# *Chapter 1.*

# Marine biodiversity, the role of marine protected areas and good practice insights

*This chapter provides an overview of the trends in the state of, and pressures on, marine biodiversity; the economic values associated with marine ecosystems; and the types of policy instruments that are available for the conservation and sustainable use of marine biodiversity. It then discusses the role of marine protected areas and summarises their current use and trends. Drawing on the key findings from the publication, the chapter concludes with good practice insights for more effective design and implementation of marine protected areas.*

## Marine biodiversity and the international context

Marine ecosystems are immensely varied both in type and geographical extent. They encompass oceans, salt marshes and intertidal zones, estuaries and lagoons, mangroves and coral reefs, the deep sea and the sea floor (Kaiser and Roumasset, 2002). Covering about 70% of the earth's surface, these ecosystems play a crucial role in human welfare, providing social, economic and environmental benefits to the earth's growing population. It is estimated, for example, that 3.1 billion people rely on oceans for almost 20% their animal protein intake (through seafood) (FAO, 2016), and that more than 500 million people are engaged in ocean-related livelihoods (UNDP, 2012). Marine ecosystems also provide a variety of other services that are critical for human well-being, such as coastal protection, marine biodiversity and carbon sequestration. Oceans, for example, contain nearly 300 000 identified species (though actual numbers may lie in the millions) and have absorbed one-third of the carbon dioxide resulting from human activities (Bijma et al., 2013), while mangroves and coral reefs provide valuable protection against extreme weather events such as storms and floods.

These ecosystems are under increasing pressure due to human activity. Today, 60% of the world's major marine ecosystems have been degraded or are being used unsustainably (UNEP, 2011). Many fisheries are over-exploited, with some stocks on the verge of collapse, and coral reefs are bleaching due to exposure to high temperatures and other pressures. Concurrently, pollution from land-based sources including marine litter is threatening species and marine habitats and climate change compounds these effects, altering both the thermal and chemical characteristics of the ocean as well as its dynamics and nutrient availability (Bijma et al., 2013). Since the 1980s, for example, an estimated 20% of global mangroves have been lost and 19% of coral reefs have disappeared (UNDP, 2012). The welfare costs that this imposes on society are high – estimates suggest that the cumulative economic impact of poor ocean management practices is in the order of USD 200 billion per year (UNDP, 2012).[1]

Growing awareness of the significance of the challenge as well as the need for more co-ordinated action to counteract these trends has put the conservation and sustainable use of the marine environment firmly on the international agenda. Marine biodiversity features among the Aichi Targets under the Convention on Biological Diversity (CBD), including Target 11 on the conservation of marine areas: "By 2020, at least … 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures …" (CBD, 2010). Marine ecosystems also feature as one of the UN Sustainable Development Goals (SDGs), i.e. to "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" (UN, 2015). Specifically, Target 14.5 states: "By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information". Moreover, Target 14.2 is to sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, and Target 14.4 is on effectively regulating, harvesting and ending overfishing.[2]

Marine protected areas (MPAs) are becoming an increasingly important element of marine conservation policies, and currently cover about 4.1% of the total marine environment (UNEP-WCMC and IUCN 2016).[3] This figure is based on the International Union for Conservation of Nature (IUCN) definition of MPAs, which is "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008).4 More concerted policy efforts will therefore be needed if these internationally agreed targets are to be achieved.

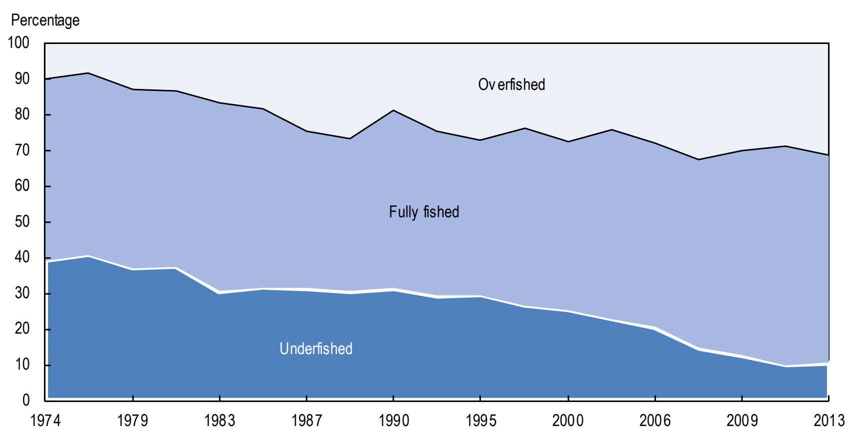
## State of and pressures on marine biodiversity

The state of and pressures on marine biodiversity are alarming and available state indicators point overwhelmingly to declining trends.[5] According to the Living Planet Index, marine species declined by 39% between 1970 and 2010 (Loh et al., 2010) and currently over 550 species of fish and invertebrates are listed as threatened (critically endangered, endangered and vulnerable) on the IUCN Red List (Pitcher and Cheung, 2013).[6] According to the same list, coral species are moving towards increased extinction risk most rapidly and coral reefs have been singled out as an ecosystem that is probably under more immediate threat from human impacts than any other (Rogers and Laffoley, 2013). Up to 19% of coral reefs have been effectively destroyed and 24% are under threat due to human pressures such as unsustainable tourism, coastal development and overfishing (Wilkinson, 2008; 2004). Some hotspots are particularly fragile, such as within the Great Barrier Reef where hard coral cover has declined from 28% to 14% since 1986 and the rate of decline has increased substantially in recent years (De'ath et al., 2012).[7]

Turning to the state of world fish stocks, the Food and Agriculture Organization (FAO) (2016) finds that in 2013, 31.4% of fish stocks were estimated as fished at a biologically unsustainable level (and therefore overfished), compared to 10% in 1974 (Figure 1.1). Of the total number of stocks assessed in 2013, fully fished stocks accounted for 58.1% and under-fished stocks 10.5% (separated by the white line in Figure 1.1). Branch et al. (2011) find that at present 28-33% of all stocks are over-exploited and 7-13% of all stocks are collapsed. Excessive depletion poses risks to the viability of stocks and can threaten biodiversity, and from an economic perspective represents foregone yields.

Moreover, the Intergovernmental Panel on Climate Change (IPCC) (2014) finds that ocean acidification has increased by around 26% since pre-industrial times[8] and notes that, based on historical evidence, recovery from such changes in ocean pH can take many thousands of years. It is projected that continued anthropogenic carbon dioxide emissions will further increase ocean acidity to levels that will have widespread impacts, mostly deleterious, on marine organisms and ecosystems. Ocean acidification is particularly a threat to coral reefs and calcifying animals such as shellfish and plankton.

Figure 1.1. **Global trends in the state of world marine fish stocks, 1974-2013**




*Notes:* Dark shading: within biologically sustainable levels; light shading: at biologically unsustainable levels. The light line divides the stocks within biologically sustainable levels into two subcategories: fully fished (above the line) and underfished (below the line).

*Source*: Food and Agriculture Organization (2016), *The State of the World Fisheries and Aquaculture*. Reproduced with permission.

The main pressures driving marine biodiversity and ecosystems loss and decline include over-exploitation of fish and other resources, pollution, habitat destruction, climate change and invasive alien species. Each of these is summarised below. It is important to note, however, that these pressures can also re-enforce each other, exerting cumulative impacts on marine biodiversity.[9]

## *Over-exploitation of fish and other resources*

With rising incomes, growing population and evolving diets, demand for fish has been steadily increasing. Global fish production is increasing at an average annual rate of 3.2%, outpacing world population growth at 1.6% (FAO, 2014). In 2014, total global fish capture production was 93.4 million tonnes with the share of fish production used for direct human consumption increasing from 70% in the 1980s to more than 85% in 2012 (FAO, 2016; 2014). Fish continues to be one of the most traded food commodities in the world, with annual exports rising to USD 148 billion in 2014 (FAO, 2016). Aquaculture is one of the fastest growing food-producing sectors and provides half of all fish for human consumption. Its production expanded at an average annual rate of 6.2% in the period between 2000 and 2012 (FAO, 2014). The total number of fishing vessels in the world was estimated to be about 4.72 million in 2012, with efforts to reduce overcapacity in fishing fleets not resulting in effective outcomes across the board (FAO, 2014). In addition, world fishery production is expected to be 17% higher by 2023 (OECD-FAO, 2014), mainly due to projected increases in aquaculture.

Illegal, unreported and unregulated (IUU) fishing also continues to present challenges. About 11-26 million tonnes of fish is lost to IUU annually, i.e. a mean loss of 18% across all fisheries (Agnew et al., 2009). Distinct from this is the issue of wastage, where 8%, or 7.2 million tonnes, of the global fisheries catch consists of non-target species, which are subsequently discarded (FAO, 2004), and thus has impacts on species and ecosystems.

