know well: a) the exact taxonomic (and eventually genetic) signature of the organisms used in monitoring programs; b) their ecological role; and c) reliable baseline data on which to base the comparison. This implies promoting existing efforts to elaborate national or regional floras and faunas, and to implement them where these efforts do not exist already. This in turn implies fostering taxonomy, be it old style (based mainly on morphology) or new fashion (genetic screening). Also, the compilation of long-term series of observational data is needed, from plankton inventories to photographic censuses of benthic communities, from commercial fish catches to weather and hydrographic data. The nature of these monitoring efforts implies that there should be previous knowledge, be it in the form of specialists on the different taxonomic groups, or on the ecological functioning of the littoral or marine communities to be surveyed, or on long term series of data on plankton, benthos, fish catches and so on. Thus the active participation of marine research institutes and experts on these areas is mandatory in these monitoring efforts.
On the precise tools to assess possible changes in Mediterranean biodiversity, there was general agreement that some of these can be particular species whose ecological and biogeographical role is known; these can be indicator species (providing a range of clues, from pollution to tropicalisation), or simply easily identified ones although perhaps less clearly related to signals or trends. Their abundance, decrease, spread, etc. should be followed synoptically throughout the Mediterranean basin. Among the suggested species are the 'fragile' sessile species: corals, sea fans, sponges; the 'engineering species': calcareous lithophyllid algae,

vermetid gastropods, some burrowers; and some 'exotics' – fast-spreading thermophiles in particular – as they clearly demonstrate human impacts. The benthic communities more akin to receive natural or man-made erosive impacts are also candidates, from seagrass beds to coralligenous bottoms, from marine caves to slope canyons. The study of some of these hot spots of biodiversity in the Mediterranean should be encouraged. In some cases, there can be whole community descriptors (such as species diversity, species richness, and so on) which, applied to well-established taxocoenoses, can give a hint of what is going on. Many of these descriptors and biomarkers have appeared in the scientific literature of the last half century, in the form of indexes of environmental quality, pollution, vulnerability, fragility, ecotoxicological and so on. In order to use these indicators only their standardization is needed. Some of these descriptors, such as the genetic markers, can be hard to apply or to follow, for various reasons (such as extreme expertise on rare taxonomic groups or sophisticated laboratory methods), but others need only routine surveys and long data series, some of which already exist.

Some national or international efforts already in force should be encouraged, such as those aimed at monitoring hard bottom benthos as a tool to detect biodiversity changes; or the long-term monitoring of protected areas in different countries, as a very useful byproduct of these rather pristine areas. These efforts should be promoted both at the national and European level, and with special emphasis in the development of parallel efforts in the Southern and Eastern countries of the Mediterranean basin, were most of the Mediterranean biodiversity resides. At the administrative and international level, the tools to achieve this are to be found in workshops aiming at the proposal of some routine surveys on well-agreed species, communities and/or biomarkers; the developing of PEET (Partnership for Enhancing Expertise in Taxonomy)-like projects; promoting the funding of normally submitted research projects with a clear biodiversity side; the implementation of Biodiversity Observatories all along the Mediterranean Sea, which should follow the monitoring protocols issued from the workshops. These activities should be taken into the main goals of already existing research associations or programmes (CIESM, MAP, SPA-RAC, ICRAM, UICN, WWF, and so on) or under a new (and effective) scientific umbrella.

Topic 6 – Ecosystem-oriented protection and management *vs.* species-specific strategies

Conservation strategies in the Mediterranean may be aimed at the preservation of individual species perceived to be under particular threat (e.g. monk seal), whereas other efforts may be aimed at the conservation of ecosystems (e.g. habitat directive). The question is whether species or ecosystem-oriented protection and management strategies are most effective and to what extent past knowledge may inform future decisions.

Concern was expressed that in general retrospective analyses on the effectiveness of each of these strategies are precluded by the lack of benchmarks against which

to measure the outcome of particular conservation strategies. In the absence of benchmarks (pristine ecosystems or protected for a long time), long-term data sets would be needed but these are rare. Hence, it appears that at present we are not well equipped to assess changes resulting from conservation measures unless the magnitude of the changes is very large. This strongly argues for foresight in establishing studies and sampling schemes with adequate spatial and temporal coverage in association with any conservation measure implemented.

