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Ecosystem and Biodiversity in Deep Waters and High Seas

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Ecosystems and Biodiversity in Deep Waters and High Seas

UNEP Regional Seas Report and Studies No. 178

UNEP

Regional Seas

WCPA
WORLD COMMISSION ON PROTECTED AREAS

IUCN
The World Conservation Union

This overview was prepared by the Regional Seas Programme of the United Nations Environment Programme (UNEP), in cooperation with the World Conservation Union (IUCN).

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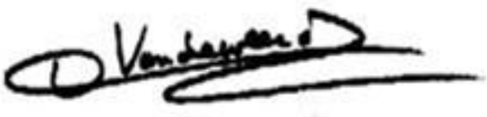
Ecosystems and Biodiversity in Deep Waters and High Seas

A report prepared by Kristina M. Gjerde

UNEP 2006

Foreword

The United Nations Environment Programme (UNEP) and the World Conservation Union (IUCN) have a long and successful history in working with states and stakeholders on marine and ocean issues. The missions of our respective organisations are “to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations” (UNEP) and “to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable” (IUCN). In the light of this complementarity, we have joined efforts to summarise facts and options for the conservation and sustainable use of marine habitats and life forms in deep waters and the open ocean, with a special focus on areas beyond national jurisdiction. We hope that this report will inspire policy and decision makers, and guide a way forward to taking urgent action to apply the spirit of our mission statements also to the unique, important and vulnerable ecosystems and biodiversity in the deep waters and high seas.



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Executive Summary

We live in an age of ocean discovery. Advances in science and technology are unveiling secrets and shattering myths about the oceans that are changing the way we view life on Earth. There is an urgent need to apply these new insights to manage human activities to protect, restore and maintain ocean life in all its variety so that life on Earth can continue to prosper.

Not long ago, deep seabed environments were thought to be empty expanses hostile to life. Today, these environments are considered to have been the very cradle for life on Earth and the largest reservoir of biodiversity on the planet. The great variety of deep seabed habitats, which includes hydrothermal vents and cold seeps, seamounts and submarine canyons, abyssal plains and oceanic trenches, and recently discovered asphalt volcanoes, hosts an amazing array of unique ecosystems and species found nowhere else. New surprises are frequent. Overturning traditional notions of deep sea ecology and coral biology, ancient coral reefs dating back to the dawn of civilization have been discovered in just the past five years in dark and frigid waters spanning from Alaska to Antarctica, from Norway to New Zealand.

The oceans provide many essential services with substantial socio-economic benefits that are often taken for granted. Recent studies have revealed that oceans are the very fabric of life: they provide oxygen, modulate weather, drive planetary temperatures and chemistry, and absorb substantial amounts of CO_2. Oceans also harbor most of the water and biological diversity on Earth. The variety and abundance of marine life is essential to the health and resilience of the oceans, for balanced ecosystems are better able to respond to changing conditions, both natural and human wrought.

Much of our current understanding of the open ocean and deep seabed stems from explorations carried out in the last five to ten years. International research projects and global cooperative efforts, such as the Census of Marine Life, are helping to assess and explain the changes in past and present diversity, distribution and abundance of marine species, and to project future ocean life. They have showed us where many large marine animals spend much of their time and enable us to monitor these habitats. Hotspots and key migratory pathways can thus be protected to give vulnerable open ocean species a chance to recover. Historic records compared with current data also tell us that these hotspots are decreasing in size and diversity, highlighting the need for rapid response. On the deep seabed, scientists continue to discover new and unique species on every cruise, and sometimes even new ecosystems and kingdoms of life. But too often scientists have found that other humans, such as fishermen, have been there first, leaving trails of broken corals and flattened sponge reefs in their wake.

The same advances in technology that enable us to peer into the ocean's murky depths have also enhanced our ability to exploit open ocean and deep seabed resources. While pollution, shipping, military activities and climate change also threaten marine biodiversity and ecosystems, fishing currently presents the greatest threat. Our ability to exploit has outpaced by far our limited understanding of what is necessary for sustainable use. We have reduced many populations of large open ocean fish stocks to 10% or less of their pre-industrial levels and have driven some species to the brink of extinction.

The special life history characteristics of deep sea organisms including slow growth, long life - over 200 years in some cases - and a low reproductive rate were discovered only after several significant deep sea fisheries had collapsed from overfishing. Without cautious management and effective regulation, deep sea fish stocks are quickly depleted and their associated seabed habitats and ecosystems destroyed, forcing fishermen to venture to new stocks and new grounds. The benefits of such 'boom and bust' operations are short-lived at best, and are disproportionate to the threats and destruction they cause for ecosystems and species that may occur no place else on Earth. These large-scale fisheries operations further undermine the hopes that oceanic resources can make a substantial contribution to human food security and poverty alleviation, as most of these resources are currently destined for markets in developed countries, and will soon be extinguished.

As human activities such as fishing and oil, gas and mineral exploration and exploitation move into deeper waters both within and beyond national jurisdiction, the relative lack of data on deep seabed ecosystems and biodiversity makes it difficult to predict and control their impacts. Still greater efforts are required to compile and review existing knowledge and to employ modern technologies for the discovery, quantification and understanding of deep sea life.

What has become clear is that the evolution of the legal system governing these areas has not kept pace with scientific and technological advances and man's expanding footprint on the oceans. The 1982 United Nations Convention on the Law of the Sea (UNCLOS) commits countries to protect and preserve the marine environment, and to conserve and wisely use marine resources - regardless of whether these are within or beyond national jurisdiction. While countries are concentrating on ecosystem-based management and networks of marine protected areas in their coastal waters and exclusive economic zones, areas beyond national jurisdiction - representing approximately 64% of the ocean's surface - lack the institutions, rules and enforcement mechanisms to ensure that similar considerations and precautionary approaches are applied.

Governments and civil society are now faced with a major challenge of developing and delivering management systems for the deep seabed and open oceans before it is too late and human demands exceed their capacity to give, absorb and support. Especially in marine areas beyond national jurisdictions, current systems need to be updated to:

- reflect ecological boundaries not just political boundaries;
- incorporate modern ecosystem-based and precautionary approaches;
- address the full range and cumulative effect of potential human activities and impacts;
- ensure a higher level of protection for vulnerable species as well as for biologically and ecologically significant areas;
- make possible a precautionary system of marine protected areas on a representative, biogeographic basis for a suite of reasons including as insurance to protect libraries of yet unknown or poorly understood biological diversity;
- provide effective mechanisms to secure compliance and enforcement; and
- enable sustainable use today and thus respect the rights of future generations to enjoy and prosper from the same ocean bounty.

The conservation and sustainable use of the vulnerable ecosystems and biodiversity in deep waters and high seas are among the most critical oceans issues and environmental challenges today. Immediate impacts and threats, such as those posed by fishing, have to be reduced urgently. Activities that generate long-lasting pollution, alter climate, disrupt oceanic circulation regimes and acidify ocean waters have to be addressed, while we still can.

1 Introduction

Soft coral (Paragorgia sp.) with brisingid sea star. Photo courtesy of Deep Atlantic Stepping Stones Science Team/IFE/ URI/NOAA.

Recent advances in science and technology are changing the way we view life in the oceans. What was regarded as featureless, unchanging and inexhaustible is now known to be complex, dynamic and finite.

These same advances in technology are also increasing man's impact on our remote, deep and little known waters. Once limited largely to shipping and open ocean fishing, commercial activities at sea are expanding rapidly and plunging ever deeper. Deep sea fishing, bioprospecting, energy development, and marine scientific research are already taking place at depths of 2,000m or more. Throughout the oceans, shipping, military operations and seismic exploration have intensified with growing impacts on deep water and high sea ecosystems and biodiversity. The spectre of climate change and its impacts such as ocean warming and acidification underscore the need to reduce direct human impacts, because healthy ecosystems are better able to respond to changing oceanic conditions.

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) is regarded by many as the 'Constitution' for the world's oceans. It establishes the basic jurisdictional zones and fundamental rights and duties of states throughout the ocean realm. Under UNCLOS, coastal states have exclusive rights to the resources of their 200nm exclusive economic zones (EEZs) and on their legal continental shelf (the submerged prolongation of the land mass to the outer edge of the continental margin, including the physical continental shelf, the slope and rise, or to a distance of 200nm, whichever is furthest). At the same time, all states have the right and freedom to access the resources of the "high seas" - the water column beyond the EEZ or territorial sea where no EEZ has been declared (e.g. the Mediterranean and Antarctica) - as well as the duty to conserve marine living resources and to protect and preserve the marine environment, wherever located. In areas beyond national jurisdiction, both in the high seas and the seabed "Area" (seafloor and subsoil beyond the legal continental shelf), the provisions of UNCLOS have been elaborated through a variety of legal agreements. These cover, for example, seabed mining, fishing for highly migratory and straddling fish stocks, waste dumping and shipping activities.

However, the evolution of the legal regime governing deeper marine areas, especially those beyond national jurisdiction, has not kept pace with the rapid technological developments over the last decades. Many governments have recognized the need for both immediate as well as long-term action for protection, conservation and sustainable use of the rich storehouse of biological diversity in the deep oceans and high seas. In global meetings, states are beginning to consider whether, and if so, what kind of new mechanisms might be needed to ensure that modern precautionary and ecosystem-based management approaches are reflected in legal responsibilities and effectively applied and enforced, so that life as we know it in the oceans - and on Earth - can thrive for the years to come.

This report reveals recent discoveries about the beauty, value and vulnerability of life in the deep seas and in the open ocean. It explores what these astonishing findings mean for current oceans governance, what the impacts are of present and potential human activities, and what can be done to promote effective and sustainable management of the riches of the deep and open oceans. The ecosystems and species described herein do not adhere to man-made boundaries; many exist within national jurisdiction as well as in the high seas and seabed "Area". It is hoped that this report will provide a common basis of knowledge to stimulate action by states and the global community.

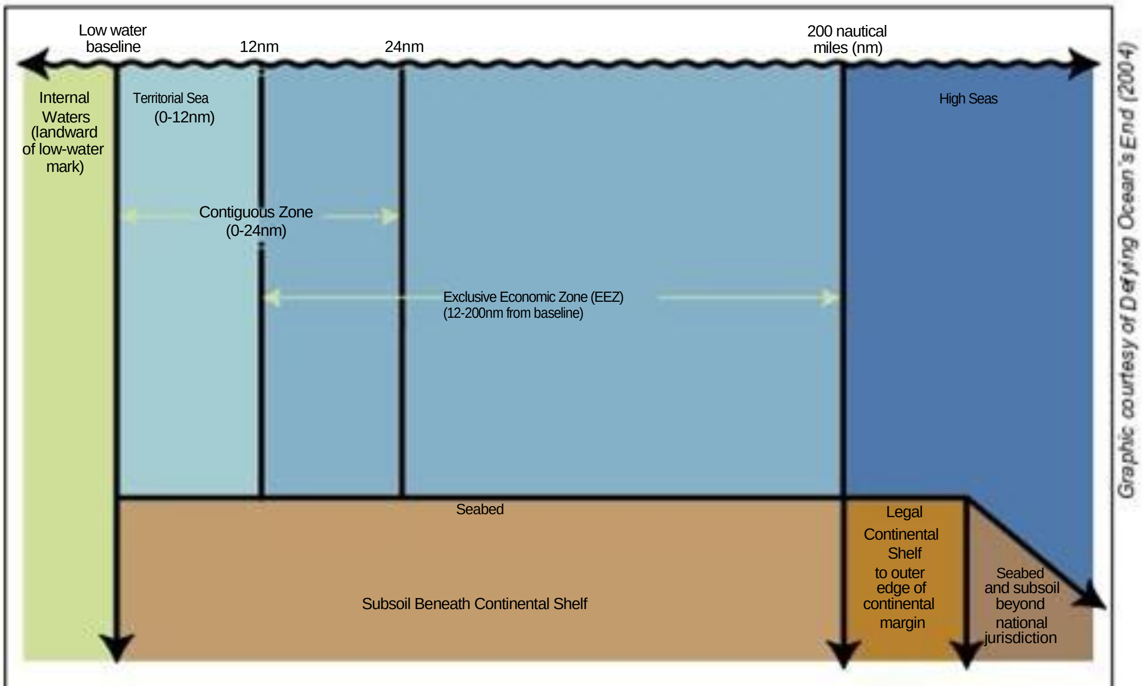
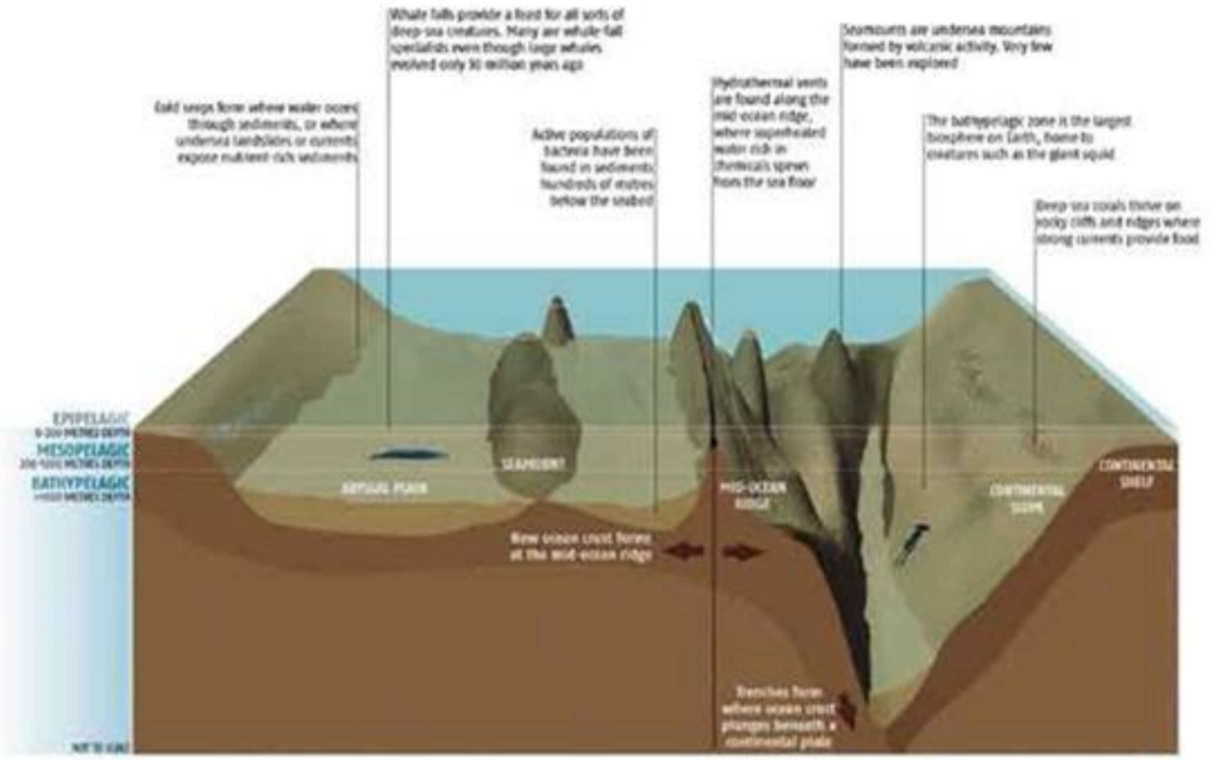


Figure 1 Maritime Zones under United Nations Convention on the Law of the Sea (UNCLOS) of 1982 (based on Gorina-Ysern 2004).

2 The Mysteries of the Remote and Deep Oceans Revealed



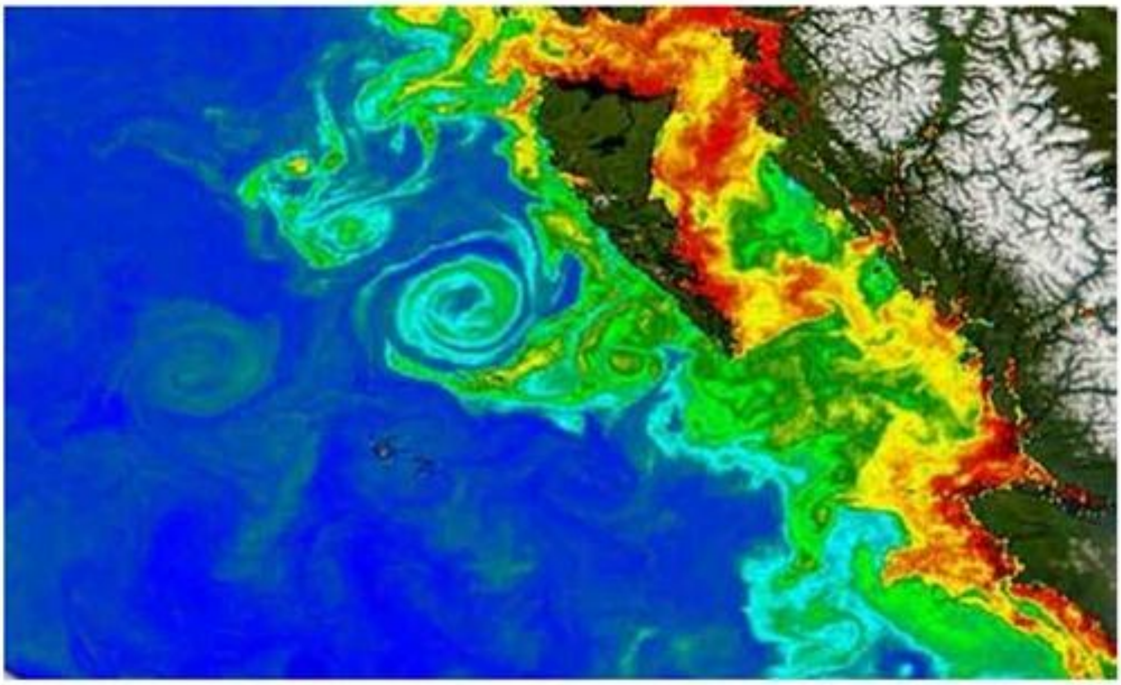
The Oceans cover 70% of the planet dropping down from the continental shelves to an average depth of 4,000m. The Marianas Trench in the Pacific is 11,000m deep. Graphic courtesy of New Scientist.

