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SCIENTIFIC INFORMATION ON BIODIVERSITY IN MARINE AREAS BEYOND THE LIMITS OF NATIONAL JURISDICTION

Note by the Executive Secretary

EXECUTIVE SUMMARY

The present document presents a map-based analysis of biodiversity in marine areas beyond national jurisdiction, which includes information about the distribution of ecosystems and species, as well as patterns of species richness. A comprehensive set of geographic information systems (GIS) maps were compiled for this analysis, which are reproduced herein and are best viewed in colour using the electronic version of the present document (available either at the Secretariat's website (www.biodiv.org) or on the CD-Rom distributed during the first meeting of the Ad Hoc Open-ended Working Group on Protected Areas). They include maps of known cold-water coral and seamount areas, as well as maps of species richness of invertebrate and vertebrate groups. Threats to biodiversity in marine areas beyond national jurisdiction are explored through maps of predicted extinction risk of commercial fish species and the distribution of red-listed non-fish vertebrates. Together, these maps provide an analysis of patterns of biodiversity in marine areas beyond national jurisdiction, which have been used to identify a preliminary set of priority sites for conservation. Specifically, the results indicate that the tropical Indo-Pacific is an area of high species richness, and that seamounts in the Pacific, Indian and Atlantic Oceans are important areas for biodiversity. The importance of seamounts as priority conservation sites is further highlighted by their apparent association with known cold-water coral reefs, their high invertebrate and fish species richness, and the threats they face from human impacts.

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I. INTRODUCTION

1. In accordance with paragraph 29 (a) of decision VII/28 and paragraph 30 of decision VII/5, the establishment of marine protected areas in marine areas beyond national jurisdiction will not only need to be consistent with international law, but also based on scientific information. While a separate information document prepared for the first meeting of the Working Group (UNEP/CBD/WG-PA/1/INF/2) provides an analysis of the international legal regime beyond national jurisdiction, this document presents a scientific study of the distribution, status and trends of biodiversity in these areas. Importantly, this study provides, for the first time, a series of Geographic Information system (GIS) maps of marine biodiversity beyond national jurisdiction. These maps are the results of extensive analysis of known locations of priority ecosystems, patterns of species richness, and extinction risks of exploited species. Together, they indicate that marine biodiversity beyond national jurisdiction is richly patterned, with some of these patterns helping to identify priority areas in need of protection.

2. Many ecosystems in marine areas beyond national jurisdiction, such as seamounts, cold water coral reefs and hydrothermal vents are home to an astonishing diversity of species. However, while our knowledge of most of these ecosystems is limited, we do know that the biodiversity they support is seriously and increasingly threatened by human activities. The need for rapid action to address these threats on the basis of the precautionary approach and the ecosystem approach has been recognized by the Conference of the Parties in decision VII/5.

3. The term "marine areas beyond national jurisdiction" refers to those areas that are located outside the 200-nautical-mile exclusive economic zone (EEZ), or outside the territorial sea, where no EEZ has been declared. This area covers approximately 202 million km^2, or an estimated 64% of the world's oceans. Included are open ocean and deep sea environments that are some of the least explored on the planet.

4. The present note has been prepared by the Executive Secretary to assist the Ad Hoc Open-ended Working Group on Protected Areas to explore options for establishment of marine protected areas in marine areas beyond national jurisdiction. The document provides a summary of a study undertaken by the Sea Around Us Project of the Fisheries Centre, University of British Columbia, Canada. 1/

5. The study relies extensively on GIS-based analysis, and has created the basis for a comprehensive global georeferenced database of biodiversity in marine areas beyond the limits of national jurisdiction that can be built upon in the future. It addresses both ecosystems and species, but concentrates primarily on identifying patterns of species richness in marine areas beyond national jurisdiction. The full study, including detailed description of methodology used, is available on the website of the Secretariat, and, like the present document, is best viewed electronically. The study was undertaken with generous funding from the European Union. Section II of the present document provides a summary of the status and trends of, and threats to, high seas ecosystems and species, while section III provides a preliminary identification of priority sites for conservation.

1/ The authors of the study were William Cheung, Jackie Alder, Vasiliki Karpouzi, Reg Watson, Vicky Lam, Catriona Day, Kristin Kaschner, Colette Wabnitz and Daniel Pauly.

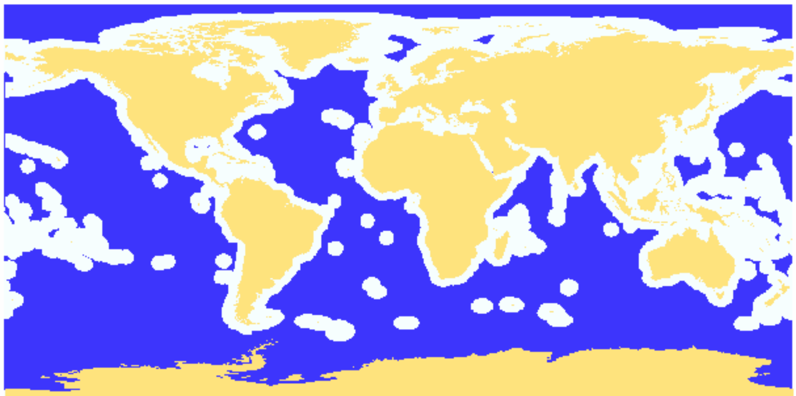

Figure 1: Marine areas beyond the limits of national jurisdiction as defined in this analysis (i.e., dark blue marine areas outside of national EEZs). This covers approximately 202 million km^2, representing an estimated 64% of the world's oceans (the total area of world's oceans is 363 million km^2).

II. STATUS AND TRENDS OF BIODIVERSITY IN MARINE AREAS BEYOND THE LIMITS OF NATIONAL JURISDICTION

A. Ecosystems: status, trends and threats

6. The detailed status of ecosystems in marine areas beyond the limits of national jurisdiction is poorly understood because there is limited global monitoring of ecosystem-specific features. While there is an extensive global monitoring system of high seas parameters such as sea temperatures, currents and other physical conditions, monitoring of ecosystem aspects, such as quality of benthic habitat, pollution from ships and other anthropogenic changes is limited to primarily fish stocks, marine mammals and some seabird species. This section briefly summarizes known information about three major ecosystems: seamounts, cold water coral reefs and hydrothermal vents. The current state of information regarding all major ecosystems and habitats in marine areas beyond the limits of national jurisdiction is summarized in table 1 (annex I).

1. Seamounts

7. Seamounts are isolated islands or island chains beneath the surface of the sea. More than 30,000 seamounts over 1000 meters high are estimated to exist in the world's oceans. As deep currents sweep past seamounts they swirl, which serves to concentrate plankton and carry nutrients up from deeper water layers. This upwelling turns these features into important feeding sites for a wide variety of bottom-dwelling and pelagic species. Many seamounts support dense assemblages of suspension feeding species such as corals (gorgonian, scleratinian and antipatharian), crinoids, hydroids, ophiuroids, and sponges (Rogers 1994). Orange roughy, pelagic armourhead, and oreos are some of the commercially important deep water fish species known to aggregate at seamounts to feed. Frequent pelagic visitors to seamounts include swordfish, tuna, sharks, turtles and whales (see UNEP/CBD/COP/7/INF/25). Figure 2 presents the estimated distribution of large seamounts based on a model using bathymetric and satellite data (Kitchingman and Lai, 2004).

8. Although relatively few (less than 200) seamounts have been comprehensively sampled, research has shown that seamounts are hot spots for the evolution of new species, refuges for ancient species, and stepping-stones for species to spread across ocean basins (Stone et al. 2004; Roberts 2002b; Koslow et al. 2001 and Richer de Forges et al. 2000). Rates of endemism are considered very high, ranging from 35% on seamounts off Tasmania, 36% for seamounts on the Norfolk Ridge; 31% on the Lord Howe Island seamounts, and 44% for fishes and 52% for invertebrates on the Nasca and Sala-y-Gomez chain off Chile (Stone et al 2004). Research suggests that these high rates are not just an artifact due to limited sampling,

for adjacent seamounts in New Caledonia have been found to share an average of just 21% of their species, and seamounts on separate ridges approximately 1000 km apart in the Tasman and Coral Seas have only 4% of their species in common (Richer de Forges et al. 2000. See also UNEP/CBD/COP/7/INF/25).

9. The biological characteristics of most deep-sea species associated with seamount ecosystems render them particularly sensitive to human disturbance and exploitation. The slow growth, longevity, late sexual maturity, and restricted distribution of many of these species (for example, deep-sea corals, sponges and fish) make them particularly vulnerable to human impacts and the risk of extinction. Concerns over the impact of fishing and the potential loss of this biodiversity are amplified by the limited information about the taxonomy, biology and ecology of most of the species found in deep ocean areas. Destructive fishing activities in these areas could bring about extinctions of entire groups of organisms that are still undiscovered (UNEP/CBD/COP/7/INF/25).