In spite of these shortcomings, experience and common sense have taught us the following:

1. Arguments in favour of single individual species conservation approaches

Three interventions explicitly advocated the use, although not exclusive, of keystone, charismatic, flagship or umbrella species in conservation strategies. The advantage of conservation measures for umbrella species, for example, would be that since these species need large expanses of habitat, protecting them would automatically protect many other species. This approach would likely result in higher degree of protection than if 'representative' portions of such habitats would be set aside for conservation. The protection of flagship species – such as the monk seal, the sea turtles, or less charismatic ones as the dusky grouper – for its own sake is considered a must of conservation efforts.

2. Arguments against individual species conservation approaches

One intervention argued against single species conservation measures on the basis of past experience in the field of fisheries. To date most conservation and management of exploited marine species have dealt with single species but failures of this approach are widespread and well documented (over 40% of the exploited populations are heavily fished and some notable collapses and near extinctions documented in recent decades). This failure has open the way to a new paradigm in fisheries management and conservation, which contemplates a more precautionary approach to management of fishing activities, species interactions within ecosystems and the importance of habitat quality to the survival of species. This paradigm strongly promotes ecosystem-oriented management through protected or no-take areas.

3. Arguments in favour of ecosystem-oriented conservation

Several interventions embraced the concept of ecosystem management with a variety of arguments. Ecosystem-oriented conservation is more inclusive, since it contains both the species that are subject to conservation as well as their interaction with others and the physical and the biogeochemical support they require. The argument for ecosystem-oriented conservation was made strongly by

the loss of deep-sea and sea mountain species – such as deep coral reefs and gas hydrate communities. Fragile species that inhabit remote areas may only be subject to ecosystem-oriented conservation measures. Concern was expressed for ecosystems located outside national jurisdictions (e.g. deep-sea habitats) because conserving and monitoring them would require a concerted international effort. In this context an argument was made in favour of deep-sea marine reserves.

4. Arguments against ecosystem-oriented conservation strategies

None of the participants argued against ecosystem-oriented conservation but three participants raised points of concern. Assuming ecosystem-oriented conservation to be a more effective strategy, the questions of determining the location and size or proportion of habitat that needs to be protected is not trivial and rests on defining specific (species specific?) objectives of the conservation strategy. Furthermore, as ecosystems are open entities interacting with adjacent ecosystems, they are subject to widespread alterations through hydrological connectivity. Even disturbances well away of the conservation sites may have profound effects on the biological integrity of these protected areas. Also, the potentiality that protected ecosystems become population 'sinks' for protected species if the health of ecosystems outside them is poor cannot be overlooked. Thus best practices to conserve marine ecosystems in general must be also envisaged. Finally, it was pointed out that ecosystem management strategies are often the result of adaptive management rather than of sound scientific research.

Topic 7 – Beach management, development and marine ecosystem under threat: the case of *Posidonia oceanica* meadows

In order to focus the discussion, which remained academic or generic throughout the conference in a particular case example, the case of beach management and its effects on marine biodiversity was selected. This case was used to challenge the ideas proposed in the context of overlapping multisectoral interest, such as these converging in beach management and use in the Mediterranean.

Is the simple view that one strategy is optimal for all beaches adequate or should the management of this situation be delivered à la carte? How to reconcile the desire to have stable beaches with the need to preserve marine biodiversity down slope?

Most beach management actions are done without considering the beach as a living, fragile ecosystem which extends well beyond the human users to include other organisms inhabiting the beach ecosystem or using it during a certain stage of their life cycle such as sea turtles. Beach management and conservation strategies must include protection measures for sea turtle nesting beaches and coastal foraging habitats throughout the Mediterranean; not only in their main nesting beaches but in all the beaches of this sea, because important gaps still exist

on the biology and distribution of these animals in the Mediterranean. Every beach can be a potential nesting beach for sea turtles, as was demonstrated with the nesting event which occurred last year in a developed beach in Almería (SE Spain).