The oceans cover nearly 71% of the Earth's surface. With an average depth of almost 4,000m, the oceans provide more than 90% of the habitable area for life on Earth. 88% of the oceans beyond the continental shelves are deeper than 1km and 76% have depths of 3-6km.

The oceans are generally divided into at least three realms, the sunlit open ocean (epipelagic), the mid-ocean water column below 200m (mesopelagic and bathypelagic), and the seabed (benthic) with its tremendous variety of geological structures and habitats. Most scientific research has focused on the sunlit open ocean, where humans have long had access to study and exploit, though fundamental discoveries continue to be made. The mid-ocean and deep seabed environment remains poorly studied and understood. In fact, only some 0.0001% of the deep seafloor has been subject to biological investigations. As has been frequently highlighted, we know more about the surface of the moon than of the bottom of the deep oceans.

Despite our depths of ignorance, recent discoveries about life in the open ocean and the deep seas have changed our understanding of oceanic life and processes that have important implications for current oceans management. The following sections highlight these discoveries and what they tell us about how we could improve management of human activities.

The **open ocean** was once viewed as a vast and featureless water body containing inexhaustible riches and bounty. Open ocean species such as many billfishes, cetaceans, seabirds, sharks and tunas are widely distributed and occur in all or most parts of the ocean. Thus, it was assumed that humans could not diminish their numbers. However, rigorous assessments and comparisons with past records have established that many species or populations of large predatory fish (e.g. tunas, sharks, and billfishes), transboundary and other migratory fish stocks (e.g. cod), sea turtles, cetaceans, and seabirds have already been depleted by human activities, primarily fishing. Some have even been brought to the brink of extinction. Scientists fear that such a decline in species numbers and diversity is altering the composition of entire ecological communities and food webs, including mid-ocean and deep seabed communities dependent on the rain of organic debris from the waters above. Recent studies have also revealed that the loss of diversity can make oceanic ecosystems more vulnerable and less resilient to climate change and other environmental shifts caused by disease, alien invasive species and the cascading effects of overexploitation. Another surprise was that the oceans contain many features and boundaries that can be detected from space. Remote satellite-based sensors can detect oceanographic conditions, both permanent and fleeting, such as temperature gradients, water depth, salinity, currents, oxygen levels and availability of nutrients. Satellite monitoring can now be used also to track the movements of tagged animals, which show that many move in predictable patterns based on these oceanic features.



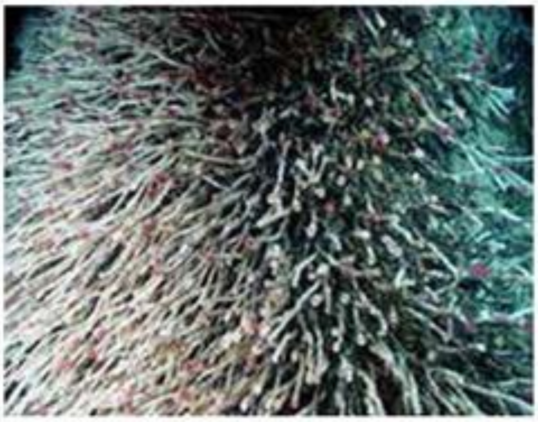
The bright red, green, and turquoise patches to the west of British Columbia's Queen Charlotte Islands highlight hotspots of biological activity (chlorophyll concentrations). Such hotspots and other oceanographic conditions can now be tracked with remote sensing satellites. Image courtesy of the SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE.

Whale sharks (Rhincodon typus) are oceanic animals but they converge in a few small areas in warm waters at predictable times to feed. Protecting these areas could protect both their food organisms and these gigantic sharks, which are killed for their meat and their fins. Photo courtesy of ©Wolcott Henry/marinephotobank.org

Open ocean hotspots are generally areas of high plankton productivity or where plankton are concentrated. Through tracking and monitoring of tagged animals, scientists have been able to determine that many large oceanic animals converge on specific areas to feed, breed, spawn, calve and often linger to grow into adulthood, i.e. these animals do not roam randomly. Open ocean hotspots are frequently created by the interaction of the water column with fixed seabed features such as seamounts, submarine canyons and shelf breaks. Such hotspots also occur at eddies and fronts where warm and cold currents converge. Satellite remote sensing has shown that these hotspots can be fixed or transient, dynamically shifting with currents and winds. Yet, other studies indicate that the living resources which depend on them are in rapid decline. An investigation of the global distribution of tuna, marlin, and swordfish showed that overfishing has reduced the abundance and variety of species in specific hotspot areas in the Pacific by up to 50% in the last 50 years. Some former hotspots have disappeared but several species-rich areas still remain, e.g. off the coasts of the US, Australia and Sri Lanka, south of the Hawaiian island chain and in the South-Eastern Pacific. As these areas of greatest species diversity and density overlap only marginally (10%) with current fishing grounds, their protection would not cause a major disruption to fishing activities. However, the new ability to uncover open ocean hotspots also creates a dilemma: prediction and identification of these areas has to go hand in hand with conservation efforts to avoid these areas being targeted before measures for their sustainable management and use are in place.

The mid-water column below 200m remains a great mystery that scientists have only just started to explore. Even here the terrain is not uniform, but rather is composed of distinct water layers and horizons that may persist year round or disintegrate in a day. The food chain is based on organic debris that drifts down from surface waters like falling snow. The mid-water column is home for many delicate creatures with special adaptations to utilize this debris, as well as for bizarre-looking fish that dangle light lures to capture unwary prey and for the elusive giant squid, captured on film for the first time only in 2005. Studies in the mid-water column pose a challenge, and scientists expect big surprises in the near future which will revolutionize our understanding of the conditions, ecosystems and life forms in this part of the oceans.

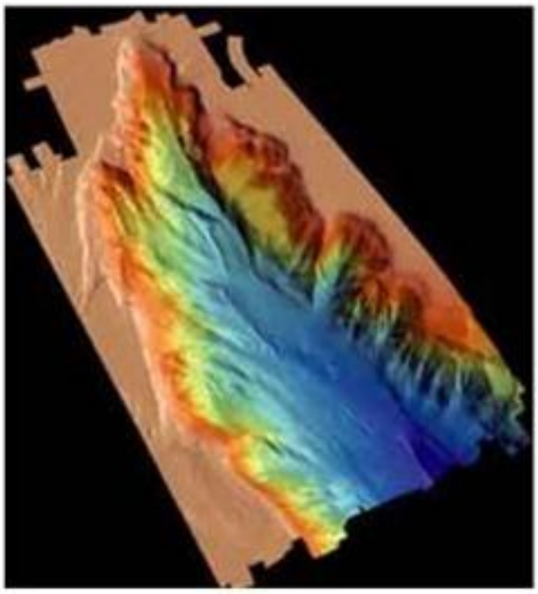
This predatory deep sea medusa (Atolla sp) lives in the dark depths below 500m, catching other animals with its stinging tentacles. This specimen is only about 10cm long. Photo courtesy of L.P. Madin, WHOI.



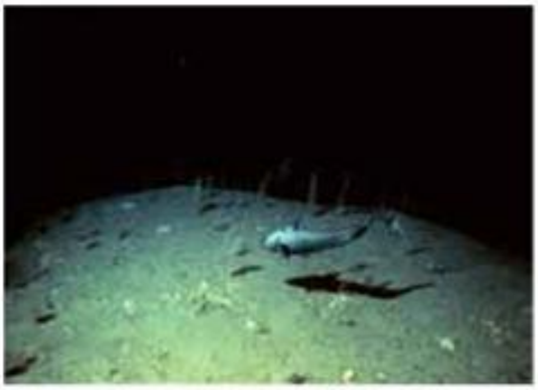
The deep seabed teems with life. Here, tubeworms are part of a lush vent biota covering a sulfide chimney at Explorer Ridge in the North East Pacific. Photo courtesy of NOAA Ocean Explorer.

The deep seabed was generally believed - until quite recently - to be a dull and lifeless place. We now recognize it as the very cradle of life, featuring a wide variety of exciting geological and biological extremes. The deepest place on the planet is the Challenger Deep in the Marianas Trench at 11,034m, deep enough to accommodate Mt. Everest. Mid-oceanic ridges form the longest mountain chain on the planet, spanning five oceans and 64,000km. With this diversity of features and habitats it is no surprise that the seabed is thought to support 98% of all marine species, and that more species live in deep seabed environments than in all other marine environments combined. The wide variety of seabed habitats gives rise to unique organisms and life forms with amazing adaptations to these harsh environments, from generalists digesting sediments to highly specialised species that are found and feed exclusively on whale bones. The evolution of life is thought to have sprung forth at submarine volcanic vents, far from the sun's rays, drawing energy from super-heated and mineral-rich compounds welling up from the Earth's molten core. Although we do not yet understand the magnitude of diversity in the deep ocean, it has been estimated that as many as 10 million species may reside on and within the sediments of the continental slope and abyssal plains.

Submarine canyons are regular features along the slopes of most continental margins and some ocean islands, but their structural complexity makes each canyon unique. Some are more than 320km long and rise nearly 5km from the canyon floor, i.e. are about three times deeper than the Grand Canyon. All canyons act as conduits for material from the continental shelf, making them rich in organic materials which support high densities and biomass of marine life. The high diversity of habitats within canyons often results in a very high density and diversity of species compared to the continental slopes. Species include many filter feeders such as corals, sponges, hydroids, seapens, tubeworms, brittle stars, sea cucumbers and anemones. Gorgonians (soft corals) up to 5m tall are not uncommon. Many commercially important species such as lobster, crab, shrimp, hake, tilefish and flounder can often be found in canyons, as canyons frequently serve as important nurseries. The rich productivity of canyons also makes them important feeding grounds for many pelagic species, and some canyons are well known for the high variety of cetaceans they support.



Bathymetric image of the Cap de Creus Canyon, W. Mediterranean. Illustration courtesy of AOA Geophysics, Fugro and University of Barcelona.

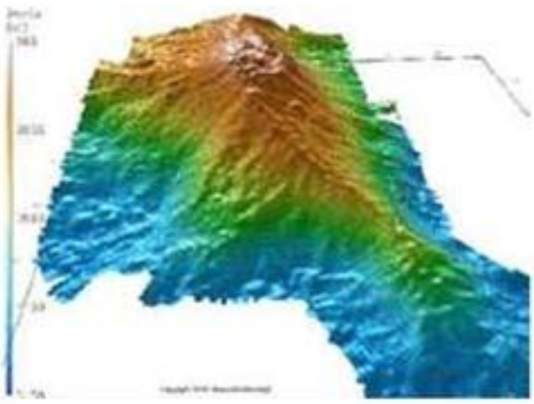


Life on the abyssal sea floor (depths ranging from 4,000-6,000m) near the Hudson Canyon off the coast of New Jersey. Photo taken using the Deep Submersible Research Vessel (DSRV) Alvin's camera system. Photo courtesy of NOAA Ocean Explorer.

Abyssal plains cover almost 50% of the deep seabed and comprise mainly mud flats that were once thought to be sterile deserts. In fact, the surface layer teems with life, including bottom-dwelling fishes sea cucumbers, star fishes, brittle stars, anemones, glass sponges, sea pens, stalked barnacles, mollusks as well as tiny worms and crustaceans. Stones and manganese nodules -- formed by the aggregation of minerals in the seawater -- provide a rare hard substrate surrounded by soft sediments, and attract different and often larger life forms to settle.

While some deep seabed organisms take opportunistic advantage of hard substrates to settle and to reach the stronger, nutrient-richer currents above the seafloor, many organisms dwelling at hydrothermal vents, cold seeps and gas hydrates rely on mineral resources for their existence. The growth of organisms within and on top of manganese nodules provides another example of the blurring and blending of minerals and biological life forms. There are even active populations of bacteria living hundreds of meters below the seafloor, feeding on ancient sediments. Many of these bacteria are different from anything scientists have seen before, representing an entire new kingdom of life with a completely new kind of metabolism.

Seamounts, undersea mountains often of volcanic origin, vary in height and size. Some rise only 100m from the seafloor, while others tower 3,000m or more without breaking the surface. It is estimated that there are more than 100,000 seamounts in the world's oceans, though fewer than 200 have so far been studied in detail. This research shows that like the Galapagos Islands, seamounts serve as centers for the development of new species, "stepping stones" for the dispersal of species across ocean basins, and a refuge for relict species with contracting ranges. Their island nature gives rise to high numbers of unique species, including fishes, corals, sponges, sea squirts, hydroids, and sea anemones, often with little similarity or overlap with species on neighboring seamounts. Seamounts interact with the oceans around them, trapping plankton and stimulating productivity, making them important hotspots for feeding, breeding and spawning for many open ocean as well as deep sea species. Regular visitors include tunas, swordfishes, sharks, rays, eels, whales, sea turtles, seabirds, orange roughy, black scabbardfish and oreos. Many of these fishes are



Digital Terrain Model (DTM) of Loihi Seamount generated from multibeam sonar data. Illustration courtesy of Alex Malahoff.

increasingly targeted by the expanding high seas and deep water fisheries, which are advancing far faster than our scientific understanding of the role and importance of seamounts for the web of life in the oceans.

Super-heated vent fluid spews from a chimney at the Explorer Ridge in the North East Pacific. Photo courtesy of NOAA Ocean Explorer.

Hydrothermal vents were discovered in 1977 -- eight years after man set foot on the moon -- as the first ecosystem on Earth that was found to be independent from the sun as an original source for energy. Rather, bacteria and primitive microbes convert sulfur-rich emissions into energy, supporting a specialized community of worms, crabs, mollusks, shrimps, anemones, soft corals and other animals found nowhere else. Most species are new to science and over 75% occur at only one site. Found typically on mid-ocean ridges, conditions near hydrothermal vents are extreme: superheated waters up to 400ºC contain a cocktail of toxic chemicals deadly to most other organisms. Nevertheless, giant tube-worms, without mouths or digestive systems, have adapted to living near these vents. Scientists were amazed to learn that these worms are the fastest growing marine invertebrate, growing almost 2.5cm in ten days, thanks to bacteria residing in a special organ that supplies the worm with energy and receives protection in return.

Cold seep and **gas hydrate communities** occur along the continental margin where cool, chemical-rich water (or hydrocarbon gases, mostly methane) oozes from the seabed, or where undersea landslides or currents expose chemical/ gas-rich sediments. These chemicals and gases support chemosynthetic ecosystems and unique

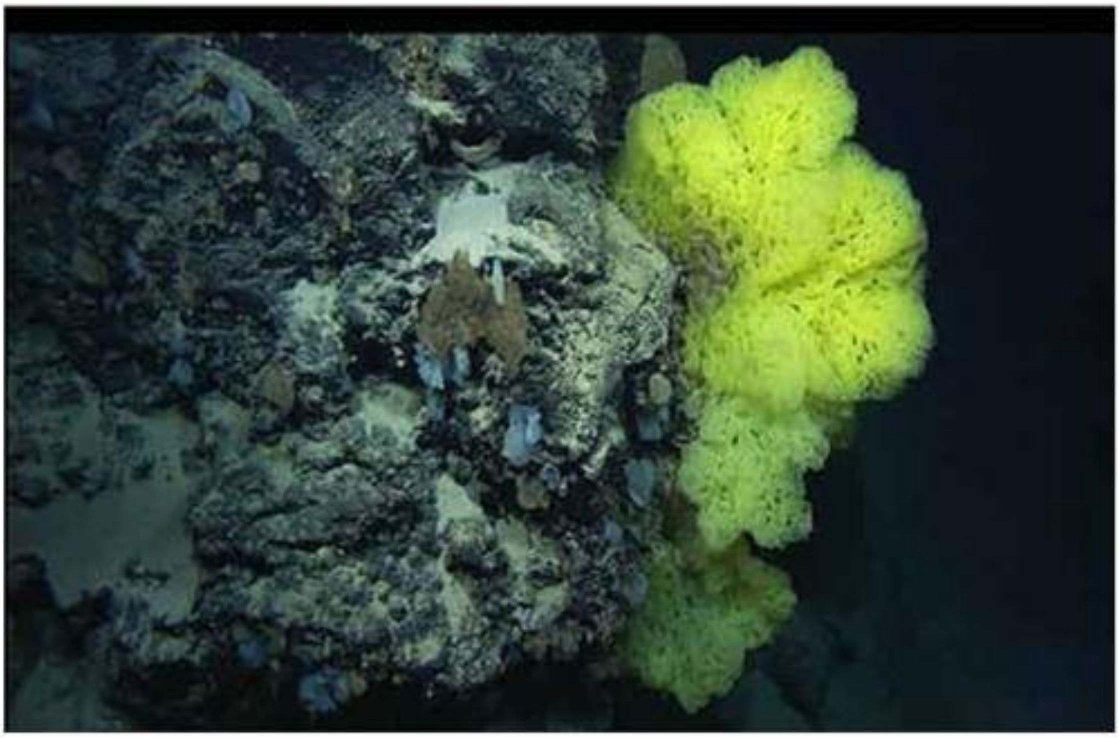
This lobe of orange gas hydrate exposed on the seafloor is home to Hesiocaeca methanicola, a newly discovered species of marine worm found in the Gulf of Mexico in 1997. Photo courtesy of Ian MacDonald.

wildlife. There is some similarity between vent and cold seep communities, but not much. Of the 211 cold seep species reported so far, 13 species occur both at seeps and vents. Scientists have just realized that the original source of these chemicals and gas hydrates is organic matter that fell to the seafloor thousands or millions of years ago, thus cold seep and gas hydrate communities are ultimately dependent on sunlight.