## *Pollution*

Marine pollution occurs when harmful, or potentially harmful, effects result from the entry into the ocean of chemicals; particles; industrial, agricultural and residential waste; noise; or the spread of invasive organisms.[10] Most sources of marine pollution are land based (80%; GOC, 2014), often from non-point sources such as agricultural runoff. The pathways of marine pollution include direct discharge, land run-off, ship pollution (e.g. ballast water and hot water discharge), atmospheric pollution and deep-sea mining (e.g. for oil and gas), with the resulting types of pollution consisting of acidification, eutrophication, marine litter, toxins and underwater noise. Carbon dioxide emissions are the main driver of ocean acidification, whereas excess nutrients lead to eutrophication. For example, 85% of the sewage discharged in the Mediterranean Sea is untreated, leading to eutrophication. Left unchecked, eutrophication can lead to the creation of dead zones, which is occurring in different parts of the world including the Gulf of Mexico, the Black Sea and the Baltic Sea.[11]

### *Habitat destruction*

Habitat destruction along the coast and in the ocean results from harmful fishing practices such as trawling or dynamite fishing; poor land-use practices in agriculture, coastal development and forestry sectors; and other human activities such as mining,[12] dredging and anchoring, as well as tourism and coastal encroachment. For example, logging and vegetation removal can introduce sediments from soil erosion, and harbour development and other land-based activities (such as shrimp aquaculture) can lead to the destruction of mangroves, which serve as nurseries for species of fish and shellfish, and provide flood protection. Poor shipping practices and coastal tourist activities such as snorkelling, boating and scuba diving come in direct contact with fragile wetlands and coral reefs, consequently damaging marine habitats and degrading the ecosystem services they provide.

### *Climate change*

Climate change is rapidly impacting species and ecosystems that are already under stress from overfishing and habitat loss. Rising sea surface temperatures and sea levels due to thermal expansion of water and melting of the continental glaciers is altering the behaviour and demographic traits of marine species. Tropical storms and heavy rainfall have physically damaged coral reefs, marine ecosystems and coastal regions. According to Doney et al. (2011), climate change impacts on marine biodiversity have already resulted in either a loss or degradation of 50% of salt marshes, 35% of mangroves, 30% of coral reefs and 20% of seagrasses worldwide. Coral reefs are one of the most vulnerable ecosystems to climate change impacts. Episodes of coral bleaching due to ocean acidification and anomalously high sea water temperatures have become more frequent in recent times, leading to coral mortality and declining coral cover, showing no immediate prospects of recovery. Cheung et al. (2009) (cited in the IPCC 5th Assessment Report) have projected climate change impacts to marine biodiversity to 2050 and predict numerous local extinctions, species invasion and turnover of over 60% of present biodiversity with implications for ecological disturbances that potentially disrupt ecosystem services.

### *Invasive alien species*

The introduction of non-native marine species to marine ecosystems to which they do not belong constitutes another serious threat to the marine environment. Most of these alien species are rapidly introduced to a different habitat through ballast water from commercial shipping operations across the oceans. An estimated 7 000 marine species are carried around the world in ballast water every day (WWF, 2009). Coastal tourism, boat hulls, eutrophication and marine pollution also move marine species far from their natural ranges. These foreign organisms are responsible for severe environmental impacts, such as altering native ecosystem by disrupting native habitats, extinction of some marine flora and fauna, decreased water quality, increasing competition and predation among species, and spread of disease. Across the oceans, fish, crabs, clams, mussels and corals that were unintentionally introduced have also resulted in adverse economic impacts, such as collapse of fish stock, damage to coastal areas (smothering of beaches; decreased recreational opportunities) and cost for control. For example, the comb jelly in the Black Sea (and most recently invaded Baltic Sea) is held responsible for the collapse of fisheries worth several million dollars annually (Science Daily, 2008). Invasive alien species affect marine industries (including fishing and tourism) as well as human health (via the introduction of fatal pathogens such as cholera bacteria) (see Bax et al., 2003).

## Economic value of marine ecosystems

Marine ecosystems degradation is arguably pushing beyond ecologically and economically sustainable thresholds. One of the underlying reasons for this is that many of the services provided by marine and coastal ecosystems[13] – such as coastal protection, fish nursery, water purification, marine biodiversity and carbon sequestration (see Table 1.1) – are not reflected in the prices of traditional goods and services on the market (and hence referred to as non-market values). While there is often a lack of scientific information to clearly understand the complex links between these marine ecosystem services and their economic value, this undervaluation of marine ecosystem services results in under-investment in their conservation and sustainable use, and lost opportunities for economic growth and poverty reduction.

Estimating and accounting for the economic values associated with some bundles of these ecosystem services is important to help improve decision- and policy-making processes, including management decisions and priority setting (i.e. to more efficiently allocate resources between competing uses) (Naber, Lange and Hatziolos, 2008), as well as the design of policy instruments for marine conservation and sustainable use. The Marine Ecosystem Services Partnership (MESP) provides information on more than 1 000 valuation-oriented studies worldwide, by ecosystem type.[14] In Sri Lanka, for example, greater conservation efforts of its salt water marsh, a natural buffer against flooding, were prompted when its ability to protect cities was valued at USD 5 million annually (Global Partnership for Oceans, n.d.).

A number of studies have estimated the economic value of marine ecosystems, examples of which are highlighted below. While these vary in terms of scope (e.g. different ecosystems, varying geographical scales), they serve to illustrate that the benefits are considerable.

Taking into account the number of people engaged in coastal livelihood activities, marine and coastal resources directly provide at least USD 3 trillion worth of economic goods and services annually (UNDP, 2012). The marine environment supports approximately 61% of world's total gross national product (GNP) by directly and indirectly providing fundamental goods and ecosystem services[15] (including coastal tourism, recreation and employment) upon which human well-being depends (UNESCO, 2012). Global aquaculture production (including food fish and aquatic algae) contributes about USD 162.2 billion towards the global economy (FAO, 2016); the shipping industry contributes to 90% of the global trade; the tourism industry, of which marine and coastal tourism is a major part, represents 5% of global GDP (UNDP, 2012).

Table 1.1. **Examples of marine and coastal ecosystem services and their scale**

| Category (examples) | Geographic scale |
|---|---|
| Food (e.g. fisheries and aquaculture) | Local/regional/global |
| Fuel (e.g. mangrove wood) | Local/regional/global |
| Water | Local/regional |
| Natural products (e.g. sand, pearls, diatomaceous earth) | Local/regional/global |
| Genetic and pharmaceutical products | Local/regional/global |
| Lifecycle maintenance, habitat and gene pool protection | Global |
| Atmospheric composition, carbon sequestration and climate regulation | Local/regional/global |
| Shoreline stabilization/erosion control | Local |
| Natural hazard protection (e.g. from storms, hurricanes and floods) | Local/regional |
| Pollution buffering and water quality | Local/regional |
| Soil, sediment, and sand formation and composition | Local/regional |
| Tourism | Local/regional/global |
| Recreation | Local/regional/global |
| Spiritual values | Local/regional/global |
| Education and research | Local/regional/global |
| Aesthetics | Local |

*Source:* Authors own work.

Coral ecosystems are estimated to provide an average value of approximately USD 172 billion a year to the world economy (Veron et al., 2009). The value is based on ecosystem services including food and raw materials, moderation of extreme ocean events, water purification, recreation, tourism, and maintenance of biodiversity. Moreover, about

500 million people directly or indirectly depend on coral reefs as their source of livelihood (Wilkinson, 2004).

The Global Ocean Commission estimates that the global economic value of carbon sequestration associated with seas and oceans ranges between USD 74 billion and USD 222 billion per year (GOC, 2014).

In a more comprehensive study, de Groot et al. (2012) provide global estimates of a number of ecosystems and services, including for open oceans, coral reefs, coastal systems, and coastal and inland wetlands. They find the total value of ecosystem services ranges between 490 int$/year[16] for the total bundle of ecosystem services that can potentially be provided by an "average" hectare of open oceans to almost 350 000 int$/year for the potential services of an "average" hectare of coral reefs.

There are numerous other valuation studies which have been undertaken at national or local scale and/or cover fewer ecosystem components. For example, a national level study for the United Kingdom provides "best estimates" of the monetary value of 8 of the 13 goods and services of marine biodiversity (Beaumont et al., 2008). These include food provision (GBP 513 million), raw materials (GBP 81.5 million), gas and climate regulation (GBP 0.4-8.4 billion), disturbance prevention and alleviation (GBP 0.5-1.1 billion), and leisure and recreation (GBP 11.77 billion). Similarly, Lange (2009) estimates the value of marine ecosystem services in Zanzibar and finds it accounts for 30% of GDP.[17] As the marine environment continues to be threatened, if corrective measures are not taken soon, the costs of inaction are anticipated to continue to increase (Box 1.1).

## Instruments for the conservation and sustainable use of marine biodiversity

A number of policy instruments are available to promote the conservation and sustainable use of marine biodiversity. Table 1.2 categorises these in terms of regulatory, economic, and information and voluntary instruments. Each of these is discussed in turn.[18]

### *Regulatory (command-and-control) approaches*

Marine protected areas are gaining increasing attention as a policy instrument for marine biodiversity conservation, and currently cover about 4.1% of the total marine environment. The number of MPAs is increasing at approximately 5% annually (Wood et al., 2008)[19]. This has been due, at least in part, to the calls at international level to scale up the conservation of marine areas (such as under the CBD) as well as other directives and regulations such as the 1992 European Directive on the conservation of natural habitats and of wild flora and fauna, and the more recent Marine Strategy Framework Directive. Studies have shown that MPAs can increase the density, diversity and size of species (Halpern, 2003; Gaines et al., 2010), protect habitats, and provide other economic benefits such as for tourism and recreation.

