Chapter 4

Marine Environment Protection

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Introduction

Oceans and seas have long been recognized as huge, unknown, and unexploited natural habitats which can provide endless resources, especially as food. Today we know that our marine resources are not infinite; this is true even for surface areas. Furthermore, human activities are responsible for severe pressures and impacts on the marine environment. The most important direct threats stem from fisheries, shipping, the oil and gas industry, mineral extraction, mariculture, maritime construction work, and tourism, as well as land-based activities such as agriculture. All the activities mentioned are a threat to marine biodiversity. Anthropogenic impacts and pressures lead to eutrophication, accumulation of toxic substances in marine animals at the end of the food chain, degradation of benthic habitats, and marked decline in number and size of exploited large marine animals. Climate change further adds to the mentioned diverse pressures, altering water temperatures, sea levels, and the pH levels of marine waters.

It is already documented that about 90% of the biomass of exploited large fish species and mammals has been lost in comparison to their historic levels. Human activities have already eliminated approximately 65% of seagrass and wetland habitats in temperate zones (Census of Marine Life International Secretariat: Consortium for Ocean Leadership 2011). The coral reefs are at high risk of extinction. The main reasons are the emission of carbon dioxide and the effects of acidification (Pandolfi *et al.* 2003).

There is no doubt that the protection and sustainable management of the oceans and seas are becoming more and more important, especially with the increase in the exploitation and uses of marine resources and therefore of pressures and impacts. Shipping and fisheries are two of the main sectors that are causing harm to the

The Handbook of Global Climate and Environment Policy, First Edition. Edited by Robert Falkner.

marine environment. This chapter offers an overview of international policies and regulations for the protection of the marine environment from shipping and fishing activities. The European fisheries policy is brought up as an example for a regional approach in managing fish stocks.

The Marine Environment

It is common knowledge that we live on a blue planet. Seventy-one percent of the Earth's surface is covered by salt water. There are on the one hand the five oceans – Pacific, Atlantic, Indian, Antarctic, and Arctic – and on the other hand the marginal seas like the Mediterranean, Baltic, and Bering. The oceans and most of the seas are connected to one another. More than half of the oceans' area is over 3000 m deep.

The oceans are an important part of the biosphere, but only about 5% of them have been systematically explored. Approximately 250 000 marine species excluding microbes have been described by scientists to date, but it is suggested that the total number of species could be at least four times higher (Census of Marine Life International Secretariat: Consortium for Ocean Leadership 2011). The marine environment is usually divided into the benthic (of the sea bottom) and pelagic (open water) zone, which can be further subdivided.

The greater part of human activities in connection with the marine environment take place near the coast or, better said, on the continental shelf. In these shallow waters of up to 200 m in depth, the productivity is generally higher than in offshore waters because of the permanent nutrient input from land and recycling runoff. High productivity means also high biomass of marine species. This is one reason why most fishery activities take place near the coast. Furthermore, these areas are also the ones with the highest biodiversity (Tittensor *et al.* 2010) (see Figure 4.1). Habitats of high ecological value are found in these shallow waters, such as mangrove forests, which are closely interlinked with freshwater and terrestrial ecosystems. The coastal seas can be highly diverse, for example about 133 different marine and coastal habitat types have been described for the Baltic Sea (IOW 2003).

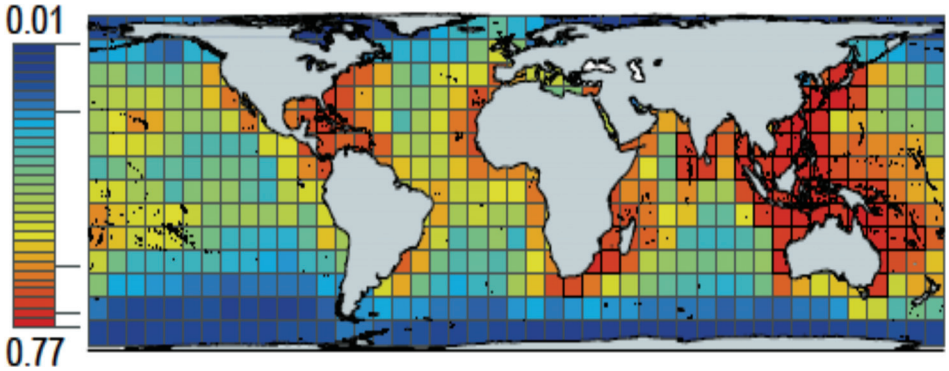

Figure 4.1 Global marine species richness for all taxa.
Source: Tittensor, D.P., C. Mora, W. Jetz *et al.* 2010. "Global Patterns and Predictors of Marine Biodiversity across Taxa." *Nature*, 466: Figure 2b.

The natural conditions for coral reefs in the tropics are different; with a tremendous variety of life, they are one of the most fascinating ecosystems of the world. Reefs are perhaps the most diverse and species-rich areas in the marine environment. This is remarkable because warm-water coral reefs appear in tropical waters that are extremely poor in nutrients. Outside of the reefs productivity is very low. One of the main reasons why reefs are very productive might be that they are able to hold all nutrients in the system and cycle them in a very efficient way, similar to rainforests. Coral reefs are very sensitive to changing conditions, for example in temperature, pH level, salinity, physical disturbance, and sedimentation (Nybakken 1993).

The far regions of the oceans are often called blue deserts because primary production as well as number of species are often very low. These areas are characterized by limited nutrition. The oceanic zone can be divided into the very thin top layer, which receives light and where primary production (growth of microalgae) occurs, and the aphotic zone, the permanently dark water masses. Approximately 90% of the volume of the ocean constitutes the dark, cold area which is called the deep sea (Nybakken 1993). The deep sea is the largest and least known ecosystem on the planet. It harbors a high and fascinating biodiversity which is adapted to extreme conditions like high pressure, low food availability, and permanent darkness.

