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Oceans and the law of the sea

Oceans and the law of the sea

Report of the Secretary-General

Addendum

Summary

The present report has been prepared in response to a request by the General Assembly, in paragraphs 73 and 74 of its resolution 59/24 of 17 November 2004, for the Secretary-General to report to the Assembly at its sixtieth session on issues relating to the conservation and sustainable use of marine biodiversity beyond areas of national jurisdiction. As provided in that resolution, the report should assist the Ad Hoc Open-ended Informal Working Group established by the General Assembly in preparing its agenda. The Working Group will be convened by the Secretary-General in New York not later than six months after the release of the present report and will study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction.

In accordance with Assembly resolution 59/24, the report presents information on the scientific, technical, economic, legal, environmental, socio-economic and other aspects of the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction, including key issues and questions where more detailed background studies would facilitate consideration by States of these issues and, where appropriate, possible options and approaches to promote international cooperation and coordination in this area. It also presents information on past and present activities of the United Nations and other relevant international organizations with regard to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction.

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I. Introduction

1. Oceans support an abundant and diverse web of life, which constitutes an integral part of the biological diversity of our planet and makes an extremely valuable contribution to its health, including for human life. For example, marine biodiversity produces a third of the oxygen that we breathe, moderates global climate conditions and provides a valuable source of protein for human consumption and other products. At the same time, available evidence indicates that biodiversity, including marine biodiversity, is under growing pressure from different types of human activity. The primary causes of loss of biodiversity include pollution, climate change and increasing demands for biological resources as a result of the growth in the human population and world production, consumption and trade. As a result of these unprecedented pressures, we are witnessing the degradation of habitats and the over-exploitation of biological resources.

2. Conservation and sustainable use of biodiversity, including marine biodiversity, must therefore become an integral part of social and economic development in order to ensure that the variety of services it provides will be available to support human needs in the long term.

3. It is important to clarify what is understood by the term biodiversity and biological resources in the context of the present report. The terms are not used in the United Nations Convention on the Law of the Sea[1] and are commonly used with different connotations. The Convention on Biological Diversity[2] uses and defines these terms. The present report follows the definitions contained in the latter Convention, taking into account that recent developments may have shed new light on their meaning.

4. Biological diversity is defined in article 2 of the Convention on Biological Diversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Biodiversity is therefore an attribute of life, and refers to the variability of life in all forms, levels and combinations. It includes ecosystem diversity, species diversity and genetic diversity.

5. On the other hand, "biological resources" are the tangible biotic components of ecosystems and species. As defined in article 2 of the Convention on Biological Diversity, biological resources include "genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity". Genetic resources, in particular, are defined as "genetic material of actual or potential value", and genetic material is defined as "any material of plant, animal, microbial or other origin containing functional units of heredity".

6. In the light of recent developments in the field of genetics, it is now known that every cell of every living organism contains "functional units of heredity". It could therefore be concluded that genetic resources can include plant seeds, animal gametes, cuttings or individual organisms, as well as DNA extracted from a plant, animal or microbe, such as a chromosome or a gene, with actual or potential value for humans in light of their genetic characteristics.

7. The value of the diversity of genes, species or ecosystems per se should not be confused with the value of a particular component of that diversity for human needs. Species diversity, for example, is valuable because the presence of a variety of species helps to increase the capability of an ecosystem to be resilient in the face of a changing environment. At the same time, an individual component of that diversity, such as a particular species of fish, may be valuable as a biological resource for human consumption or use.

8. Biodiversity can be diminished either if the diversity itself is reduced, such as through the extinction of a species, or if the potential of the components of diversity to provide a particular service is diminished, such as through unsustainable harvesting. Both a change in the diversity itself per se and a change in specific components of biodiversity deserve attention from decision makers and each often requires its own management goals and policies.[3]

9. The issue of conservation and sustainable use of biodiversity, including marine biodiversity, has been attracting increasing attention recently as part of the growing concern about the future of our planet. This resulted in a series of decisions adopted in recent years by the General Assembly, under its agenda item on oceans and the law of the sea. The most recent action taken by the General Assembly was to adopt resolution 59/24 of 17 November 2004, in paragraph 73 of which the Assembly decided to establish an Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction: (a) To survey the past and present activities of the United Nations and other relevant international organizations with regard to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction; (b) To examine the scientific, technical, economic, legal, environmental, socio-economic and other aspects of these issues; (c) To identify key issues and questions where more detailed background studies would facilitate consideration by States of these issues; and (d) To indicate, where appropriate, possible options and approaches to promote international cooperation and coordination for the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction. In paragraph 74 of the same resolution, the Secretary-General was requested to report on these issues to the Assembly at its sixtieth session, in order to assist the Working Group in preparing its agenda, in consultation with all relevant international bodies, and to convene the meeting of the Working Group in New York not later than six months after the release of the present report.

10. The present report is presented in response to the request of the General Assembly. It is based on publicly available information, as well as information received from relevant organizations and experts cooperating with the Division for Ocean Affairs and the Law of the Sea of the Office of Legal Affairs of the Secretariat. The Secretariat is grateful to those who have contributed to the preparation of this report.[4]

11. The information is organized around the issues to be studied by the Working Group. An addendum to the previous report of the Secretary-General on oceans and the law of the sea (59/62/Add.1) presented information on vulnerable marine ecosystems and biodiversity in areas beyond national jurisdiction, and reports of the Secretary-General relating to fisheries, in particular his report contained in document A/59/298 complement the information provided in the present report.

II. Scientific, technical, economic, environmental, socio-economic and legal issues

12. The present chapter of the report responds to subparagraphs 73 (b) to (d) of General Assembly resolution 59/24. It examines scientific, technical, economic, socio-economic, environmental and legal issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction. It also identifies, under each of these themes, key issues and questions where more detailed background studies would facilitate consideration by States of these issues, as also requested by the Assembly. Similarly, the report indicates, where appropriate, possible options and approaches to promote international cooperation and coordination for the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction. Possible options for cooperation are also presented in the conclusions to the present report.

A. Scientific issues

13. The oceans are characterized by an exceptional range of ecosystems with complex structures and functions. These can be broadly divided into the pelagic (water column) and the benthic (seabed) ecosystems. The pelagic and benthic environments are high in biodiversity,[5] suggesting a greater number of species exist in the sea than on land. Analyses of selected deep sea floor systems have led some scientists to predict that the whole deep sea floor beyond areas of national jurisdiction could perhaps harbour several million species (see also A/59/62/Add.1, paras. 167-199).

14. Research in areas beyond national jurisdiction is carried out in complex and little known environments. With the development of new technologies and techniques, scientists have had to adjust their thinking about the processes and functions of ecosystems found in oceans. At the same time, knowledge about the biological diversity of the deep ocean is so limited that it is not possible to estimate the number of species in any region or to predict the geographic range they occupy. Efforts need to be made to understand these ecosystems in order to be able to promote their conservation and sustainable use.

1. Ocean ecosystems

(a) Pelagic ecosystems

15. The pelagic environment can be divided vertically into three zones, the epipelagic or “light” zone, extending from the surface to approximately 150 to 200 metres below sea level, the mesopelagic or “twilight” zone, extending from approximately 200 metres to 1,000 metres below sea level and the bathypelagic zone, which is dark and cold and extends from 1,000 metres downwards.[6] The boundaries of each zone vary in depth depending on local or regional conditions and each is characterized by a distinct community of plankton, micronekton and fish. A distinctive fauna has been identified close to the seabed known as the hyper-benthic or benthopelagic fauna. The species diversity of pelagic ecosystems is low compared to benthic ecosystems. Species diversity generally increases to the

transition between the mesopelagic and bathypelagic zones and then decreases with increasing depth.

Epipelagic zone

16. The epipelagic zone generally goes down to 150 to 200 metres, where there is sufficient light for photosynthesis. Broadly, species diversity is highest in the subtropics followed by the equatorial belt and then drops markedly after the transitional zone, with polar seas having diversities of less than 50 per cent of the tropics and subtropics. This pattern, however, is not even across all groups of animals.[7] Recently, a new framework has been established for a global regional ecology of the pelagic environment based on a suite of physical processes and patterns of phytoplankton productivity. This scheme takes into account features of oceanography that do not necessarily reflect latitude, such as major upwellings on the western boundaries of continents.[8]

17. Recent studies on zooplankton have indicated that knowledge concerning the diversity of the epipelagic communities is still inadequate. Even in well-studied groups such as copepods, new species are being regularly described and, more significantly, widely distributed "old" species are being recognized as complexes of several morphologically very similar species. This means that the collation of old records of species occurrence may be highly inaccurate.[9] The use of DNA sequencing has shown that these problems are not restricted to small animals.[10] In addition, it is difficult to acquire knowledge about gelatinous and meso- and bathypelagic soft tissue animals, which do not preserve well using conventional methods of fixation,[7] leading to the general conclusion that knowledge of the zooplankton also decreases with increasing depth.

Mesopelagic zone

18. The mesopelagic zone contains communities of animals that undergo daily migrations (which are visible with sonar as dense reflective layers) towards the surface at dusk to feed, returning to deeper waters at daybreak to avoid predators. These migrators make a significant contribution to the rapid transport of carbon from the surface layers to depth, but this is secondary to sinking of surface production.[11] The daily migrating plankton and micronekton layers are also critical in trophic focusing in areas of elevated topography (see Seamounts). As with the epipelagic zone, many mesopelagic species are thought to have wide geographic distribution. However, confidence in putative distributions has been undermined by recent discoveries triggered by the use of new technology, such as DNA or genetic investigation.[12]

Bathypelagic zone

19. In the bathypelagic zone, diversity of pelagic species appears to peak at around 1,000 metres partially because the mesopelagic and bathypelagic faunas mix at these depths. Such transition zones are known as ecotones. Below this depth, the biomass of pelagic organisms decreases exponentially and species diversity also apparently decreases steadily. This zone is probably the least studied and least understood part of the pelagic realm. The animals are different from those in the mesopelagic zone as there is no light. The rain of food from the epipelagic zone decreases from the surface of the oceans to the seabed and life at these depths is sluggish. Topographic

barriers, such as the mid-ocean ridges, tend to separate areas of the ocean at these depths and bathypelagic species have a stronger tendency towards regional distribution rather than the (putative) cosmopolitanism typical of the shallower pelagic realms. However, below 3,000 metres, sometimes termed the abysso-pelagic zone, cosmopolitanism increases (see also A/59/62/Add.1).

20. The understanding of how pelagic biodiversity varies with oceanic, regional and mesoscale oceanographic features is limited. This situation becomes worse with increasing depth and is a major technological and financial challenge to investigate.

(b) Benthic ecosystems

21. The geological morphology of some of the oceanic basins can be important in determining the ecological characteristics of the oceans by modifying the hydrography.[13] Central ridges that cross some of the major ocean basins, dispersed and aggregated seamounts and other topographic features of the sea floor define the type of sea floor biological assemblage encountered. Trenches affect the sedimentation rates of nearby abyssal habitats by trapping sediment that would otherwise be transported to the abyssal plain where it could create perturbations, eradicating benthic assemblages on occasion, generating mosaics of isolated habitats within which speciation of taxa with limited dispersive ability occur, thus contributing to high regional diversity.[14] The knowledge of how these events take place is poorly documented.

Continental slopes and abyssal plains

22. The largest seabed habitats are the continental slopes and abyssal plains, with an area equivalent to 90 per cent of the total global ocean. Work based on deep-sea samples indicates that the diversity of animals living in or on deep-sea sediments is high.[15] At the same time, evidence shows that despite the large number of rare animals, a few species make up most of the individuals in a set of deep-sea samples. The most diverse species were small animals up to about 1 millimetre in size, termed the macrofauna. While it is clear that some species of animals can have a very wide distribution in the deep sea, this is likely to be strongly influenced by life-history characteristics or size. The high numbers of rare species in deep-sea samples sustain viable populations by way of the so-called "source-sink dynamics", whereby reproductive populations living in optimal conditions (source populations) produce large numbers of offspring which are broadcast into the water lying over the seabed and many of which end up settling in areas where they can survive but are unlikely to reproduce and contribute to the next generation (sink populations). Given the vast size of the abyssal plains and continental slopes, the potential for larvae and juveniles and even adults, in the case of the smallest organisms, to drift over large distances is significant. Therefore the pool of species contributing to any single local area of the deep sea is very great.

23. In this hypothesis, the bathyal zone is thought to act as the "source" population for the abyssal plains that are therefore viewed as a giant "sink" for propagules of bathyal origin.[16] The source-sink hypothesis has important implications in terms of conservation and development of deep-sea resources. It may be argued that exploitation of resources on the abyssal plains will not result in species extinctions because source populations of affected species would still exist on the continental margins. However, to assess the potential for extinction resulting from such

activities requires information on the geographic range and distribution of individual abyssal species, which is very limited.

Seamounts

24. Seamounts are undersea mountains of tectonic and/or volcanic origin. Estimates from the digital global elevation map based on the 2-Minute Gridded Global Relief Data (ETOPO2) dataset distributed by the United States National Oceanic and Atmospheric Administration give numbers of between 14,000 and 30,000 seamounts with an elevation of 1,000 metres or higher,[17] although the number of seamounts in the world's oceans remains uncertain. A more accurate prediction of the location of seamounts is also not possible without making available higher resolution data that is currently classified and out of the reach of scientists, although it appears that seamounts are found across all oceans.

25. A recent analysis of the SeamountsOnline database (http://www.seamounts.sdsc.edu) reveals 1,971 species recorded from 171 seamounts, mostly in the Pacific Ocean, with several in the Atlantic Ocean and only a few in the Indian Ocean. This analysis confirms the previous view that seamount communities are distinct from the surrounding deep-sea fauna and therefore are highly endemic. It is increasingly recognized that seamounts may also act as biological hot spots in the oceans and often attract a high abundance and diversity of large predators, such as sharks, tuna, billfish, turtles, seabirds and marine mammals. Crustaceans and corals are the next most commonly sampled animals, followed by molluscs, sea urchins, brittlestars, starfish, segmented worms and sponges. Almost every seamount that has been sampled has revealed markedly high levels of new species. Any estimates are likely to be conservative in terms of the number of species because of limited numbers of samples and limitations of sampling gear. The lack of affinity between seamount communities across only 1,000 kilometres of ocean is remarkable and indicates that seamount species may be restricted in distribution to single clusters or chains of seamounts or even to single seamounts. This means that human impacts on seamounts resulting from fishing or mining may result in species extinction and a global reduction in the diversity of the global seamount fauna. There is therefore an urgent requirement to assess the distribution of biogenic structures and associated communities on seamounts to identify which areas harbour significant species diversity.

Cold-water coral reefs

26. Cold-water corals are formed by a few species of stony corals, including *Lophelia pertusa, Madrepora oculata, Solenosmilia variabilis, Goniocorella dumosa, Oculina varicosa, Enallopsammia profunda* and *Enallopsammia rostrata*. Discoveries of new cold-water coral reefs have continued over the past few years. These discoveries have included the largest *Lophelia* reef found to date, the Røst Reef off the Lofoten Islands, which lies at a depth of 300 to 400 metres and covers an area 40 kilometres long by 2 to 3 kilometres wide. Sightings on the western side of the Atlantic Ocean are sparse, but indicate that a similar belt stretches from off the coast of Canada to Brazil.[18] Genetic analysis of *Lophelia pertusa* from off the Brazilian coast indicates a large genetic distance from European populations, which may suggest that the south-west Atlantic populations may not be co-specific to north-east Atlantic animals.[19]

27. In the southern hemisphere, cold-water coral ecosystems have been found associated with seamounts south of Tasmania and around New Zealand. These coral ecosystems, as with *Lophelia pertusa* reefs, are associated with highly diverse and endemic communities of animals. The fracture zone in the South Pacific area has not been explored to confirm the existence of cold-water coral reef ecosystems and the area off the coast of Chile also remains uninvestigated with regard to the presence of cold-water coral ecosystems.

28. Other types of coral can form distinct habitats with associated communities of animals. In particular, large colonies of octocorals or gorgonians can form dense forests or gardens, as found in the North Pacific, along the Aleutian Island chain, in the Bering Sea and in the Gulf of Alaska. These habitats are rich in rockfish (*Sebastes* spp), shrimp and other crustaceans. They also host other suspension-feeding attached animals, such as crinoids, basket stars and sponges. Gorgonians and other corals form dense populations in areas such as canyons and may have a highly diverse associated fauna. The New England seamounts have recently been investigated primarily with regard to octocorals and fish, but results have not yet been reported.[20]

29. There is an urgent need to identify areas hosting cold-water coral or other biogenic reef communities. Deep-sea corals grow slowly and reefs take thousands of years to develop. These structures can be imaged from ships using acoustic methods, but since vast areas of the seabed are potential habitats for reef-forming organisms, seabed assessment using autonomous underwater vehicles may be useful. The diversity and levels of endemism of species associated with such biogenic reefs are poorly understood and require urgent investigation. There is also little information on the reproduction, recruitment and ability to recover from human impacts for many reef-forming deep-sea corals, gorgonians and sponges and most information is on *Lophelia pertusa*. In situ observations and experimentation are required to address these issues. Although scientists generally agree that it is difficult at the present time to predict the impact of human activities on deep-sea species, there is some evidence of the impact of trawling on cold-water corals.[21]

Trenches

30. There are 37 trenches, mostly distributed around the periphery of the world's oceans.[22] The supply of organic material to trenches can be high and abundances of animals living on the seabed can be higher than in the surrounding deep sea.[23] About 700 deep-sea species have been recorded inhabiting trenches below 6,000 metres in depth. This fauna is highly endemic, with 56 per cent being found only in trenches and 95 per cent occurring only in a single trench.[24] Species diversity declines with depth, especially below 8,500 metres. Endemism is mainly at the species level and it is clear that many trench species are derived from close relatives in the adjacent oceans. These habitats remain poorly explored.

Canyons

31. The continental margins are dissected in many places by submarine canyons. These areas are often a focus for biological activity and are characterized by dynamic currents driven by internal waves and upwelling and high rates of accumulation of organic matter from the shelf. Communities may be quite different from the surrounding continental slope. Canyons can be rich in species but are

extremely variable in physical form and biology. They may also support considerable populations of fish, including commercial species. An abundance of large predators such as cetaceans are also attracted to these localities, which may be regarded as pelagic and benthic hot spots. As a result, they have also become a focus of conservation efforts.[25]

Reducing habitats

32. Reducing habitats occur in regions of the oceans where oxygen concentrations are low. Such areas are often associated with high concentrations of methane or hydrogen sulphide and include dysaerobic ocean basins, hydrothermal vents, cold seeps and the remains of large dead animals, such as whales, described below.

33. Dysaerobic basins or extreme oxygen minimum zones (EOMZs) occur where intense upwelling leads to high surface productivity. This productivity sinks and decomposes at mid-ocean depths, consuming dissolved oxygen and, when combined with sluggish water circulation, leads to the development of massive areas of mid-water oxygen minima. The eastern Pacific Ocean, the south-east Atlantic, the area off west Africa, and the northern Indian Ocean are by far the largest reducing habitats in the oceans.[26] The boundaries of the EOMZs may fluctuate (for example in the eastern Pacific during the El Niño phenomenon) causing marked economic impacts by influencing the catches of fish and shellfish, often abundant around these areas because of high surface productivity. These areas may also be important as global sinks for the deposition of carbon.[6]

34. The organic-rich sediments of EOMZs can support dense mats of sulphide oxidizing bacteria that thrive in waters rich in the nitrate used for sulphide oxidation to produce energy.[27] Overall, the diversity of EOMZ communities is depressed compared to normal deep-sea habitats and many of the residents of these zones are specially adapted for life in low oxygen conditions. Adaptations include small body size, special respiratory structures, blood pigments such as haemoglobin, the formation of biogenic structures such as tubes or "nests" to survive in very soupy sediment, the occurrence of sulphide oxidizing symbionts (as in vent and seep organisms) and other biochemical adaptations. Sometimes, dense aggregations of macrofauna and megafauna can occur at the base of EOMZs where organic material is plentiful and oxygen levels are sufficiently elevated for more animals to survive. In general, the species diversity of EOMZs is not well studied.[26]

35. Subsurface reducing habitats occur when, within the ocean bottom sediment, anoxia is created by the microbial degradation of organic matter. These areas are populated by communities of anaerobic bacteria, which can extend hundreds of metres into the sediments, representing a vast reservoir of microbial diversity. Even on crustal rocks, deep subsurface microbial communities exist, deriving energy from oxidation of hydrogen generated by the chemical interactions of seawater percolating up from beneath the seabed. These organisms are extremely difficult to access but have been sampled from venting fluids, especially following sea-floor eruptions. These hyperthermophilic organisms may influence the chemistry of venting fluids, but little is known about the diversity or function of these communities.

Hydrothermal vents

36. Hydrothermal vents are ecosystems that occur at divergent plate boundaries (mid-ocean ridges) and convergent plates where back-arc spreading centres occur. At mid-ocean ridges, interaction among the liquid magma from the earth's mantel, gases and water at extreme pressures create high-temperature deep-sea vents rich in chemicals that feed bacteria at the base of unique food chains.[28] A recent investigation of the biogeographic value of chemosynthetic systems has revealed that vents are like oases in the deep, supporting life and spreading species richness. The biological processes occurring at hydrothermal vents are powered by chemical energy rather than sunlight.[29] Because of the peculiar circumstances in which life develops in these ecosystems, hydrothermal vent organisms are a subject of interest from both a scientific and a commercial point of view.

37. The main characteristic of hydrothermal species is their tolerance to extreme conditions and their very peculiar physiology. Organisms mostly belong to the domain archaea, an evolutionary branch that is separate from those of bacteria and eukarya. The biomass at these habitats is typically high and dominated by tubeworms (*Riftia pachyptila*), clams (*Calyptogena magnifica*), mussels (*Bathymodiolous thermophilus*) and a variety of gastropods, polychaete worms and shrimps.

38. The diversity of species around hydrothermal vents is low, with about 500 described species, but levels of endemism in these habitats are high (more than 90 per cent). Although different vents have similar taxa at higher taxonomic levels (the genus and family), at the species level there are significant differences between vents. This led to the establishment of biogeographic provinces including the East Pacific, comprising the Galapagos Rift, the east Pacific Rise and the Guaymas Basin; the north-east Pacific; the western Pacific, where hydrothermal vents have been found in a variety of back-arc basins, including the Lau Basin, the Manus Basin, the Marianas Trough and the Fiji Basin (1987) and the Okinawa Trough (1988); and the mid-Atlantic, where a number of vents have been discovered.[30] The species also vary between Atlantic and Pacific vents. The first plume signals south of the equatorial fracture zone have recently been reported but have not yet been located. The most recent discoveries have been in the Indian Ocean.[31]

Cold seeps

39. Cold seeps are areas where cold, oxygen-depleted fluids, which may be rich in hydrogen sulphide or methane, flow upwards through cracks in the ocean floor. Cold seeps are associated with active and passive continental margins from 400 to 6,000 metres deep. New discoveries of seep sites are continuing.[32] In general, the diversity of seep communities is thought to reflect the age of a seep site, with ages up to 200,000 years being reported for some areas, such as the Gulf of Mexico. Many species appear to be restricted in distribution to one or two seep sites. Very few species are shared with other reducing habitats, such as vents, although there are similarities at higher taxonomic levels that indicate a common origin for elements of the faunas of these habitats. The biological diversity of seeps is less understood than that of deep-sea hydrothermal vents. Despite the fact that these habitats are probably more diverse than hydrothermal vents, only 200 to 300 species of seep-endemic animals have been identified. A high proportion remains undescribed, in particular those animals that do not contain symbiotic bacteria.

Carcasses

40. There are thousands of whale carcasses on the bottom of the oceans. These massive but highly localized influxes of organic matter represent a source of food for a specialized but poorly studied fauna. The animals inhabiting whale carcasses can occur in huge densities. Over 400 species have been documented. Macrofaunal diversity appears to rival many other hard substrate habitats in the deep sea.[33] At least 19 species are shared with other reducing habitats, including hydrothermal vents and cold seeps, and they may have represented important geographic stepping stones during the evolution and radiation of organisms reliant on these habitats.