Most managed beaches undergo recurrent interventions to maintain a certain size, which implies a high frequency of perturbation and, consequently, a high degree of artificiality of the beach ecosystem. These 'hard approaches' to beach management seem driven by the explosive combination of economic and political interests, which represent the most serious threat for the preservation of biodiversity. Concerns were raised about the significance of these highly artificial ecosystems to maintain the overall biodiversity of the coastal zone. Frequent beach interventions can have detrimental effects on adjacent ecosystems or provide open space for the invasion of alien species such as the whelk *Rapana venosa* in the Adriatic Sea. Preservation of marine biodiversity cannot be reconciled with the introduction of alien elements/factors of disturbance in the ecosystem. Beach abandonment was seen as the most sound, effective target for beach management in the long-term, although politically and socially unacceptable in the short-term. A forecasted scenario of sea level rise and widespread coastal erosion supports beach abandonment as a management option, which can be achieved through the sound use of dedicated taxes on tourism along a time scale of a generation (30 yrs).

What to do in the mean time? Shall we allow beaches, whose natural regulatory mechanisms have been discontinued by urban expansion, to be eroded altogether? Will this erosion not affect equally the submarine rooted communities that we are trying to preserve? How to reconcile short-term with long-term goals?

Posidonia beds can be also at risk in an erosional coast, and intervention to maintain the beach and the *Posidonia* beds can be positive at the local scale. This may result, however, in managed *Posidonia* beds, or '*Posidonia* gardens' with, perhaps, little value for the preservation of biodiversity and the natural ecological processes. They can be an asset for tourism and an educational tool to convey the message of biodiversity preservation to the society, if done in a compatible way and with the adequate scientific control.

Shall we abandon all intervention to restore natural systems on the grounds that they may become gardens or shall we exert responsible management where human action has compromised the natural processes that sustain ecosystems? Is any extent of damage tolerable? If not, should a zero tolerance policy be extended to all activities on the sea and the littoral zone? What should be an acceptable time-scale for recovery when management has been implemented?

Posidonia oceanica growth is slow and recovery of disturbed meadows may take centuries provided the habitat is still favourable to *Posidonia* recolonization. Understanding of how the spatial structure of *Posidonia* beds is affected by the balance between physical perturbations (natural hydrodynamics, beach

management) and the potential for recolonization via both sexual reproduction and vegetative propagation is still limited and prevents the elaboration of models to predict the effects of different beach management options and set acceptable time scales to evaluate their success. Beach management policies that include a zero tolerance for damages to *Posidonia* beds seem appropriate to maintain the important resources and services provided by this ecosystem. Zero tolerance for damage, however, should be based on strong scientific knowledge to facilitate communication to society and confront the tourist industry.

Posidonia beach cast material serves important roles in initiating dunes, transferring nutrients to the dune vegetation, and preventing, by increasing the roughness of the beach surface, erosion and wind transport of the sand. Removal of *Posidonia oceanica* is therefore acting directly to increase beach erosion. Recent experiences in the island of Menorca, where a successful beach management plan that does not remove *Posidonia oceanica* except in limited areas, where it uses special tools to do so, has provided evidence of the benefits for the beach stability and, therefore, beach users. This programme is supported by tourist local entrepreneurs, which suggests that current attitudes can be changed through demonstration and education programmes. Once the benefits from alternative management options are demonstrated, the tourism industry can become a strong force to push for sustainable beach management. To implement with success coastal management actions that incorporate goals such as biodiversity maintenance, or long-term sustainable use of natural ecosystems is necessary to demonstrate the society the benefits it gets from healthy coastal ecosystems. Concerns were raised about placing a strong focus on the services provided to human society by *Posidonia* meadows for it could be interpreted as an excuse to disregard those species with not known services and, therefore, a threat for biodiversity preservation.