### Box 1.1. **Examples of costs of inaction (global)**

- The cumulative economic impact of poor ocean management practices is about USD 200 billion per year (UNDP, 2012). For example, invasive marine species, especially those carried in ship ballast water and on ship hulls, cause an estimated USD 100 billion each year in economic damage to infrastructure, ecosystems and livelihoods (based on estimates in the UNDP-GEF GloBallast programme, as cited in UNDP [2012]). The World Bank and Food and Agriculture Organization estimated the economic losses due to overfishing at USD 50 billion annually (World Bank-FAO, 2008, cited in UNDP [2012]).
- The Intergovernmental Panel on Climate Change (IPCC) (2014) model projections suggest a potential loss of up to 13% to annual total fishery value in the United States, and globally over USD 100 billion annually, by 2100 (Cooley and Doney, 2009; Narita, Rehdanz and Tol, 2012).
- Brander et al. (2012) estimate that the loss of tropical reef cover due to ocean acidification will cause damages of between USD 528 billion and USD 870 billion (year 2000 value) by 2100.
- The total estimated costs of coastal protection, relocation of people and loss of land to sea-level rise ranges from about USD 200 billion for an increase of sea level of 0.5 metres to five times that – USD 1 trillion – for a 1-metre rise, to about USD 2 trillion for an increase of 2 metres (Nicholls and Cazenave, 2010).
- In the absence of proactive mitigation measures, climate change will increase the cost of damage to the ocean by an additional USD 322 billion per year by 2050 (Noone, Sumaila and Diaz, 2012).

The Convention on International Trade in Endangered Species (CITES) is also important for marine species, as many species that are traded internationally are highly migratory. CITES provides a legal framework to regulate the international trade of species and includes restrictions on commercial trade when species are threatened with extinction. As of October 2013, there were 16 fish species listed under Appendix I (trade is permitted only under exceptional circumstances) and 87 species in Appendix II (trade is allowed but must be controlled).[20]

Table 1.2. **Policy instruments for marine biodiversity conservation and sustainable use**

| Regulatory instruments (i.e. command-and-control) | Economic instruments | Information and voluntary approaches |
|---|---|---|
| Marine protected areas | Taxes, charges, user fees (e.g. entrance fees to marine parks) | Certification, eco-labelling (e.g. Marine Stewardship Council) |
| Marine spatial planning | Individually transferable quotas | Voluntary agreements, including public-private partnerships (which can include, for example, voluntary biodiversity offset schemes) |
| Spatial and temporal fishing closures; bans and standards on fishing gear; limits on number and size of vessels (input controls); other restrictions or prohibitions on use (e.g. CITES) | Subsidies to promote biodiversity – and the reform of environmentally harmful subsidies | |
| Catch limits or quotas (output controls) | Payments for ecosystem services (PES)[1] | |
| Standards (e.g. MARPOL for ships); bans on dynamite fishing | Biodiversity offsets | |
| Licenses (e.g. aquaculture and offshore windfarms) | Non-compliance penalties | |
| Planning requirements (e.g. environmental impact assessments and strategic environmental assessments) | Fines on damages | |

*Notes:* CITES: Convention on International Trade in Endangered Species; MARPOL: International Convention for the Prevention of Pollution from Ships ("marine pollution").
1. France uses the term payments for environmental services to emphasise that payments should only be made for services rendered that are additional to what the natural ecosystem would provide (i.e. in the absence of changes in management practices). This should, in fact, be a requirement for all PES programmes; see OECD (2010) for further discussion.

*Source:* Author's own work.

Another instrument that has been increasingly used over the past decade is marine spatial planning (MSP). MSP refers to a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives. MPAs can (and should) form an integral part of an MSP (see also Chapter 5 for further discussion). The main elements of an MSP include an interlinked system of plans, policies and regulations, which are generally accompanied by the use of maps.[21] MSPs are currently being used in about 50 countries worldwide including Canada, the People's Republic of China, Germany, New Zealand, the Netherlands, Norway and the United States.[22] Collie et al. (2013) examine 16 MSPs around the world to compare practical experience with formulaic guidance on MSPs. As the development of MSPs is still fairly recent, further progress is needed in areas such as identifying data needs as well as clear criteria or frameworks for developing planning options (see, for example, Jay [2015]).

Other regulatory instruments include the more traditional standards on fishing gear, quotas on fish catch, commercial fishing permits, emission standards for waterway engines, fuel sulphur limits for vessels, among many others. Habitat conservation bycatch limits (or individual habitat quotas) also exist though these are not yet common (for an application in British Colombia, Canada, see Wallace et al. [2015]). Planning tools such as environmental impact assessments (EIAs) and strategic environmental assessments (SEAs) are also used. EIAs can be required to assess the impacts of projects such as offshore windfarms, harbour expansion and dredging, marine aquaculture, and oil platforms and rigs. SEAs tend to be undertaken for larger activities, such as to inform a country's strategy for the development of marine energy (e.g. Scotland).

### *Economic instruments*

Probably the most commonly applied economic instrument to address marine conservation and sustainable use is individually transferable quota (ITQ) systems for fisheries or other variants to ITQs. As of 2008, 148 major fisheries around the world had adopted some variant of this approach (Costello, Gaines and Lynham, 2008), along with approximately 100 smaller fisheries in individual countries. Approximately 10% of the marine harvest was managed by ITQs as of 2008. ITQs for habitat also exist, though very few have been implemented in practice (see Innes [2015] for a discussion).

Other examples of economic instruments include the US 10% federal excise tax on sales of sport fishing equipment and motorboat fuel, which is used to finance the US Aquatic Resources Trust Fund. In Israel, a marine environmental protection fee is levied on ships calling at Israeli ports and oil unloading platforms. This fee varies according to the size of the ship and the amount of oil, with the revenues going to the Marine Pollution Prevention Fund (OECD, 2011a).

Entrance fees to marine national parks are being used in a number of countries, including Belize, Mexico, Thailand and the Galapagos Islands in Ecuador. Payments for ecosystem services (PES) in the marine context have also been introduced. For example, local hotels and tourism operators can pay for reef conservation due to the benefits associated with decreased beach erosion and species conservation (e.g. for scuba divers) (see Chapter 4 for a further discussion). The Great Barrier Reef Marine Park Authority requires the payment of bonds to manage certain approved activities within the park (e.g. marina development, dredge disposal, tourism and aquaculture facilities) (Lal and Brown, 1996).

Revenue from fines imposed on damages caused can also be used for MPAs. In Canada, for example, an environmental protection fund was created for the Gilbert Bay MPA through proceeds of fines imposed on business following an oil spill. Another concept that is being explored is marine biodiversity offsets, for industries such as petroleum exploration, renewable energy and seabed mining. Scoping work for such instruments has been undertaken for Belize and the United Kingdom.

### *Information and voluntary instruments*

Information instruments aim to address informational asymmetries that often exist between business, government and society. Eco-labels and certification are instruments that have been fairly widely adopted in the case of fisheries. Two hundred and twenty-four fisheries have been independently certified as meeting the Marine Stewardship Council (MSC) standard for sustainable fishing with another 94 currently undergoing assessment (MSC, 2014). Friend of the Sea is another important certification scheme in terms of volume, though several others also exist (OECD, 2011b). Other voluntary instruments that have been used include negotiated agreements between government and fishers to establish voluntary marine conservation areas.

## The role of marine protected areas and an overview of current status and trends

Each of the instruments described above within the broad headings of regulatory, economic, and information and voluntary instruments are able to help address one or more of the drivers of marine biodiversity loss discussed before. For example, MPAs can contribute to help address overfishing[23] and habitat destruction, and can help to minimise noise pollution, for example, if ships are not allowed to navigate through such areas. MPAs can also protect seagrass beds and salt marshes, which act as carbon sinks (Simard, Laffoley and Baxter, 2016). Instruments such as ITQs are able to contribute to addressing overfishing, and pollution abatement measures (including those targeting land-based pollution) are able to contribute to addressing issues such as plastics pollution, nutrient loading, greenhouse gas emissions and invasive alien species. A simplified (non-comprehensive) depiction of this is provided in Table 1.3.

Table 1.3. **Pressures on marine biodiversity loss and instruments to address them**

| Pressures on marine biodiversity loss | Instruments | | | |
|---|---|---|---|---|
| | Marine protected areas | ITQs for fisheries | Pollution abatement measures | Other regulatory measures |
| Overfishing | 2 | 2 | 0 | 1 |
| Pollution | 1 | 0 | 2 | 1 |
| Habitat destruction | 2 | 0 | 1 | 1 |
| Climate change | 1 | 0 | 2 | 1 |
| Invasive alien species | 0 | 0 | 1 | 1 |

*Notes:* ITQ: individual transferable quota.

0 implies not able to address this pressure; 1 implies has potential to help address pressure (depending on instrument and context); 2 implies has significant potential to address pressure. The ability of marine protected areas to help address the spread and impact of invasive alien species is not clear (see De Poorter [2007] and Otero et al. [2013] for further information). In certain cases, such as in the Bouche de Bonifacio marine reserve in France, it is prohibited to introduce non-native species without prior authorisation. Similarly, the impact of ITQs for fisheries on habitat destruction is not necessarily clear with some claiming positive, no or potentially negative impacts on habitat (though the latter can be avoided when complimentary measures are put in place).

