MARBENA

Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy'

13 to 30 April 2004

Summary of discussions

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Organized by:

Ecological Consultancy Services Limited (EcoServe)

Centre for Estuarine and Marine Ecology (CEME)

Flanders Marine Institute (VLIZ)

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The topics and issues raised in the electronic conference have been presented to the EPBRS meeting "Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy" held on 21-24 May 2004 in Killarney, Co. Kerry, Ireland, under the Irish EU presidency. The PowerPoint presentation is available at http://www.vliz.be/marbena/sixthsummaries.htm. This volume includes introductions and summaries of discussions. All the discussion points raised during the conference can be reviewed by registering onto http://www.vliz.be/marbena

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Report of the MARBENA e-conference on ‘Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy’

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[*] Welcome and introduction

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It has given me great pleasure to organise this electronic conference together with the Flanders Marine Data and Information Centre as a part of the MARBENA e-conference series.

This e-conference gives us all the very important opportunity to contribute to prepare points of view and comments on the EU Biodiversity Action Plans (BAPs) related specifically to the marine environment. A parallel e-conference under the Bioplatform framework (www.bioplatform.info) will approach the BAPs from a non-marine perspective. These will be synthesised at presented at the next European Platform for Biodiversity Research and Strategy (EPBRS) meeting in Ireland in May. Following that meeting our ideas will probably also have input in the Malahide Stakeholder Conference that will review the European Biodiversity Strategy at a high political level.

Three BAPs are on the table for discussion.

The first three sessions of the e-conference will be devoted to BAP Fish. Highlighted in BAP fish are three core biodiversity and fish related issues.

1) the conservation and sustainable use of fish stocks and feeding grounds.
2) the impact of fishing activities and other human activities on non-target species and on marine and coastal ecosystems to achieve sustainable exploitation of marine and coastal biodiversity.
3) aquaculture practices that may affect habitat and species conservation.

One session will be devoted to each and will be run in parallel from 13th - 23rd April. Due to the Easter holidays we will possibly take a day to get fully up and running!

The final two sessions will also be run in parallel from 26th - 30th April (following a weekend break from the discussions) and cover the marine components of the two remaining BAPs on Economic and Development co-operation and Conservation of Natural Resources.

Much of our introduction will be expanded by the co-chairs of the sessions:

Session 1 - BAP fish - fishstock biodiversity
Chair: Einar Eg Nielsen [een@dfu.min.dk] Danish Institute for Fisheries Research
Co-chair: Uwe Piatkowski [upiatkowski@ifm.uni-kiel.de] University of Kiel

Session 2 - BAP fish - non-target species biodiversity
Co-chairs: Michel Kaiser [Michel.Kaiser@bangor.ac.uk] - Univ. North Wales, Bangor

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Emblow, C.S. (2004). Welcome and introduction. Pp 3-4 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

Henn Ojaveer [henn@pc.parnu.ee] - Estonian Marine Institute
Melanie Austen [MCVA@pml.ac.uk] - Plymouth Marine Laboratory

Session 3 - BAP fish - aquaculture
Chair: Yannis Karakassis [jkarak@imbc.gr] - IMBC

Session 4 - BAP natural resources
Co-chairs: Adrianna Ianora [ianora@alpha.szn.it] - Stazione Zoologica "A. Dohrn"
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Session 5 - BAP Economic development
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[*]Introduction to Session 1: Biodiversity Action Plan for Fish - fishstock biodiversity

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There has been an accelerated loss of species as human society has expanded. Consequently, the conservation of biological resources has been on the public agenda for several decades. Initially, focus was on the protection of species, but with the growing body of evidence of within-species differences, there has been an increasing awareness of the need to protect intraspecific diversity. This awareness has to some extent been delayed in "classical" marine fishes, i.e. species with wide distributions, large population sizes, high fecundity, pelagic eggs and larvae, to which most of our commercially important fin-fish (such as small tuna species, mackerel, herring, cod and haddock) stocks belong. The classical life-history traits of these species combined with the general lack of physical barriers in the sea has lead to the expectation of weak or absent population structure; in particular, on a micro-geographical scale where individual dispersal capability is expected to vastly exceed the size of the geographic range, genetic differentiation is not expected. Recently, however, a number of studies have challenged this "conventional wisdom" by inferring population subdivision in marine fishes on a very limited geographical scale.

Likewise, theoretical, experimental and empirical evidence strongly suggests that fishery induced selection can and has caused evolutionary change at life-history traits, such as growth and size at maturity in marine fish populations, resulting in slower growing faster maturing fish eventually reducing sustainable yield.

Finally, some recent studies have suggested that the effective population size in marine fishes is many folds lower than census size and has been affected by the large reduction in census size observed in most commercially exploited marine fish species. This in turn implies that loss of genetic variation (by random genetic drift) and possibly inbreeding could occur in natural populations of marine fishes.

In summation, there are three levels of biodiversity, which need to be recognised when managing biodiversity in marine fishes:

- Population structure
- Genetic diversity among populations
- Genetic diversity within populations

[*] Please refer to this section as:

Nielsen, E.E.; Piatkowski, U. (2004). Introduction to Session 1: Biodiversity Action Plan for Fish - fishstock biodiversity (1). Pp 5-6 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

Scientific justification for conserving intraspecific genetic diversity stems from several sources including:

1) maintaining adaptability of natural populations to future environmental changes (such as global warming);
2) changes in life history traits and/or behaviour that influence the dynamics of fish populations, energy flows in the ecosystem, and ultimately, sustainable yield;
3) the future utility of genetic resources for producing a diversity of aquaculture and other products. The challenge is to formulate appropriate management actions for the preservation of genetic diversity. This will require consensus on what it is we are trying to preserve (e.g., alleles, traits, population structure) and some means of assessing genetic "status".

