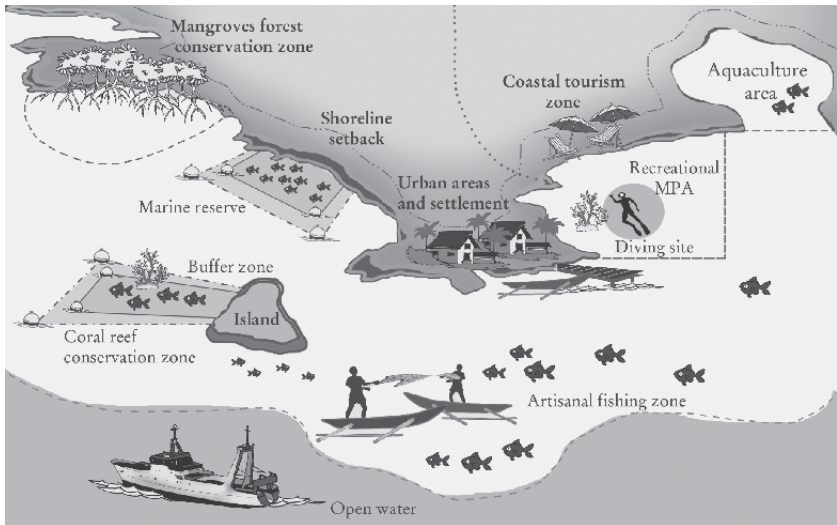


What are MPAs and what do they do?



1. MPA DEFINITION AND CONTEXT

The term ‘marine protected area’ or MPA has gained prominence in the dialog on fisheries management and biodiversity conservation since the early 1990s. The concept and its application continue to evolve and recent developments – particularly with regard to rapidly increasing recognition of the threat of climate change and the related focus on ecosystem resilience – have brought MPAs to the forefront of discussions in global marine conservation and management strategies. But what exactly is an MPA and why do we set up MPAs or MPA networks?

This chapter attempts to answer these basic questions paying particular attention to the fisheries perspective. The concepts of fisheries management and EAF are discussed in the following chapter.

While the Code of Conduct for Responsible Fisheries does not refer explicitly to MPAs, their use is implied in the recommendation for management measures – including closed areas, seasons and reserved zones – to minimize waste, discards, bycatch, lost or abandoned gear, catch of non-target species (fish and non-fish species), and negative impacts on associated or dependent species, in particular endangered species. The FAO technical guidelines for The ecosystem approach to fisheries (FAO 2003a) recognize that MPAs can contribute to achieving sustainable fisheries.

1.1 WHAT IS AN MPA?

These Guidelines do not propose a single definition for MPAs, but explore the full range of spatial management measures and area closures in a broader sense with relevance to fisheries – and generally refer to them as MPAs. For the purposes of this document, **any marine geographical area that is afforded greater protection than the surrounding waters for biodiversity conservation or fisheries management purposes will be considered an MPA.**⁵

⁵ This broad characterization includes very large areas, such as exclusive economic zones (EEZs) at the extreme, but the term MPA is usually understood to apply to areas specifically designated to protect a particular ecosystem, ecosystem component or some other attribute (e.g. historical site).

However, the MPA concept is applied diversely around the world, and with different names for similar policies. MPAs can range from small village-level community-managed areas to large, zoned national parks. The specific rules associated with an MPA vary by context and names are not used consistently. A ‘reserve’ in one country may prohibit fishing, while a ‘reserve’ in another country may allow non-destructive fishing. Other terms used, to name a few, are fully protected marine areas, no-take zones, marine sanctuaries, ocean sanctuaries, marine parks, fishery closed areas, fisheries refugia and locally managed marine areas (LMMAs).

Probably the most widely accepted definitions of MPAs have been the ones established by the International Union for Conservation of Nature (IUCN) and the CBD (Box 2). Other organizations and individual countries have also established definitions of MPAs, with a biodiversity conservation or fisheries management focus (Box 3).

Commonly, there are also different categories of MPAs attached to established definitions. These Guidelines are intended to provide guidance relevant to all of them, especially at the interface between fisheries management and biodiversity conservation. IUCN recognizes six different categories of MPAs, classified according to their objectives and ranging from fully protected areas (no-take zones where no extraction is permitted) to multiple-use areas (where a range of resource uses are allowed) (Table 1).

TABLE 1
IUCN categories of protected areas

Category	Description
I	Protected area managed mainly for science or wilderness protection (Strict Nature Reserve/Wilderness Area)
II	Protected area managed mainly for ecosystem protection and recreation (National Park)
III	Protected area managed mainly for conservation of specific natural features (Natural Monument or Feature)
IV	Protected area managed mainly for conservation through management intervention (Habitat/Species Management Area)
V	Protected area managed mainly for landscape/seascape conservation and recreation (Protected Landscape/Seascape)
VI	Protected area managed mainly for the sustainable use of natural ecosystems (Managed Resource Protection Area)

Sources: IUCN, 1994, and Dudley, 2008.

BOX 2
IUCN and CBD definitions

IUCN has defined an MPA as:

Any area of the intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment (Kelleher, 1999).¹

More recently, a revised definition of a protected area has been provided by IUCN and developed within the WCPA framework.² This definition is applicable to both MPAs and protected areas on land:

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 ad hoc Technical Expert Group associated with the CBD Programme of Work on Marine Biodiversity has adopted a similar definition for marine and coastal protected areas:

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 or coastal biodiversity enjoys a higher level of protection than its surroundings (CBD, 2004a).

¹ IUCN. Resolution 17.38 of the IUCN General Assembly in 1988 (reaffirmed in Resolution 19.46 in 1994).

² The World Commission on Protected Areas (WCPA) is a network of protected-area expertise (for both land and marine environments). It is administered by IUCN's Programme on Protected Areas and has over 1 400 members, spanning 140 countries.

The World Bank has developed a scheme to classify the most common forms of MPAs according to area coverage and degree of protection – from minimal to full protection. The following graph provides a method (based on a review of MPAs by the World Bank) for organizing some of the most common

BOX 3**What is an MPA? – examples of national definitions**

In **Brazil**, there are two main categories of protected areas: (i) areas under total protection (no-take zones) and (ii) areas for sustainable use. The main difference between the two relates to permission to extract natural resources and to live inside their boundaries, which is forbidden in the first category and allowed in the second. Within these two categories, there are different types of no-take and sustainable-use protected areas, each of them with specific objectives.

In the **Philippines**, there is a wide range of terms used for MPAs, which may vary depending on the legislation, designating authority and type and quality of the resources and the intent. However, in practice, a standardized terminology is emerging among policy-makers: MPAs are defined as “any specific marine area which has been reserved by law or other effective means and is governed by specific rules or guidelines to manage activities and protect part of the entire enclosed coastal and marine environment”.

In **Senegal**, the concept of MPAs continues to be the subject of numerous discussions with regard to their objectives, origin, legal status, relevant institutions, and design and implementation approaches. In the legal framework, the role of MPAs has been defined as “protection, on a scientific basis, for current and future generations, of important natural and cultural resources and ecosystems representative of the marine environment”. In practice, MPAs in Senegal have two main characteristics. First, the purpose of MPAs is to contribute to the conservation of marine and coastal biodiversity. Second, an area of particular interest can be designated according to bioecological, territorial or socio-economic considerations and given special management measures for improving conservation, while taking the livelihoods of the resource users into account. Recently, an MPA (Aire du Patrimoine Communautaire Kawawana) was created in the Casamance province on the initiative of a fishers’ association. It was inspired by various international conventions promoting traditional area management by local communities.