Lophelia with outstretched tentacles. Photo courtesy of André Freiwald, IPAL-Erlangen.

Cold water corals have been known to science for centuries. However, recent studies revealed that they are wide-spread in all oceans from the poles to deep waters off tropical islands, on seamounts as well as in fjords, submarine canyons, continental slopes, banks and mid-ocean ridges. They live in water temperatures from 4 to 13ºC and depths ranging from 39m to 5,630m. Unlike tropical corals, deep sea corals thrive without sunlight by capturing small food particles from the water column. Nevertheless, some species, such as *Lophelia pertusa*, are capable of forming extensive and complex reefs, similar to their tropical shallow-water cousins; other corals can form lush thickets or forests on the seabed or seamounts, generally in areas of strong current flow. The largest *Lophelia* reef found so far was discovered only in 2002 off the coast of Norway. The Røst reef is 35km long, 3km wide and covers some 100km^2 (twice the size of Manhattan) and is over 8,000 years old. These coral ecosystems play an important role for deep sea biodiversity, as they can provide habitat for a high diversity of associated species and shelter for juveniles of many commercially important fish species. Not only did investigations with remote sensing and underwater cameras reveal the beauty and importance of cold water coral reefs, they also demonstrated the reefs' vulnerability: the majority of reefs in the North Atlantic are already heavily damaged or have been destroyed by fishing activities, especially by bottom trawling. Images of lost fishing nets entangled in corals and whole sections of reefs reduced to coral rubble are common and have triggered calls to action from countries and international organisations. Increasingly, national and international measures to protect some of the known cold water reefs and coral 'gardens' have been taken or are under development. Nevertheless, coral ecosystems off the coasts of developing countries and on seamounts are still under great danger from expanding human activities in the deep waters and on the high seas.

Sponge reefs and fields can grow to immense size and age. Off of British Columbia, in Canada, a 9,000 year old reef of glass sponges has been found covering 700km^2 and in some



Yellow-green sponge on basalt wall. Photo courtesy of Deep Atlantic Stepping Stones Science Team/IFE/URI/NOAA.

False boarfish (Neocytlus helgae). This and other Oreo dories species often form large aggregations over rough grounds near seamounts and canyons. Photo courtesy of Deep Atlantic Stepping Stones Science Team/IFE/URI/NOAA.

areas towering 19m high. Individual sponges may be more than 100 years old, weighing up to 80 kg. Sponge aggregations add a three dimensional structure to the seabed that provides habitat, hunting ground and refuge for many species, including commercially important fish species like redfish, cod and ling. In the North Atlantic, where most studies have occurred, scientists have found nearly twice as many species near sponge fields as they found on the surrounding seabed. Through the same studies scientists also found areas damaged by bottom trawling. Like cold water corals, deep sea sponges are slow-growing, fragile and highly vulnerable to damage by bottom fishing gear. Recovery may take centuries, if it occurs at all.

Deep sea fish dwelling on or near the seabed, like most deep sea organisms, grow extremely slowly, live long, mature late and have few natural predators. For example, one specimen of commercially exploited orange roughy has been documented to be an incredible age of 240 years - i.e. it was born roughly at the same time as Napoleon Bonaparte. Only after industrial-scale fishing had commenced did scientists discover that age at sexual maturity for orange roughy typically exceeds 25 years, and stocks undergo extended periods of very low recruitment (on the order of a decade or more). These special life traits and adaptations mean that most industrial-scale deep sea fisheries are rapidly depleted (often within less than 5 years), though fishers may then move on to the next stock or area. A recent study in the Northwest Atlantic revealed that five species of deep sea fishes were all close to extinction, declining by up to 99.6% in 26 years. Remarkable is that only two of the five deep sea fish stocks are commercially targeted; the other three are netted by trawlers as unintended "bycatch". Experts at the United Nations Food and Agriculture Organization (FAO) warn that not enough is known about the population biology of deep sea stocks and the impacts of fishing on seabed habitats to enable responsible management. Compounding the situation is the fact that many deep water species are found on the high seas, where governance is particularly complex.

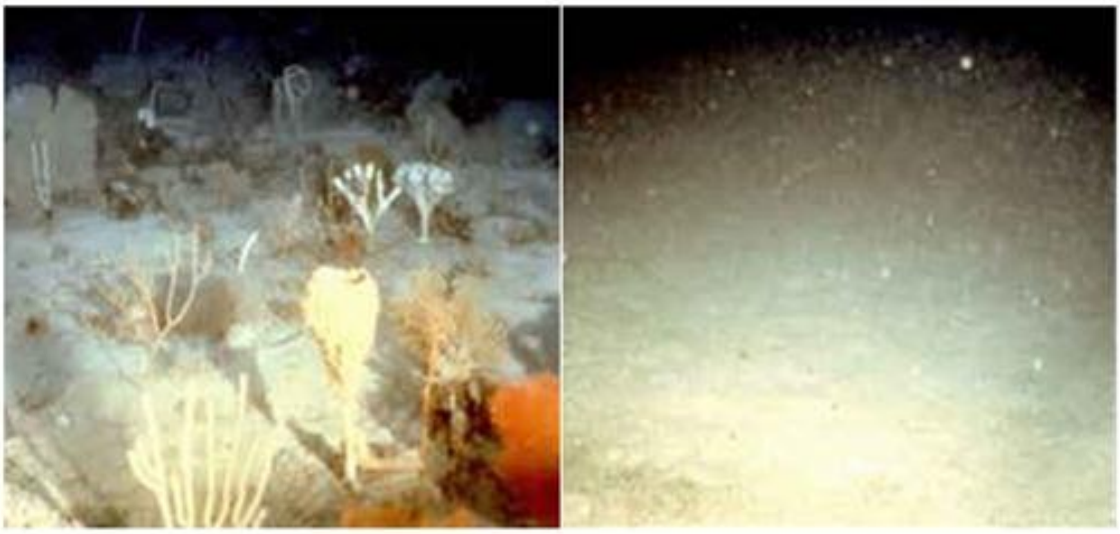
As revealed by recent research, the oceans are much more complex and dynamic than previously assumed. The open oceans are not featureless, but have many boundaries and oases upon which large oceanic species depend. These oases and key migratory corridors can now be identified through oceanographic monitoring and wildlife tagging studies. Real-time data can be used to identify priority foci to protect, even when these move. Deeper down, organisms generally move at a slower pace and the extreme and food-poor environment gives rise to many unique deep seabed ecosystems and species. Scientists are just beginning to understand the life histories of the species and their different types of metabolism and how these ecosystems function and interact with the water column above. Some life forms, such as bacteria at hydrothermal vents, derive their energy from deep seabed minerals; however the majority of organisms depend on organic material sinking down from surface waters through the water column. Most are extremely vulnerable to damage and slow to recover.

We have also learned that the oceans are not the infinite and inexhaustible source of food that we had once imagined. Although research increased in recent years, scientists still do not know enough to enable sustainable exploitation of many fish stocks, and some long-lived and slowly reproducing open ocean species have been fished almost to extinction. Despite this, fishers are increasingly targeting and exploiting species on seamounts and in the deep sea - species that are even more vulnerable to disturbance and over-exploitation than their coastal or shallow water equivalents.

Better knowledge and assessment are critical to improving our ability to conserve the ecosystems and biodiversity of the deep seabed and open oceans, and to better manage human activities. Integrated research projects designed to gain new insights into the biodiversity, structure, function and dynamics of open ocean and deep seabed ecosystems such as HERMES (Hotspot Ecosystem Research on the Margins of European Seas) are vital. Yet as human activities expand faster than our abilities to manage them, many scientists fear that much of the ocean’s amazing diversity in form, shape and function may be destroyed before that living diversity has even been discovered, identified or understood. While more information is essential, we know enough already to implement sound precautionary management. Areas critical to biodiversity, such as open ocean hotspots, seamounts, cold water corals, hydrothermal vents and sponge fields, can be protected, and unsustainable and destructive practices can be curtailed. Precautionary action can also be taken to reduce the human footprint and to safeguard areas representative of particular habitat types with as yet unknown libraries of biodiversity.

The protection of the remote reaches of the open ocean and the deep seabed cannot wait, and urgent action is needed before it is too late. The first step to action is to understand why. Hence the next sections describe in more detail the importance of the oceans and the impacts that current and potential human activities may have on their biodiversity and ecosystems.

3 The Expanding Human Footprint



The seafloor off Northwest Australia before (left, showing dense populations of corals and sponges) and after trawling (right). Photo courtesy of Dr. Keith Sainsbury, CSIRO.

Socio-economic importance of the open ocean and deep Seabed

The ocean makes life on Earth possible. It generates nearly half of the oxygen in the atmosphere, absorbs huge quantities of carbon dioxide, governs our climate and weather, regulates temperature, drives planetary chemistry, harbors most of the water and contains the greatest abundance and diversity of life on Earth. At a smaller scale, the diversity of species within marine ecosystems, and the diversity of genes within populations, enhance resilience in the face of both natural environmental variability and human-induced stresses such as climate change.

The **value of marine ecosystem goods and services**, in addition to the traditional human uses of the ocean such as transportation, resource extraction and waste disposal, has been estimated in 1998 at a minimum US$20,900,000,000,000 (US$20.9 trillion) a year, approximately 63% of the total estimated value of all systems on Earth. Though this figure may be a preliminary "guestimate," based on limited information, its magnitude underscores the importance of nature's services to the planet and humanity and the risk of underestimating ecosystem services whose values cannot be easily quantified.

Non-market value resources are the ecosystem goods and services we benefit from that are not yet recognized or valued. This lack of direct market value means that their loss is often not, or not appropriately, taken into account in planning or management systems. As noted by many experts, the primary objective of market participants is maximization of individual wealth, thus the failure to place limits on the use of these resources will invariably result in their degradation.

Markets and policy makers often discount the future and long-term benefits of maintaining biological resources, by focusing on the current or short-term cost of conservation. The lack of consideration for the effects of economic activity on habitats and ecosystem services may create costs over the long-term that may greatly exceed the short-term economic benefits of unsustainable exploitation and use. Hence, there is a need for policies that achieve a balance by protecting ecosystem services while pursuing economic development. An example is the important role of the oceans in the global carbon cycle. Oceans remove a significant proportion of carbon dioxide released into the atmosphere from human activity. However, this excess carbon is beginning to change the delicate balance of the carbonate equilibrium and the pH of ocean waters. Scientists predict that this will have devastating effects on open water communities and seabed ecosystems throughout the oceans, from the deep seas to shallow waters.

The **market value of ocean resources** is a poor, but often the only available, indicator of the state of marine resources. For instance, the value of trade in oceanic species caught mainly on the high seas such as tunas, squids and deep sea fishes is valued at US$5.9 billion a year, a six fold increase from 1976 levels. Yet this hides the fact that of the seventeen main tuna stocks, almost 60% are in need of population rebuilding and/or reduction of fishing pressure. Major tuna stocks are now listed as critically endangered (Southern bluefin tuna (all stocks), Western Atlantic stock of Northern bluefin tuna, South Atlantic stock of albacore) or endangered (Pacific stock of bigeye tuna, Eastern Atlantic stock of bluefin tuna, Monterrey Spanish Mackerel) on IUCN's Red List of species, facing a high risk of extinction in the near future. Many deep sea fish stocks are already depleted, and some populations are on the brink of extinction. Thus market values generally fail to reflect the full price of the resource and the cost imposed on the environment or on society by unsustainable exploitation and practices.

Fishing provides an essential source of food and income for numerous people in many nations. However, catch rates are declining and almost 75% of the world's fish stocks are already fished up to or beyond their sustainable limit. FAO experts now recognize there is little room for expansion of current fishing effort. As fisheries are depleted in national waters, fishers are moving out to the high seas and deep oceans in search of new and less controlled or regulated stocks.

Tunas for sale at the Tokyo fish market. Photo courtesy of © Kristian Teleki.

Total world catches of open ocean and deep water species occurring principally in high seas areas have doubled from 5% in 1992 to almost 11% in 2002. Without sound conservation and management measures in place, these fisheries (and their current market value of US$5.9 billion, as noted above) will become quickly depleted and their potential benefit to future food security and ecosystem resilience lost.

Shipping across the global oceans makes a significant contribution to the world economy, with more than 90% of international trade carried by sea. No estimates have been made of the value of this global seaborne trade in monetary terms, but the UN estimates that operation of merchant ships contribute about US$380 billion in freight rates to the global economy, equivalent to about 5% of total world trade.

The view off the bridge of the SEALAND COMMITMENT at the container terminal at Port Elizabeth, New Jersey. Photo courtesy of Captain Albert E. Theberge, NOAA Corps.

Total seaborne trade has more than quadrupled in the last four decades, from less than 6 billion tonne-miles in 1965 to 25 billion tonne-miles in 2003.

Bioprospecting is another economic activity occurring both in the open ocean and on the deep seabed within and beyond national jurisdiction. At least 14 biotechnology and other companies, predominantly based in North America and Europe, are known to be actively involved in product development and/or collaboration with research institutions in search for new substances and compounds from deep sea organisms and genetic resources both within and beyond national jurisdiction. Six companies are already marketing products, and at least 37 patents for products have been granted.

Some examples of commercial applications include the use of compounds from deep seabed organisms as the basis for potential cancer fighting drugs, commercial skin products, detoxification agents, anti-viral compounds, anti-allergy and anti-coagulant agents, enzymes for biotechnology applications, as well as industrial and commercial products such as anti-freeze and viscosity reducers. The costs of development and commercialization of products are high and the chances for success low; it can take up to 15 years to produce results, and only one to two % of candidates actually become clinically approved and produced. However, the potential value of a successful product can be great. Profits from a compound derived from a sea sponge to treat herpes have been estimated to be US$50-100 million annually, and the estimated value of anticancer agents from marine organisms is up to US$1billion a year. When bioprospecting takes place on land and in marine areas subject to national jurisdiction,

Sponges, soft corals, sea-fans and sea-squirts are among the bottom-dwelling marine organisms that use chemicals for their defence. Photo courtesy of Deep Atlantic Stepping Stones Science Team/IFE/URI/NOAA.

some pharmaceutical companies and others have been willing to pay substantial sums to access the genetic resources with potential for biotechnology products. Host countries might receive a royalty on any revenue derived from such products. For the use of organisms and genetic resources from the waters and deep seabed beyond national jurisdiction, there are no such mechanisms or specifically applicable legal regime.

Oil and gas development can already take place below 3,000m depth, such as in the Gulf of Mexico. Figures on the market value of deep oil and gas development are difficult to obtain, but are expected to be quite substantial.

Oil and gas platforms in the Gulf of Mexico. Drilling can now reach depths of over 3000m. Photo courtesy of © Walcott Henry 2005 / marinephotobank.org

Oil and gas exploitation currently takes place within national waters but may someday extend onto the continental margin of coastal nations and into the seabed "Area" beyond the legal continental shelf.

Dumping and disposal of waste from ships, airplanes and offshore platforms is another ongoing use of the oceans. Though now highly restricted and regulated, sewage sludge, dredged material (up to 400 million tonnes a year), mine tailings, decommissioned platforms and vessels, and fish wastes (about 50-100,000 tonnes a year) continue to be legally disposed of at sea. The newer approach is to prevent and reduce the generation of wastes at the source (e.g. reuse and recycling), thereby lessening the need for waste disposal at sea or on land.

Other potential economic benefits that could be derived from deeper waters both within and beyond national jurisdiction include deep seabed mineral mining, methane gas extraction from methane hydrates, carbon dioxide sequestration and burial, tourism, aquaculture and use of the properties of deep sea water. Most of these potential uses are as yet not economically or practicably feasible, a situation which can change quickly in the light of increasing demands and advances in underwater technology.

The Threats and Impacts of Current Exploitation

To enable sound management of the deep oceans and high seas, it is necessary to look beyond the current market value of marine goods and services and assess what impacts human activities may be having, or could potentially have, on marine biodiversity and ecological processes.

Fishing activities are the most pressing threat to open ocean and deep seabed biodiversity. Overfishing, destructive fishing practices and illegal, unreported and unregulated fishing activities (IUU fishing) are taking a tremendous toll. In national waters, states are legally able to limit or control access to fisheries, but often have difficulty in setting and enforcing sustainable limits. On the high seas, access to fisheries can only be limited by international agreement, and enforcement difficulties are compounded by many factors. In some parts of the high seas, regional management bodies have been established to agree on fishing regulations, including limits on catch and effort. But nations and their fishing fleets can and do refuse to join or abide by the rules. In other regions, and for other fisheries, there are no management bodies and no agreed rules.