(c) Micro-organisms

41. In the last 15 years, there has been a revolution in the understanding of the contribution of microbial organisms to production, biochemical cycling and diversity in the oceans. Despite these advances, the available knowledge is still in its infancy, but the continued application of genomic technologies will bring further revelations on biological processes driving the marine biosphere at the global scale.[6]

42. Micro-organisms include both heterotrophic (consumers), autotrophic (primary producers or photosynthetically active organisms) and mixotrophic (mixed nutritional strategy) prokaryotes (bacteria) and microbial eukaryotes. Particular interest is generated by micro-organisms in the deep ocean, below the sea floor and deeper into the subsurface. Buried deep within ocean sediments, in hot-ocean crust crevices, they have adapted to extreme environmental conditions (extremophiles) that include high pressure, high and low temperatures, unusual or toxic chemicals and minerals, or low availability of essential nutrients. In addition to those in vents and seeps, organisms found in brine pools (features similar to lakes at the bottom of the ocean, which result from the higher salinity of water bodies above certain areas of the ocean floor where significant amounts of salt deposits are buried) are of potential interest to marine scientists as a result of their unique physiological characteristics.[34]

Hot spots

43. Hot spots are microscopic rich areas of organic matter, typically related to living and dead microbial cells, floating in an otherwise nutrient-poor ocean environment.[35] Hot spots of diversity and biological activity in the ocean or pelagic zone occur in areas associated with coral reefs, oceanic islands, seamounts and other topographic and hydrographic areas such as canyons and fronts. In the food-limited environment of the open oceans, these areas are of major importance for the survival of large predators and support extensive populations of fish and other pelagic organisms.

44. Major hot spots are located in the tropical Indo-Pacific area, in particular on the seamounts in the Pacific, Indian and Atlantic Oceans. Although hot spots in species diversity are located mainly in the subtropics, hot spots of productivity with a high importance to pelagic predators have also been located in temperate and polar zones.[36] Hot spots should form natural focuses for conservation measures to protect both pelagic and benthic habitats, especially in the subtropics where the biodiversity across many trophic levels and groups of organisms is very high.[37]

2. Research activities

(a) Ongoing research

45. In present times, a host of research activities are carried out to study the ecology, biology and physiology of deep seabed ecosystems and species. The majority of activities are on a small scale, spread among independent research activities and programmes that are ongoing in many universities and research institutions in the world.[38] Most of these activities are of an exploratory nature. Some are a joint effort between the scientific communities of two or more States, such as the Arctic Mid-Ocean Ridge Expedition in 2001, conducted by scientists from the United States and Germany.[34]

46. More ambitious programmes involve a strong element of international scientific cooperation as well as joint ventures between public and private institutions. The New Challenger Global Ocean Expedition, organized by Deep Ocean Expeditions, the P. P. Shirshov Institute of Oceanology, the Russian Academy of Sciences, and Diversa Corporation, is an example of a joint venture. Census of Marine Life and the InterRidge organization are examples of international research programmes. Census of Marine Life is a global network of researchers engaged in an initiative to explain the diversity, distribution and abundance of marine life in the oceans, with a strong focus on deep-sea species. It has seven field projects, including the Census of Diversity of Abyssal Marine Life, the Biogeography of Deep-Water Chemosynthetic Ecosystems and the Mid-Atlantic Ridge Ecosystem Project.[39] InterRidge is an international organization comprising 2,700 researchers from 27 countries whose objective is to develop oceanic ridge research in a cost-effective and cooperative manner.[40]

47. The Integrated Ocean Drilling Program is an international marine research programme that investigates sub-sea-floor environments by studying the deep biosphere, environmental changes, processes and effects, and solid earth cycles and geodynamics. The Program has four international partners: two lead agencies: the National Science Foundation of the United States and the Ministry of Education, Culture, Sports, Science and Technology of Japan; a contributing member: the European Consortium for Ocean Research Drilling Managing Agency; and an associate member: the Ministry of Science and Technology of China. The Program also works in collaboration with other research programmes, such as the Global Ocean Observing System of the Intergovernmental Oceanographic Commission and International Geosphere-Biosphere Programme.[41]

48. A number of national institutions, some of which are mentioned below, are at the forefront of research on the deep oceans.

49. The French Research Institute for Exploitation of the Sea[42] carries out research projects on the exploration, knowledge and exploitation of the deep-ocean and its biodiversity with a focus on developing deep-ocean-related technology and ocean-floor observatories.

50. The National Oceanic and Atmospheric Administration of the United States, in particular its vent programme, studies the impacts and consequences of submarine volcanoes and hydrothermal venting on the global ocean.[43] This is an integrated research programme, focusing on the distribution and evolution of hydrothermal plumes and their geological, physical, chemical and geophysical characteristics.[34]

51. The Japan Agency for Marine-Earth Science and Technology, with its research centre known as the Extremobiosphere Research Center, conducts research on organisms thriving in the deep sea and in the deep subsurface, concentrating on extremophiles in terms of (a) what kinds of organisms live in such extreme environments; (b) what are their distinctive features; and (c) what is their potential usefulness in human life and/or in industrial applications.

Marine genomics

52. Researchers are using innovations in genomics research[44] to develop an accurate portrayal of the mechanisms employed by deep-sea life forms to survive in the harsh conditions of the marine abyss.[45] The findings might assist research efforts relating to the application of characteristics of deep-sea bacterial genes for improving human nutrition and degrading pollutants. In February 2005, the J. Craig Venter Institute, a non-profit research organization based in the United States, announced the launch of its marine microbe genome project, which aims to sequence the genome of more than 100 of the key marine microbes stored in culture collections around the world and provide a baseline against which to interpret the structure and functions of marine microbial genes. All the results of this project will be made public through the National Center for Biotechnology Information of the United States. Although the Institute's activities have focused on water column species, some of the techniques used may be relevant to future studies on deep seabed genetic resources.[34]

53. The Ocean Genome Legacy is a non-profit, private research foundation whose mission includes promoting the conservation of marine genomic diversity through the creation and maintenance of a publicly accessible, permanent archival collection of genomic DNAs, DNA libraries, voucher specimens and voucher strains and development of improved methods for genome resource banking, including genome amplification and cell and tissue cultivation and preservation. The mission of the Marine Genome Resource Bank is not only to preserve a portion of the disappearing diversity of marine environments, but also to provide access to a wide representation of marine genomes in the hope of augmenting the emergent science of environmental, functional and evolutionary genomics.[46]

54. While genome resource conservation is not a substitute for species and ecosystem conservation, it can provide many important tools for preservation and management of endangered species. The archived genomic DNAs and DNA libraries contain the raw genetic materials that can be isolated, sequenced, expressed and manipulated, so that genetic processes, products and regulation can be examined and explored. Thus, public genome resource collections can provide the physical materials and source information that add value to the sequence data currently being made available through the electronic media. Public genome conservation archives can serve to democratize genomic research, placing publicly funded resources within the reach of a greater number of researchers and fostering cooperation among smaller groups to utilize products created by centralized research facilities. The website of the Japan Agency for Marine-Earth Science and Technology also hosts a metadatabase of the genomes of several deep-sea micro-organisms that have been sequenced by the Agency and other scientific institutions in the world.[47]

(b) Research activities that need to be undertaken

55. To understand fully the ocean ecosystems so as to ensure their sustainable use and conservation, there are areas where more research needs to be carried out, some of which are identified below.[48] The geographic variation in diversity of the pelagic realm is complex and poorly understood. Species diversity and the presence or absence of individual species or communities have a large influence on processes related to the major biogeochemical cycles in the oceans. A major international research effort is required to address the lack of data on the diversity and species distribution of deep-sea animals, the benthic fauna, from the shallow bathyal to the abyssal zones of the central ocean basins and along isobaths on the continental slope.[49] Special efforts should be made to explore unsampled regions of the oceans.

56. Many questions regarding diversity and distribution will require simultaneous studies in conventional and molecular taxonomy.[50] Old records of species, including distribution information, are probably highly inaccurate.[9] Revising classification of species will require a large amount of human effort, as sorting benthic macrofaunal and meiofaunal samples is a lengthy procedure and requires skilled parataxonomists. A lack of trained taxonomists is currently a major barrier to overcoming the lack of understanding of the biology of the high seas.[6]

57. Major challenges relate to the remoteness of the study areas and the difficulty and expense of conducting continuous sampling from research vessels. In addition, high costs are involved in building infrastructure for the systematic recording of findings and analysis of the varied environments and biodiversity of the deep ocean. In many areas of the world, the resources and efforts required exceed the existing oceanographic capabilities and institutional framework, including human resources.[13] To address these challenges, international research projects offer a significant opportunity to train a new generation of marine scientists from around the world, thus spreading expertise and knowledge to the parts of the globe with the richest marine biodiversity, including developing countries in need of capacity-building. The Census of Marine Life programme provides an effective model on which to base such an effort.[6]

B. Technological issues

58. While the oceans cover two thirds of the planet,[51] it is estimated that the vast majority — 90 per cent — are unexplored. Access to the deep sea is dependent on technological progress relating to vessels, equipment, techniques for sampling and analysis, appropriate infrastructure, highly trained personnel and adequate financial resources. Although marine technology has advanced immeasurably in recent years, it still has limitations in collecting samples and in documenting observations in both the water column and on the seabed. In addition, the cost and infrastructure required by institutions and Governments to obtain systematic recordings of the biodiversity and to characterize the high seas and seabed exceeds, in most cases, the existing oceanographic capabilities and institutional infrastructure, as well as available human resources.

59. The section below describes selected examples of technology and tools that scientists use (in situ or ex situ) in their exploration of the deep ocean, its biodiversity and ecosystems. Technologies used for marine science include survey vessels with surface or deep tows, to take images of the seabed for bathymetric

charts; several types of submersibles lowered and operated from mother ships; equipment for geological, geochemical and biological sampling; techniques for preservation of biological samples; and analytical techniques to classify the organisms. There are also emerging molecular, chemical, optical and acoustical technologies, which will help to improve the understanding of biological diversity in the pelagic and benthic environments.

1. Research and supporting vessels

60. Research vessels used in areas beyond national jurisdiction are large ships capable of oceanic research cruises lasting several months at sea, serving as mobile platforms for marine research with a wide variety of sampling and surveying equipment. Such equipment includes traditional gear, such as box corers, multicorers, dredges, trawls and water samplers,[52] very sophisticated and expensive unmanned platforms, such as remotely operated and autonomous underwater vehicles, hybrid remotely operated vehicles, deep-towed vehicles and a range of manned submersibles launched and retrieved by vessels. Remotely operated vehicles are becoming the primary tool for studying the biodiversity of the deepest oceanic ecosystems and are a key technology in the international Census of Marine Life programme which has utilized, for example, the French remotely operated vehicle “Victor”. These vehicles are manoeuvrable and can be easily controlled from the surface. Because it is exponentially more expensive to build all of these vehicles as the attainable depth increases, owing to the increased pressure they must endure, they are built in various classes suited for specific ranges of water depth.[53]

Survey ships (surface or towed arrays)

61. The first stage of the exploration of seabeds is the creation of bathymetric charts. The use by ships of acoustic systems, including sonar imaging presenting local reflectivity of the bottom and thus its nature, make it possible to obtain in a precise and fast way topographic images of the relief of the seabed (bathymetry). Vessels conducting physical oceanography and marine biology surveys of the deep are often equipped with autonomous laboratories and instruments for storing and analysing collected data.

62. Manned submersible vehicles are defined as any undersea vehicle that has a one atmosphere cabin for human occupancy and is dependent on a surface support vessel. The primary advantage of the manned submersible is that it permits the researcher, in particular, to work in situ at great depths in the sea. The United States deep-diving submersible “Alvin”, operated by the Woods Hole Oceanographic Institution, and the French submersible “Nautile” have been diving on the Mid-Atlantic Ridge in a historic example of international cooperation and exploration of the planet Earth. The Japan Agency for Marine-Earth Science and Technology has also developed the “Shinkai 6500”, which is capable of carrying out surveys and observations at a maximum depth of 6,500 metres and navigating along the bottom, holding its position at a constant depth to conduct visual observation and capture videotape and still photographs. The “Mir I” and “Mir II” are three-person submersibles of the Russian Federation with a maximum operating depth of 6,000 metres. The Mir vessels allow scientists to observe the deep sea through multiple viewing ports, video records, instrument placement, sample collecting and environmental monitoring. The submersibles are launched and recovered with a specialized crane from the starboard side of their primary support vessel.

63. Unmanned platforms or remotely operated vehicles are attached to the mother ship by a control/retrieval cable, which supplies power to the unit, allows for real-time transfer of data, including pictures and video, to shipboard monitors where pilots and scientists can safely follow its progress and direct its movements. Remotely operated vehicles can be fitted with multifunction manipulators for complex tasks. The “Victor 6000” of the French Research Institute for Exploitation of the Sea is one of the leading remotely operated vehicles equipped to provide high resolution maps of the deep. The Japan Agency for Marine-Earth Science and Technology also operates the “Hyper Dolphin”, which incorporates various state-of-the-art features such as a unique super-high-definition camera to display images of the high quality necessary to observe the sea floor closely. Such high resolution is also essential when observing living organisms. Another example is the Canadian “ROPOS” (Remotely Operated Platform for Ocean Science), which is launched into deep water in a cage to a maximum depth of 5,000 metres, to about 40 metres above the sea floor. Attached to ROPOS are two video cameras, two robotic arms for taking samples of rocks or organisms, bottles for collecting water samples, a box for collecting biological samples and preserving them at in situ pressure and temperature, a suction sampler that can vacuum up sediments and organisms and a specialized water sampler for hydrothermal fluids.

64. Autonomous underwater vehicles are economically more viable than remotely operated vehicles and can function without tethers, cables or remote control. They have a multitude of applications in oceanography, environmental monitoring and underwater resource studies.

65. The Japan Agency for Marine-Earth Science and Technology, for example, developed the “Urashima”, which is fitted with a closed-cycle type fuel cell and a highly sophisticated navigation system, which has allowed the Urashima to establish a world record for continuous underwater operation. It automatically collects various ocean data, such as salinity and temperature. The Urashima can conduct expeditions in such areas as submarine volcanic zones. It is equipped with side-scan sonar and a digital camera to obtain topographical data on the deep sea floor. Another autonomous underwater vehicle frequently used in deep sea explorations is the Woods Hole Oceanographic Institution vehicle ABE (Autonomous Benthic Explorer), which is intended for long-duration deployment of up to one year.[54] It runs on batteries and, at present, can survey the sea floor at depths up to 5,000 metres on dives lasting more than a day. The United States also operates a new vehicle designed for science missions at abyssal depth, the “Odyssey II”, intended for survey operations.

66. The hybrid remotely operated vehicle, a new type of vehicle developed by the Deep Submergence Laboratory at the Woods Hole Oceanographic Institution and Johns Hopkins University, is capable of reaching a depth of 11,000 metres to perform a variety of tasks, such as photography, biological sampling and topographical mapping. The hybrid operates in two modes: as a remotely operated vehicle utilizing up to 20 kilometres of armoured, lightweight microcable, which allows scientists to receive data and communicate with the craft in real time; or as an autonomous underwater vehicle pre-programmed to collect data in wide-area surveys for later analysis.

67. Deep towed vehicles are less complex than remotely operated and autonomous underwater vehicles, but are useful as platforms for a variety of different

oceanographic instruments that measure biological, chemical and physical aspects of the ocean. The deep towed vehicle is different from a remotely operated vehicle in that it has no propelling device. It was originally developed for mapping the sea floor. Deep towed vehicles can be equipped for studies on archibenthic organisms, preliminary surveys for deep-sea exploration by manned and unmanned submersibles and underwater installation of observation instruments. The main purpose of this type of vehicle is to conduct wide-area deep-sea surveys and towing is best suited for this purpose. This system permits simpler design and has much lower operating costs. The Japan Agency for Marine-Earth Science and Technology has two deep towed vehicle systems. The camera system consists of two types: the 4,000 metre class and the 6,000 metre class. The sonar system is the 4,000 metre class. There are many different types of towed vehicles such as the Canadian Moving Vessel Profiler, which can house a video plankton counter or similar device while simultaneously utilizing several external sensors that record various physical qualities such as conductivity (salinity), temperature and current speed.[55] Another example is the deep towed vehicle “Bridget” of the British National Oceanography Centre in Southampton, which moves up and down near the ocean floor to study water plumes associated with hydrothermal vents. In the 6,000 metre class, other examples of deep towed vehicles are the “Deep Tow 6000” of the Scripps Institution of Oceanography; Scampi and SAR (Système Acoustique Remorqué) of the French Research Institute for Exploitation of the Sea; Argo II of the Woods Hole Oceanographic Institution and the Towed Ocean Bottom Instrument system of the National Oceanography Centre, whose main sensor is a sidescan sonar, which sends a sound pulse whose echoes are used to produce an acoustic image of the sea floor.[56]

2. Sampling techniques

68. Detection and identification techniques, both morphological and molecular, have relied on collecting samples from remote sites and analysing them in laboratories. In order to advance the understanding of pelagic biodiversity and its role in the oceans, there is a need to develop methods for surveying large volumes of water, preferably at timescales appropriate to variations in physical parametres that can be measured using oceanographic instrumentation. Once samples are collected and concentrated, automated systems must accommodate the analysis method. Identifying the diversity of organisms from marine samples is a particular problem, especially because many are not amenable to culture, although recent developments in culture technology have increased the range of species that can be grown in artificial conditions.

69. Deep-sea drilling remains the best way to sample the subsurface, but it is costly and there is a risk of contamination of the results from retrieved samples.[57] However, the Japan Agency for Marine-Earth Science and Technology’s vessel “Chikyu”, with its blowout prevention system similar to those used on high-pressure oil wells, will maintain environmental safety against oil or gas spills while recovering sediment and rock cores.[58] The Chikyu will be a state-of-the-art scientific drilling vessel equipped with 10,000 metres of drill string to allow the vessel to drill more than 7,000 metres beneath the sea floor, at a depth of 2,500 metres.[59] A riser drilling system will make it possible to drill through formations that have been difficult to drill using current conventional scientific drilling methods. The system will recover and collect core samples (columns of sediments

and rocks) for analysis and study aimed at measuring the formation properties by logging instruments and performing long-term monitoring in the deep.

70. Scientists have developed new instrument packages that plug into sealed drilled holes in the sea floor. These probes, or circulation obviation retrofit kits, offer potential windows into the interacting chemical, hydrological, geological and biological processes that occur beneath the sea floor.[57]

71. The main technologies that have advanced the understanding of seabed organisms are high performance liquid chromatography, used for detailed analysis of photosynthetic pigments; flow cytometry, used in the enumeration of size-fractionated particles and the discrimination of specific groups of organisms by cell scatter and characteristics of fluorescence; the use of DNA clone libraries for identification of groups of organisms by nucleotide sequence similarity; and the use of oligonucleotide probes, which have allowed identification of specific groups of organisms and enumeration or relative quantification by epifluorescence microscopy, or dot-blot hybridization (arrays). Other examples include (a) the Environmental Sample Processor, developed at the Monterey Bay Aquarium Research Institute, which extracts nucleic acids from protists in the water and detects specific organisms by their DNA; (b) the Submersible Incubation Device of the Woods Hole Oceanographic Institution, which determines levels of photosynthesis in the water around it; and (c) the submersible flow cytometer, which analyses microbial cells in the water continuously for up to two months. Because it samples continuously, scientists can see changes in plankton populations over time that cannot be detected by traditional sampling.[60]

72. Underwater video profilers, optical plankton recorders and shadowed image particle profiling and evaluation recorder systems have already been successfully used to quantify particulate matter and zooplankton in the water column. Such equipment has generally been deployed from surface vessels and towed through vertical profiles in the water column. Approximately 100 optical plankton recorders are in use throughout the world, although the resolution of these machines is limited. The development of these technologies in a small size, with high resolution and to the point where they could be mounted on autonomous underwater vehicles, deployed on fixed moorings at dynamic locations (that is, ocean fronts) or drifting-arrays equipment, would greatly increase their utility.

73. Autonomous underwater vehicles already carry a range of equipment for gathering oceanographic measurements including fluorimetres, transmissometres, temperature and salinity probes and acoustic devices. Increasing the speed and range of these platforms will greatly enhance the ability to study pelagic ecosystems not only in the epipelagic and mesopelagic zones but to full ocean depth. Miniaturizing a range of equipment used to characterize small organisms will greatly enhance our understanding of how the diversity of these organisms is influenced by the physical environment and, in turn, how these organisms influence biogeochemical cycling and the formation of biological hot spots. Further miniaturization of such equipment would reduce it to a size where it could be deployed on deep-ocean observatories or even on autonomous underwater vehicles.

3. Preservation of samples and data analysis

74. For marine biological research in deep-sea environments, deep-sea samples need to be collected and kept under the same environmental conditions as those in

the deep sea where the organisms grow naturally. For such purposes, the Japan Agency for Marine-Earth Science and Technology has developed the deep-sea baro/thermophiles collecting and cultivating system (DEEP-BATH), which samples mud containing deep-sea micro-organisms under deep-sea environments and then isolates and cultivates the bacteria without subjecting them to above-ground conditions. This system also allows micro-organisms to grow at different temperatures and pressure conditions for observation. To date, the Agency has been able to isolate 180 microbial species from the Mariana Trench. The Agency has also developed a pressurized aquarium tank (DEEP AQUARIUM), which maintains deep sea organisms in conditions similar to their original environment.[59]

75. The traditional procedure for identifying organisms involves comparing the physical characteristics of a collected specimen with the characteristics for a known species. Today, deep-sea investigations can complicate this process because two identical specimens can be named differently since there is no comparison to another type of sample. DNA-based methods are objective and avoid such problems, allowing classification and distribution of organisms across the world's oceans. A recent advance in the field of molecular techniques is the development of DNA bar coding. This approach uses a small segment of an organism's DNA to identify its species name. This technology affords scientists an advantage when trying to identify large numbers of collected organisms. This process is being used by the Census of Marine Life.[6]

4. Databases

76. Databases are information tools that are researchable and allow for wide and quick sharing and access. There are a number of databases containing information on deep-seabed resources and expeditions. The InterRidge website, for example, hosts several relevant databases, including the hydrothermal vent database, the Mid-Ocean Ridge back-arc basin MOR and BAB cruise database, and the hydrothermal vent faunal database. The latter, which contains almost 500 species, is currently being merged with the ChEss (Biogeography of Chemosynthetic Ecosystems) database, which is a project of the Census of Marine Life. This database includes ascertained and suspected hydrothermal vent sites and contributes also to the International Seabed Authority central data repository, which was developed to collect and centralize all public and private data and information on marine mineral resources.[34] The Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO) has developed a dataset on a register for marine organisms, which is being maintained at the National Museum of Natural History, in Leiden, the Netherlands. The register contains a list of species names as well as additional information, such as author names, vernacular names and information on geographical and bathymetrical distribution. Synonyms are also added, but only if they are still in use or have been used recently. The Ocean Biogeographic Information System is the information component of the Census of Marine Life and is a web-based provider of global geo-referenced information on marine species and strives to assess and integrate biological, physical and chemical oceanographic data from multiple sources.[61]

5. Biotechnology

77. The biotechnology sector is one of the most dynamic research areas with increasing prospects for growth and profitability.[62] The marine environment covers a

wide thermal range whose variability has facilitated extensive speciation at all phylogenetic levels, from micro-organisms to mammals, and includes plenty of metabolites and other resources in living or dead form. Developments in molecular technology and bioinformatics will allow more information to be gathered on the diversity of existing bacteria and their potential. The next generation of technology for monitoring biological processes, remediation of pollutants and conversion of wastes will all be linked to these new biological technologies.

78. Marine biotechnology is the science in which marine organisms are used in full or partially to make or modify products, to improve plants or animals or to develop micro-organisms for specific uses. Advances in biotechnology with the ability to transfer genetic material from one organism to another, have opened up the exciting possibility of transferring segments of DNA that are responsible for the biosynthesis of secondary metabolites from unculturable bacteria. Synthetic methods are constantly improving so that complex molecules can be synthesized on industrially useful scales. Ongoing exploration will provide subsurface organisms and genes for by-product screening.

79. Deep sea organisms, in particular, are interesting because of their ability to adapt to extreme environments. Knowledge of their adaptation process provokes questions as to the mechanisms they use and possible commercial applications. Many have been sampled with an eye to their biotechnology potential. The marine biotechnology industry is based on the realization that many micro-organisms found in various marine environments can, through biotechnology, provide new products and processes for use in many sectors. The biomass of bacteria constitutes promising deposits of molecules that can be used in the areas of health, pharmacology, cosmetology, the environment and chemistry. The number of related patents is rising (see also paras. 215 and 216, below).