The blue desert is interrupted by little ocean oases, the seamounts. These are undersea mountains which are usually volcanic in origin. It is estimated that about 1000 seamounts exist in the Atlantic Ocean and 30 000 in the Pacific Ocean. Seamounts are quite important because they are hotspots of marine life. The upwelling of nutrient-rich deepwater at the seamounts results in high productivity. High productivity means a high biomass of phyto- and zooplankton, which attracts a lot of fish. This is why many top predators such as marine mammals and large fish species congregate over seamounts. However, because of the high biomass of fish there, seamounts are therefore also attractive to the fishing industry. Seamounts have been targeted by fishermen since the middle of the twentieth century. The problem with this exploitation is that not much is known about the targeted fish species and stocks. They are often, like the orange roughy (*Hoplostethusatlanticus*), long-lived, slow–growing, and late-maturing species with a low productive potential. Despite their aggregation at seamounts, their overall abundance is actually very low. Therefore, they are quickly fished out, as already documented, and will likely need decades for recovery (Morato n.d.).

The marine ecosystems provide a huge number of goods and services to human beings. Benefits people obtain from ecosystems are generally called ecosystem services (ES). In the Millennium Ecosystem Assessment ecosystem services are divided into the following four categories (Reid *et al.* 2005):

1. provisioning services: goods and benefits to people with a clear monetary value;
2. regulating services: for example regulation of climate and control of local rainfall;
3. cultural services: which provide no direct material benefit, like aesthetic beauty of coastal formations;
4. supporting services: which are of no direct benefit to people but essential for the ecosystems, like formation of sediments or nutrition cycling.

Important provisioning services from oceans and seas are food, energy, transportation routes, minerals, recreational areas, and biomedical products. The marine ecosystem also have other services that are of great value: oceans, for instance, are the most important natural sink for anthropogenic carbon dioxide (CO_2) (Sabine *et al.* 2004). Some of the marine ES create direct economic benefits, while the value of others, especially of regulating and supporting services, are generally very difficult to estimate. This is true for example for climate regulation, water purification, and coastal protection.

International Legal Background for the Use of the Marine Environment

The oceans have been subject to the freedom of the seas doctrine since the seventeenth century. This principle limits national rights and jurisdiction over the oceans and seas to a narrow area surrounding a nation's coastline. The remainder of the oceans is free to all and belongs to none. The doctrine was slightly restricted by different conventions and measures, falling within the competences of different global international organizations for marine matters. Important organizations in this respect include the Food and Agriculture Organization of the United Nations (FAO), the International Maritime Organization (IMO), and the United Nations Environment Programme (UNEP), among others.

The most important convention regulating access to the resources of the oceans is the 1982 United Nations Convention on the Law of the Sea (UNCLOS) (United Nations Office for Legal Affairs 2011). UNCLOS entered into force in 1994 and is an important attempt by the international community to regulate all aspects of resources and use of the oceans and the seas. In this way, UNCLOS is more or less delivering a framework with limited concrete obligations but it calls for implementation through other global or regional treaties (Kachel 2006).

The main motivation for the convention was to end rising tensions between nations over conflicting claims to ocean space and resources. The hope was that with more stable governance, conflicts among nations over the use of the different resources of the oceans could be avoided in the future.

The most important aspects of the Law of the Sea treaty are: navigational rights, such as the right of innocent passage through the territorial sea, territorial sea limits, economic jurisdiction, legal status of resources on the seabed beyond the limits of national jurisdiction, conservation and management of living marine resources, a marine research regime, a binding procedure for the settlement of disputes between states, and the protection of the marine environment.

States are in principle free to enforce any law, regulate any use, and exploit any resources in coastal waters up to 12 nautical miles from the national coastline. This sovereignty extends to the air space over the territorial sea as well as to its bed and subsoil. The introduction of the exclusive economic zone (EEZ) was an innovative step made under the Law of the Sea treaty. The EEZ is a seazone over which a state has special rights for the exploration of marine resources. It stretches from the seaward edge of the state's territorial sea out to 200 nautical miles from its coast or even to the continental shelf beyond the 200-mile limit. In the EEZ third states enjoy freedom of navigation and have the right of other uses of the sea that are in line with international agreements. The reason for establishing the EEZ was the increasing

interests in exploiting offshore resources like fish, oil, or gas but also concerns over the threat of pollution and wastes from shipping, especially from oil tankers (United Nations Office for Legal Affairs 2011).

International Shipping

Transportation of goods and products is essential for international trade. It is the bloodstream of the global economy. And as all countries are more or less surrounded by the sea, most of the goods are transported by ship. Furthermore, the costs for transporting goods and bulk materials on ships are the lowest compared to all other forms of commercial transportation and they produce the lowest CO_2emissions. The establishment of a global system of trade was highly dependent on the development of shipping. About 90% of global trade today is done by sea. There was a steady and considerable increase in goods loaded aboard ship between the 1970s and 2008; total cargoes loaded on ship went up from 2.6 billion t. to 8.2 billion t. (Figure 4.2). This development was temporarily hampered by the financial crisis in 2009 that was accompanied by a decline in the volume of global merchandise trade (IMO 2012).

