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CONVENTION ON THE CONSERVATION OF EUROPEAN WILDLIFE
AND NATURAL HABITATS

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**Conservation of marine habitats
and species in Europe**

*Document established
by Mr Mark Costello
Ecological Consultancy Services Ltd (Ireland)*

PREFACE

The Bern Convention aims to protect nature in all habitats in Europe. To date, it has focused on terrestrial and freshwater habitats, and more recently has been prompting the conservation of invertebrates. The marine environment has received less attention within the Bern Convention, yet it has been recognised by the Jakarta Mandate of the Convention on Biological Diversity as a priority. A meeting of the Bern Convention invertebrates conservation group identified a need for the convention to better address marine biodiversity (Costello 1996). However, a range of international agreements and related initiatives in Europe address the protection of the marine environment. This report thus aims to identify how the Bern Convention might best address the conservation of marine life, within the context of existing activities which aim to protect the marine environment.

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SUMMARY

Marine biodiversity provides resources for man, including fisheries, aquaculture, biotechnology, recreation, and oil and gas. It also provides essential services in recycling waste nutrients discharged from land, maintaining fish and aquaculture stocks, controlling the global carbon cycle and buffering the world against climate change. Yet all parts of the oceans are contaminated or polluted, and marine biodiversity suffers from over-harvesting and the artificial spread of exotic (alien) species. Management of marine systems, including nature conservation, is complicated by the large number of organisations and laws that must be involved, and the very limited knowledge and understanding of marine biodiversity.

The convention on biological diversity has recognised the urgent need for action to protect marine biodiversity through its Jakarta Mandate. This emphasises the need for Integrated Marine and Coastal Area Management (IMCAM) which parallels actions at European, regional and national levels in Integrated Coastal Zone Management (ICZM).

This report reviews activities that relate to the protection of marine biodiversity in Europe, both from a global to regional perspective. The most notable regional activities are:

- Oslo - Paris Commission for the protection of the north east Atlantic (OSPARCOM),
- Helsinki Commission for the protection of the Baltic Sea (HELCOM),
- International Council for the Exploration of the Sea (ICES) in the north Atlantic,
- Barcelona Convention and Mediterranean Action Plan (MAP) in the Mediterranean,
- International Commission for the Scientific Exploration of the Mediterranean Sea (CIESM).

However, there is no co-ordination of these activities at European level.

The European Union (EU) does not have any particular group working to conserve marine habitats and species. The EU Habitats and Birds Directives will create marine protected areas in member states as part of the Natura 2000 network. However, what biotopes these will contain is not known because marine areas are categorised at a seascape (e.g. estuary, mudflat, inlet, bay) rather than habitat or biotope level in the Habitats Directive. There are less marine species listed in the Habitats Directive than under the Bern Convention and regulations in some European countries. This further indicates the urgent need to review both species and habitats in need of conservation in Europe.

Marine conservation in the Bern Convention and EU Habitats Directive concentrates on mammals, birds and turtles. Assessment of conservation priorities for fish, invertebrates and seaweeds is urgently needed, despite the limited information base.

None of the present conventions, directives or national laws protect marine biodiversity outside of territorial waters (12 nautical miles). However, European countries are polluting, heavily fishing and trawling, and increasing oil and gas exploration the offshore and deep seas.

The conservation of marine biodiversity in Europe is being aided by the control of pollution, habitat damage and species introductions through national, regional and EU regulations. The EU Natura 2000 network will protect marine areas at a seascape level. However, the conservation of marine habitats, biotopes and species is not being adequately addressed at either national, regional or European scales. There is thus an urgent need to identify what marine habitats and species need protection, and what are being protected within present marine protected areas in Europe. This analysis will identify critical gaps in marine nature conservation at the habitat, biotope and species level.

It is recommended that the Bern Convention provides leadership in marine nature conservation at a European level by focusing attention on marine habitats, biotopes and species, particularly those important to fish, invertebrates and seaweeds, and including offshore and deep sea areas.

INTRODUCTION

As this century ends three priorities have emerged in environmental management, namely biodiversity, coastal zone management, and sustainable use of natural resources. At the United Nations Conference on Environment and Development (UNCED) in Rio, 1992, the nations of the world agreed that the basis for future economic development must be the sustainability of biodiversity. These priorities are setting the agenda for the management of the marine environment and require people to broaden their understanding of the marine ecosystems and review their approaches to the use of marine resources.

The world is a blue planet because the sea covers about 70 % of the earth's area and it is deeper than land is high. Thus more than 70 % of the planet is dominated by marine biodiversity. Because more than 51 % of the earth is covered by sea greater than 3000 m deep, most of the planet is dominated by deep-sea life (World Conservation Monitoring Centre 1992). This includes a remarkable diversity of marine life living in extreme conditions of temperature and pressure (e.g. Ray 1988, Petersen 1992). While deep sea biodiversity is largely dependent on a rain of food from surface waters, it does include its own chemosynthetically based ecosystems around the 'deep sea vents'. Life on earth originated in the sea, and there are fundamental differences in the physical and biological structure of marine compared to terrestrial ecosystems (Table 1).

Marine biodiversity is a priority for management because of the 'goods and services' it provides to humanity, including its major role in maintaining the global ecosystem. The services provided by the world's ecosystems have been calculated to be 33,000 billion US\$, of which 21,000 billion US \$ is provided by the ocean (Costanza *et al.* 1997). Coastal seas provide 60 % of the ocean services. The services accounted for by Costanza *et al.* (1997) were nutrient cycling, recreation, cultural, food production, biological control, disturbance regulation, raw materials, habitats and refugia, waste treatment, and gas regulation. The ocean acts as a sink and buffer against rising levels of carbon dioxide which is a major factor in global warming.

The difficulties of exploring the ocean, and its great size, have resulted in it being less well known than land and freshwater environments. As an example of the poor basic information on marine biodiversity, the rate of species discovery continues even in the best-studied seas. The small taxa, notably polychaetes, copepods, nematodes, and oligochaetes, are the poorest known but the richest in species (Costello *et al.* 1996). Recent discoveries in marine biodiversity (Heip *et al.* 1998) include:

- 2 new phyla discovered since 1980;
- a new ecosystem, "deep sea hot vents", where primary production is based on energy from chemosynthesis instead of photosynthesis, and abundant unique communities occur;
- viable bacteria living several hundred metres inside marine sediments at high temperatures and pressures;
- the smallest microscopic photosynthetic organisms in the world (prochlorophyte bacteria) occur in the ocean, and they contribute over 20 % of the primary production in over 70% of the sea.

The difficulty of exploring the sea is being overcome with new technology. The ocean is earth's 'inner space' and last great frontier of discovery on earth. Man first reached the bottom of the sea in 1960, only one-year before man first orbited the earth.

Until the middle of this century, man had limited impact on the marine environment. While the lower priority of conservation efforts to marine ecosystems may have been justified in the past, this is no longer the case. The lack of knowledge and visibility of the marine environment must not delay attempts to conserve it. Marine biodiversity provides direct and indirect benefits to man. Every part of the ocean is being increasingly impacted by human activity, from hydrocarbon exploration in the

deep sea, to accumulation of persistent pollutants in the Antarctic. There are economic, ecological, moral and legal reasons to protect marine biodiversity (Table 2) (e.g. Ehrlich and Ehrlich 1992, Perrings *et al.* 1992, Oksanen 1997, O'Neill 1997, Reaka-Kudla *et al.* 1997), and perhaps innate behavioural reasons (Oriens 1998). In this report, it is understood that the modern concept of biodiversity, as defined in the Convention of Biological Diversity, requires the conservation of more than 'species', it itself a human construct. Biodiversity involves interactions from the biochemical to ecosystem scale, and the range of biological units from cells to communities (Figure 1). However, it is proposed that the most practical working basis for conserving biodiversity is action at the species and biotope level, while noting that these concepts must be used to protect biodiversity from the below species to ecosystem levels.

What benefits arise from marine biodiversity?

Marine biodiversity has both direct and indirect importance to mankind. The sea provides food in the form of fisheries and aquaculture, and a recreational environment for tourism (Figure 1). This food is eaten directly by man, and fed to farmed animals. Many species of marine life which are not directly harvested for food, are themselves food for fish and shellfish and thus key elements in the marine food chain.