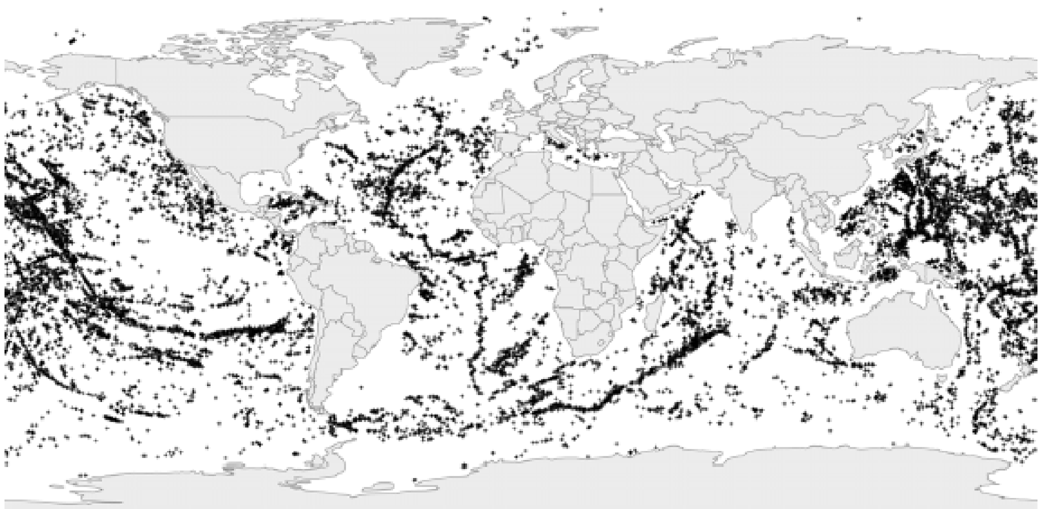

Figure 2: Distribution of large seamounts estimated by Kitchingman and Lai (2004). This map displays approximately 14,000 particularly well-defined (conical), seamounts. Including a wider range of seamount shape and size could increase their number to 100,000.

2. Cold-water coral reefs

10. Cold-water coral reefs, like their tropical warm and shallow-water counterparts, are built predominately by stony corals (*Scleractinia*). Cold-water corals grow in dark deep waters, and, unlike tropical corals, do not have light-dependent symbiotic algae in their tissues. Because of this, they depend solely on current-transported particulate organic matter and zooplankton (animal plankton) for their food. They grow slowly, at only a tenth of the growth rate of warm-water tropical corals. Many of them produce calcium carbonate skeletons that resemble bushes or trees, and provide habitat for associated animal communities. Cold-water corals can exist as small, scattered colonies of no more than a few metres in diameter to vast reef complexes measuring several tens of kilometres across. Radioactive dating techniques have shown that some living banks and reefs are up to 8000 years old. Cold water coral systems can be found in almost all the world's oceans and seas: in fjords, along the edge of the continental shelf, and around offshore submarine banks and seamounts (Freiwald et al. 2004). Although our understanding of the distribution, ecology and biodiversity of cold-water coral reefs is limited, a map of known location of cold-water coral areas has been produced (see figure 3).

11. Cold-water coral reefs support rich and diverse assemblages of marine life, and are home to thousands of other species, in particular animals like sponges, polychaetes (bristle worms), crustaceans

(crabs, lobsters), echnoderms (starfish, sea urchins, brittle stars, feather stars), bryozoans (sea moss) and fish (Freiwald et al. 2004). For example, *Lophelia pertusa* coral reefs in cold waters of the North-East Atlantic provide habitat for over 1,300 species of invertebrates. Marine scientists have observed large numbers of commercially important but increasingly uncommon groupers and redfish among the sheltering structures of deep-sea coral reefs, indicating their importance as habitat (UNEP/CBD/COP/7/INF/25).

12. Because cold water corals are long-lived, slow growing and fragile, they are especially vulnerable to physical damage. Damage from bottom trawling is also reported to be the main threat to cold-water coral reefs, resulting in mechanical damage, which breaks up the reef structure. Recent surveys of cold-water coral reefs have shown that, in many locations, the reefs have already been destroyed or damaged (Freiwald et al. 2004 and UNEP/CBD/COP/7/INF/25).

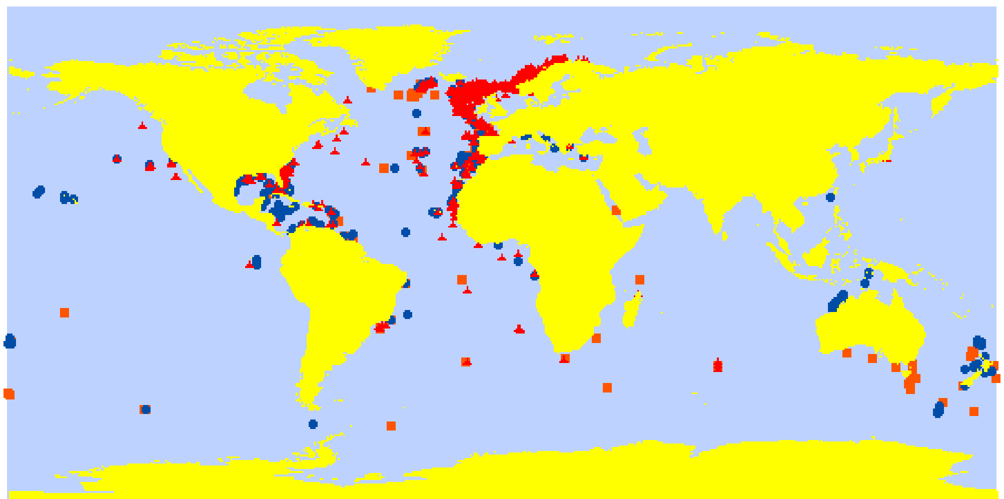

Figure 3: Distribution of known cold-water coral areas based on species distributions, *Lophelia pertusa* (red triangles), *Madrepora oculata* (blue circles) and *Solenosmilia varialilis* (orange squares) (UNEP-WCMC sourced from A. Freiwald from various sources)

3. Hydrothermal vents

13. Hydrothermal vents are typically found along mid-ocean ridges, at an average depth of 2100 m. As the tectonic plates that form the earth's crust move apart, they create cracks and crevices on the ocean floor. Seawater seeps into these openings and is heated by the molten rock, or magma, that lies beneath the Earth's crust. As the water is heated, it rises and seeks a path back out into the ocean through an opening in the seafloor. This surging hot water may be up to 400 ºC in temperature and is laden with mineral salts. Vents are characterized by extremely high temperatures and pH values, and by extreme salinity and toxicity. The micro-organisms that are the basis of the hydrothermal vents' food chains depend on these mineral substances. Hydrothermal vents are found only in areas where there is volcanic activity and magma is close enough to the surface to heat the fluids. These areas include active spreading ridges, subduction zones, fracture zones and seamounts. The Hydrothermal Vent Database on the InterRidge website (http://interridge.org/) currently lists 212 vent sites.

14. The discovery of chemosynthetic-based ecosystems at hydrothermal vents in the deep ocean was arguably one of the most important findings in biological science in the latter quarter of the twentieth century. More than 500 new animal species, most of which are endemic to vents, have been described from this environment. These animal species have adapted to exploit the extreme physio-chemical conditions found at vents, and range from tiny chemosynthetic bacteria to tube worms, giant clams, and ghostly white crabs (WWF/IUCN, 2001).

15. The only current anthropogenic threat to hydrothermal vent systems is from marine scientific research. Current research efforts concentrate on temporal changes at individual sites, which often involves repeated sampling, observation and instrumentation of a small number of well-known hydrothermal vent sites. Already, effects of biological and geological sampling operations on vent faunal communities have been documented. As vent sites become the focus of intensive, long-term investigation, it will become essential to introduce mitigative measures to avoid significant loss of habitat or oversampling populations. Bioprospecting, mining of polymetallic sulphide deposits associated with vent systems, and high-end tourism present potential future threats to vent ecosystems (WWF/IUCN, 2001).