In the **United States of America**, the term ‘marine protected areas’ is defined by a Presidential Executive Order as: “any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein”. In practice, MPAs are defined areas where natural or cultural resources are given greater protection than in the surrounding waters. MPAs are applied

(Box 3 cont.)

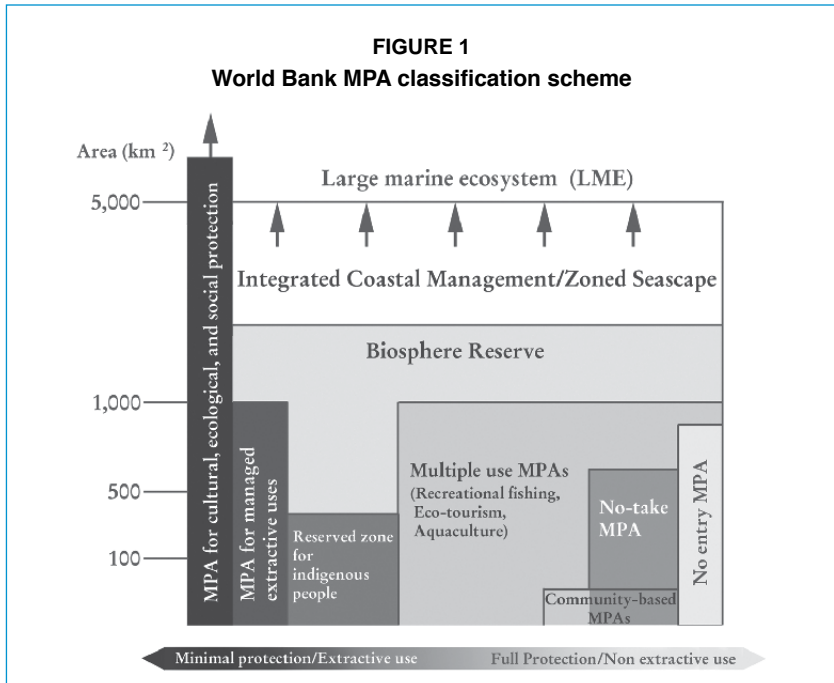
to a range of habitats, and an MPA classification scheme results in a great variation in purpose, legal authorities, management approaches, level of protection and restrictions on human uses.

Sources: Kalikoski and Vasconcellos, (forthcoming); Christie and Eisma-Osorio, (forthcoming); Breuil, (forthcoming); National Marine Protected Areas Center (www.mpa.gov/welcome.html).

forms of MPAs (see Figure 1). Size and degree of environmental or fisheries protection are two important scales influencing MPA effects. According to this, any MPA can be characterized along a gradient of size and protection.

1.2 WHAT ARE THE PRIMARY REASONS FOR ESTABLISHING MPAs?

MPAs are generally designated with biodiversity conservation objectives, to protect fishery resource species or habitat, or with a broader ecosystem purpose



Source: Based on World Bank, 2006.

within the framework of EAF. Within this context, MPAs tend to be conceived and implemented to achieve a subset of a wide variety of potential objectives. A list of examples of objectives for establishing MPAs is provided below:

- rebuilding fish stocks;
- ensuring sustainability of fish stocks and fisheries;
- protection of marine biodiversity and critical habitats;
- support local and traditional sustainable marine-based lifestyles and communities;
- increase resilience to climate and other environmental changes;
- facilitate the resolution of multiple stakeholder conflicts;
- facilitate scientific research, education and recreation;
- protect cultural and archaeological sites.

In addition to these, other indirect objectives could be envisioned:

- generating ‘spin-off’ benefits to the coastal economy, creating opportunities for alternative uses and thereby helping diversify the economy (e.g. through tourism and biodiversity conservation work or recreational fisheries), which in turn can reduce stress on fish stocks;
- provide a hedge against uncertainty, a form of conservation ‘insurance policy’;
- generating non-market values such as ‘indirect’ (or use) values, ‘existence’ (or non-use) values⁶ and option (or future use) values;
- raising awareness of the importance of certain places in supporting fisheries production and biodiversity conservation;
- providing a demonstration of the successful integration of management across sectors and achievement of multiple goals (for instance, maintaining fisheries and conserving biodiversity).

Spatial-temporal fishing closures as a management tool have a long history in fisheries and predate the current concept of MPAs for biodiversity conservation. These may not have been thought of as biodiversity conservation measures, but were established with fishery conservation and improving long term fishery yields in mind. The protection of certain life stages of marine species (e.g. banning of fishing in spawning areas) and of recruits to fish stocks of interest to commercial fisheries (e.g. limiting fishing in areas with high

⁶ Non-use values, also referred to as ‘passive use’ values, are values that are not associated with actual use, or even the option to use a good or service, but with its intrinsic significance for culture, aesthetics, heritage, bequest, etc. ‘Existence value’ is the non-use value that people place on simply knowing that something exists, even if they will never see it or use it.

abundance of juvenile fish) are noted in the preceding list. Similar reasons for establishing MPAs or spatial-temporal fishing closures include:

- protecting a particular habitat important to commercially exploited fish stocks, for example an MPA on a tropical coral reef could be designed to improve reef quality and increase fish biomass;
- protecting depleted stocks and their habitats during the rebuilding phase of a fishery, that is, stopping fishing on stocks that have collapsed, or are close to collapse, to allow the resource to recover;
- potentially protecting genetic structure, that is, through preventing genetic bottlenecks when populations are reduced, maintaining a reserve of diverse age groups and sizes of the target species and of genetically diverse subpopulations (typically through an MPA network) to safeguard genetic traits of the fish population;
- limiting bycatch by closing areas, temporally or permanently, where bycatch and discard rates are high;
- allocating use rights in specific locations in order to reduce competition between user groups or to enhance opportunities for certain groups of users (for example, artisanal or recreational fishers).

Moreover, most MPAs are likely to have consequences for fisheries and fishery resources – even when established without explicit fisheries management objectives in mind. In the same way, it is probable that fisheries spatial management measures will have biodiversity conservation outcomes. As fisheries management is increasingly moving towards EAF, fisheries MPAs with explicitly broader, combined objectives are likely to become more common (MPAs ‘with multiple objectives’). The reasons for establishing MPAs with both fisheries management and biodiversity conservation objectives could be, for example, the protection of habitats, food web integrity and biodiversity, and the reduction of bycatch, discarding and other negative effects on harvested species, endangered species and other species society wants to protect.

Other protected areas have been established without explicit fisheries management or biodiversity conservation objectives. These include military zones and energy production areas, or areas for the protection of cultural and archaeological values, where fishing and other uses are prohibited or limited. These are not addressed in the Guidelines, but could have effects on both biodiversity conservation and fisheries.

The key to success is to be clear about the objectives and potential effects – both with regard to fisheries management and biodiversity conservation – when planning and implementing MPAs. Early involvement of stakeholders

and a participatory process that takes the human dimensions of MPA planning and implementation into account are other prerequisites for achieving the objectives.

1.3 WHAT ARE THE RISKS OF MPAs?

MPAs may well be a compelling tool to use in fisheries and conservation management regimes but they are subject to the same pitfalls and difficulties as any other available tool. Blanket MPA targets with a ‘one size fits all’ approach will not suit all habitat types, objectives and must be treated with caution. Poorly-informed and over-optimistic implementation of MPAs will result in more failures arising from inappropriate use, faulty design, poor implementation or all three. Therefore, the establishment of MPAs must be seen as one of the tools to be considered in the overall goal of achieving sustainable use of oceans. A major risk of excessive emphasis on MPAs alone is that it will, and probably already has in some cases, diverted limited and already over-stretched international, national and local capacity and resources from other priorities and approaches that, in many cases, may have been more effective and appropriate for the problems being addressed (Cochrane, 2006).