So, what kind of biodiversity are we trying to conserve in marine fishes?

How do we prioritize what kind of biodiversity should be conserved?

How do we measure biodiversity in marine fishes?

How do we establish reference points for biodiversity in marine fishes?

Which fishery regulating tools (quotas, closed areas, mesh size etc.) can be used (and which cannot) in order to maintain biodiversity in marine fishes?

[*]Introduction to Session 2: Biodiversity Action Plan for Fish - non-target species biodiversity

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One of the three objectives of the Biodiversity Action Plan for fisheries is 'to reduce the impact of fishing activities and other human activities on non-target species and on marine and coastal ecosystems to achieve sustainable exploitation of marine and coastal biodiversity'. Few fisheries remove only the target species, most affect the biota associated with the target species or the habitats in which they are found, resulting in much wider ecological effects. Non-target species may be more or less resilient to the effects of fishing than the target species which is dependent upon their life-history and vulnerability to capture. Non-target species may have multiple or key roles in marine food-webs that underpin ecosystem processes and functioning. These in turn may be integral to the productivity of marine capture fisheries (e.g. in the provision of habitat or prey species). Our current knowledge of the ecosystem role performed by many non-target species is often lacking and may not extend beyond basic information such as distribution or population dynamics. Thus our ability to understand the wider ecological consequences of management decisions devised for target species is limited at present.

Undoubtedly the most effective mechanism of achieving the Biodiversity Action Plan for non-target species is to reduce the actual amount of fishing activity (fishing effort) that occurs in the sea. The current European system of management is based on the allocation of catch quotas (Total Allowable Catches TACs) that encourages increasing amounts of fishing activity in response to declining fish abundance. Increasing the time spent fishing elevates the probability of capture for non-target species such marine mammals, seabirds and fish. The relationship is not as simple for non-target benthic communities and habitats as fishing effort is not uniformly distributed. The distribution of fishing activities is spatially aggregated and many of these patterns are relatively consistent through time unless the imposition of regulations or area-closures forces a movement of activity into other areas. As a result, a proportion of the European shelf has been fished many times while other areas remain unfished.

Areas subjected to repeated fishing disturbance will be held in a permanent state of degradation, with lower species diversity and alteration of benthic production. Hence, populations of non-target species whose distribution is currently aligned with areas of most intense fishing are subjected to severe stress and may be threatened with either population declines or degradation of their habitat. A reduction of fishing effort would focus the remaining activity on the most heavily fished areas,

[*] Please refer to this section as:

Kaiser, M.J.; Ojaveer, H.; Austen, M.C. (2004). Introduction to Session 2: Biodiversity Action Plan for Fish - non-target species biodiversity. Pp 7-9 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

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but would result in a reduction in activity in less heavily fished areas as a result of fishermen's behaviour. An increase in fishing activity would have the opposite effect, leading a further elevation of disturbance in the most heavily disturbed areas with little net decline in ecological status, but increasing the propensity of fishermen to explore 'new' areas of the seabed for which they had little previous knowledge. As the initial one or two disturbances of the seabed lead to the greatest reduction in benthic production, the negative ecological effects of increasing fishing activity would be proportionately greatest in these 'new' areas.

European member states are keen to pursue mechanisms that might alleviate some of the negative effects of fishing on non-target species, but the emphasis seems to be focussed on the use of technical measures, such as the introduction sorting devices, promotion of devices that have a reduced physical impact on the marine environment etc. Although these measures are desirable, we suggest that they will not achieve the aims of the BAP without a concomitant reduction in the amount of time spent fishing. The increased survivorship of non-target species associated with technological improvements could easily be obviated by increases in the time spent fishing to achieve unrealistic quotas set against declining fish stocks.

The use of Marine Protected Areas has been strongly advocated both as management tools and as tools to conserve and even restore marine biodiversity. In Europe, areas closed to some or all forms of fishing already exist to protect spawning and nursery areas. The debate remains unresolved as to their viability as a useful management tool for the conservation of mobile stocks of temperate fish species, but they are likely to be an effective tool to alleviate the negative effects of fishing activities on sedentary target species (e.g. shellfish and some demersal fish) and benthic habitats and their associated fauna. However, in the current push towards achieving ecosystem management we need to give serious consideration to the means by which we monitor the performance of these and other management tools.

Currently in some European member states, the conservation monitoring of marine taxa is species and biotope based. Inevitably much emphasis is given to the occurrence of rare species. However these are the most problematic group to quantify with any level of certainty and they have a strong influence on the definition of biotopes. Given the large-scale environmental changes (global warming, eutrophication and pollution) that currently impact upon the marine environment, we may need to consider the use of other tools to assess ecosystem health. Most individual species are relatively uncommon or rare within an assemblage of fauna. Thus whole community metrics may be more robust tools to detect changes that have greater ecological relevance than the presence or absence of individual taxa (unless perhaps these are dominant ecosystem engineers). Such metrics would include abundance/biomass curves, body-size spectra and stable-isotope signatures. Classical taxonomic approaches are still required, most importantly to detect the invasions of alien species. While the latter may be required to detect the presence of alien species, a detailed understanding of their individual ecological impact may not be required if community health is measured in terms of whole community metrics. The current levels (in terms of effort – both financial and manpower) of taxon-specific marine conservation monitoring may require reassessment. The effort demanded by the latter inevitably reduces sample replication and hence the statistical power to detect the very changes in which we are interested. Worse still, large-scale programmes to create inventories of marine fauna have been abandoned at a point close to completion, a decision no doubt predicated on cost. Greater emphasis on whole community metrics would give greater power to detect ecological change and may prove more cost-effective in the long-term.

The BAP suggests four technical measures to reduce the impact on non-target species and habitat and should form the focus of the e-conference discussion.