Fisheries are the greatest source of meat and wild food to mankind, in terms of quantity and protein (World Conservation Monitoring Centre 1992). Most fish production is in the higher latitudes, including the north-east Atlantic, while most fish species occur in tropical seas. Thus while biodiversity in terms of species is lower in the north Atlantic than tropical seas, the within-species (genetic) diversity of north Atlantic fish stocks may be critical for the survival of fish of most importance to man. Aquaculture is dependent on relatively few species for production, as is agriculture. Thus the within-species component of biodiversity of aquaculture species is very important to maintain. This is probably more cost effectively maintained by ensuring the health of the wild stocks of the cultured species than establishing captive breeding stocks. Some cultured species, such as mussels, *Mytilus edulis*, are derived entirely from wild juveniles, while farmed Atlantic salmon, *Salmo salar*, and rainbow trout, *Oncorhynchus mykiss*, are hatchery reared.

Of less obvious importance is the key role that the biodiversity of marine ecosystems plays in: providing food for directly harvested species; recycling nutrients (notably nitrogen, phosphorus and carbon); acting as a sink for other wastes man discharges to the sea; and role in global climate control (e.g. Grassle *et al.* 1991, Angel 1992). The ocean is a physical (temperature) and chemical buffering system against global climate change, including absorption of carbon dioxide from the atmosphere and storing carbon in sediments. These benefits to society are enormous (Costanza *et al.* 1992) and are provided at no financial cost. In contrast food production from land must pay for the land, maintenance of soil quality, and food for farm animals. Because of these hidden benefits, marine biodiversity is undervalued by society. This value becomes more apparent when the availability of the 'goods and services' of marine biodiversity is reduced.

The increasing spread and urbanisation of the human population is placing greater value on natural areas for recreation. Marine biodiversity is of growing importance in Europe: directly for angling, nature watching, scuba diving, and photography; and indirectly by providing a pleasurable and clean environment for activities such as water sports and boating.

Marine ecosystems provide other resources; including oil, gas, gravel, sand, transport routes, cooling water for power generation and industry, and wind and wave energy for electricity. Even the non-living natural resources of coal, gas, oil and limestone are the product of biodiversity, and these and living resources provide the raw materials for many of the products used by man (e.g. plastics).

Considering the rapid development of human technology, it is prudent to assume that future generations could identify and use marine biodiversity in ways that are not anticipated at present. For example, while a wide range of pharmaceutical products has been derived from terrestrial biodiversity, there has been less marine 'bioprospecting'. Yet, the greater phylogenetic diversity of marine life suggests a greater diversity of biochemical compounds and pathways are likely to occur in the sea.

Predictions of what uses man may make of the sea and marine resources in years to come are too general for a full environmental impact assessment. The advance of technology and changing global economics may result in the sea becoming as closely managed as the terrestrial environment. For example, the present state of development of modern fish farming was not predicted 30 years ago. Thus it is naïve to assume that mankind will not invent new uses of marine biodiversity in the years, centuries and millennia to come.

Why special concern over the state of marine biodiversity?

There is concern over the loss of biodiversity because man has affected the local environment for millennia, and is altering the global environment during this century. There is a responsibility on society to protect all parts of biodiversity, and on governments to ensure it is sustainably managed. The costs of protecting biodiversity will be far less than the cost of its restoration, if restoration is possible. Rapport and Whitford (1999) described examples of estuarine, freshwater and terrestrial ecosystems that did not recover once human impacts were reduced, and this is likely to apply similarly to some marine ecosystems.

There are increased pressures on marine biodiversity, including over-fishing and over-harvesting, introductions of exotic (or alien) species, and widespread pollution (Table 3). The apparent vastness of the sea meant that in the early part of this century it was believed impossible for man to have any impact on fish stocks. Now most fish stocks are over-fished or fished to the maximum sustainable level without any understanding of the effect of the removal of this biomass of predators on marine ecosystems.

The seabed in Europe has been trawled to over 1,000 m depth since the 1970's (Connolly and Kelly 1996), and oil and gas exploration can now operate down to 4,000 m depth and extraction to 2,000 m (Costello 1998). Video observations show the seabed at depths below 1,000 m to be criss-crossed with trawl tracks, and trawling (Rogers 1999) has already damaged discovered deep-water coral reefs. These reefs, mainly composed of the coral *Lophelia pertusa*, are remarkably large structures (Freiwald and Wilson 1998), with a biodiversity comparable to shallow-water corals (Rogers 1999). It is reasonable to assume that soon technology will allow more people to extract and harvest more resources from the deep-sea, and to visit there for education and recreation. The economic value of the deep-sea to mankind is thus increasing, and with that the pressures on its biodiversity.

All wastes, whether emitted to freshwater, land or air, ultimately end up in the sea (Figure 2). Litter is everywhere in the ocean, floating at the surface and sinking to the seabed. The most critical source of contamination of human food is through wild fish (European Commission 1996), because in contrast to farmed animals, they live and feed in the open environment. Pollution reduction will improve food quality, for example through less sewage contamination of shellfish, and less organochlorines and dioxins in the food chain. The most polluted area is along the coast, and here plants and microbes feed on wastes rich in nutrients, and persistent chemicals collect in sediments and marine life. In some areas, such as the Baltic Sea, levels of contamination of some fish stocks present a significant risk for human consumption, and the health and reproduction of long-lived sea mammals (whales, seals) is compromised.

Until recently it was a common belief that marine species could not be driven to extinction by man because they would find shelter in the vast ocean. Such beliefs demonstrated a lack of knowledge of the habitat requirements of many marine species and their ability to disperse. Indeed, as on land, the first marine species driven to extinction by man were the larger species, notably Steller's sea cow,

great auk and Caribbean monk seal. Other large species are or were recently in danger of extinction, including sea turtles, whales, manatees, groupers, sea otters and Mediterranean monk seals. Deep water oxygen depletion due to eutrophication of the Adriatic Sea has resulted in the extinction of 31 species of hydromedusae (jellyfish) (Benovic *et al.* 1987). These were species which had a benthic (seabed living) stage in their life-history. It is probable that other benthic species, including many undescribed species, also went extinct in the Adriatic Sea due to this human impact.

Considering that life began in the sea it should not be surprising that many marine species have evolved very specialist associations with other species. As on land, such specialisation exposes species to extinction should the populations of their associates' decline. It is likely that species associated with the globally or regionally extinct marine species have also gone extinct. These may include symbiotic, commensal and parasitic associates. For example, a range of species specific crustaceans parasitise fish, mammals and jellyfish.

There is minimal knowledge on the dispersal ability of most marine species. Certainly, some whales migrate similar distances to the furthest travelling birds, and some fish populations move between spawning and feeding grounds as many birds do. Many marine species disperse as planktonic larvae, largely at the mercy of the ocean currents, again at scales not dissimilar to the seeds of many land plants blown on the wind. In both instances, the survival of the larvae and seed depends on their landing in a suitable habitat and surviving the critical early stages of colonisation. In contrast, many species (e.g. amphipods, isopods, cumaceans, many gastropods) do not have a planktonic larval stage and can develop populations adapted to local environmental conditions on a scale of a few 100 m. For example, gastropod shells can be adapted to withstand wave exposure on a headland, but be differently adapted to protect the snail from predation in relatively wave sheltered conditions. Thus local and regional scale impacts may cause the extinction of biodiversity at the genetic and below species level in the marine environment.

There are particular difficulties in managing marine as compared to terrestrial and freshwater biodiversity. The marine environment is the least visible, least documented, least understood, and least constrained of these environments. It is underwater and under explored, and compared to land, it is under developed. Its management is divided by a complexity of national and international legislation and management authorities. Marine and coastal zone management, typically crosses administrative boundaries at local and international scales. The sea connects local, regional to global ecosystems such that pollution and biodiversity must be considered of this range of spatial scales (Figure 3).

It is clear that the Europe's seas (Figure 4) are under threat of over-exploitation and pollution, and that the most severely impacted areas are near the coast (Stanners and Bourdeau 1995). Coastal habitats are being lost and fragmented through drainage of wetlands, trawling of the seabed, urbanisation of estuaries, and increased turbidity limiting growth of seaweeds and seagrass beds. As has occurred on land, it is likely that the loss of marine habitats is causing extinctions at a local scale and thus loss of populations and biodiversity. It is thus important to protect examples of marine habitats at a local scale, and to relate the distribution of these habitats to the region so as to encompass the biogeographic variation of species composition for that habitat.