Impacts of Shipping on the Marine Environment

Even though shipping is the most climate-friendly form of commercial transport it is not at all environmentally friendly. Shipping is responsible for a number of pressures

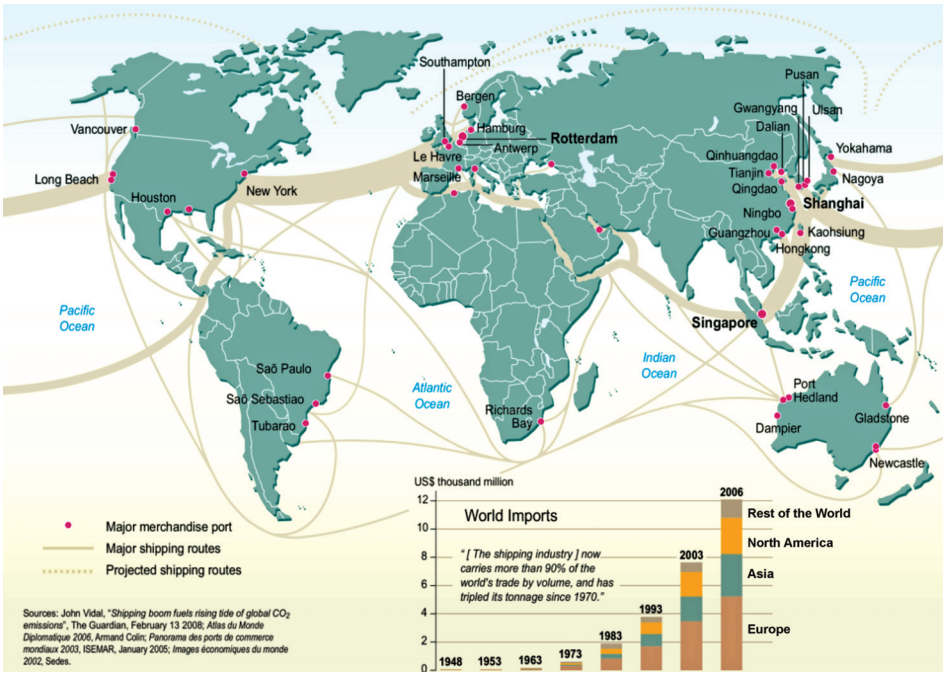

Figure 4.2 The boom in shipping trade.
Source: UNEP/GRID-Arendal. 2009. "The Boom in Shipping Trade." UNEP/GRID-Arendal Maps and Graphics Library 2, http://maps.grida.no/go/graphic/the-boom-in-shipping-trade1.

and risks to the seas and oceans: discharges of hazardous substances such as oil, atmospheric emissions, noise pollution, discharge and disposal of sewage and litter, introduction of non-indigenous species, and risk of oil spills. Most of the threats from shipping are not well monitored.

The release of airborne pollutants by ships has harmful impacts on the ecosystem and the atmosphere. Of key importance for the marine environment are sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emissions that result in the acidification and eutrophication of sea water. Heavy oil or bunker oil are used as fuel in ships. These oils have a high sulphur content of around 3%, which leads to high SO_2 emissions. Another problem is the emission of particulate matter, which not only affects the climate but also human health. The most important greenhouse gas emitted by shipping is CO_2. It is estimated that shipping is responsible for 3.3% of global emissions of CO_2 (Buhaug *et al.* 2009). A large proportion of emissions are released near the coast. As a consequence, atmospheric emissions from ships have created a serious air-quality problem in some port cities (EMSA n.d.).

Shipping is an important source of oil inputs in the sea. Oil enters the marine environment via incidental, operational, illegal discharges and accidental oil spills (OSPAR Commission 2010). Oils and their components can damage the marine ecosystems in a variety of ways, such as toxic effects on organisms that ingest oil components. An important indicator for chronic oil pollution is the occurrence of oiled seabirds at beaches. Major sources for oil pollution are not accidental oil spills but illegal discharges, especially of residues from fuel preparation and tank-wash water. In 2009, for example, 173 oil spills were observed in the North Sea and Baltic Sea through aerial surveillance, with a high density of occurrence near the main shipping routes (Figure 4.3).

Other harmful substances in the marine environment stemming from shipping are antifouling agents. A well-known example is tributyltin (TBT), a highly toxic substance that affects the endocrine system of mollusk species in particular. With the global ban on TBT the release of this antifouling agent from ships' hulls is expected to cease, while such agents as copper are expected to increase. It is nevertheless still necessary to foster the development of less toxic substitutes (OSPAR Commission 2010).

It is acknowledged that shipping is a major source of marine litter (UNEP 2009). The illegal disposal of waste, especially plastic, is a threat to marine life. The ingestion of all kinds of plastic debris by water-surface-feeding seabirds such as the fulmar that leads to a variety of negative health effects is well documented (Mallory 2008). Illegal sewage discharges near the coast pose a problem for water quality and are related to the eutrophication of the seas.

Ship traffic has been shown to be a major source of low-frequency noise in the sea, especially in coastal waters. A strong increase in shipping noise was estimated in the last decades with the growing ship traffic. Noise pollution can cause behavioral changes in cetaceans, for instance abandoning breeding and feeding areas, and in extreme cases can lead to physical damage or stranding and death (IFAW 2008).

Furthermore, shipping is the main vector for introducing non-indigenous species in the seas and oceans. They are usually transported in the ballast water. The main problem is the transportation of species over physical barriers that separate communities and ecosystems. These non-indigenous species can harm native species and