4. Analysis of ecosystem distribution

16. Detailed analysis of known cold-water coral reefs (figure 4) showed that they generally occur near (within 50-100 km) of large seamounts. This was particularly true for two species, *Madrepora oculata* and *Solenosmilia variabilis*. All of the three species for which distribution data exists (*M. oculata, S. variabilis, and L. pertusa*) were generally clustered within 400-450 km and 650-700 km from seamounts. It is likely that these corals are associated with smaller seamounts not detected by the model used to produce figure 2. Seamounts tend to occur in clusters, with one large seamount generally associated with several smaller ones. This analysis presents evidence that, in marine areas beyond national jurisdiction, cold-water corals are generally associated with seamounts, and thus emphasizes the importance of seamount ecosystems in efforts to protect biodiversity in these areas. In addition, this apparent association would allow predicting the existence of far more cold-water coral sites than so far documented. A preliminary analysis also provides evidence that cold-water corals are associated with continental slopes. Although these areas are largely within national jurisdiction, some reefs on continental slopes may extend into areas beyond the limits of national jurisdiction.

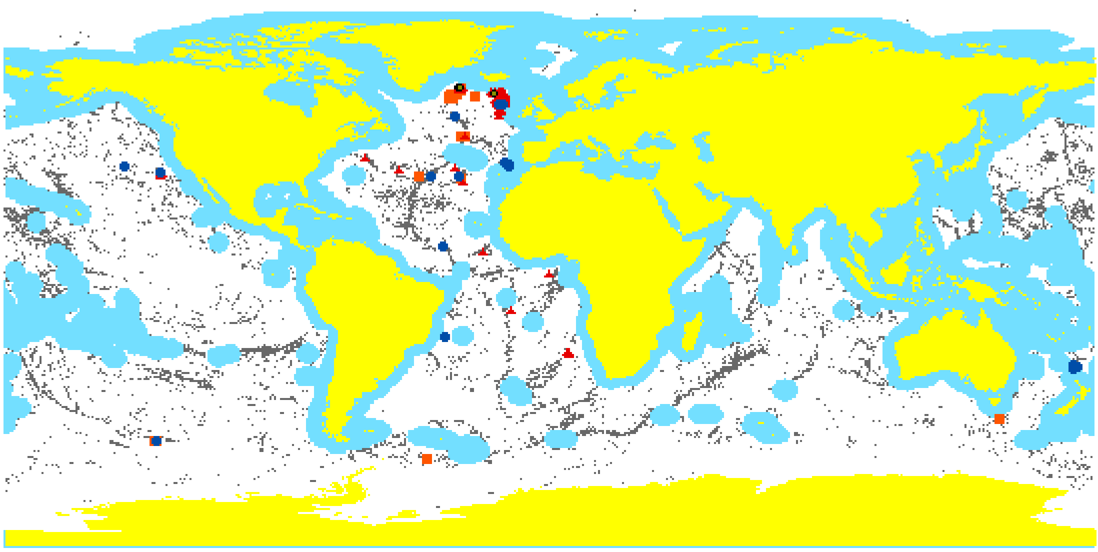

Figure 4: Cold-water corals (figure 3) superimposed on the distribution of seamounts (figure 2), both outside EEZs. The modal distance between seamounts and cold-water coral reefs is 50 - 100 km. Modes at higher distances are likely associated with smaller seamounts (see text). This suggests that outside of EEZs, cold-water corals are exposed to the same threats as oceanic seamounts (figure 8).

B. Species: status, trends and threats

17. This section presents an analysis of patterns of species richness in marine areas beyond the limits of national jurisdiction, while tables 2 and 3 in annex I contain a summary of status and trends of, and threats to, fish stocks and other species. As part of the analysis, maps of species richness, based on the

distribution of individual species of marine invertebrate and vertebrate groups, have been produced. Distributions of individual species were obtained from published maps, notably in FAO catalogues (e.g. Márquez 1990; Roper *et al*. 1984), existing databases, such as FishBase, or from depth and latitudinal range data, and other information. Latitudinal and longitudinal species richness gradient (increased species richness at the Equator, and between 95 and 141º latitude East, respectively) were assumed for higher taxa (fish and invertebrates) lacking specific information about their distributions, consistent with observed distribution patterns for fish (Fishbase; Froese and Pauly 2000) and invertebrates (Ekman 1967). The distribution data was incorporated into a GIS system to obtain ranges of species distribution. The methodology used is described in detail in document UNEP/CBD/WG-PA/INF/3.

1. Invertebrates

18. The distribution of exploited marine invertebrates beyond the limits of national jurisdiction is shown in figure 5, indicating that areas of highest invertebrate richness occur in the tropical Indo-Pacific. The map in figure 5 combines the distribution ranges of invertebrate species known to occur in marine areas beyond the limits of national jurisdiction, including crustaceans (crabs and lobsters), gastropods (snails), bivalves, clams, oysters, etc., and cephalopods (mainly squids and cuttlefish). Overall, there is limited information about the distribution of invertebrates, though better information exists for cephalopods (www.cephbase.org). When cephalopods are mapped on their own (figure 6), maximum species richness occurs in the Atlantic.

19. Overexploitation is the biggest threat to invertebrate species richness in marine areas beyond the limits of national jurisdiction. Catches of marine invertebrates in these areas are primarily composed of cephalopods (80%), crustaceans (14%) and non-cephalopod molluscs (4%). Other invertebrates contribute only 2% to the total catch of invertebrates from marine areas beyond national jurisdiction. Invertebrates associated with seamounts are highly threatened by fishing, especially trawling (Stocks 2004), particularly because many of these species are attached to the bottom and thus vulnerable to mechanical damage. A database documenting seamount invertebrates has been created (Stocks 2004b; http://seamounts.sdsc.edu), which, although still incomplete, shows that seamounts are characterized by strong endemism. A study of fished and unfished seamounts found that species richness on unfished seamounts was 106 % higher than on fished seamounts, and biomass was more than 7 times higher (Koslow *et al.* 2001). Similarly, cold-water coral species such as *Oculina* and associated rich invertebrate diversity are threatened by fishing especially, trawling (Freiwald *et al.* 2004). The high degree of endemism, combined with high degree of threat, suggests that there is a need to focus conservation efforts on seamount ecosystems.

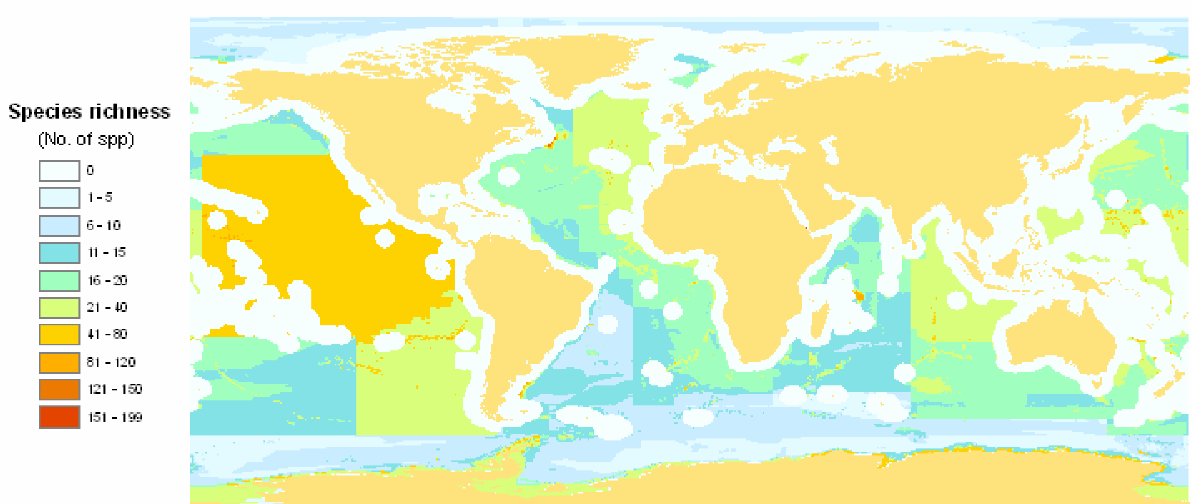

Figure 5: Map of species richness of exploited marine invertebrates in areas beyond the limits of national jurisdiction. This is based on 330 distribution ranges representing 557 species, plus 276 pertaining to species, notably of cephalopods (119). This map is structured in large blocks because for many invertebrate groups, all that was known of their distribution is that they occurred in certain FAO statistical areas, whose borders define the blocks.