Method 1; introduction and promotion of the use of selectivity devices that reduce or eliminate by-catches of non-target species;

Method 2; introduction and promotion of fishing methods that have a reduced physical impact on the marine environment;

Method 3; when appropriate institute temporal and spatial closures to enhance protection of species or habitats, including ‘no-take’ zones;

Method 4; introduction, as appropriate, of limits on by- or incidental catches especially for species listed in environmental legislative instruments.

[*]Introduction to Session 3: Biodiversity Action Plan for Fish - Aquaculture

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Aquaculture interferes directly or indirectly with different biogeochemical processes in the marine environment, involving impacts at varying spatial and temporal scales. It is a rapidly expanding industry with high potential for further expansion and therefore, has the potential for large-scale effects. It takes place mainly in the coastal zone where biodiversity is high and human pressures are increasing and complex. In this context, aquaculture can be seen as a miniature comprising all the current problems encountered in the coastal zone and a very good example for analysing human impacts on marine biodiversity.

Although some species are directly affected by aquaculture, and species diversity beneath fish cages is generally decreased, it is not certain that the biodiversity is in danger due to fish farming. According to Margalef (1997), there is a clear distinction between biodiversity (i.e. the total number of available species or genotypes in an area) and ecological diversity or eco-diversity which can be inferred by sampling local biotic communities. In this context, the local changes in community structure, affecting a few square metres should not be considered as a decline in biodiversity. By contrast, risks for biodiversity arise when a particular type of habitat (rare, endemic or supporting an endangered species or a key-habitat supporting life of the wider area) is severely degraded over large scales or when populations of k-selection species are reduced to unsustainable sizes. At present most of the scientifically documented effects are those on macrofaunal invertebrates at a zone beneath and close to the farm cages. These organisms are ecologically important but it is very unlikely that they will become extinct or that their populations at larger spatial scales will be significantly affected.

The potential problems affecting biodiversity in relation to aquaculture are the mortality of large fauna, the effects on sea-grass meadows and other sensitive habitats, the changes in the trophic status of large water bodies and the introductions of alien species.

There is little evidence for change in trophic status of large water bodies in relation to fish farming with the exception of the low salinity Northern Baltic where increased growth of macrophytes has been reported in the vicinity of fish farms.

The effects on seagrass meadows and particularly *Posidonia oceanica* in the Mediterranean are probably a risk to biodiversity since the habitat of this phanerogam is ideal for fish farming (strong currents, coarse sediment, adequate oxygenation, clear waters). The EU-funded MedVeg project has investigated these effects along an East-West transect in the Mediterranean and there are

[*] Please refer to this section as:

Karakassis, I. (2004). Introduction to Session 3: Biodiversity Action Plan for Fish – Aquaculture. Pp 10-12 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

considerable indications that fish farming has a significant negative effect on Posidonia meadows and therefore it could pose an important risk if sites are not properly selected (Holmer et al. 2003).

The effects on wild fish have been recently investigated in the framework of EU-funded AQCESS project (Aquaculture and Coastal, Economic and Social Sustainability). This survey involved experimental trawling (3 areas by 2 seasons) at near and far fields, before-after comparisons of catches, hydroacoustic surveys over large spatial scales, underwater investigations by means of ROV (Remotely Operated Vehicle) and time-series analysis of commercial data on fish landings in 5 different areas (with and without fish farming effects). The results of this project have shown clearly that the presence of aquaculture zones induces higher abundance, biomass (by a factor of 2) as well as higher diversity at intermediate spatial scales (1-20 km) which positively affects local fisheries by increasing total landings. This effect is probably related to the oligotrophic regime of the Aegean Sea, where even small amounts of nutrients are rapidly and effectively transferred up the food chain. It is worth noting that in the framework of AQCESS, an identical survey conducted in parallel in the more productive waters of North Atlantic showed little response of wild fish abundance and biomass to the presence of fish farming zones.

The introduction of alien species due to aquaculture is an existing risk as well although it is considerably lower than that of ballast water and hull fouling. The intentional introductions for stock enhancement should be severely regulated.

The BAP priorities include the following points:

- Promote measures to reduce direct impact on the environment of waste products from aquaculture installations;
- Promote best practice for EIA for aquaculture projects with the requirement that fish-farming projects be subject to EIA provisions;
- Promote shellfish cultivation and restoration of natural shellfish beds. Shellfish cultivation requires neither supplementary feeding nor a direct energy input to support growth;
- Promote environmentally friendly methods of harvesting shellfish beds;
- Promote the development of secure offshore technology and water re-circulation systems
- Thoroughly evaluate the potential impact of new non-indigenous species to aquatic aquaculture and promote the application of ICES/EIFAC Code;
- Review existing Community aquatic animal health legislation with a view to ensuring its updating to assist the maintenance of biodiversity in the aquatic environment;
- Promote the development of guidelines on containment of farmed fish in aquaculture;

In the framework of the e-conference discussion, it is worth asking which of those priorities can have a significant positive impact on the preservation of biodiversity given the present level of documentation of risks. For instance:

Reduction of local effects can increase the number of species beneath the fish farming facilities from e.g. 0-3 to 5-10 but would this have a measurable effect on even mesoscale biodiversity?

There is no doubt that a reliable Environmental Impact Assessment (EIA) is needed before approving an aquaculture project, but is the knowledge-base strong enough to allow accurate predictions of impacts at scales relevant to biodiversity?

There is a strong message that shellfish farming is less harmful than fish farming and indeed this is the case regarding the use of exogenous feed, but is the reduction of phytoplankton in the water column and the increase in sedimentation due to precipitation of pseudofaeces a process more friendly to biodiversity?