In addition, there is a further risk that the designation of an MPA could be seen as goal in its own right, with proponents forgetting that they are just one tool, undoubtedly a potentially useful tool, amongst a number of possible options for achieving sustainable, equitable and optimal use of marine ecosystems. To avoid this, the promotion of careful planning, a basis in sound science, and a focus on management effectiveness must occur in tandem with increased interest in the establishment of MPAs.

MPAs impact both the biological environment and people. The process by which an MPA is planned and implemented greatly influences what benefits and costs it generates and hence its impact. If an MPA is planned and implemented without involving the coastal communities and resource users concerned, and without considering their situations and needs, there is a risk of failure. This could involve several aspects, including a lack of acceptance of the MPA and hence enforcement difficulties, and hardship for those communities and resource users that it affects. With regard to the lack of acceptance, this could, in an extreme case, lead the MPA becoming a ‘paper park’, that is, something that has been formally designated and exists on paper but not in practice, because the relevant provisions and regulations are not respected. Unfortunately, paper parks are common, with estimated rates reaching nearly 80–90 percent in some countries. Lack of community support is a major reason for management

failure, but other factors such as lack of funding and ineffective management also play major roles.

The resource-use restrictions that an MPA implies are likely to affect different groups of people and stakeholders in different ways. When planning an MPA, it is important to ensure that it will not deprive particular groups of their livelihoods without providing alternatives. This is particularly important for coastal MPAs in contexts of poverty or in areas with limited livelihood options. The designation of MPAs needs to be based on a combination of bioecological and socio-economic criteria, ensuring long-term sustainability, but also considering and mitigating short-term costs. The best way to ensure successful MPAs is to use a participatory planning and implementation process.⁷

1.4 WHAT IS AN MPA NETWORK?

An MPA network refers to two or more MPAs that complement each other. IUCN defines an MPA network as “a collection of individual MPAs or reserves operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels designed to meet objectives that a single reserve cannot achieve” (IUCN-WCPA, 2008).

Ecological networks are formed when the natural connections among and within sites enhance ecological functions. In order to enhance the administration and management of ecological networks, social or institutional networks are formed through communication, sharing of results and coordination among institutions. Both types of networks should be considered, social/institutional and ecological, in order to optimize the benefits of a more holistic approach.

The World Wide Fund for Nature (WWF) considers that for a network to be representative, it should afford protection across and within the multiple dimensions of ecosystem complexity (WWF International, [no date]). The CBD has established a number of criteria for a network to be considered representative. These include: (i) biologically and ecologically significant areas; (ii) ‘representativity’; (iii) connectivity; (iv) replicated ecological features; and (v) adequate and viable sites (CBD, 2007). Principles of comprehensiveness, adequacy and representativeness (CAR) are applied to

⁷ The human dimensions of MPAs are discussed further in Chapter 4, and planning and implementation processes in Part 2.

MPA networks in Australia.⁸ A CAR MPA network includes the full range of ecosystems (*comprehensiveness*), maintains viability of species and ecosystems (*adequacy*) and reflects the biodiversity of the ecosystems from which they are derived (*representativeness*). These criteria and principles concern bioecological features and do not cover socio-economic aspects or the human dimensions of the network.

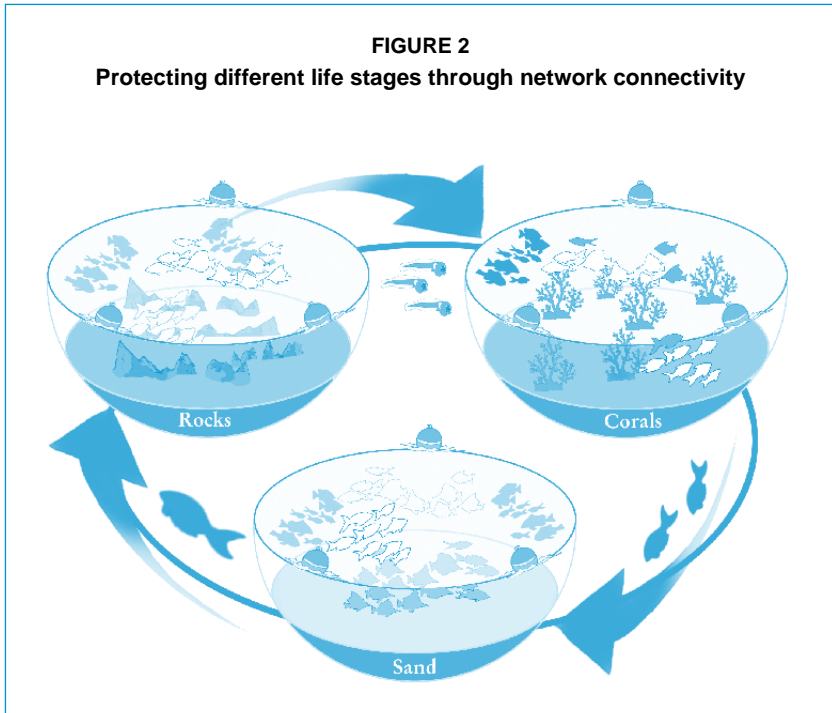
1.5 WHY DO WE NEED MPA NETWORKS?

The marine environment is made up of many geographical spaces with different physical, chemical and biological features, and is populated by communities of marine species that persist through time by interacting across the region. Some fish populations with highly mobile adults may congregate in specific locations for spawning, while others may be more sedentary and restricted to a specific habitat, interacting with neighbouring fish populations and marine communities through mobile larvae. Networking adds the potential benefit of MPAs supporting each other through connections between them (see Figure 2). Such connections could be currents transporting fish eggs and larvae, thus potentially adding to more-sustainable fish populations. Networks may act synergistically relative to a single MPA. Thus the whole is greater than the sum of the parts when a network of MPAs:

- takes advantage of the heterogeneous distribution of a fishery resource, habitat and important biodiversity areas to afford more protection than would be possible using a single MPA of the same size;
- protects various areas of particular importance to a fish population, such as spawning grounds and nursery areas; or
- potentially protects genetic structure through maintaining a reserve of genetically diverse subpopulations to safeguard genetic traits of the fish population.

MPA networks may involve zoning, in which different areas can have diverse levels of protection. Multiple MPAs in an area can be flexible with regard to which activities are allowed in which areas (no-take areas, fishing with certain types of gear, recreational fisheries, etc.), while still having common fisheries management and biodiversity conservation objectives.

⁸ The Government of Australia's MPA site can be accessed at www.environment.gov.au/coasts/mpa.



A network of smaller MPAs may have more flexibility to mitigate undesirable social impacts than a single large MPA. The protective benefits of MPAs, as well as the costs incurred through access and usage limitations, are often more easily distributed among coastal communities and other user groups of marine ecosystems in an MPA network than in a large, single MPA. It may also offer opportunities to spread costs and disadvantages across multiple communities, rather than concentrating them in one community – as could be the case with a single large MPA. This could be particularly relevant in tropical developing countries, where the entire coastal zone is being exploited by the communities located along that coast.

Fishers may benefit more from a network than from a single MPA if it increases the number of adult fish that migrate across the boundaries of the protected areas (the spillover effect that makes fish available to fisheries). This is a result of the normally greater amount of boundary per unit area protected than in a single MPA. It will, however, increase the vulnerability of fish

resources, and the appropriate balance between protection and spillover should be sought. Thus MPA networks must be designed with the mobility of the targeted fish species in mind, to ensure that an appropriate level of protection is afforded to the fish moving across the MPAs in the network. If a network is made up of MPAs that are too small, they may offer very little or no protection for adults of mobile species. In addition, unless an MPA is large enough to retain some of its pelagic eggs and/or larvae, it is not self sustaining.