80. Most inventions concern the genomic features of deep seabed species, the isolation of active compounds and sequencing methods. Others relate to the isolation of proteins that present enzymatic activity with potential for industrial applications. Several inventions concern the cell components and biological compounds themselves, which offer interesting properties for use in biomedical applications. While studies that extend biological technologies to the marine environment are few, they hold great promise.[63]

81. Modern technologies such as molecular techniques have opened up vast areas of research for the extraction of biomedical compounds, including from the oceans and seas. The search for new metabolites from marine organisms has led to the isolation of around 10,000 metabolites many of which are endowed, in particular, with pharmacodynamic properties. In recent years, many bioactive compounds have been extracted from various marine animals, such as sponges, soft corals and sea slugs, and are being sold commercially by this developing industry.[62]

82. From discovery and recovery of an organism from its original habitat to practical application of the organism, several steps take place. To obtain a molecule of biotechnological interest, the succession of phases includes fermentation, extraction, purification, identification and validation of biological activities. Once validated, there may be an attempt to synthesize the molecule, totally or partially. Natural molecules may then become models that can be copied or modified to increase their effectiveness and/or to reduce their level of toxicity.

Biotechnology research

83. Biotechnology research includes applied programmes that promote the systematic collection, culture of and research on deep-sea organisms. This type of activity entails describing the genetic and physiological features of deep-sea organisms and assessing their potential for biomedical, industrial, environmental and other types of application.

84. Research in the area of biotechnology is being carried out in a number of universities and institutes all over the world, including the Extremobiosphere Research Center of the Japan Agency for Marine-Earth Science and Technology. In addition to its main mission, marine biological research, the Research Center aims at realizing practical industrial applications, including the production of useful substances by taking advantage of organisms' functions. In its Cooperative Research Project for Extremophiles, the Research Center seeks out contacts with corporations through the Deep-Sea Bioforum to provide proposals for experimental and joint research based on corporate needs and to accept researchers from the private sector for research projects. In addition, depending on corporate needs, it is also prepared to provide research facilities alone. The Research Center supports private sector research and development through this initiative by providing the results of its research as well as organism resources, genomes and other organism data. In order to support the needs of the private sector, in particular, the Research Center strives to realize ongoing development including the establishment of a genome bank of useful enzymes of new micro-organisms as well as deep-sea micro-organisms and the utilization of genome data analysis software.[59]

85. The Marine Bioproducts Engineering Center is a research centre of the National Science Foundation in the United States working in partnership between the University of Hawaii at Manoa and the University of California at Berkeley. The Center's activities span from discovery and screening of new organisms (including extremophiles) to the design of cultivation and purification systems, aimed at the production of marine bioproducts such as polyunsaturated fatty acids, antibiotics, antivirals and enzymes. The Center is structured in such a way as to bridge research activities with development of products and processes.[34] Undersea technology issues such as biotechnology and pharmaceuticals, sea-floor observing and sensing and vehicle development are also addressed by the National Oceanic and Atmospheric Administration of the United States in its Undersea Research Program. The Program is a unique national service that provides scientists with the tools and expertise they need to work in the undersea environment. Six regional research centres provide the scientific community with access to a wide array of underwater technologies, including submersibles, remotely operated and autonomous underwater vehicles, underwater laboratories and sea-floor observatories.[64]

86. The French Research Institute for Exploitation of the Sea also implements a programme on biotechnological transfer from deep water species for oncological, cardiovascular and tissue regeneration applications and for new anti-tumour strategies. This programme is conducted in cooperation with the University of Western Brittany, the Regional University Hospital Center in Brest, France, the French National Institute of Health and Medical Research, the French National Centre for Scientific Research and the Faculty of Odontology at the University of Paris V.[34]

87. The activities of the Australian Institute of Marine Science in the field of marine biotechnology are oriented towards the development of pharmaceutical and health-care products, agri-chemicals for crop protection and novel bioremediation agents for environmental protection. The Institute possesses one of the world's largest publicly owned collections of biotic extracts for bioactive chemical discovery, including material from around 20,000 marine macroscopic and microscopic organisms from around Australia. Since only an estimated 1 per cent of microbial diversity can be cultured using standard techniques, a large proportion of the microbiology effort at the Institute is spent on the development of novel culture and fermentation procedures.[34]

Biotechnology and its applications

88. Potential applications from marine-sourced material include pharmaceuticals, fine chemicals, enzymes, agri-chemicals, cryoprotectants, bioremediators, cosmaceuticals and nutraceuticals. A study of small-molecule new chemicals introduced globally as drugs between 1981 and 2002 showed that 61 per cent can be traced to, or were inspired by, natural products.[65] This figure rose to 80 per cent in 2002-2003. Compounds from natural products are considered to be more agreeable to consumers and two thirds of the anti-cancer drugs, for example, are derived from both terrestrial and marine natural products. Marine plants, animals and micro-organisms produce many unique biochemicals with great potential in treating diseases such as cancer and inflammatory disorders and may prove effective against HIV/AIDS. Marine-sourced material (for example, from sea water/sediment) has a higher chance of being successful commercially because of its mega-diversity.[65]

89. Although natural molecules are used by a variety of industries, they are mostly known for their application in the health sector. Biotechnology could lead to more preventive medicine based, inter alia, on genetics and targeted diagnostics. There are also a considerable number of new drugs that are the result of biotechnology, including anti-cancerous and anti-inflammatory agents. In addition, biotechnology may bring solutions to illnesses such as obesity, diabetes or neurological ailments. The role of biotechnology in the health-care industry is increasing and more and more partnerships are being created between biotechnology and pharmaceutical companies. From 22 in 1993, companies using biotechnology for the health sector now number 190, of which 13 have over $1 billion in sales each per year. In the United States, the approval of new drugs increased by 25 per cent in 2003, with some 300 biotechnology products based on natural compounds (see also para. 125, below).[34]

90. The area of cosmetology is also a growing economic sector. The most researched and in-demand products are in relation to anti-ageing and wellness agents. Biotechnology is also applied for the preservation of the environment and to dispose of non-biodegradable products and their toxic components. Micro-organisms (bacteria and micro-algae) and algae, can be used to fight pollution through bio-absorption or degradation of the pollutant agents. According to the mechanisms used, these processes are called, for example, bio-detoxification, bio-purification or bio-fixation. With regard to the environment, an important area of application relates to antifouling systems. There is a need for new non-toxic agents to protect equipment such as ships' hulls that do not have an adverse impact on marine flora or fauna. The possibility of cloning genes of biosynthesis enzymes is promising for genetically modified plants. In the area of agriculture and the food

industry, the possibility to exploit marine molecules as additives or texturizing agents has been recognized.[66]

Bioinformatics

91. Bioinformatics play a key role in the identification of candidate compounds for pharmaceutical and many other purposes in that it allows the rapid screening and selection of potential compounds for further testing. Since the technology and software associated with bioinformatics is increasingly being made available, including through open source software, bioinformatics is likely to change the way biotechnology research is conducted in the future. Trends suggest that there is a decreasing dependence on physical transfers of biological material in favour of electronic transfers. Bioinformatics is also likely to reduce research and development costs. It should be noted that the development of genomics has been favoured by the advent of biological informatics (bioinformatics), which can be loosely defined as the application of information technologies to biodiversity studies and their applications.[66]

Biotechnology and partnerships

92. Biotechnology is also emerging as a sector that increases cooperation between pharmaceutical companies and other biotechnology companies, academic researchers, non-profit institutions, medical centres and foundations. For example, Targeted Genetics, a company based in the United States, has entered into a collaboration with the International AIDS Vaccine Initiative, which aims at producing an affordable vaccine at an accessible cost for developing countries and that can also be commercialized in developed countries. The Millennium Ecosystem Assessment found that bioprospecting partnerships are most effective when supported by a range of international and national laws, as well as self-regulation measures such as codes of ethics.[66]

93. The nature of partnerships between biotechnology and pharmaceutical companies is also changing: instead of simply licensing out their products, biotechnology companies increasingly demand a partner role in most phases of the commercialization phase, including the sharing of royalties. For example, the Industry Sponsor Program of the Marine Bioproducts Engineering Center was set up to interact with industrial sponsors, with the aim of building a group of industry participants in the Centre's activities.[66]

6. Need for further technology development

94. As technology develops and becomes more widely available, scientific research in the extreme environments of the deep ocean is likely to increase. The best technology that could be developed for the study of biological diversity in environments beyond areas of national jurisdiction will vary from one ecosystem to the other and from mission to mission.[13] It should also take into account the need for characterizing biological diversity. Not only will this allow an expansion of knowledge on extreme ocean ecosystems in order to improve their conservation and sustainable use, but it will also provide opportunities to discover valuable resources and compounds of potential application to the food, industrial and pharmaceutical sectors.

95. Understanding the emerging areas of chemical signalling and signal transduction are important to enhance knowledge of bioluminescence, biofouling, biocorrosion, biofilm function and symbiosis. The results of such research can be used to develop anti-fouling and anti-corrosion materials as well as create an understanding of how microbes colonize surfaces.

96. Sensitive and accurate means of predicting the impacts of stressors on marine organisms are needed to strengthen indices of ecosystem health. This can be achieved through genome-enabled technologies and their application to real-time monitoring technologies to complement engineering and remote sensing initiatives. An ultimate goal would be to design, programme and build a system to carry out multiple tasks remotely.

97. A limited number of institutions worldwide own or operate vehicles that are able to reach areas deeper than 1,000 metres below the oceans' surface and can therefore be actively involved in deep seabed research. A larger number of institutions operate vehicles that are capable of reaching shallower depths. In either case, developing or operating deep-sea technology is a highly consuming exercise, financially as well as in terms of time.[34] It is estimated that the operation of a research vessel with its equipment may cost around $30,000 per day.[67] Scientific programmes on vent communities have been carried out by States that have access to the latest technologies for vent exploration and sampling. Such programmes could involve some of the ocean rim countries. These efforts, in accordance with the United Nations Millennium Declaration (General Assembly resolution 55/2), which prescribes that benefits from the use of new technology should be available to all, would promote more international cooperation in sharing of logistics in scientific exploration. Some of the programmes in waters beyond national jurisdiction could be linked to national programmes of countries for both work sharing and economic reasons. It is noted that, similarly, strong attempts are currently being made for sharing of technical and scientific know-how for better returns from different research programmes. The Census of Marine Life is one such example where ocean rim countries are encouraged to come together to understand biodiversity in the past, present and future timescales.

C. Economic issues

1. Tragedy of the commons and the free-rider problem

98. Many of the benefits derived from biodiversity and ecosystem services are characterized by economists as public goods, which means that rivalry among users and exclusivity of uses are low. For example, the services of oceans in regulating global climate are purely public goods, since one person's consumption does not interfere with another's. The conservation and sustainable use of public goods are problematic because there are no incentives to ensure their continued supply, since markets do not place a monetary value on their conservation and use, that is, they are non-market goods.[68]

99. Biological resources beyond national jurisdiction are resources shared by all States, also referred to in economic terms as "global commons". Markets treat shared resources as "free resources" available through an open access regime. Economic theory and evidence demonstrates that open access to such resources leads to inefficient exploitation to the point that no further surplus value can be

derived from these resources.[68] In fact, as the primary objective of market participants is maximization of individual wealth, the market's failure to place limits on the use of these resources will invariably result in their degradation.[69] Fishers who refrain from harvesting in order to promote conservation of a stock have no assurance that other fishers will not deplete the same stock.[68] From an economic point of view, it appears that the tools to deal with this problem include the assignment of property rights and the adoption of management rules to regulate access to the resources.[70]

2. Economic valuation of ecosystem services and biological resources

100. Two aspects of the valuation of ecosystem services and biological resources are often mentioned in literature. First, usually only market values are taken into account in decision-making regarding the use of marine biological diversity. Second is the issue of discounting. This procedure allows the conversion in mathematic terms of costs and benefits of a thing or activity at different points in time in the future to comparable costs and benefits at another point in time, such as in the present.[71] For example, while the cost of refraining from fishing in the present may appear great as compared to the benefit of harvesting in the future, the benefit of abundance of fish will be greater than it may appear now. The future benefit only looks small due to discounting, because it is so far away. Discounting is important for environmental policymakers as it could be used to reduce the urge to focus on the current or short-term cost of conservation and to avoid disregarding future and long-term benefits of maintaining biological resources. There is no agreement by economists on the discounting method to be used.

101. Lack of conservation measures for biological resources and ecosystems in general is also a result of gross undervaluation of biodiversity, especially of ecosystem services. There are many different values of biodiversity, some of which are not taken into account as modern economies focus on market transactions. As a result, goods and services that do not enter the marketplace and remain outside the traditional economic accounting system are largely overlooked.[71] Therefore, non-marketed ecosystem goods and services are not treated as a form of capital subject to depletion and depreciation. Countries depleting their natural resources can appear to be experiencing economic growth, but in reality the erosion of their natural wealth is not shown on their balance sheets.[71] Furthermore, as ecosystem goods and services are not traded in formal markets, they do not send price signals that warn of changes in their supply or condition, nor are people conscious of the role ecosystem services play in generating those ecosystem goods that are traded in the marketplace.[72] Thus, even if biodiversity is of great importance to society, its importance is not reflected in the marketplace and it appears that there is a lack of will to allocate adequate funding for its conservation. The lack of consideration for the effects of economic development on habitats and ecosystem services may create costs over the long term that may greatly exceed the short-term economic benefits of development. Hence, there is a need for policies that achieve a balance between sustaining ecosystem services while pursuing economic development.[72]

102. One way of achieving this balance is by placing a value on all the uses provided by ecological goods and services to enable policymakers to decide whether the resource is worth preserving, given the cost of its conservation. Calculating the total economic value of ecological goods and services is a difficult task. Economic values include direct use value, indirect use value, option value, bequest value and

other non-use value of ecosystem goods and services. Direct use values are those generated by ecosystem goods and services used directly by human beings. They include the value of consumptive uses, such as harvesting of food products and medicinal products, and the value of non-consumptive uses, such as the enjoyment of recreational activities that do not require harvesting of products. Indirect use values are those generated by ecosystem services that maintain the health of the ecosystem itself and provide outside benefits.[73] For example, marine ecosystems provide natural goods and services such as carbon storage, atmospheric gas regulation, nutrient cycling and waste treatment. Often the values of ecosystem services are not considered in commercial market analyses, despite their critical importance to human survival.[74] Option values are derived from preserving the option to use, in the future, ecosystem goods and services that may not be used at present. Many components of biodiversity that we do not use, or are unaware of at present, may in the future be used to meet human needs. For example, advances in molecular biology are leading to an acceleration in the use of genetic materials. The underlying genetic diversity of marine organisms therefore has tremendous potential economic importance that would not be realized by the loss of marine biodiversity. Bequest value is the value that captures the willingness to pay to preserve a resource for the benefit of future generations. Non-use values are values given to the enjoyment people may experience simply by knowing that a resource exists even if they never expect to use that resource directly themselves (existence value).[73]

103. The calculation of the total economic value offers a way to compare the diverse benefits and costs associated with ecosystems, by attempting to measure them and express them in a common denominator, typically a monetary unit.[73] It can also assist in determining whether the benefits justify the costs involved in the implementation of conservation measures. It should be borne in mind that the costs for conservation measures should include both the direct costs of implementing conservation measures and the opportunity costs of foregone uses. Furthermore, conservation measures may not conserve biodiversity in its entirety, depending on the measure adopted, and this must be taken into consideration when calculating the benefits. This cost-benefit analysis will allow for the identification and estimation of the impact that conservation measures will have.[73]

3. Economic value of biodiversity in areas beyond national jurisdiction

104. The economic value of biodiversity in areas beyond national jurisdiction is especially difficult to ascertain. One exercise found that marine systems contributed to around two thirds of the total value of global ecological services. It also showed that the areas beyond national jurisdiction had a very significant role to play. Although the exercise was theoretical and criticized by some scholars, it nevertheless provided an idea of the relative importance of the components of the biosphere.[75]

105. The commercial value or direct use value of ecosystem goods and services can be calculated to a certain extent by looking at the main commercial activities relating to biological resources currently being carried out in areas beyond national jurisdiction. For example, the commercial value of fisheries and bioprospecting can provide an idea of the direct use value of biodiversity, although the extent of bioprospecting activities currently being undertaken is unclear.

Fishing

106. In its publication *The State of World Fisheries and Aquaculture 2004*,[76] the Food and Agriculture Organization of the United Nations (FAO) reported that catches of oceanic species occurring principally in the high seas continued to increase. The share of oceanic catches in global marine catches reached 11 per cent in 2002.[76] In the same year, there was an increase in trade of oceanic species amounting to $5.9 billion. This state of affairs also causes increased pressures on fish stocks in areas beyond national jurisdiction. The actual value may be more than FAO estimates, as many catches are the result of illegal, unreported and unregulated fishing.

Bioprospecting

107. In order to provide an idea of the commercial value of bioprospecting beyond national jurisdiction, the broader context of the biotechnology sector needs to be considered[34] (see also paras. 77 to 93, above). As reported by the United Nations University (UNU) Institute of Advanced Studies,[34] according to the Ernst & Young global biotechnology market overview in 2004, the global biotechnology industry (not limited to marine biotechnology) supported almost 200,000 employees worldwide and generated revenues of up to $46.6 billion in 2003.[77] In connection with marine biotechnology, a 1996 study estimated that the worldwide sales of products related to marine biotechnology were expected to reach $100 billion by the year 2000.[78] Profits from a compound derived from a sea sponge to treat herpes were estimated to be worth $50 million to $100 million annually and estimates of the value of anti-cancer agents from marine organisms are up to $1 billion a year. However, it is not clear how many, if any, of these products use biological resources from areas beyond national jurisdiction. The UNU study demonstrates that, on the basis of an analysis of patent databases, bioprospecting for deep seabed genetic resources is taking place and related commercial applications are being marketed.[34] Furthermore, there are some patents involving genetic resources from the deep seabed where it is unclear whether practical applications for their use have been developed or not.[34] Bioprospecting activities may therefore create a market for genetic resources.

108. Bioprospecting, including the development and commercialization of products derived from genetic resources in areas beyond national jurisdiction involves very high costs (see paras. 83 to 90, above) and it is estimated that it may take approximately 15 years to produce results.[34] Furthermore, only 1 to 2 per cent of preclinical candidates actually become clinically produced.[34] Estimates for the costs of research and development to develop a new drug (not necessarily one related to marine biotechnology) presently range between $231 and $500 million to $800 million and $1.7 billion.[79] Due to the high costs involved, patenting is presently the main avenue for securing economic benefit as a return for investment.[80] The protection of inventions is granted for a limited period, generally 20 years.[81]

109. In the case of land-based bioprospecting, pharmaceutical companies have been willing to pay substantial sums for access to the regions where there is extensive inter-species competition and have made deals with host countries that involve giving them a royalty on the products that might eventually be based on this prospecting. In some cases, the terms of agreement for bioprospecting includes the

allocation of a fixed sum of money, to be used for conservation measures, in exchange for the right to receive samples from bioprospecting.[82] The UNU study highlights, however, that it appears that the extension of patentability of biological and genetic material has not been based on sufficient economic analysis and that the positive benefits expected from patent protection with regard to trade, foreign direct investment and technology transfer have not been evidenced.[34]

4. Possible economic tools for the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction

Environmental externalities

110. In the absence of suitable regulatory and enforcement mechanisms, people and companies can shift a part of the costs of their economic activities onto others.[68] For example, the environmental impacts resulting from their activities are often paid for by everyone affected, as there is often no liability as the damages may not be attributable solely to one person or company. As these costs are external to the costs people and companies pay to operate, they are in economic terms known as "externalities". It is important that those who exploit shared biological resources pay for the full cost of their acts, including any damage. Failure to do so will lead to overuse of the resources. The process for making economic actors recognize and assume responsibility for environmental and social costs is known as "internalizing externalities". This process should ensure that shared resources do not become over-exploited.

111. Some of the options for internalizing externalities are based on market approaches for the conservation of biodiversity. These approaches seek to change the users' behaviour through incentives, thus encouraging them to adopt more environmentally benign uses and discouraging them from engaging in harmful uses.[73] However, as the Millennium Ecosystem Assessment reported, there remain many challenges in implementing market-orientated approaches. These include the difficulties in obtaining the information needed to ensure that the buyers are indeed obtaining the services that they are paying for; the need to establish underlying institutional frameworks required for markets to work; and the need to ensure that benefits are distributed in an equitable manner.[3] Technical literature suggests several options for internalizing environmental externalities, some of which are outlined in the paragraphs below.

Elimination of perverse incentives

112. Perverse incentives such as subsidies to promote economic growth may discourage conservation. For example, perverse subsidies in fishing industries are incentives for fishers to overfish.[68] According to the Millennium Ecosystem Assessment report, fishery subsidies amounted to approximately $6.2 million in Organization for Economic Cooperation and Development (OECD) countries in 2002, or about 20 per cent of the gross value of production. The report added that many countries outside the OECD area also have inappropriate input and production subsidies.[3] Estimates of global industrial fisheries subsidies vary between $15 to $30 billion each year.[83] The Millennium Ecosystem Assessment highlighted the need to eliminate subsidies that promote excessive use of ecosystem services and, where possible, to transfer those subsidies to payments for non-marketed ecosystem services.[3] The issue of subsidies that lead to illegal, unreported and unregulated

fishing and fishing overcapacity was addressed by the General Assembly in its resolution 59/25 of 17 November 2004 and, more recently, at the sixth meeting of the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea (see A/60/99).

Reforming tax systems

113. Certain types of tax can be adopted to correct market failures. In particular, placing taxes on polluting materials, wastes, emissions and other activities and products, could internalize externalities. It has been suggested that such taxes could raise revenues while also raising economic efficiency.[68] Furthermore, Governments could impose mitigation and restoration requirements on both public and private projects to facilitate the restoration of ecosystem services that a project might affect.[68] Taxes could also be placed directly on resources, as a form of rent on resource extraction. The failure to collect resource rents from exploitation of common resources has generated excessive profit-seeking behaviour without proper consideration for the environment. Revenues from these charges would raise additional funds that could be used for conservation projects, while discouraging environmentally damaging activities.

Payment for environmental services

114. Payments for environmental services are based on the idea that those who provide environmental services should be compensated for doing so and that those who receive the services should pay for their provision.[84] Examples include pollution charges (paying those who minimize pollution) and eco-labelling and certification schemes for environmentally friendly goods in order to allow consumer preferences to be expressed through markets (for example, dolphin friendly tuna).[3]

Property rights over the "commons"

115. Some experts believe that replacing open access with some form of property rights could stimulate economic measures for protection of ecosystems.[68] This enables the creation of markets, based on the premise that holders of these rights will maximize the value of their resources over time, thereby optimizing biodiversity use, conservation and restoration.[85] In the case of resources beyond national jurisdiction, these property rights would have to be in conformity with the existing legal framework.

116. Licences that establish a form of property rights and encourage sustainable use, rather than serving only to collect revenue, act as incentive mechanisms. The longer the term of the licence, the more likely the user will have a long-term interest in the area and therefore an incentive to use the resources sustainably, that is, self-regulation. Instruments that promote self-regulation may be useful, especially in areas beyond national jurisdiction where it is more difficult to enforce protection measures.[86]

117. By assigning property rights within the existing and future management regimes established by the Regional Fisheries Management Organizations, systems such as individual transferable quotas and cap-and-trade systems could be set up to promote the conservation and sustainable use of the resources in question by promoting a sense of ownership by all stakeholders. Shares and quotas can be transferred, divided and bought or sold. They can also be leased or mortgaged, like

other types of property rights.[87] Limits can be placed on their transferability to ensure equity, if necessary. In the example of fisheries, management regimes for commercial fisheries can be shifted from effort control to transferable harvest quotas, defined as shares in the total allowable catch. By securing harvest shares in the total allowable catch, fishers are provided with an economic incentive to build or rebuild stocks to optimum levels since they are assured a fair share in the derived benefits.[68]

118. The establishment of appropriate forms of property rights, in conformity with the international legal regime, could also constitute a basis for the development of exchange markets. Exchange markets have been established for environmental commodities, such as credits for sulfur dioxide, the gas largely responsible for acid rain. Other examples include markets for nitrogen oxide, wetland mitigation credits, particulate matter and volatile organic compounds. The biggest emissions market, however, for carbon dioxide, the gas believed to be most responsible for global climate change, is still in its earliest phases. The carbon market, which follows the emissions trading approach of the United Nations Framework Convention on Climate Change[88] and its Kyoto Protocol,[89] is rapidly becoming a global market. Similar types of markets could be envisaged to stimulate biodiversity conservation.