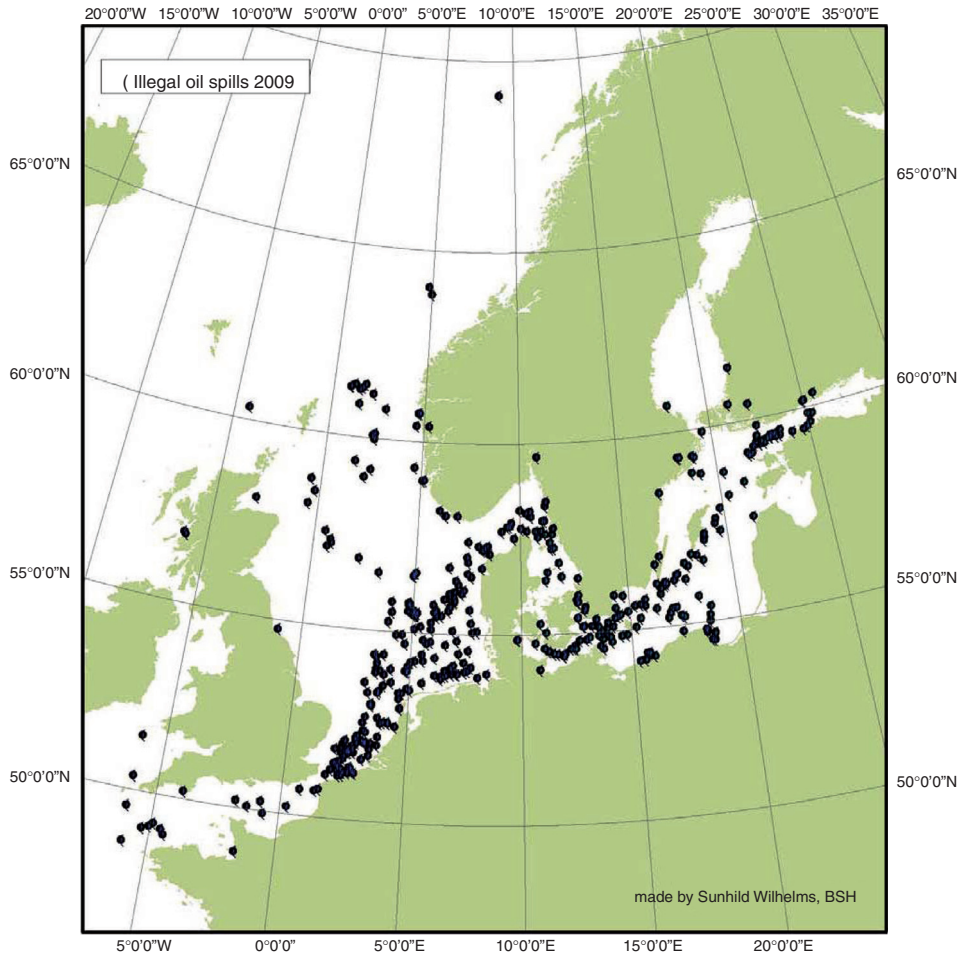

Figure 4.3 Oil spills observed via aerial surveillance in the North Sea and Baltic Sea in 2009. Source: Bonn Agreement. 2010. *Bonn Agreement Aerial Surveillance Programme: Annual Report on Aerial Surveillance for 2009*. London: Bonn Agreement Secretariat, http://www.bonnagreement.org/eng/doc/2009_report_on_aerial_surveillance.pdf.

ecosystems as predators, competitors, parasites, and pathogens. The main negative ecological effect is the loss of region-specific species in the habitats (Gollasch n.d.). However, economic damages have also been documented (Paalvast and van der Velde 2011).

Regulating International Shipping

UNCLOS, among others, provides a framework for the management of shipping worldwide (Khee-Jin Tan 2006). The Law of the Sea treaty is based on the principle that shipping standards concerning construction, equipment, seaworthiness, and manning of ships are primarily the concern of the respective flag states. Ships are subject to the exclusive jurisdiction of the state whose flag they are flying. If requested

by another state, a flag state must investigate any and all violations committed by a ship flying its flag. Measures against ships flying foreign flags are only permissible under the Law of the Sea treaty if they are restricted to the territorial waters of the respective coastal states. If a port state detects the violation of international rules and standards on seaworthiness by a vessel in one of its ports that threatens to damage the marine environment, the state must take administrative measures to prevent the vessel from sailing. Coastal states also have authority to monitor compliance of ships within their EEZs with international regulations against pollution. However, coastal states have in the past made little use of this authority to prosecute pollution of the high seas (König 2002; SRU 2004). One of the main problems linked with the flag-state principle is that a lot of ships today are flagged-out to "convenient" flags. These are often countries with lax manning standards and rules, poor safety and environmental protection regulations, as well as bad performance in the control of vessels (DeSombre 2006).

UNCLOS also lays down general obligations for marine environment protection. The treaty's key organization is the IMO. The IMO is the specialized UN agency responsible for the safety and security of shipping and the prevention of marine pollution by ships. The IMO was established with the Convention of the International Maritime Organization, which was adopted in 1948 and came into force 10 years later. Currently the IMO has 170 member-states which represent almost 100% of the world merchant fleet. The organization consists of an assembly, a council for the coordination of activities, and five committees, with one for marine environment protection (MEPC). The MEPC is concerned with adoption, amendment and enforcement of conventions, regulations, and measures for the prevention and control of pollution from ships.

The IMO convention grants IMO the authority to draft conventions, agreements, and other instruments. But IMO is only charged with the elaboration of a treaty, which must be agreed upon by the member-states. The main objective of the IMO is the preparation of the draft instruments and serving as a forum for the states and international organizations during their committee meetings and conferences (Anianova 2006). Besides member-states, non-governmental organizations and intergovernmental organizations are also involved in the activities of the IMO; but only member-states have voting rights.

The main convention for protecting the marine environment from shipping pollution (which IMO is responsible for) is the 1973/1978 International Convention for the Prevention of Pollution from Ships (MARPOL) (Nauke and Holland 1992). The MARPOL convention with its thematic Annexes I to VI regulates all kinds of marine pollution from ships: the emission, release, and discharge of oil; noxious liquid substances carried in bulk; harmful substances carried by sea in packaged form; sewage; garbage; and air pollution.