An MPA network can also operate in a social sense by fostering shared management responsibilities, common management policies, economic efficiencies and learning opportunities. It can strengthen the governance of individual MPAs by providing common rules and sharing of knowledge and experience. On the other hand, if it is too large and stretches across a very broad spectrum of administrative layers and structures, it may become difficult to govern.

An additional potential benefit of a network of MPAs rather than a single (presumably larger) MPA, is that the network may be more resilient to a wide range of threats. A network can provide extra robustness to local disasters, such as an oil spill, or to a management failure. If the network spreads protection over a broad geographical area and along a gradient of climatic regimes, it may provide more resilience to climate change than would a concentration of MPA protection in one or a few places.

MPA networks in relation to fisheries management are discussed further in the subsequent chapters on the effects of MPAs.

KEY CONCLUSIONS AND RECOMMENDATIONS No. 1

With a view to facilitating understanding of the purpose of MPAs and MPA networks and their effects, the meaning and characteristics of this conservation and management tool must be clearly defined within a particular context. In spite of its popularity and frequent use in international fora, there is no universal definition of the term MPA. It may be necessary to define different types of MPAs according to local needs and circumstances.

- ◆ Clear terminology will facilitate understanding of the MPA and related concepts. For the purpose of these Guidelines, an MPA is any marine geographical area that is afforded greater protection than the surrounding waters for biodiversity conservation or fisheries management objectives. These Guidelines consider all types of MPAs, including no-take areas and areas with sustainable use arrangements.
- ◆ MPAs are established with a variety of objectives. Moreover, in most cases, they will produce cross-sectoral outcomes, some of which may be undesired, even when not designated for multiple objectives. The main objectives for establishing an MPA should be clearly defined, and the likely additional impacts, positive/negative social effects and other unintended effects must also be identified and considered. The process by which an MPA is planned and implemented greatly influences its outcome. Applying a participatory approach involving concerned resource users and other stakeholders is fundamental for successful MPA planning and implementation.
- ◆ MPA networks are composed of two or more MPAs that are linked in diverse ways (e.g. biological or institutional) and complement each other. If properly designed, they may offer benefits over single MPAs.

2. FISHERIES MANAGEMENT AND THE ECOSYSTEM APPROACH TO FISHERIES (EAF)

In relation to fisheries management, MPAs have variously been characterized as a new name for spatial-temporal fishing closures and as a necessary new approach to replace fisheries management measures that have failed. Worldwide recognition is given to the need to take a broader, integrated ecosystem approach to fisheries management, including both environmental and human dimensions. Approaches such as EAF are increasingly being promoted. But what are fisheries management and EAF, and what role do MPAs and area closures play in this context?

This chapter discusses some of these important concepts and how MPAs and MPA networks relate to them. It also offers an introductory consideration of how they can bridge pure fisheries management and biodiversity conservation objectives. Subsequent chapters will look more specifically at the effects of MPAs on the biological, ecological and human dimensions of fisheries.

The Code of Conduct for Responsible Fisheries emphasizes that fisheries management shall promote maintenance of the quality, diversity and availability of fishery resources and that management measures shall also take wider ecosystem considerations into account.

2.1 WHAT IS FISHERIES MANAGEMENT?

The FAO Technical Guidelines on Fisheries Management series defines fisheries management as the “integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and accomplishment of other fisheries objectives” (FAO, 1997, p. 7).

Fisheries management aims to achieve the optimal and sustainable utilization of the fishery resource for the benefit of humanity, while maintaining biodiversity. Biodiversity is an integral part of ensuring future generations the

same choices for resource use that current generations are allowed – and hence an important aspect of sustainable fisheries management.

Conventional fisheries management is largely informed by scientific information, which is used to develop the rules under which a fishery operates to ensure its sustainability. Management approaches using sources of information such as indigenous and local knowledge are also increasingly being applied.

Fisheries management generally regulates fishers' use of fishery resources by controlling the fish mortality generated by the fishery. Fish mortality is a way of expressing the fraction of the fish population removed by the fishery annually. Typically, management is directed towards maintaining fish stock abundance and a size and age structure that give the maximum average yield or catch sustainable over the long term. This is achieved through various management rules and regulations aimed at controlling, either directly or indirectly, the level of fish mortality for different size or age groups of the population. This is sometimes summarized as maximum sustainable yield (MSY). When regulating the use of fishery resources, economic efficiency and the social dimensions of the fishery must also be factored into management analysis.

Many types of fisheries management tools exist, including:

- Input controls: access controls and fishing effort limits (e.g. restrictions on the number of boats/licenses, gear or trips);
- Output controls: catch limits such as total allowable catch (TAC) quotas;
- Technical measures: restrictions on the size of fish that can be caught or retained, or gear restrictions;
- Spatial-temporal measures: zoning and area-time-gear type closures.

Successful fisheries management is not simply the result of applying rules and regulations to control how much, where, when and how fishers fish. Indeed short-term input or output controls (be they spatial, temporal, or gear-based) are best considered as complementary measures. The fundamental issue is to develop fisheries management arrangements that capture the social and economic forces that allow and motivate fishers to operate efficiently and flexibly within the limits of resource and ecosystem sustainability. This means, in one way or another, fisheries management needs to be premised on providing fishers with secure tenure systems and addressing the management of fishing capacity through proper incentives.⁹

⁹ To address the issue of overcapacity in world fisheries, an International Plan of Action (IPOA) for the management of fishing capacity was agreed in 1999. See also FAO, 2008c.

Fisheries management arrangements can be implemented under various governance systems. While centralized, state-controlled command-and-control systems are still common, there has been a trend towards increasingly decentralized fisheries management during the last decades. Various forms of co-management governance systems are applied in many parts of the world, based on partnerships between governments and resource users with shared responsibility and authority for fisheries management.¹⁰ These governance systems are often combined with rights-based approaches to fisheries management, that is, property rights in the form of access or management rights are allocated to individuals, groups of individuals or communities¹¹ (e.g. individual transferable quotas [ITQs], days at sea allocations, community access quotas, or territorial use rights in fisheries [TURFs]).

In spite of the availability of a variety of fisheries management tools, many fishery resources are in a precarious state due to overfishing and, in the case of some coastal and diadromous species,¹² environmental degradation. Fisheries management fails for many reasons. Common causes are the open-access nature of fishery resources, insufficient capacity to apply and enforce appropriate management systems, and subsidies. In addition, an increased understanding of the interactions among diverse ecosystem components has led to a growing recognition of the need to manage fisheries in a broader environmental perspective. The scope of fisheries management has widened in recent years to consider aspects beyond the abundance, size and age structure of the target fishery resource. The principles for and approach to effective, integrated and responsible fisheries management contained in the CCRF reflect this wider scope and thus also relate to EAF.

2.2 WHAT IS THE ECOSYSTEM APPROACH TO FISHERIES?

EAF¹³ has evolved based on an appreciation of the interactions that take place between fisheries and ecosystems, taken in a broader perspective. The purpose of an EAF is “to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services

¹⁰ See also Part 2, Chapter 6, Section 6.8, “What are the key MPA design considerations?”

¹¹ See Glossary, “Use, management and property rights”.

¹² Fish that migrate from fresh water to salt water, or vice versa.