D. Socio-economic issues

119. Knowledge about the socio-economic importance of marine biological diversity beyond national jurisdiction is necessary in order to formulate policies dealing with the conservation and sustainable use of those resources. However, preliminary research indicates a lack of relevant in-depth studies. This dearth of information can be explained by various reasons, including the fact that interest in marine biodiversity, and specifically marine biodiversity in areas beyond national jurisdiction, is relatively new.

120. In addition, difficulties arise when trying to assess the socio-economic benefits of marine biodiversity, since a comprehensive evaluation of marine biodiversity is, for the moment, impossible owing to a lack of basic knowledge. It is difficult to relate the provision of goods and services to biodiversity, as the link between biodiversity and ecosystem functioning is not clearly understood.[90]

121. Despite these difficulties, it is generally understood that ecosystems, including marine ecosystems in areas beyond national jurisdiction, play a key socio-economic role. Socio-economic goods and services provided by living marine environments include employment, food, raw materials, leisure and recreation, cultural services, information services (genetic and medicinal resources), education, research, aesthetic, inspiration and other non-use values and option-use values. Thus, marine ecosystems not only provide us with an array of goods and services that are essential to a healthy environment, but they also contribute significantly to food security and global employment.[91] As a consequence, their degradation often causes significant harm to human well-being, including livelihoods and health.[91] Two examples from marine ecosystems clearly illustrate the above. The first example is the collapse in the early 1990s of the Newfoundland cod fishery because of overfishing, which resulted in the loss of tens of thousands of jobs and cost at least $2 billion in income support and retraining. In the second example, the total damages for the Indian

Ocean region over 20 years resulting from the long-term impacts of massive coral bleaching in 1998 are estimated to be between $608 million and $8 billion.[91]

122. Socio-economic goods and services are easily identifiable in the cases of fisheries and marine genetic resources. Fisheries represent an important source of employment and income. FAO has estimated the number of individuals earning an income from primary sector employment in fisheries and aquaculture at around 38 million in 2002.[76] Fish also represents a valuable source of micronutrients, minerals, essential fatty acids and protein in the diet of people in many countries. Overall, fish provides more than 2.6 billion people with at least 20 per cent of their average per capita intake of animal protein.[76] The declining state of capture fisheries threatens to reduce a cheap source of protein in developing countries[91] and also has major implications for artisanal fishers and the poor.[3] The conservation of fishery biodiversity is the sine qua non condition for the existence of fisheries as an economic activity and for the livelihoods of many fishing communities. Nonetheless, there are few socio-economic studies available and these aspects tend to be underrated or neglected in the debates regarding management of high-seas fisheries.[92]

123. The analysis of future population growth trends indicates a need for the adoption of conservation measures that will take into account the socio-economic impact of marine biological diversity beyond areas under national jurisdiction. According to United Nations estimates, by 2050 the world population is projected to reach 9.1 billion persons, 2.6 billion more than in 2005. Most of this growth will be in developing countries.[93] Lastly, projections show that most of the population growth will be coastal,[94] thus putting additional pressure on marine ecosystems.

124. In consequence, world total demand for fish and fishery products is projected to expand by almost 50 million tons to 183 million tons in 2015.[94] On the other hand, world capture production is projected to stagnate,[94] and demand would tend to exceed potential supply.[94] According to the latest projections of FAO,[76] there would be a global shortage in the supply of fish in the future, the overall effects of which would be a rise in the price of fish.[95] Reduction in fish supply would also have negative effects on food security and livelihoods among other things.

125. As regards genetic resources found in marine areas beyond national jurisdiction, they are expected to become an important socio-economic issue because of the social gains that would result from the numerous products derived from them (see also paras. 88 to 90, above). The pace of discovery of new species, as well as of products that are potentially useful to pharmacology, is higher for marine and microbial life than for terrestrial organisms.[34] The pharmaceutical industry has identified a number of uses for these new species and products. Marine drugs obtained from these and other organisms could be used as antioxidants, antifungals and antibiotics and to fight diseases such as HIV/AIDS, cancer, tuberculosis, malaria, osteoporosis, Alzheimer’s and cystic fibrosis. Some of these drugs are at the preclinical development phase.[34] Much hope is placed in drugs based on marine organisms in light of the shortcomings of current drugs.

126. Other industries could also benefit from discoveries made in marine environments beyond national jurisdiction. Among the many examples of commercially useful compounds that have been discovered is a glycoprotein which functions as the “anti-freeze” that circulates in some Antarctic fish, preventing them from freezing in their sub-zero environment. The application of this glycoprotein in

a range of processes is being considered, including to increase the freeze tolerance of commercial plants; to improve farm-fish production in cold climates; to extend the shelf-life of frozen food; to improve surgery involving the freezing of tissues; and to enhance the preservation of tissues to be transplanted.[34]

127. In sum, potential uses of marine organisms are numerous. The possibility that certain types of bacteria could be useful in dealing with marine pollution, especially oil spills, is currently being investigated. Furthermore, oceans have been characterized as an infinite reservoir of high-quality food, anti-biofouling and anti-corrosion substances, biosensors, biocatalysts, biopolymers and other industrially important compounds.[78]

E. Environmental issues

128. The high seas and the ocean floor beyond national jurisdiction are the least explored areas on the planet. They are believed to contain vast energy and mineral resources and to shelter major biological resources. Furthermore, the oceans in general, including areas beyond national jurisdiction, play a key role in the biogeochemical cycles that regulate oxygen and carbon dioxide in our atmosphere and hence global climate and the very continuation of life on Earth. However, marine biodiversity and ecosystems in these areas are increasingly affected by a wide array of anthropogenic stresses.

129. As pointed out in the preceding sections of the present report, the conservation of marine biological resources and their sustainable use are closely interrelated. Therefore, potential adverse impacts caused by various ocean uses on marine biodiversity need to be identified and managed.

130. The present section will outline the main current and foreseeable impacts on marine biodiversity in areas beyond national jurisdiction. Human activities already affecting marine biodiversity must be properly managed in accordance with existing legal regimes in order to minimize their impact and to ensure sustainable use of marine biodiversity. Furthermore, emerging activities should be assessed for possible impacts, in order to enable the development of an appropriate regime to ensure that biological resources are not destroyed and that any development is sustainable. Activities and phenomena that could have an impact on marine biodiversity include fishing, climate change, pollution, the introduction of alien species, waste disposal, mineral exploitation, anthropogenic underwater noise, marine debris, scientific research, carbon sequestration, tourism and pipelines and cables.[96]

131. To meet these environmental challenges, more research is needed to assess the biogeography of the deep sea floor biota and the distribution of key habitats as well as the impacts of anthropogenic stresses on deep-sea biota. The few well-established studies on the deep-sea and open-ocean ecosystems should be continued.

1. Impacts of fishing

132. By and large, the dominant human-caused direct effect on fisheries ecosystems is fishing itself,[97] thus making the global impact of fishing activities on marine ecosystems a major concern for the international community. As an anthropogenic activity in the marine environment, fishing affects marine habitats worldwide and

has the potential to alter the functioning and state of marine ecosystems, in particular vulnerable ecosystems as well as the biodiversity associated with them. Compounding the effects of fishing activities on the marine environment, unsustainable fishing practices, such as over-exploitation of fishery resources, illegal, unreported and unregulated fishing, the use of non-selective fishing gear, as well as destructive fishing practices and techniques in fishing operations, have aggravated the ecosystem effects of fishing activities and made such fishing practices the single greatest risk to vulnerable marine ecosystems and associated biodiversity.

133. According to the most recent information from FAO, reported landings of fish have continued to grow, albeit at a lower rate than in preceding decades. They are now oscillating around 80 million tons. If China, a large producer, is excluded, the production of the rest of the world decreased by about 10 per cent since the mid-1980s.[76] Reported landings of distant-water fishing have also been decreasing since the mid-1980s, after a plateau of 20 years at 7 million tons. As a percentage of total world landings, they have been sharply declining since 1970 with the extension of exclusive economic zones.

134. Fishing pressure on stocks is generally high. While close to 25 per cent of stocks are moderately or under-exploited, 52 per cent of the stocks are fully exploited and 25 per cent of them are over-exploited, depleted or recovering. Considering stocks for which information is available, overfishing appears widespread and the majority of stocks are fully exploited. The percentage of stocks exploited at or beyond their maximum sustainable levels varies greatly by area. Assessments regularly conducted on the 17 major tuna stocks indicate that close to 60 per cent requires stock rebuilding and/or reduction of fishing pressure. Analysis of FAO statistics indicate that overfishing has increased from 1950 to 1990 and has been stable since 1990 at about 25 per cent. A small proportion of stocks appear to be recovering. Top predators, medium-level predators, as well as sub-surface pelagic and deep-sea resources, show similar trends. In addition, overfishing tends to lead to decline in these large predatory fish so that the relative numbers of low trophic-level small fish and invertebrates increases. This also leads to a phenomenon known as "fishing down marine food webs", whereby second-level marine life preyed upon by the fish at the top of the trophic levels are increasingly used for human consumption, thus causing further disruptive effects on the whole food chain.

135. The World Summit on Sustainable Development called for recovery of overfished stocks by 2015. Considering the stagnation observed, a very serious change is required if the goal is to be reached.[98] As to the impact of fishing on dependent and associated species, what is required is the implementation of existing measures, both legally binding and recommendatory, which mandate States to eliminate unsustainable fishing practices and develop selective, environmentally friendly and cost-effective fishing gear and techniques, as well as the application of the ecosystem approach to fisheries management.

Pelagic fisheries

136. In high-seas pelagic fisheries, catches of tuna and tuna-like species have been increasing throughout the years. The rate of increase has been much higher in comparison to other epipelagic species and tuna catches are still growing at a rapid pace, while those of other species have decreased in recent years.[99] Trends in catch

per unit effort over nine oceanic areas indicate that tuna and billfish biomass has declined by approximately 90 per cent, with a shift towards dominance by smaller pelagic species.[100] Reduction of fish stocks below 30 per cent of their unfished biomass is generally not considered sustainable.

By-catch

137. Pelagic open-ocean fisheries seriously affect several groups of species, such as whales, sharks, seabirds, dolphins and turtles, whose biological characteristics render them vulnerable to depletion or even extinction. Oceanic sharks, primarily blue (*Prionace glauca*), oceanic whitetip (*Carcharhinus longimanus*), and silky shark (*Carcharhinus falciformis*), are taken in large numbers as by-catch of longline fisheries and their highly prized fins are removed. This catch is largely unreported and unregulated.[101]

138. Seabirds are taken as incidental by-catch by pelagic longliners, most notably those targeting tuna and toothfish in the Southern Ocean.[102] Albatrosses are particularly vulnerable, as they are long-lived and slow-breeding. Modifications to longline equipment and deployment techniques as well as other mitigation measures are being implemented to reduce seabird by-catch. FAO has adopted international plans of action for both seabirds and sharks that should assist in reducing the incidental catch of these two species in longline fisheries.

139. All seven species of sea turtle are endangered and some are on the verge of extinction. Among the major threats to sea turtles are incidental capture and drowning during commercial fishing with gill nets, shrimp nets, trawls, set nets, traps and longline equipment. Modifications to fishing equipment, such as the use of circle hooks and whole-fish bait, could substantially reduce sea turtle mortality.[103]

140. The death of large numbers of dolphins caught as by-catch by purse-seiners targeting tuna in the late 1960s alarmed the public and led to government action to modify net design and fishing practices, which have reduced dolphin by-catch to a level of mortality considered to be sustainable. However, by-catch problems remain for juvenile tuna, endangered turtles and other non-target species attracted to logs and other floating objects associated with some tuna schools.

Drift nets

141. Drift gill nets up to 60 kilometres in length were used to fish for dispersed species of salmon, squid, tuna and billfish on the high seas until General Assembly, in its resolution 46/215 of 20 December 1991, called on the international community to ensure that a global moratorium on the use of large-scale pelagic drift-net fishing on the high seas was implemented. An estimated 40 per cent of the catch by this type of equipment was unwanted catch, including sea turtles, seabirds and marine mammals.[104] Although the moratorium has been widely observed, recent reports indicate that some drift-net fishing may still occur, particularly in the Mediterranean Sea.[105]

Deep sea fisheries

142. Until 1975, catches of deep-water species were relatively small, ranging between 2 and 10 per cent of the total oceanic catches. Since the late 1970s, however, their contribution has consistently been greater than 20 per cent, reaching

30 per cent of the total oceanic catches in recent years. The life history attributes of deep-sea fish species (long lifespan, high age at maturity, low natural mortality, low fecundity, low levels of recruitment, high inter-annual variation in recruitment and aggregation over small areas) make them highly vulnerable to depletion by fishing. A reduction of adult biomass by fishing may have a stronger negative effect on deep-sea fish species than for species living on the shelf.[107] This would mean that exploited populations of deep-sea fish species are likely to reduce quickly and take decades, or longer, to recover. For instance, some species, such as orange roughy, become more vulnerable by aggregating on isolated topographic features, such as seamounts.

143. Deep-trawl fisheries, which target bottom fish species on the high seas, are largely unregulated and unreported fishing activities. Often important biological information relevant to the conservation and management of target species has simply not been collected prior to commencement of the fisheries or following the exploitation of specific deep-sea areas. Deep-water fisheries tend to be more intermittent, less predictable and so less manageable than shallow-water fisheries. They are often characterized as being "serial" or "sequential depletion" fisheries, because fishing vessels find and deplete a stock then move on and repeat the practice.[108] Altogether, it is believed that 62 deep-water species have been fished commercially. Owing to their biological characteristics, most target species are easily over-exploited. Stocks are typically depleted within 5 to 10 years. Some scientists believe that all deep-sea fisheries present in 2003 will be commercially extinct by 2025.[109]

144. In addition, bottom fisheries are known to induce considerable damage to benthic habitats and other underwater features.

145. Deep-water fisheries often target features, such as seamounts and ridges, where food inputs advected by topographically enhanced currents support benthic communities dominated by hard and soft corals, sponges and other suspension feeders. Bottom trawls pick up these benthic communities as by-catch or otherwise reduce them to rubble.[110] Given the slow growth of deep-water corals and uncertain rates of recruitment, the re-establishment of deep-water coral reefs will probably take centuries to millennia. Continued unrestricted fishing could destroy reefs in many areas, leading to extinction for the large proportion of seamount species with highly restricted distribution. Management of bottom trawling has been considered by the General Assembly (see resolution 59/25) and control measures have been taken by some States and regional fisheries management organizations. The issue was also discussed at the sixth meeting of the Informal Consultative Process (see A/60/99).

146. In March 2005, the FAO Committee on Fisheries called on member States conducting deep-sea fisheries on the high seas, individually and in cooperation with others, to address adverse impacts on vulnerable marine ecosystems and to manage sustainably the fishery resources being harvested, including through controls or limitations on new and exploratory fisheries.[111]

2. Whaling and whale falls (sunken whale carcasses)

147. Since the 18th century, whaling has depleted most populations of the larger baleen whale species, eliminating some, such as the North Atlantic grey whale, and driving many others to the verge of extinction. Since the International Whaling

Commission moratorium on commercial whaling, several species now appear to be recovering, although the recovery baseline remains controversial.[112] Current major threats to some populations of whales and other cetaceans are from by-catch, ship strikes, anthropogenic underwater noise, entanglement in fishing equipment and alteration of habitats.

148. The dramatic reductions in populations of great whales could result in species extinctions in seabed ecosystems.[113] Sunken whale carcasses harbour species of invertebrates that must colonize a whale fall to complete their life cycles.[114] Because major habitat loss leads to species extinction, loss of 65 to 90 per cent of whale-fall habitat may well drive 30 to 50 per cent of the whale-fall species extinct.[115]

3. Impacts of climate change

149. Climate change has potentially a great impact on the open-ocean and deep-water environment. The earth has warmed by approximately 0.6° centigrade in the past century and since 1976 the rate of warming has exceeded that at any time during the last 1,000 years.[116] During the past 50 years, a general warming trend has also been documented for large portions of the oceans. One of the consequences of that development for ocean ecosystems could be the partial or complete shutdown of global thermohaline circulation, predicted by several global circulation models.[117] This would alter the currents, oxygenation and temperature of the deep ocean, as well as the productivity of near-surface waters. A recent study predicted that a shutdown of the North Atlantic overturning would cause plankton biomass to decline by more than 50 per cent and global ocean productivity to decline by about 20 per cent.[118] Biogeochemical models generally predict that climate warming will enhance ocean stratification and decrease overturning and hence lead to diminished ocean productivity.[119]

150. The influences of changing climate on regional patterns of circulation, upwelling, production and community structure in the surface ocean are difficult to predict, in part because the ocean-atmosphere system exhibits natural patterns of regional and basin-scale variability over time scales of years to at least several decades.[120] These mini-climate changes induce substantial alterations in the patterns of marine primary production, the structure of phytoplankton, zooplankton, nekton and megabenthic communities, fish recruitment, fisheries yields and the regional abundance and reproductive success of seabirds and marine mammals.[121] While these natural changes obscure the effects of anthropogenic global warming, they clearly demonstrate that ocean ecosystems are highly sensitive to subtle changes in climate and that regional patterns of ecosystem structure, production and biodiversity will be altered substantially as the climate warms.

151. The most dramatically affected marine ecosystems in international waters are likely to be those associated with sea ice. The structure and dynamics of sea-ice communities are linked to seasonal freezing and thawing of seawater and to the steep physical gradients resulting from phase changes and brine formation around sea-ice margins.[122] Sea-ice biota exhibit unique adaptations to their solid/liquid habitat. Sea-ice margins are zones of enhanced productivity and the focuses of population growth, feeding and/or reproduction for a diverse range of organisms, including ice algae, krill, penguins, pinnipeds, cetaceans and polar bears. The size of sea-ice zones and the length of their margins are likely to decrease dramatically

with climate warming, shrinking habitats and threatening the biodiversity of these fragile ecosystems.

152. The fluid nature and great spatial scales of the ice-free upper ocean are likely to allow marine organisms to move to new areas in response to climate changes, with the result that local community structure and function may change; but extinctions of pelagic species may seem unlikely in international waters as the climate warms. The ranges of some species will be compressed and others expanded and some populations will lose essential linkages to particular oceanographic structures, such as fronts and upwelling zones, disrupting life cycles and yielding population, and possibly species, extinctions. This has already happened in the North Sea.[123] Furthermore, continuing fishing pressure on stocks dwindling as a result of climate change, in combination with the synergistic effects of multiple stressors, such as pollutant loading, could very easily drive certain open-ocean species, including non-target species affected by indirect fishing impacts, over the edge to global extinction.[124] This threat is probably greatest for species placed high in marine food webs, whose populations often show pronounced fluctuations in response to natural climate variability. In addition, elevated atmospheric CO_2 concentrations will most probably increase ocean acidity, which may impede calcification processes in a broad range of open-ocean phytoplankton and zooplankton, as well as corals, potentially altering pelagic ecosystem function and biodiversity in the open ocean.[125]

153. Deep sea-floor and mid-water communities will also be affected by climate change. In particular, many deep sea-floor biological processes appear to be linked to the quantity and quality of food material sinking from the euphotic zone, as well as to the variations in sinking flux.[126] Climatic changes resulting in decreased near-surface productivity and deep organic-carbon flux may lead to reductions in benthic standing crops, bioturbation rates and depths and carbon sequestration in deep-sea sediments.[127] However, the resulting changes in ecosystems are very difficult to evaluate until ranges, population structure and rates of gene flow at the deep-sea-floor, both on slopes and in the abyss, are much better known. Healthy ecosystems have a significant capacity both to resist and to recover from periodic disturbances, such as population collapses owing to shifts in currents and changes in sea temperature. Unhealthy ecosystems have a limited capacity to do so. Therefore, the maintenance of ecosystem resilience through the minimization of other major human-induced impacts on marine ecosystems and species would enhance adaptation strategies to climate change.

4. Impacts of non-point source pollution

154. Heavy metals, especially mercury, and halogenated hydrocarbons, such as polychlorinated biphenyls (PCBs), dichlorodiphenyl trichloroethane (DDT) and similar compounds, are semi-volatile and thus are globally distributed via the atmosphere and largely deposited in the oceans. About 80 per cent of PCBs and 98 per cent of DDT and related compounds enter the ocean through the atmosphere.[128] Relatively insoluble in water but lipophilic, they are rapidly taken up by the marine biota, transported to deep water and concentrated in long-lived top predators, where they then become available to humans. A number of highly persistent pollutants appear to be at critical or near-critical levels in deep water organisms, as well as in marine mammals and turtles. These also pose risks to human health. The mercury content of tuna, swordfish, orange roughy and similar

fish now poses a health risk, particularly to women of childbearing age. Environmental concentrations of mercury have tripled in historic times, but production is now being reduced. Use of DDT and PCBs has largely been phased out, but these are highly persistent pollutants.

155. The potential pollutant effects on the behaviour, physiology, genetics and reproduction of open-ocean operations and deep-sea biota remain very poorly known.[129] In addition to metals and chemicals transported from the land to the sea through the atmosphere, diffuse discharges of oils, chemicals, sewage and refuse directly from land-based activities and from ships can have a cumulative impact on the general pollution load of the oceans. However, all of the above effects can be addressed through implementation of the relevant provisions of UNCLOS, proper national management of land-based activities, as recommended in the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, and more effective enforcement of existing shipping regulations.

5. Effects of shipping, including species introduction

156. Ships transport approximately 90 per cent of world trade. Intentional and accidental discharges can have serious effects on biological resources, although this could be avoided by strict enforcement of international regulations adopted by the International Maritime Organization (IMO). Accidental oil spills from tankers can have a catastrophic local impact on marine ecosystems. If large spills occur near oceanographic features where biological activity is concentrated, such as in convergence zones, near sea-ice fronts and in polynyas (areas of open water surrounded by sea ice), they could have substantial negative effects on marine biodiversity. Such effects may be particularly persistent at high latitudes, where low temperatures impede the microbial breakdown of toxic hydrocarbons. Ships may also cause harm to marine organisms and their habitats through physical impact, including ship strikes, in particular with whales, as mentioned in paragraph 147 above.

157. Since 1914, more than 10,000 ships have sunk to the sea floor as a result of warfare and accidents.[130] Although the impact of shipwrecks has not been extensively studied, they may generate reducing habitats[131] and release petroleum hydrocarbons and other pollutants.[132] The scale and duration of such effects merit further study.

158. Ships also affect biodiversity through the release of alien invasive species transported in ballast water and in fouling assemblages on ship bottoms.[133] The threats to biodiversity from invasions of alien species in the high seas are believed to be substantially less than in coastal waters, because natural ocean circulation causes biotic exchanges over vast scales. However, the open ocean contains distinct biogeographic provinces (or biomes), separated by land masses, underwater topography and major circulation features and characterized by distinct production cycles.[134] Consequently, species introduction between ocean basins with similar oceanographic regimes could have adverse effects on biodiversity in the open ocean.[135] This issue is being addressed through the International Convention for the Control and Management of Ships' Ballast Water and Sediments.[136]

6. Anthropogenic underwater noise

159. Noise levels in the ocean are increasing dramatically from human activities such as shipping (propellers, machinery and hydrodynamic flow over the hull of ships); oil and gas exploration (explosives and seismic air guns), scientific research and military operations (sonar). Recent estimates suggest that in some ocean basins such as the North Atlantic, the level of ocean noise is doubling every decade. Research using large-scale underwater listening systems reveals that many large cetaceans (including endangered species of balaenopteridae), under natural conditions, communicate and orient acoustically over scales of thousands of kilometres in the ocean, for example detecting topographic features more than 500 kilometres away. The increasing levels of anthropogenic noise in the oceans constitute smog for acoustically active species, obscuring acoustic signals potentially critical to migration, feeding and reproduction. Other observed effects include stranding and displacement from habitat, tissue damage and mortality (see A/59/62/Add.1, para. 220). Fish are also damaged by noise and this may reduce fish catches. Better assessment of the impacts of underwater noise on acoustically sensitive oceanic species, including both fish and cetaceans, as well as consideration of noise abatement strategies, are needed. In the past two years, concern regarding marine noise has been expressed in meetings of the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas, the International Whaling Commission, the European Parliament, the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area and the World Conservation Union.[137] However, there is no international instrument directly aimed at controlling underwater noise. The sixth meeting of the Informal Consultative Process has proposed that the General Assembly should request further studies and consideration of the effects of ocean noise on marine living resources.