*Source*: Author's own work.

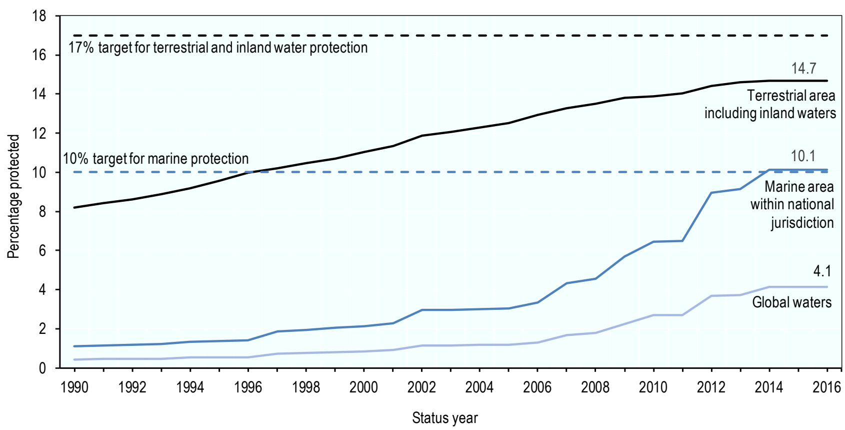
Despite the suite of policy instruments that is available to address marine conservation and sustainable use, current and projected trends in the state of marine biodiversity clearly highlight that the collective response to this challenge must be significantly scaled up and improved. Reflecting experience in the United States, for example, The Nature Conservancy (TNC) summarises:

> For years, there has been chronic underinvestment in marine conservation funding. Underfunding and shrinking budgets at the federal, regional, state, and local levels have left critical habitats unmapped and unprotected; reduced monitoring and scientific investments; hampered restoration efforts; and impeded new, effective national policy initiatives such as fishery reforms, regional ocean governance, marine spatial planning, large-scale coastal conservation, and ecosystem-based management. This situation persists despite longstanding and widespread recognition of the problem. (TNC, 2012)

These issues by no means only arise in the United States but are prevalent across many, if not most, OECD countries, and indeed worldwide.

As indicated above, MPAs are an important component of the suite of instruments for the conservation and sustainable use of marine biodiversity. Interest in MPAs as a management instrument has been increasing over the past two decades, with more than 14 600 MPAs in place around the world today. According to the *World Database on Protected Areas* (WDPA), they cover about 14.9 million km$^2$, or 4.1% of the global ocean area and 10.2% of coastal and marine areas under national jurisdiction, of the global marine area, with substantial variation on coverage between different regions (UNEP-WCMC and IUCN, 2016) (Figures 1.2 and 1.3). As indicated above, to be included in this database, MPAs must meet the IUCN definition of MPAs, which is "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008). The IUCN has developed six categories that classify areas according to their management objectives (Table 1.4). Mackie et al. (2017) examine the proportion of areas under each IUCN category, in OECD and G20 countries.

Figure 1.2. **Trends in global marine protected areas coverage over time**



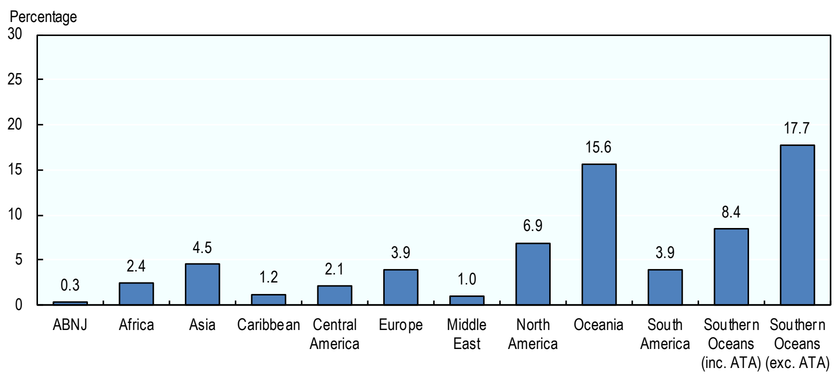

*Source:* Adapted from UNEP-WCMC and IUCN (2016), *Protected Planet Report 2016*.

While many different names have been given to marine areas that are, to some degree, protected by spatially explicit restrictions (see also Box 1.2), the definition adopted by the Ad Hoc Technical Expert Group on Marine and Coastal Protected Areas[24] for a marine and coastal protected area is:

- (a)"'Marine and coastal protected area' means any defined area within or adjacent to the marine environment, together with its overlying 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."

- (b)“Areas within the marine environment include permanent shallow marine waters; sea bays; straits; lagoons; estuaries; subtidal aquatic beds (kelp beds, seagrass beds; tropical marine meadows); coral reefs; intertidal muds; sand or salt flats and marshes; deep-water coral reefs; deep-water vents; and open ocean habitats.”

Figure 1.3. **Percentage of marine area (0-200 nautical miles) covered by protected areas in the regions**




*Notes:* ABNJ: areas beyond national jurisdiction. ATA: Antarctic Treaty Area. The numbers indicate the percentage of marine area protected in each region.

*Source*: Deguignet, M. et al. (2014), *2014 United Nations List of Protected Areas*, www.unep-wcmc.org/system/dataset_file_fields/files/000/000/263/original/2014_UN_List_of_Protected_Areas_EN_web.PDF?1415613322.

MPAs have a wide range of potential ecological, social and economic functions, including biodiversity conservation, protecting sensitive habitats, maintaining tourism, providing refuge for intensively fished species and ensuring sustainable multiple uses. Accordingly, the levels of restriction associated with MPAs vary, from partial (e.g. focus only on benthic species, or only limiting one type of fishing gear or activity) to high (e.g. “no-take” zones, also often called “marine reserves”) and almost total (“no-entry” zones). While some MPAs have a single level of protection, others are multi-use areas subdivided into zones of various levels of protection. According to the WDPA, of the 3.41% global MPA coverage in 2014, only 0.59% was established as no-take MPAs (Thomas et al., 2014). Instead, many MPAs allow extractive activities such as commercial trawling and oil and gas exploration and extraction. In Australia, for example, trawling is permitted in specific areas of the Great Barrier Reef Marine Park and also in the Shark Bay Marine Park (a Western Australian state MPA), although both are World Heritage Areas and highly valuable MPAs (Devillers et al., 2015).

Table 1.4. **Definition and primary objectives of IUCN protected area categories**

| IUCN category | Definition | Primary objective |
|---|---|---|
| Ia | Category Ia are strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring. | To conserve regionally, nationally or globally outstanding ecosystems, species (occurrences or aggregations) and/or geodiversity features: these attributes will have been formed mostly or entirely by non-human forces and will be degraded or destroyed when subjected to all but very light human impact. |
| Ib | Category Ib protected areas are usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition. | To protect the long-term ecological integrity of natural areas that are undisturbed by significant human activity, free of modern infrastructure and where natural forces and processes predominate, so that current and future generations have the opportunity to experience such areas. |
| II | Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities. | To protect natural biodiversity along with its underlying ecological structure and supporting environmental processes, and to promote education and recreation. |
| III | Category III protected areas are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine caverns, geological feature such as a caves or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value. | To protect specific outstanding natural features and their associated biodiversity and habitats. |
| IV | Category IV protected areas aim to protect particular species or habitats and management reflects this priority. Many category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category. | To maintain, conserve and restore species and habitats. |
| V | Category V protected areas are where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values. | To protect and sustain important landscapes/seascapes and the associated nature conservation and other values created by interactions with humans through traditional management practices. |
| VI | Category VI protected areas conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area. | To protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial. |

*Source:* Dudley, N. (ed.) (2008), *Guidelines for Applying Protected Area Management Categories*, https://cmsdata.iucn.org/downloads/guidelines_for_applying_protected_area_management_categories.pdf.

### Box 1.2. **Different terminology for different types of marine protected areas across countries**

In the Philippines, marine protected areas (MPAs) in general take four forms: 1) marine sanctuary or no-take marine reserve, where all forms of extractive activities are prohibited; 2) marine reserve, where extractive and non-extractive activities are regulated; 3) marine parks, where uses are designated into zones; and 4) protected landscape and seascape, where protection may include non-marine resources (Cabral et al., 2014).

In the United States, a national marine sanctuary usually allows fishing but prohibits other activities such as oil exploration. Instead, no-take areas are called marine reserves. Various other terminology is used depending on objectives and the levels of protection, such as marine wildlife refuges, estuarine research reserves and ocean parks.[1]

In France, the Law of 14 April 2006 defined six MPA categories: 1) national parks; 2) natural reserves; 3) biotope protection areas; 4) marine nature parks; 5) Natura 2000 sites; 6) parts of the maritime public domain managed by the Coastal and Lake Shore Conservation Authority. The regulatory objectives assigned to the different categories of MPAs include good environmental status of species, and/or of marine waters; sustainable exploitation of resources; and preservation of maritime cultural heritage (French Ministry of Ecology, Sustainable Development and Energy, 2015). Nine additional categories were added via a Decree of 3 June 2011, including for the Convention on Wetlands sites, UNESCO World Heritage sites, sites under the Barcelona Convention (Mediterranean), OSPAR (North East Atlantic), among others.