¹³ For more information on EAF, see FAO, 2003a, 2003b and 2009a. It should also be noted that there are several approaches similar to EAF applied by diverse organizations and countries (see Glossary, “Ecosystem approach [EA]”).

provided by the aquatic ecosystems” (FAO, 2009a, p. 6). Accordingly, fisheries management according to EAF “strives to balance diverse societal objectives by taking account of the knowledge and uncertainties of biotic, abiotic and human components of ecosystems and their interactions, and applying an integrated approach to fisheries within ecologically meaningful boundaries” (FAO, 2003a, 14). Thus EAF requires the inclusion in the management paradigm of interactions between the core of the fishery – fish and fishers – and the other elements of the ecosystem, including the human system relevant to management (see Figure 3).

EAF is closely linked to other approaches in the field of development, natural resource and spatial area management, for example the sustainable livelihoods approach and integrated management. These approaches are complementary to EAF and, indeed, there is a substantial overlap in terms of their underlying principles, philosophy and methods. MPAs and other spatial management tools can support EAF, while EAF, in turn, can be used as a management approach to implementing an MPA. EAF represents a more explicit bridging mechanism between fisheries management and biodiversity conservation, bringing together bioecological and human considerations.

It should be remembered that EAF is still an evolving practice and, at least in the short term, will be an extension of the current approach to fisheries management. The evolution is occurring now: today’s fisheries management captures more of the elements of an ecosystem approach than it did a decade ago, but less than will be captured a decade from now. The pace at which this is happening varies in different parts of the world and in diverse situations, but conventional fisheries management is changing shape. It should also be noted that EAF does not replace or diminish the need to assess and control fish mortality on target and bycatch species in order to sustain fisheries, nor the need to control fishing capacity in order to avoid economic waste.

When referring to fisheries management in the Guidelines, this situation of evolution is generally intended, and the term ‘fisheries management’ implies fisheries management as it is developing with EAF (even when EAF is not explicitly mentioned).

2.3 WHAT ABOUT THE PRECAUTIONARY APPROACH?

The precautionary approach is a basic principle of the CCRF, involving the application of prudent foresight in dealing with uncertainties in fisheries systems. It implies the explicit consideration of possible undesirable outcomes and the inclusion of appropriate contingency and mitigation measures.

FIGURE 3
Moving towards EAF – examples of the shifting focus



Source: Based on FAO 2009a.

Undesirable outcomes include not only overexploitation of fishery resources and negative environmental consequences, but also unacceptable social and economic consequences. Hence, both long-term and short-term costs and benefits are involved and should be considered in the adoption of the precautionary approach.

Because uncertainty can be expected to be greater when widening fisheries management to include ecosystem considerations, the precautionary approach frequently gains even greater importance within EAF. One objective in establishing MPAs can be to provide a hedge against such uncertainty, constituting a sort of ‘conservation insurance’.¹⁴ At the same time, there is the possibility that an expanded ecosystem focus can help explain trends in fish stocks and hence contribute to less uncertainty.

2.4 HOW ARE MPAs AND OTHER SPATIAL MANAGEMENT TOOLS USED IN FISHERIES MANAGEMENT?

Definition of space is a fundamental concept in fisheries management, applying to management units with geographical specifications that – to the extent practicable – correspond to the geographical range of the fishery being managed. At the largest scale, the international regime of oceans is based on defined areas as set out in the United Nations Convention on the Law of the Sea (UNCLOS).¹⁵ These include the EEZ – within which a coastal state has sovereign rights and responsibilities with regard to, inter alia, fisheries management – and the high seas and the Area¹⁶ – beyond national jurisdiction. There are international and regional agreements regulating certain aspects of marine areas beyond the limits of national jurisdiction, as well as of some areas cutting across these and EEZs or parts of EEZs.

Some states apply zoning in their EEZs as a basic measure for directing where different types of fishing or other activities may take place. A typical example is a coastal area reserved for small-scale or artisanal fishing only, banning larger fishing vessels and trawlers. Closures (spatial-temporal-gear or spatial-temporal-fishing types) are one of the oldest forms of fisheries management. Some common reasons for establishing such measures were

¹⁴ See also Chapter 3, Section 3.4, “How do MPAs work as a hedge against uncertainty?”

¹⁵ The United Nations Convention on the Law of the Sea of 10 December 1982 is the fundamental instrument establishing international regimes for the oceans. Institutional and legal aspects of MPAs are discussed further in Part 2, Chapter 5.

¹⁶ See Glossary.

given in Chapter 1, section 1.2, “What are the primary reasons for establishing MPAs?”.

Box 4 gives examples of various fisheries management measures based on the zoning and spatial considerations used in India.

Certain allocations of use rights, such as the TURFs mentioned earlier, are also area-specific, and the management objective here is to allocate use rights in specific locations in order to reduce competition among user groups, to enhance opportunities for certain groups of users or to improve management and compliance with fisheries rules and regulations by providing users with increased responsibility for and authority over fishery resources (see example from Chile in Box 5).

With the move of fisheries management towards EAF – that is, a broader conception of ecosystem well-being – the use of spatial management tools will probably become more prevalent. In line with the principles of EAF, it is likely that it will become more common to designate and implement MPAs with multiple objectives, covering both fisheries management and biodiversity conservation considerations.

2.5 IN WHAT SITUATIONS ARE MPAs USEFUL AS A FISHERIES MANAGEMENT TOOL?

MPAs should not be viewed as a solution for all fisheries management problems. They do not address key issues for the overall management of the area beyond the boundary of an MPA. Nor do they redress past unsuccessful fisheries management that has, in many cases, led to overcapacity, overfishing and economic loss. Moreover, if MPAs were to be used as the sole mechanism for limiting the amount of fish to be caught, with a view to sustaining fish populations, the extent of the area to be protected might be unrealistically large, particularly for mobile fish species, even if successful in meeting ecological objectives, the approach would waste a large portion of potential economic benefits. In many circumstances, MPAs will be inferior to an appropriate mix of other fisheries management tools in terms of the combined protection offered, potential yield and economic performance, as long as these tools are effectively implemented.

With the move towards an ecosystem approach in the management of the world’s oceans, however, MPAs can be a very useful component within the fisheries management toolbox. In several situations, there is a need for a greater consideration of MPAs as a main management measure, although the best results may still be achieved with a combination of fisheries and

BOX 4**Use of various fisheries management tools in India**

Countries use different approaches to fisheries management as well as different sets of fisheries management tools within those approaches. These depend on numerous factors, for example the types of fisheries and resources, and the preferred governance approach and political reality of the country. This MPA case study has made the following information on India available:

Fisheries management is undertaken mainly through licensing, prohibitions on certain fishing gear, regulations on mesh size and establishment of closed seasons and areas. Under the Marine Fishing Regulation Acts (MFRA), zones are demarcated by each state based on distance from the shoreline (from 5 to 10 kilometres [km]) or on depth. These inshore zones, where trawling and other forms of mechanized fishing are not permitted, are perhaps the most important spatial fisheries management measure in place. The closed season or 'monsoon fishing ban' is another important spatial-temporal management measure. It is implemented on both the east and west coasts of India for a period of 47 days and 65 days, respectively, during what is considered to be the spawning and breeding season.

Several state-specific management measures exist. In Orissa, for example, fishing regulations have been adopted by the State Fisheries Department, under the MFRA, to restrict and regulate fishing activities in territorial waters. Regulations also protect the nesting and breeding grounds of turtles, both within and outside the Gahirmatha (Marine) Wildlife Sanctuary, through designation of 'no-fishing' and 'no-trawling' areas. There is also a mandatory requirement under the MFRA in some states that trawlers use turtle excluder devices (TEDs).

It is important to draw attention to certain fisheries management initiatives of local fishing communities that are 'space-based'. Communities living along the coast often have a spatial perception of their 'rights', in which fishing by outsiders or the use of certain gear is regulated. Traditional fishing communities on the shores of Pulicat Lake, Tamil Nadu, practise a rotational system of access to resources, called the padu system, that serves to reduce conflicts and the pressure on resources. In coastal areas of Kerala, a similar system of rotational access to resources is practised that defines the group of rights holders, resource boundaries and fishing sites. However, these systems of self-governance are not legally recognized for management purposes in India.