Of course there can be no objection to the development of new technological options (offshore structures, recirculation systems, improvement of containment conditions) or to increase the knowledge basis for the potential impact of non-indigenous species.

The overall questions are:

- Do the measures proposed in the BAP cover the existing problems concerning the interactions of aquaculture and biodiversity?
- Is there enough scientific understanding (documentation) of the effects of aquaculture on biodiversity to allow firm decisions to be made?

[*]Introduction to Session 4: Biodiversity Action Plan for Natural resources

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What are natural products and why are these resources worth conserving?

Strictly speaking, any biological molecule is a natural product. But this term usually refers to secondary metabolites that are not involved in primary metabolism, and therefore differ from the more prevalent macromolecules such as proteins and nucleic acids that make up the basic machinery of life. Often these secondary metabolites represent only about 0.0001% of the total biomass of an organism, and it is not clear what biological role these compounds play and what advantages they offer to the producing organism. To date, tens of thousands of secondary metabolites have been described from sponges, ascidians, soft corals, seaweeds, marine microbes and many other benthic and pelagic organisms, with more being discovered daily. Many of these products find important biotechnological applications in biomedical research, and in the agriculture, aquaculture and chemical industries. For example, domoic acid, the causative agent for amnesic shellfish poisoning, is produced by species of diatoms belonging to the genus *Pseudo-nitzschia*. The toxicity of domoic acid is due to the fact that it mimics the excitatory activity of L-glutamic acid, inducing neuronal depolarisation and successive degeneration of the hippocampus of the brain. Due to its ability to mimic L-glutamic acid, domoic acid shows very strong insecticidal activity and is more potent than most other synthetic insecticides. The advantage in this case is that it is a natural product and therefore presumably causes less damage to the environment.

Aside from their biotechnological applications, many natural products play fundamental roles as defences against predators, competitors and pathogens, and are therefore driving ecosystem functionality. For example, plants can produce allelopathic substances inducing either deleterious or advantageous effects that are crucial in the competition for available resources. They can also produce teratogens (substances that induce congenital malformations in the offspring of organisms exposed to them during gestation, ultimately giving rise to embryo or fetal mortality, i.e. abortions) with dramatic consequences on recruitment rates of animal populations feeding on them (Miralto et al. 1999; Ianora et al. 2003). Chemical diversity among species is at the basis of ecological specialization, can affect species' distribution and community organisation, determine feeding patterns, and promote evolution and maintenance of biodiversity through resource and habitat partitioning. An increased understanding of chemical defenses is thus fundamental to a wide range of ecological and evolutionary issues (see Hay 1996; Hay and Fenical 1996).

This discussion on marine natural products is aimed at understanding how marine natural products can help regulate ecosystem functionality by underpinning the chemical and molecular processes that are crucial for maintenance of biodiversity. The idea is that if we can understand the natural function of these compounds, we can develop new strategies for the correct management and

[*] Please refer to this section as:

Ianora, A.A.; Davies, J.J. (2004). Introduction to Session 4: Biodiversity Action Plan for Natural resources Pp 13-15 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium..

protection of these potentially important natural resources for the future, and find new biotechnological applications for these products in our day-to-day lives.

Not only rare species, but also widely distributed species, either cultivated or of recent introduction into regions of comparable climates and resources, may produce unusual secondary metabolites that can alter ecosystem functionality. The accidentally introduced alga, *Caulerpa taxifolia*, has shown a spectacular proliferation and the area colonized by this species in the Mediterranean has reached more than 1500 ha (French-Italian coast). Some settlements have been discovered recently from the Croatian coast (Adriatic sea) to the Balearic Islands (Spain). This explosive development has endangered the endogenous ecosystem and ecosystem functionality (trophic relationships) largely due to the production of repellent toxins such as caulerpenyne, oxytoxins, taxifolials and other terpenes. For example, caulerpenyne is toxic for molluscs, sea urchins, and herbivorous fish, and is capable of killing off many microscopic organisms and other submarine flora. Due to its fast growth rates, *Caulerpa* is becoming the canopy forming species in the Mediterranean and is replacing other autochtonous floral competitors.

Several species of dinoflagellates are responsible for harmful algal blooms (HABs) that cause massive fish kills as well as the death of many aquatic birds and mammals. The toxins produced by HABSs are also responsible for at least four different pathologies in human consumers of shellfish: paralytic, diarrheic, neurotoxic and amnesic poisoning. A related problem, known as ciguatera fish poisoning, causes more illness than any other toxicity due to human consumption of seafood, and affects annually ten to fifty thousand individuals in many tropical and sub-tropical regions of the world. Such toxic events are a serious constraint to the sustainable development of many coastal areas, and a concerted scientific and management approach is needed to mitigate the effects of HAB toxins, and to protect European areas from outside invasions of HAB species, in order to safeguard the commercial value of coastal marine ecosystems (Zingone and Enevoldsen 2000).

There is also a chemical threat to marine biodiversity due to the introduction of external toxicants that can build up in the marine environment and cause harmful effects such as changes in the immune system, behavioural alterations and impaired reproduction of resident populations. Pharmaceuticals (human and veterinary) and personal care products (musk-derived ingredients in perfumes and deodorants) are constantly being released into the environment and it is believed that these can elicit effects at very low ambient concentrations, disrupting the endocrine system in wildlife and possibly humans. Many of these compounds (musk) are similar to natural pheromones that are vital for chemical communication affecting mating and development. The potential long-term risk posed by pharmaceuticals and other toxicants is largely unknown, and new legislative measures will have to be adopted to avert environmental risks of exposure to these toxicants, in addition to classical toxicants such as DDT and PCBs.