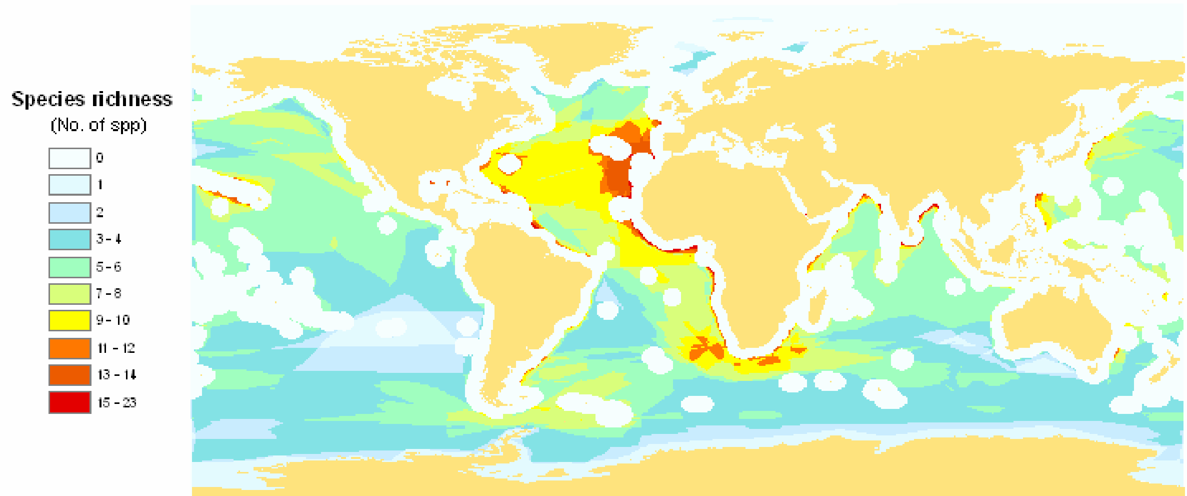

Figure 6: Map of species richness of commercial cephalopods (largely squid and cuttlefish) in marine areas beyond the limits of national jurisdiction, based on 119 distribution ranges in Roper *et al.* (1984). The total number of cephalopods (both high seas and coastal) is 786 (www.cephbase.org).

2. Fish

20. A map of the distribution of species richness of exploited marine fish in the high seas is presented in figure 7, showing higher species richness in the tropics, in particular South-East Asia. Localized concentrations of species richness occur also in more temperature latitudes, where they are mainly associated with seamounts. The map was created from available distribution ranges for 463 high seas species, all commercially important and contributing 9.4% of the marine fish catch in 2000. In addition, data for 104 genera (representing 631 species) and 75 families (representing 848 species) were included. In total, 1942 fish species were included in this analysis. They included all large pelagic fish, such as tuna and billfish.

21. A separate analysis was undertaken for fish associated with seamount ecosystems, the results of which are presented in figure 8. The analysis is based on an assigned degree of association for each fish taxon, ranging from 0 (no association) to 1 (obligatory association), based mainly on information in FishBase (Froese and Pauly 2000; www.fishbase.org), which incorporated the data in Froese and Sampang (2004). The map indicates high fish species richness in seamount areas. In addition, the association of cold water corals with slopes of seamounts in marine areas beyond the limits of national jurisdiction (figure 4) would result in increased habitat complexity, likely increasing species richness in these areas.

22. Threats to exploited marine fish in the high seas were demonstrated through an analysis of relative extinction risk over three time periods: 1950s, 1970s and 1990s (see figure 9a-c). For each taxon, with time-series of catch, a relative extinction risk index was estimated for each time-period using an algorithm based on the estimated intrinsic vulnerability of the taxa (Cheung *et al.* 2005) and the patterns of their catch time-series (Cheung *et al.* unpublished data). The index ranges from 1 to 100 and increases with the extinction risk of the taxon to fishing. In the 1950s (figure 9a), most fisheries were concentrated in close inshore areas, and the expansion of commercial fishing into deeper and more distant waters had

just begun (Pauly *et al*. 2002). Hence the risk of extinction for many taxa was quite low. However, by the 1970s (figure 9b) commercial fishing had expanded significantly and extinction risks increased accordingly, as fishers targeted various stocks, including vulnerable species, that until recently were too deep and too distant to exploit. By the 1990s (figure 9c), with fleets fishing much deeper and further offshore, the risk of extinction has increased dramatically as stock are being overfished, and in some cases locally extirpated. A number of fish stocks in the high seas are currently threatened; these include some species of tuna in the open pelagic systems, notably Atlantic bluefin tuna, as well as demersal stocks such as the Patagonian toothfish found on seamounts in the Southern Ocean. The intrinsic vulnerability of seamount fishes has been found to be higher than for fish in other habitats (Morato et al. 2004, Froese and Sampang 2004). Table 2 (annex I) presents a summary of the status, trends and threats to biodiversity of fish stocks.

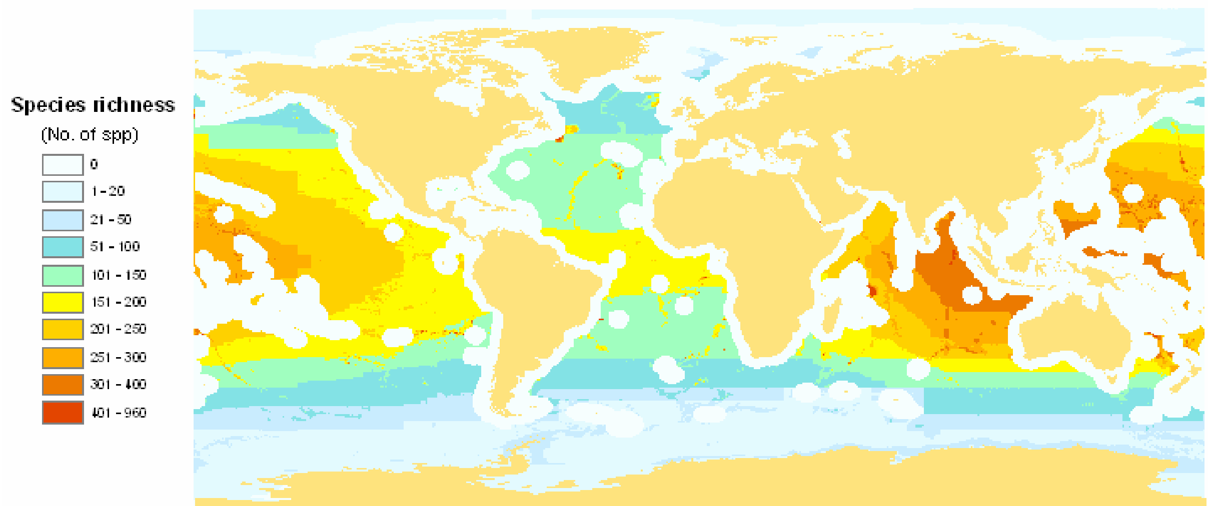

Figure 7: Map of species richness of exploited marine fish in the high seas based on 463 species distributions and 189 additional ranges representing 1,942 species.

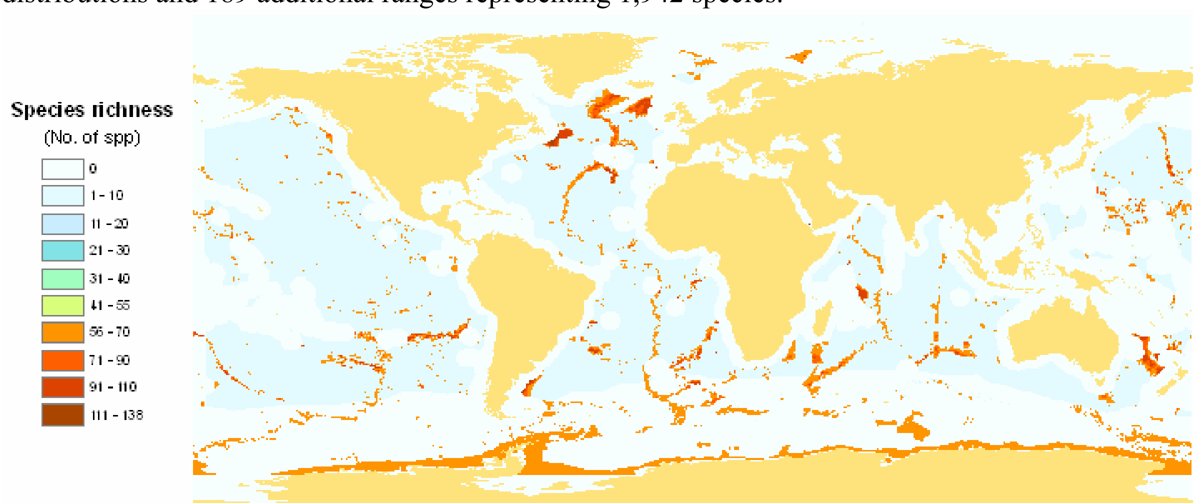

Figure 8: Species richness of exploited fish associated with seamounts.

a)
b)
c)