Orange roughy catch harvested off the east coast of Tasmania. Australia's Threatened Species Scientific Committee has recently recommended the listing of domestic orange roughy stocks as an "endangered" species. Photo courtesy of © Stephen McGowan, 2006/ marinephotobank.org

Overfishing has many detrimental effects. First, it reduces the size and genetic diversity of marine fish populations. This decline has been found to reduce reproductive success and increase susceptibility of stocks to disease and environmental stresses. Second, in some cases, overfishing can lead to complete collapse of an ecosystem, termed a trophic cascade. Overfishing for cod and other large predators in the eastern Scotian Shelf ecosystem in the Northwest Atlantic, for example, has already triggered a shift to a new invertebrate-dominated ecosystem where small pelagic fishes and bottom-dwelling snow crabs and northern shrimps thrive. By removing the top predator fish (in this case by more than 90% of the populations), fishing has disrupted predation and feeding relationships, undermining the stability of the ecosystem and the potential for cod to recover. Yet, governments and regional fisheries bodies remain reluctant to take the tough decisions necessary to stop overfishing, despite the negative effects on the marine systems and the sustainable development of fisheries and dependant communities.

Chesapeake Bay purse seine vessel vacuuming menhaden, an important forage fish that also filters algae from the Bay. Due to overfishing concerns, a harvest cap was established in 2005. Photo courtesy of John Surrick, Chesapeake Bay Foundation

Bycatch or "incidental mortality" of non-target species and undersized juveniles of target species caught or killed during fishing often exceeds the amount of saleable fish, and can reach levels that threaten large and long-lived species such as albatross, petrels, leatherback sea turtles and many sharks with extinction. Most regional fisheries management bodies concentrate on target species and do not regulate bycatch effectively. Though simple changes can often reduce bycatch, the open access regime for high seas fishing means that not all fishers are bound to comply with such bycatch reduction measures. Lethal 'ghost fishing' by gear that is lost or abandoned by fishing vessels takes a further toll.

In 2000, more than 200,000 loggerhead sea turtles and 50,000 leatherbacks were accidentally caught as "bycatch" in fishing gear worldwide. Populations of both species have fallen by 80-90% over the past decade. Photo courtesy of PRETOMA (www.tortugamarina.org).

By scaring seabirds away from baited longline hooks, plastic streamer lines can significantly reduce seabird bycatch. Photo courtesy of Save the Albatross Campaign (www.savethealbatross.net).

Pelagic longlines, widely used to catch tunas and billfishes, may also catch hundreds of thousands of seabirds (albatrosses, fulmars,

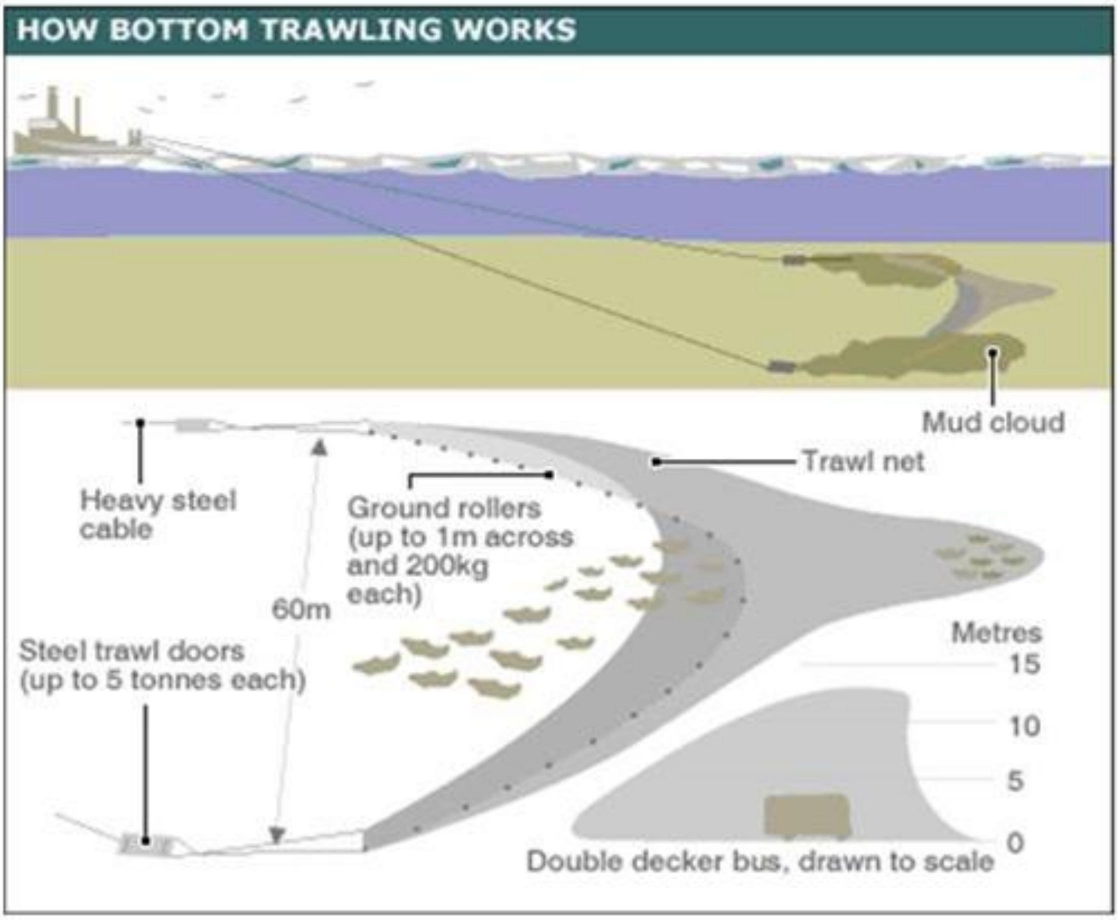


Illustration courtesy of BBC News website

and petrels), sea turtles and cetaceans, and millions of oceanic sharks and rays each year. The lines can now stretch up to 100km and bear up to 2,000 baited hooks. The impact can be devastating: 19 of the 21 species of albatross are globally threatened, placing the entire family of these magnificent birds under threat of global extinction. Oceanic whitetip sharks, until the 1950s one of the most abundant large animals on Earth, have declined in the Gulf of Mexico by 99.7% since tuna longlining began there. Within less than three decades, the Pacific leatherback turtle may be lost if industrial longlining and other pressures are not curtailed. A few regional fisheries management organizations have adopted rules to limit such bycatch, but these require wide adoption and broad compliance to be effective.

Bottom trawling is used to catch approximately 80% of the deep sea fish stocks taken in areas beyond national jurisdiction. However, the estimated high seas bottom trawl catch in 2001 represented only about 0.2-0.25% of the global marine fisheries catch, and less than 0.5% of its value. While the role of high seas bottom trawl fishing may be minor in terms of total global marine fisheries output and value, it causes major and disproportionate damage to deep sea ecosystems. Losses of up to 98% of the coral cover of seamounts as a result of deep sea bottom trawl fishing have already been documented. As noted earlier, the long lives, slow growth and high rates of endemism of many deep sea species, including fishes, sharks, corals and sponges, makes them highly vulnerable to damage and even extinction. And this type of high seas bottom fishing is likely to grow in coming years as deep sea fish stocks within national jurisdiction are depleted and/or increasing restrictions are placed on them. Many scientists around the world have urged their governments and the United Nations to adopt urgent conservation measures, including an interim prohibition on high sea bottom trawling where effective controls do not exist and the establishment of deep sea protected areas.

In most areas of the high seas, shark fisheries are unregulated. The oceanic blue shark (right) is one of the most frequently caught (and finned) species in the high seas. In total, more than 100 million sharks and related species are caught each year. Photo courtesy of IUCN Photo Library © Imène Meliane.

Illegal, unreported and unregulated (IUU) fishing is now a global problem affecting both EEZs, particularly of developing countries unable to patrol their own waters, and the high seas. The total value of IUU fishing lies between US$4.9 and US$9.5 billion a year. IUU fishing on the high seas alone is estimated to be on the order of US$1.2 billion a year. In addition to the lost revenue that goes to the pockets of a few irresponsible companies, IUU fishing is undermining sustainable fisheries, harming and destroying marine habitats and species, and threatens the livelihood of responsible fishermen and communities dependant on fishing. This is a tremendous loss to all nations.

Illegal fishing thrives even in well-managed fisheries, for example, that of Patagonia toothfish (sold as "Chilean seabass"), which is regulated by the Commission for the Conservation of Antarctic Living Marine Resources (CCAMLR). Illegal fishers do not abide by stock and catch regulations or controls, they also ignore rules adopted by CCAMLR to reduce seabird bycatch. Satellite tracking of vessels, electronic documentation systems for catch, thorough port-side inspections and source certification can make real inroads into the ability of pirate fishers to offload and sell their illegal wares. As recommended in the final report of the High Seas Task Force, nations will need to step up efforts to share information, cooperate in pursuit of pirate fishers and prosecute offenders with tough penalties.

Unregulated fishers are not technically breaking the law, as the state where the vessel is registered (flag state) may not have agreed to join a specific agreement or no agreement may yet exist. However, the results are the same: fishers operate without rules to prevent overfishing or to minimize impacts. Unregulated fishing for sharks, squids and deep sea fish stocks persists in three quarters of the high seas (the Indian and Pacific Oceans, and large parts of the Atlantic). Though regional regimes for deep sea fisheries are now emerging in the Southwest Indian Ocean and South Pacific, the extreme vulnerability of most deep sea fish stocks to rapid depletion means that the fishery may no longer exist by the time agreement is reached. This has already happened in the Southwest Indian Ocean, where the orange roughy and oreo-based fishery peaked and collapsed in three years (1999-2001) - the agreement, under negotiation since 2001, is not yet open for signature as of May 2006. This shows that precautionary and ecosystem-based international management measures need to be in place before the fisheries begin. Where fishing has already commenced, provisional measures may be required to prevent overfishing and protect biodiversity until the new agreement enters into force.

Unreported fisheries, where the fishers fail to report or misreport their catch, further undermine the sustainability of fisheries, for they deprive managers of essential data on catch and by-catch quantities, on areas fished, and on the number of vessels involved. This lack of data, in conjunction with the general absence of even the most basic information on the biology and ecology of target and by-catch species or seafloor habitats, means we cannot learn from past mistakes, as documented baselines do not exist.

Noise pollution may have significant impacts on whales, fish and other marine wildlife. Powerful sonar systems, used in military operations and scientific research to detect and survey remote objects and the seafloor, as well as airguns used for seismic surveys and drilling for mineral, gas and oil exploration and exploitation, are thought to cause loss of hearing and disruption

This Cuvier's beaked whale is one of four who stranded in an atypical mass stranding event in Southern Spain in January 2006. The necropsy results showed that they died of "Gas and Fat Embolic Syndrome" and gave anthropogenic acoustic activities as the most likely cause of the mass stranding event. Photo courtesy of ALNITAK/SEC/ULPGC.

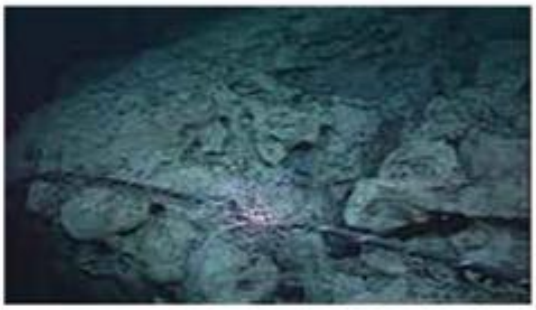
to feeding, communication, mating and migration patterns, and may even kill. Studies have also noted the impact of noise on breeding patterns of fish and acknowledged the need to avoid the use of intense noise sources in the habitat and breeding grounds of vulnerable species or where marine mammals and endangered species may be concentrated. The International Whaling Commission has repeatedly noted that marine mammals are at potential risk from increasingly intense man-made underwater noise. Currently no regulatory structure exists to control noise production in the high seas beyond the general provisions of UNCLOS.

Shipping is another activity that is impacting marine wildlife and habitats through increasing noise, accidental spills of oil, and the deliberate, operational discharge of garbage, oily wastes, sewage, chemical residues and ballast water and

Legal and illegal discharges from ships are accumulating in open ocean fronts, eddies and gyres, affecting animals that gather there to eat, breed and spawn. Photo courtesy of © Walcott Henry 2005 / marinephotobank.org

use of anti-fouling paints toxic to marine organisms. Though most ship discharges and emissions are regulated by international treaties such as the International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL 73/78), existing rules generally are less strict in areas beyond national jurisdiction than in waters closer to shore. Ship wastes and other marine litter / debris often accumulate in open ocean hotspot areas where waters and winds meet, such as fronts, gyres and eddies and can impact marine mammals, fish and seabirds who gather there to feed, breed and spawn. Oil spills and oily wastes in or near these areas can directly impact marine wildlife and also reduce fertility, weaken immune systems, and disrupt hormonal functions. Alien invasive species transferred through ballast water exchange and attached to ship hulls are another clear and growing concern. However, in contrast to shallow waters, the risk of invasives and the impact of polluted ballast waters on open ocean and deep water ecosystems and species are virtually unstudied. International regulations will need to be developed to address ship-generated noise, and shipping regulations will need to be reviewed and updated where necessary to protect sensitive ecosystems and species in offshore and high seas waters.

Submarine cables and pipelines form artificial hard substrates, which have provided scientists with some valuable information about colonisation, recruitment and growth of sessile deep and high sea organisms. The laying of cables and pipelines is recognised in UNCLOS as a traditional high seas freedom, a right conditioned by UNCLOS's obligations to protect and preserve the marine environment. Due to the different diameter, rigidity and function of cables



A basketstar living on a submarine cable stretched out over an ancient carbonate reef. Photo courtesy of © Monterey Bay Aquarium Research Institute (MBARI).

and pipelines, their placement on or in the seafloor requires different techniques and tools, and also their potential for environmental impact is quite different. In depths less than 1,000m, cables are often buried to avoid accidental damage and interference with other uses of the sea. Further research is needed to reveal what, if any, threats arise for the surrounding environment from the placement and operation of submarine cables and pipelines. Until such information comes forward, it would be a valuable safeguard for the cable and pipeline industries to agree to avoid routes through areas hosting sensitive deep-sea ecosystems or areas of scientific or historic interest.

Sampling a small coral colony with ROV Hercules manipulator arm. Photo courtesy of M. Grady NOAA Ocean Explorer

Marine scientific research provides the basis for our understanding of oceanic processes and ecosystems, essential ingredients for rational conservation and management. Marine research in the open ocean and deep seabed, both for scientific and for commercial purposes, is set to increase in order to fill the large gaps in our knowledge and understanding of these environments. Whereas most forms of marine research are generally benign, certain types of research activities have the potential to adversely impact marine species and ecosystems. Examples include large-scale seismic surveys or long-range acoustic studies conducted, e.g. to investigate if ocean temperatures are increasing. Others may involve manipulation of certain elements of the environment, such as the introduction of substances like iron in efforts to stimulate the ocean's uptake of carbon dioxide.

Under UNCLOS, marine scientific research is also a freedom of the high seas, but it must comply with any regulations on environmental protection adopted in conformity with the Convention. As the nature and scope of marine research changes and increases, it is important to ensure that activities that may have harmful environmental impacts are properly assessed before they begin in order to minimize unnecessary impacts and to balance societal interests. In small and vulnerable areas and ecosystems, such as hydrothermal vents and cold water coral reefs, there is a need to conduct research efforts with no or minimum impact, and to coordinate work to ensure that over-sampling does not take place; this could also prevent conflicts between different types of investigations and facilitate the sharing and best use of data, material and specimens collected, so as to avoid the need for repeat sampling.

Bioprospecting is already taking place among deep sea hydrothermal vents, corals and sponges as well as in the open oceans and polar regions. The likely impact of bioprospecting activities will depend on the scale of the proposed operation, the species to be collected, the methods used and the amounts of material extracted. At a minimum, a requirement for prior impact assessment of large-scale collection or other potentially harmful activities would be beneficial in ensuring that they are sustainable and do not cause harm to the environment. It should also be noted that destruction of deep-sea habitats and disruption of ecosystems from other activities could lead to the irreversible loss of unique species and their beneficial properties.

Pollution from land-based activities is contaminating even the deepest ocean trenches with heavy metal and pesticide residues. It comes from industries, agriculture as well as households, either by direct disposal of harmful

Wastewater causes serious problems in coastal areas and can also impact waters and wildlife far offshore. Photo courtesy of UNEP/Topham.

substances into the sea or indirect discharges that reach the ocean via the rivers, the subsoil or the atmosphere. Pollutants can be transported long-distances by winds and currents and to great depths by down-welling water masses and sinking organic matter. Persistent organic pollutants (POPs) consumed by organisms at the bottom of the food chain get concentrated as predators eat contaminated prey. The contaminants accumulate in the fatty tissues and can diminish the reproductive rate and weaken the immune system. The Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities and a treaty on POPs have done much to stem the impact of land activities on the marine environment, but most efforts have focused so far on nearshore waters and major challenges in funding, coordination and capacity-building remain.