Novel and ecologically relevant methodologies need to be developed and applied to investigations of allelopathy, antipredation, antifouling, antimicrobial, and other possible functions of secondary metabolites. An adequate understanding of chemical defenses will be achieved when we know how ecologically realistic doses of these metabolites affect growth, reproduction and survivorship of consumers. In the long run, such studies will lead to a better understanding of how these compounds can alter marine biodiversity at the genetic, species and ecosystem level.

The BAP priorities in this field are:

1) to address the chemical threat to biodiversity through collection of environmental toxicity information and application of risk reduction measures.
2) to address potential problems of endocrine disruptors on biodiversity

3) to update the list of alien species that are known to pose an ecological threat to native flora and fauna, habitats and ecosystems, and to prevent the introduction of or eradicate those alien invasive species.
4) to prevent or minimize adverse effects on biodiversity caused by release of GMOs.

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[*]Introduction to Session 5: Biodiversity Action Plan for Economic development

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Mainstreaming biodiversity objectives into EC development and economic cooperation strategies and policy dialogue with partner countries is as much a political as a technical challenge - without high level political support progress will be slow and difficult. Those concerned with developing cooperation strategies across different sectors, and those who negotiate cooperation agreements at the highest political level, need to be convinced of the value of biodiversity for achieving poverty reduction and economic objectives.

A good starting point would therefore be to identify examples of approaches that integrate biodiversity, livelihoods and economic objectives in each key sector, and conduct a detailed assessment of their impacts on the ground, including their contribution to food, health, income, livelihood security and ecosystem services (as well as cultural and spiritual well-being). These impacts should then be compared with those of more conventional non-biodiversity based approaches. Such case studies would also serve to demonstrate the types of activities and approaches that can be supported to integrate biodiversity, development and economic objectives. The selection of case study examples could be guided by the principles of the ecosystem approach.

Furthermore, the case studies should also examine the wider policy and governance context in which these examples exist to identify the 'external' conditions needed to better support such approaches and facilitate their wider replication and adoption - for example, secure land tenure, strong representative local peoples' organisations, democratic local governance, effective decentralisation, participatory and adaptive policy processes, flexibility to experiment, feedback from local experience, institutional coordination, and so on. Within a given country, such findings could be distilled from case studies in different sectors and regions.

The research process should itself be used as a means to enhance political support for biodiversity and promote change by engaging with many stakeholders, including current 'power brokers' and 'agents of change', seizing political opportunities, and strengthening the negotiating capacity of local representative organisations. In other words, it should be highly participatory, both in terms of the community level assessment, and the policy analysis process. It should also be tailored to inform key economic and development processes in partner countries such as Poverty Reduction Strategies, macro-economic reforms and agricultural modernisation policies.

In addition to comparison of impacts of biodiversity and non-biodiversity based approaches, deliberative democracy approaches such as 'citizen's juries', scenario workshops or visioning exercises, could also be used to enable poor farmers and communities to assess the implications of different policy options and articulate their preferred vision of the future.

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[*] Please refer to this section as:

Swiderska, K. (2004). Introduction to Session 5: Biodiversity Action Plan for Economic development. Pp 16 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

Summaries of the discussions

[*] Summary of discussions on Session 1: Biodiversity Action Plan for Fish - fishstock biodiversity

Einar Eg Nielsen* and Uwe Piatkowski

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The session was introduced by Einar Eg Nielsen, who outlined current knowledge on biodiversity in fish-stocks and threats to fish-stock biodiversity such as over-fishing and global warming. The level of knowledge is sufficient to know that we should take action to preserve biodiversity in exploited fish stocks. The future challenge will be to formulate appropriate management actions for the preservation of genetic diversity. This will require consensus on what it is we are trying to preserve (e.g. alleles, traits, population structure) and some means of assessing genetic "status". The introduction was ended by a series of questions regarding fish stock biodiversity, which opened the floor for discussion.

The introduction was followed by a discussion on the role of modeling in fish ecology and management of fish-stock biodiversity. This discussion was spawned by a contribution suggesting that modelling of fish stock abundance is too complex to give any good predictions, since the fish are a part of a large and multifaceted ecosystem. Other contributions focused on the quality of data fed to the fisheries models. There were concerns regarding the reliability of official catch statistics and data from scientific surveys on diminishing populations. There was a general consensus that this would lead to uncertain and in some instances wrong predictions from the models. A phenomenon termed “rubbish in – rubbish out”. It was also suggested to abandon the current way of modelling by picking up on the methods applied in metrology and bioinformatics, so-called inferential models. These models do not rely on pure mathematics, but more pattern recognition and case based reasoning by employing neural networks and artificial intelligence.

Finally, it was discussed whether there was a need for a paradigm shift abandoning modelling of fish stock abundance as a tool for managing fish-stock biodiversity. One possibility would be to use protected zones/marine reserves instead. These areas could at the same time serve as general reference points for marine biodiversity. The application of marine reserves as a tool for managing marine biodiversity, however, needs a much more co-ordinated global fishing effort to be effective.