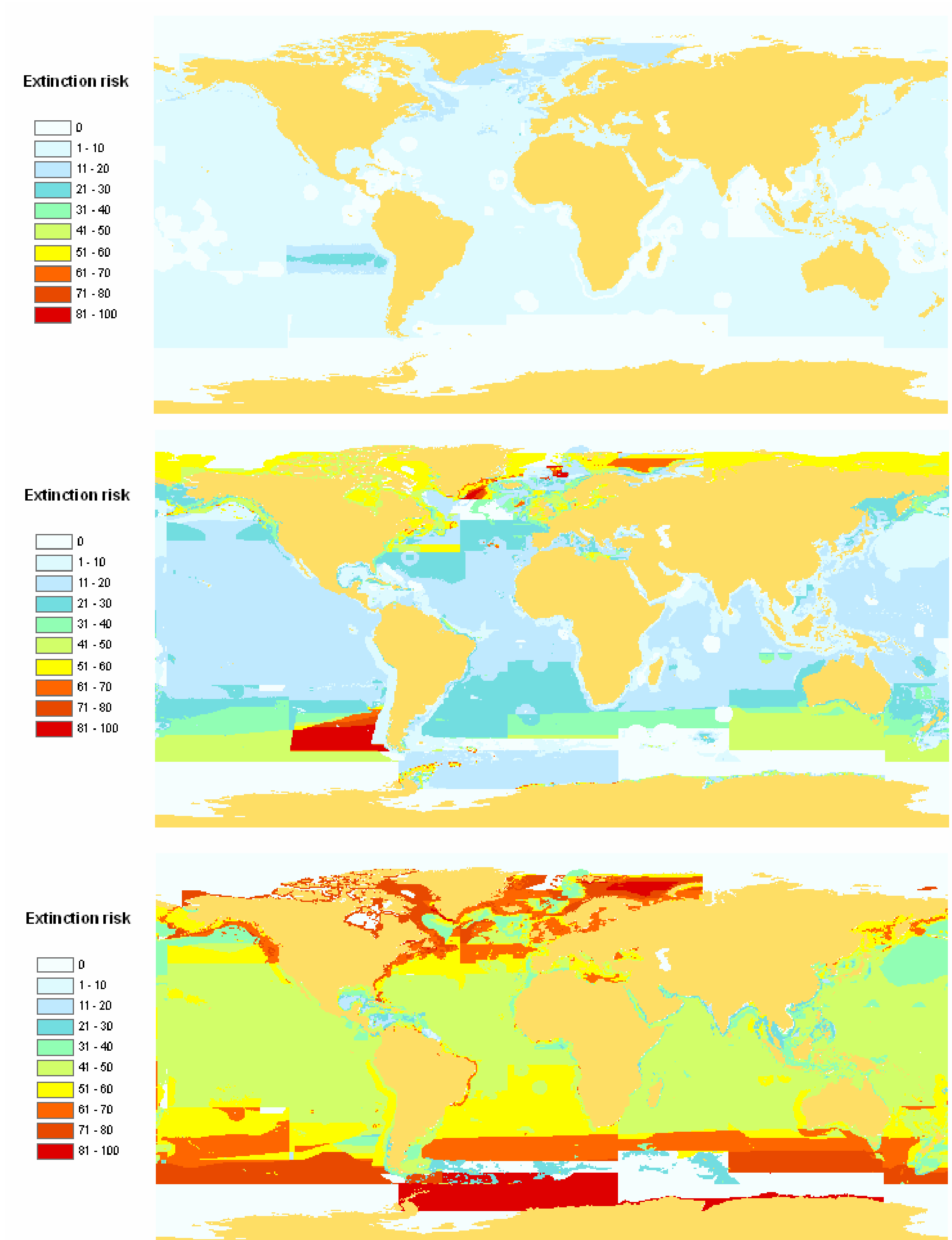

Figure 9: Maps of average relative extinction risk (0=lowest risk of extinction, 100=highest risk) of exploited marine fish weighted by their total catch in the (a) 1950s, (b) 1970s and (c) 1990s. The relatively low risk in the inter-tropical belt is in part a result of lack of detailed statistics.

3. Marine reptiles

23. Figure 10 presents a map of the species richness of marine reptiles whose range extends into the high seas. They include 7 species of sea turtle (based on Márquez 1990) and one species of sea snake. The map of the species richness of reptiles is dominated by the seven species of turtles, with many species widely dispersed on the high seas (figure 10). The resolution of the mapping method fails to identify the areas where turtle biodiversity is endangered. In the high seas, pelagic (particularly driftnet and longline) fisheries catch turtles as by-catch.

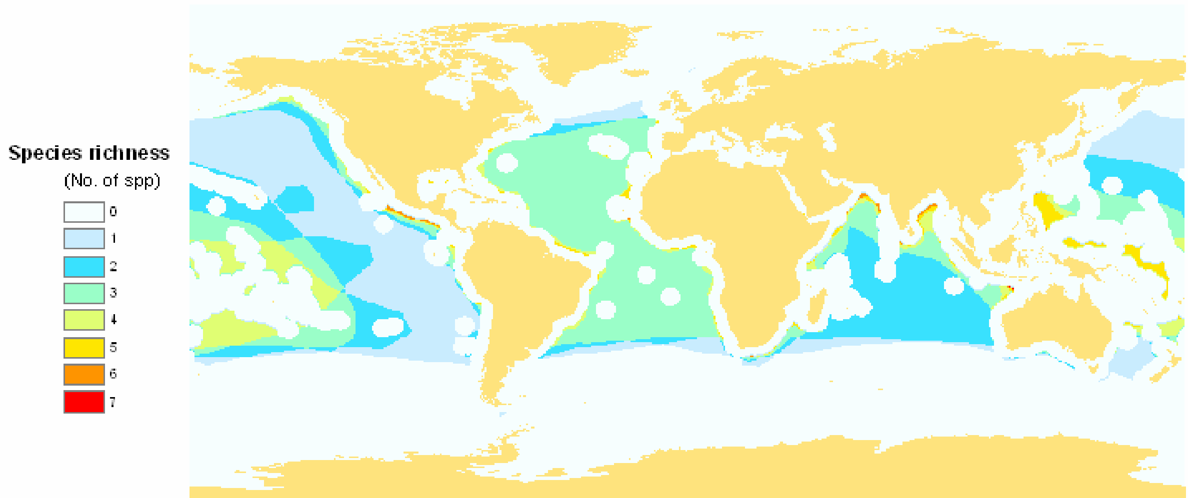

Figure 10: Map of species richness of marine turtles (7 species) and one pelagic sea snake found in the high seas, based on the distribution ranges of these 8 species.

4. Seabirds

24. The distribution of seabird species richness also exhibits more species in the Pacific than the Atlantic (figure 11). On the other hand, the majority of seabird species do not occur on the equator, but in the Southern Hemisphere. Isolated islands in the Southern Hemisphere are important in serving as nesting grounds around which feeding occurs. The map in figure 11 is based on the distribution maps of 115 species of pelagic seabirds known to occur in the high seas. These species forage in the deeper offshore waters and include pelagic, deep-diving penguins, albatrosses, prions, petrels, and shearwaters. The distribution ranges were further refined, for some species of shearwaters, by taking into account the distribution of tunas, which drive their prey to the surface, and hence facilitate the predation of smaller fishes by shearwaters (C. Walters, Fisheries Centre, UBC, pers. comm.).

25. Biodiversity of seabirds is declining rapidly compared to other groups of birds, as shown by an analysis using the IUCN Red List Index (DèCruz and Finlayson, in press). Albatross species are declining at an alarming rate, with longline fishing the greatest threat to these birds (Birdlife International 2004). Petrels are also declining, but not as fast as albatross species. The recent introduction and further development of longline hooks that do not entangle seabirds are a cause of cautious optimism regarding the recovery of many seabirds. Declining food supply is an additional threat to seabirds, directly from fisheries that exploit their prey, and indirectly from fisheries for large pelagics (which by reducing their biomass, preclude them from playing the facilitating role described above).