Recognising the urgent need to protect marine habitats and species, a review of current efforts to do this at a European scale is appropriate. The present report considers organisations and agreements active internationally in the area of marine environmental protection and resource management. It excludes consideration of national marine conservation programmes, non-governmental organisations, and current projects. In particular, this report will consider what additional role that the Bern Convention may contribute to marine nature (biodiversity) conservation in Europe's seas (Figure 4).

INTERNATIONAL RECOGNITION OF THE BIODIVERSITY CHALLENGE

The Convention on Biological Diversity

The importance of, and urgent need for action on, marine biodiversity has been recognised at an international level. The Convention on Biological Diversity obliges nations :

- to develop national strategies for conservation and sustainable use of biodiversity;
- to use biodiversity in Environmental Impact Assessment for planning and development;
- to identify activities likely to have significant adverse effects on biodiversity;
- to sustainably use biodiversity so harvesting does not result in a decline of biodiversity;
- to identify, monitor, legally protect, conserve, and restore biodiversity;
- to provide education and training in biodiversity;
- to conduct research into biodiversity;
- to establish special protected areas, and
- to take measures to control alien and genetically modified species.

The Convention covers both traditionally harvested natural resources, and the increasing 'bio-prospecting' of genetic resources for biotechnology. Because the latter often involves the taking of genetic resources from a 'Developing' country to a 'Developed' country, issues of ownership, patenting and royalties have been identified as needing attention.

The Convention and Jakarta Mandate require that a lack of scientific information or uncertainty shall not be used to postpone measures to avoid threats to biodiversity. This places the onus on developers, including both government and private industry, to provide the information to demonstrate that developments will not have impacts on biodiversity. To date this has not happened in Ireland in the case of wild fisheries and oil and gas exploration.

At the 2nd meeting of the convention in Jakarta (1995) the scientific advisory committee recommended that special attention was required for marine and coastal biodiversity, the 'Jakarta Mandate'. Following this convention, several international conventions and organisations (e.g. OSPARCOM, IMO, ICES, IOC, UNCLOS) and national policies are now bringing the concept of biodiversity into environment management. Following on the Jakarta Mandate, the IUCN and WWF produced a guide to the implementation of the Convention (Fontaubert *et al.* 1996). This concluded that action should focus on five thematic areas:

1. integrated marine and coastal area management (IMCAM);
2. promotion and maintenance of marine protected areas;
3. sustainable use of living resources (e.g. fisheries, corals, seaweeds);
4. prior studies and a precautionary approach to mariculture, and
5. control of introductions of exotic or alien species.

This action would require monitoring of biodiversity, development of methods to better use and share genetic resources, and countries to take responsibility for trans-boundary impacts (notably water pollution) which may impact on marine biodiversity. It also requires further research to assist its implementation. For example, it supports the general consensus that resource management should develop from single species (e.g. a fish stock) to more ecosystem based multidisciplinary approaches. This will require a range of studies to establish general and specific methods for the sustainable use of living resources.

The importance of marine biodiversity and the urgent need for its conservation have made it a priority for the Convention on Biological Diversity. The Council of Europe, through the Bern Convention, now also needs to review the priority it has given to marine nature conservation.

Other international agreements

While the Convention on Biological Diversity provides the most modern and holistic conceptual framework for the protection of biodiversity throughout the world, a number of other global agreements address the protection of particular aspects (Table 5). These include trade in endangered species (CITES), transport of species by shipping (IMO), hunting of whales (IWC), coastal wetlands (Ramsar) and migratory species (Bonn). CITES lists a few species of marine fish (e.g. some sturgeon species) and corals (e.g. *Antipatharia*) which occur in European waters (e.g. Almada-Villela *et al.* 1988). These species are also protected under European Conventions, Directives and national Regulations.

The Law of the Sea (UNCLOS) aims to develop global agreements about the management of seas outside territorial waters, including fish stocks which 'straddle' or migrate across territorial seas, and hydrocarbon exploration. A UN General Assembly Resolution banned the use of drift nets longer than 2.5 km in international seas. However, individual states do not necessarily interpret or act in a harmonised manner in relation to UNCLOS. In a European context it may have most importance in protecting the marine environment, habitats, and species (including fisheries) outside the European Union economic zone. This could be particularly important in mid-Atlantic and Arctic waters.

A set of regional Conventions within Europe act to protect the marine environment in the north-east Atlantic (OSPARCOM), Baltic (HELCOM) and Mediterranean (Barcelona Convention) seas (Table 5). Their membership includes all countries bordering each sea area, they produce reviews of the state of the environment (e.g. Marine Institute 1999), and they make recommendations to member countries for actions to reduce pollution and protect nature. Additional conventions have been signed to protect against oil and other pollution, such as the Lisbon convention for the north-east Atlantic and Bonn Convention for the North Sea. These agreements are not described further here because their impact on the conservation of marine biodiversity is superseded by OSPARCOM, HELCOM and Barcelona Convention. In recent years, these three conventions have been developing lists of habitats, biotopes and species that are a priority for protection (e.g. BALTIC LIST). However, these efforts are not co-ordinated between the regions, and whether similar approaches are applied would require more detailed study.

A range of agreements cover the management of living resources, including the Common Fisheries Policy (CFP) of the European Union, and Warsaw Convention for the Baltic Sea. The CFP is widely regarded as having failed to sustainably manage fish resources and some stocks have declined below commercially viable levels. Fishing has the greatest human impact on marine biodiversity through its removal of large numbers of fish and physical damage to habitats from trawling and dredging. These impacts occur within European Union managed waters, and extend into international mid-Atlantic waters.

The recommendations of the above global and regional conventions eventually become incorporated into regulations in each country and thus carry considerable political and economic importance. The cost of implementing these conventions falls to the individual countries. In contrast, the European Union provides additional funding to member states to implement its Directives, and will not provide financial support where its existing Directives have not been implemented. For example, the EU would not allow its financial aid to be given for a fish farm which occurred within a marine Special Area of Conservation unless it had been shown that that farm would not compromise the nature conservation status of that area.

The EU does not include all countries bordering European seas (e.g. Norway, Iceland, Poland, Latvia, Lithuania, eastern and southern Mediterranean countries). However, it does include most, and has working agreements with others, for example with regard to fisheries and research. These agreements are strengthened through the regional conventions already mentioned. In addition, European

countries that are not EU members generally adopt similar actions to the EU so as to ease the implementation of EU Directives if they become members, or to aid trade with the European Economic Area. Thus the EU is the dominant force in marine nature conservation throughout Europe.

The European Union Strategy

On 4 February 1998 the European Commission (EC) produced a strategy on biodiversity in the context of the Convention on Biological Diversity (European Commission 1998). This was accepted by the EU Council (17 June) and Parliament (20 October 1998), and thus is now policy which the EC will implement. The Communication deals with each of the topics in the Convention of Biological Diversity. It requires member states to have Action Plans in place to implement this EU strategy. It notes the need for biodiversity to be addressed by all sectors, including fisheries, forestry, agriculture, energy, transport, tourism, and aid to developing countries. All EU funding measures, including Structural and Cohesion Funding, and programmes funding environmental management, research, and external aid, will need to support the sustainable use of biodiversity. Cross-border co-operation within and beyond the EU will need to be strengthened to better manage biodiversity. The sections on Research and Fisheries are of particular relevance to marine biodiversity. The need for sustainable use of fisheries, protection of non-target species, establishment of fishing exclusion zones, and prevention of aquaculture impacts (especially in the intertidal) are mentioned.

The EU Strategy document provides criteria for the identification of priority areas of biodiversity research and management, in relation to species, biotopes and ecosystems. They include:

- areas with high biodiversity, presence of endemic and threatened species, and/or which are important for migratory species;
- biodiversity of social, economic, cultural and scientific importance;
- areas which are representative, unique, or demonstrate key evolutionary or biological processes;
- species important as indicators, or for medicinal, economic or farming significance;
- genomes and genes of social, scientific and economic importance.

This emphasis recognises that member states and the private sector already fund research to help exploit biodiversity, such that different management and research actions may now need greater attention. Within the EU, the European Environment Agency (EEA) will collate baseline data on the status, trends, pressures, and causes of biodiversity losses, and identify gaps in knowledge.