Posidonia oceanica is a slow growing species, which forms an ecosystem with low resistance and resilience. *Posidonia* reforestation is not a tool to be considered in current beach management programs for it cannot achieve a scale adequate to compensate for the many losses occurring, but it may be an educational tool, in the same way as planting a tree will not help achieve healthy forests but conveys a strong educational message to the citizens that do. Collection of *Posidonia* fruits and seedlings and the establishment of these programmes could help to preserve part of *Posidonia* genetic diversity.

Conclusions

The discussion provided ample evidence for the present loss of marine biodiversity in the Mediterranean, through climate change, inappropriate development of the coastal zone and widespread ecosystem degradation derived from pollution and nutrient inputs. However, the evidence for these changes is fragmented, mostly derived from observation on large vertebrate (e.g. monk seal), invertebrate (*Pinna nobilis*), or plant (e.g. *Posidonia oceanica, Caulerpa taxifolia*) species, but present knowledge is far more fragmented for more cryptic species. Moreover, the

observed changes cannot be, in many cases, separated from the effect of natural oscillations, so that the evidence for anthropogenic causes of the observed changes are confounded with these natural oscillations. Nevertheless, the significant changes observed in the biotic composition in some areas, and the growing evidences for a tendency of the Mediterranean to evolve into severely 'simplified' ecosystems, seem to confirm the rigour of the symptoms, and their extension from local to basin-wide scales. The symptoms appear to be more evident in bottom communities, both in shallow coastal and deep water ecosystems, but the observed plankton changes are important too, or at least suspiciously coincident along the last three decades.

The evidence of changes in marine biodiversity is less controversial for the case of introduced species, where human intervention is clearly established. The bulk of the alien species introduced have not caused any observable negative effect on the indigenous biodiversity of the Mediterranean. However, about 10% of the introduced species have been found to cause severe problems, either by inducing major changes in the food webs or by excluding indigenous species, besides their economic impact. Because the prediction of which particular species are likely to have negative effects appears cumbersome, the precautionary principle should prevail, and introductions of alien species in the Mediterranean Sea must be closely monitored.

Comprehensive, long-term observational programmes coordinated across the entire Mediterranean basin are essential to be able to resolve the rates of change in Mediterranean Marine Biodiversity, as well as to provide clues on the proximal causes of these changes. Such long-term observational programs, using standardized protocols, are indeed few in the Mediterranean, and this represents a major bottleneck to progress in our capacity to detect threats, and therefore protect, Mediterranean marine biodiversity. Use of indicators, whether species or environmental factors, may provide more efficient ways to monitor Mediterranean marine biodiversity. However, use of these indicators must be based on adequate scientific evidence, validated through carefully-designed experiments, as well as the necessary expertise (taxonomic, genetic, etc.).

Management and monitoring strategies may effectively combine species-oriented approaches with more integrative ecosystem-oriented protection. The adequate combination of these interacting strategies must be based on adequate scientific knowledge, where target species may be selected in relation to their value as keystone or umbrella species or critical risks.

Parallel to observational efforts, there must be an increase in our understanding of the functional role of marine biodiversity, and its bearing on the services and functions that support societal use of the Mediterranean Sea. Tourism, which is closely dependent on ecosystem quality (healthy ecosystems, transparent waters, etc.), has the potential to become a force in the preservation of Mediterranean marine biodiversity, once its benefits for ecosystem quality are effectively conveyed. A clear example may be beach management, where conservation of particularly important communities, such as *Posidonia oceanica* beds, provides clear benefits

for beach stability, by biogenic sediment particles to the beach and by dissipating wave energy before this reaches the beach, and stabilizing sediments.

In summary, the conference participants called for improved international cooperation for research on marine biodiversity in the Mediterranean basin, through concerted efforts involving all countries in the basin. This cooperation should be based on synoptic monitoring programmes using standardized procedures, as well as the effective partnership for the transference of know-how among countries and the design and execution of focussed, large-scale experiments to test the functional role of Mediterranean marine biodiversity. Increased scientific networking and progress must provide the advice needed to optimize the conservation of Mediterranean marine biodiversity, and to engage – through the demonstration of the multiple benefits from the maintenance of healthy marine ecosystems – all sectors involved in the use of the Mediterranean marine environment in the preservation of its biodiversity.