*Note:* 1. See: http://marineprotectedareas.noaa.gov/pdf/helpful-resources/factsheets/mpa_classification_may2011.pdf.

A more recent trend has been the establishment of large-scale MPAs, often described as MPAs larger than 100 000 km$^2$. Data indicate that ten of the existing MPAs or those currently under creation account for more than 53% of the worlds' total MPA coverage (Devillers et al., 2015). Several of the very large MPAs recently created or planned in the Pacific Ocean (e.g. Phoenix Islands Protected Area) allow fishing across most of their extents (De Santo, 2013; Pala, 2013) (Table 1.5; and Table 2.A1.1 for zoning of other MPAs).

While some progress has been made towards meeting the CBD 2011-2020 Aichi Target for MPAs, the literature suggests that considerably more needs to be done to ensure their effectiveness and ecological representativeness, in addition to their geographic coverage (Ban et al., 2014; Juffe-Bignoli et al., 2014; Dunn et al., 2014; Fox et al., 2014, cited in Brander [2015]).

Table 1.5. **Examples of recent designations of large marine protected areas and potential sites under development**

| Year | Marine protected area | Extractive activities allowed | Total size |
|---|---|---|---|
| 2007 | Benthic Protection Areas, New Zealand (17 sites) | Off-bottom trawl fishing permitted with strict controls in most sites.<br>Kermadec Islands' territorial waters (7 450 km$^2$) is currently no-take but there is a proposal to make the entire 620 500 km$^2$ area no-take, which would represent 56% of total combined area of New Zealand's Benthic Protection Areas. | Combined area of: 1 100 000 km$^2$ |
| 2007 | South East Commonwealth Marine Reserve Network, Australia (14 sites) | Depending on the area, recreational fishing, charter fishing, mining, some commercial fishing | 68% (154 435 km$^2$) is no-take 226 458 km$^2$ |
| 2008 | Phoenix Islands Protected Area (PIPA), Kiribati | 1. Distant Water Fishing Nation tuna fishing<br>2. Domestic commercial fishing licenses<br>3.87% (15 800 km$^2$) is no-take, to be increased to 25% when trust fund becomes active | 408 250 km$^2$ |
| 2009 | Marine National Monuments, United States:<br>1. Marianas Trench (246 608 km$^2$)<br>2. Pacific Remote Islands (225 039 km$^2$)<br>3. Rose Atoll (34 838 km$^2$) | Commercial fishing is prohibited but recreational, non-commercial and traditional/sustenance fishing may be allowed | Combined area just under 500 000 km$^2$ |
| 2009 | Prince Edward Islands MPA, South Africa | Commercial fishing: 34% (61 415 km$^2$) is no-take | 180 633 km$^2$ |
| 2009 | South Orkneys Marine Protected Area, British Antarctic Territory | 100% no-take | 93 787 km$^2$ |
| 2010 | Motu Motiro Hiva Marine Park, Chile | 74% (150 000 km$^2$) of the area is no-take | 203 374 km$^2$ |
| 2012 | Coral Sea Commonwealth Marine Reserve, Australia | 51% (504 820 km$^2$) is proposed to be no-take.<br>Recreational fishing and selected commercial fishing gear types allowed in remainder, but demersal trawling, demersal longlining and gillnetting are banned throughout. | 989 842 km$^2$ |
| 2014 | Coral Sea Natural Park, France/ New Caledonia | Multiple use area with various zones. No-take area is 3 236 km$^2$. | 1 300 000 km$^2$ |
| 2015 | Nazca-Desventuradas Marine Park, Chile | 100% no-take | 297 000 km$^2$ |
| 2015 | Palau Marine Sanctuary, Palau | 100% no-take | 500 000 km$^2$ |
| 2015 | Pitcairn Island, United Kingdom | 100% no-take | 800 000 km$^2$ |
| 2015 | Kermadec Ocean Sanctuary, New Zealand | 100% no-take | 620 000 km$^2$ |
| 2016 | Papahānaumokuākea Marine National Monument, North West Hawaiian Islands, United States | Initially established in 2006, bottomfish fishing was allowed. Since 15 June 2011, 341 362 km$^2$ area has been no-take. Area expanded fourfold in 2016. | 1 509 000 km$^2$ |
| 2016 | Ascension Island, United Kingdom | Proposed but not yet designated. 50% no-take. | 234 291 km$^2$ |

*Source*: Adapted from De Santo, E.M. (2013), "Missing marine protected area (MPA) targets: How the push for quantity over quality undermines sustainability and social justice", http://dx.doi.org/10.1016/j.jenvman.2013.01.033; Jones, P.J.S. and E.M. De Santo (2016), "Viewpoint – Is the race for remote, very large marine protected areas (VLMPAs) taking us down the wrong track?", https://doi.org/10.1016/j.marpol.2016.08.015; with updates from www.mpatlas.org/mpa/sites.

Moreover, the economic aspects of marine protected areas have received less attention in the literature, with studies suggesting that MPA decision making and management may not be as efficient or cost-effective as it could be. Given that countries are supposed to increase MPA coverage to 10% by 2020, from a level of 4.1% today, issues that are relevant and that this report examines include:

- What are the costs and benefits associated with MPAs?
- Across nations, how and why have MPAs been chosen as the appropriate management response? How are MPAs being sited in practice? To what extent are siting decisions informed by economic considerations (i.e. cost-benefit analysis), as well as other factors such as climate change?
- What type of monitoring, compliance and enforcement regimes have been adopted across different MPAs and how do they compare in terms of effectiveness and cost?
- How are MPAs financed and what options are there to scale this up?
- How effective have MPAs been in addressing the threats caused by overfishing and habitat destruction, and in conserving biodiversity more broadly?
- How have MPAs been implemented together with other policy instruments, to more comprehensively and effectively address the multiple drivers of marine biodiversity loss?
- What are the political economy issues surrounding MPAs, including the interplay/competences between fishery and environmental institutions/ministries/agencies, and how can synergies best be used?

## Key findings and good practice insights

**MPAs can provide a wide variety of benefits.** These benefits range from the conservation of areas that harbour important biodiversity, serving as nursery grounds for fisheries, protecting habitats that buffer the impacts of storms and waves, removing excess nutrients and pollutants from the water, and providing more sustainable tourism and recreational benefits. These benefits fall under the various components of the total economic value (TEV), which is the sum of all the use and non-use values for a good or service.

**Clear measures and well-defined goals and objectives are necessary for MPAs to be successful.** When considering the introduction of an MPA, it is first important to have a clear understanding of the state of, and pressures on a particular marine and/or coastal ecosystem, the likelihood that an MPA or network of MPAs can address these, and the range of stakeholders involved.

Secondly, the goals and objectives of the MPA must be clearly defined, as well as the required level of protection to achieve these. These should be stated at an operational level, so as to be specific, measurable, achievable, realistic and time-bound (SMART), and accompanying indicators should be identified that will enable the eventual assessment of whether the objectives are being met.

**Information on the expected costs and benefits of the particular MPA is important for a number of reasons.** It allows decision makers to better evaluate the net benefits to society from investing in an MPA and to prioritise efforts among various possible MPAs if resources are limited. It can also provide insights on how these net benefits are distributed (i.e. over time, different geographic scale and between different user groups), which is important for understanding the distributional implications of MPAs, and thus how they can best be managed. Understanding the costs associated with MPAs also enables planners to budget and to help secure sufficient finance for the effective long-term management of the MPA.

Looking across the establishment costs of 13 MPAs which varied in size, location, objectives and degree of protection, McCrea-Strub et al. (2011) find that variation in MPA start-up costs are most significantly related to MPA size and the duration of the establishment phase. MPA operating costs have been found to depend on several variables, particularly design, location, configuration, socio-economic context and zoning (Ban et al., 2011). In a global study, Brander et al. (2015) examine the net benefits of protecting marine habitats through expanding the coverage of MPAs to 10% and 30% and find that the ratios of benefits to costs are in the range 3.17-19.77.

While studies evaluating the benefits and costs of individual MPAs do exist, in general **economic valuation is not yet widespread** and is not being used to help inform the design and implementation of MPAs. Software tools such as Marxan and MarZone which aid systematic reserve design by analysing how given conservation objectives can be attained at least cost, have been used in several cases but could be adopted more widely.

**More strategic siting of MPAs is needed, to enhance the environmental as well as cost-effectiveness of MPAs.** While ecological criteria are the norm for determining where to locate an MPA (i.e. by identifying ecologically significant and representative areas), studies suggest that often MPAs are situated in locations that are not under direct threat of loss (Burke et al., 2011; Edgar, 2011; Deviliers et al., 2014). As noted by Watson et al (2014), large and remote MPAs may not necessarily avert imminent and direct threats in populated coastal waters where pressures on biodiversity often remain intense. This implies that resources are not allocated to areas where they will have the greatest environmental impact.

While MPAs are being established to address a variety of different (and often multiple) objectives, the primary objective is most commonly to conserve protected, rare or threatened species of populations and their habitats. The past few years have witnessed a marked increase in global MPA coverage. This has also been achieved, in large part, via the recent trend in the establishment of large-scale MPAs (larger than 100 000 $km^2$). Ten of the existing MPAs or those under creation accounted for more than 53% of the worlds' total MPA coverage (Devillers et al., 2015). The impetus for MPA creation is also likely to be attributable to the internationally agreed targets on marine and coastal protection, namely those under the Convention on Biological Diversity (CBD), and echoed in the Sustainable Development Goals.