7. Effects of waste disposal

160. The high seas have been a dumping ground for conventional and chemical weapons,[138] low and intermediate-level radioactive waste and other types of hazardous materials. Although dumping of hazardous waste is prohibited under the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Convention) and regional agreements, there have been proposals to dump sewage sludge, dredge spoils and other hazardous wastes in deep ocean trenches. Such disposal could cause future environmental concerns if the London Convention and its 1996 Protocol are not properly implemented and enforced.

8. Carbon sequestration

161. Because of the effects of rising atmospheric CO_2 concentrations,[139] some States are considering the large-scale sequestration of CO_2 in the ocean. Detailed analyses of these sequestration strategies and their impacts on the ecosystem will be available in September 2005 with the release by the Intergovernmental Panel on Climate Change of a special report on carbon dioxide capture and storage and the planned publication in 2006 in the Journal of Geophysical Research of the results from the UNESCO symposium on the ocean in a high CO_2 world.

162. One proposal with potentially far-reaching implications for open ocean ecosystems is to drawdown atmospheric CO_2 by fertilizing large areas of the open

ocean with iron.[140] However, biogeochemical models indicate that iron fertilization, even if carried out on a massive scale, may have only a modest impact on atmospheric CO_2 levels (17 per cent or less) and that the CO_2 would return to the atmosphere within decades.[141] Furthermore, iron-enrichment studies in equatorial and antarctic waters indicate that even short-term iron enhancement can dramatically alter community structure and potentially, carbon export, in iron-limited ecosystems.[142] The efficacy and environmental impacts of such projects should be adequately assessed.

163. Direct injection of CO_2 into the deep ocean is being considered for ocean depths greater than 500 metres, where CO_2 may exist in liquid or solid gas-hydrate form.[143] The principal impact on mesopelagic and benthic ecosystems is likely to be reduced pH values and, for those organisms directly in the path of the CO_2 plume, physiological stress caused by an elevated partial pressure of CO_2. If industrial-scale disposal of CO_2 were to occur in the deep sea, it is clear that few organisms in the direct path of the concentrated plume would survive. Far-field impacts on biodiversity are also expected, with the spatial scale of effects depending on the size of the injection operation and the nature of advection and eddy mixing processes in the injection zone. Because sensitivities to elevated CO_2 concentrations can vary substantially among major mid-water and benthic taxa, community structure and biodiversity levels could change over areas substantially larger than those directly affected by the toxic plume itself. Substantially more research is required to evaluate fully the potential local and regional impacts of CO_2 injection in the deep ocean.[144]

164. Most recently, the Scientific Group of the London Convention has studied proposals for carbon sequestration in geological structures under the ocean floor.[145] While it is intended that the CO_2 would be trapped in these structures, if it escapes, the consequences could be similar to those of deep injection.

9. Energy and mineral exploration and exploitation

165. Exploration and exploitation of the substantial mineral and energy resources on the seabed could potentially have significant effects on high-sea and seabed ecosystems. However, proper regulation and management could prevent or mitigate these effects. Under UNCLOS, the International Seabed Authority has the authority to regulate mineral exploration and exploitation in the International Seabed Area and the protection of the marine environment from harmful effects that may arise from activities in the Area, as defined in the Convention.

Oil and gas exploration and exploitation

166. Large oil reserves have been discovered in water depths exceeding 1,000 metres on several continental margins,[146] generating substantial interest in the expansion of oil and gas production in the International Seabed Area. Environmental effects of oil and gas production are reasonably well-studied at shelf depths and many such effects should be qualitatively similar in the deeper waters. However, the relatively low productivity and slow growth rates of high-seas species and low current velocities in many deep-sea habitats mean they will be more sensitive to disturbance and recover more slowly.[115] Drill cuttings and drilling mud may pose a significant risk to marine life[147] through physical smothering, organic enrichment and chemical contamination by hydrocarbons, heavy metals, special

chemicals and sulphides of the benthos near the cutting source.[147] Experimental studies indicate that drilling muds can inhibit the settlement of marine invertebrate larvae. The environmental impacts of effects drilling should be assessed and ways found to mitigate them.

Methane hydrates

167. Methane hydrates in the deep seabed are likely to be exploited for energy in the future, as they potentially contain twice as much carbon as all other fossil fuels combined.[143] Once exploitation technology for methane hydrates is better established, environmental impact assessments should consider the potential impacts on the novel biota associated with hydrates.

Polymetallic nodule mining

168. Polymetallic nodules, which abound on the abyssal plain in the Area,[148] are a potential source of copper, nickel, manganese and cobalt.[143] The most obvious direct consequence of mining would be the removal of the nodules themselves, which would require millions of years to regrow.[149] Nodule mining would thus essentially permanently remove the only hard substrate present over much of the abyssal sea floor, causing habitat loss and local extinction of the nodule fauna, which differs markedly from the sediment fauna.[150]

169. Because polymetallic nodules are imbedded in sea-floor sediments, nodule mining activities also will inevitably remove much of the top five centimetres of sediment, potentially redistributing this material into the water column.[130,151] Most sediment-dwelling animals in the path of the collector, with the possible exception of nematodes, will be killed immediately and communities in the general mining vicinity will be buried under varying depths of sediment.[130,152] Because abyssal nodule habitats are dominated by very small and/or fragile animals feeding on a thin veneer of organic matter near the sediment-water interface, it has been postulated that the mechanical and burial disturbances resulting from commercial-scale nodule mining will be locally devastating.[153]

170. Nodule mining is also likely to involve discharge of nutrient-rich deep-ocean water, sea-floor sediments and nodule fragments into the surface and/or deep layers of the water column. The location and scale of such discharges will depend on mining technology but they could affect large areas — hundreds to thousands of square kilometres at any given moment. The injection of nutrients, particles and heavy metals from nodule mining into the euphotic zone has the potential to alter dramatically light and productivity regimes, food-web structure, particle export and heavy-metal loading within the zone of influence of the plume. The ecological impacts of nodule discharge on mid-water communities, including those in the oxygen minimum zone, are even more difficult to predict because of extremely limited understanding of the structure and function of these ecosystems. As mining technologies and discharge rates and patterns become better constrained, process studies to address the nutrient and toxicant loading effects of mining discharges will be essential to evaluate threats to biodiversity in the water column. Similar effects from discharges into the water column are likely to occur with mining of polymetallic sulphides and cobalt crusts.

171. To predict and manage commercial mining impacts fully, substantially more information is required concerning (a) species ranges and rates of gene flow for both

the sediment and nodule biota; (b) sensitivity of sea-floor biota to sediment burial; and (c) the spatial-scale dependence of recolonization in abyssal benthic communities. The International Seabed Authority has sponsored a number of scientific studies and workshops on the seabed environment and the potential effects of mining as the basis for regulations that are protective of the environment.

Polymetallic sulfide mining

172. Polymetallic sulphide deposits at hydrothermal vents in the deep sea have recently attracted commercial interest as sources of gold, silver, zinc, lead, copper and cobalt.[143] These deposits are generally associated with mid-ocean ridge or back-arc spreading centres and often occur in the Area. Current commercial interests focus on the massive sulphides around inactive hydrothermal sites at bathyal depths in the territorial waters of New Zealand and Papua New Guinea.[154] Mining of massive sulphides at active vents would undoubtedly be harmful to the local vent communities. However, the impacts of vent mining would differ dramatically from those of nodule mining because new vents would probably form quickly following mining and recolonization of local vent sites, once mining ceased, is expected to proceed rapidly.[155] However, if sulphide mining targeted much larger areas or isolated geologic features with potentially endemic fauna such as calderas on seamounts, there could be a significant risk to biodiversity. Any mining operation for deep-sea massive sulphides should be preceded by a detailed study of the composition and broad-scale distribution of the vent and non-vent biota of the region and at the targeted vent sites.[156]

Cobalt-rich ferro-manganese crusts

173. Cobalt-rich ferro-manganese crusts are found on hard-rock substrates on seamounts, ridges and plateaus. Seamount mining would involve the removal and loss of the biological resources living above, within and alongside the crusts, which can be quite thick. Presumably, mining the crusts and transporting them to the surface would also release sediments and metal species onto adjacent areas of the seamount and into the water column, with a potential impact on the primary production and grazing of fauna in the area, possibly even resulting in extinction. The probable time scale for recovery of the seamount fauna needs to be assessed, on both mined and adjacent areas. While mining of crusts may be far more localized than that of nodules, the distribution of seamount benthic species may also be far more restricted.[115] Management of mining effects must also take account of fishing activities.

10. Marine scientific research

174. Marine scientific research is essential in order to understand marine ecosystems, discover sustainable uses of biological resources and assess the potential effects of other ocean activities. However, if not conducted with due care, scientific research itself could have an adverse impact on marine biodiversity and ecosystems. Research vessels and equipment could cause disturbances in the water column and on the seabed, especially with frequent visits and repeated sampling of the same areas. Research activities on the seabed could alter environmental conditions and cause perturbations harmful to organisms similar to those of seabed mining. Even the introduction of light, noise and heat in areas where these are absent could cause stress to organisms in the area. Smothering, physical disturbance

from sediment removal or spreading, the deposit of debris and chemical or biological contamination also have an impact on biodiversity. Finally, the removal of an entire hydrothermal vent could cause the extinction of associated fauna.

175. The frequency of research expeditions is a cause for concern, especially with plans for systematic observations under various monitoring programmes.[34] Finally, different scientific projects could be incompatible and interfere with each other. To address these concerns, some groups of scientists, such as those at InterRidge, have been working on codes of conduct. However, it has been suggested that international regulatory measures will be needed to ensure that potential effects are assessed in advance and that the resources are used in a sustainable manner.

F. Legal issues

176. The present section is divided into two parts: the first part presents information on the jurisdictional framework and the general principles applicable to the conservation and sustainable use of marine biodiversity beyond areas of national jurisdiction and explains the legal framework provided by UNCLOS and other relevant instruments. The second part addresses legal issues relating to genetic resources.

1. Legal framework for the conservation and sustainable use of marine biodiversity beyond national jurisdiction

177. UNCLOS establishes the legal framework for all activities in the oceans. As stated in its preamble, UNCLOS sets out a legal order for the seas and oceans to facilitate international communication and promote peaceful uses of the seas and oceans, equitable and efficient utilization of their resources, conservation of their living resources and study, protection and preservation of the marine environment.

178. UNCLOS does not specifically address issues relating to biodiversity. However, as the Convention applies to all activities in the oceans, its jurisdictional framework and general principles also apply to the conservation and sustainable use of biodiversity, including in areas beyond national jurisdiction.

(a) Jurisdictional framework

179. In setting out a comprehensive set of rules governing ocean activities, UNCLOS divides marine space into a number of zones, divided both horizontally and vertically. Vertically, the sea is divided into the seabed or ocean floor and the superjacent water column. Horizontally, space is measured from baselines extending along the coast, in accordance with articles 5 and 7 of the Convention. In the sea area between the baseline and the coast, called “internal waters”, the coastal State enjoys absolute sovereignty. Extending seawards from the baselines for up to 12 nautical miles is the territorial sea, where the coastal State also enjoys sovereignty, with the exception of a right to innocent passage by foreign ships (article 8). In the exclusive economic zone, which may extend up to 200 miles from the coast, coastal States enjoy sovereign rights over natural resources, both living and non-living, as well as jurisdiction for the construction of artificial islands, the protection of the marine environment and over marine scientific research (article 56). Although in most cases the seabed beyond the territorial sea, termed “the continental shelf”, is subsumed within the regime of the exclusive economic zone, where the physical

shelf extends beyond the 200-mile limit, the sovereign rights of the coastal State over the mineral resources of the shelf and the living "sedentary species" attached to it continue up to the limits set out in article 76 of the Convention.

180. The water column that is not included in the exclusive economic zone, the territorial sea or the internal waters of a State, or in the archipelagic waters of an archipelagic State, constitutes the "high seas" (article 86). Under part VII of the Convention, the high seas are open to all States, under the regime of the freedom of the high seas. The freedom of the high seas includes freedom of navigation; freedom of overflight; freedom to lay submarine cables and pipelines; freedom to construct artificial islands and other installations, subject to part VI; freedom of fishing and freedom of marine scientific research, subject to parts VI and XII. These freedoms must be exercised by all States with due regard for other States' interests in their exercise of high-seas freedoms (article 87). High-seas freedoms must also be exercised under the conditions laid down by UNCLOS, including the provisions on the conservation and management of living resources (part VII, section 2), the general obligations to protect and preserve the marine environment (part XII) and by other rules of international law.

181. Under UNCLOS, the seabed and ocean floor and subsoil thereof beyond the limits of national jurisdiction have been designated as "the Area" (article 1, para. 1 (1)). Part XI of UNCLOS and the 1994 Agreement relating to the Implementation of Part XI of UNCLOS (the Part XI Agreement) specifically define the legal regime for the Area. The Area and its resources are the common heritage of mankind (article 136). Resources are defined in article 133 to mean "all solid, liquid and gaseous mineral resources in situ in the Area at or beneath the seabed, including polymetallic nodules". The International Seabed Authority is the organization through which States organize and control all activities of exploration for and exploitation of the resources of the Area (article 1, para. 1 (3)), particularly with a view to administering mining activities in the Area (article 157). Activities must be carried out for the benefit of mankind as a whole and the Authority must provide for the equitable sharing of financial and other economic benefits derived from activities in the Area (article 140).

182. The continental shelf shall not extend beyond the limits defined in article 76 of UNCLOS and the coastal State is required to delineate the outer limit of its continental shelf in accordance with the provisions of that article.

183. As provided in article 77, coastal States exercise sovereign rights for the purpose of exploring the continental shelf and exploiting its natural resources. The natural resources consist of the mineral and other non-living resources of the seabed and subsoil, together with living organisms belonging to sedentary species, defined as organisms which, at the harvestable stage, are either immobile on or under the seabed or unable to move except in constant physical contact with the seabed or the subsoil. The extent to which the definition of sedentary species under article 77 covers the complex web of life of deep-sea ecosystems may need to be addressed in order to clarify whether such ecosystems and organisms belong to the regime of the continental shelf or of the water column above it. The issue is important since, beyond the 200 nautical mile limit, or within that limit in cases where an exclusive economic zone has not been declared, while the coastal State has sovereign rights over biological resources belonging to sedentary species on the continental shelf, other biological resources are subject to the regime of the high seas. In the context

of conservation and sustainable use, the relationship between high-seas activities, in particular fishing, and a coastal State's sovereign rights over the sedentary species of the continental shelf may therefore need to be clarified.

(b) Instruments relevant to the conservation and sustainable use of marine biodiversity beyond areas of national jurisdiction

184. UNCLOS establishes the legal framework for all activities in the oceans and contains the general principles applicable to the conservation and sustainable use of marine biodiversity in areas beyond the limits of national jurisdiction. It is supplemented by a number of specialized instruments, concluded either prior to or after its adoption or which may be concluded in order to implement its general principles. Articles 237 and 311 of UNCLOS define its relationship with these instruments. Below is a brief summary of the relevant instruments that directly or indirectly address issues relevant to the conservation and sustainable use of biodiversity in areas beyond national jurisdiction. Some of the instruments referred to aim at regulating specific activities, such as those discussed in chapter II.E above on environmental issues, others address the conservation and sustainable use of biodiversity itself.[157]

Instruments addressing biodiversity

185. The Convention on Biological Diversity is complementary to UNCLOS in relation to its specific objectives.[158] Pursuant to its article 1, the three objectives of the Convention on Biological Diversity are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources, by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding. While in areas within national jurisdiction the Convention on Biological Diversity applies both to components of biological diversity and to processes and activities carried out under the jurisdiction or control of States, in areas beyond national jurisdiction, that Convention applies only to processes and activities carried out under the authority of States (article 4). This means that the Convention on Biological Diversity does not apply to the components of marine biodiversity beyond national jurisdiction. Nevertheless, in accordance with article 5, States party to that Convention are required to cooperate directly, or through competent international organizations, for the conservation and sustainable use of biodiversity beyond national jurisdiction (see also A/59/62/Add.1, paras. 254-260). In carrying out activities beyond national jurisdiction that have, or are likely to have, a significant adverse impact on the conservation and sustainable use of biodiversity, States parties must take into account the provisions of the Convention (articles 6 to 14) and the policy decisions taken by its Conference of the Parties.

186. Other relevant instruments include the Convention on Migratory Species (including its regional agreements: the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area, the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas and the Agreement on the Conservation of Albatrosses and Petrels, under which parties agree to take, individually or in cooperation, appropriate and necessary steps to conserve migratory species and their habitats; and the Convention on International Trade of Endangered Species, which provides measures to curtail global trade in

threatened and endangered species. Among marine listings established under these instruments are many species of cetaceans, marine turtles and corals (see also A/59/62/Rev.1, paras. 261-264).

Living resources of the high seas

187. The conservation and management of the living resources of the high seas is addressed in articles 116 to 120 of UNCLOS. Fishing on the high seas must be exercised in conformity with the general provisions on conservation and management, as well as with a number of specific global and regional instruments that require high-seas fishing States to cooperate in the establishment of conservation and management measures in the high seas. At the global level, relevant instruments include the United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks and the 1993 FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (see also A/59/62/Add.1, paras. 301-305 and A/59/298, paras. 105-107). At the regional level, the duty of States to cooperate for the conservation and management of marine living resources is implemented through regional fisheries management conventions and arrangements. The regional organizations created under these instruments establish conservation and management measures for specific areas and species in accordance with their mandates. Not all areas beyond national jurisdiction are covered by regional fisheries management organizations and most of these organizations do not manage all fish species (see also A/59/298, paras. 131-149). In addition, the 1946 International Convention for the Regulation of Whaling regulates the conservation and utilization of whale resources.

188. Non-binding instruments relevant in this regard include the FAO Code of Conduct for Responsible Fisheries and four FAO international plans of action. The Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem and the second supplement to the FAO Technical Guidelines for Responsible Fisheries, on the ecosystem approach to fisheries, provide voluntary guidelines on the implementation of the ecosystem approach (see also A/59/298, paras. 110-112).

Navigation

189. Navigation on the high seas is subject to the general provisions under UNCLOS on the prevention, reduction and control of pollution from vessels and the duty of the flag State (articles 194, 211 and 217-220), which are reinforced by a number of specific instruments adopted by IMO, including the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, the International Convention on the Control of Harmful Anti-fouling Systems on Ships and the International Convention for the Control and Management of Ships’ Ballast Water and Sediments (see also A/59/62/Add.1, paras. 265-270).

Marine scientific research

190. Marine scientific research must be carried out in conformity with the provisions contained in part XIII of UNCLOS, including the general principles

under article 240. These include the requirement that marine scientific research must be conducted in compliance with all relevant regulations adopted in conformity with UNCLOS, including those for the protection of the marine environment (see also paras. 203 to 205 below).

Cables, pipelines and artificial islands

191. The laying of submarine cables and pipelines is also subject to UNCLOS general provisions on the protection of the marine environment. The same applies to the construction of artificial islands and other installations, which are also regulated by the 1978 Protocol relating to the Convention for the Prevention of Pollution from Ships as regards discharges, while the 1972 London Convention covers their deliberate disposal at sea.

Protection and preservation of the marine environment

192. The protection and preservation of the marine environment is addressed in general by the comprehensive framework set out in part XII of UNCLOS. Article 192 establishes a general obligation for States to protect and preserve the marine environment. States are required to take all measures necessary to prevent, reduce and control pollution of the marine environment from any source, using "the best practicable means at their disposal and in accordance with their capabilities" (article 194, para. 1). In particular, States must "protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life" (article 194, para. 5). States are also required to avoid the use of technologies, or the intentional or accidental introduction of alien species to a particular part of the environment, which may cause harmful changes thereto (article 196). In addition, States are required to exercise their prescriptive and enforcement jurisdictions to prevent, reduce and control pollution from all sources (articles 194, para. 1, 207, para. 1, 208, para. 1, 209, para. 2, 210, para. 1, 211, paras. 2-4, 212, para. 1 and section 6 of part XII generally on enforcement). They are also to cooperate on a global and, as appropriate, on a regional basis, in the formulation of international rules, standards, recommended practices for the protection and preservation of the marine environment (articles 207, para. 4, 208, para. 5, 209, para. 1, 210, para. 4, 211, para. 1, 212, para. 3). They must monitor the risks or effects of pollution of any activities conducted under their control, as well as assess the potential effects of planned activities on the marine environment (articles 204-206). Moreover, States are required to provide scientific and technical assistance to developing States to enhance their capabilities to protect and preserve the marine environment (articles 202 and 203). Pursuant to article 235, States are responsible for the fulfilment of their international obligations concerning the protection and preservation of the marine environment and they are liable in accordance with international law. They are also responsible and liable for damage caused by pollution of the marine environment arising out of marine scientific research undertaken by them or on their behalf (article 263).

193. The obligations for States to protect and preserve the marine environment are complemented by a number of international instruments, including the IMO instruments mentioned in paragraph 189 above dealing with pollution from vessels, the 1972 London Convention and its 1996 Protocol and the non-binding Global Programme of Action. Other conventions whose implementation would enhance the conservation and sustainable use of biodiversity beyond national jurisdiction, even

though they do not directly address the issue, include the United Nations Framework Convention on Climate Change, the Kyoto Protocol thereto and the Stockholm Convention on Persistent Organic Pollutants (see also A/59/62/Add.1, paras. 271-273 and 275).

194. As envisaged under article 197 of UNCLOS on regional cooperation, a number of regional seas conventions and action plans address the protection of the marine environment, including through measures specifically dealing with marine biodiversity, on a regional basis (see also A/59/62/Add.1, paras. 279-287).[159]

195. The protection of the marine environment from harmful effects that may arise from activities in the Area, is provided for by article 145, under which the International Seabed Authority must adopt measures, including the protection and conservation of the natural resources of the Area and the prevention of damage to the flora and fauna of the marine environment of the Area. The Authority has adopted Regulations on Prospecting and Exploration for Polymetallic Nodules[160] and is currently considering draft regulations for prospecting and exploration of polymetallic sulphide and cobalt-rich crust deposits. These regulations have a strong environmental element aiming, inter alia, at the protection and conservation of the natural resources of the Area and the prevention of damage to marine biodiversity. The Authority also plays an important role in promoting marine scientific research in the Area (article 143; see also paras. 204 and 205 below and A/59/62/Add.1, paras. 252 and 253).

Protection of specific areas and species

196. Some of the legal instruments mentioned above provide for defined geographic areas, including beyond national jurisdiction, to be placed under a higher level of protection than the waters and/or seabed around them (for example, the 1978 Protocol relating to the Convention for the Prevention of Pollution from Ships; the IMO “Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas, which provide for the designation of areas within and beyond the limits of the territorial sea; measures adopted under regional fisheries management conventions and arrangements; the Convention on Migratory Species; and the Regulations on Prospecting and Exploration for Polymetallic Nodules of the International Seabed Authority). At the regional level, some binding legal agreements provide for multiple-use marine protected areas beyond national jurisdiction, while ensuring that the regulation of particular activities is consistent with high-seas freedoms under UNCLOS (for example, the Convention for the Protection of the Marine Environment of the North East Atlantic and the 1995 Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean). High seas sanctuaries, where commercial whaling is prohibited, have been established under the International Convention for the Regulation of Whaling in the Southern Ocean and the Indian Ocean.[161]

2. Genetic resources

197. As described in the introduction to the present report (see, in particular, paras. 5 and 6), the term genetic resources should be read in a broad sense.

Jurisdictional framework

198. Discoveries of highly complex and diverse ecosystems in areas beyond national jurisdiction, coupled with advances in the biotechnology sector, have led to increasing interest and activities in relation to genetic resources beyond national jurisdiction. Such interest has also generated a debate over the legal status of genetic resources.