Source: Ramya (in press).

BOX 5**Areas for Management and Exploitation of Benthic Resources (AMEBR) in Chile**

The Chilean Fisheries and Aquaculture General Law provides for the establishment of different types of special areas as part of fisheries management. Areas for Management and Exploitation of Benthic¹ Resources (AMEBR) are areas that aim to ensure sustainable use of marine resources by assigning territorial use rights to legally recognized artisanal fisheries organizations. This has become a common management tool and is adopted by most such organizations in Chile.

AMEBRs can only be established within five nautical miles of the shore and in inland areas (rivers and lakes). The average surface area is 190 ha and the number of fishers involved nationwide is approximately 16 500 of a total number of about 52 000 artisanal fishers in Chile. In order to be granted an AMEBR, a community must constitute a legal organization (e.g. artisanal fishers' association or fishers' cooperative). Establishing an AMEBR involves extensive consultations among government organizations and local communities to assess feasibility. Based on these consultations – and assuming there are no conflicts with other users – exclusive use rights to the area can be granted to the association or cooperative and a management plan developed. The plan must be approved by the Under-Secretariat for Fisheries, and thereafter the National Fisheries Service can establish an 'agreement of use' with the fisheries' organization for a period of four years.

In addition to the provisions of the Fisheries and Aquaculture General Law, the management plan of an AMEBR specifies a set of actions to ensure the sustainable management of the fishery. The fishers themselves control the fishing area, generally through establishment of a control committee. Government authorities monitor that the provisions of the management plan are followed. The fishers' organization might lose the exclusive right to manage the area if actual exploitation is in violation of the management plan.

Source: FAO, 2007a.

¹ 'Benthic' refers to organisms that live on or in the seabed.

ecosystem management tools. Multiple tools are available for achieving fisheries objectives and these should be selected and balanced within the relevant policy and management frameworks.

Used wisely, MPAs can generate both bioecological and socio-economic benefits. However, not all MPAs have the same benefits, which will depend on the specific local circumstances (both natural and human), the type of MPA and the protection it offers, and legal and governance attributes. In coastal areas where local communities are directly affected by the declaration of MPAs, it is particularly important to involve communities as early in the process as possible. In situations where complete or partial closure of the fishery is required, long-term sustainable alternative livelihood options should be identified and developed in consultation with the affected communities. Where the benefits of MPAs accrue elsewhere or could be gained by other stakeholders, mechanisms must be established to ensure that benefits (economic and sociocultural) flow directly back to the community, guided by the principle of equitable benefit-sharing and internalization of costs and benefits.

Within this context, some situations in which MPAs can be useful in fisheries management and can create sustainable benefits include:

Controlling fish mortality of sedentary species in data-poor situations

For fisheries targeting relatively small stocks of sedentary fish or invertebrate species (i.e. organisms whose movements are short-range), MPAs can be an effective management tool. The use of an MPA as a tool for controlling fish mortality does not require a reliable estimate of population size, as do some alternative management tools (e.g. TACs). For this reason MPAs can be particularly useful in some data-poor contexts. MPAs may also be useful in situations where the capacity to implement other forms of management is lacking. However, establishing effective MPAs would still require effective enforcement as well as reliable information on population distribution densities and habitat preferences.

Assisting management of multispecies fisheries

It may be difficult to manage a multispecies fishery with numerous species-specific rules and regulations, particularly if information is limited on a large number of species. In this case, MPAs might afford protection to assemblages of species associated with particular types of habitat. A combination of species-

specific management measures and MPAs to protect multiple species may be a useful approach.

Minimizing bycatch

The places and seasons in which bycatch occurs are generally reasonably consistent from year to year and thus can be predicted. Experienced fishers know where and when to expect large amounts of bycatch. They usually want to avoid unwanted bycatch because they recognize it as wasteful, and it creates additional work in sorting the catch. However, there are many cases in which both the retained bycatch and discarded bycatch are abundant, in which case, fishers may consider discards an acceptable ‘cost’. Nevertheless, MPAs may be an effective fisheries management tool for addressing a bycatch problem if they are located in areas and seasons of high bycatch and discards.

Protecting habitat and biodiversity

The unintended effects of fisheries on habitat and biodiversity have become a greater concern in recent years. Habitat changes potentially have an adverse effect on the future productivity of fisheries (e.g. loss of shelter of juvenile fish from predators). In addition, habitat and biodiversity protection are often desirable in relation to the direct and indirect services such preservation provides to society, regardless of its effect on fish productivity and fisheries, and MPAs may be used to protect areas of particular concern in terms of habitat and biodiversity.

Buffering against uncertainty

MPAs may be used in combination with other fisheries management tools as a hedge against uncertainty to make management more robust. In case conventional management fails – due, for example, to assessment errors – MPAs can provide a buffer against the consequences of failure. However, the effectiveness of the MPA in the context of fisheries management – for example the degree to which it achieves its objective to sustain fish populations – will be dependent on its design and the characteristics of the fish populations being protected. Knowledge of these characteristics will be essential for an adequate design, but crucial processes such as larval dispersal patterns, for example, are generally poorly known.¹⁷

¹⁷ See also Chapter 3, Section 3.5, “How do MPAs work as a hedge against uncertainty?”

Delegating management responsibilities or tasks

In certain areas, co-management arrangements¹⁸ provide a way to share the management burden between government and local communities or users. MPAs can circumscribe the area in which this divestment of management responsibility or management tasks can be accomplished. Such tasks include patrolling and surveillance; monitoring (and sometimes even scientific research); maintenance of buoys, signage and other controls; enforcement; and public outreach and education associated with fisheries management and biodiversity conservation. The benefits of co-management approaches include increased participation of stakeholders, empowerment of local communities and users through participatory management, and a lightening of the burden of management for the government.

Protecting traditional and cultural use rights and practices

Although it is often assumed that MPAs will be in conflict with the rights and traditional practices of indigenous peoples, formal protected areas can provide a mechanism for recognizing and protecting traditional fishing grounds and places of cultural importance and practices. In some cases, indigenous peoples may need support in having such areas and practices protected from external threat. The CBD encourages “the establishment of protected areas that benefit indigenous and local communities, including by respecting, preserving and maintaining their traditional knowledge” (CBD, 2004b). A joint policy statement to this effect has been issued by IUCN, WCPA and WWF (Principles and Guidelines on Indigenous and Traditional Peoples and Protected Areas), calling for “the development of policies for protected areas that safeguard the interests of indigenous peoples, and take into account customary practices ...”.¹⁹ When indigenous communities are concerned about the conservation and maintenance of traditional and customary practices, MPAs can be employed to protect customary use rights and practices, as well to achieve fisheries management and biodiversity conservation objectives. The involvement of the indigenous peoples concerned in the planning and implementation of the MPA will be critical to its success.

¹⁸ See above and also Chapter 6, Section 6.8, “What are the key MPA design considerations?” in Part 2.

¹⁹ Available at http://assets.panda.org/downloads/pa_princguide_en.pdf.

Protecting and enhancing local livelihoods

The declaration of MPAs in coastal areas where local communities depend on marine resources for food and income is often associated with negative impacts and the loss of livelihoods. In other instances, however, the declaration of MPAs can lead to the protection of small-scale fishing areas (for example, demarcation of an exclusive coastal area for small-scale fishers) and enhancement of local livelihoods where fishery resources recover and catches improve over time, in the MPA and in surrounding waters.