Message titles

Is marine biodiversity under threat in the Mediterranean?

Message	Date	Posted by
Is Marine Biodiversity under threat in the Mediterranean?"	22 Apr 02	Carlos Duarte & Damian Jaume
no title 1	22 Apr 02	Ferdinando Boero
no title 2	22 Apr 02	Ferdinando Boero
no title 3	22 Apr 02	Ferdinando Boero
no title 4	22 Apr 02	Ferdinando Boero
no title 5	22 Apr 02	Ferdinando Boero
Is extinction the only serious threat?	22 Apr 02	Carlos Duarte & Damian Jaume
Threats for losses in genetic diversity	24 Apr 02	Emanuil Koutrakis
Cryptic losses of biodiversity	22 Apr 02	Ferruccio Maltagliati
Threats to Mediterranean marine biodiversity	23 Apr 02	Bella Galil
Loss - yes or no	23 Apr 02	Andrej Jaklin
Is Marine biodiversity under threat in the Mediterranean?	22 Apr 02	Enrique Macpherson
Are endemisms particularly under threat?	22 Apr 02	Carlos Duarte & Damian Jaume
Are endemisms particularly under threat?	22 Apr 02	Enrique Macpherson
When did the erosion of Mediterranean marine biodiversity s	22 Apr 02	Carlos Duarte & Damian Jaume
When did the erosion of Mediterranean marine biodiversity s	22 Apr 02	Enrique Macpherson
no title	22 Apr 02	Raquel Goñi
Life history and loss probability	22 Apr 02	Carlos Duarte & Damian Jaume
sensivity to disturbance	22 Apr 02	Enrique Macpherson
When did the erosion of Mediterranean marine biodiversity s	22 Apr 02	Enrique Macpherson
Is Marine Biodiversity under threat in the Mediterranean dee	22 Apr 02	Joan Cartes
Is Marine biodiversity under threat in the Mediterranean?	22 Apr 02	Sotiris Orfanidis
Eutrophication and acidification of natural marine ecosystem	22 Apr 02	ZBYNEK VECERA
The environmental stress reduce biodiversity?	22 Apr 02	Franco Andaloro
deep-sea basin	22 Apr 02	Enrique Macpherson
Own dynamism and specific interaction	22 Apr 02	Lloris Domingo
A data more on Mediterranean deep sea	22 Apr 02	Lloris Domingo

What are the rates and causes of the erosion of Mediterranean marine biodiversity?

Message	Date	Posted by
What are the rates and causes of the erosion of Mediterranea	23 Apr 02	Carlos Duarte & Damian Jaume
The definition of biodiversity	23 Apr 02	Sotiris Orfanidis
On the definition of Biodiversity	23 Apr 02	Miquel Alcaraz
Causes/impacts and rates/info	23 Apr 02	Pere Oliver
no title	23 Apr 02	Francesc Pagès
Human activity is the problem	23 Apr 02	Miquel Alcaraz
Studies of biodiversity	23 Apr 02	Ana Carbonell Quetglas
Human constructions threat anadromous species	24 Apr 02	Emanuil Koutrakis
On the term "Erosion"	23 Apr 02	Lloris Domingo
natural vs. artificial changes in the biodiversity	23 Apr 02	Lloris Domingo
no title	23 Apr 02	Antoine Grémare
natural vs artificial changes	23 Apr 02	Bella Galil
no title	23 Apr 02	Lloris Domingo
deep water ecosystems	23 Apr 02	Joan Cartes
The deep sea as a witness of change	23 Apr 02	Carlos Duarte & Damian Jaume
Time series is the answer	23 Apr 02	Miquel Alcaraz
Retrospective data	23 Apr 02	gabriel gorsky
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to quantify changes	23 Apr 02	Pere Oliver
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There seems to be a substitution, at least	23 Apr 02	Miquel Alcaraz
No "gain"	23 Apr 02	Francesc Pagès
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balanced losses?	23 Apr 02	Bella Galil
Are the policies on environmental protection adding trouble?	23 Apr 02	Miquel Alcaraz
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Olympic practises	23 Apr 02	Pere Oliver
Dr Z.A.Sabeur	23 Apr 02	Sabeur Zoheir
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Exploitation of top-predators	23 Apr 02	Pere Oliver
top predators?	24 Apr 02	Ferdinando Boero

Is invasion by alien species a major problem?