199. The legal framework established by UNCLOS applies to all activities in the oceans and seas, including those relating to genetic resources, as noted above.

200. As also mentioned above, in the two maritime areas beyond the limits of national jurisdiction, the high seas and the Area, UNCLOS establishes two distinct regimes. Genetic resources in the high seas are subject to the regime of part VII of UNCLOS and other relevant provisions, as described in paragraph 180 above. As regards the Area, the regime set up under part XI and the 1994 Agreement deal specifically with activities relating to mineral resources. Article 145 provides, inter alia, for the protection and conservation of the natural resources of the Area and the prevention of damage to the flora and fauna of the marine environment, from harmful effects which may arise from activities in the Area. In addition, article 143, as well as article 256 and other relevant provisions of part XIII on marine scientific research, could also apply to research relating to biodiversity (see below for further details). Commercial activities relating to genetic resources are not specifically addressed by part XI of UNCLOS.

201. Different views have been expressed on whether, in accordance with UNCLOS, deep seabed genetic resources beyond national jurisdiction fall under the regime for the Area or under the regime for the high seas (see A/59/122). Consequently, the status of these resources should be clarified, in the light of the general principles contained in UNCLOS.

Activities relating to genetic resources

202. It is difficult to differentiate scientific research from commercial activities involving genetic resources, commonly referred to as bioprospecting. In most cases, genetic resources are collected and analysed as part of scientific research projects, in the context of partnerships between scientific institutions and industry. It is only at a later stage that knowledge, information and useful materials extracted from such resources enter a commercial phase. The difference between scientific research and bioprospecting therefore seems to lie in the use of knowledge and results of such activities, rather than in the practical nature of the activities themselves.

203. There is no internationally agreed definition for either marine scientific research or bioprospecting. UNCLOS provides the regime for the conduct of marine scientific research but does not define the term, although it requires States to promote the establishment of general criteria and guidelines to assist States in ascertaining the nature and implications of marine scientific research, through competent international organizations (article 251).[162] At the same time, neither UNCLOS nor the Convention on Biological Diversity use or define the term bioprospecting. The expression is commonly used to cover a broad range of activities, aimed at the exploration of biodiversity for commercially valuable genetic and biochemical resources and further as the process of gathering information from the biosphere on the molecular composition of genetic resources for the

development of new commercial products.[163] The United Nations University, Institute of Advanced Studies, in its report on bioprospecting[34] states that possible elements of a definition of bioprospecting include systematic search, collection, gathering or sampling of genetic resources for purposes of commercial or industrial exploitation; screening, isolation or characterization of commercially useful compounds; testing and trials; and further application and development of the isolated compounds for commercial purposes, including large-scale collection, development of mass culture techniques and conduct of trials for approval for commercial sale. It has also been suggested that the phase of initial research and gathering of information could also be referred to as "biodiscovery", while the term bioprospecting could cover the subsequent phases of collection of the resources for purposes of further investigation and eventual commercial application.[164]

204. As stated above, the conduct of marine scientific research is subject to the general principles under part XIII of UNCLOS. Article 240 establishes that such research shall be conducted exclusively for peaceful purposes; that it shall be conducted with appropriate scientific methods and means; that it shall not unjustifiably interfere with other legitimate uses of the sea and shall be duly respected in the course of such uses; and that it shall be conducted in compliance with all relevant regulations adopted in conformity with UNCLOS, including those for the protection and preservation of the marine environment. Marine scientific research shall not constitute the legal basis for any claim to any part of the marine environment or its resources (article 241). States and competent international organizations shall promote international cooperation in marine scientific research (article 242). States and competent international organizations are further required to make available by publication and dissemination through appropriate channels information on proposed major programmes and their objectives, as well as knowledge resulting from marine scientific research (article 244). For this purpose, States, both individually and in cooperation with other States and with competent international organizations, shall actively promote the flow of scientific data and information and the transfer of knowledge resulting from marine scientific research, especially to developing States, as well as the strengthening of the autonomous marine scientific research capabilities of developing States through, inter alia, programmes to provide adequate education and training of their technical and scientific personnel.

205. As mentioned above, marine scientific research is one of the freedoms of the high seas under articles 87 and 257 of UNCLOS, subject to the general principles of part XII. Under articles 143 and 256, marine scientific research in the Area must be carried out exclusively for peaceful purposes and for the benefit of mankind as a whole, in accordance with part XIII. The International Seabed Authority may carry out marine scientific research concerning the Area and its resources and may enter into contracts for that purpose. The Authority must also promote and encourage the conduct of such research in the Area and shall coordinate and disseminate the results of such research and analysis when available. States parties to UNCLOS may carry out marine scientific research in the Area and shall promote international cooperation in that respect. In particular, they are required to participate in international programmes and encourage cooperation in marine scientific research by personnel of different countries and of the Authority; ensure that programmes are developed through the International Seabed Authority or other international organizations, as appropriate, for the benefit of developing countries and

technologically less developed States with a view to strengthening their research capabilities, training their personnel and the personnel of the Authority in the techniques and applications of research, and fostering the employment of their qualified personnel in research in the Area. States must also disseminate the results of research and analysis, when available, through the International Seabed Authority or other international channels, when appropriate.

206. Although the Convention on Biological Diversity contains provisions regulating access to genetic resources, transfer of technologies, technical and scientific cooperation, funding and handling of biotechnology,[165] in the light of its jurisdictional scope, these provisions regulating access and benefit-sharing are only applicable to marine genetic resources found in areas under national jurisdiction. Access to genetic resources under article 15 is regulated by national Governments on the basis of mutually agreed terms between the country with sovereign rights over the genetic resources and the country using them. Parties are required to undertake scientific research related to resources provided by other parties with the full participation of those parties and take measures to share, in a fair and equitable way, the results of research and benefits arising from commercial and other utilization of genetic resources with parties providing the resources.

207. The Conference of the Parties to the Convention on Biological Diversity has developed the Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization,[166] which are only applicable to marine genetic resources found in areas under national jurisdiction. The Guidelines, which are voluntary, provide guidance for policymakers and persons using and providing genetic resources. They apply to the genetic resources covered by the Convention on Biological Diversity, as well as to benefits arising from the commercial and other utilization of such resources, with the exception of human genetic resources.

208. The nature of activities relating to genetic resources should be clarified, in light of the general principles contained in UNCLOS.

Technology transfer and intellectual property rights

209. Technology transfer is also particularly important in the context of activities relating to genetic resources beyond national jurisdiction, which require sophisticated and costly equipment and expertise (see paras. 60-97 above).

210. Part XIV of UNCLOS establishes the general principle by which States are required to cooperate, either directly or through competent international organizations, with a view to promoting the development and transfer of marine science and marine technology on fair and reasonable terms and conditions. This should be done particularly for the benefit of developing States, which may need and request technical assistance in this field, with regard to the exploration, exploitation, conservation and management of marine resources, the protection and preservation of the marine environment, marine scientific research and other activities in the marine environment (article 266). States are also required to endeavour to foster favourable economic and legal conditions for the transfer of marine technology for the benefit of all parties concerned on an equitable basis (article 266, para. 3).

211. UNCLOS also encourages States to establish national and regional marine scientific and technological centres, particularly in developing coastal States, and to strengthen existing ones, in order to advance the conduct of marine scientific research in such States and enhance their national capabilities to utilize and preserve their marine resources for their economic benefit (article 275, para. 1). Such regional centres are to provide training and educational programmes on various aspects of marine scientific and technological research, particularly marine biology, including conservation and management of living resources (article 277).

212. Article 267 of UNCLOS recognizes that in promoting the development and transfer of marine technology, due regard must be paid to all legitimate interests including the rights and duties of holders, suppliers and recipients of marine technology.

213. With particular reference to the Area, UNCLOS requires the International Seabed Authority to acquire technology and scientific knowledge relating to activities in the Area and to encourage their transfer to developing States and the Enterprise (articles 144 and 170). Under the Part XI Agreement,[167] seabed mining technology shall be acquired on fair and reasonable commercial terms and conditions on the open market, or through joint-venture arrangements and consistent with the effective protection of intellectual property rights (section 5, para. 1 (a) and (b)). States parties have a duty to promote international technical and scientific cooperation with regard to activities in the Area either between the parties concerned or by developing training, technical assistance and scientific cooperation programmes in marine science and technology and the protection and preservation of the marine environment (section 5, para. 1 (c)).

214. As regards access to and transfer of technology, including biotechnology, States Party to the Convention on Biological Diversity must provide and/or facilitate access to, and transfer of, technologies that are relevant to the conservation and sustainable use of biodiversity or make use of genetic resources (articles 2 and 16, para. 1). Access to and transfer of technologies to developing countries shall be provided under fair and most favourable terms and, in the case of technologies subject to patents and other intellectual property rights, on terms that recognize and are consistent with the adequate and effective protection of those rights (article 16, para. 2). Article 19, which addresses the handling of biotechnology and distribution of its benefits, provides that measures shall be adopted for the effective participation in biotechnology research by countries providing the genetic resources and that they are given priority access, on a fair and equitable basis, to results and benefits arising from biotechnologies based upon such genetic resources (article 19, paras. 1 and 2). The Bonn Guidelines[166] also highlight that the sharing of benefits and transfer of technology and regimes covering intellectual property rights must be mutually supportive.

215. As regards the protection of intellectual property rights, it is believed that the granting of patents is important because it stimulates commercial innovation in the life sciences. A patent is a legal certificate that awards temporary protection over a claimed invention for a period that is generally 20 years. In order for a patent to be awarded, inventions must meet three criteria, they must be (a) new (or novel); (b) involve an inventive step (be non-obvious); and (c) be capable of industrial application (be useful or of utility). A patent awards an exclusive temporary protection to its holder including the right to exclude others from “making, using,

offering for sale or selling" or "importing" the protected invention into a jurisdiction where the patent protection is in force, or to charge others for any uses or purposes involving the protected invention within such jurisdictions, through licensing.[79]

216. At the same time the rise of patent protection in the field of life sciences has raised concerns, such as whether the extension of patent protection to genetic material is justifiable on ethical grounds; whether the "identification, isolation or purification" of genetic material meets the criteria of an inventive step or constitutes mere discovery for the purposes of determining patentability; whether claimed inventions meet the criteria of being capable of industrial application; the impacts of permitting patent claims that are very broad in scope; the economic evidence upon which the extension of patentability to biological and genetic material has been based and implications for competition and innovation; and the implications of multiplying patent protection claims for public health, agriculture, development, scientific research, industry and trade.[79]

217. A number of international instruments on intellectual property are relevant in this context. For activities of relevant international organizations relating to the correlation between the regime for genetic resources under the Convention on Biological Diversity and intellectual property rights regimes see paragraphs 273 and 301 to 304 below.

Conventions and treaties of the World Intellectual Property Organization[168]

218. The World Intellectual Property Organization (WIPO), which has 180 member States, administers 23 international treaties dealing with different aspects of intellectual property protection.

219. The main international instrument in terms of operationalizing international patent protection is the Patent Cooperation Treaty,[169] which makes it possible to seek patent protection for an invention simultaneously in each of a large number of countries by filing an international patent application. Patent filings under the Treaty are an increasing feature of the international intellectual property regime.

220. Another relevant instrument is the Patent Law Treaty,[170] which aims at harmonizing and streamlining formal procedures in respect of national and regional patent applications and patents and thus to make such procedures more user-friendly. Standardization and simplification of the formality requirements reduces risks of formality errors and thus will result in a less frequent loss of rights as well as in cost reductions.

221. Disclosure of the invention is a requirement for the grant of a patent. For disclosure to be adequate, an invention must be described in sufficient detail to permit a person skilled in the art to repeat the effect of the invention. Where an invention involves a micro-organism or the use of a micro-organism, disclosure is not possible in writing but can only be made by the deposit, with a specialized institution, of a sample of the micro-organism. The Budapest Treaty on the International Recognition of the Deposit of Micro-organisms for the Purposes of Patent Procedure provides for the deposit of micro-organisms with an international depositary authority,[171] where a deposit is necessary to satisfy the descriptive requirements of patents legislation for inventions involving a micro-organism or the use of a micro-organism. The deposit assures access to the micro-organism by persons other than the inventor for the purposes of testing or experimenting or for

commercial use when the patent expires. Member States who allow or require the deposit of micro-organisms for the purposes of patent procedure must recognize, for such purposes, the deposit of a micro-organism with any international depositary authority, irrespective of its location. Under the Budapest Treaty, the term "micro-organism" is not explicitly defined so that it may be interpreted in a broad sense. The term has been interpreted to cover genetic material the deposit of which is necessary for the purposes of disclosure, in particular regarding inventions relating to the food and pharmaceutical fields.

Agreement on Trade-Related Aspects of Intellectual Property Rights of the World Trade Organization[172]

222. The Agreement on Trade-Related Aspects of Intellectual Property Rights provides minimum standards of intellectual property protection. It deals with domestic procedures and remedies for the enforcement of intellectual property rights and makes disputes between members of the World Trade Organization (WTO) concerning obligations under the Agreement subject to the WTO dispute-settlement procedures. The Agreement also provides for the applicability of basic General Agreement on Tariffs and Trade (GATT) principles, such as most-favoured-nation status and national treatment.

223. The goals of the Agreement include the reduction of distortions and impediments to international trade; promotion of effective and adequate protection of intellectual property rights; and ensuring that measures and procedures to enforce intellectual property rights do not themselves become barriers to legitimate trade. Article 7 of the Agreement sets out as one of its objectives that the protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations.

224. With respect to patents, article 27, paragraph 1, of the Agreement defines the formal requirements regarding patentable subject matter and provides that patents shall be available for inventions that are new, involve an inventive step and are capable of industrial application. Article 27, paragraph 3 (b), of the Agreement provides that members may exclude from patentability plants and animals other than micro-organisms and essential biological processes for the production of plants or animals other than non-biological and microbiological processes. The Agreement calls for a review of the provisions of article 27, paragraph 3 (b) four years after it has entered into force;[173] that review is ongoing.

225. Under article 28 of the Agreement, a patent confers on its owner the exclusive rights to prevent third parties who do not have the owner's consent from making, using, offering for sale, selling or importing for those purposes the product that is the subject matter of the patent; using the process that is the subject matter of the patent; and using, offering for sale, selling or importing for those purposes the product obtained directly by the process, which is the subject matter of a patent. Patent owners have the right to assign, or transfer by succession, the patent and to conclude licensing contracts. Applicants for a patent have to disclose the invention in a manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art and may be required to indicate the best mode for carrying

out the invention known to the inventor at the filing date or, where priority is claimed, at the priority date of the application (article 29).

III. Past and present activities of the United Nations and other relevant international organizations

226. The present chapter of the report addresses the issues referred to in paragraph 73 (a) of General Assembly resolution 59/24.

A. United Nations

227. UNCLOS, which entered into force on 16 November 1994, provides the legal framework within which all activities in the ocean and seas must be carried out. As a result, the Convention is frequently referred to as a constitution for the oceans. UNCLOS was subsequently supplemented by the two implementing agreements: the 1994 Agreement relating to the Implementation of Part XI of the Convention and the 1995 Agreement for the Implementation of the Provisions of the Convention relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.

228. Oceans and their importance in our life have always occupied a central place at the United Nations. In addition to various instruments adopted under the auspices of the United Nations, including the Convention on Biological Diversity, the General Assembly and other United Nations bodies have adopted over the years numerous decisions on the marine environment and biodiversity. Thus, issues relating to the protection of the marine environment were addressed in a comprehensive way in such documents as the Stockholm Declaration on the Human Environment,[174] and in the World Charter for Nature (see also A/59/62/Add.1, paras. 239 and 240).[175] In 1992, the Rio Declaration on Environment and Development,[176] adopted by the United Nations Conference on Environment and Development, developed the principles that form the basis of sustainable development (see also A/59/62/Add.1, paras. 241 and 242). It stressed in particular the need for inter-State collaboration and developed a number of new and different approaches for the conservation and management of the environment, such as the precautionary approach (principle 15 of the Rio Declaration).

229. The need to improve the conservation of biological diversity and the sustainable use of biological resources is elaborated in chapter 15 of Agenda 21,[177] the programme of action adopted by the United Nations Conference on Environment and Development. Chapter 17 of Agenda 21, dealing with the sustainable development of oceans, coastal areas and seas, promotes an ecosystem approach to ocean management and calls for new approaches to marine and coastal area management and development that are integrated in content and precautionary and anticipatory in ambit. Chapter 17 notes the inadequacy of management measures for high-seas fisheries and calls for an emphasis on multi-species management and other approaches that take into account the relationships among species, especially in addressing depleted species, but also in identifying the potential of underutilized or unutilized populations. It also underlines the need to protect and preserve vulnerable marine ecosystems and, with respect to the high seas, requires States to develop and increase the potential of marine living resources to meet human

nutritional needs, as well as social, economic and development goals, protect and restore endangered marine species, preserve marine habitats and other ecologically sensitive areas and promote scientific research with respect to the living resources.

230. Following the process of the United Nations Conference on Environment and Development, a number of instruments were adopted to implement the commitments agreed upon in Rio de Janeiro, Brazil, in 1992: the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, the 1995 Agreement of Straddling and Highly Migratory Fish Stocks and the Jakarta Mandate on Marine and Coastal Biological Diversity of the Convention on Biological Diversity.

231. The United Nations Millennium Declaration (General Assembly resolution 55/2), and the eight Millennium Development Goals, set the development agenda of the international community for the new century, through an integrated vision aimed at the achievement of peace and decent standards of living for all human beings. The Millennium Declaration emphasizes that respect for nature, and in particular the sustainable management of all living species and natural resources, is the only key to ensure that the "immeasurable riches provided to us by nature" are "preserved and passed on to our descendants". The Declaration underlines that the current unsustainable patterns of production and consumption must be changed in the interest of our future welfare and that of our descendants.

232. In 2002, the World Summit on Social Development followed up on the United Nations Conference on Environment and Development to assess progress in implementing sustainable development (see also A/59/62/Add.1, para. 243). In particular, in the Johannesburg Declaration on Sustainable Development,[178] States noted the continuing loss of biodiversity and resolved to protect it, through decisions on targets, timetables and partnerships. The Johannesburg Plan of Implementation[179] encourages the application by 2010 of the ecosystem approach and underlines the need to promote the conservation and management of oceans at all levels and to maintain the productivity and biodiversity of important and vulnerable marine and coastal areas, including in areas within and beyond national jurisdiction. It further calls for the implementation of the work programme arising from the Jakarta Mandate of the Convention on Biological Diversity; to develop and facilitate the use of diverse approaches and tools, including the ecosystem approach, the elimination of destructive fishing practices, the establishment of marine protected areas consistent with international law and based on scientific information, including representative networks by 2012 and time/area closures for the protection of nursery grounds and periods; and to develop national, regional and international programmes for halting the loss of marine biology, including in coral reefs and wetlands.

233. In recent years, the General Assembly, including through the Informal Consultative Process established in its resolution 54/33 of 24 November 1999, has addressed issues relating to the conservation and sustainable use of marine ecosystems and biodiversity, both within and beyond national jurisdiction, under its agenda item on oceans and the law of the sea.

234. In 2002, on the basis of the recommendations of the third meeting of the Informal Consultative Process (see A/57/80) and of the Johannesburg Plan of Implementation, the General Assembly, in its resolution 57/141 of 12 December 2002, called upon States to develop national, regional and

international programmes for halting the loss of marine biodiversity, in particular fragile ecosystems, and to develop and facilitate the use of diverse approaches and tools, including the ecosystem approach, the elimination of destructive fishing practices, the establishment of marine protected areas consistent with international law and based on scientific information, including representative networks by 2012 and time/area closures for the protection of nursery grounds and periods, proper coastal and land use and watershed planning, and the integration of marine and coastal areas management into key sectors. The Assembly reiterated its call in resolutions 58/240 of 23 December 2003 and 59/24 of 17 November 2004. In its resolution 57/141, the Assembly also encouraged relevant international organizations to consider urgently ways to integrate and improve, on a scientific basis, the management of risks to marine biodiversity of seamounts and certain other underwater features within the framework of UNCLOS. In its resolutions 58/240 and 59/24, the Assembly reiterated that need, addressing its call to States as well as international organizations and including cold-water corals and hydrothermal vents as ecosystems of concern.

235. On the recommendation of the fourth meeting of the Informal Consultative Process (see A/58/95, in particular para. 20 (c)), whose areas of focus included protecting vulnerable marine ecosystems, the General Assembly, in its resolution 58/240, called upon States to improve the scientific understanding and assessment of marine and coastal ecosystems as a fundamental basis for sound decision-making through the actions identified in the Johannesburg Plan of Implementation. It invited the relevant global and regional bodies, in accordance with their mandates, to investigate urgently how better to address, on a scientific basis, including the application of precaution, the threats and risks to vulnerable and threatened marine ecosystems and biodiversity in areas beyond national jurisdiction; how existing treaties and other relevant instruments could be used in this process consistent with international law, in particular with UNCLOS and with the principles of an integrated ecosystem-based approach to management, including the identification of those marine ecosystem types that warranted priority attention; and to explore a range of potential approaches and tools for their protection and management. The Assembly requested the Secretary-General to cooperate and liaise with the relevant bodies and to submit an addendum to his annual report to the General Assembly at its fifty-ninth session, describing the threats and risks to such marine ecosystems and biodiversity in areas beyond national jurisdiction as well as details on any conservation and management measures in place at the global, regional, subregional or national levels addressing these issues. The report of the Secretary-General in response to that request is contained in document A/59/62/Add.1.

236. Furthermore, in its resolution 58/14 of 24 November 2003, the General Assembly requested the Secretary-General, in his next report concerning fisheries, to include a section outlining current risks to the marine biodiversity of vulnerable marine ecosystems including, but not limited to, seamounts, coral reefs, including cold-water reefs, and certain other sensitive underwater features related to fishing activities, as well as detailing any conservation and management measures in place at the global, regional, subregional or national levels addressing those issues. That report of the Secretary-General is contained in document A/59/298 (see also A/59/62/Add.1, chap. V).

237. In 2004, the fifth meeting of the Informal Consultative Process organized its discussions around the issue of new sustainable uses of the oceans, including the

conservation and management of the biological diversity of the seabed in areas beyond national jurisdiction. The meeting noted the increasing levels of concern over ineffective conservation and management of the biodiversity of the seabed beyond national jurisdiction, which remained largely unexplored but contained, on the basis of current knowledge, areas rich in unique and diverse species and ecosystems, with high levels of endemism and in some instances with a relationship to the non-living resources of the Area (see A/59/122, para. 2).

238. In that connection, the General Assembly, in its resolution 59/24, reiterated its concern at the adverse impacts on the marine environment and biodiversity, in particular on vulnerable marine ecosystems, including corals, of human activities, such as overutilization of living marine resources, the use of destructive practices, physical impacts by ships, the introduction of alien invasive species and marine pollution from all sources, including from land-based sources and vessels, in particular through the illegal release of oil and other harmful substances and from dumping, including the dumping of hazardous waste such as radioactive materials, nuclear waste and dangerous chemicals. It called upon States and international organizations to take action urgently to address, in accordance with international law, destructive practices that have adverse impacts on marine biodiversity and ecosystems, including seamounts, hydrothermal vents and cold-water corals.

239. As noted in the introduction to the present report, the General Assembly has decided to establish an Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction and has requested the Secretary-General to prepare the present report for its consideration.

240. The sixth meeting of the Informal Consultative Process focused its discussions on fisheries and their contribution to sustainable development and marine debris, subjects directly relevant to the conservation and sustainable use of marine biodiversity. It adopted a number of elements to be suggested to the General Assembly for consideration at its sixtieth session (see A/60/99).

B. United Nations programmes and institutions

241. The Programme for the Development and Periodic Review of Environmental Law for the First Decade of the Twenty-first Century (Montevideo Programme III) of the United Nations Environment Programme (UNEP),[180] under the theme “conservation and management”, identifies the need to promote and improve the integrated management, conservation and sustainable use of coastal and marine resources and ecosystems. The conservation of biological diversity and its enhancement, the sustainable use of its components, biosafety and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources are important aspects of the Montevideo Programme III. The Programme was adopted by UNEP Governing Council by its decision 21/23 of 9 February 2001 (see A/56/25, annex).