Marine litter from both land- and sea-based activities has accumulated to such an extent that in central Pacific areas the mass of floating plastic is six times greater than that of plankton. Mass concentrations of marinelitter consisting of plastics, ropes, fishing nets and cargo-associated wastes (including whole shipping containers) extending over many kilometers have been observed in high

Marine litter kills and injures marine mammals, birds, turtles, fish and even invertebrates. It threatens marine and coastal biological diversity by disturbing essential, productive ecosystems. Photo courtesy of UNEP.

seas 'sink' areas in the equatorial convergence zone. It is estimated that over 46,000 pieces of litter are on the surface of every square mile of ocean today. 70% of marine litter will eventually sink to the seafloor, and can be regularly seen in benthic video surveys. Impacts of marine litter on high seas marine life include entanglement and ingestion, and are a serious cause of mortality for seabirds, marine turtles, marine mammals and fish. Plastic bags have a particularly lethal effect on turtles and mammals, who mistake them for prey (squid and jellyfish) and eventually die of suffocation or blocked intestines. Marine litter also provides transport for invasive alien species and is a compounding factor in their long-distance dispersal across the oceans to remote islands and polar regions. Lost or abandoned fishing gear and other debris can entrap, entangle and choke wildlife, and smother or fracture seabed habitats. The UNGA has recognized the urgent need to address this growing problem, particularly the lack of controls on debris from fishing operations. Annex V of MARPOL 73/78 regulates the disposal of garbage from all vessels. However, the lack of adequate reception facilities and the costs of using them tempt many ships to dispose their garbage over board, especially in the high seas far from land. UNEP, through the Regional Seas Programme of the GPA, has developed a global initiative for co-operation and co-ordination to control and manage activities and sources of marine litter. Action plans are being developed in various regions to encourage cultural, social and behavioural changes to reduce or prevent litter from entering the marine environment.

Chemical and radioactive wastes, deliberately dumped or lost at sea in the past and present, constitute a serious environmental threat to deep seabed communities. The location of many vessels lost at sea (e.g. those sunk during the 2nd World War) containing hazardous or radioactive wastes are still not well known. Many historic dumpsites of chemical munitions and radioactive wastes remain unaccounted for. Even when their location is known, they are seldom monitored. Historic dumping of nuclear submarines and warheads, chemical munitions and ships with noxious cargoes and fuel occurred without knowledge or basic understanding of the

Barrel of radioactive waste on the steep continental slope at a depth of about 610m. Photo courtesy of R. Dryer, U.S. Environmental Protection Agency.

ecology of the deep sea and potential long-term effects. This legacy may come back to haunt us. By international agreement, the deliberate disposal of wastes at sea has been regulated. The dumping of high- and low-level radioactive wastes as well as harmful and toxic materials is banned or prohibited. Nevertheless, illegal dumping continues to be a problem in some regions.

Climate change and ozone depletion caused by atmospheric pollutants are long-term risks that, like the sword of Damocles, threaten the oceans, and indeed all life on Earth. Increased ultraviolet radiation due to ozone depletion harms microscopic, photosynthetic algae and zooplankton at the base of the oceanic food web, potentially affecting the food supply of the entire marine community. Climate change may not only result in sea level rise and more severe coastal storm damage, it may also affect temperature, salinity and other parameters in particular marine environments, causing a wide range of effects from species mortality, modifying species composition and migratory patterns to shifts in whole ecosystems. At the global level, it may lead to major changes in ocean circulation patterns, which determine the distribution of all marine life. Moreover, the increased amounts of atmospheric CO_2 absorbed by the oceans is beginning to change the delicate balance of the carbonate equilibrium and the pH of ocean waters. Increasing carbonate undersaturation and acidity in the oceans are predicted to have widespread effects on marine animals with calcareous shells or structures, such as certain plankton and a large number of seabed groups (e.g. corals, molluscs), by impairing their growth and dissolving their skeletons. It is predicted that these effects, combined with the rise of sea water temperatures, will disrupt the marine food webs with devastating effects on open water communities and seabed ecosystems throughout the oceans, from the deep seas to shallow waters. Scientists have already estimated that the predicted changes in ocean chemistry will affect around 70% of the world's deep sea corals by 2100.

Potential high SeaS and deep ocean activitieS and related threatS

Deep seabed mineral deposits had a major influence on the development of UNCLOS. Initial interest during the 1960s and 1970s in manganese nodules on the deep seafloor may now be shifting to polymetallic sulphide deposits. The latter are found on oceanic ridges and seamounts at and near active sites of hydrothermal venting. The resulting metallic sulfide deposits can reach sizes ranging from several thousand to about 100 million tons and are highly enriched in gold, copper, and base metals. Depending on the movement of fluids in the Earth's crust and ocean floor, hydrothermal vents and their communities last for relatively short periods, and the deposits are not renewable resources. Deep seabed mining poses a substantial threat in terms of physical damage in the area of operation and surrounding habitats, with inevitable severe disturbance to the associated ecosystems. Mining activities at vents may also result in increased sedimentation and plume generation, and disturb the hydrothermal vent water circulation systems. Another concern is that the deep water which is lifted to the surface during a mining operation has a high nutrient content that could lead to local or regional increases in primary productivity and associated impacts, including eutrophication (i.e. lack of oxygen) and changes in the structure of biological communities. The International Seabed Authority established by UNCLOS is charged with developing environmental regulations to protect the marine environment and species from the impact of mining activities in the seabed Area beyond national jurisdiction.

Gas Hydrates may be the largest reservoir of hydrocarbons on Earth, existing in crystalline form in a matrix of sediment and ice along continental shelves and slopes/margins down to 2,000m deep. The potential for these hydrates to serve as a tremendous source of energy as well as their role in past and future disasters has made them a subject of intense scientific interest. Several countries including Japan, India, the USA and Canada have started gas-extraction feasibility studies, and drilling has been carried out in Japan's Nankeen Trough as well as in the permafrost region of northern Canada. It is estimated that commercial production is still at least 15 years away, but this depends on demand and the availability and price of other fossil fuels. Potential environmental risks from methane hydrate extraction are receiving serious scrutiny as extensive losses of methane to the atmosphere during drilling operations could exacerbate global warming. Another concern lies in the role gas hydrates play in maintaining seafloor stability. Removing the hydrates could trigger massive slides of underwater sediments, which poses the threat of both tsunamis and enormous uncontrolled releases of methane. Even without direct human intervention, scientists fear that increased water temperature and decreased pressure caused by melting ice caps could spark the release of methane from gas hydrates.

Ocean storage of CO_2. Transfer of CO_2 from the atmosphere to the oceans at the air-sea interface and transport of CO_2 to the cold ocean waters are natural, be it slow, processes - the cooler the water, the more soluble the gas. The ocean holds about 50 times more CO_2 than the atmosphere, and its capacity to store it is much larger. As part of a portfolio of climate change mitigation measures, scientists have tried a variety of experiments to increase the oceans' capacity to absorb CO_2. 'Ocean fertilization' involves the artificial fertilization of specific areas with dissolved iron -- iron is often the limiting factor for phytoplankton growth -- to increase the absorption of CO_2 which ultimately is deposited on the deep seabed. Apart from the severe effects of increased CO_2 levels in the oceans outlined in the previous section, most experiments to date have shown the method to be very inefficient, and to cause problems such as changing the marine food web and suffocating all bottom dwelling life in the affected area due to oxygen depletion caused by decaying plankton. Beyond the general duty of UNCLOS to protect the marine environment, there are no internationally agreed guidelines or rules in place to govern experimental or industrial scale activities for CO_2 storage and fertilization.

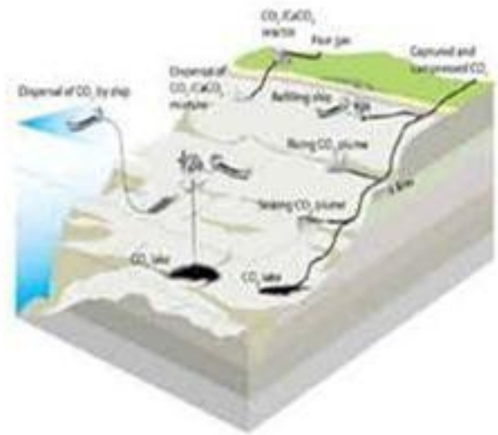


Diagram of options under consideration for ocean storage of CO_2. Illustration courtesy of IPCC (www.ipcc.ch).

Direct CO_2 injection into deep ocean waters is another ocean storage option that, unlike other suggestions, is already today feasible with existing technology. CO_2 captured from large point sources could be transported by tankers or pipelines to special sites at sea to be pumped into the water. When CO_2 is injected into the water column between 1,000 and 3,000m depth, it dissolves rapidly. The CO_2-enriched water increases in density and sinks into cooler, slow moving/circulating waters. Model simulations indicate that the CO_2 could remain dissolved in the water for more than 1,000 years. When CO_2 is directly injected close to the seafloor below 3,000m, the liquid CO_2 becomes so dense that it sinks to the seafloor and forms a CO_2 "lake".

The most significant potential threat of CO_2 ocean storage is the change in the deep sea carbonate balance and acidity, and the effects thereof on calcareous organisms and ecosystems (cf. above). Injection into the water could also disrupt marine microbial processes and cause widespread degradation of the seafloor - all sea floor animals underneath and within the vicinity of the CO_2 lake would die.

Geological storage of CO_2 is another option to store unwanted CO_2 several 1,000m beneath the seabed by injecting it into disused oil wells or saline aquifers, as has been done since 1996 in the Northeast Atlantic. These operations require extreme care to prevent and monitor any leakage from the seafloor. This form of geological storage of wastes in the seabed is thought to be covered by the 1996 Protocol to the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter. However, the Protocol, which entered into force just in March 2006, has not yet been widely ratified, and needs greater participation to ensure that its provisions are effectively applied.

Using the unique qualities of deep ocean water to serve coastal communities.

Deep ocean water has the potential to contribute to sustainable development in warm (and dry) coastal areas with nearshore access to deep waters. Deep ocean water is cold, nutrient rich, and assumed unpolluted. With new technologies, these unique qualities can be utilized and optimized. The basic idea is to pump up cold deep ocean water and lead it to shore via a pipe system. If applied wisely, various economically viable technologies could be used without insult to natural environments. Examples of test applications in Hawaii are air conditioning, industrial cooling, and fresh water production through condensation (for instance for agricultural use). After the deep ocean water has been employed in one or more cold utilization applications, it can be re-used for its nutrients, residual cold and purity (for instance in aquaculture operations). A potential threat from such applications could stem from the food particles and mid-water organisms, which are sucked up with the cold water and thereby removed from the deep water environment, and the construction and maintenance of the pumping and pipe systems, which could possibly damage the surrounding habitat and its wildlife. It should also be noted that pollution of the deep sea, both historic and ongoing, may undermine assumptions as to the absolute purity of all deep sea water.

Just as scientists and economists are confirming the importance of the oceans for planetary and human welfare, the oceans are under threat from human activities as never before. Overfishing, destructive fishing practices and IUU fishing are destabilizing ecosystems while multiple sources of pollution are weakening wildlife and undermining their ability to withstand further stresses such as those wrought by climate change and ozone depletion. Previously unrecognized threats, such as noise pollution and marine debris, are now clearly impacting marine species and habitats. Alien invasive species taking a ride in ballast water and on ships' hulls are a growing concern. Marine scientific research and bioprospecting may also pose threats, but with a sustainable approach can significantly contribute to human welfare and ecosystem health. New industrial uses of the oceans are emerging, such as deep seabed mining, methane gas extraction, CO_2 sequestration, deep sea tourism and even use of the properties of deep water itself. The benefits as well as risks and threats associated with pursuing these various activities remain uncertain as we still have but a poor understanding of open ocean and deep sea ecosystems. The question is: can the legal system keep pace and ensure the sustainability of human activities, even those undreamed of today, so that our oceans are conserved, managed and used equitably for the benefit of present and future generations?

4 The Evolving International Legal and Policy Regime

the international legal framework

Rights and duties of states with respect to protecting and conserving living marine resources and biodiversity beyond national jurisdiction are contained in an array of legally binding global and regional agreements.

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) is often referred to as the "Constitution for the Oceans", the legal framework applicable to all activities in the oceans and seas. UNCLOS sets out that all states have the right to exercise traditional high seas freedoms such as fishing, navigation, the laying of submarine cables and pipelines, marine scientific research and construction of artificial islands and other installations. However, UNCLOS also sets out the obligation to protect and preserve the marine environment, including rare and fragile ecosystems and the habitats of depleted, threatened or endangered species and other forms of marine life. UNCLOS calls for an integrated approach to ocean use and conservation. With respect to high seas living resources, all states have the duty to take, and to cooperate with other states in taking, measures necessary for their conservation. UNCLOS gives coastal nations the exclusive right to exploit and explore all mineral resources and bottom dwelling sedentary creatures such as corals, sponges and crabs on their legal continental shelf. However, back in the 1970s when UNCLOS was negotiated, the possibility of high seas fishing impacting these deep seabed resources was clearly not envisaged. Bottom trawl fishing today can impact a coastal state's sedentary species where the legal continental shelf extends beyond 200 nautical miles. The rules governing coastal state conservation duties and high seas fisheries suggest that coastal states have the right to protect and conserve these sedentary species; yet what action coastal states may take if foreign fishing fleets on the high seas impact these species when they are fishing for other, non-sedentary species, has not yet been elaborated or tested.

The 1995 United Nations Fish Stocks Agreement (Fish Stocks Agreement or UNFSA) is an example of an agreement designed to "implement" UNCLOS, in this case by elaborating on and specifying certain UNCLOS provisions in the light of the evidence of overfishing emerging in the early 1990s. To address these concerns, the Fish Stocks Agreement imposes more stringent obligations on both coastal nations and fishing nations with respect to their management of highly migratory fish stocks and of straddling fish stocks, as these stocks require consistent and coherent management in both national and international waters. The Fish Stocks Agreement explicitly incorporates modern precautionary and ecosystem-based approaches to fisheries management, and transparency and public participation in decision-making. Parties to the Fish Stocks Agreement that are fishing in regions covered by a fisheries management body are to join such body or, at a minimum, have their fishing vessels comply with any conservation and management measures agreed by this body. The alternative is to refrain from fishing in the region. Further duties set out in the UNFSA require parties to develop conservation measures to: (1) ensure long-term sustainability of fish stocks; (2) minimise the impact of fishing on non-target, associated and dependent species and ecosystems; (3) protect biodiversity in the marine environment; (4) apply the precautionary approach; and (5) protect habitats of special concern.

Despite its ambitious scope, it is widely recognised that the Fish Stocks Agreement has three major shortcomings. First, there are still some major fishing states that have not yet become parties; second, of those that have become parties, many are not applying it fully; and third, it does not apply to "discrete" high seas fish stocks associated with features like seamounts. Recently, however, the UN General Assembly (UNGA) has called on all states to improve their implementation of the Fish Stocks Agreement, and UNFSA parties are discussing mechanisms for assessing the performance of states and regional fisheries bodies. A major international conference is planned in 2006 to review the effectiveness of the Fish Stocks Agreement with a view to proposing, *inter alia*, means of strengthening its implementation. To improve management of discrete high seas fish stocks, the UNGA has called on all states to apply the general principles set out in the Fish Stocks Agreement also to such stocks. More broadly, it has urged states and regional fisheries bodies to consider, on a case by case and scientific basis, the interim prohibition of destructive fishing practices, including bottom trawling that has adverse impacts on sensitive marine ecosystems like seamounts beyond national jurisdiction. In 2006, the UNGA will review progress made by states and regional fisheries bodies to protect vulnerable marine ecosystems from destructive fishing activities and make further recommendations.

The International Seabed Authority (ISA) administers the seabed "Area" beyond national jurisdiction and its solid, liquid or gaseous mineral resources, which are recognized under UNCLOS as the "common heritage of mankind." The ISA is to oversee resource development, distribute the benefits arising from activities in the Area, and ensure that the marine environment is protected from any harmful effects which may arise during mining operations.

The ISA has established regulations for the exploration of manganese/polymetallic nodules, and is in the process of developing environmental regulations with respect to activities to explore minerals on hydrothermal vents and seamount crusts. All these regulations are, or will, include measures to prevent pollution, protect and conserve the natural resources, and prevent damage to the marine environment. The ISA is also sponsoring and coordinating marine scientific research for this purpose.

The 1992 Convention on Biological Diversity (CBD) is based on the principle that conservation of biological diversity is a "common concern of humankind." Its three main objectives are (i) the conservation of biological diversity, (ii) the sustainable use of its components and (iii) the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Although in areas beyond national jurisdiction the CBD's provisions do not apply to the components of biodiversity *per se* (as they do within national jurisdiction), they do apply to countries individually in regard to national activities that may adversely impact biodiversity wherever located. In areas beyond national jurisdiction, the 188 countries that have ratified the CBD have two strict obligations. One, parties are to ensure that activities within their jurisdiction or control do not damage the environment of other states or areas beyond the limits of national jurisdiction. Second, parties are to cooperate with respect to the conservation and sustainable use of biological diversity in areas beyond national jurisdiction, either directly or through the appropriate international organization. Parties to the CBD are to implement these obligations consistently with the rights and requirements of states under UNCLOS. At the 2004 Conference of the Parties to the CBD, the Conference called upon the UN General Assembly and other relevant international and regional organizations to urgently take the necessary short, medium and long-term measures to protect areas with seamounts, hydrothermal vents and cold water corals as well as other vulnerable ecosystems. Parties were recommended to take similar action. The Conference of Parties further requested the *Ad hoc* Open-ended Working Group on Protected Areas to explore options for cooperation to establish MPAs in areas beyond national jurisdiction.