Resolving user conflicts

In areas where user conflicts occur, zoning through the establishment of MPAs with different use patterns can help resolve such conflicts. In this way, diverse user groups can be assigned different areas for their activities. These use rights can be combined with delegation of responsibilities (see also “Delegating management responsibilities or tasks” above).

2.6 HOW CAN MPAs BE USED TO BRIDGE FISHERIES MANAGEMENT AND BIODIVERSITY CONSERVATION?

MPAs will generally have both biodiversity conservation and fisheries outcomes, whether or not they have been established explicitly for both purposes. To date, however, the entities using MPAs for the purpose of biodiversity conservation have often worked independently from fisheries managers, who look to MPAs to supplement conventional fisheries management. But there is great potential in having these approaches planned in concert, or at least in ways in which they can complement one another. Bridging the two worlds not only eliminates duplication of effort and overlap (and possible conflicts that arise from overlapping initiatives), but can also lead to enhanced efficacy of management. Biodiversity conservation is vital to fisheries management, especially so when it is implemented according to EAF. At the same time, fisheries management considerations are critical in effectively conserving biodiversity.

However, the two objectives can be viewed differently by diverse groups of people, and reconciling these priorities can be difficult. The goals and objectives of an MPA are established by individuals and institutions, and many MPAs address biological, socio-economic and governance needs. Strong conservation objectives, that is, focusing on maintaining biodiversity through protecting areas from most human interventions, and yield maximization for fisheries management purposes can be contradictory.

To gain maximum benefit, both the fisheries management and biodiversity conservation effects must be considered and taken into account in MPA planning and implementation processes, which requires appropriate processes. MPAs should be considered in a wider perspective, and planning and implementing them in a holistic and integrated spatial management framework is the ideal. The need for integrated coherent management frameworks is discussed further in Chapter 5 in Part 2.

KEY CONCLUSIONS AND RECOMMENDATIONS No. 2

MPAs and MPA networks can constitute an important management tool, especially for achieving both biodiversity conservation and direct fisheries management objectives. However, there are many management options in addition to MPAs that may produce better effects. The management context needs to be understood and combinations of appropriate measures implemented accordingly.

- ◆ Fisheries management aims to achieve optimal sustainable utilization of fishery resources, generally focusing on limiting fish mortality to sustainable levels, while also taking broader ecosystem considerations into account. EAF expands the conventional fisheries management framework to explicitly consider a wider range of aspects of the fishery and its ecosystem, including its human dimensions.
- ◆ A precautionary approach to the management of marine resources should be adopted, promoting the use of the best tools and measures available according to defined objectives and case-specific circumstances.
- ◆ Spatial-temporal-gear closures are historically some of the most common fisheries management measures. In the broadened context of EAF, it is likely that spatial management measures and MPAs with multiple objectives, for example for fisheries management and biodiversity conservation, will increase in importance.
- ◆ MPAs are not always the preferred management measure, but can be very useful in a number of contexts, e.g. for fisheries targeting relatively small stocks of sedentary fish or invertebrate species, in some data-poor contexts and for addressing bycatch problems when in discrete areas or specific seasons. For MPAs to generate maximum benefit, stakeholders must be involved.
- ◆ MPAs will generally have both biodiversity conservation and direct fisheries management outcomes, whether or not they have been established for both these purposes explicitly. To gain the most benefits, the two concepts need to be bridged when planning and implementing MPAs.

3. BIOLOGICAL AND ECOLOGICAL EFFECTS OF MPAs IN A FISHERIES CONTEXT

The effects of MPAs and MPA networks on fishery resources, ecosystems and people depend on a variety of factors, including where they are located, how big they are, how many there are, the nature of protection within the MPA (is all fishing prohibited or only fishing with some gears?), and the movement of the fish species (at all life stages) across MPA boundaries. It is also important to consider activities occurring outside the MPA itself.

This chapter examines how MPAs work with respect to bioecological systems and fish yield. There will also be indirect biological and ecological effects of MPAs, depending on how humans, especially fishers, react to the establishment of an MPA and the related management framework. The human dimensions of MPAs and their effects are discussed in the next chapter.

The Code of Conduct for Responsible Fisheries states that appropriate fisheries management measures should be adopted for the long-term sustainability of fishery resources. Fishing capacity and effort should be commensurate with the productive capacity of the resources, and measures should be taken to rehabilitate fish populations when required. Resource users should safeguard aquatic ecosystems and protect habitats from negative outcomes.

3.1 WHAT ARE THE KEY FACTORS THAT DETERMINE THE EFFECTS OF AN MPA OR MPA NETWORK?

Some key factors determining the protective effects of MPAs on fishery resources include:

- The *location* of an MPA determines what it protects. The more concentrated the fishery resources, habitat or biodiversity in the MPA location, the more protection the MPA provides. Conversely, placing an MPA where there are fewer organisms to protect provides proportionally less protective benefit. The networking benefits of

MPAs are also determined by the location of MPAs relative to each other (their connectivity).²⁰

- The *size* of an MPA and the *number* of MPAs in a network – and the *total area* they cover – are other factors determining their effect. Obviously, the larger the total area protected, the greater the protective benefit, all other factors being equal. What is less obvious is the relative effect of a single MPA compared with multiple MPAs of the same total area. For species that are immobile (except for drifting eggs and larvae) a single MPA can sustain a population if it is large enough for a sufficient number of drifting eggs and larvae produced in the MPA to settle within its boundaries. Multiple independent or unconnected MPAs of the same total size will be less able to sustain a population. However, if the smaller MPAs are connected (larvae drift between them), they may be better at sustaining a population.
- The *nature of protection* in an MPA determines the effect on species and habitats. MPAs that prohibit all human extractive activity within their boundaries will provide greater conservation benefit than MPAs that allow some activity, such as fishing with certain gears or for specific species. From a fisheries point of view, the local context and the nature of the activities allowed – or not allowed – will determine the effects on diverse subcategories of the fishery resources and on fishers.
- The effectiveness of MPAs is also determined by *the movement of animals* in and out of MPAs. Less movement means more protection for the species or population within the MPA. However, MPAs may benefit populations and fisheries beyond their borders by exporting eggs and larvae to support recruitment outside MPAs (although there is little evidence of this benefit), and by migration of legal-sized individuals, so that they can add to the fishery resources outside MPAs (the ‘spillover’ effect; see section 3.2).
- Even with complete protection inside an MPA, benefits may be jeopardized by *activities outside the MPA*. The greater the fishing pressure on stock outside MPA boundaries, the larger the portion of stock protected by MPAs must be to sustain the resources being fished. Also, activities outside MPAs that degrade habitat and water quality may undermine the effectiveness of MPAs (e.g. because water

²⁰ See also Section 3.4, “What happens in MPA networks with regard to sustaining fish populations and supporting fishing yields?”

quality will not honour MPA boundaries). The effects of the MPA are conditioned by the effectiveness of management of all human activities, including fisheries, outside of the MPA.

While some factors listed are beyond management control, others are part of MPA design and implementation decisions. A monitoring system tracking environmental changes, production (biomass, number and size of individuals) and user satisfaction will inform managers as to how MPA management could be changed to improve its effects. Such changes generally concern the boundaries of the MPA, zoning within it, and its rules and regulations including its relation to fisheries management measures or regulations in the wider area where it is located.²¹

3.2 WHAT HAPPENS TO FISH AND THEIR ECOSYSTEMS WITHIN MPAs?

One of the most common types of indicators of the effect of MPAs, and the one for which there is the most empirical evidence, concerns the biological response within MPAs, such as the density, biomass and size of animals. There is substantial scientific evidence that, when designed appropriately, there are more fish and bigger fish, with a higher biomass, inside MPAs than outside (Box 6). It appears that the increases are greatest for higher trophic levels and for species with greater body size. It is reasonable to expect that these

BOX 6 Effects on biomass

One study of MPA effects on biomass summarizes results from 69 no-take MPAs by comparing measurements within MPAs to the same areas before the MPAs were established, or to reference areas presumed to be ecologically comparable except for protection from fishing. The results indicate on average a 91 percent increase in the density (number per unit area) of fish and a 192 percent increase in biomass (weight per unit area). The greater increase in biomass than in density implies an increase in mean size of organisms, which the study estimated to be 31 percent on average.