[*] Please refer to this section as:

Nielsen, EE.; Piatkowski, U. (2004). Summary of discussions on Session 1: Biodiversity Action Plan for Fish - fishstock biodiversity. Pp 18 in Emblow, C.S. *et al.* (eds): *Electronic conference on ‘Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy’ - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

[*]Summary of discussions on Session 2: Biodiversity Action Plan for Fish –non-target species biodiversity

Michel Kaiser[1,2]**, Melanie C.V. Austen**[3] **and Henn Ojaveer**[4]

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A priority identified during the forum was the need to search for methods that might enable the determination of any broader effects of fishing on ecosystem functioning. An examination of ecosystem function moves away from a species by species approach to the examination of the effects of fishing and implies that groups of species or taxa perform similar roles or functions within the ecosystem. The majority of species compose a minor proportion of the total abundance or biomass of most assemblages. As a consequence the loss or replacement of a proportion of the less common species may result in no net change in ecosystem functioning. There was some disagreement with this proposition and it was felt by some that our understanding of the links between loss of biodiversity and loss of ecosystem functioning were insufficiently robust at present based on limited and simplistic mesocosm manipulations of species richness. As a result, the true ecological importance of non-target species was unknown and hence it is not possible to imply ecological redundancy based on our current knowledge. In such circumstances, the use of the precautionary principle was advocated in terms of management measures. However, if assemblages are resilient to the loss of a certain proportion of species, the critical question remains 'the loss of how many species results in an alteration of ecosystem function?' and does this have wider consequences for human society? While most contributors appreciated the need or desirability to study the ecological role of individual species, the practicality of such an undertaking, and current funding constraints, dictate that monitoring of the effectiveness of BAP needs a two pronged approach: detailed but targeted studies to understand smaller-scale ecological issues in conjunction with a wide-scale uniform effort in the assessment of more fundamental community characteristics.

The discussion also focussed on the BAP research priorities in terms of the level at which they are aimed. Some thought that these should have a stronger emphasis on research to understand the ecological importance of different organisms and biodiversity in general and their relationship to ecosystem maintenance and the sustainability of the ecosystem itself (including the fisheries). Research priorities that focus on 'biodiversity indicators of ecosystem health' would address this requirement. The current research priorities of the BAP for Fisheries seem biased towards the 'top-down' (predatory fish removal) effects rather than considering the implications of fishing at all trophic levels (from marine mammals down to the benthos). The outcome of this 'fisheries'

[*] Please refer to this section as:

Kaiser, M.J.; Austen, M.C.; Ojaveer, H. (2004). Summary of discussions on Session 2: Biodiversity Action Plan for Fish - non-target species biodiversity. Pp 19-21 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

approach to the non-target species BAP means that the research priorities are focussed on the implementation or development of technical or mechanical measures to reduce adverse effects. This is of concern particularly given the lack of fundamental knowledge with regard to non-target species in marine ecosystems. Moreover, there are discrepancies in the level of knowledge for different European seas, with wide variation in the complexity of different systems (e.g. The Baltic c.f. The Mediterranean).

There was some consensus that fishing capacity and fishing effort (amount of time spent fishing) should be matched with the available resources (fish) as this will inevitably reduce the impact of fishing on non-target species. Yet the failure to implement appropriate effort reductions proposed over the last 20 years of CFP has resulted in the current situation of declining stocks and fleet over-capacity. Matching capacity and fishing effort with the available resource will be extremely painful for the fishing industry in the short to medium term. It was considered that the reality of unpalatable economic hardship has resulted in the focus on technical measures in the BAP. Technical measures are often easier to implement than an overall reduction in fishing effort and fulfil the requirement for some (any) remedial action to be effected, even if it means that the real problem is not addressed. The BAP for Fisheries has made positive steps towards a consideration of the wider effects of fishing on the marine environment but adequate monitoring will be needed to determine the success of any resulting initiatives, which will require the clear goals and objectives against which achievements can be measured. The BAP for Fisheries targets for 2010 need to be set in light of the objectives and aims of other conventions or agreements that affect similar species. There is also potential for over-lap among the different BAPs which has the potential for positive synergies (e.g. reducing fishing effort benefits for both commercial fish stocks and non-target species), but also carries the risk of antagonistic actions (e.g. the displacement of a fishery to conserve a commercial stock resulting in negative effects for non-target species that are affected as a result of the displacement of activities).

There was considerable discussion over the rationale behind the utility of Marine Protected Areas (MPAs) to achieve either traditional fisheries management goals or wider-ecosystem management objectives such as the conservation of non-target species or habitats. The combination of adequately designated and managed closed areas in combination with reduced fishing effort was advocated to achieve a sustainable ecosystem approach to management. The mechanism of deciding which areas should be designated as MPAs was considered problematic. Some argued that MPAs can never be too large (a precautionary approach) but that their designation needs input from a broad range of ecologists and marine scientists, not just fisheries biologists. It was also argued that reduction of time that fishing boats spend at sea would lead to a decrease in the overall area of the sea affected by fishing activities, and that this on its own could achieve many of the aims of the BAP Fisheries for non-target species. Faced with a reluctance to reduce the time spent at sea we may be forced to turn to the use of No Take Zones or MPAs as a last ditch mechanism of reducing the adverse affects of fishing, but this may not be the optimal approach (c.f. fishing effort reduction). All concurred that sensitive habitats could only be fully protected from the adverse effects of fishing activity through the exclusion of fishing gear from appropriate areas of the seabed. Reducing fishing effort is critical as it could address many current fishery related problems through one action. In the current political climate, a combination of different approaches could ensure a long term future for a marine environment with a diverse range of ecosystems, habitats and species, coexisting with human activities such as fishing.

It was considered that it was difficult to encourage fisheries managers to consider the wider ecosystem effects of fishing in their deliberations regarding fish stock management, particularly in the case of the former Eastern Block states. For these states, wider ecosystem effects of fishing are likely to be much further down the list of management priorities. A considerable effort in terms of education was considered to be essential to encourage the fisheries managers within EU new

member states to take a more holistic view of the consequences of fisheries exploitation.

Acknowledgements: The summary of the conference presented herein represents the authors' views and interpretation of the substance of the forum. These views do not necessarily fully represent the opinions of all the contributors to the forum. In addition to the authors, the following individuals contributed to the forum: F. Blanchard, R. Blyth, F Boero, R. Ferris, E. Koutrakis, P. Lorance, E. Mostarda, E. Pinn, F. Pranovi, C. Von Dorrien.