UNCLOS and the CBD both envisage the development of additional agreements, measures or cooperative mechanisms to implement the obligations under these Conventions to protect and conserve the marine environment and biodiversity.

The 1979 Convention on Migratory Species (CMS) requires "Range States" to protect listed migratory species including sea turtles, sea birds and small cetaceans, as well as their habitat. This obligation applies also to open ocean hotspots that provide important habitat for these species. A "Range State" includes any state whose authorized or "flagged" vessels are engaged in taking a specific migratory species, also in areas beyond national jurisdiction. Several regional agreements and memoranda of understanding have already been developed to promote cooperation in protecting small cetaceans, albatrosses and petrels, and sea turtles. These encourage Range States to protect migratory corridors, breeding and feeding grounds and other essential habitats.

The 1973 Convention on Trade in Endangered Species (CITES) was developed in response to concerns that unregulated international trade in wild species of flora and fauna could have a detrimental impact on species and their ecosystems. The Convention explicitly envisages its application to marine species. CITES establishes the international legal framework for the prevention of trade in endangered species (Appendix 1) and for regulation of trade in species that might become endangered without such regulation (Appendix II). Export of Appendix II species requires a permit, which may be issued only if the specimen was legally obtained and if the export will not be detrimental to the survival of the species. With respect to high seas species, CITES has a specific provision called 'introduction from the sea' relating to the transportation into a State of a marine species from an area that is not under the jurisdiction of any State. Currently, and as more marine species are listed under the convention, there is debate in CITES as to 1) what constitutes "waters not under the jurisdiction of any state", and 2) how to implement this provision. CITES with its wide membership (169 Parties) is one of the few fora that brings together both producer and consumer states and has legally binding measures to ensure that any trade in marine products is based on sustainable harvests. It also provides mechanisms to tighten the scope of illegal trade, one of the major concerns in marine conservation. As such it will have a role to play in ensuring that the management of marine species addresses both global market forces as well as its effects on wider marine ecosystems and resources.

Additional global agreements relevant for the conservation and sustainable use of biodiversity in areas beyond national jurisdiction include those which address shipping activities, the transport and dumping of land-based wastes at sea, long-range air pollution, climate change and ozone depletion, as well as land-based activities that may degrade the coastal and marine environment.

The Regional Seas Programme (RSP) addresses the accelerating degradation of the world's oceans and coastal areas through the sustainable management and use of the marine and coastal environment by engaging neighbouring countries in comprehensive and specific actions to protect their shared marine and coastal environment including resources. Today, more than 140 countries participate in 18 RSPs, six of which are directly administered by UNEP: Caribbean, East Asian Seas, Eastern Africa, Mediterranean, North-West Pacific, and West and Central Africa.

Most RSPs implement Regional Seas Conventions and Action Plans and are tailored to suit the environmental challenges in the particular region, including: ecosystems, biodiversity and the

Regional Sea Conventions and Action Plans, Illustration courtesy of © UNEP

conservation of living resources; land-based sources of pollution; shipping and sea-based pollution; integrated coastal zone management; monitoring and assessment; small islands; the impact of marine litter on sea life; and other related activities.

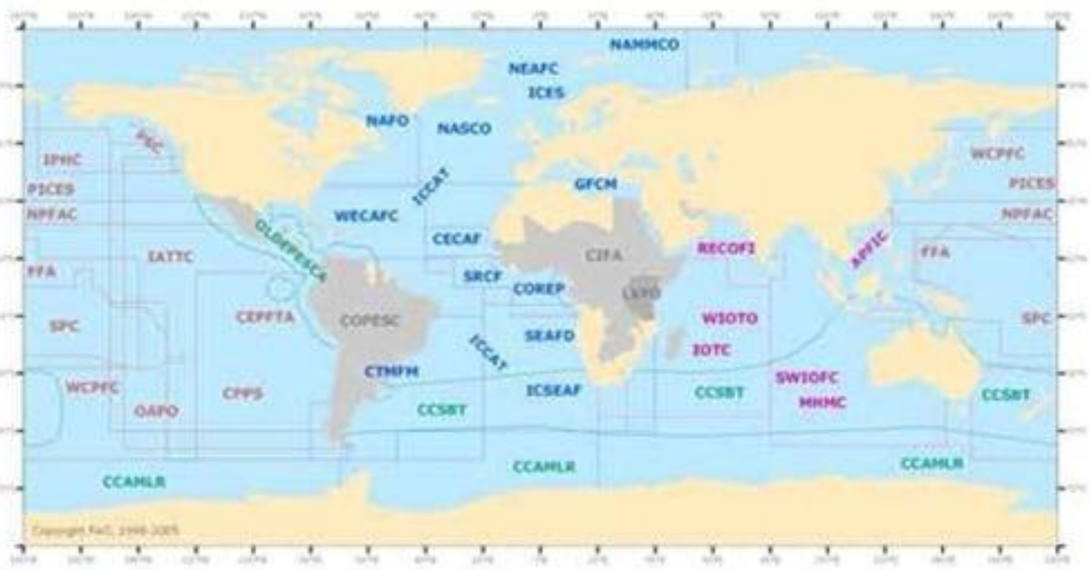
Currently, the RSP work on conservation and management of marine and coastal biodiversity covers a variety of topics and issues, including: Large Marine Ecosystems; invasive species; marine litter; and key marine ecosystems and species e.g. coral reefs; mangroves; sea turtles; sharks and marine mammals. The analysis of progress towards the establishment of representative systems of Marine Protected Areas (MPAs) at national, regional and international level is the subject of a special project carried out by RSP in partnership with the UNEP-World Conservation Monitoring Centre, the International Coral Reef Action Network (ICRAN) and the CBD secretariat.

The RSP Strategic Directions (2004-2007) call for, *inter alia,* the use of the individual Regional Seas Conventions and Action Plans as a platform for promoting synergies and coordinated regional implementation of relevant MEAs, international commitments and global initiatives. Subject to endorsement by the respective RSP governing bodies, the RSP could potentially act as a regional platform for the development and implementation of activities relating to the conservation of high seas ecosystems and biodiversity. The regional agreements covering the Antarctic (ATCM), Mediterranean (MAP), North-East Atlantic (OSPAR), and South Pacific Region (SPREP) include the high seas as part of their geographic area of responsibility, thereby providing examples that nations can act cooperatively on a regional basis to manage specific areas beyond national jurisdiction.

Regional Fisheries Management Conventions have also been agreed in certain regions of the world's oceans to establish commissions or bodies to develop conservation and management measures for fisheries. There are 12 regional fisheries management organizations (RFMOs) with full responsibility to agree on binding measures that cover areas beyond national jurisdiction. At the time of writing, a new regional fishery convention and body for the South Pacific area is being negotiated. However, only the five RFMOs for the Southern Ocean, Northwest Atlantic, Northeast Atlantic, Southeast Atlantic and the Mediterranean have the legal competence to manage most or all fisheries resources within their areas of application, including the management of deep sea stocks beyond national jurisdiction. The other RFMOs have competence only with respect to particular target species like tuna or salmon. Several ocean regions also lack management bodies for straddling fish stocks. The scope of conservation responsibility of RFMOs varies. Some, especially those which were developed after establishment of the UNFSA in 1995, but also CCAMLR in the Southern Ocean, are mandated to develop measures based on ecosystem and precautionary approaches. Others focus more narrowly on managing target fishery resources. Thus at present not all RFMOs have the mandate or the capacity to include in their work the effects of fishing on non-target species or the other stresses caused by fishing activities on resources, ecosystems and habitats. At least in two RFMOs, work is now underway to update their mandates to enable ecosystem-based management in line with the Fish Stocks Agreement.

In total, the global and regional agreements form a web of obligations for states regarding biodiversity and ecosystems beyond national jurisdiction, including the duty to conserve high seas living resources, to protect biodiversity, to preserve the marine environment, to prevent pollution and to cooperate in so doing. However, the international community has realised that there are inadequacies, both with respect to the implementation of existing legal requirements ("implementation gap"), as well as in the coverage of the existing conventions and organisations ("governance gap"). Key issues to be addressed in closing these gaps include:

- improving the ratification of some legal instruments;
- strengthening the implementation of existing legal requirements and measures;
- development and implementation of mechanisms to ensure compliance and enforcement of existing legal requirements and measures;
- increasing coordination and cooperation among specialized agreements;
- widening the mandate and scope of regional or sectoral agreements, which either do not include areas beyond national jurisdiction (e.g. most Regional Seas Conventions and Action Plans) or do not include the conservation and sustainable



Map of Regional Fishery Bodies. Illustration courtesy of © UN Food and Agriculture Organisation (FAO).

use of marine biodiversity (most RFMOs);

- the need to implement an ecosystem-based and precautionary approach to ocean management and conservation and sustainable use of biodiversity in areas beyond national jurisdiction, especially in the work of RFMOs which predate the UN Fish Stock Agreement;
- the need to consider the impacts of activities on high seas biodiversity;
- the need to invest in protective or precautionary measures to prevent increased long-term damage and costs; and
- reducing government incentives and subsidies that act perversely and promote overcapacity, inefficiency and destructive practices, especially regarding fisheries.

In addition, while some legal agreements provide for the establishment of management areas where a higher level of protection applies, they collectively are not in the position (i) to provide the comprehensive scope required to protect marine areas on a precautionary or integrated basis against the full range and cumulative effect of existing (and emerging) human activities and impacts or (ii) to ensure that all activities are conducted in a manner consistent with legal responsibilities to protect, conserve, and use biodiversity sustainably. Moreover, new and emerging issues and activities such as noise pollution, bioprospecting or ocean storage of CO_2 are not yet covered by specific agreements, only the general rights and duties of UNCLOS.

Other International OrganizationS and Intergovernmental ProceSSeS

Coordination of institutional and intergovernmental activities to ensure a holistic, effective and integrated approach to oceans management remains a challenge. Several international organizations and processes that are not backed by a Convention play a key role by providing fora for discussion and exchange of views regarding the conservation and sustainable management of the oceans within and beyond national jurisdiction.

The **United Nations General Assembly** (UNGA) is the key political forum for member states to raise issues relevant to oceans and law of the sea. The UNGA adopts an annual resolution on oceans and law of the sea, which combined with the related resolution on sustainable fisheries, provide general policy guidance to a wide range of international institutions as well as states. These resolutions identify a broad range of marine and maritime issues, and include specific recommendations, calls and invitations to international institutions and states on actions to be taken.

The **UN Informal Consultative Process on Oceans and Law of the Sea** (UNICPOLOS) was established in 2000 to provide a forum for informal discussions on pressing issues in the area of oceans affairs and to enhance coordination. Meeting annually, it enables states, international institutions, NGOs and other actors to explore problems, exchange views, and identify action which should be taken to address these problems. The reports of UNICPOLOS provide guidance and enrich the annual debates on oceans and law of the sea in the UN General Assembly, which also agrees on the focus and topics of forthcoming UNICPOLOS meetings. The protection of vulnerable marine ecosystems, including those in areas beyond national jurisdiction, was discussed by UNICPOLOS in 2003 and 2004.

A **UN *Ad-hoc* Open-ended Informal Working Group** was convened in February 2006 following the agreement reflected in the 2004 UNGA resolution on oceans and the law of the sea to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction. The purpose of this Working

Group was to enable more focused discussion and to indicate key areas for future cooperation. The meeting surveyed four topics: (1) past and present activities of the UN and other relevant organizations; (2) scientific, technical, economic, legal, environmental and socio-economic aspects; (3) key issues and questions where more detailed background studies would facilitate consideration by states of these issues; and (4) 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. Some of the options raised at this meeting are explored in more detail in the subsequent sections of this report.

The **UN Food and Agriculture Organization** (FAO) promotes the conservation and sustainable use of marine living resources through, among other activities, coordinating and promoting implementation of the FAO Code of Conduct for Responsible Fisheries. Important aspects of this are strengthening institutions and human capacity in developing countries and helping countries to implement action plans for reducing overcapacity, conserving sharks, reducing seabird by-catch and combating IUU fishing. The FAO is the global forum where FAO members discuss fisheries issues and the central source of information on fishes and fisheries, releasing every two years a report on the State of Fisheries and Aquaculture (SOFIA) based on data provided by states and RFMOs.

The **International Maritime Organization** (IMO) is responsible for establishing globally applicable measures to improve maritime safety and security and to protect the marine environment. Through IMO and IMO Conventions, e.g. the 1974 International Convention for the Safety of Life at Sea (SOLAS) and MARPOL 73/78, specific protective measures such as routing and reporting requirements as well as discharge and waste disposal restrictions can be established in defined areas where shipping presents a risk to the marine environment. Other agreements address, *inter alia* ballast water and oil pollution preparedness.

The **Intergovernmental Oceanographic Commission** (IOC) of the UN Educational, Scientific and Cultural Organization (UNESCO) is another institution with a mandate encompassing biodiversity of the high seas and deep oceans. The IOC focuses on developing and facilitating international oceanographic research programmes to improve understanding of global and regional ocean processes and their relationship to the sustainable development and stewardship of ocean resources; the establishment and coordination of an operational global ocean observing system and the dissemination of ocean data and information. IOC also provides international leadership for education and training programmes and technical assistance essential for systematic observations and related research of the global ocean and its coastal zone. Much of IOC's work has clear relevance to enhancing conservation and sustainable use of open ocean and deep seabed areas.

The **United Nations Environment Programme (UNEP)** has supported and coordinated major international programmes for the conservation and sustainable use of the oceans, including Regional Seas Conventions and Action Plans covering 140 countries, the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), and programmes of work on Small Island Developing States (SIDS) and coral reefs. UNEP also cooperates closely with various other ocean related initiatives, such as the Global Invasive Species Programme (GISP) and the Marine Mammal Action Plan. As regards vulnerable deep water marine ecosystems, UNEP (in cooperation with Ireland, Norway, the UK, and WWF) published in 2004 a report on cold-water coral reefs and currently facilitates the implementation of the report's recommendations for the sustainable management of cold-water coral ecosystems at the national, regional and global level.

UN-Oceans is an interagency coordinating mechanism within the UN system, which was established in 2003 by the UN General Assembly to bring together UN agencies and bodies, international financial institutions such as the World Bank and marine environmental convention secretariats dealing with oceans and coastal issues. Among its functions are to promote the implementation of international commitments within the framework of UN system and the mandates of the governing bodies of UN-Oceans. It is also empowered to pursue time-bound initiatives, with well-defined terms of reference, through *ad hoc* Task Forces open to the participation of NGOs and other international stakeholders, as required. The CBD Secretariat is currently spearheading a Task Force on biodiversity conservation in marine areas beyond national jurisdiction.

A **Regular Process** for the global reporting and assessment of the state of the marine environment, including socio-economic aspects, has been under development since the global community agreed at WSSD in 2002 to establish such a process. The UN General Assembly agreed in 2005 for a preliminary "Assessment of Assessments" to be carried out with a view to surveying and consolidating existing knowledge on marine assessment processes. A report of this work is expected in 2007. Once fully operational, this regular process would serve as a valuable tool to guide policy and decision makers at the international level also on issues related to the conservation and protection of marine biodiversity in areas beyond national jurisdiction.

Global Commitments, Goals and Principles

Since 2002, urgent discussions on vulnerable and threatened marine ecosystems and biodiversity in areas beyond national jurisdiction have been held, *inter alia*, at the United Nations, by Parties to the Convention on Biological Diversity as well as in the framework of FAO. As a result, the UN General Assembly, the CBD parties and FAO members have adopted a series of resolutions and decisions on the matter calling for urgent action. In 2003 and 2004, the UN General Assembly resolutions on oceans and the law of the sea 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 the Convention [UNCLOS] and with the principles of an integrated ecosystem-based approach to management, including the identification of those marine ecosystem types that warrant priority attention; and to explore a range of potential approaches and tools for their protection and management …."

The UN General Assembly also called upon states and international organizations "…to urgently take action 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."

The international community has already agreed on a number of important goals, targets and principles that provide a strong basis for action to conserve and sustainably use biodiversity and ecosystems within and beyond national jurisdiction. Many of these are being successfully implemented in nearshore waters but have not yet been applied consistently in offshore waters or beyond national jurisdiction. While many of these principles are not legally binding, they complement and help to elaborate the array of legally binding agreements described above.

The **Rio Declaration on Environment and Development** and **Agenda 21** were agreed in 1992 at the United Nations Summit on Environment and Development. The Declaration established the basic principles for sustainable development, and endorsed the concepts of the precautionary approach and the polluter pays principle. In chapter 17 of Agenda 21, global leaders recognized the necessity of adopting an integrated, precautionary and ecosystem-based approach to oceans management.

The **Millennium Declaration** and eight **Millennium Development Goals** (MDGs) were adopted in 2000 by the UN General Assembly. The Declaration emphasizes "Respect for nature. Prudence must be shown in the management of all living species and natural resources, in accordance with the precepts of sustainable development. Only in this way can the immeasurable riches provided to us by nature be preserved and passed on to our descendants. The current unsustainable patterns of production and consumption must be changed in the interest of our future welfare and that of our descendants." One of the eight MDGs is to ensure environmental sustainability, and pledges to "integrate the principles of sustainable development into country policies and programmes; and reverse loss of environmental resources."