Organisations influencing marine biodiversity management in Europe

Several organisations are involved in protecting the marine environment in Europe. These range from the secretariats, committees, and working groups of the conventions (Table 5), to advisory organisations (Table 6). Within the European Union several Directorate Generals are directly involved in managing marine biodiversity, from nature conservation (DG11), to research (DG12) and fisheries and aquaculture (DG14). The latter two directorates have considerable in-house expertise related to marine biodiversity research and living resources respectively. However, the directorate with responsibility for nature conservation has no in-house marine ecological expertise, except in relation to birds. The European Environmental Agency collects environmental data and reviews the state of the European environment, including the sea. However, it also lacks in-house marine expertise, perhaps reflecting a lack of priority to the marine environment. It is advised by Topic Centres, including those on nature conservation, and on marine and coastal issues. However, the former has no marine expertise and the latter has not dealt with marine biodiversity or nature

conservation. The research directorate (DG12) has marine expertise, and funds working groups to develop understanding and research, including in marine biodiversity (e.g. Warwick *et al.* 1997, Larson and Catizzone 1997, Esteban *et al.* 1998).

The greatest expertise in the management of living resources in the north Atlantic (including north America) resides in the International Council for the Exploration of the Sea (ICES). ICES has a large number of committees and working groups. It has produced a code of practice with regard to the introduction of marine species for use in aquaculture which is the standard most countries now work to (ICES 1995). The ICES Benthos Working Group is particularly concerned with the management of seabed living species and their habitats, and is working to identify species and habitats of conservation priority. Its membership overlaps that of HELCOM and OSPARCOM, and in the Mediterranean it is complemented by activities carried out by the International Commission for the Scientific Exploration of the Mediterranean Sea (CIESM). The latter has conducted a study on invasive exotic species in the Mediterranean. These species are having significant impact on native biodiversity in the region and the introduction has been primarily through man's activities (e.g. Suez Canal).

The United Nations Food and Agriculture Organisation (FAO) has a similar role to ICES but more limited to fisheries and aquaculture. It compiles statistics on fish production throughout the world, and produces guidelines on related issues, such as fisheries and coastal zone management. Of particular nature conservation importance is that the FAO has produced guidelines and a code aimed to reduce the environmental impacts of fisheries and aquaculture (Barg 1992, FAO 1995a, b).

Other global organisations with advisory and co-ordinating roles under the United Nations include the Intergovernmental Oceanographic Commission (IOC), International Maritime Organisation (IMO), and Diversitas (Table 6). The IOC has an *ad hoc* "Consultation on Marine Biodiversity" which encourages member states to support the Convention on Biological Diversity with regard to the marine environment. It emphasises the need for training in taxonomy and is supporting the development of a world list of marine species (IOC-NOAA 1995). The IMO has developed advice for the use of ballast water on ships so as to reduce the risk of transfer of exotic organisms (IMO 1993). Following several major accidental oil spills, the IMO has also identified sensitive areas which ships should avoid. Diversitas promotes, but does not fund, research that contributes to a better understanding and management of biodiversity, and it has identified marine biodiversity research as a particular priority.

CONSERVING MARINE BIODIVERSITY

Control of human activities

The aim of nature conservation is to protect species from extinction through protecting their natural habitats and ecosystems. It takes millennia for species to evolve and once lost they are lost forever. While one can debate the current relative value of species to man and the environment, it is certain that with each extinction an option for the future use of biodiversity has been lost forever. Amongst other reasons (Table 2), preventing this loss of present and future resources is the driving force behind biodiversity management.

Human activities will continue to impact on the environment at local, regional and European scales. It is thus necessary to distinguish between acceptable and unacceptable impacts. In making such distinctions, it is invaluable to have a checklist of habitats and species that are already threatened with extinction. The protection of these elements of biodiversity protection is thus a priority and used as a threshold which human activities must not compromise. The listing of priority species, and sometimes habitats (or biotopes), has thus been the policy of the Bern Convention, European Union, IUCN, and countries throughout Europe.

It is not possible to conserve biodiversity by managing it directly. Rather, the causes of biodiversity loss, namely human activities, must be managed. In the marine environment, this management

requires direct actions, such as regulations, fishery controls, marine areas where certain activities are restricted, and pollution reduction. Indirect actions involve education, economic, social and political measures, all based on current knowledge of marine ecology.

Conservation will promote sustainable, and minimise unsustainable, use of resources. Indicators are required for management to determine what level of use is sustainable. Prudent management will minimise pollution and habitat damage, and allow and monitor the recovery of impacted habitats and communities. It will also involve local people in coastal management, and identify priority areas and species for special protection. Thus the Jakarta Mandate, EU, FAO and other organisations, are all actively promoting integrated marine and coastal area management.

Marine Protected Areas

Nature reserve and species protection measures are essential techniques for conserving biodiversity in the marine environment. However, they must be accompanied by wider pollution control measures because it is impossible to prevent the dispersal of persistent pollutants through the ocean. In addition, the population range and dispersion of most marine species is unknown, so it is difficult to determine if marine populations in a locality are self-sustaining in the long term. Therefore, it must be realised that nature reserves are only partial solutions to protecting marine biodiversity. Within these constraints, it is clear that one of the most effective and simplest to manage approaches to the conservation of natural resources and biodiversity is to ban certain human activities, such as commercial fishing, in designated areas.

The Bern Convention has led European policy in the development of areas where nature is protected. It published a classification of marine seabed communities in the Mediterranean (Augier 1982), and reviews of protected marine areas in France and the Mediterranean (Augier 1985) and North Sea and Baltic Sea (Mitchell 1987). A more recent review of all protected areas in Europe published by the Council of Europe (Roekaerts 1995) did not distinguish which areas were marine. However, the review of the state of Europe's environment (Stanners and Bourdeau 1995) found that the creation of marine protected areas "lag far behind those on land". Nijkamp *et al.* (1994) found there were 92 marine nature reserves within the European Union but that only about 1/5 were fully marine, and 1/2 were only partly marine. All were restricted to inshore territorial waters. The criteria used to select areas, and the forms of protection provided varied greatly between countries. There was a strong bias towards selection of areas of importance for sea birds and mammals. They concluded that the present marine protected areas in the EU were not representative of its habitats, biotopes and species. However, current regulations would allow protection of offshore and deeper areas within countries exclusive economic zones, and present knowledge would allow the selection of areas to represent habitats, biotopes and species in Europe.

Within countries a variety of forms of protection can be given to marine protected areas. These range from voluntary nature reserves, private owned reserves, fishing restrictions, to complete legal protection with restriction of any human activity which may impact on wildlife. A variety of protected area designations that can be applied to marine and coastal areas in Europe. These include World Heritage Sites, Biosphere reserves, Ramsar sites, Biogenetic reserves and European Diploma sites (Council of Europe), Special Protection Areas (EU Birds Directive), and Special Areas for Conservation (EU Habitats Directive). The most important of these, because it encompasses marine biodiversity and all habitats and species, is the 1992 European Union 'Habitats' Directive for the conservation of natural habitats of wild fauna and flora (European Union 1992).

The Habitats Directive directly builds on the Bern Convention and aims to create a network of Special Areas of Conservation (SAC) called 'Natura 2000'. This will include sites designated under the EU Habitats and Birds Directives. It expects about 5-20% of each member state to become part of Natura 2000. Member states should protect habitats in proportion to the area of that habitat in their country. The annexes of the Directive list over 200 habitats, 278 plants, 175 birds and 193 other animals in need of protection, and priorities are asterisked. Marine species protection is limited to marine mammals, reptiles and birds, three molluscs, one sea-urchin and crustacean, and two species of

coralline algae. Yet, additional species are protected within some member states. Insufficient attention has been given to the assessment of the conservation priorities of marine species in the Habitats Directive. The criteria for selecting habitats at a national and community level include habitat area, naturalness, restorability, contribution to European network, and representativity. Species criteria are similar, and include degree of population isolation, range and size.