[*]Summary of discussions on Session 3: Biodiversity Action Plan for Fish - Aquaculture

Ioannis Karakassis

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Altogether 3 scientists participated in the discussions concerning Session 3 (F. Boero, S. Orfanidis and C. Zago). Among the issues described in the opening statements, the participants addressed only issues regarding the ecological efficiency of fish farming and the effects on *Posidonia* meadows. Concerns have been expressed regarding the sustainability of the mariculture particularly when carnivorous species are farmed demanding high input of fish protein. It has also been estimated that the effects on *Posidonia* meadows impose a rather high ecological cost since sea grass ecosystems offer high value ecosystem services. The potential use of alternative aquaculture practices (sea grass farming) as a means for restoration of disturbed habitats has been discussed and there have also been suggestions that polyculture could be used to minimize the ecological effects of fish framing.

However, the main issues regarding the efficiency of BAP priorities have been little discussed during the electronic conference despite the large scientific audience that has been involved in research on aquaculture-environment interactions during the last years. Perhaps, the lack of adequate response denotes that there is still a lot of research needed before arriving at firm conclusions on the significance of aquaculture effects on biodiversity.

[*] Please refer to this section as:

Karakassis, I. (2004). Summary of discussions on Session 3: Biodiversity Action Plan for Fish - Aquaculture. Pp 22 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

[*] Summary of discussions on Session 4: Biodiversity Action Plan for Natural resources

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What are natural products and why are these resources worth conserving?

The introduction to the forum stressed the importance of marine natural products and secondary metabolites, and how these can help regulate ecosystem functionality by underpinning the chemical and molecular processes that are crucial for maintaining biodiversity. Many of these metabolites have also found important biotechnological applications in medicine and the chemical industry, or in the development of bioremediation strategies for the world's oceans. There is, therefore, a need to better understand the natural function of these compounds so as to be able to manage and conserve these potentially important natural resources.

The discussion on this subject was not very active, and I apologize for not having been able to raise more interest in what I believe is a very important new field of research (this is the first time I participate in an e-conference!), but several interesting points were addressed by different colleagues that I acknowledge below.

Rob Van Soest addressed the problem of symbionts as being often the true producers of secondary metabolites rather than the host species, and how this issue complicates studies on the function and biosynthesis of secondary metabolites. Rob cites sponges as examples of suspected cases of microsymbionts that live in the tissues of sponges. But this also reminds me of the case of toxin-producing dinoflagellates where scientists have suspected for years that bacteria associated with these microalgae are responsible for the production of these metabolites rather than the dinoflagellate cells themselves. A debate still continues today about whether bacteria produce saxitoxin, or influence dinoflagellate production of this toxin. But since scientists have been unable to render the dinoflagellate axenic, it has been impossible to test this hypothesis. However, the recent identification of enzymes involved in saxitoxin synthesis may open the door to disclosing the source of the compound. Saxitoxin, the poison that causes paralytic shellfish poisoning, is so potent the United Nations Chemical Weapons Convention lists it among the leading chemical weapons of war, and there are very strict regulations defining the use of this compound in research programmes. I fully agree with Rob's comment that questions on what environmental factors trigger increased production of secondary metabolites, coupled with rigorously controlled experiments, will be extremely important before industrial production of useful metabolites can be designed.

Isabella Buttino addressed the problem of experimental design and the use of animal bioassays to identify new bioactive compounds. Unfortunately, we are still at an early stage in identifying

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[*] Please refer to this section as:

Ianora, A.A.; Davies, J.J. (2004). Summary of discussions on Session 4: Biodiversity Action Plan for Natural resources. Pp 23-24 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

bioassays for such purposes. Sea urchins are a standard assay for identifying anti-mitotic compounds produced by marine organisms for possible applications as anti-cancer drugs. But there are thousands of compounds, including not only natural products but toxicants and pollutants, that are capable of arresting cell cleavage in sea urchins. We therefore need to identify new cellular and enzyme assays that are important checkpoints in cell cycle progression. This would allow for the identification of compounds with specific cellular and enzyme targets. I agree with Isabella's comments that the use of specific probes, such as those to study tubulin depolymerization or apoptosis, can be useful instruments in controlled experiments to understand the cellular targets of potentially interesting secondary metabolites.

Adriana Vella posed an interesting question regarding not only the problem of introduced alien species, but the impacts of introduced new diseases and pathogens within the marine environment resulting from increased population growth in coastal areas or new marine environments. These would certainly be expected to have far reaching impacts on biodiversity and natural resources, especially if the pathogens do not already occur in the autochthonous organisms. But I myself have never heard of new introduced marine pathogens, and if there are such examples, they probably are very few. But I would like to go back to the question of introduced alien species and the fact that such animal and plant migrations have occurred throughout history, and often the introduction has been extremely beneficial for humans. Many terrestrial plants were introduced into Europe centuries ago and are now part of our day-to-day lives (what would we Italians have done without tomatoes!). The question is not whether new species appear but whether they impact biodiversity. If a new species simply replaces another one, then it may have important commercial or social implications, especially if the species is not adequate for human consumption, but not necessarily disrupt ecosystem functionality. Adriana also poses the question of possible impacts of exploitation of natural resources due to organisms being unable to cope with a rapidly changing environment, or one that is subjected to heavy pollution. Again, I think there is no information on this subject. Since we know so little about what environmental factors trigger increased production of secondary metabolites, it is difficult to predict what would happen to their production under stressed conditions.