242. The UNEP Regional Seas Programme was launched in 1974 to address the accelerating degradation of the world’s oceans and coastal areas, through the sustainable management and use of marine and coastal environments. The Programme involves neighbouring countries in comprehensive and specific actions to protect their shared marine environment (see also A/59/62/Add.1, paras. 279-

281). New regional seas strategic directions for 2004-2007 were developed by the sixth Global Meeting of the Regional Seas Conventions and Action Plans in 2004 and promote the implementation of biodiversity-related conventions such as the Convention on Biological Diversity, the Convention on International Trade in Endangered Species, the Convention on Migratory Species, the Convention concerning the Protection of the World Cultural and Natural Heritage and the Convention on Wetlands of International Importance, especially as Waterfowl Habitat. For example, Regional Seas Programmes are the main mechanism for implementing the Convention on Biological Diversity programme of work on marine and coastal biodiversity at the regional level. The collaboration between the secretariat of the Convention on Biological Diversity and the Regional Seas Coordinating Unit of UNEP currently focuses on two concrete activities: the development of a cooperative initiative for the management of marine alien species, also in collaboration with the Global Invasive Species Programme, and the establishment of regional marine protected area networks.

243. The Regional Seas Programme and the secretariats of the Endangered Species Convention, the Whaling Convention, the Convention on Biological Diversity and the Convention on Migratory Species are also collaborating in the Marine Mammal Action Plan. The central goal of the Plan is to generate a consensus among Governments on which to base their policies for marine mammal conservation under the auspices of UNEP. The Plan has helped to enhance the technical and institutional capacities for the conservation and management of marine mammals in several regional seas, in particular those of Latin America and the Caribbean, East Africa, West and Central Africa, the Black Sea and South-East Asia. Furthermore, the Regional Seas Programme and the secretariat of the Convention on Migratory Species have worked jointly on a publication entitled “Review on small cetaceans: distribution, behaviour, migration and threats”, to be published in 2005.

244. Other relevant activities under the Regional Seas Programme include development within the framework of the Global Environment Facility GEF/United Nations Development Programme (UNDP)/IMO Global Ballast Water Management Programme (GloBallast), of joint activities to reduce the transfer of harmful aquatic organisms and pathogens in ships’ ballast water, to implement the IMO Guidelines for the Control and Management of Ships’ Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens[181] and the new International Convention for the Control and Management of Ships’ Ballast Water and Sediments through the Programme; collaboration with GEF in the large marine ecosystems projects; and collaboration with the Intergovernmental Oceanographic Commission of UNESCO (IOC/UNESCO) in global scientific programmes for the marine environment, in particular to set up and implement the Global Ocean Observing System, including in the Mediterranean Sea, the Indian Ocean, the Western Pacific Ocean and the North-west Pacific Ocean.

245. The UNEP World Conservation Monitoring Centre marine programme compiles information on marine ecosystems, including on the conservation of species. The importance of the Monitoring Centre for assessing progress in achieving the internationally agreed target of significantly reducing the rate of biodiversity loss by 2010 was underlined by the seventh meeting of the Conference of the Parties to the Convention on Biological Diversity. UNEP analyses the status and trends in the distribution and condition of global biodiversity and provides early warning of emerging threats.

246. In partnership with the Regional Seas Programme and the World Conservation Union, the UNEP Coral Reef Unit will pursue a closer collaboration with regional fisheries bodies. This will include consideration of how to manage the risks and mitigate the adverse effects of destructive fishing practices on vulnerable marine ecosystems, including cold-water corals located beyond national jurisdiction. The Coral Reef Unit is also pursuing contacts and establishing collaboration with industry in regions with coral reef ecosystems beyond national jurisdiction, such as the submarine cable industry and the offshore oil and gas industry.

247. UNU, in particular through its Institute of Advanced Studies, has published a number of studies providing relevant information on the conservation and sustainable use of marine biodiversity beyond national jurisdiction. These include a report entitled *The International Regime for Bioprospecting: Existing Policies and Emerging Issues for Antarctica,*[182] and another entitled *Bioprospecting of Genetic Resources in the Deep Seabed: Scientific, Legal and Policy Aspects*.[34] These studies may assist the international community's discussion on the subject.

C. United Nations specialized agencies

248. FAO has promoted the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction through the implementation of its Code of Conduct for Responsible Fisheries, which provides a broad and comprehensive framework for the conservation, management and utilization of fisheries within and beyond areas of national jurisdiction. An important aspect of this is the institutional strengthening of human resource development in developing countries, in various aspects of fisheries conservation and management.

249. More specifically, FAO has carried out activities to implement the 1993 Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas[183] and the FAO international plans of action, as well as the FAO strategy on improving information on status and trends of capture fisheries. These plans of action and the strategy have been developed within the framework of the Code of Conduct for Responsible Fisheries to enhance fisheries conservation and management by targeting particular aspects of management that need special attention. In this connection, specific concern was expressed at the twenty-sixth session of the FAO Committee on Fisheries on the need to take urgent action regarding the implementation of the FAO International Plan of Action for the Conservation and Management of Sharks and the International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries.

250. FAO has also taken measures to encourage the strengthening of regional fisheries bodies to make them more efficient and cost-effective. Additional activities include: (a) identification of high-seas fish species through the setting up of a species identification and data programme to improve knowledge of marine organisms of actual and potential interest to fisheries; (b) collaboration with "FishBase", a global information system on fish with key data on the biology of all finfishes, many of which occur in the high seas; (c) partnership arrangement with the World Fisheries Resources Monitoring System to establish a framework for the promotion of reporting on status and trends for all fisheries resources;[184] and (d) promotion of the ecosystem approach to fisheries, including participation in the

management of the Canary Current large marine ecosystem and the Bay of Bengal large marine system projects, as well as cooperation with UNDP in the execution of the Benguela Current large marine system project.

251. The twenty-sixth meeting of the FAO Committee on Fisheries in March 2005 noted the particularly difficult challenge represented by the management of deep-water demersal fisheries. The deficiencies in the present legal framework were discussed and calls were made for improvements. The Committee requested its members to submit detailed catch information to FAO and called on the meeting of regional fisheries management organizations, held immediately after the Committee on Fisheries, to consider the issue. It also requested FAO to provide the General Assembly with information, technical advice and leadership. In addition the Committee on Fisheries highlighted the need for collection and collation of information concerning past and present deep-water fishing activities; undertaking an inventory of deep-water stocks and an assessment of the effects of fishing on deep-water fish populations and their ecosystems; and convening technical meetings to develop a code of practice and technical guidelines.

252. In relation to sea turtles, the Committee on Fisheries agreed on several recommendations, including to pay more attention to interactions between turtles and fisheries; to develop technical guidelines for the reduction of sea turtle mortality in fishing operations; to develop understanding and review progress on the issue; to broaden the mandate of regional fisheries management organizations to reduce fishing impacts on turtles; to strengthen links between environmental and fisheries agencies; to report on turtle stock status and trends and review progress; to coordinate research and promote information exchange, including through a website; and to facilitate harmonization of legislation and management within regions.

253. The Committee on Fisheries briefly addressed the issue of marine protected areas, recognizing that such areas could be useful as fisheries management tools if specifically designed through acceptable processes. The Committee recommended the elaboration of technical guidelines on the design, implementation and testing of marine protected areas and agreed that FAO should assist members in meeting the 2012 goals of the World Summit on Social Development in collaboration with other relevant intergovernmental organizations.

254. In the Rome Declaration on Illegal, Unreported and Unregulated Fishing, the ministerial meeting that followed the twenty-sixth meeting of the Committee on Fisheries agreed to renew efforts and cooperation to combat illegal, unreported and unregulated fishing; to revise legislation and increase deterrence; to implement catch certification schemes and adopt internationally agreed market-related measures; to require that all vessels fishing in the high seas be equipped with vessel monitoring systems no later than December 2008; to eliminate economic incentives leading to illegal, unreported and unregulated fishing; to develop and implement vessel boarding and inspection schemes; to strengthen measures by port States; to pursue the flags of convenience and genuine link debate; to strengthen regional fisheries management organizations; to exercise full control by flag States on vessels flying their flags; and to collect and submit to FAO and relevant regional fisheries management organizations the data on vessels authorized to fish in the high seas. They also asked for assistance to developing countries in these undertakings and for the strengthening of regional fisheries management organizations.

255. IMO is considered to be the competent international body to establish international measures facilitating navigation and ensuring common standards for worldwide shipping. It also establishes special protective measures in defined areas where shipping presents a risk to the marine environment and to marine biological resources. These measures include routing and discharge restrictions and reporting requirements.

256. Discharges from ships, both intentional and accidental, are regulated by the International Convention for the Prevention of Pollution from Ships, as modified by the Protocol of 1978 relating thereto. The Protocol regulates vessel design, equipment and operational discharge from all ships, both within and beyond national jurisdiction. It provides for the designation of special areas, where more stringent discharge rules apply in respect of oil, noxious liquid substances, refuse (marine debris) and air pollution. Special areas are defined as areas in which, for technical reasons relating to their oceanographical and ecological condition and to their sea traffic, the adoption of special mandatory methods for the prevention of sea pollution is required. IMO has developed Guidelines for the Designation of Special Areas to provide guidance to States parties in the formulation and submission of applications for the designation of special areas. Two special areas extending beyond national jurisdiction are the Antarctic and Southern Ocean (south of latitude 60 degrees south) and the Mediterranean Sea.

257. In 2001, the IMO Assembly, in its resolution A.927(22), adopted Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas. These areas are defined as areas which need special protection through action by IMO because of their significance for recognized ecological, socio-economic or scientific reasons, and which may be vulnerable to damage by maritime activities. The process of designating a particularly sensitive sea area offers a means for selecting the most appropriate mechanisms available through IMO to reduce or eliminate risks posed by shipping to the area or a specific portion thereof. Particularly sensitive sea areas may be designated within and beyond the limits of national jurisdiction. The Guidelines relating to such areas are currently under review within the IMO Marine Environment Protection Committee with a view to clarifying and, where appropriate, strengthening them.

258. In 1999, the IMO Assembly adopted a resolution calling on the Marine Environment Protection Committee to develop a legally binding instrument to address the harmful effects of anti-fouling systems used on ships. The resolution called for a global prohibition on the application of organotin compounds, which act as biocides in anti-fouling systems on ships, by 1 January 2003 and a complete prohibition by 1 January 2008. On 5 October 2001, IMO adopted the International Convention on the Control of Harmful Anti-fouling Systems on Ships, which includes such requirements. The Convention will enter into force 12 months after the date on which no fewer than 25 States, representing 25 per cent of the gross tonnage of the world's merchant shipping, have expressed their consent to be bound by it.

259. The introduction of harmful aquatic organisms and pathogens to new environments has been identified as the second greatest threat to the world's oceans. Because the uncontrolled discharge of ballast water and sediments from ships had already caused damage to the environment, human health, property and resources, the International Convention for the Control and Management of Ships' Ballast

Water and Sediments was adopted by IMO in 2004, in order to prevent, minimize and ultimately eliminate the risks arising from the transfer of harmful aquatic organisms and pathogens by ships. The Convention will enter into force 12 months after ratification by 30 States, representing 35 per cent of the world's merchant shipping gross tonnage.

260. Ballast water exchange is currently the only method used to minimize the transfer of harmful aquatic organisms and pathogens through ships' ballast water. Ships are required to conduct exchanges beyond 200 nautical miles from the nearest land, in water at least 200 metres in depth or, if this is not possible, at least 50 nautical miles from the coast and in water at least 200 metres in depth in accordance with the guidelines developed by IMO. The Marine Environment Protection Committee is developing a number of guidelines for the implementation of the Convention.

261. The Intergovernmental Oceanographic Commission of UNESCO has developed a number of initiatives under its programme on ocean ecosystems. In 2004, it launched a project on biodiversity and distribution of megafaunal assemblages in the abyssal nodule province of the eastern equatorial Pacific: management of the impacts of deep seabed mining. This initiative aims to propose a baseline reference of the environment and the structure of megafaunal assemblages and develop recommendations for the management of the impacts of deep seabed mining. The baseline reference includes a quantitative and qualitative analysis of faunal assemblages, a compilation of the morphological identification of the taxa, an assessment of the taxonomic richness, the faunal composition, the relative abundance of the megafauna and the assessment of functional and trophic groups within particularly well-explored areas.

262. In January 2005, UNESCO and the Government of France organized the International Conference on Biodiversity: Science and Governance.[185] The statement issued by the Conference recalled the global target of significantly reducing the rate of biodiversity loss by 2010 as a fundamental condition for sustainable development and for the achievement of the Millennium Development Goals. It was recognized that biodiversity was being irreversibly destroyed by human activities at an unprecedented rate, and that urgent and significant action was required to conserve, sustainably use and equitably share the benefits of biodiversity. One of the final recommendations of the Conference was that an international multi-stakeholder consultative process, guided by a steering committee, should be launched to assess the need for an international mechanism that would provide a critical assessment of the scientific information and policy options required for decision-making, building on existing bodies and activities. The recommendation was based on a proposal by the scientific committee of the Conference to establish an international mechanism that would include intergovernmental and non-governmental elements and that would build on existing initiatives and institutions, with a view to providing scientifically validated information on the status, trends and services of biodiversity, identifying priorities and recommendations for biodiversity protection and informing the relevant international conventions and their parties. The scientific committee also recommended that interdisciplinary research programmes should be set up to discover, understand and predict biodiversity, its status, trends and the causes and consequences of its loss and to develop effective science-based decision tools for its conservation and sustainable use; that biodiversity should be integrated without delay, based on existing knowledge, into the criteria considered in all

economic and policy decisions as well as environmental management; that education of citizens and public awareness programmes should be greatly strengthened and improved to reach these objectives; and that a major effort should be made to build the capacity, especially in developing countries, to undertake biodiversity research and implement biodiversity protection.

D. Other international organizations

263. Following the recommendations adopted by the first meeting of its Subsidiary Body on Scientific Technical and Technological Advice,[186] the second meeting of the Convention on Biological Diversity Conference of the Parties agreed on a programme of action for implementing the Convention in respect of marine and coastal biodiversity (decision II/10), known as the Jakarta Mandate on Marine and Coastal Biological Diversity. On the basis of the Jakarta Mandate, the fourth meeting of the Conference of the Parties adopted decision IV/5 on the conservation and sustainable use of marine and coastal biological diversity, which contained, in an annex, the programme of work arising from decision II/10. The programme of work was reviewed and updated at the seventh meeting of the Conference of the Parties (see decision VII/5, annex I).

264. In relation to biodiversity beyond national jurisdiction, in its decision II/10 the Conference of the Parties requested the secretariat of the Convention on Biological Diversity, in consultation with the Division for Ocean Affairs and the Law of the Sea, to undertake a study of the relationship between the Convention on Biological Diversity and UNCLOS with regard to the conservation and sustainable use of genetic resources on the deep seabed, with a view to enabling the Subsidiary Body on Scientific, Technical and Technological Advice to address at future meetings, as appropriate, the scientific, technical and technological issues relating to bioprospecting of genetic resources on the deep seabed (see also A/58/65, para. 147). The study was presented to the eighth meeting of the Subsidiary Body, in March 2003.[187]

265. The conservation and sustainable use of biological diversity in marine areas beyond national jurisdiction was an important issue at the seventh meeting of the Conference of the Parties. The resulting decisions addressed several aspects of the issue: (a) marine protected areas in areas beyond national jurisdiction; (b) conservation and sustainable use of deep seabed genetic resources beyond national jurisdiction; and (c) the conservation and sustainable use of biological diversity beyond the limits of national jurisdiction in general terms.

266. In decision VII/5, the Conference of the Parties noted that there were increasing risks to biodiversity in marine areas beyond national jurisdiction and that marine and coastal protected areas were extremely deficient in purpose, numbers and coverage in these areas. The Conference of the Parties agreed that there was an urgent need for international cooperation and action to improve conservation and sustainable use of biodiversity in marine areas beyond the limits of national jurisdiction, including through the establishment of further marine protected areas consistent with international law and based on scientific information, including areas such as seamounts, hydrothermal vents, cold-water corals and other vulnerable ecosystems.

267. Regarding conservation and sustainable use of deep seabed genetic resources beyond national jurisdiction, the Conference of the Parties considered the work of the Subsidiary Body resulting from a joint study of the relationship between the Convention on Biological Diversity and UNCLOS, undertaken by the secretariat of the Convention and the Division for Ocean Affairs and the Law of the Sea. In its decision VII/5, paragraph 54, the Conference of the Parties requested the secretariat, in consultation with parties and other Governments and the relevant international organizations, to compile information on the methods for identification, assessment and monitoring of deep seabed genetic resources in areas beyond the limits of national jurisdiction; and to compile and synthesize information on their status and trends, including identification of threats to such genetic resources and the technical options for their protection. The Conference of the Parties also invited States to identify activities and processes under their jurisdiction or control that might have significant adverse impacts on deep seabed ecosystems and species beyond the limits of national jurisdiction in order to address article 3 of the Convention on Biological Diversity.

268. The Conference of the Parties expressed its concern about the serious threats to biodiversity in these areas and expressed the need for rapid action to address such threats, on the basis of the precautionary approach and the ecosystem approach. Consequently, the Conference of the Parties suggested that the General Assembly and other relevant international and regional organizations should urgently take the necessary short-term, medium-term and long-term measures to eliminate and avoid destructive practices, consistent with international law, on a scientific basis, including the application of precaution, for example, by consideration, on a case-by-case basis, of interim prohibition of destructive practices adversely impacting the marine biological diversity associated with seamounts, hydrothermal vents and cold-water corals. It further recommended that parties to the Convention should urgently take the necessary short-term, medium-term and long-term measures to respond to the loss or reduction of marine biological diversity associated with these areas.

269. By decision VII/28 on protected areas, the Conference of the Parties adopted a programme of work and established an Ad Hoc Open-ended Working Group on Protected Areas. The overall objective of the Working Group was the establishment and maintenance, by 2012, of a comprehensive, effectively managed and ecologically representative national and regional system of marine protected areas that collectively, inter alia through a global network, contributed to achieving the three objectives of the Convention and the 2010 target to significantly reduce the current rate of biodiversity loss. The Working Group held its first meeting from 13 to 17 June in Montecatini, Italy. One of the four items on the agenda of that meeting related to options for cooperation for the establishment of marine protected areas in marine areas beyond the limits of national jurisdiction.

270. The main outcome of the meeting of the Working Group concerning the marine protected areas related to the initiation of work to compile and synthesize existing ecological criteria for future identification of potential sites for protection in marine areas beyond the limits of national jurisdiction, as well as applicable biogeographical classification systems. The Working Group expressed its appreciation to the Government of Canada for its offer to host a scientific experts' workshop for this purpose.

271. The Working Group recommended that the Conference of the Parties should note that the establishment of marine protected areas beyond national jurisdiction must be in accordance with international law, including UNCLOS, and on the basis of the best available scientific information, the precautionary approach and the ecosystem approach. Regarding scientific information, the Working Group recommended that the Conference of the Parties should request the Executive Secretary to work with relevant institutions to synthesize, with peer review, the best available scientific studies on priority areas for marine biodiversity conservation, and that relevant organizations should collaborate in filling data gaps. In addition, the Working Group recommended that the Executive Secretary should explore options with relevant international and regional organizations to verify and develop a spatial database of biodiversity in marine areas, building on the database developed as part of a scientific study presented to the meeting.

272. Regarding options for cooperation, the Working Group on Protected Areas recommended that the Conference of the Parties recognize that UNCLOS set out the legal framework within which all activities in oceans and seas must be carried out. The Working Group also recommended that the Conference of the Parties should urge parties to work towards cooperation and coordination among various institutions for the establishment of marine protected areas consistent with international law and to work to develop measures to combat illegal, unreported and unregulated fishing. The Working Group decided that the results of its work should be transmitted for information to the Ad Hoc Open-ended Informal Working Group established by the General Assembly in its resolution 59/24.

273. In relation to the issue of access to genetic resources and benefits sharing, the fifth meeting of the Conference of the Parties to the Convention on Biological Diversity established in 2000 an ad hoc open-ended working group with the mandate to develop guidelines on access and benefit sharing. The sixth meeting of the Conference of the Parties adopted in 2002 the Bonn Guidelines on Access to Genetic Resources and the Fair and Equitable Sharing of the Benefits arising from their Utilization.[166] The Guidelines aim to assist Governments and other stakeholders in developing an overall access and benefit-sharing strategy and in identifying the steps involved in the process of obtaining access to genetic resources and benefit-sharing. Decision VII/19 D, adopted by the seventh meeting of the Conference of the Parties on recommendation 44 (o) of the Plan of Implementation[179] of the World Summit on Sustainable Development, mandates the working group to elaborate and negotiate an international regime on access to genetic resources and benefit-sharing with the aim of adopting an instrument. The third meeting of the Working Group, held in February 2005, addressed the nature, scope, potential objectives and elements to be considered for inclusion in the international regime. Other issues addressed during the meeting included use of terms; other approaches, including consideration of an international certificate of origin, source and legal provenance; measures to support compliance with prior informed-consent procedures and mutually agreed terms; and the need and possible options for indicators for access and benefit-sharing. (See also section F below for more information on the work of other organizations on intellectual property rights.)

274. The Convention on International Trade in Endangered Species of Wild Fauna and Flora aims at preventing the overexploitation of certain species of wild animals and plants through the regulation of international trade. Protected species are listed in appendices, which include a number of marine species, some which are found on

the high seas (see also A/59/62/Add.1, paras. 263-264). Conditions for international trade in specimens of these species depend on the appendix in which they are listed, which reflects the degree of protection needed to ensure their survival in the wild. The term “trade” is defined in article 1 of the Convention to mean not only export, re-export and import, but also “introduction from the sea”. The latter term is defined to mean “transportation into a State of specimens of any species which were taken in the marine environment not under the jurisdiction of any State”. At its eleventh and thirteenth meetings, the Conference of the Parties to the Convention sought to clarify the concept of “introduction from the sea” but did not reach a final conclusion. Decision 13.18 directs the Standing Committee of the Convention to convene a workshop on introduction from the sea to consider implementation and technical issues, taking into account the two FAO expert consultations in 2004, on implementation and legal issues related to the Convention and issues associated with listing commercially exploited aquatic species.[188]

275. The secretariat of the Convention actively provides advice and assistance to parties on all aspects of the Convention, in areas of general implementation, science, legislation, compliance and enforcement, training and information. National and regional participation is promoted through regular meetings of the Conference of the Parties, technical committees and regional/national training workshops. Training is provided through workshops and various forms of electronic learning. The main priority for training is improving capacity to manage and regulate legal trade in specimens listed in the appendices to the Convention, including marine species, focusing on permits and certificates, non-detriment findings, border inspections and general compliance with the provisions of the Convention.

276. The Convention on Migratory Species aims at the conservation of avian, terrestrial and aquatic migratory species that cross national jurisdictional boundaries in the course of their migration. These include marine species (avian and aquatic) moving between areas of the national jurisdiction and the high seas.

277. Parties to the Convention that are range States for a migratory species have the obligation of taking individually or in cooperation appropriate and necessary steps to conserve such species and their habitat (article II, para. 1). Significant in this regard is the definition of a range State provided by the Convention (article I, para. 1(h)), according to which a range State in relation to a particular migratory species means any State which exercises jurisdiction over any part of the range of that species, or a State, flag vessels of which are engaged outside national jurisdictional limits in taking that migratory species. This implies that the obligation of the parties to conserve migratory species applies also to their flag vessels operating in the high seas.

278. Parties to the Convention on Migratory Species should provide protection to migratory species listed on appendix I to the Convention; that appendix includes species that are considered in danger of extinction. It includes at present 107 species, among which are nine species of whale, one species of seal, several species of seabirds, six species of marine turtle and one species of shark that occur predominantly or occasionally in the high seas.

279. Besides the obligations of individual parties, the Convention has actively promoted the conservation of these species by providing support to research and conservation projects aimed at addressing some of the threats they face, in particular by-catch. Guidance to the parties in addressing the issue of by-catch of migratory

species has been provided by the Conference of the Parties through resolution 6.2 (By-catch) and recommendation 7.2 (Implementation of resolution 6.2 on by-catch).