The criteria can be applied to marine habitats but there is unlikely to be sufficient data to apply similar criteria to marine species. Marine habitats are very broadly outlined in the Directive, and many are seascapes at a scale appropriate to birds rather than fish and invertebrates habitats. It is anticipated that the BioMar-LIFE biotope classification (Connor *et al.* 1997a, b) will be applied in marine conservation management, and that future revisions of the Directive will refer to the BioMar classification as they now do to the CORINE biotope classification. This classification is compatible with one proposed for France (Dauvin 1995), has been cross-related to the Habitats Directive categories (Connor *et al.* 1997a, b), and can be expanded to other sea areas. If surveys of marine areas use the BioMar classification, at least at the higher levels of the hierarchy, this will facilitate mapping and analysing patterns in biotopes between studies. The BioMar classification was developed for Britain and Ireland, and its structure and upper levels are applicable to the north-east Atlantic. However, it will need to be expanded to include more biotopes as these are described in the region, and its applicability in the Mediterranean has yet to be tested.

The Habitats Directive requires all states to have legislation in place to apply the Directive in 1994, and to have a review of their habitats and species complete by June 1995. States vary greatly in their rate of implementation of the Directive, but this is the first effort to legally protect marine biodiversity on a large spatial scale in Europe. By June 2004 all member states must designate and complete management plans for their SAC. However, areas qualifying and proposed as SAC are regarded as legally protected even before full formal designation and any developments in a SAC require an environmental impact assessment (EIA). The philosophy behind the Directive is of conservation management, such that no new human activities are necessarily excluded from SAC unless they compromise its biodiversity.

A number of seashore and coastal sublittoral areas have been designated as nature reserves, marine parks or protected from fishing within Europe. The reduction in fishing pressure in these areas typically results in increases in fish size and abundance and a return to a more natural state of the biotopes.

The occurrence and priorities for marine protected areas (MPA) have been recently reviewed for the Arctic (Bleakley and Alexander 1995) north-east Atlantic (Gubbay 1995), Baltic (Esping and Grönqvist 1995), and Mediterranean (Batisse and Jeudy de Grissac 1995). In the Mediterranean, a network of Special Protection Areas has been established under the Mediterranean Action Plan (Table 6), and proposed for the Baltic under HELCOM. The EU is establishing the Natura 2000 network, which includes marine and coastal Special Protection Areas for birds (SPA) and Special Areas of Conservation (for habitats and other species), under the Birds and Habitats Directives respectively. However, the Habitats Directive lists seascapes (i.e. sandbanks, seagrass beds, estuaries, lagoons, reefs, mudflats and large shallow inlets and bays) which may be 'habitats' for birds but can contain a wide and variable range of habitats for most marine life. What habitats, biotopes and species do and will occur in Natura 2000 is thus known. Because of this, the contribution of these sites to the conservation of marine biodiversity in Europe cannot yet be quantified.

A recent review of the protected marine areas in Europe concluded that they were neither sufficiently representative nor large enough to adequately protect marine biodiversity (Batisse and Jeudy de Grissac 1995, Bleakley and Alexander 1995, Esping and Grönqvist 1995, Gubbay 1995). A critical review of the biogeographic distribution, and habitat, biotope and species composition, of marine protected areas in Europe would be desirable once the Natura 2000 network is in place. This should include all the European seas, not just those within EU territorial waters and economic zones. At present it would appear that all existing and proposed marine protected areas are limited to coastal waters and species.

Need for species distribution information

Habitats are defined as where a species lives, and they are important because of the species they support. In a marine context, habitats are largely sediment and rock. The aim of habitat protection is to protect species rather than the habitat itself. To protect species it is firstly necessary to recognise their presence, secondly to correctly identify and name them, and thirdly to be able to relate their occurrence to the distribution and abundance at a local and wider (e.g. European) spatial scale. Indeed, a Council of Europe report by Augier (1982) recommended a mapping of the Mediterranean benthos to better identify areas and biotopes needing conservation.

The abundance of marine species is difficult to quantify because many species abundance changes by orders of magnitude within a year. It is also difficult to compare abundances between taxa because of different growth forms; such as colonial species (e.g. bryozoans, sponges) which grow like a plant, small species such as barnacles and planktonic copepods, and fish. Indeed, what the 'effective' abundance of each species is to maintain a population is unknown. In practice, the best measure of the effective species abundance, which incorporates its success in dispersal, is its distribution. The key element to the assessment of the status of marine species, with the possible exception of some cetaceans and birds, is thus their distribution rather than abundance.

The distribution of marine species is the best indicator of the distribution of habitats and environmental conditions (e.g. seasonal variation in temperature) in the sea. Linking species distribution with oceanographic conditions, including temperature, current movements, and bathymetry, can illustrate the importance of environmental conditions to the distribution of natural resources. Such understanding provides a basis for predicting the impacts of changes in climatic conditions on the distribution and abundance of natural resources, notably fisheries but also seaweed and aquaculture. It may also identify key areas where habitats should be protected; for example a locally rare habitat may be an important 'stepping stone' for dispersing species.

Bern Convention and species protection

The Bern Convention has the greatest geographic scope in Europe, and has led the development of policy and action in nature conservation in Europe. When first established, the Convention listed species of marine mammals, reptiles and birds that needed protection. It has since identified a number of conspicuous non-vertebrate marine species threatened by collection for the curio trade and human consumption (Table 4). These include species of seagrass, seaweed, sponge, coral, hydroid, starfish, brittlestar, sea urchin, bivalve mollusc, snail, limpet, and crustaceans. Additional species, including the sea fan *Eunicella verrucosa*, anemones *Edwardsiella ivelli* and *Nematostella vectensis*, sea slug *Doridella batava*, sea urchin *Echinus esculentus* have been mentioned as of conservation concern in Council of Europe publications (Collins and Wells 1987, Koomen and Helsdingen 1996, Helsdingen *et al.* 1996). The EU Habitats Directive lists less and no additional marine species to the Bern Convention. The latter suggests that some experts feel additional species should already be listed as in need for conservation in the Bern Convention.

The present list does not reflect the actual rarity, endemism, and threatened status of marine species in Europe. Of the 369 threatened European invertebrates listed by Kooman and Helsdingen (1996), just 12 (3 %) were marine. Yet, about 20 % of the described European fauna is marine. The Macronesian islands and Mediterranean contain a range of endemic species, many species are still only known from a few locations in Europe, and additional marine species are listed as threatened in

some countries (e.g. lagoon fauna in Britain). A more thorough analysis of existing information on marine species is thus likely to identify others which are threatened because of over-exploitation, habitat loss, and localised distribution.

The Bern Convention Charter on Invertebrates notes the great economic and ecological importance of marine invertebrates, although they have received minimal attention within the Convention to date. A priority for future development of the Bern Convention is to address the conservation status of marine fish, invertebrates, and marine algae. This emphasis on fish, invertebrates and plants would be justified because mammal, reptile and bird conservation has been better addressed throughout Europe.

CONCLUSIONS

A comprehensive approach to marine nature conservation requires:

- Wider control of pollution of marine waters;
- Protect habitats from physical damage;
- Conserve resources from over-exploitation;
- Measures to control the introduction of invasive organisms;
- Establishment of areas where human activities are strictly controlled (i.e. marine protected areas);
- Identification and protection of biotopes threatened with extinction;
- Identification and protection of species threatened with extinction.

Several regional conventions and EU Directives are successfully reducing pollution in European seas. The ICES and IMO codes of practice provide recommendations to control the transfer of invasive marine species into and within Europe. The Bern Convention, EU Birds and Habitats Directives, and national measures, are significantly increasing the number of marine protected areas. It is further likely that fishery regulations will establish more 'no-take' areas that will also aid conservation of non-commercial marine species. However, relatively few marine biotopes and species have been identified as in need of conservation measures at a European level. Reflecting this need, the HELCOM, OSPARCOM, and Barcelona regional conventions have begun to draft lists of threatened biotopes and species. However, their geographic scope is limited and there is no co-ordination at an all-European level. Indeed, the distribution of marine biotopes has never been reviewed at a pan-European scale.

A wide range of local, regional, European, and international agreements are working to reduce pollution of the marine environment and control fisheries. A smaller number of actions address marine nature conservation, namely the Oslo-Paris Commission for the north-east Atlantic (OSPARCOM), the Helsinki Commission for the Baltic Sea (HELCOM), the Barcelona convention for the Mediterranean, and the European Union Habitats Directive for EU member states. They are contributing significantly to the understanding of the state of the marine environment in Europe and development of national action to protect marine biodiversity. While these initiatives are limited in their geographic coverage of Europe's seas, and focus on coastal waters, they have considerable support from national governments.