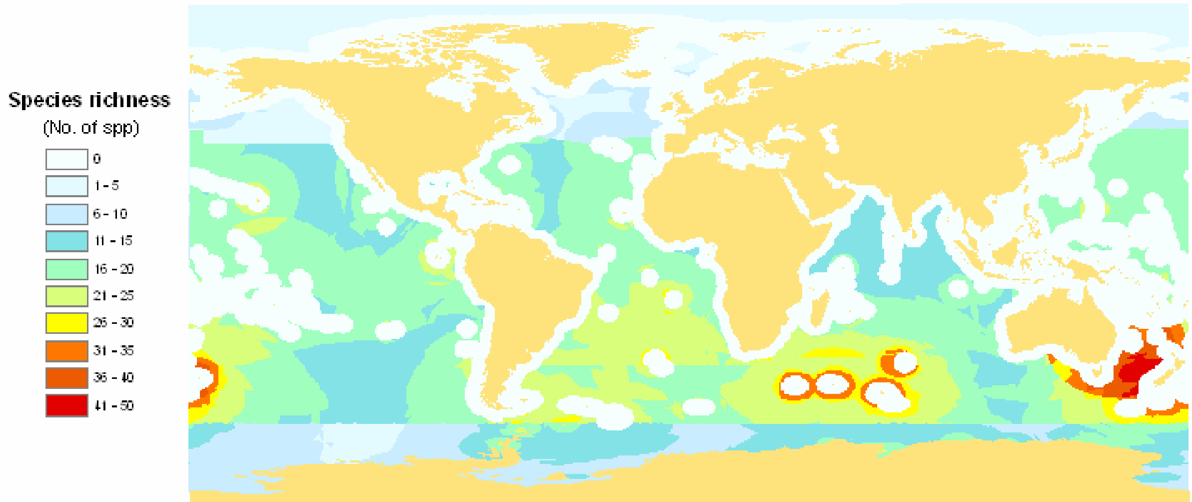

Figure 11: Map of species richness of pelagic sea birds, based on the distribution maps of the 115 species. The area of high species richness is in eastern Australia, New Zealand and on islands north of the Antarctic Convergence.

5. *Marine mammals*

26. Figure 12 shows the species richness of marine mammals based on distribution maps of all 100 species occurring in the high seas. Marine mammal distributions are characterized by a latitudinal gradient wherein the maximum number of species occurs in the South-East Pacific (figure 12). There is low diversity in the North Atlantic, where at least two coastal species, the Atlantic grey whale, and the Caribbean monk seal, are extinct. The mapping of geographic ranges of marine mammal species was based on the predicted relative suitability of the environment for each species throughout its range (Kaschner *et al*. in review). The environmental suitability predictions were based on qualitative and where possible quantitative observation of the relationship between a species' presence and environmental conditions such as depth and annual sea surface temperature (Kaschner *et al*. in review).

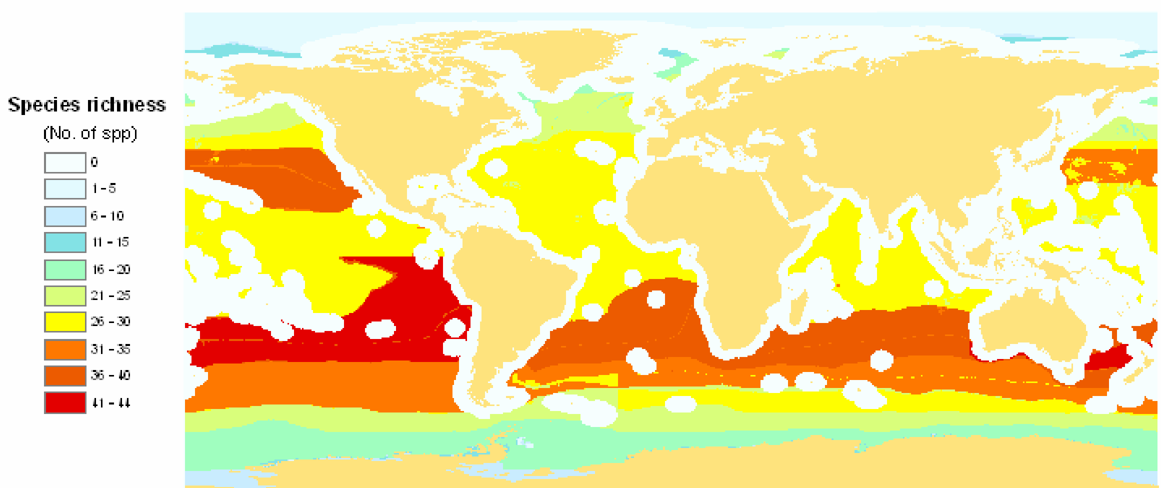

Figure 12: Map of marine mammal species richness based on distribution maps of all 100 species occurring in the high seas. Distribution of species richness is characterized by latitudinal bands with highest species richness in the south-eastern Pacific. Two species of marine mammals (Caribbean monk seal and Atlantic grey whale) in the North Atlantic are extinct.

III. TOWARDS SELECTING PRIORITY SITES FOR CONSERVATION

27. In order to determine potential locations for priority conservation sites in marine areas beyond the limits of national jurisdiction, the data from the above analysis were combined. Fish and invertebrate species richness were mapped together (figure 13), as were non-fish vertebrate species richness (figure 14). A map of threatened marine non-fish vertebrates was produced (figure 15), so that the degree of threat to both fish (figure 9) and other vertebrates could be understood. Finally, a species richness maps for all marine taxa (figure 16) and all higher vertebrates and fish (figure 17) were produced. Based on these maps, patterns for marine biodiversity beyond national jurisdiction emerge. The results confirm the importance of the tropical Indo-Pacific, as well as seamount areas in the Pacific, Indian and Atlantic oceans. The importance of seamounts as hot spots of biodiversity is additionally verified by their association with known cold-water corals in marine areas beyond the limits of national jurisdiction (figure 4), and their high invertebrate and fish species richness. Cold-water corals may also be associated with continental slopes, and may, in some cases be partially inside, and partially outside national jurisdiction.

28. Figure 13 presents the combined species richness of exploited marine fish and invertebrates in marine areas beyond the limits of national jurisdiction. As expected, there is a gradient of species richness that is higher in the tropics, particularly in South-East Asia. In addition, several priority biodiversity areas associated with seamounts emerge in the Indian and Pacific oceans, many of them in the tropical belt. In the Atlantic, only a few such areas are indicated, and these are associated with seamounts.

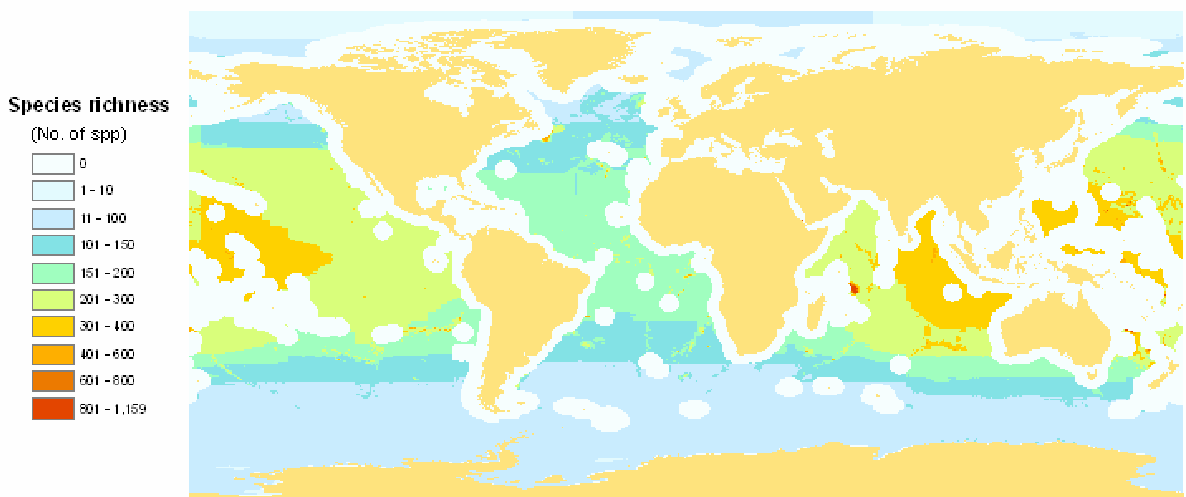

Figure 13: Map of species richness for exploited marine fish and invertebrates in areas beyond the limits of national jurisdiction based on 1,072 species distribution ranges, and 267 ranges representing an additional 3,678 species.

29. A map of non-fish vertebrate species richness in marine areas beyond the limits of national jurisdiction can be seen in figure 14. Again, species richness is higher in the tropics, except that seabirds pushed the overall distribution southward. In this analysis, the only potential priority biodiversity area for non-fish vertebrates emerged in the high-seas area of the Tasman Sea.