**Monitoring and reporting on MPAs needs to be more robust.** Monitoring is important both initially in order to establish ecological and socio-economic baseline data, as well as regularly thereafter, to assess trends in performance over time, but has often not been undertaken as rigorously as needed. Challenges encountered include lack of sufficient human resources (staff, capacity), financial resources, equipment and infrastructure, and knowledge. Indicators selected should be able to determine whether the objective(s) of the MPA are being achieved. Monitoring protocols can help to provide guidance to MPA managers, as well as to streamline monitoring methods across MPAs so as to facilitate comparison. Reporting including via online databases with publicly available information can help to increase transparency and enable the sharing of information and lessons learnt across different MPAs, their respective management approaches, and their effectiveness in achieving the intended objectives.

**Compliance and enforcement** methods also vary substantially across MPAs. Approaches for assessing compliance include direct surveillance (e.g. air surveillance, vessel patrols), indirect observation (e.g. discarded gear on reefs) and law enforcement records. Methods that are able to attribute non-compliance to those directly responsible are best suited to applying sanctions. With regard to enforcement, either the probability of detection or the sanctions must be high so as to offset the potential economic gains from MPA violations. However, existing studies suggest that few MPAs have a robust compliance and enforcement regime in place, which has been cited as an important reason for lack of MPA effectiveness. While the costs of enforcement have traditionally been high, recent technological innovations such as vessel monitoring systems and remote sensing can help to drive the costs down.

Adequately **financing** the conservation of coastal and marine areas is often a major challenge and is likely to be exacerbated as countries strive to meet the 10% target under the CBD. Though not comprehensive, available information suggests that the main source of MPA financing in developed countries is government budget, whereas in developing countries, international donors as well as entrance fees to MPAs can constitute an important source of finance. Overall, **more comprehensive and diverse MPA financing portfolios are needed**, via the introduction of instruments such as taxes, fines and other revenue-generating mechanisms, which are also in line with the polluter-pays approach (and can therefore provide incentives to mitigate other pressures on marine biodiversity such as pollution) or which can serve as deterrents to non-compliance. MPA financing strategies, which include identifying the financing needs, and the possible instruments through which additional finance can be mobilised, should form an integral component of an MPA management plan.

Given the vastness, the multidimensionality and the ecological complexity of the oceans; the lack of internationally comparable and systematic indicators and databases that assess MPA effectiveness; the aforementioned management challenges that persist; as well as the continuously mounting pressures on marine ecosystems, it is not possible to ubiquitously say all MPAs have been effective in addressing threats such as overfishing and habitat destruction, and in achieving their conservation objectives. Many have been effective or partially so, though pressures still remain. No single policy instrument is a panacea, and the design and implementation features do matter. In the absence of perfect information, and while scientific understanding improves, there is increasing evidence to suggest that the benefits of MPAs are considerable and that the costs of inaction will continue to rise if further corrective measures are not taken. Adopting a precautionary approach in this context is therefore also relevant.

In addition to more effective design and implementation of MPAs, however, greater emphasis is also needed on putting in place **effective policy mixes** that can meaningfully address the full range of pressures on marine biodiversity conservation and sustainable use. While MPAs are a crucial component of this, they are not sufficient to ensure that the broader environmental goal is met. Complementary instruments need to be in place to manage pressures, such as overfishing (including outside MPA boundaries), marine pollution (including from land-based sources) and climate change. A full package of policy measures is needed to ensure the sustainable use of marine resources, including policies that lie beyond the mandates of environment ministries. Marine spatial planning is an instrument increasingly being used in a number of countries, and can help to obtain a broader understanding of the often competing demands on the ocean space and the diverse stakeholders involved.

The **political economy** of MPAs in this regard is also important and another area where a clearer understanding of the costs and benefits of MPAs, including inter-temporally, can help to alleviate potential conflicts. Opponents to MPAs, for example, tend to focus on the short-run opportunity costs, primarily the loss of fishing opportunities. Embedding MPA design issues into other policy approaches, such as marine spatial planning and other ecosystem-based management regimes, and the establishment of inter-ministerial committees to develop national marine and coastal development strategies, which bring together multiple stakeholders, can help to ensure a better understanding of the costs and benefits of decisions to different users, and the possible measures needed to address vulnerable groups most affected. Such measures can help to address political economy issues that arise, for example, between conservation and fishing communities. Such approaches can also help to foster **policy coherence** – a fundamental component of any strategy that can meaningfully contribute to the achievement of the Sustainable Development Goals, including those for oceans and marine biodiversity, for food security, and for poverty alleviation.

# Notes

1. Invasive marine species, especially those carried in ship ballast water and on ship hulls, cause an estimated USD 100 billion each year in economic damage to infrastructure, ecosystems and livelihoods (based on estimates in the UNDP-GEF GloBallast programme, as cited in UNDP [2012]).

2. The importance of oceans has recently also received higher recognition at the United Nations Framework Convention on Climate Change (UNFCCC) COP21 and in the Paris Agreement. The IPCC Panel has also recently decided to prepare a special report on climate change and the oceans and the cryosphere.

3. A few MPAs have also been created in areas beyond national jurisdiction, notably in in the Mediterranean Sea, the north-east Atlantic and the southern Ocean, where regional initiatives and organisations have had the appropriate mandate to do so.

4. The Ad Hoc Technical Expert Group on Marine and Coastal Protected Areas adopted the following definition: "Marine and coastal protected area" means any defined area within or adjacent to the marine environment, together with its overlying 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. See the section on "Economic value of marine ecosystems" for further detail on this and other definitions of MPAs.

5. The UN World Ocean Assessment (2016) has also recently been released (www.worldoceanassessment.org).

6. While the marine data is poor, a first IUCN Red List of Threatened Species assessment available for all known species of marine shore-fish, marine mammals, seaturtles, seabirds, corals, mangroves and seagrasses in a major marine biogeographic region of tropical eastern Pacific, indicated that 12% are under threat (Polidoro et al., 2012).

7. The decline has been most severe on the reefs south of the latitude 20° (near Bowen) particularly since 2006. Since then hard coral cover has fallen from about 35% to 8% in the southern third of the region.

8. Measured as hydrogen ion concentration.

9. For example, compounding of human activities in areas where there is overfishing with bottom contact gear types in addition to other activities that damages benthic habitat (coastal/offshore development projects, dredging for shipping, etc.) can adversely affect the spawning grounds habitats for various species. Similarly, climate change effects may put pressure on ecosystems and also create a more conducive environment for invasive species to extend their range and thereby increase the pressure on marine biodiversity.

10. Marine pollution has been defined as "the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities" (Art.1 (4) UNCLOS).

11. There are reportedly 405 dead zones worldwide covering an ocean expanse of 250 000 km² (UNDP, 2012). According to another study, there are over 600 dead zones in the world's coastal areas covering more than 245 000 km² of sea bottom (Diaz and Rosenberg, 2008).

12. For example gravel extraction and oil exploration.

13. Ecosystem services refer to the benefits people obtain from ecosystems (Millennium Ecosystem Assessment, 2005).

14. http://marineecosystemservices.org.

15. Not necessarily confined to coastal activities but including coastal industries such as maritime equipment industry and many more.

16. Values converted to a common set of units, namely 2007 "international" $/year, i.e. translated into USD values on the basis of purchasing power parity (PPP).

17. This study only accounted for provisioning (fishing, seaweed farming, mangrove harvesting) and cultural services (tourism).

18. It is important to note, however, that since most of the drivers of marine biodiversity loss stem from land-based activities (as described above), instruments to address these activities are just as relevant. Moreover, issues such as building the necessary scientific and technical capacity, as well as ensuring stakeholder engagement in the policy-making process are important elements that need to be considered. These issues are examined in Chapter 3.

19. A few MPAs have also been created in areas beyond national jurisdiction, notably in the Mediterranean Sea, the north-east Atlantic and the southern Ocean, where regional initiatives and organisations have had the appropriate mandate to do so.

20. www.cites.org/eng/disc/species.php.

21. But note that Collie et al. (2013) state that, in fact, there is disagreement about what constitutes an MSP per se as opposed to coastal zone management, marine protected area networks and government frameworks to support marine spatial planning.

22. www.unesco-ioc-marinesp.be/msp_around_the_world.

23. A study by Halpern et al. (2010) indicates that, based on several small-scale fisheries, spillover effects from no-take marine reserves can partially or fully offset losses in catch due to reserve closure. The results suggest that reserves can simultaneously meet conservation objectives and benefit local fisheries adjacent to their boundaries. Similarly, Florin et al. (2013) find positive effects – such as lower mortality rate, higher densities and higher mean age within the area but also potential for spillover effects – in a no-take area in the Baltic Sea (i.e. Gotska Sandön, the largest no-take area in the Baltic covering 360 km²). They conclude that their results strengthen the findings from previous studies stating that no-take marine reserves provide a useful instrument not only for nature conservation but also for fisheries management in northern Europe.