In another message Adriana Vella addresses the problem of the use of natural resources and how economic profit is often the driving force behind exploitation of these products, with little being done to encourage scientific research prior to exploitation of new resources. She cites the example of tuna penning in the Mediterranean Sea, and how this activity not only increases when spawning of the Blue fin tuna is greatest, but also continues into the non-fishing season so as to extend the period of economic profit. As she comments, we know so little of the impacts of these activities on Mediterranean Blue fin tuna stocks, and if we could assess such impacts, we could ensure sustainable use of this important natural resource and conserve both the resource and biodiversity for the future. I agree with Adriana that economic profit will often be the major force driving the exploitation of natural resources. The important thing is to exploit these products wisely. Taxol, probably the most important chemotherapeutic drug in use today, is extracted from the bark of the Pacific yew tree (*Taxus brevifoglia*) and exploitation of this resource has come to the point that there are hardly any yew trees left! Adriana concludes that marine biodiversity is a natural resource we cannot afford to deplete due to the lack of adequate precautions and proactive and efficient scientific research.

[*] Summary of discussions on Session 5: Biodiversity Action Plan for Economic development

Krystyna Swiderska and Chris Emblow)

Biodiversity and Livelihoods Group, International Institute for Environment and Development (IIED), United Kingdom
Ecological Consultancy Services Limited (EcoServe), Ireland

This session of the electronic conference was unfortunately not well subscribed to. The introduction was provided by Krystyna Swiderska, Biodiversity and Livelihoods Group, International Institute for Environment and Development (IIED), London, who also contributed to the sister Bioplatform electronic conference.

She identified the need for research to be focused on comparing the impact of conventional approaches to economic development strategies in the economic and natural resources sectors with 'biodiversity-based' strategies. Also the challenges involved in and the need to convince those negotiating co-operation and EC development strategies the value of biodiversity in achieving poverty reduction and economic objectives.

As a starting point research should

1. use examples of approaches that integrate biodiversity, livelihoods and economic objectives in each key sector
2. detail assessments of the impacts on the ground, including their contribution to food, health, income, livelihood security and ecosystem services (as well as cultural and spiritual well-being) be conducted
3. make comparisons of these approaches with more conventional non-biodiversity based approaches

Such case studies should

- serve to demonstrate the types of activities and approaches that can be supported to integrate biodiversity, development and economic objectives
- be guided by the principles of the ecosystem approach
- examine the wider policy and governance context to identify the 'external' conditions needed to better support and facilitate wider replication and adoption

The need to involve local representative organisations within the research process, strengthening their negotiating powers is important. Research should be used to promote political support for biodiversity and promote change by engaging with as many stakeholders as possible. Further engagement and education of local communities and stakeholders in assessing the implications of different policy options will enable them to further articulate their preferred vision of the future.

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[*] Please refer to this section as:

Swiderska, K., Emblow, C.S. (2004). Summary of discussions on Session 5: Biodiversity Action Plan for Economic development. Pp 25-26 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium.

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The only other contributor to this session was Ferdinando Boero. He highlighted the underlying problems of global development. The short term solutions provided by policy makers to long term problems, the more political narrow view of problems which require broad solutions. He also highlighted the juxtaposition of asking economically emerging countries to look after their biodiversity for the benefit of everyone when we have made a poor job of managing our biodiversity during our development. He also highlighted that the problem is primarily political and although ecologists can do their best to advise and convince politicians otherwise, particularly that there are no simple solutions and predictions for the future, and it is the future we need to be concerned with. In short we need a lot of integration between politicians, economists and scientists and we need more insight and less focus on isolated issues.

Organisation and Statistics

[*]Organisation 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.

A total of five separate sessions were discussed in three weeks (table 1). Discussions were guided by one or more co-chairs, each specialized in one of the topics. The first three sessions had two weeks to run intensively, but discussions continued until the end of the conference. The last two sessions ran for one week. The co-chairs were responsible to open the discussion by making their opening statements and to follow up the discussion. They were also responsible to provide a general summary and synthesis of the discussions to include in this report.

Date	Title	Chairs
13 April	"Welcome and introduction"	Chris Emblow
I: 13-23 April	"BAP Fish - fishstock biodiversity"	Einar Eg Nielsen and Uwe Piatkowski
II: 13-23 April	"BAP Fish - non-target species biodiversity"	Michel Kaiser, Henn Ojaveer and Melanie Austen
III: 13-23 April	"BAP Fish - Aquaculture"	Ioannis Karakassis
IV: 26-30 April	"BAP Natural resources"	Adrianna Ianora and Jon Davies
V: 26-30 April	"BAP Economic development"	Krystyna Swiderska

Table: 1. Time table: date, sessions and co-chairs respectively.

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, is open to everyone. To be able to post messages and also to view posted messages, registration through a form on the web site was necessary. The requests for registration were handled individually; applicants were informed of successful registration in an e-mail. Once registered, access to the forum was possible by logging-in with user-defined username. The obliged login username aids in referring to the authors' details by linking to IMIS (Integrated Marine Information System), and in addition enables us to score participation during the course of the conference.

[*] Please refer to this section as:

Vanden Berghe, E. (2004). Organisation and statistics. Pp 28-29 in Emblow, C.S. *et al.* (eds): *Electronic conference on 'Sustaining Livelihoods and Biodiversity - attaining the 2010 target in the European Biodiversity Strategy' - Summary of discussions, 13 to 30 April, 2004.* Flanders Marine Institute: Oostende, Belgium

Statistics

Registered participants (includes ‘marble’ participants): 979
Registered participants to ‘marble’: 336
Number of countries: 59
Participants requesting summaries through e-mail: 149
Numbers of addresses on the circulation list: 2275
Number of messages: 72
Number of contributors: 24

Hits on marbena web site: (from 13 April to 30 April 2004)
Hits on /cgi-bin/marbena.exe: 9,969
Hits on /marbena: 18,320 or approximately 4,460 html pages
Total number of pages requested: 14,429

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[*] For the sake of saving paper, the complete list of MARBENA subscribers is omitted and reduced to those who have contributed to the discussions.