A network of marine protected areas is expanding, and achieving greater legal protection, through the EU Natura 2000 network. The composition of the Natura 2000 marine areas with respect to habitats, species and geographic distribution is not yet known. Future action may better identify what habitats and species and so should be well represented in these areas

The limitations of available data, and diversity of life-history strategies of marine organisms, makes the quantitative evaluation of the conservation status of many marine species difficult. Thus details of the methods for assessing the 'red list' status of marine species may need to be reviewed. Nevertheless, it is clear that marine species can become extinct and that marine ecosystems can be altered by over-harvesting, pollution and species introduced by man.

RECOMMENDATIONS

1. The Bern Convention should continue its leadership of nature conservation policy in Europe, by increasing attention to the marine environment. This may require the establishment of a special working group or committee.
2. The Bern Convention should identify marine habitats, biotopes, and species that are a priority for conservation at a European scale. This should build on the work of previous groups, in particular the regional OSPARCOM, HELCOM, Barcelona Convention (MAP), Black Sea programmes, and European Union (Birds and Habitats Directives).
3. The geographic scope addressed by the Bern Convention should differ from existing international agreements in considering all of Europe seas, regardless of depth and distance from land, namely from the mid-Atlantic ridge to the North Pole, Macronesia (Azores, Madeira, Canaries), Mediterranean, and Baltic and Black Seas.
4. Offshore waters and deep-sea habitats and species should be a priority for conservation assessment.
5. This marine initiative could consider narrowing its scope by excluding:
 - a. species that may be threatened locally but are not threatened in other parts of Europe, unless these populations represented unique varieties or sub-species;
 - b. populations depleted by over-harvesting except where such over-harvesting is likely to compromise the survival of these populations or their associated species.
6. The Bern Convention should co-ordinate with, support the initiatives by, the EU, HELCOM, OSPARCOM, Barcelona Convention, IMO, ICES and other organisations with regard to establishing marine protected areas, control of pollution, and minimising the transport of exotic species.

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Some useful web sites

- The 1998 electronic conference on biodiversity research (Esteban *et al.* 1998) <http://www.gencat.es/mediamb/biodiv>
 - European Community biodiversity strategy (European Commission 1998) <http://europa.eu.int:80/en/comm/dg11/docum/9842en.pdf>
 - The European Science Foundation plan for marine biodiversity research (Heip *et al.* 1998) <http://www.esf.org/mpb/Marbio.html>
 - The European Register of Marine Species project (1998-2000) <http://erms.biol.soton.ac.uk>
 - EWGRB agenda for research into biodiversity (Larson & Catizzone 1997) <http://www.odn.se/~ewgrb>
 - Convention on Biological Diversity <http://www.biodiv.org>
 - Jakarta Mandate <http://www.biodiv.org/jm>
 - International council for the Exploration of the Seas (ICES)
 - International Commission for the Scientific Exploration of the Mediterranean Sea <http://www.ciesm.org/>
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Table 1 – Key differences between open ocean and terrestrial ecosystems

Comparisons between these systems may provide insights into the general relationships between biodiversity and ecosystem function. In contrast, some marine and terrestrial systems may be similar in biological structure and would similarly benefit from comparison (from Anon. 1993, Committee on Biological Diversity in Marine Systems 1995).

	MARINE	TERRESTRIAL
Dominant primary producers	Small, motile, live for days to weeks	large, fixed, live for years
Plant production		
Total biomass	Small	Large
Total production	Low	High
Longest lived organisms	top of food chain	bottom of food chain
Growth	indeterminate	Determinate
Physical structure determined by	physical medium	Organisms
Species diversity	Low ?	High
Phylum diversity	High	Low

Table 2 – Ten economic, ecological, moral and legal reasons why society needs to protect and manage biodiversity

Economic

- it is essential for the assimilation and recycling of wastes derived from human activity;
- it is the source of food for man and domestic animals;
- it provides valuable recreational resources;
- it contains biotechnological resources of increasing commercial importance;
- it produces non-living resources of commercial importance such as maerl, coral, coal, oil, gas.

Ecological

- it supports economic resources through the food chain and interaction between species.
- it maintains local to global ecosystem health through its interaction with the physical and chemical environment (e.g. atmospheric carbon dioxide, oxygenation) and can buffer the world against climate change.

Moral and ethical

- it is generally accepted that other life forms have a right to exist, and that man has a responsibility of stewardship to protect our natural inheritance for future generations. Indeed, a review of history suggests that we can have little idea of what uses and values future generations may discover in biodiversity.
- the production of unnecessary waste and thus pollution can be considered immoral.

Legal

- the Convention on Biological Diversity and other laws now places a legal obligation on most countries and their citizens to protect and sustainably use biodiversity. This is essential because some people will not have ability or willingness to understand the importance of biodiversity, or their short-term perspectives will result in their activities reducing biodiversity.

Table 3 – Why there is special concern over threats to marine biodiversity

Increased pressures	<ul style="list-style-type: none">• Widespread pollution• Contamination of human food supply• Over-fishing• Over-harvesting• Introductions of exotic (alien) species• Increasing fishing and use of deep-sea resources
Untapped resources	<ul style="list-style-type: none">• Biotechnology applications• Aquaculture
Knowledge base	<ul style="list-style-type: none">• Less studied than terrestrial environment• Less visible, accessible and understood by wider public• Many undescribed species even in European seas• Remarkable new deep-sea habitats still being discovered (e.g. hot vents, <i>Lophelia</i> coral reefs)• Inventories and maps of seascapes and resources primitive compared to land maps
Management	<ul style="list-style-type: none">• Complexity national and international laws, regulations, conventions, commissions, and other agreements

Table 4 – Marine species protected under the Bern Convention 1998**Vertebrates****All marine:**

seals,
whales,
dolphins,
reptiles,
and most birds.

Fish

Many fish which migrate through estuaries
(salmonids, sturgeons, clupeids, lampreys,
coregonids, etc.)

Two seahorse and several shark species

Plants**Seagrasses**

Posidonia oceanica (Med.)
Cymodocea nodosa (Med.)
Zostera marina (Med.)

Seaweeds (algae)

Caulerpa ollivieri (Med.)
Cystoseira amentacea (Med.)
Cystoseira mediterranea (Med.)
Cystoseira sedoides (Med.)
Cystoseira spinosa (Med.)
Cystoseira zosteroides (Med.)
Laminaria rodriguezii (Med.)
Laminaria ochroleuca (Med.)
Goniolithon byssoides (Med.)
Lithophyllum lichenoides (Med.)
Ptilophora mediterranea (Med.)
Schimmelmannia schousboei (Med.)

Invertebrates**Sponges**

Aplysina cavernicola (Med.)
Asbestopluma hypogea (Med.)
Axinelle polyplöides (Med.)
Petrobiona massiliana (Med.)
Hippospongia communis (Med.)
Spongia agaricina (Med.)
Spongia officinalis (Med.)
Spongia zimocca (Med.)

Anemones

Astroides calycularis (Med.)
Gerardia savaglia (Med.)

Corals

Antipathes sp. plur. (Med.)
Corallium rubrum (Med.)

Hydroid

Errina aspera (Med.)

Snails

Gibbula nivosa (Med.)

Limpets

Patella ferruginea (Med.)
Patella nigra (Med.)

Bivalve molluscs

Lithophaga lithophaga (Med.)
Pinna pernula (Med.)
Pholas dactylus (Med.)

Lobsters and Crayfish

Homarus gammarus (Med.)
Maja squinado (Med.)
Palinurus elephas (Med.)
Scyllarides latus (Med.)
Scyllarides pigmaeus (Med.)
Scyllarus arctus (Med.)

Starfish

Asterina pancerii (Med.)

Brittlestar

Ophidiaster ophidianus (Med.)

Seurchins

Centrostephanus longispinus (Med.)
Paracentrotus lividus (Med.)