One recent success story for IMO's work was the amendment of Annex VI of the MARPOL convention for the prevention of air pollution in 2008 to further reduce harmful emissions from ships. This welcomed revision of the annex was surprisingly far reaching. It reduced the global cap on sulfur content in heavy oil used in shipping from 4.5% to 3.5% from January 2012 and to 0.5% by January 2025 at the latest. The sulfur limit in Emission Control Areas is also to be reduced in two steps from the current 1.5% to 0.1% from January 2015. Under the revised Annex VI the use

of alternative technologies like exhaust gas cleaning systems is also allowed if they are able to achieve the relevant emission reductions. Another aspect of the revision was the tightening of NO_x emission limits for engines onboard ship. It is expected that the new international limit for sulfur content of marine fuels will significantly reduce emissions of SO_2 (EMSA n.d.).

Spatial rules are an important element in marine environmental protection. The IMO recognized that certain marine areas require a stricter regulatory regime against pollution from ships. For this reason Special Areas and Particularly Sensitive Sea Areas (PSSAs) were introduced under the work of the IMO by a resolution of the MEPC in 1991. PSSAs are areas that need special protection for ecological, socio-economic, or scientific reasons and which may be vulnerable to damage by international maritime activities. One ecological criterion is to be a unique or rare ecosystem. When an area is approved as a PSSA, specific measures can be used to control maritime activities in that area, such as strict application of MARPOL discharge and equipment requirements for ships. To date IMO has adopted 13 PSSAs.

In Special Areas, the adoption of special mandatory methods for the prevention of sea pollution is required due to technical reasons related to their oceanographical and ecological condition and to their sea traffic. Today for example the North Sea and Baltic Sea are designated as SO_x Emission Control Areas (SECAs) where sulfur content in fuel used by ships must be lower than that set under the global cap. The expansion of PSSAs and Special Areas to other marine regions is one option for increasing the protection of highly polluted coastal seas from shipping pressures (Kachel 2008).

Another successful step towards reducing pollution from shipping at international level was the adoption of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention, LC) from 1972 and of the 1996 London Protocol of the convention (Nauke and Holland 1992). Both convention and protocol in general ban dumping of waste and other matters into the sea, with some exceptions, for example dredged materials and sewage sludge (IMO n.d.).

An important part of IMO's work deals with the safety of ships, which is highly relevant for the protection of the marine environment, particularly the prevention of harmful substance release due to shipping accidents. Some important IMO conventions in this context are: the 1978 International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) as amended, the 1972 Convention on the International Regulations for Preventing Collisions at Sea (COLREG), and the 1965 International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION). In this respect Port State Control and the classification of ships are very important issues. Port State Control is the inspection of foreign ships carried out at national ports to verify that the condition of the ship and its equipment as well as its handling comply with the requirements of international regulations.

The IMO has encouraged the establishment of regional Port State Control organizations and agreements, for example the Paris Memorandum of Understanding on Port State Control (Paris MoU), which is applicable to Europe. This Memorandum signed by 27 states requires shipping authorities to inspect ships entering their ports. In 2010 alone, over 24 000 inspections had been performed in European ports (Paris

MoU 2011). In May 2011, the Paris MoU adopted a new inspection regime (Paris MoU 2010). The goal of this welcomed revision is to implement a more risk-based targeting mechanism for ship inspection. With the new inspection regime, the obligation for an inspection is dependent on the risk profile of the ship and its last inspection in one of the Paris MoU member-states. This system intends to reward quality shipping on the one hand and to concentrate efforts on high-risk ships on the other hand. Furthermore, flag states are categorized according to their performance, which influences the profiling of ships under their flags. The Paris MoU published annually for a number of years so-called White/Grey/Black Lists of flag states. The flag-state administrations are ranked according to their ships' performance in Port State Controls over the last three years. On the White List are flag states with a very good performance and on the Black List are flag states with a very bad performance. This instrument works according to the principle of "blaming and shaming" and seems to be quite successful. In recent years, there was a steady increase in ships on the White List and a steady decrease of ships on the Black List (Paris MoU 2011).

Some 50 international conventions and numerous soft-law instruments have until recently been initiated by and adopted under the IMO. There are some success stories for clean shipping, aside from the one already mentioned, as well as the phasing out of single-hull tankers and TBT as an antifouling agent. Some developments are still very slow, such as reducing air pollution from ships, particularly nitrogen oxides, CO_2 and particulate matter. One of the main critiques of the work done under IMO is that the law-making process is very slow (Anianova 2006). But this is not really the fault of the institution; rather it is a weakness in the international decision-making procedure. Generally, the IMO members try to make decisions by consensus, and it is also a challenge to adapt instruments or conventions unanimously. For example, the debate about making double hulls for tankers mandatory took up to 20 years; the convention for this task was adopted in 1992 and the complete global phasing out of single-hull tankers will go on until 2015.

Another problem is the enforcement of international standards. The effective implementation and enforcement of international standards for clean shipping are primarily the responsibility of the flag states. There are still numerous low-standard vessels sailing the oceans. One reason is that many states are not willing or are not able to guarantee compliance with international standards. Reasons for the latter are the lack of financial capacity or technical expertise, and conflicts between national and international regulations (Knudsen and Hassler 2011).

In general the chance of single states regulating shipping is low given the international nature of shipping. Action is restricted to a few measures in territorial waters. The priority given to the flag-state principle in the Law of the Sea treaty is another reason that has prevented regional decision-making bodies from setting regional protection standards (SRU 2004: paragraph 506). Nevertheless, Europe and the United States have acted as drivers of global developments of more stringent shipping provisions in the past (SRU 2004; EPA 2011).

Fisheries

Fish are on the one hand an important food resource but on the other hand a central part of the marine ecosystem. Fishing is one of the oldest human activities exploiting

living resources. It is an important industry and source of income and livelihood for millions of people, especially coastal communities, to date. While there is still a constant increase in employment in the fishing industry in some parts of the world, it is clearly a downward trend in industrialized continents like Europe and North America. Several factors are responsible for the latter; one is the decrease in catches. In 2009 about 80 million t. of fish was captured in the seas and oceans. Global production of marine-capture fisheries reached a peak of 86.3 million t. in 1996 and then declined slightly to 79.9 million t. in 2009 (FAO 2010).