The **World Summit on Sustainable Development** (WSSD) in 2002, complemented the MDGs with world leaders committing to achieve a number of specific goals and targets, *inter alia*, to reduce the rate of loss of biodiversity by 2010, encourage the application by 2010 of the ecosystem approach and to establish representative networks of marine protected areas by 2012. To reach these aims, the leaders agreed to develop and facilitate the ecosystem approach, to eliminate destructive fishing practices, to improve scientific understanding and assessment of marine and coastal ecosystems to assist sound decision-making and to "maintain the productivity and biodiversity of important marine and coastal areas both within and beyond national jurisdiction."

The **principle of sustainable development** includes four interrelated components: (1) The need to take into consideration the needs of present and future generations; (2) The acceptance, on environmental protection grounds, of limits placed upon the use and exploitation of natural resources; (3) The role of equitable principles in the allocation of rights and obligations; and (4) The need to integrate the environmental, social and economic aspects of sustainable development.

The **precautionary approach** calls for states and decision-makers to be more cautious when information is uncertain, unreliable or inadequate. This approach is reflected, *inter alia*, in the Fish Stocks Agreement, which calls for states and users to "apply the precautionary approach widely to conservation, management and exploitation of straddling fish stocks and highly migratory fish stocks in order to protect the living marine resources and preserve the marine environment." It further clarifies that "absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures." Parties to the CBD agreed that a precautionary approach should be applied to the full range of human activities affecting marine biodiversity, and not just to fishing activities.

Ecosystem-based management, as defined by Parties to the CBD, is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. As such, the ecosystem approach provides for the comprehensive integrated management of human activities, based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity. Adopting this approach should: (1) avoid degradation of ecosystems, as measured by indicators of environmental quality and system status; (2) minimize the risk of irreversible damage to natural assemblages of species and ecosystem processes; (3) obtain and maintain long-term socio-economic benefits without compromising the ecosystem; and (4) generate knowledge of ecosystem processes sufficient to understand the likely consequences of human actions.

Stakeholder participation is another important principle whose benefits have been widely recognized. Full stakeholder participation enhances transparency and contributes to credible and accepted rules that identify and assign the corresponding responsibilities appropriately. Thus, as called for in the Principles for Oceans Governance developed for the Independent World Commission on the Oceans in honour of the "Year of the Ocean" in 1998, "all stakeholders should be engaged in the formulation and implementation of decisions concerning environmental resources."

The **responsibility principle** is a corollary to the participation principle. In a broader environmental sense, this means that access to environmental resources carries attendant responsibilities to use them in an ecologically sustainable, economically efficient, and socially fair manner. Individual and corporate responsibilities and incentives need to be aligned with each other and with social and ecological goals. The FAO Code of Conduct for Responsible Fisheries sets out that "the right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources."

Transparency is an important principle in any organisation to ensure that it develops and maintains integrity and delivers on its objectives. To ensure transparency, it is important that actions, decisions and decision-making processes of an organisation are open to scrutiny by its members, stakeholders, civil society and outside institutions.

Accountability is another important principle that should be inherent in any organisation seeking to operate efficiently and effectively. To ensure accountability, an organisation should be able and willing to show the extent to which its performance, including actions and decisions, is consistent with clearly-defined and agreed-upon objectives.

Reaffirmation of these principles and approaches, and vigorous pursuit of agreed targets, would reinforce the collective responsibility of all states for the health and integrity of marine biodiversity in areas beyond national jurisdiction. Certain of these principles could be elaborated in relation to emerging activities in the deep oceans and high seas, in the same way that several of them have already been elaborated through the UN Fish Stocks Agreement. Further agreement on principles and approaches to implement the agreed goals and targets would help: (1) to ensure that all activities in areas beyond national jurisdiction are carried out to the same standards; (2) to ensure that principles, approaches and best practices are consistently applied across regions; (3) to guide the elaboration of specialized regimes; and 4) to advance a more coherent approach to oceans management across jurisdictions.

5 Examples of Options, Tools and Good Practices

A close-up of the coral Iridogorgia showing the feeding polyps lined up on one side of the branches. Photo courtesy of Deep Atlantic Stepping Stones Science Team/IFE/URI/NOAA.

The previous sections have demonstrated the need for open oceans and deep seabed areas beyond national jurisdiction to be conserved and sustainably managed. They also identified some of the key international legal obligations to protect and conserve marine ecosystems, biodiversity and resources as well as an array of international bodies which could assist countries in doing so. Here, we give examples of options, tools and good practices that are available or could be further developed and adapted to areas beyond national jurisdiction. Common agreement on the consistent application of basic management principles to human activities carried on throughout the marine realm would be an important first step towards integrated management of the oceans and safeguarding them for present and future generations.

To achieve these ends, environmental impact assessments, marine protected areas and other, more sector-related tools such as codes of conduct, voluntary guidelines and codes of practice (e.g. for marine scientific research and bioprospecting) could be considered. Some of these existing tools can be applied as they are, whereas the feasibility and means of effective implementation of others will have to be tested and adapted to the remote parts of the deep oceans and high seas and their particular and unique properties.

Environmental impact assessments (EIAs) and impact minimization are key components of a precautionary and ecosystem-based approach to management. Provisions and calls for EIA are contained in numerous global and regional agreements, from UNCLOS to regional seas conventions. As set out in the UN Fish Stocks Agreement, Parties are to “assess the impacts of fishing…[on] species belonging to the same ecosystem or associated with or dependent upon the target stocks”, “minimise…catch of non-target species…and impacts on associated or dependent species, in particular endangered species, through measures including…the development and use of selective, environmentally safe and cost-effective fishing gear and techniques.” The UNFSA furthermore requires Parties to apply strict rules on new and exploratory fisheries that encourage the development of new fisheries only in keeping with adequate information on which to base cautious conservation and management measures. The CBD calls for each Party to assess the environmental impacts of proposed projects under its jurisdiction or control with a view to avoiding or minimising significant adverse effects. The EIA process is to provide for public participation as well as appropriate notification and consultation with other states if adverse effects may occur in areas beyond national jurisdiction. However, there is a need to define the modalities for such procedures in order to support impact assessments of human activities in the deep oceans and high seas.

Marine protected areas (MPAs) are another key part of an ecosystem-based and precautionary approach to oceans management. As defined by the CBD, a marine and coastal protected area means “any defined area within or adjacent to the marine environment, together with its overlaying waters and associated flora, fauna and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoys a higher level of protection than its surroundings.” Such protection can range from areas managed strictly for science or wilderness values to areas managed more broadly for the sustainable use of natural ecosystems and resources (as reflected in the six IUCN Protected Area Management Categories).

The CBD parties have recommended a national framework of MPAs that is based on sustainable management practices throughout the wider marine environment, and includes: (a) areas where extractive uses may be allowed and threats are managed for the purpose of biodiversity conservation and/or sustainable use and (b) areas where extractive uses are excluded and other significant human pressures are removed or minimized, in order to maintain or restore the integrity, structure and functioning of ecosystems. Both types of MPAs are equally valid for marine areas beyond national jurisdiction.

MPAs and representative networks can provide enhanced protection to habitats or ecosystems that are vulnerable, unique, or representative including seamounts, cold water coral reefs, hydrothermal vents, and open ocean hotspots and other areas important for marine biodiversity or productivity. Similarly, ecologically coherent networks of MPAs are crucial for sustaining highly mobile seabirds, marine mammals, sea turtles and fish species, by safeguarding migratory routes, larval sources and other ecologically and biologically significant areas. As within coastal waters, MPAs in areas beyond national jurisdiction could provide a safeguard against irreversible biodiversity loss.

Representative MPA networks can also provide a cautious and scientifically rigorous approach to protecting not just what is known to be important today, but what may turn out to be important tomorrow. A representative approach to MPAs would include comprehensive and adequate protection for examples of all major ecosystem components in conjunction with their characteristic habitats and species. Experience on land and in coastal waters has shown that actions to restrict human activities are generally taken reactively, only after the future viability of species or biological communities is in doubt, or where evidence of damage to the ecosystem or its features is produced. Such management processes bear the risk that the actions taken are insufficient to keep up or prevent continued decline. On the high seas and in deep waters, where even less is known than in coastal waters, a more preventative approach would be a desirable and efficient strategy.

Obstacles to the establishment of MPAs and networks of MPAs beyond national jurisdiction are the lack of a common definition of what is or may constitute a MPA and the lack of internationally agreed criteria for the identification and establishment of areas in need of enhanced management,including biogeographic classification systems to help characterize special, unique and representative habitats, and mechanisms for their effective monitoring, management and enforcement.

Sustainable fisheries management tools continue to be essential. These include catch, effort and vessel regulations, bycatch limitations, precautionary reference points for catch and bycatch, capacity controls and reductions, gear restrictions (including bans and mandated improvements), as well as spatial and temporal closures of areas to protect fish stocks and other vulnerable species. Destructive fishing practices will need to be replaced by selective and environmentally friendly gear, as called for by the UNFSA. Obstacles to the implementation of these and other tools for sustainable fisheries management are the limited mandates of key regional fisheries bodies, the lack of experience in ecosystem-based fisheries management, and the uncertainties in finding a sustainable balance between short-term use and long-term conservation needs.

Guidelines, Codes of Conduct and Codes of Practice are another potentially useful tool. They can be voluntary initiatives developed by specific sectors, governments or regional or international organizations, or they can be made binding via national legislation. The FAO's Code of Conduct for Responsible Fisheries sets internationally agreed minimum standards that the fishing industry, nations and regional fisheries bodies are seeking to implement. Guidelines and codes of conduct have also been suggested to guide those engaged in marine scientific research, bioprospecting, cable-laying, and deep sea tourism, assuming the risks from these activities do not warrant stricter regulation. A noted limitation of such guidelines or codes of conduct is that they are voluntary and often remain 'dormant', for nations and users may lack the capacity or incentive to pursue active implementation. To address this concern, some governments are in the process of developing, together with stakeholders, Codes of Practice for human activities (e.g. marine scientific research) carried out in areas designated to protect vulnerable deep water ecosystems such as cold-water coral reefs. Under these Codes of Practice, research would become a "notifiable action" requiring authorisation from national authorities, following an assessment of the risks, probability and potential impact of the proposed research activities.

From the **governance perspective**, options to promote improved coordination and harmonization of high seas activities might include allocating more management responsibility to regional bodies - a spatial scale better suited to ecosystem-based cooperation and collaboration. In this aspect, the management regime established in the Southern Ocean may provide some useful lessons. In that region two different bodies play a role in the conservation of the Antarctic environment and resources. One organization (CCAMLR) oversees the conservation of living marine resources, and is responsible for minimizing the adverse impact of fishing while promoting rational use. Another body (ATCM) oversees the implementation of a regime of environmental impact assessments, develops rules to minimize human impacts, and oversees and promotes the establishment of protected areas. Applying a similar management regime in other regions might entail expansion of the mandate of regional fisheries bodies to give priority, as in CCAMLR, to ecosystem-based conservation and management; the extension of the mandates of regional seas programmes to cover adjacent high seas areas that are ecologically-related to areas within national jurisdiction; the enhanced cooperation between regional bodies; or some combination of the above, recognizing that high seas areas would remain open to use by all states subject to conformity with applicable global and regional rules. Existing organizations and institutional structures could be used where they exist. Another important aspect of governance would be to promote consistent application of the accountability, transparency, stakeholder participation and responsibility principles described above, both within and between organisations.

An **implementing agreement** to UNCLOS is another option that was proposed by some states at the February 2006 United Nations *ad hoc* Open-ended Informal Working Group meeting. According to its proponents, such an agreement could help implement already existing obligations under UNCLOS for international cooperation with respect to the protection of marine ecosystems while respecting the jurisdiction and sovereign rights of the coastal state over its territorial sea, EEZ and continental shelf. The implementing agreement could supplement the scope of existing global and regional bodies, and provide a mechanism for cumulative impact assessment across different sectors. It could be designed to: (1) embrace an integrated and precautionary approach to the protection, conservation and management of biodiversity in areas beyond national jurisdiction; (2) facilitate and enhance cooperation and coordination between existing regulatory frameworks and bodies; (3) ensure that all measures in areas beyond national jurisdiction are based on the best available scientific information and the precautionary approach, and are coherent and compatible with measures taken within national maritime zones; and (4) facilitate the establishment and effective management of representative networks of MPAs. Such an implementing agreement could draw on the experience of regional and sector-based organizations, which have a more narrow scope and limited membership.

The discussions and deliberations in the UN General Assembly show that the global community has recognized that it is time for action. The question now is how to achieve an integrated, ecosystem-based and precautionary approach to ocean management, which includes enhanced protection for vulnerable, threatened and representative ecosystems and biodiversity beyond national jurisdiction. It is generally acknowledged that such an approach is to be consistent with UNCLOS, but the door is open to explore a range of potential approaches and tools to enhance conservation, sustainable development and equitable use.

6 Charting a Course for Progress

The oceans are under threat as never before. As seen in previous sections, the intensity of human activities which affect the oceans are rapidly increasing and expanding, and with it the threats and impacts on marine biological diversity and productivity both within and beyond national jurisdiction. But unlike the former, conservation of marine biodiversity beyond national jurisdiction requires all nations and peoples to act together. Recent scientific research has confirmed that ocean life and processes are highly interconnected and that their protection requires urgent attention and action. Critical ecological processes and services of the oceans cannot be maintained by focusing only on those within 200nm of shore. Highly migratory species cannot be safeguarded without protecting their whole distributional range both in national and international waters. The full spectrum of marine biodiversity and resources cannot be conserved and used sustainably if we protect only known ecosystems and areas, for there is much that remains unknown and unexplored.

The deeper parts of the oceans and the high seas might be beyond national jurisdiction, but they are not beyond national responsibility. Governments, individually and collectively, have the duty to manage and sustainably use the biodiversity and resources of marine areas beyond national jurisdiction.

The next few years will be vital for ensuring that action is taken to improve the management of the global oceans and seas in their entirety. As was recognized by the UN General Assembly 35 years ago, "the problems of ocean space are closely interrelated and need to be considered as a whole." In areas beyond national jurisdiction, recognized priorities include combating damage from IUU fishing and destructive fishing practices, filling the gaps in high seas governance, integrating and implementing conservation and protection measures to ensure sustainable use of resources, and enhancing coherence and complementarity between national and international measures in adjacent areas. These will all play an important role in maintaining the vibrant life and diversity of oceans beyond national jurisdiction.

Some of the key recommendations from recent meetings that may help chart a clear course for progress are highlighted below:

Moving from words to action. It will be essential to improve implementation of all existing instruments and commitments related to the conservation and sustainable use of marine biodiversity beyond national jurisdiction, and to fill gaps in the current governance arrangements, where necessary. Political will is particularly important to combat the threats and impacts arising from IUU fishing and destructive fishing practices, to enforce all applicable measures, and to implement more effectively flag state responsibilities and the full range of port state controls available under international law.

Strengthening internal coordination and cooperation at all levels. This will promote the establishment of sound national views and priorities, and enable them to be expressed in a coherent, consistent way in international fora and across intergovernmental bodies and specialised agencies, which is essential for transparent, effective decision-making.

Enabling an integrated approach in oceans management. To achieve sustainable development it will be essential to balance conservation and sustainable use, and to combat the cumulative effects of human activities. For a successful establishment of an integrated approach in oceans management, it should be considered whether and how actions taken in territorial and EEZ waters could complement and reinforce international action for the conservation and sustainable management of marine biodiversity and resources beyond national jurisdiction, and vice versa. This also includes consideration of mechanisms to improve the coherence and compatibility of management actions by international and regional organisations, and ways to fruitfully utilise the expertise of regional organisations dealing with the marine environment, such as the Regional Seas Conventions and Action Plans.

Implementing ecosystem-based management. For marine biodiversity and areas beyond national jurisdiction, additional legal and other mechanisms consistent with the UN Convention on the Law of the Sea may be needed so that management: (i) reflects ecological boundaries and not just anthropogenic or political boundaries, (ii) incorporates best practices for ecosystem-based and precautionary management, (iii) addresses the full range of human impacts, (iv) identifies areas in need of enhanced management to ensure a higher level of protection for vulnerable species as well as biologically and ecologically significant areas, (v) makes possible a precautionary system of MPAs, established with clear and delineated objectives on a representative, biogeographic basis, as insurance to protect libraries of yet unknown biological diversity, (vi) provides effective mechanisms to secure compliance and enforcement, and (vii) enables sustainable and equitable use today while respecting the rights of future generations to enjoy and prosper from the ocean's bounty.

Building and strengthening the capacity of developing countries. To support the implementation of their rights and duties concerning marine biodiversity and the environment beyond nationaljurisdiction, assistance to developing countries should be enhanced. Key target areas include: (i) to support participation in global and regional forums where resource-related decisions are made; (ii) to enhance capacity to patrol and enforce domestic fisheries regulations against IUU fishers; (iii) to strengthen integrated oceans management within national waters; and (iv) to increase the opportunities for developing country scientists to participate in training programs as well as in the planning and execution of bi- or multilateral research projects and programmes.

Improving data collection and exchange. To improve coordinated and integrated management and storage, it will be necessary to compile and consolidate existing data and knowledge and to share this among all nations and stakeholders. Enhanced access and use of existing information, data bases and archives can improve understanding of the conditions, and human activities in, the deep oceans and high seas in general, and shed light especially on vulnerable habitats and ecosystems and species beyond national jurisdiction.