Table 5 – International Conventions and European Union Directives which affect the conservation of marine habitats and species in Europe (following Fontaubert *et al.* 1995, Stanners and Bourdeau 1995)

Convention or Directive	Relevance to marine biodiversity
Convention on the Law of the Sea (UNCLOS)	Management of resources in international seas, including fisheries.
Convention on Biological Diversity (CBD)	Management of biodiversity. Its 'Jakarta Mandate' leads activity in marine biodiversity management and conservation
Convention on International Trade in Endangered Species of wild fauna and flora (CITES) MARPOL and London Convention (International Maritime Organisation)	Control of trade in endangered species, including some marine species at risk from over-collecting. Control of pollution from ships and by dumping, including the transport of marine and estuarine species in ballast water and as fouling by shipping.
International Whaling Commission (IWC)	Management of whale hunting.
Ramsar Convention on Wetlands	Protection of wetlands of international importance especially as waterfowl habitat. Includes saltmarsh and some lagoon systems, and marine water to maximum depth of 6m.
Bonn Convention on the Conservation of Migratory Species of Wild Animals	Conservation of migratory animals, including marine mammals, bats and birds.
World cultural and natural Heritage convention (UNESCO) European Union Birds Directive	Recognises outstanding landscapes and ecosystems as World Heritage Sites Birds which are resident and migrate through European Union.
European Union Habitats Directive	All habitats and species in EU states. Marine habitats broadly defined, and few marine species listed.
Council of Europe Bern Convention on the conservation of European wildlife and natural habitats	Conservation of species and natural habitats through agreement and co-operation between member states.
Convention for the protection of the N. E. Atlantic (Oslo-Paris Commission, OSPARCOM)	Protection of marine environment. Preparing lists of habitats and species that are a priority for protection in the north-east Atlantic.
Helsinki Commission (HELCOM)	Protection of marine environment. Developed lists of habitats and species which are a priority for protection in the Baltic Sea.
Barcelona Convention for the protection of the marine environment and the coastal region of the Mediterranean	All aspects of environmental protection and human impacts in the Mediterranean: pollution ; nature; tourism; CZM. Under its Geneva Protocol, it has developed a protocol for marine and coastal Specially Protected Areas including species that are endangered, threatened, or whose exploitation needs regulation.
Bucharest Convention	Protection of the Black Sea from pollution.

Table 6– Organisations involved in the management of marine habitats and species in Europe in addition to those mentioned in Table 5

Organisation	Focus of attention
European Science Foundation	Research policy. Marine and Polar Sciences Board (EmaPS) has a working group on marine biodiversity research which produced an action plan for marine biodiversity research in Europe.
European Commission	DGX I (environment) implements Habitats and Birds Directives in EU member states. Funds conservation and environmental management measures in member states. Establishing Natura 2000 network. DGX II (research) funds biodiversity research in EU and EEA states. DGX IV (fisheries) funds management and research related to fisheries and aquaculture in EU member states.
European Environment Agency EEA	Organisation of data and production of state of environment reviews in EU member states. Nature Conservation (NCTC) and Marine and Coastal (MCTC) Topic Centres provides advice and services to EC and EEA on nature conservation and marine environment respectively.
International Council for the Exploration of the Sea (ICES)	Provides advice to member states on management of benthos in north-east Atlantic. Benthos Working Group is preparing lists of habitats and species which a priority for protection.
International Commission for the Scientific Exploration of the Mediterranean Sea (CIESM)	Facilitates co-ordination of research, and establishes special task forces. Recently one completed a special study on exotic invasive species in the Mediterranean.
Food and Agriculture Organisation (FAO)	Statistics and advice on fisheries and aquaculture management, including coastal area management.
Environmental Programme (UNEP)	Regionals Sea programmes include the Black Sea. Established the MAP. Implements Global environmental Facility (GEF) funding in relation to biodiversity and international waters.
Intergovernmental Oceanographic Commission (IOC) (UNESCO)	Co-ordinates ocean climate research, mapping, and data management with occasional studies on special topics (e.g. harmful alga blooms, pollution, living resources, CZM).
Diversitas (UNESCO)	Promotion of biodiversity research around the world.
UNESCO Man and the Biosphere (MAB) programme	Establishes Biosphere nature reserves where man uses resources sustainably.
World Conservation Union (IUCN)	Working groups address conservation of particular groups of species or habitats.
Mediterranean Action Plan (MAP)	Implements Barcelona convention.
Birdlife International	Uses network of national organisations, its own expertise, and lobbying to protect birds.
Organisation for Economic Co-operation and Development (OECD)	Environmental Policy Committee (EPOC) leads international policy in relation to chemical management and pollution.

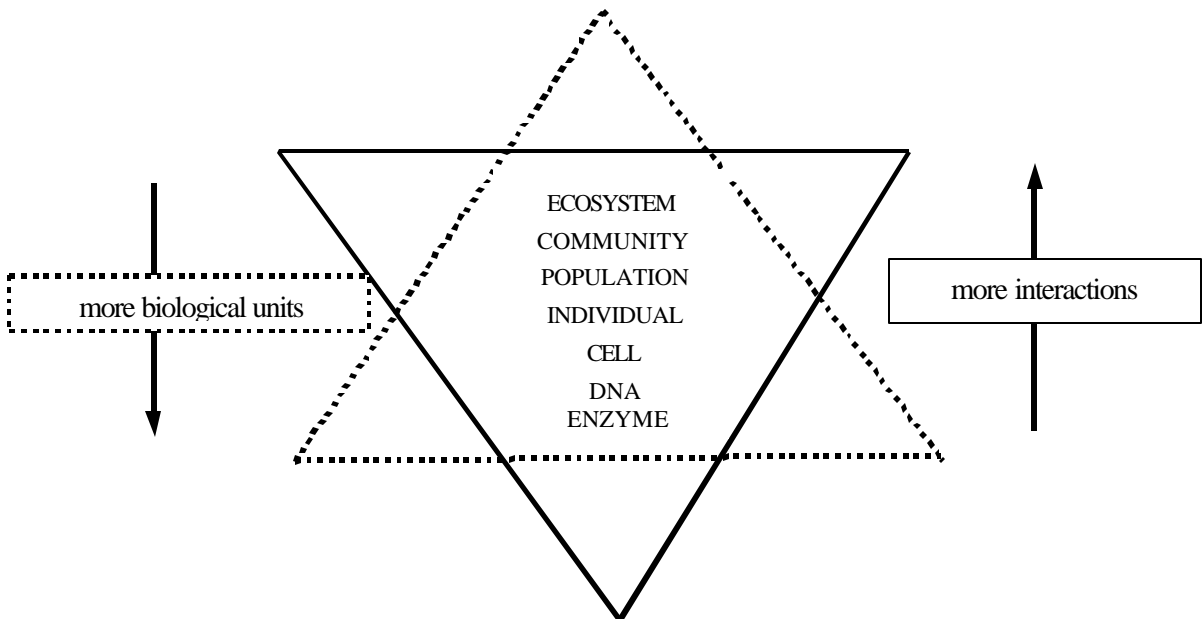


Figure 1. Biodiversity represents the variety of biological units and the variety of biological, biochemical, and biophysical interactions between these units. The complexity of interactions increases as one moves from cellular to ecosystem levels of organisation. The abundance of biological units increases as one considers smaller biological scales, from individuals to enzymes. Any single measure of biodiversity cannot be considered to be representative of all aspects of biodiversity.