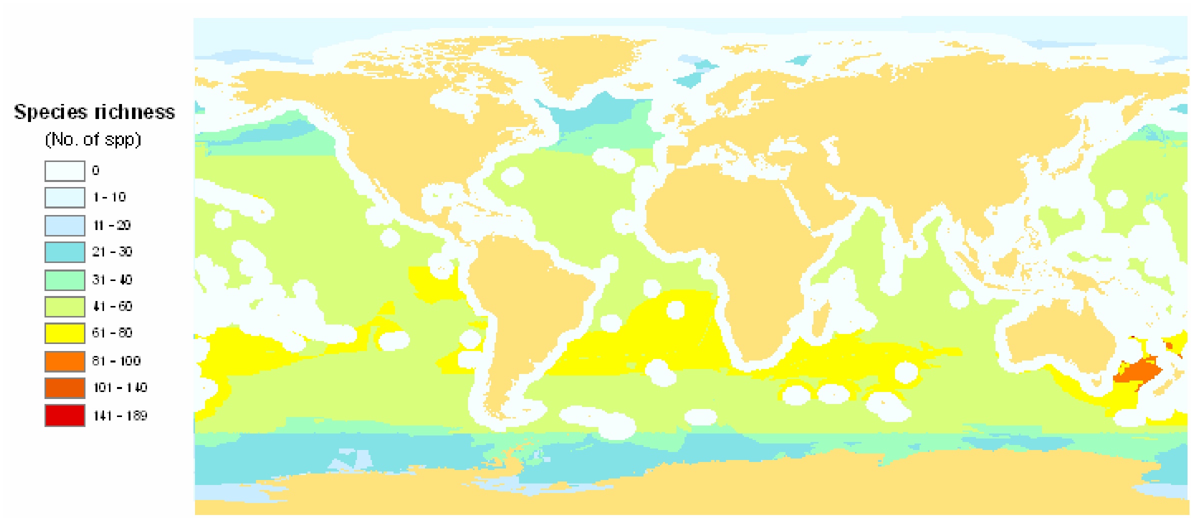

Figure 14: Map of non-fish vertebrate species richness in the high seas.

30. As indicated in figure 15, the need to implement specific conservation efforts in marine areas beyond the limits of national jurisdiction of the Indo-Pacific is further corroborated by the analysis of threatened marine non-fish vertebrates. In this case, the high seas areas of the southwest Pacific are home to particularly threatened non-fish vertebrates, a pattern mainly driven by seabirds. However, the mean risk of extinction for commercially exploited marine fish species is most significant in the higher latitudes (figure 9). This may reflect the long history of intensive exploitation in these regions. The relatively lower extinction risk in the tropics may be a result of lower catch data resolution, as only 10% of the catch data for the late 1990s for the Central Western Atlantic was reported at species level (Pauly and Palomares 2005). Thus extinction risk of individual fish species in these areas may be underestimated.

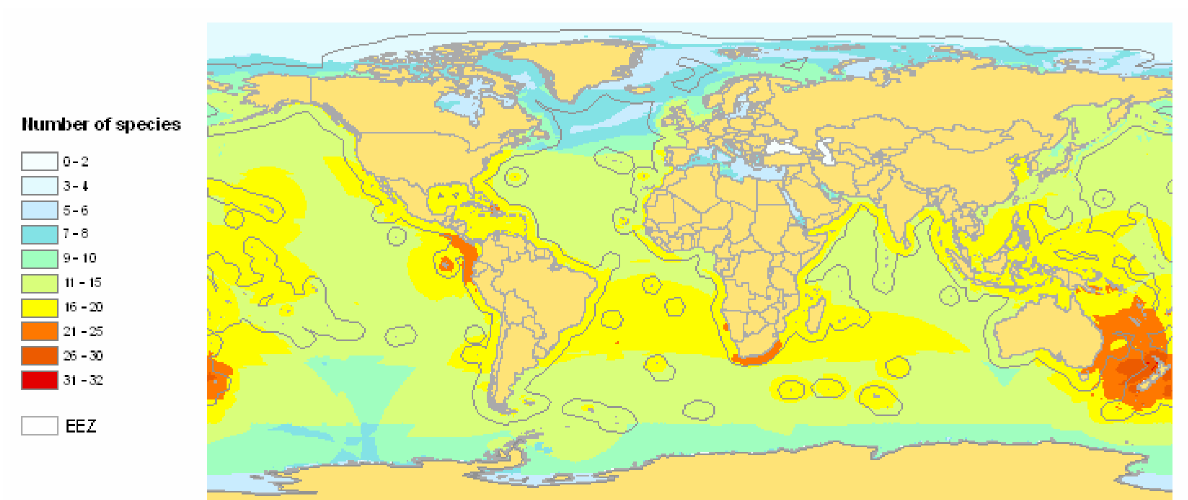

Figure 15: Map of threatened marine non-fish vertebrates that are listed as vulnerable, endangered, or critically endangered on the IUCN Red List based on their species-specific ranges (N=103). The threatened birds largely dominate the observed pattern with 81 species listed versus 16 for marine mammals and reptiles.

31. The map of species richness in figure 16 is based on ranges of exploited invertebrates and fish, and of reptiles, birds and marine mammal species, while figure 17 presents the species richness of all marine fish and higher vertebrates. There are large areas of high species richness in marine areas beyond national jurisdiction of the tropical Indo-Pacific. In the Atlantic, at least two small areas of high species richness emerge in the North-East and North-West Atlantic. These areas are not associated with seamounts, but overlap with important fishing grounds. In the North Atlantic, small areas associated with

ridges and some seamounts are also highlighted. In addition, this study demonstrates the high species richness along the Southern Ocean convergence zone.

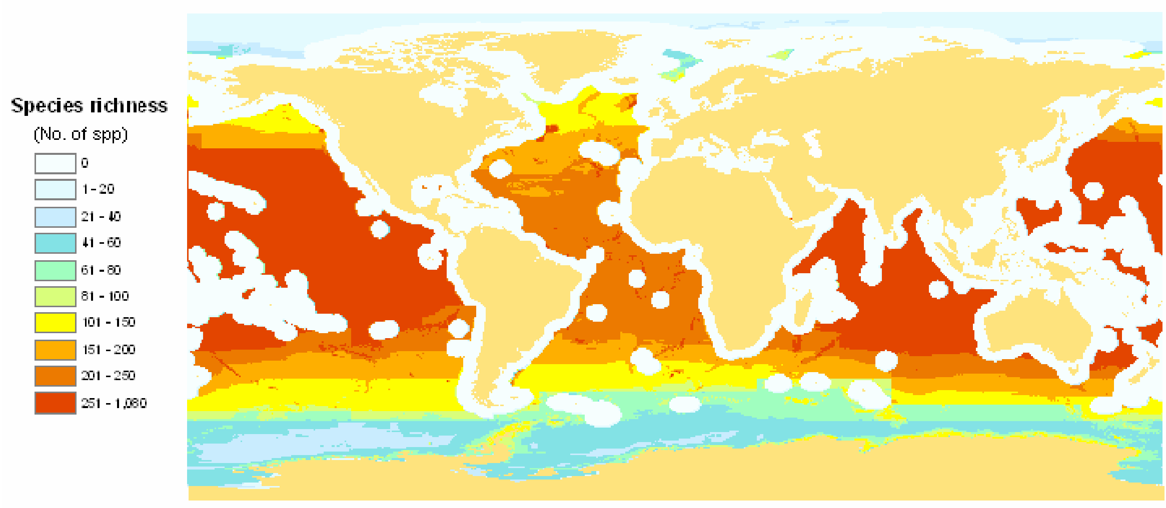

Figure 16: Map of marine species richness in areas beyond the limits of national jurisdiction (based on the ranges of exploited invertebrates and fish, and of reptiles, birds, and marine mammal species).

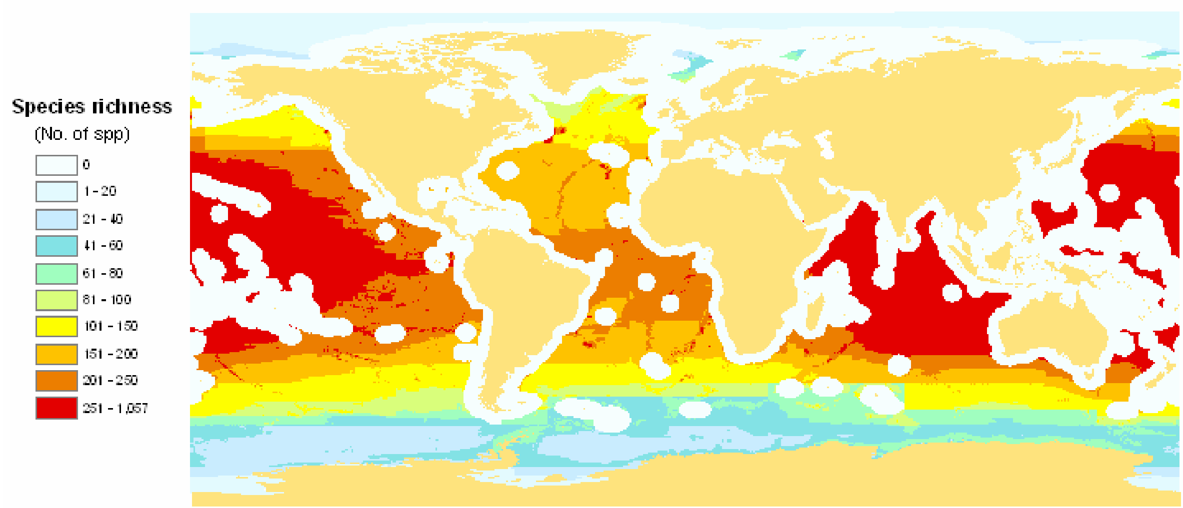

Figure 17: Map of marine fish and higher vertebrates' species richness in the high seas. Note the relatively high species richness of seamounts in the Atlantic.