Message	Date	Posted by
Is invasion by alien species a major problem?	24 Apr 02	Carlos Duarte & Damian Jaume
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and the meridionalisation ?	24 Apr 02	Franco Andaloro
northward expansion of distribution range	24 Apr 02	Francesc Pagès
Boreal Atlantic, Indopacific, Tropical, Alien, Amphiatlantic	24 Apr 02	Lloris Domingo
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Is invasion of species a major problem?	24 Apr 02	Sabeur Zoheir
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CIESM Atlas of exotic fishes in the Mediterranean	24 Apr 02	Massuti Enric
Fish, crustaceans, molluscs and.....?	24 Apr 02	Francesc Pagès
ciesm atlas	26 Apr 02	Ferdinando Boero
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Is invasion by alien species a major problem?	03 May 02	Sabeur Zoheir
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Development of information exchange network: CIESM atlas, GI	29 Apr 02	Vadim Panov

How to incorporate Mediterranean marine biodiversity into sustainable management strategies?

Message	Date	Posted by
How to incorporate Mediterranean Marine Biodiversity into Su	25 Apr 02	Carlos Duarte & Damian Jaume
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Regarding the framework for protecting biodiversity	25 Apr 02	Pere Oliver
EU ICZM strategy should incorporate Mediterranean Marine Bio	26 Apr 02	Emanuil Koutrakis
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Proxies and models without adequate data. What for?	26 Apr 02	Raquel Goñi
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Neither moral concern is enough, nor to wait for unchallenge	25 Apr 02	Pere Oliver
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How should Mediterranean marine biodiversity be monitored? How to develop and use early warning indicators?

Message	Date	Posted by
How should Mediterranean Marine Biodiversity be monitored? h	25 Apr 02	Carlos Duarte & Damian Jaume
Monitoring biodiversity at genetic level	26 Apr 02	Ferruccio Maltagliati
Handicaps are hindering the monitoring of Mediterranean Mari	26 Apr 02	Joandomènec Ros
benthic monitoring	26 Apr 02	Ferdinando Boero
Monitoring Mediterranean Biodiversity	27 Apr 02	Bella Galil
monitoring Mediterranean biodiv	26 Apr 02	gabriel gorsky
More on indicator species and communities and indexes	26 Apr 02	Joandomènec Ros
Bioindicators of biodiversity	06 May 02	Jean-Pierre Feral

Ecosystem-oriented protection and management *vs.* species-specific strategies

Message	Date	Posted by
Ecosystem-oriented protection and management vs. Species-spe	29 Apr 02	Carlos Duarte & Damian Jaume
What tools to measure effectiveness? Trial and error?	29 Apr 02	Raquel Goñi
Ecosystem-based conservation is more inclusive	29 Apr 02	Carlos Duarte & Damian Jaume
"Keep warter in a basket"	29 Apr 02	Raquel Goñi
Ecosystem-oriented protection and management including speci	29 Apr 02	Jurgen Tack
ecosystem-oriented protection in the deep sea	29 Apr 02	Bella Galil
One possible goal for science	29 Apr 02	Raquel Goñi
The dilemma "ecosystem-oriented" or "species-specific" strat	29 Apr 02	Emanuil Koutrakis
Widespread Ecosystem Conservation practices	29 Apr 02	Carlos Duarte & Damian Jaume
Protect habitats or the habitats needed for vulnerable speci	29 Apr 02	Raquel Goñi
What you see depends on what you look for	29 Apr 02	Paul Somerfield
whales and krill	30 Apr 02	Ferdinando Boero

Beach management, development and marine ecosystem under threat: the case of *Posidonia oceanica* meadows