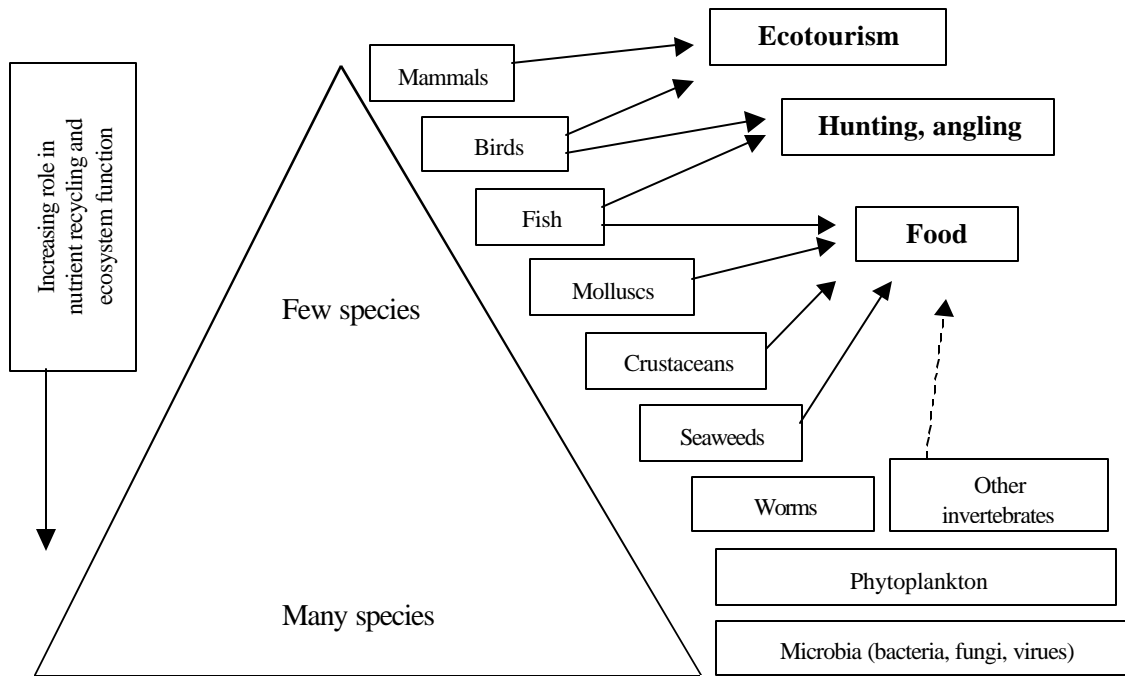


Figure 1. A diagram illustrating the relationship between different components of marine biodiversity and their uses to man. While it is easier to quantify the economic benefits of species higher on the pyramid, the lower part of the pyramid is more important for the healthy functioning of ecosystems.

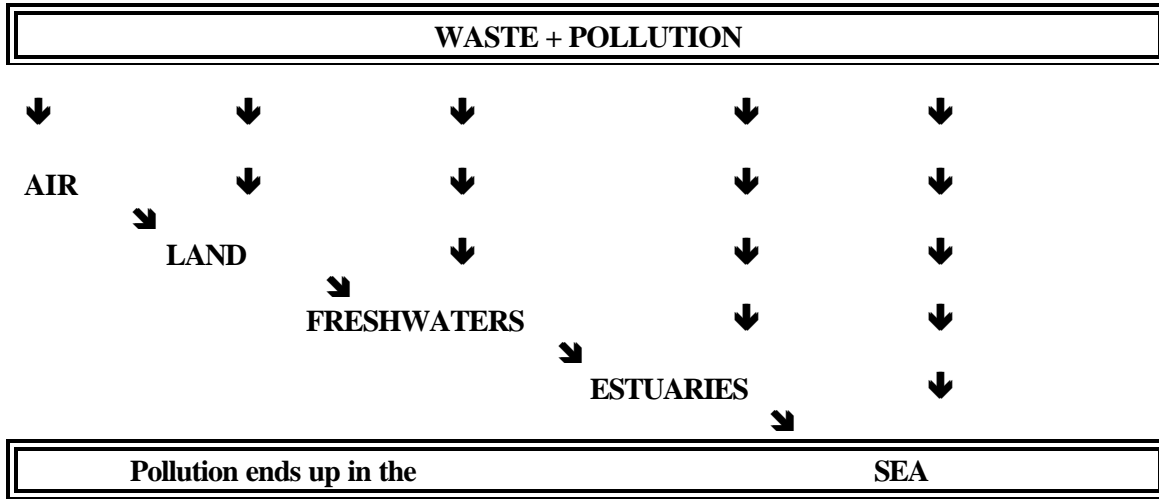


Figure 2. All wastes, contaminants and pollutants eventually end up in the sea from which it is impossible for man to remove them. Yet, the most important source of wild food eaten by man and his animals is marine biodiversity, notably fish, and these fish are directly exposed to these contaminants. A priority of pollution control must thus be to prevent the release of persistent contaminants into the environment.

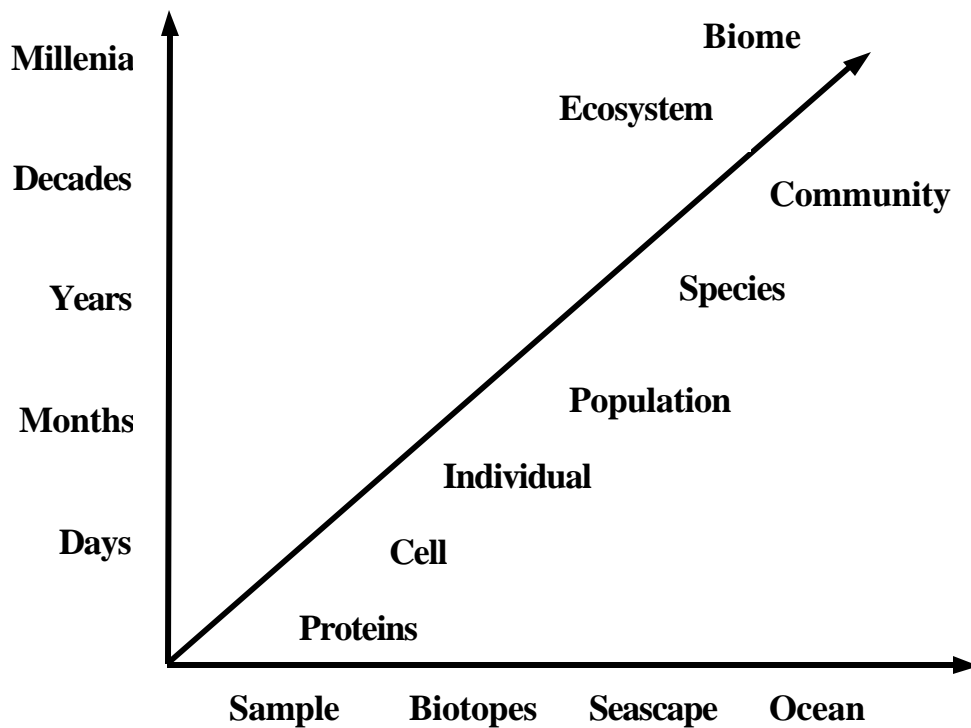


Figure 3. The different spatial, temporal and biological scales which need to be studied and linked in research into biodiversity.

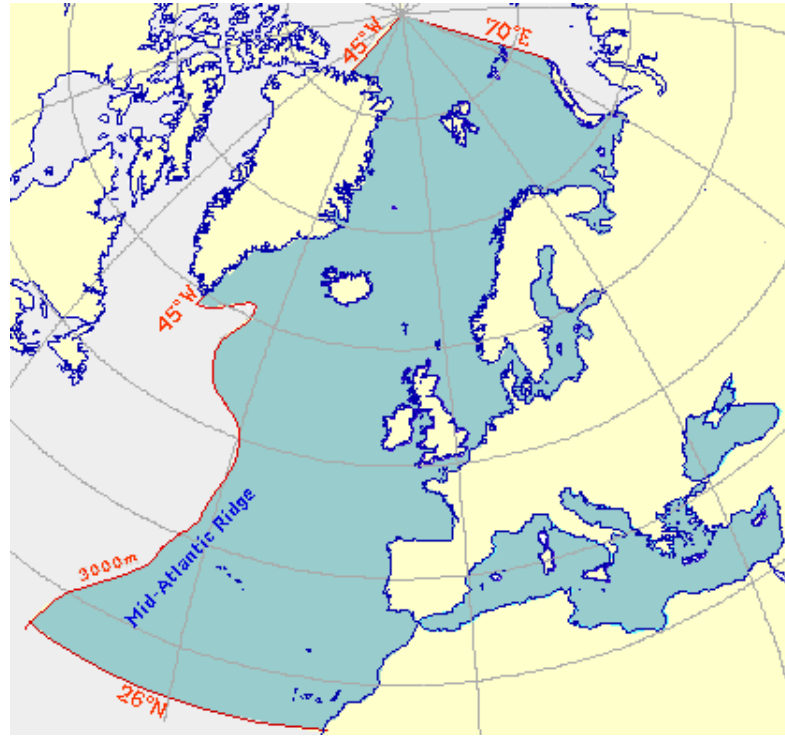


Figure 4. The geographic scope of 'European' seas following the EU project 'European Register of Marine Species' (web site ermis.biol.soton.ac.uk).