24. UNEP/CBD/COP/Dec/VII/5 Marine and coastal biological diversity.

# *References*

Agnew, D.J. et al. (2009), "Estimating the worldwide extent of illegal fishing", *PLoS ONE*, Vol. 4/2, https://doi.org/10.1371/journal.pone.0004570.

Ban, N.C. et al. (2014), "Systematic conservation planning: A better recipe for managing the high seas for biodiversity conservation and sustainable use", *Conservation Letters*, Vol. 7/1, pp. 41-54, http://dx.doi.org/10.1111/conl.12010.

Ban, N.C. et al. (2011), "Designing, implementing and managing marine protected areas: Emerging trends and opportunities for coral reef nations", *Journal of Experimental Marine Biology and Ecology*, Vol. 408/1-2, pp. 21-31, https://doi.org/10.1016/j.jembe.2011.07.023.

Bax, N. et al. (2003), "Marine invasive alien species: A threat to global biodiversity", *Marine Policy*, Vol. 27/4, pp. 313-323, https://doi.org/10.1016/S0308-597X(03)00041-1.

Beamont, N.J. et al. (2008), "Economic valuation for the conservation of marine biodiversity", *Marine Pollution Bulletin*, Vol. 56/3, pp. 386-396, https://doi.org/10.1016/j.marpolbul.2007.11.013.

Bijma, J. et al. (2013), "Climate change and the oceans – What does the future hold?", *Marine Pollution Bulletin*, Vol. 74/2, pp. 495-505, https://doi.org/10.1016/j.marpolbul.2013.07.022.

Branch, T.A. et al. (2011), "Contrasting global trends in marine fishery status obtained from catches and from stock assessments", *Conservation Biology*, Vol. 25/4, pp. 777-786, http://dx.doi.org/10.1111/j.1523-1739.2011.01687.x.

Brander, L. et al. (2015), "The benefits to people of expanding of marine protected areas", IVM Institute for Environmental Studies, Amsterdam, Netherlands, www.ivm.vu.nl/en/Images/R15-05_Final_report_tcm234-454651.pdf.

Brander, L.M. et al. (2012), "The economic impact of ocean acidification on coral reefs", *Climate Change Economics*, Vol. 1/3, http://dx.doi.org/10.1142/S2010007812500029.

Burke et al. (2011), *Reefs at Risk Revisited*, World Resources Institute, www.wri.org/publication/reefs-risk-revisited.

Cabral, R.B. et al. (2014), "The Philippines Marine Protected Area (MPA) database", *Philippine Science Letters*, Vol. 7/2, pp. 300-308, http://philsciletters.org/2014/PSL%202014-vol07-no02-p300-308%20Cabral-Alino.pdf.

CBD (2010), Strategic Plan for Biodiversity 2011-2020, including Aichi Biodiversity Targets, Decision X/2, CBD Secretariat, https://www.cbd.int/decision/cop/?id=12268.

J.S. et al. (2013), "Marine spatial planning in practice", *Estuarine, Coastal and Shelf Science*, Vol. 117, pp. 1-11, https://doi.org/10.1016/j.ecss.2012.11.010.

Cooley, S.R. and S.C. Doney (2009), "Anticipating ocean acidification's economic consequences for commercial fisheries", *Environmental Research Letters*, Vol. 4/2, http://dx.doi.org/10.1088/1748-9326/4/2/024007.

Costello, C., S.D. Gaines and J. Lynham (2008), "Can catch shares prevent fisheries collapse?", *Science*, Vol. 321/5 896, pp. 1 678-1 681, http://dx.doi.org/10.1126/science.1159478

De'ath, G. et al. (2012), "The 27-year decline of coral cover on the Great Barrier Reef and its causes", *PNAS*, Vol. 109/44, pp. 17 995-17 999, http://dx.doi.org/10.1073/pnas.1208909109.

De Groot, R. et al. (2012), "Global estimates of the value of ecosystem services", *Ecosystem Services*, Vol 1/1, pp. 50-61, https://doi.org/10.1016/j.ecoser.2012.07.005.

De Poorter, M. (2007), "Invasive alien species and protected areas: A scoping report Part 1", produced for the World Bank as a contribution to the Global Invasive Species Programme (GISP), www.issg.org/pdf/publications/GISP/Resources/IAS_ProtectedAreas_Scoping_I.pdf.

De Santo, E.M. (2013), "Missing marine protected area (MPA) targets: How the push for quantity over quality undermines sustainability and social justice", *Journal of Environmental Management*, Vol. 124, pp. 137-146, http://dx.doi.org/10.1016/j.jenvman.2013.01.033.

Deguignet, M. et al. (2014), *2014 United Nations List of Protected Areas*, United Nations Environment Programme World Conservation Monitoring Centre, Cambridge, United Kingdom, www.unep-wcmc.org/system/dataset_file_fields/files/000/000/263/original/2014_UN_List_of_Protected_Areas_EN_web.PDF?1415613322.

Devillers, R. et al. (2015), "Reinventing residual reserves in the sea: Are we favouring ease of establishment over need for protection?", *Aquatic Conservation: Marine Freshwater Ecosystems*, Vol. 25/4, pp. 480-504, http://dx.doi.org/10.1002/aqc.2445.

Diaz, R.J. and R. Rosenberg (2008), "Spreading dead zones and consequences for marine ecosystems", *Science*, Vol. 321/5 891, pp. 926-929, http://dx.doi.org/10.1126/science.1156401.

Doney, S.C. et al. (2012), "Climate change impacts on marine ecosystems", *Annual Review of Marine Science*, Vol. 4, pp. 11-37, http://dx.doi.org/10.1146/annurev-marine-041911-111611.

Dudley, N. (ed.) (2008), *Guidelines for Applying Protected Area Management Categories*, International Union for Conservation of Nature, Gland, Switzerland, https://cmsdata.iucn.org/downloads/guidelines_for_applying_protected_area_management_categories.pdf.

Dunn, D.C. et al. (2014), "The convention on biological diversity's ecologically or biologically significant areas: Origins, development, and current status", *Marine Policy*, Vol. 49, pp. 137-145, https://doi.org/10.1016/j.marpol.2013.12.002.

Edgar, G. (2011), "Does the global network of marine protected areas provide an adequate safety net for marine biodiversity?", *Aquatic Conservation: Marine Freshwater Ecosystems*, Vol. 21/4, pp. 313-316, http://dx.doi.org/10.1002/aqc.1187.

FAO (2016), *The State of World Fisheries and Aquaculture 2016: Contributing to Food Security and Nutrition for All*, Food and Agriculture Organization, Rome, www.fao.org/3/a-i5555e.pdf.

FAO (2014), *The State of World Fisheries and Aquaculture*, Food and Agriculture Organization, Rome.

FAO (2004), *The State of the World Fisheries and Aquaculture*, Food and Agriculture Organization, Rome, www.fao.org/docrep/007/y5600e/y5600e00.htm.

Florin, A.-B. et al. (2013), "Effects of a large northern European no-take zone on flatfish populations", *Journal of Fish Biology*, Vol. 83/4, pp. 939-962, http://dx.doi.org/10.1111/jfb.12097.

Fox, H. et al. (2014), "How are our MPAs doing? Challenges in assessing global patterns in marine protected area performance", *Coastal Management*, Vol. 42/3, pp. 207-226, http://dx.doi.org/10.1080/08920753.2014.904178.

French Ministry of Ecology, Sustainable Development and Energy (2015), "National Strategy for the Creation and Protection of Marine Protected Areas: Summary", Ministry of Ecology, Sustainable Development and Energy, Paris, www2.developpement-durable.gouv.fr/IMG/pdf/National_strategy_for_the_creation_and_management_GB_Web.pdf.

Gaines, S.D. et al. (2010), "Designing marine reserve networks for both conservation and fisheries management", *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 107/43, pp. 18 286-18 293, http://dx.doi.org/10.1073/pnas.0906473107.

Global Partnership for Oceans (n.d), www.worldbank.org/en/topic/environment/brief/global-partnership-for-oceans-gpo.

GOC (2014), *From Decline to Recovery: A Rescue Package for the Global Oceans*, Global Oceans Commission.

Halpern, B.S. (2003), "Impact of marine reserves: Do reserves work and does reserve size matter?" *Ecological Applications*, Vol. 13/sp1, pp. S117-S137, http://dx.doi.org/10.1890/1051-0761(2003)013[0117:TIOMRD]2.0.CO;2.

Halpern, B.S. et al. (2010), "Spillover from marine reserves and the replenishment of fished stocks", *Environmental Conservation,* Vol. 36/4, pp. 268-276, http://dx.doi.org/10.1017/S0376892910000032.

Innes, J. et al. (2015), "Mitigating undesirable impacts in the marine environment: A review of market-based management measures", *Frontiers in Marine Science*, Vol. 2/76, https://doi.org/10.3389/fmars.2015.00076.

IPCC (2014), *Climate Change 2014*: *Synthesis Report: Summary for Policymakers*, Intergovernmental Panel on Climate Change, www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

Jay, S. (2015), "Marine spatial planning: Current status and challenges", prepared for the OECD Committee for Fisheries Meeting, Paris, 13-15 April 2015.

Jones, P.J.S. and E.M. De Santo (2016), "Viewpoint – Is the race for remote, very large marine protected areas (VLMPAs) taking us down the wrong track?", *Marine Policy*, Vol. 73, pp. 231-234, https://doi.org/10.1016/j.marpol.2016.08.015.