Message	Date	Posted by
Beach management, development and marine ecosystem under-thr	30 Apr 02	Carlos Duarte & Damian Jaume
Our artificial beaches	30 Apr 02	Jorge Terrados
A Kyoto convention for beaches?	30 Apr 02	Carlos Duarte & Damian Jaume
Posidonia gardens	30 Apr 02	Jorge Terrados
Gardens or responsible management?	30 Apr 02	Carlos Duarte & Damian Jaume
What to do?	30 Apr 02	Miquel Alcaraz
Zero tolerance policy	30 Apr 02	Jorge Terrados
What is precautionary?	30 Apr 02	OCCHIPINTI Anna
Beach management	30 Apr 02	Miquel Alcaraz
Let's have a look on sea turtles	30 Apr 02	Jesús Tomás
Beach ecology	30 Apr 02	Carlos Duarte & Damian Jaume
debris and sex	30 Apr 02	Ferdinando Boero
Posidonia reforestation	30 Apr 02	Jorge Terrados
Education may help conservation	30 Apr 02	Carlos Duarte & Damian Jaume
Demonstration to society is the key for succesful, sustainab	30 Apr 02	Jorge Terrados
Anthropocentric and efficient	30 Apr 02	Miquel Alcaraz
hormesis and ethics	30 Apr 02	Ferdinando Boero
The value of biodiversity	30 Apr 02	Jorge Terrados
value of biodiversity	30 Apr 02	Ferdinando Boero
Approaching the beach: also whelks are coming	30 Apr 02	OCCHIPINTI Anna

Organization and statistics

ORGANIZATION AND STATISTICS

Edward Vanden Berghe

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The conference was organized as a moderated bulletin board. Both the introduction to the themes and topics, and summaries of the discussions, were available on the Internet, (www.vliz.be/marbena). Contributions to the conference were posted through a form on the web site. Contributions by non-moderators were flagged as 'non-moderated', until a moderator released them. For this purpose, the moderators had access to a separate form, which allowed editing or deletion of messages.

Discussions were guided by two chairmen, Carlos Duarte and Damian Jaume. Seven separate themes were discussed in consecutive days. For each of these themes, an 'opponent' was appointed. The chair was responsible to open the discussion, and to provide summaries of the discussions at regular intervals. They were also responsible to provide a general summary and synthesis of the discussion at the end of the week. These were posted on the web and also reproduced here. The opponents were responsible to keep the discussion lively. Dates, themes and opponents were as follows:

- day 1: Is marine biodiversity under threat in the Mediterranean
    - Opponent: Enrique Macpherson
- day 2: What are the rates and causes of the erosion of Mediterranean marine biodiversity
    - Opponent: Miquel Alcaraz
- day 3: Is invasion by alien species a major problem?
    - Opponent: Francesc Pagès
- day 4: How to incorporate Mediterranean marine biodiversity into sustainable management strategies
    - Opponent: Pere Oliver
- day 5: How should Mediterranean marine biodiversity be monitored? How to develop and use early warning indicators
    - Opponent: Joandomènec Ros
- day 6: Ecosystem-oriented protection and management *vs.* species-specific strategies
    - Opponent: Raquel Goñi
- day 7: Beach management, development and marine ecosystem under threat: the case of *Posidonia oceanica* meadows
    - Opponent: Jorge Terrados

The basic flow of information of the conference was through the WWW. This was done to stimulate 'external' parties to participate in the discussion. To make sure the conference was widely known, mailing lists of several organizations and activities were used to invite all interested parties to register. Access to the general

pages of the conference, and to the summaries, was open to everyone. To be able to post messages and also to view posted messages, registration through a form on the web site was needed. Requests for registration were handled individually; applicants were informed of successful registration in an e-mail. On the registration form, participants could choose to receive the summaries of the discussions, as drafted by the chairpeople and opponents, by e-mail. This was done by the vast majority of the participants.

Statistics

Registered participants (includes 'marble' participants): 438
Registered participants to 'marble': 328
Number of countries: 44
Participants requesting summaries through e-mail: 152
Number of messages: 146
Number of contributors: 33

Hits on marbena web site: 29071 (to 7/5/2002)
Hits on /cgi-bin/marbena.exe: 13162
Hits on /marbena: 15909, or approximately 3182 html pages

List of participants

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