Impacts of Fisheries on the Marine Environment

Fishing is responsible for considerable pressures on the marine environment. The main challenges of fishing are at present the overexploitation of fish stocks, the discard problem, and the destruction of benthic habitats. The consequences are depletion of main predator and prey species, threat to sea birds and marine mammal populations, impacts on the marine food web, loss of sensitive benthic communities, but also, let us not forget, loss of income and the destruction of important food resources.

According to the last status report on world fisheries and aquaculture from the FAO, 32% of the world fish stocks were overexploited, depleted, or recovering from overexploitation (FAO 2010) (Figure 4.4). Since the mid-1970s, there has been a steady increase in fish stocks, which have suffered from excessive fishing pressure. During the same period, a steady decrease in stocks considered as underexploited or moderately exploited was observed. In 2008 this was true for only 18% of the monitored fish stocks and 53% of the stocks were fully exploited, meaning that no room for further expansion was available.

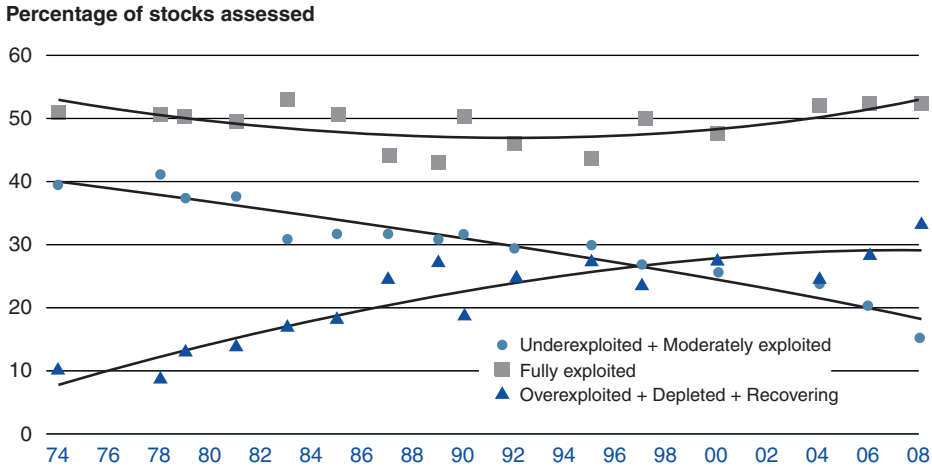

Figure 4.4 Global trends in the state of the world marine stocks since 1974.
Source: FAO (Food and Agriculture Organization of the United Nations). 2010. *The State of World Fisheries and Aquaculture 2010*. Rome: FAO.

Another problem of present fishing practices is the high quantities of fish and other species which are caught unintentionally (bycatch) and discarded, and consequently wasted. Fish are thrown overboard for several reasons: some fish have very low commercial value, fishermen lack quotas for the species, or there are length constraints. Most of the discarded fish die because they are badly injured, which becomes a loss for stock productivity and the ecosystem. It is estimated that the worldwide weighted discard rate of fish is at 8% (Kelleher 2005), which seems to be pretty low. But discard rates in some fisheries, particularly bottom trawling of flatfish, is much higher, at up to 90% of the caught species (STECF 2010). It is important to note that it is generally very difficult to monitor discard. Bycatch and discard can therefore be a direct threat for species diversity. For example, the bycatch of harbor porpoises in gillnets in the Baltic Sea is a direct threat to the population, which is at high risk of extinction (HELCOM 2010). However, there is also evidence of reduction in discards in recent years due to the increased utilization of catches, more selective fishing gears, and introduction of bycatch and discard regulations (Kelleher 2005).

Fishing activities can also harm the marine ecosystem directly. Bottom trawls are responsible for causing severe damage to the benthic habitats. For example tickler chains used in beam trawling dig several centimeters into the sea-bed and plow through the sediment or benthic communities on hard substrates. Sessile organisms or coral reefs in particular are very sensitive to bottom trawling. Recovery from one bottom trawling over a cold-water coral reef can take up to hundreds of years (Institute for Marine Research in Bergen n.d.).

Lost fishing gear can also harm the marine environment, as seen in ghost fishing or the entangling of marine species in lost nets or net fragments.

International and Regional Activities and Regulations for Fisheries

Instruments and Measures There exist a number of instruments and measures for sustainable fisheries management. The first step is to limit the exploitation of fish resources to an extent that is compatible with the marine environment and the future use of the resource.

Fish are a classic common resource; the management of fish stocks is therefore a special challenge. Often the lack of exclusive access rights is blamed for the difficulties in implementing a fisheries management system that is focused on long-term interests. The implementation of individual transferable quotas (ITQs) might be one solution, as already seen in different nations (Hentrich and Salomon 2006).

In most cases the management of fish stocks is based on a quota-management system. The amount of fish taken annually from the stock is determined by the total allowable catch (TAC). The question of how much fish can be taken from a stock is being disputed in fisheries science (Froese *et al.* 2010). At the World Summit on Sustainable Development in 2002 it was agreed that fish stocks should be restored to levels that can produce the maximum sustainable yield (MSY), and this should be achieved by no later than 2015 (United Nations 2002). Simplified, MSY is theoretically the largest yield or catch that can be taken from a fish stock over an indefinite period. The concept of MSY aims to maintain the fish stock size at the point of maximum growth rate by harvesting only the surplus production. Fish stocks adapt

to fishing pressures through an increase in productivity. This increase in production in comparison to natural conditions, called surplus production, can be fished without affecting the size of the stock. MSY is a rather old concept that is criticized for several reasons, for example: it focuses solely on a particular species in question; it ignores the size, age, and reproductive status of the caught individuals, and also ignores a lot of the natural factors influencing the development of a fish stock (Larkin 1977). The concept was permanently modified as a result of the weaknesses mentioned. It is therefore important to take the precautionary approach into account by applying MSY, especially given the many uncertainties caused by incomplete data on fish stocks (SRU 2011). Furthermore, fish species are often dependent on one another, for example in predator–prey or competitive relationships and should, therefore, be managed using multi-species approaches.