32. Based on the above analysis of patterns of species richness in marine areas beyond the limits of national jurisdiction, preliminary observations can be made about priority areas for protection. In order of priority, the analysis highlights the following areas for targeted conservation action:

(a) The marine areas beyond national jurisdiction of the of the Indo-Pacific, specifically centered on South-East Asia, northern Australia and the Tasman Sea (figures 14, 15 and 16);

(b) Seamounts beyond national jurisdiction in the North and South Atlantic, and the Southern Ocean convergence zone (Figure 16 and 17). These areas are especially significant since protection of seamounts and surrounding areas will more than likely also protect cold-water corals;

(c) Marine areas beyond national jurisdiction adjacent to islands in the Southern Ocean (figure 12); and

(d) Small shelf areas beyond national jurisdiction in the North-East and North-West Atlantic (figures 16 and 17).

33. The analysis did not take into consideration threatened marine fish and invertebrates. Once such an analysis is completed, alternative and additional priority areas for action may emerge. It is also noted that data on ecosystems and species in marine areas beyond the limits of national jurisdiction is still lacking, and the investigation identified priority data gaps as follows:

(a) The distribution of all Red-Listed species, especially for fish;

(b) Information on seamount and cold-water coral species from a range of depths, and in particular from poorly sampled areas such as the Indian Ocean;

(c) Associations between cold-water corals and seamounts including underwater features especially of seamounts, so that inferences on cold-water corals can be drawn from seamounts (where an increasing amount of information is available); and

(d) Studies of the features of animals and their behaviours that makes them vulnerable to fishing.

34. The analysis of species richness patterns in marine areas beyond the limits of national jurisdiction undertaken here presents a first look at priority areas for conservation, for which immediate action can be considered. In the longer term, and in accordance with the objectives stated in decisions VII/28 and VII/5 of the Conference of the Parties to the Convention on Biological Diversity, systems of ecologically representative marine protected areas would need to be established in areas beyond the limits of national jurisdiction. This would require the development of a bioregional framework for oceans management, as well as the establishment of criteria for site selection. The data layers created as part of this study provide the basis for a global GIS database of biodiversity in marine areas beyond the limits of national jurisdiction, which can be expanded and built upon in the future to support the establishment of representative systems of marine protected areas. Even though our current knowledge of biodiversity beyond national jurisdiction is far from complete, cooperative action in the context of the precautionary approach can be taken immediately to target areas in particular need of protection. In this regard, the legal analysis contained in section V of the information document on the legal regime of the high seas (UNEP/CBD/WG-PA/1/INF/2), and summarized in annex VI to the note by the Executive Secretary on options for cooperation for the establishment of marine protected areas in marine areas beyond the limits of national jurisdiction (UNEP/CBD/WG-PA/1/2, provides specific illustrative examples of how the priority biodiversity areas identified here could be protected under existing legal regimes, and how cooperation towards the conservation and sustainable use of resources in marine areas beyond national jurisdiction might be undertaken in identified geographic locations. It is clear that marine protected areas and other such measures beyond the limits of national jurisdiction will be needed if we are to reach the 2010 target for reducing the rate of biodiversity loss.

Annex I

***Table 1**: Status and trends: high sea and deep-sea habitats* (modified from Baker *et al.* 2001)

Habitat	Status	Trend and immediate threats	Potential threats
Seamounts (Figures 2 and 8)	Less than 200 seamounts have been studied; high endemism on studied seamounts; some seamounts are heavily exploited for fisheries resources (Watson & Morata 2004), trawling damages benthic habitats. Few seamounts protected by MPAs (Alder & Wood 2004)	High seas fishing on seamounts to continue especially in the Southern Ocean; impacts are not monitored; it is anticipated that heavily exploited stocks will be threatened with over exploitation - therefore fish biodiversity threatened; attention to managing and protecting seamounts is increasing (e.g. Bowie Seamount (Canada), and fishing restrictions on EU vessels in the Azores)	Mining of ferromanganese oxide and polymetallic sulphides, climate change
Deep-water corals (Figures 3 and 4)	Limited knowledge, they may be more widespread than currently known (figure 8b); high diversity, except for fish and mollusks compared to tropical reefs; easily damaged by trawling, but spatial extent unknown	Fishing on coral or adjacent to coral reefs with consequential damage still occurs, especially in areas outside of EEZs. As fisheries continue to move further offshore and into deeper waters the threat to these habitats will continue since these areas are often now in the high seas and outside of national jurisdictions. Many countries are identifying coral areas and initiating action to protect them from fishing.	Biotechnology, bioprospecting and climate change; gas and oil platforms can damage corals
Hydrothermal vents (see Cone 1997 for review of earlier literature)	Limited disturbances – currently due to limited research on vents, low number of species, but high endemism and high abundance. Two vent areas (Canada and Azores) are declared MPAs.	Research community is initiating self-policing activities regarding impact of research activities so it is anticipated in the short-term that impacts from research will decline; in the long-term commercial exploitation is a concern.	High potential for biotechnology, mining, energy and high-end tourism
Open pelagial (Figures 5, 6, 10, 13)	Highly dynamic and diverse ecosystem is heavily exploited globally (Pauly *et al.* in press) Also increasing levels of pollution and eutrophication impacting on biodiversity (Verity *et al.* 2002)	Overall continuing decline in biodiversity as fishing further offshore and deeper continues; the impact of climate change may exacerbate decline.	Climate change, expansion of aquaculture into the open ocean/high seas
Deep-sea trenches	Unique 'hadal' fauna, much of it associated with soft sediments and holothurians; high endemism; diverse and abundant bacterial community; no known disturbances	Research is increasing in these areas, but, it is anticipated that based on experience of hydrothermal vents, appropriate guidelines will be developed to minimize the impacts of research on these ecosystems.	Research, biotechnology and waste disposal
Cold seep and pockmarks	Limited knowledge; high endemism; limited disturbances except for Gulf of Mexico (trawling and oil exploitation) or research sites	As fishing and gas and oil operations continues to go further offshore and deeper, anticipate that disturbance may increase.	Biotechnology and mineral exploitation
Submarine canyons	High diverse flora and fauna with commercial important species such as lobsters; important nursery areas; areas impacted by fishing and oil exploitation	As fishing and gas and oil operations continues to go further offshore and deeper, anticipate that disturbance may increase.	Gas and oil developments

Table 2: *Summary of the status, trends, and threats to biodiversity of fish stocks*[1]

Ecosystem[a]	Status	Trend	Threats
Seamounts & Deep water coral reefs (see Figures 8 and 4).	Many species such as Patagonian toothfish and Orange roughy are overfished, including in areas outside of EEZs. Areas that were fished more than 20 years ago are not showing signs of recovery.	Continued declines in biodiversity due to over fishing except in MPAs or areas where fishing is restricted; recovery of some stocks may take decades once fishing ceases (see also Watson and Morato 2004).	Over fishing, climate change (Glover and Smith 2003)
Open ocean pelagic (see Figure 7).	Concern over specific tuna (e.g. Bigeye in the Pacific, and Bluefin in the Atlantic).	Continued over fishing as aquaculture expands and the demand for fish and fish oil continues to grow.	Over fishing, aquaculture, climate change, pollution, eutrophication (Verity *et al*. 2002).

[a] Information on fish stocks associated with thermal vents is not available; they are presently likely not threatened (see Cone 1991).

Table 3: *Summary of the status, trends, and threats to species diversity in marine areas beyond the limits of national jurisdiction*

Species or groups	Status	Trend	Threats
Invertebrates	Limited knowledge, except for cephalopods, which are strongly exploited	Cephalopods increasing where fishing has reduced the biomass of bony fish, but compensatory potential has limits.	Overexploitation
Reptiles	Most species of turtles under threat	Declining, in spite of some success of mitigation	By-catch
Seabirds	Biodiversity declining rapidly	New gear technology, if widely implemented, may provide hope of recovery	By-catch, prey depletion
Marine mammals	Modest to good knowledge of population sizes in some groups. Population trends and abundance in beaked whales unknown	Some species of baleen whales recovering from historic depletion. Some dolphins recovering from by-catch mortality in tuna fisheries. Some others affected by increase in fishing on their prey.	By-catch, especially for smaller species. Fishing on their prey organisms. Resumption of commercial whaling

Annex II

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