Juffe-Bignoli, D. et al. (2014), *Protected Planet Report 2014: Tracking Progress Towards Global Targets for Protected Areas* , United Nations Environment Programme World Conservation Monitoring Centre, Cambridge, United Kingdom, www.unep-wcmc.org/resources-and-data/protected-planet-report-2014.

Kaiser, B. and J. Roumasset (2002), "Valuing indirect ecosystem services: The case of tropical watersheds", *Environment and Development Economics*, Vol. 7/4, pp. 701-714, https://doi.org/10.1017/S1355770X02000426.

Lal, P. and D. Brown (1996), "Using performance bonds as an environment management tool: The Great Barrier Reef Marine Park Authority's experience", *Australian Journal of Environmental Management*, Vol. 3/2, pp. 86-97, http://dx.doi.org/10.1080/14486563.1996.10648346.

Lange, G.M. (2009), "Economic value of marine ecosystem services in Zanzibar: Implications for marine conservation and sustainable development", *Ocean and Coastal Management*, Vol. 52/10, pp. 521-532, https://doi.org/10.1016/j.ocecoaman.2009.08.005.

Loh J. et al. (2010) *Living Planet Index in: Living Planet Report 2010* (ed. Almond, R.), WWF, Gland, Switzerland, http://d2ouvy59p0dg6k.cloudfront.net/downloads/wwf_lpr2010_lr_en.pdf.

Mackie, A. et al. (2017), "Indicators on terrestrial and marine protected areas: Results on OECD and G20 countries", *OECD Environment Working Paper*, OECD Publishing, Paris, forthcoming.

McCrea-Strub, A. et al. (2011), "Understanding the cost of establishing marine protected areas", *Marine Policy*, Vol. 35/1, pp. 1-9, https://doi.org/10.1016/j.marpol.2010.07.001.

Millennium Ecosystem Assessment (2005), *Ecosystems and Human Well-being: Synthesis*, World Resources Institute, Island Press, Washington, DC, www.millenniumassessment.org/documents/document.356.aspx.pdf.

MSC (2014), *MSC Global Impacts Summary Report 2014*, Marine Stewardship Council, www.msc.org/documents/environmental-benefits/global-impacts/msc-global-impacts-summary-report-2014/view.

Naber, H., G.-M. Lange and M. Hatziolos (2008), "Valuation of marine ecosystem services: A gap analysis", www.cbd.int/marine/voluntary-reports/vr-mc-wb-en.pdf.

Narita D, R. Rehdanz and R.S.J. Tol (2012), "Economic costs of ocean acidification: A look into the impacts on global shellfish production", *Climatic Change*, Vol. 113/3, pp. 1 049-1 063, http://dx.doi.org/10.1007/s10584-011-0383-3.

Nicholls, R.J. and A. Cazenave (2010), "Sea level rise and its impacts on coastal zones", *Science*, Vol. 328/5 985, pp. 1 517-1 520, http://dx.doi.org/10.1126/science.1185782.

Noone, K., R. Sumaila and R.J. Diaz (eds.) (2012), "Draft executive summary", in: *Valuing the Ocean*, Stockholm Environment Institute, www.sei-international.org/mediamanager/documents/Publications/SEI-Preview-ValuingTheOcean-DraftExecutiveSummary.pdf.

OECD (2016), *The Ocean Economy in 2030*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264251724-en

OECD (2011a), *OECD Environmental Performance Reviews: Israel 2011*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264117563-en.

OECD (2011b), *Fisheries and Aquaculture Certification*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264119680-en.

OECD (2010), *Paying for Biodiversity: Enhancing the Cost-Effectiveness of Payments for Ecosystem Services,* OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264090279-en.

OECD/FAO (2014), *OECD-FAO Agricultural Outlook 2014*, OECD Publishing, Paris, http://dx.doi.org/10.1787/agr_outlook-2014-en.

Otero, M. et al. (2013), *Monitoring Marine Invasive Species in Mediterranean Marine Protected Areas (MPAs): A Strategy and Practical Guide for Managers*, IUCN Centre for Mediterranean Cooperation, Malaga, Spain, https://portals.iucn.org/library/sites/library/files/documents/2013-008.pdf.

Pala (2013), "Giant marine reserves pose vast challenges", *Science,* Vol. 339/6 120, pp. 640-641, http://dx.doi.org/10.1126/science.339.6120.640.

Pitcher, T.J. and W. Cheung (2013), "Fisheries: Hope or despair?", *Marine Pollution Bulletin*, Vol. 74/2, pp. 506-516, https://doi.org/10.1016/j.marpolbul.2013.05.045.

Polidoro, B.A. et al. (2012), "Patterns of extinction risk and threat for marine vertebrates and habitat-forming species in the Tropical Eastern Pacific", *Marine Ecology Progress Series*, Vol. 448, pp. 93-104, https://doi.org/10.3354/meps09545.

Rogers, A and D. Laffoley (2013), "Introduction to the special issue: The global state of the ocean; interactions between stresses, impacts and some potential solutions: Synthesis papers from the International Programme on the State of the Ocean 2011 and 2012 workshops", *Marine Pollution Bulletin*, Vol. 74/2, pp. 491-494, http://dx.doi.org/10.1016/j.marpolbul.2013.06.057.

Science Daily (2008), "Invasion of comb jelly fish", https://www.sciencedaily.com/releases/2008/08/080813101741.htm

Simard, F., D. Laffoley and J.M. Baxter (eds.) (2016), *Marine Protected Areas and Climate Change: Adaptation and Mitigation Synergies, Opportunities and Challenges*, International Union for Conservation of Nature and Natural Resources, Gland, Switzerland, http://dx.doi.org/10.2305/IUCN.CH.2016.14.en.

Thomas, H.L. et al. (2014), "Evaluating official marine protected area coverage for Aichi Target 11: Appraising the data and methods that define our progress", *Aquatic Conservation: Marine and Freshwater Ecosystems*, Vol. 24/S2, pp. 8-23, http://dx.doi.org/10.1002/aqc.2511.

TNC (2012), "Monies for marine conservation: A white paper examining new funding sources for oceans and coasts", The Nature Conservancy, www.marineplanning.org/pdf/Monies_for_Marine_Conservation.pdf.

UN (2015), *Transforming Our World: The 2030 Agenda for Sustainable Development*, A/RES/70/1, United Nations General Assembly, https://sustainabledevelopment.un.org/post2015/transformingourworld.

UNDP (2012), *Catalysing Ocean Finance Volume I Transforming Markets to Restore and Protect the Global Ocean*, United Nations Development Programme.

UNEP (2011), "Towards a green economy: Pathways to sustainable development and poverty eradication: A synthesis for policy makers", United Nations Environment Programme, Nairobi, https://sustainabledevelopment.un.org/content/documents/126GER_synthesis_en.pdf.

UNEP-WCMC and IUCN (2016), *Protected Planet Report 2016: How Protected Areas Contribute to Achieving Global Targets for Biodiversity*, UNEP-WCMC and IUCN, Cambridge, United Kingdom and Gland, Switzerland, www.protectedplanet.net/c/protected-planet-report-2016.

UNESCO (2012), Rio Ocean Declaration, Co-Chairs' Statement of the Oceans Day at Rio+20, 16 June 2012, United Nations Conference on Sustainable Development, Rio de Janeiro, www.unesco.org/fileadmin/MULTIMEDIA/HQ/SC/pdf/pdf_Rio_Ocean_Declaration_2012.pdf.

Veron, J.E.N et al. (2009), "The coral reef crisis: The critical importance of <350 ppm $CO_2$", *Marine Pollution Bulletin*, Vol. 58/10, pp. 1 428-1 436, https://doi.org/10.1016/j.marpolbul.2009.09.009.

Wallace, S. et al. (2015), "Canada's pacific groundfish trawl habitat agreement: A global first in an ecosystem approach to bottom trawl impacts", *Marine Policy*, Vol. 60, pp. 240-248, http://dx.doi.org/10.1016/j.marpol.2015.06.028.

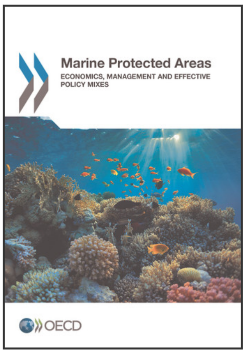
Wilkinson, S. (2008), *Status of the Coral Reefs of the World, 2008*, Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Australia.

Wilkinson, C. (2004), *Status of Coral Reefs of the World, 2004 (Vol 1)*, Australian Institute of Marine Science, Townsville, Australia.

Watson, J.E. et al. (2014), "The performance and potential of protected areas", *Nature*, Vol. 515, pp. 67-73, http://dx.doi.org/10.1038/nature13947.

Wood, L.J. et al. (2008), "Assessing progress towards global marine protection targets: Shortfalls in information and action", *Oryx*, Vol. 42/3, pp. 340-351, https://doi.org/10.1017/S003060530800046X.

WWF (2009), "Silent invasion: The spread of marine invasive species via ships' ballast water", WWF International, Gland, Switzerland, www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Study_Silent_Invasion.pdf.

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## Economics, Management and Effective Policy Mixes

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