Besides proper management of commercial fish stocks, measures are necessary for protecting non-target species and the marine ecosystems from fishing activities, such as reducing bycatch. The strongest incentive for fishermen to take efforts to reduce bycatch is a discard ban, that is, the obligation to land the entire catch. Other options are economic incentives, guidelines, or obligatory standards for the use of less destructive fishing technologies. Important instruments for the protection of marine biodiversity, especially sensitive ecosystems, from impacts of fisheries are marine protected areas (MPAs).

Regulations and Standards Sea fisheries have international characteristics because fishing activities are not restricted to marine areas under national jurisdiction, although most fish worldwide are captured in coastal waters or in the EEZ. As mentioned earlier, the Law of the Sea treaty gives coastal states exclusive authority over living marine resources in coastal waters and the EEZ. But the states are obliged to adopt proper conservation and management measures to ensure sustainable use of the fish stocks and to avoid overexploitation of the living resources. Therefore, best available scientific evidence should be taken into account. The target mentioned in UNCLOS for the management of the fish stocks is MSY.

Article 62 of UNCLOS contains some conservation measures and instruments – for example licensing of fishermen and vessels, fisheries research programs, catch quotas, temporal and spatial fishing bans, gear restrictions, vessel position reporting, enforcement procedures, and minimum fish sizes – which coastal states may establish. If a coastal state does not have the capacity to harvest the total allowable catch, it could give other states access to the surplus of the allowable catch. But these states must comply with the conservation measures and with the other terms and conditions established in the laws and regulations of the coastal state.

Non-target species and the protection of the marine ecosystem are also addressed in UNCLOS. According to Article 61(4) with respect to conservation and management measures, "the coastal states shall take into consideration the effects on species associated with or dependent upon harvested species." There are also general obligations to protect the marine environment, as well as rare and fragile ecosystems, and the habitats of depleted, threatened, or endangered species; the latter applies for example to marine mammals.

Fish stocks are not confined within national borders. A lot of stocks are highly mobile, which means they migrate long distances and are abundant, at least

temporarily, in the high seas. For the regulation of the management of these living resources, the Straddling Fish Stocks Agreement (SFSA, http://www.un.org/depts/los/convention_agreements/convention_overview_fish_stocks.htm) was adopted in 1995. The agreement is closely linked to UNCLOS and its objective is to ensure the long-term conservation and sustainable use of straddling and highly migratory fish stocks. The SFSA provides a framework for cooperation in the conservation and management of those resources to ensure that measures taken in areas under national jurisdiction and in the adjacent high seas are compatible and coherent. In some instances the agreement goes beyond the UNCLOS provisions. For example, the conservation and management of relevant fish stocks should be based on the precautionary approach. Other aspects agreed upon by the signatory states are: assessment of impacts of fishing on target stocks and the affected marine environment, adoption of conservation and management measures for non-target species, minimization of bycatches, protection of marine biodiversity, and performance of effective monitoring and controls. Coastal states are obliged to set precautionary reference points to maintain populations at levels that can produce MSY and to take conservation and management measures to prevent fish stocks from falling below a limit reference point or to facilitate stock recovery. The SFSA was signed by 59 nations as of September 2011.

Another approach in regulating the use of marine biological resources in international waters is the introduction of Regional Fisheries Bodies (RFBs) (FAO 2009). RFBs are international bodies formed by countries with fishing interests in the same area to foster cooperation towards conservation, management, and development of the living marine resources. Some of them manage all fish stocks abundant in a specific area, while others focus on specific highly migratory species, like tuna, through vast geographical areas. The first regional fisheries body had in fact already been introduced in 1948 with the Indo-Pacific Fisheries Council. RFBs are based on an agreement or an arrangement between different states. The function and the mandate of the different RFBs vary to a great extent. Some RFBs have a purely advisory mandate; their decisions are consequently not binding for their members. Other bodies adopt fisheries conservation and management measures that have binding characteristics. Their duties are therefore different. In some cases it is just the collection, analysis, and dissemination of information and data; in other cases concrete decisions for stock management and conservation are made. If they have a clear management mandate, they are called Regional Fisheries Management Organizations (RFMOs). Currently, 44 RFBs exist worldwide, and 20 of them are management bodies. The status of tuna stocks shows quite clearly that RFBs are not as successful as they should be, even though several attempts had been made in the past to improve their performance. Reasons for this are: implementation lag of management decisions, egoism of national states hindering good fisheries governance, members' unwillingness to fund research, difficulties in consensus decision-making, and focus on crisis management instead of long-term management (FAO 2009).

The FAO adopted a Code of Conduct for Responsible Fisheries in 1995 to meet international management obligations and in response to the increasing problems in world fisheries (http://www.fao.org/docrep/005/v9878e/v9878e00.htm#7). This recommendation is not legally binding. However, it contains a range of principles and provisions for the management of fish stocks and the protection of the

marine environment from fishing activities, including long-term sustainability of fishery resources, conservation and protection of aquatic biodiversity and endangered species, recovery of depleted fish stocks, and minimization of adverse impacts from fisheries on the target stocks and the remaining ecosystem. In the meantime a number of further FAO guidelines on fisheries such as the 2008 International Guidelines for the Management of Deep-Sea Fisheries in the High Seas have been adopted (FAO 2009).