280. The Convention on Migratory Species also operates through the establishment of agreements among range States aimed at the conservation of individual species or groups of related species on a regional scale. Several of the agreements concluded so far under the auspices of the Convention cover areas in the high seas. These include: (a) the Agreement on the Conservation of Albatrosses and Petrels (the Agreement covers 22 species of albatrosses and 7 species of petrels throughout their entire range, covering most of the southern hemisphere and was negotiated with the main purpose of tackling the problem of by-catch of these birds in long-line fisheries); (b) the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (the Agreement covers all species of cetaceans occurring regularly or occasionally in the Agreement area); (c) the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (the Agreement covers all species of small cetaceans — all toothed whales with the exception of the sperm whale *Physeter Macrocephalus* — occurring in the Agreement area; once the extension of the Agreement area decided by the fourth meeting of the parties to the Agreement, held in Esbjerg, Denmark, in August 2004, enters into force, the Agreement will cover parts of the high seas); and (d) Memorandum of Understanding on the Conservation and Management of Marine Turtles and their habitats of the Indian Ocean and South-East Asia (the Memorandum covers six species of marine turtle in the Indian Ocean and South-East Asia and adjacent seas, extending eastwards to the Torres Strait).

281. The International Seabed Authority’s basic function is to manage the mineral resources of the Area, which are the common heritage of mankind, in such a way as to give effect to the principles contained in part XI of UNCLOS and the 1994 Agreement for the Implementation of Part XI. By definition, the Area is the seabed and ocean floor and subsoil thereof beyond national jurisdiction. In managing the mineral resources, the Authority is required to ensure effective protection of the marine environment, and therefore biodiversity, from harmful effects which might arise both from exploration for, and subsequent exploitation of, these resources (article 145). In addition, the Authority has a general responsibility to promote and encourage the conduct of marine scientific research in the Area and to coordinate and disseminate the results of such research and analysis (article 143, para. 2). The Authority is carrying out its mandate by promoting and encouraging international cooperation, establishing databases on species to be found in potential exploration and mining areas and their distribution and gene flow and by encouraging the use of a uniform taxonomy and other standardized data and information in this regard.

282. The International Seabed Authority has developed and adopted regulations to govern prospecting and exploration for polymetallic nodules deposits in the Area. It is currently considering draft regulations on prospecting and exploration for polymetallic sulphides and cobalt-rich ferro-manganese crusts. Given the dearth of knowledge of the marine environment of the Area and the potential impact of exploration and mining on its biodiversity, these regulations have a strong environmental focus.

283. Threats to deep-sea biodiversity from mineral prospecting, mineral exploration or mineral exploitation in the Area need to be managed in such a way as to prevent species extinctions. In relation to the benthic ecosystem, the International Seabed

Authority is in the process of establishing a framework to manage successfully threats to the marine environment and its biodiversity from activities in the Area, through its regulations on prospecting and exploration. This framework includes the guidelines recommended by the Legal and Technical Commission of the Authority to contractors for environmental impact assessments, standardization of relevant environmental data and information and international cooperative scientific projects designed to increase the international community's knowledge of species ranges, species distribution and gene flow in the various mineral provinces of the Area.

284. Since 1998, the International Seabed Authority has held workshops and seminars on specific issues related to deep seabed mining, with participation by internationally recognized scientists, experts, researchers and members of the Legal and Technical Committee of the Authority as well as representatives of contractors, the offshore mining industry and member States. The workshops have dealt with a variety of topics, including the assessment of environmental impacts from activities in the Area, the development of technology for deep seabed mining, the status and prospects of deep-sea mineral resources other than polymetallic nodules, standardization of techniques for data collection and analysis and prospects for international collaboration in marine environmental research to enhance understanding of the deep-sea environment, including its biodiversity. Many of these workshops have had substantial components addressing the biodiversity of the Area.

285. As a direct result of the discussions in these workshops, the International Seabed Authority is currently collaborating in a major research project, referred to as the Kaplan project because of its main source of funding, the J. M. Kaplan Fund in New York. The Kaplan project is an international research project carried out in the Clarion-Clipperton Zone nodule province, in the Pacific Ocean. The aims of the Kaplan project are to measure biodiversity, species ranges and gene flow in the Clarion-Clipperton Zone. This information can be used to determine the level of risk introduced to the province's biodiversity as a result of mining for polymetallic nodules. The outputs will include a DNA database of species found in the Clarion-Clipperton Zone, the creation of a uniform taxonomy for the region and the integration of the results for the various taxa (polychaetes, nematodes, foraminifera and microbes) based on molecular and morphological approaches into a database. Genetic sequences will be included in this database, making it the first project to assess the genetic resources in the most significant polymetallic nodule province in the Area. A proposed component of this project is to train scientists from developing countries in the use of molecular techniques to study biodiversity. Therefore the project is aimed at both increasing the international community's knowledge of marine biodiversity in the Area and training of scientists to assess biodiversity better.

286. In 2004, the Legal and Technical Committee discussed the role of the International Seabed Authority in relation to the management of high-seas biodiversity. In his report to the Council, the Chairman of the Committee noted that the Commission's discussion during the session was for the purpose of gathering information and improving understanding of seabed biodiversity and the management and legal status of the living organisms of the Area. A paper on the legal implications related to the management of seabed living resources in the Area had been prepared by the Vice-Chairman of the Committee in her personal capacity, containing an analysis of the provisions of the Convention and the mandate of the

Committee.[189] The discussions revealed a need to address relevant issues taking into account the work of other organizations. Taking note of the Committee's discussions on issues relating to biodiversity in the Area, the President of the Council expressed the support of the Council for the work of the Committee in protecting the marine environment and managing the biological resources of the world's oceans.

287. During the 2004 session of the International Seabed Authority, a presentation was made by Census of Marine Life on its programmes, in particular on the work on the Biography of Deep-Water Chemosynthetic Ecosystems, and the Seamounts Group, as they cover the environments where polymetallic sulphides and cobalt-rich crusts deposits are found, respectively. As a result, the Authority is in communication with both bodies to investigate the potential for collaboration. It is hoped that the Authority can assist both of those bodies in terms of international cooperation, broadening the understanding of the effect these environments have on global biodiversity and how best to protect them.

288. While the International Seabed Authority is benefiting from close collaboration with those already conducting research on biodiversity in and around mineral deposits in the Area, it is also providing a forum for the discussion and development of principles for the management of this biodiversity.

289. The third World Conservation Congress of the World Conservation Union, held in November 2004, recognized the need to enhance the understanding of high-seas biological diversity, productivity and ecological processes. It called on States and international organizations to increase funding and support for marine scientific research, in particular capacity-building collaborative research, in order to improve knowledge and to ensure the sustainability of human activities. The Congress also called for cooperation to establish representative networks, to develop the scientific and legal basis for the establishment of marine protected areas beyond national jurisdiction and contribute to a global network by 2012. The Congress also requested States, regional fisheries management organizations and the General Assembly to protect seamounts, deep-sea corals and other vulnerable deep-sea habitats from destructive fishing practices, including bottom trawling, on the high seas.

290. A Task Force on High Seas Marine Protected Areas was established in 2004 by the World Commission on Protected Areas of the World Conservation Union. This is intended to facilitate the development of marine protected areas, particularly in vulnerable environments such as seamounts and deep-sea coral habitats. Under the Global Marine Species Assessment project, the Union and its partners are launching a global assessment to improve knowledge of marine species.

291. The 1946 International Convention for the Regulation of Whaling provides the International Whaling Commission with the dual mandate of both conserving whale stocks and managing whaling. The Convention applies both in areas under national jurisdiction and on the high seas. The Commission's activities relate mostly to the conservation of cetaceans and the sustainable use of whale stocks through consumptive or non-consumptive use (such as whale watching).

292. Since the International Whaling Commission agreed on a moratorium on commercial whaling in 1982, its Scientific Committee has developed conservative scientific methods for determining safe catch limits explicitly taking uncertainty into account. In 1994, the Commission adopted the Revised Management Procedure

for determining commercial whaling catch limits, but agreed that it would not be implemented until a Revised Management Scheme was developed to ensure that catch limits were not exceeded. Since no agreement has yet been reached on the Scheme, the moratorium on commercial whaling continues to be in force.

293. Although the management procedures of the International Whaling Commission take into account environmental factors in a precautionary manner, they are essentially single-species approaches. However, the Commission's Scientific Committee has begun to examine the links between fisheries and cetaceans, including how any change in the abundance of cetaceans is likely to be influenced by changes in fishery catches. A recent workshop on these issues was inconclusive. The Scientific Committee has either completed or is continuing in-depth assessments of a number of whale populations under its management. It has expressed concern over the status of a number of small populations of large whales, particularly the North Atlantic right whale and the western North Pacific grey whale.

294. There are currently two whale sanctuaries in which commercial whaling is prohibited: the Indian Ocean and the Southern Ocean. These include areas beyond national jurisdiction. Whale sanctuaries have been proposed in the South Pacific and the South Atlantic but have not been adopted. All sanctuaries are subject to periodic review: the Indian Ocean sanctuary was reviewed in 2002, while the Scientific Committee completed in 2004 the review of the Southern Ocean sanctuary.

295. The International Whaling Commission has been involved since the early 1990s in aspects of whale watching as a sustainable use of cetacean resources. A series of objectives, principles and guidelines have been adopted for managing whale watching. It has cooperated with FAO and the secretariats of the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas and the Agreement on the Conservation of Cetaceans of the Black Sea, the Mediterranean Sea and Contiguous Atlantic Area, in addition to general calls to States to take measures to reduce by-catch. The Commission has invited member States to raise the issue of ship strikes at IMO.

296. In order to investigate the effects of environmental change on cetaceans, the Scientific Committee has conducted two research projects: "POLLUTION 2000", aimed at determining whether predictive and quantitative relationships exist between biomarkers of exposure to and/or effect of PCBs and PCB levels in certain tissues, as well as at validating and calibrating sampling and analytical techniques; and "SOWER 2000", aimed at examining the influence of temporal and spatial variability in the physical and biological Antarctic environment on the distribution, abundance and migration of whales.

297. In addition, the Scientific Committee held a mini-symposium in 2005 to consider its possible assistance in the development and interpretation of studies aimed at elucidating the potential impacts of anthropogenic noise on cetaceans.

E. Other international entities

298. The International Coral Reef Initiative was established in 1994 to conserve, restore and promote the sustainable use of coral reefs and related ecosystems. Coral reefs are located both within and beyond national jurisdiction. Furthermore, the

potentially harmful impacts (and the solutions that might apply) on vulnerable biodiversity such as reefs and the contribution they make to other sectors such as fisheries, are similar whether that biodiversity is found within areas of national jurisdiction or beyond.

299. The activities of the International Coral Reef Initiative are facilitated by the International Coral Reef Action Network, an operational network established in 2000. The Network has created a globally integrated action plan to manage and protect coral reefs, thereby supporting the implementation of the call to action and framework for action adopted under the Initiative and other internationally agreed goals, objectives, targets and commitments related to coral reefs. Field projects have been developed to assist in the realization of the abstract agreements on marine biological diversity. The Global Coral Reef Monitoring Network was established in 1995 with the aim of improving the management and sustainable conservation of coral reefs by monitoring and assessing the status and trends of the reefs and how people use and value their resources. As an operational network under the Initiative, the Monitoring Network produces, among other products, regular biennial reports on the status of coral reefs of the world. The latest report was in December 2004 and includes a chapter on the status of cold-water coral reefs.[190] The UNEP Coral Reef Unit was established in 2000 as the focal point for coral reefs within UNEP and the United Nations system. Promoting a diverse portfolio of coral-reef work, the Unit has led the implementation of UNEP's Governing Council decisions on coral reefs and guided UNEP's programme support and policy analysis on the conservation, management and sustainable use of coral reefs and the resources and services they provide.

300. In July 2004, the International Coral Reef Initiative adopted a decision on cold-water coral reefs, which, inter alia, widened the remit of the Initiative and called on an ad hoc committee to prepare a draft work programme on cold-water coral reefs. The General Meeting of the Initiative, held in the Seychelles from 25 to 27 April 2005, endorsed the establishment of a cold-water corals committee and agreed on a work programme for the committee, which will report progress at the next meeting of the Initiative.

F. Organizations working on intellectual property rights

301. As the United Nations specialized agency responsible for the promotion and protection of intellectual property, WIPO has considered intellectual property issues related to genetic resources. In 1998, UNEP and WIPO jointly produced a study on the role of intellectual property rights in the sharing of benefits arising from the use of biological resources.[191] The same year, the WIPO Standing Committee on the Law of Patents, which is the body mandated to harmonize patent law, discussed issues related to intellectual property and genetic resources. In the context of its work on a draft substantive patent law treaty, the Standing Committee has continued to consider issues related to genetic resources, including the disclosure of origin of genetic resources. Furthermore, in 1999 the WIPO Working Group on Biotechnology issued a questionnaire to gather information about the protection of biotechnological inventions. The questionnaire addressed aspects related to intellectual property and genetic resources.

302. In 2000, the WIPO General Assembly established the Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore, which deals with a range of issues concerning the interplay between intellectual property and genetic resources. The work of the Intergovernmental Committee covers three main areas: defensive protection of genetic resources through measures that prevent the grant of patents over genetic resources that do not fulfil the requirements of novelty and non-obviousness; intellectual property aspects of access to genetic resources and equitable benefit-sharing arrangements (including the commissioning of a database to serve as a capacity-building tool and to help inform policy debate); and disclosure requirements in patent applications that relate to genetic resources and associated traditional knowledge used in a claimed invention.

303. Responding to an invitation from the sixth Conference of the Parties to the Convention on Biological Diversity in 2002, WIPO prepared a technical study on patent disclosure requirements related to genetic resources and traditional knowledge.[192] In 2003, the Working Group on Reform of the Patent Cooperation Treaty discussed proposals regarding the declaration of the source of genetic resources in patent applications. In response to an invitation from the seventh meeting of the Conference of the Parties, WIPO is currently examining the interrelation between access to genetic resources and disclosure requirements in intellectual property rights applications. To that end, the WIPO General Assembly decided to convene an ad hoc intergovernmental meeting on genetic resources and disclosure, which met in June 2005 to discuss a consolidated document of all comments and observations submitted by member States concerning the issues above. The results of the meeting were presented to the Intergovernmental Committee, which also met in June 2005.

304. The 2001 Doha Declaration[193] instructed the Trade-Related Aspects of Intellectual Property Rights Council, the body responsible for administering the Agreement on Trade-Related Aspects of Intellectual Property Rights, in its review of article 27.3 (b) of the Agreement, to examine the relationship between the Agreement and the Convention on Biological Diversity.[34] In 2002, the WTO secretariat prepared a summary of the issues raised and points made by delegations in the Council on the relationship between the Agreement and the Convention. During the Council’s discussions, the following topics were raised: ways of applying provisions of the Agreement on patenting biological inventions, including the extent to which life forms should be patentable; ways to implement the Agreement and the Convention together and whether the Agreement should be amended to avoid potential conflicts; whether patents should disclose the source of genetic material; and the type of approval necessary prior to using genetic material. Discussions are ongoing in the Council regarding disclosure requirements.

IV. Conclusions

305. As the conservation and sustainable use of biodiversity in general and marine biodiversity including in areas beyond national jurisdiction in particular, are increasingly attracting attention as an integral part of socio-economic development, the question arises as to how this goal can be achieved. Key issues and questions requiring further consideration and more detailed background studies, as well as possible options and approaches for the promotion of cooperation and coordination

in the conservation and sustainable use of marine biodiversity beyond areas of national jurisdiction, are set out below.

306. As scientific information and data on the diversity of deep-sea organisms, the biogeography of the deep sea floor biota and the distribution of key habitats and ecosystems functions are highly insufficient, there is an urgent need to expand and increase such scientific research programmes and studies. In particular, further research and studies are required to promote the conservation and sustainable use of marine biodiversity, bearing in mind the precautionary approach.

307. Enhanced scientific research will require the development of new and more targeted technologies, including sampling techniques. These technologies should be environmentally sound in order to minimize effects on marine ecosystems.

308. Since scientific research programmes utilizing highly sophisticated technology are very costly and labour intensive, cooperation and collaboration among States, competent international organizations, research institutions, funding agencies, academia and private sectors, should be encouraged, including through partnerships and joint ventures. This cooperation could result not only in a sharing of costs, but also in an increased geographical coverage, better sharing of information and a contribution to capacity-building. In this regard, consideration could be given to greater involvement of scientists from developing countries in scientific research programmes and activities in areas beyond national jurisdiction.

309. As biodiversity is increasingly acquiring importance from the perspective of economic development, there is an urgent need to balance economic benefits of such development with long-term conservation and sustainable use of biodiversity. In order to achieve this balance, the value of ecological goods and services should be taken into account, including indirect and non-use values. This would enable the preparation of a cost-benefit analysis for the conservation and sustainable use of biodiversity. However, as it is difficult to obtain the information necessary to assign an appropriate value to biodiversity and as there is also a need to identify the procedure for subsequent analysis of such information, more research and economic studies are required to examine these issues. The use of market-based approaches and incentives, such as those described in chapter II.C above, could be explored to improve conservation and sustainable use of marine biodiversity.

310. The loss of marine biological diversity can greatly limit socio-economic benefits derived from it for future generations, hence the importance of using biological resources in a sustainable manner. Socio-economic aspects of marine biodiversity beyond national jurisdiction need to be given a more prominent role when designing, developing or implementing conservation and management measures. In that context, conservation measures should be an essential component of economic planning, in order to attain sustainable development. Furthermore, socio-economic assessments should be included in cost-benefit analysis for the conservation and sustainable use of biodiversity.

311. Marine biodiversity is increasingly affected by a wide range of anthropogenic stresses related to existing and emerging activities. Further research is also urgently required to understand better environmental issues relating to marine biodiversity, including its assimilative capacity, in order to ensure its conservation and sustainable use as an integral part of economic development. Further studies are also

needed to understand better the impacts of current and future anthropogenic stresses on marine biodiversity in order to identify means to mitigate them.

312. Since fishing activities are recognized to have a significant impact on marine biodiversity beyond national jurisdiction, cooperation and coordination in conservation and management of fish stocks through relevant organizations should be enhanced. Biodiversity concerns should therefore be taken into account in developing measures for the conservation and management of fish stocks and fishing should be considered as one of the activities to be addressed in the conservation and sustainable use of marine biodiversity.

313. As highlighted in chapter II.F, UNCLOS provides the legal framework for all activities in the oceans, including for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction. A number of specialized international instruments supplement UNCLOS by directly or indirectly providing measures for the conservation and sustainable use of biodiversity beyond national jurisdiction. Increased membership in these treaties, their implementation and strict compliance with their provisions will promote the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction. The effective implementation of the voluntary instruments mentioned in chapter II.F, would also be beneficial in this regard. A coordinated approach to the implementation of all these instruments is also essential.

314. As not all activities affecting biodiversity beyond national jurisdiction, including their cumulative effects, and not all components of marine biodiversity are specifically regulated by UNCLOS and other instruments, the establishment of new measures and regulations for the conservation and sustainable use of marine biodiversity consistent with UNCLOS and, where necessary, regulatory mechanisms, may be considered.

315. This is of particular relevance to the issue of genetic resources. Different views have been expressed on whether, in accordance with UNCLOS, deep seabed genetic resources beyond national jurisdiction fall under the regime for the Area or under the regime for the high seas. Consequently, the status of these resources and the nature of activities relating to them should be clarified, in the light of the general principles contained in UNCLOS.

316. Another area that needs to be clarified in the context of conservation and sustainable use of marine biodiversity, is the relationship between high-seas activities, in particular fishing, and a coastal State’s sovereign rights over the sedentary species of the continental shelf.

317. Lastly, public awareness about the benefits derived from the conservation and sustainable use of marine biodiversity beyond national jurisdiction should be promoted. Improved communication strategies and education campaigns for the general public as well as decision-makers are essential to achieve the objectives of conservation and sustainable use as an integral part of social and economic development.

Notes

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[48] This section of the report was written on the basis of contributions from experts collaborating with the Division for Ocean Affairs and the Law of the Sea of the Office of Legal Affairs of the Secretariat.

[49] See also the report of the first meeting of the Ad Hoc Open-ended Working Group on Protected Areas of the Conference of the Parties to the Convention on Biological Diversity (UNEP/CBD/WG-PA/1/L.6).

[50] Taxonomy is defined in the contribution of A. Rogers as "the science of classification according to a pre-determined system with the resulting catalogue used to provide a conceptual framework for discussion, analysis or information retrieval".

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[156] For a description of biodiversity at deep-ocean hot springs in polymetallic massive sulphide deposits, see *Marine Mineral Resources: Scientific Advances and Economic Perspectives* (United Nations publication, Sales. No. E.05.V.12).

[157] The present section supplements part II of the report of the Secretary-General contained in document A/59/62/Add.1 and part II of the report of the Secretary-General contained in document A/59/298, which provided greater detail on the instruments mentioned.

[158] The relationship between the two conventions is articulated under articles 237 and 311 of the United Nations Convention on the Law of the Sea and article 22 of the Convention on Biological Diversity. For a study on the relationship between those conventions with regard to the conservation and sustainable use of genetic resources on the deep seabed, see UNEP/CBD/SBSTTA/8/INF/3/Rev.1.

[159] Additional information on these instruments can be found at www.unep.org/regionalseas.

[160] Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area (ISBA/6/A/18, annex) contain a definition of "marine environment". See also the recommendations for the guidance of the contractors for the assessment of the possible environmental impacts arising from exploration for polymetallic nodules in the Area (ISBA/7/LTC/1/Rev.1).

[161] For further information on the instruments that provide for the protection of specific areas and species, see UNEP/CBD/WG-PA/1/INF/2.

[162] Such criteria and guidelines have not yet been developed.

[163] See UNEP/CBD/COP/5/INF/7.

[164] *Deep Sea 2003* ..., see in particular the account of the Workshop on Bioprospecting in the High Seas.

[165] Articles 15 to 21 deal, respectively, with access to genetic resources; access to and transfer of technology; exchange of information; technical and scientific cooperation; handling of biotechnology and distribution of its benefits; financial resources; and the Financial Mechanism.

[166] UNEP/CBD/COP/6/20, annex to decision VI/24 taken by the Conference of the Parties at its sixth session.

[167] The Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982 (the Part XI Agreement) was drawn up primarily to address certain difficulties and number of States had in relation to the deep seabed mining provisions contained in part XI and the related annexes. The Agreement was adopted in 1994. The provisions of the Agreement and Part XI are to be interpreted and applied together as a single instrument.

[168] The information in the present section was taken primarily from *WIPO Intellectual Property Handbook: Policy, Law and Use* (WIPO publication No. 489 (E)) and from document UNEP/CBD/WG-ABS/3/2.

[169] The Patent Cooperation Treaty was adopted in 1970, amended in 1979 and modified in 1984 and 2001.

[170] The Patent Law Treaty was concluded on 1 June 2000 and entered into force on 28 April 2005.

[171] As at 28 January 2005, there were 36 such authorities: seven in the United Kingdom of Great Britain and Northern Ireland, three each in the Republic of Korea and the Russian Federation, two each in China, Italy, Japan, Poland and the United States of America and one each in Australia, Belgium, Bulgaria, Canada, the Czech Republic, France, Germany, Hungary, Latvia, India, the Netherlands, Slovakia and Spain.

[172] The information in the present section was primarily taken from document UNEP/CBD/WG-ABS/3/2.

[173] The Agreement on Trade-Related Aspects of Intellectual Property Rights entered into force on 1 January 1995.

[174] *Report of the United Nations Conference on the Human Environment, Stockholm, 5-16 June 1972* (United Nations publication, Sales No. E.73.II.A.14 and corrigendum), chap. I.

[175] General Assembly resolution 37/7, annex.

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[177] Ibid., annex II.

[178] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 1, annex.

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[180] UNEP/Env.Law/4/4, annex I.

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[182] *The International Regime for Bioprospecting: Existing Policies and Emerging Issues for Antarctica* (United Nations University, Institute of Advanced Studies, 2003).

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[184] The Fisheries Resources Monitoring System is expected to monitor the state of high-seas biodiversity.

[185] The Conference, organized by the French Government and sponsored by UNESCO independently from intergovernmental negotiations, was held in Paris from 24 to 28 January 2005. For more information see http://www.recherche.gouv.fr/biodiv2005paris.

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[193] World Trade Organization decision WT/MIN(01)/DEC/1.