Accelerating scientific research. Filling the gaps in our basic understanding and acquiring new knowledge are essential to conserving, and benefiting from, the marine resources beyond national jurisdiction, as well as for prioritising and developing effective policies and measures. Further biological and ecological research, as well as socio-economic studies, are needed in many areas, including: (i) data about the current state, natural variability and human-induced drivers of change and on future trends in the use and exploitation of marine resources, (ii) emerging threats, including the effects of climate change and ocean acidification on vulnerable marine ecosystems, (iii) the use and non-use values of biodiversity, including deep seabed genetic resources, and (iv) economic and market-based incentives for using, and regulating the use, of deep seabed and high seas resources. This new research should be targeted and the results translated into policy relevant terms in order to strengthen the interface between science and policy. The Intergovernmental Panel on Climate Change could serve as a useful model for integrating, assessing and studying the implications of scientific knowledge for national and international response actions. Whether and how such a model could be applied to marine issues beyond national jurisdiction could be studied, *inter alia*, in the UN process to develop a regular reporting and assessment process on the state of the marine environment.

Raising awareness of the importance and value of marine biodiversity. Governments, global and regional organizations, scientists, industry, media and civil society as a whole all have a critical role to play in determining who should -- or could -- do what to improve the conservation and sustainable use of marine biodiversity beyond national jurisdiction. Increased awareness and understanding of the issues at stake are needed to change cultural, social and behavioural attitudes towards the deep oceans and high seas and to help policy and decision makers take sound and effective action.

"It is not how many species we discover. It is how to protect them once we have found them and how to keep from destroying the species we do not know before we have a chance to find them..."

Verlyn Klinkenborg (member of the New York Times editorial board), 2006.

Fingertip Facts about Deep Waters and High Seas

Stony corals, such as this Enallapsammia specimen, provide an important three-dimensional - but very fragile -- habitat for many species. Photo courtesy of Deep Atlantic Stepping Stones Science Team/IFE/URI/NOAA.

Geomorphology and physical facts

- 95% of the ocean area is below 130m deep, the average ocean depth is approximately 3,800m.
- Photosynthetically useful light penetrates the water column usually only down to 200m.
- Of the Earth's area, about 5% are continental shelves from 0-200m depth, 13% are continental margins (slopes and rises) from 200-3,000m, 51% abyssal depths between 3,000-6,000m. The deepest parts of the oceans (including many of the ocean trenches) constitute less than 2%.
- The mid-oceanic ridge system spans around 64,000km, four times longer than the Andes, the Himalayas and the Rocky Mountains combined.
- More than 100 hydrothermal vent systems have been documented, mostly along the mid-ocean ridge system.
- There are 37 trenches, mostly around the periphery of the world's oceans.
- The number of large seamounts is estimated to be over 100,000, 54% are in international waters. Less than 200 have been studied.
- Sediment accumulation rates in the abyssal zones are low, approximately 0.5mm per thousand years.
- Manganese nodules 'grow' about 1mm in 10,000 years.
- Water temperatures at depths of 1,000m and below ranges mostly between -0.9ºC and 5ºC.
- While significant in total area, the rocky substrates of mid-ocean ridges, seamounts and submarine canyons are rare habitats in the enormous expanses of the deep sea, occupying 4% of the sea floor.

Life in the deeper water and high seas

- The volume of living space provided by the waters of the oceans is 168 times larger than that of terrestrial habitats.

- More than 90% of the planet's living biomass is found in the oceans. Models estimate that bacteria in deep sea sediments alone account for almost 10% of the Earth's biomass. Single cell and microbial species make up 90% of the oceans' biomass.

- There are 43 marine phyla and only 28 terrestrial ones. Of the 33 phyla of animals, 32 are found in the oceans, and 15 are exclusively marine.

- 90% of the oceans are unexplored. Only some 0.0001% of the deep seafloor has been subject to biological investigations.

- A bluefin tuna crossed the Pacific three times in 600 days. The fish traveled 40,000km, equivalent to the distance around the world.

- Orange roughy matures after around 32 years. A specimen of this species was recently found to be approximately 240 years old.

- Manta rays can travel over 2,200km at speed above 11 knots, diving to depths of 450m.

- A Northern Royal Albatross can fly up to 1,800km in 24 hours. A Grey-headed Albatross can circle the globe in 46 days.

- Offshore, where it is too deep for enough sunlight to reach the seabed to fuel photosynthesis, phytoplankton suspended in near-surface waters are solely responsible for the primary production, apart from the estimated 0.03% produced by chemosynthetic communities.

- About 50% of animals collected from areas deeper than 3,000m are new species.

- Cold-water coral reefs have been found so far off the coast of 41 countries from the poles to deep equatorial waters. These reefs can be up to 35m high, 40km long, 3km wide, and 8,500 years old.

- Two-thirds of all known coral species live in deeper and cold waters, but only less than 10 cold-water coral species form reef structures, compared to around 800 coral species found in tropical, shallow water reefs.

- Individuals of gold corals (*Gerardia* spp.) found on seamounts may have been alive for up to 1,800 years, making them the oldest known animals on Earth.

- Communities living on hydrothermal vents and cold seeps obtain their energy from chemicals seeping from the Earth's crust or ancient sediments. They are examples of life on Earth which does not depend directly on energy from the sun.

- Out of the 500 species described from hydrothermal vents, 90% are endemic. Biomass around vents can be 500-1,000 times higher than in the surrounding deep sea and includes the fastest growing animals in the sea (tube worms grow up to 2.5cm in 10 days).

- Only 200-300 species associated with cold seeps have been identified so far, many remain undescribed.

- At any given time, there are thousands of whale carcasses on the bottom of the oceans. 400 species have been documented to live and feed mainly, or exclusively, on these remains.

- So far, around 1,970 species have been recorded from 171 seamounts, with a large number of new species. 16 to 36 per cent of the 921 species of fish and other benthic macrofauna collected on 24 seamounts in the Tasman and Coral Seas in the South Pacific were new to science.

- Seamounts can have a high rate of species endemism, 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 seamount chain off Chile.

- Species richness on unfished seamounts in southern Tasmania was found to be 46% higher than on fished seamounts, and biomass was more than 7 times higher.

- Trench faunas are highly endemic, with 56% of the species only found in trenches, and 95% occurring only in a single trench.

Human activities and impacts

- Seafood provides almost 20% of the world's total animal protein intake.

- In the last 42 years, capture of wild marine fish for human consumption increased from 20 million tonnes to 84.5 million tonnes, with more than 40% entering international trade.

- Global by-catch amounts to 20 million tons a year, approximately 25% of the fish caught.

- Over half (52%) of the global fish stocks are fully exploited. Overexploited and depleted species have increased from about 10% in the mid 1970s to 24% in 2002.

- The percentage of fish caught on the high seas in relation to the global marine catch rose from 5% in 1992 to 11% in 2002.

- Catch from high seas bottom trawl fishing in 2001 was worth an estimated US$300-400 million, equal to approximately 0.5% of the value of global marine catch. The sector employs an estimated 1,000-2,000 people using around 250-300 boats (on a full time-equivalent basis).

- The worldwide value of IUU catches is estimated between US$4.9-9.5 billion. Up to 30% of IUU fishing (US$ 1.2 billion) occurs beyond national jurisdiction.

- Each year, illegal longline fishing kills over 300,000 seabirds, including 100,000 albatrosses.

- Around 3.5 million fishing boats use the world's ocean. 1% of these are classified as large, industrial vessels, which have the capacity to take around 60% of all the fish caught globally.

- 15 million people work aboard fishing boats globally, 90% work from small-scale, non-industrialized vessels.

- 15% of the world's large-scale fishing fleet is operating under a flag of convenience (FOC) or listed as flag 'unknown'.

- Government subsidies — estimated at US$15-20 billion per year — account for nearly 20% of revenues to the fishing industry worldwide.

- Populations of large fish with high commercial value, such as tuna, cod, swordfish and marlin, have declined by as much as 90% in the past century.

- Southern bluefin tuna, Western Atlantic Northern bluefin tuna, South Atlantic albacore are classified as 'Critically Endangered' in IUCN's Red List. Northern Atlantic swordfish, Pacific bigeye tuna and Eastern Atlantic Northern bluefin tuna are classified as 'Endangered'.

- Every year 100 million sharks and related species are caught in fisheries, mostly for their fins.

- Stocks of two north Atlantic deepwater sharks -- the Leafscale gulper shark and Portuguese dogfish -- have crashed by 80% in just 10 years. Both species are listed as 'Endangered'.

- Stocks of two species of northwest Atlantic deep sea fish - the onion eye grenadier and round-nose grenadier - declined 93.3% and 99.6% between 1978 and 2004.

- In the first year of the orange roughy fishery in the South Tasman Rise, trawl nets brought up 1.6 tons of coral per hour as bycatch, with an estimated total of around 10,000 tons of coral by-catch over the year. The catch of orange roughy in the same time was 4,000 tons.

- Most deep sea fisheries peak within 5 years and collapse within 15 years. The unregulated orange roughy fishery in the Southwest Indian Ocean collapsed within less than 4 years.

- 19 of 21 albatross species are under global threat of extinction.

- In 2000, more than 200,000 loggerhead sea turtles and 50,000 leatherbacks were accidentally caught in fishing gear worldwide. Populations of both species have fallen by 80-90% over the past decade.

- Most cold-water coral reefs in the North East Atlantic show signs of, or have been destroyed by, bottom trawling.

- The operation of a deep sea research vessel with equipment can cost around US$30,000 a day.

- In 2002-2003, 80% of new chemicals introduced globally as drugs can be traced to, or were inspired by, natural products.

- Profits from a compound derived from a sea sponge to treat herpes were estimated to be worth US$50-100 million annually, and estimates of the value of anti-cancer agents from marine organisms are up to US$1 billion a year.

- The substance ‘Neosaxitoxin’ derived *inter alia* from dinoflagellates, blue-green algae and toxic shellfish is valued at US$21,400 per mg.

- It takes 2,400kg of sponge to produce less than 1mg of the substance ‘Spongistatin’.

- In the last 50 years, levels of human-generated noise have increased dramatically in our oceans, doubling every decade for five decades running in some coastal areas.

- Intense undersea noise can kill and injure wildlife and decrease commercial fish catch rates by as much as 40-70% as shown by a study on cod and haddock around an oil and gas seismic survey in the Barents Sea.

- More than 90% of goods traded between countries are transported by sea.

- Oil tankers transport 60% (approximately 2,000 million tons) of oil consumed in the world.

- Due to an oversupply of vessels, tanker companies have the lowest price-to-earnings valuation of any sector within the energy industry.

- 25% of the natural gas and 30% of the oil used domestically in the US comes from the Gulf of Mexico Outer Continental Shelf (OCS). 3.9 seconds of OCS production would allow a car to travel around the earth’s equator.

- 50% of leased acreage in the Gulf of Mexico OCS is in deep water (greater than 300m), and a first exploratory well has been drilled in over 3,000m of water. Seven of the top 20 oil fields in the US (ranked by liquids proved reserves) are now located in federal deep water areas.

- Each year 10 billion tons of ballast water is transferred around the globe and released into foreign waters.

- Ballast water often contains species that as 'aliens' colonize new environments to the detriment of native species and local economies.

- Today 95% of the Black Sea's biomass is made up by the Atlantic comb jellyfish. This species was accidentally introduced by ballast water and has severely affected the commercial fishery in the six states surrounding the Black Sea.

- Wastes created per day vary from 4,400kg (cruise ships), 60kg (cargo ships) to 10kg (fishing vessels). About 1/3 of the waste from cruise ships visiting the Caribbean is deliberately dumped.

- The total input of marine litter into the oceans was estimated at approximately 6.4 million tonnes per year, of which nearly 5.6 million tonnes came from merchant shipping.

- Some 8 million items of marine litter have been estimated to enter the sea every day, about 5 million of which have been thrown overboard or lost from ships.

- Over 46,000 pieces of plastic litter are floating on every square mile of ocean today. In the Central Pacific, there are up to 6 pounds of marine litter to every pound of plankton.

- Plastic waste kills up to 1 million sea birds, 100,000 sea mammals and countless fish each year.

- Between 1949 and 1970, 50,201 metric tonnes (equivalent to about 100,000 drums) of low-level radioactive waste was dumped in the Northeast Atlantic. A further 64,525 tonnes (122,732 barrels) was dumped between 1971 and 1982, when this dumping stopped. The US deposited 34,282 drums in the Western Atlantic between 1949 and 1967, and another 56,261 containers in various places of the Pacific Ocean between 1946 and 1970.

- The Gulf Stream flow has declined 30% in the last half century, with the rate of decline accelerating in the past five years.

- About 38,000 gigatonnes of carbon (Gt C) are stored in the oceans, compared with about 2,000 Gt in the terrestrial biosphere and 700 Gt in the atmosphere.

- Oceans act as an important carbon sink, including a significant proportion of the 6 Gt C which originates from human activities each year, and absorb 2 Gt C per year more CO_2 than they are releasing.

- If CO_2 emissions continue to rise, by 2100 the entire Southern Ocean, the subarctic Pacific Ocean and large parts of the deeper waters in the North Atlantic will be undersaturated with aragonite (a form of calcium carbonate), which will impair coral and mollusc growth.

This list is taken from various literature sources and does not attempt to be exhaustive. The author is not responsible for the accuracy of these facts.

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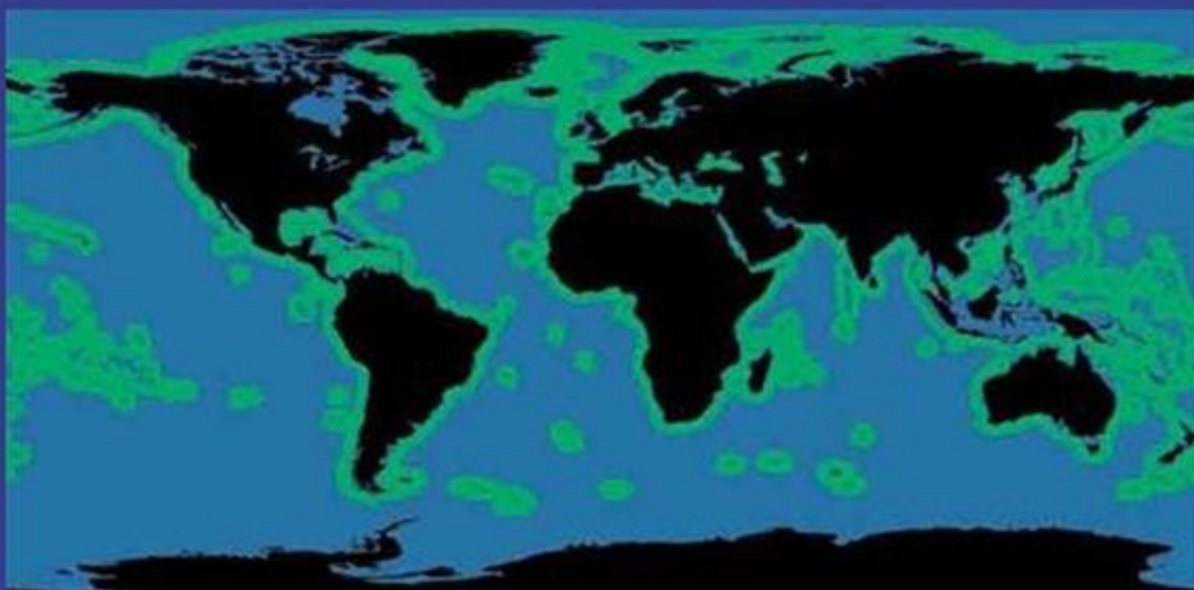
List of Acronyms

ATCM:	Antarctic Treaty Consultative Meetings
CBD:	Convention on Biological Diversity
CCAMLR:	Convention on the Conservation of Antarctic Marine Living Resources
CITES	Convention on International Trade in Endangered Species
CO_2:	Carbon Dioxide
EEZ:	Exclusive Economic Zone
EIA:	Environmental Impact Assessment
FAO:	United Nations Food and Agriculture Organisation
FOC:	Flag of Convenience
HERMES:	Hotspot Ecosystem Research on the Margins of European Seas
HSTF:	High Seas Task Force
IMO:	International Maritime Organisation
IOC:	Intergovernmental Oceanographic Commission
IPCC:	Intergovernmental Panel on Climate Change
ISA:	International Seabed Authority
IUCN :	The World Conservation Union
IUU:	Illegal, unreported and unregulated fishing
MDG:	Millennium Development Goals
MPA:	Marine Protected Area
NGO:	Non-governmental Organisation

POP:	Persistent organic pollutant
RFMO:	Regional Fisheries Management Organisation
SOFIA:	State of Fisheries and Aquaculture
UN:	United Nations
UNCLOS:	United Nations Convention on the Law of the Sea
UNEP :	United Nations Environment Programme
UNESCO:	United Nations Economic, Social and Cultural Organisation
UNFSA:	United Nations Fish Stock Agreement
UNGA:	United Nations General Assembly
UNICPOLOS:	United Nations Informal Consultative Process on Oceans and the Law of the Sea
WCPA:	World Commission on Protected Areas
WSSD:	World Summit on Sustainable Development



MAP COURTESY OF DEFYING OCEANS END (2004)

The average depth of the ocean is almost 4,000m, 95% is below 130m deep. Almost two-thirds of the ocean's surface lies beyond national jurisdiction - the Earth's final frontier. As human activities and uses have intensified and expanded into remote and unexplored areas, their impacts on ocean life and ecological processes have mounted.

Conservation and sustainable use of the ecosystems and biodiversity in deep waters and high seas are among the most critical ocean issues today. Concerted efforts are now required to conserve and sustainably manage the vital goods and services these vast areas provide, before it is too late.

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