Overall, the international law of fisheries provides a number of obligations and provisions for sustainable fisheries management and the protection of marine life from fishing activities. The major problem to date is the absence and incoherent implementation and enforcement of international or regional standards at the national level. The consequences are inadequate control regimes, management systems that force fishermen to compete for their share instead of supporting sustainable fish stocks management, unsustainable subsidies, and defiance of scientific advice (Markowski 2009; Mora *et al.* 2009; SRU 2011).

Europe as an Example of a Regional Approach The European nations started to cooperate in the field of fisheries back in the 1970s. The main concern in those days was to prevent conflicts between nations by exploring living marine resources. It was also the time when a lot of coastal states were extending their territorial waters and before EEZs were introduced. The Common Fisheries Policy (CFP) was only formally created in 1984 (Markus 2009).

Today, the EU has the exclusive competence for the management and conservation of marine living resources in sovereign waters (within the 12-mile zone) and in common waters under national jurisdiction (EEZ). But the Community has redelegated some power to the member-states, for example they are allowed to take emergency measures for the protection of living aquatic resources (Markus 2009). The aims of the CFP are to give member-states equal access to common waters, excluding coastal waters in the 12-mile zone; to increase fisheries productivity; to provide acceptable livelihood for fisheries-dependent communities; and to stabilize the market and secure supply. The four central elements of the CFP are:

1. rules for the management and conservation of fisheries resources;
2. common structural policy;
3. common organization of the market for fisheries products;
4. the external dimension of the CFP or fishing agreements with third countries.

One objective of the CFP is the sustainable exploitation of living aquatic resources. Therefore, the community is limiting fishing opportunities by adopting total allowable catches (TACs), effort limitations, and technical measures. By requiring the use of less destructive fishing gear and prohibiting fishing in sensitive marine areas, environmental concerns are therefore taken into consideration.

The core management instrument for the regulation of fishing effort is the regular setting of TACs for the entire EU, which must be based particularly on the scientific recommendations of the International Council for the Exploration of the Sea (ICES). One of the main shortcomings of the CFP was that the scientific advice of the ICES had been regularly ignored. Accordingly, the TACs exceeded the scientific advice on

average by more than 40% (European Commission 2011). Consequently, two-thirds of the European fish stocks are still overexploited. The responsibility for setting the TACs and most of the other decisions under the CFP lies in the hands of the council of the fisheries minister of the member-states. In order to improve the management of the fish stocks, the EU has most recently started to draw up multiannual management plans. These management plans have helped to improve the status of some important stocks (SRU 2011).

An important aspect of sustainable fishing management is the adaptation of fishing fleets to the sustainable use of the available resources. This is the intention of the structural policy of the CFP. Different instruments had therefore been implemented in the past, for example an entry–exit regime (new entries into the fleet must be compensated for by the exit of 1.35 times the amount of capacity), scrapping premiums, and withdrawal of subsidies for vessel modernization. Unfortunately, the measures taken had only minor successes. One of the reasons was the unwillingness of some member-states to reduce their fishing fleet. Another was the existence of ongoing direct and indirect subsidies supporting overcapacities (SRU 2011).

The common organization of the European markets in fishery and aquaculture encompasses quality and marketing standards, as well as requirements on minimum level of consumer information. Further, it establishes producer organizations in order to improve the sale conditions of members' products. It also includes intervention mechanisms for guaranteeing a minimum price for fish products. Another aspect is the building up of a trade system with third countries (Markus 2009).

The EU has bilateral and multilateral fisheries agreements with third countries. Today, more than a quarter of the fish caught by the European fleet comes from waters outside of the EU. Partnership agreements with developing countries in particular are under criticism for being responsible for the overexploitation of marine living resources in external waters.

The CFP is currently under reform to improve its sustainability (SRU 2011).

Conclusions: Special Challenges in International Marine Protecting Policies

Only if we are able to protect marine biodiversity and use marine resources in a sustainable way will future generations have the chance to profit from all services provided by the marine ecosystems. The example of shipping and fisheries shows clearly that the implementation of marine environmental protection instruments and measures in relevant sectors is still a great challenge. Although there are already some successful international initiatives for the greening of shipping, developments at the international level to protect marine waters from impacts of sea transport are still very slow. For example, ambitious emission-control standards for particulate matter and CO_2 and effective control systems to prevent inputs of litter and oil residues are urgently needed. One possibility of speeding up these processes at the international level lies in leadership initiatives taken by important actors, such as the USA or Europe.

International obligations for sustainable fisheries management exist, but they are too weak to enforce national implementation. Some coastal states such as Iceland and Norway are successful in managing their marine living resources; Europe is on its way to improving its fisheries policy. These approaches might be good examples

for others. One prime reason for the poor compliance of national regulations with international marine protection standards is the focus on short-term economic and political interests. In order to break this dominance, it is necessary to give the consumers and the public, who own the marine ecosystems and the living resources, more say in the decision process.

One way of enforcing the implementation of internationally agreed decisions might be for coastal states or regions to develop an integrated maritime policy with ambitious targets and goals for the conservation and protection of their marine waters. Strategies for the protection of the marine ecosystems are an important part of this policy approach. This is one reason why the EU adopted a marine strategy framework directive (MSRL) in 2008 as the environmental pillar of the European maritime policy. With the MSRL the European coastal states are for the first time obliged to take actions in all fields of marine environmental protection. An important part of this obligation is the setting of targets for good environmental status of the marine waters concerned and developing programs for measures (Salomon 2009). Important instruments that can assist this process are marine spatial planning and MPAs, as well as concepts for the implementation of the ecosystem approach in the management of marine resources. However, the basic requirement is the improvement of our knowledge of marine ecosystems and the threats human activities present.

Finally, it would be highly desirable to have a more in-depth public discussion and understanding of our oceans and seas, their sustainable use as well as their marine ecosystem services.

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