Source: Halpern, 2003.

²¹ MPA monitoring systems and adaptive management are discussed in Chapter 7 in Part 2.

effects would be greater for species with limited mobility, but conclusions are inconclusive because of limitations of the available data.

Sustainability of fish populations

MPAs contribute to sustaining a population by allowing animals within MPAs to mature and spawn, thus increasing the reproductive output of populations above what it would have been under fishing pressure. If enough of a population is afforded protection in an MPA – that is, the MPA contains a sufficiently large number of individuals – the population should persist regardless of the intensity of fishing outside the MPA.

For a population to be self-sustaining in this way, a single MPA must be large enough to ensure that sufficient eggs and larvae survive within the boundaries of the MPA. In contrast, a network of smaller MPAs could provide protection to spawning aggregations in one MPA and juveniles in a second MPA that receives eggs and larvae from the first. In the case of mobile species, the extent of the area contained in an MPA will have to be large to sustain the population, particularly if fishing intensity outside the MPA is high. MPAs can also have positive effects on fish populations not targeted by fisheries. If fishing is restricted through MPAs in areas where bycatch is an issue, the reduced fishing effort on bycatch species can support the sustainability of these fish populations.

Prohibiting fishing in areas where fish concentrate reduces the fish mortality per unit of fishing effort, and as long as fishing effort does not increase outside the MPA, fish mortality can be decreased. The issue of controlling fishing effort outside the MPA so that displacement of effort does not compromise the outcomes of the MPA is discussed in the next chapter.²²

Preserving genetic diversity

There is value in a fish population being genetically diverse, although the benefits are difficult to quantify. Fishing may influence the biological characteristics passed on from one fish generation to the next. It usually targets larger fish, and removing these favours reproduction by younger (and smaller) fish, a trait that can be inherited and can eventually lead to overall smaller fish. Keeping a reservoir of larger fish can counteract this trend. Moreover, genetic variation may provide higher resilience against changing environmental conditions, for

²² See Chapter 4, Section 4.5, “How are MPAs likely to affect fishers’ behaviour, fishing effort and fishing capacity?”

example some individuals in a fish population may grow well in warmer water and others better at colder temperatures. If fishing reduces the longevity of a fish population considerably, some of these variations may be lost. An MPA can help preserve genetically diverse subpopulations within its boundaries if other solutions providing wider protection of habitat diversity cannot be applied.

Effects on habitats and biodiversity

There is irrefutable evidence of the alteration of some types of habitat by fishing. Some heavy, mobile bottom-fishing gear (e.g. beam trawls and otter trawls) alter habitats if used in sensitive areas, and particularly damage habitat-forming communities such as cold and warm coral reefs and seagrass beds. The indirect effects that these alterations may have on fish populations include reduction in productivity as a result of loss of shelter from predators or of habitats critical to spawning. Empirical evidence of the effects on populations tends to be limited to nearshore populations such as those dependent on wetlands, riverine systems and tropical coral reefs, but this may be mostly due to lack of data from other areas. Many factors in addition to fishing affect these nearshore areas.

MPAs can protect habitats within their boundaries, and there is evidence that they can also facilitate recovery of certain disturbed habitats (Box 7). However, intensification of fishing outside MPAs as a reaction to the implementation of the MPA may adversely affect habitats outside MPAs, even as habitat inside recovers, potentially offsetting the benefits of the protected area. MPA implementation thus needs to be accompanied by complementary fisheries management measures.²³

A project to assess recovery after earlier experimental, intensive repeated trawling on the Great Barrier Reef (northeast Australia) used video recordings to document changes in the seabed habitat fauna. Selected areas were trawled repeatedly in 1995 and then resurveyed by video camera on four occasions over the following five years. There was apparent recovery for all 20 species analysed in the study (and for the multispecies composition of the assemblages). However, recovery rates varied greatly, and the predicted time frame for recovery of large benthos was more than five years, for some up to many decades.

A review of published studies on the effects of MPAs on biodiversity documents an average increase in the number of species inside MPAs by

²³ Ibid.

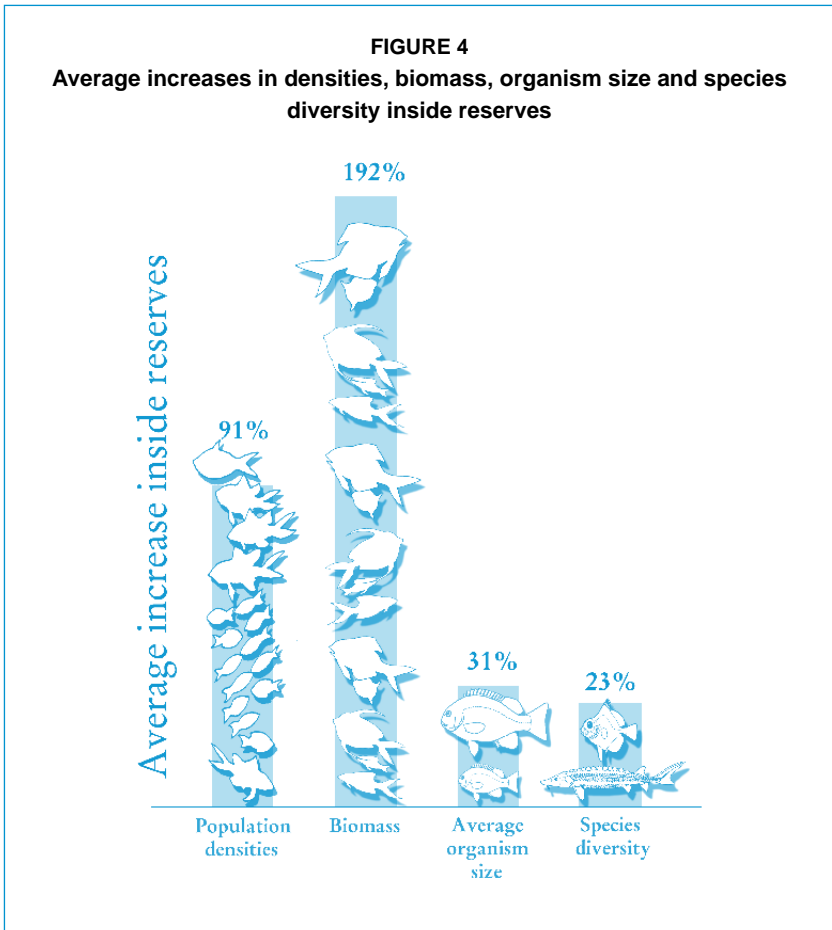
BOX 7**Recovery of benthic fauna on Georges Bank (United States) and in the Great Barrier Reef area (Australia)**

Marine protected areas that prohibit the types of fishing (such as mobile bottom-fishing) that damage habitats of concern and habitat-forming species (such as corals and sponges) are an obvious form of effective management. They can also result in the recovery of habitat that has previously been damaged by fishing. For example, changes in benthic habitat have been documented in protected areas on **Georges Bank** (northeastern United States) five years after closure to fishing by mobile bottom gear. There was a significant shift in species composition and in benthic fauna cover, and an increase in abundance (number of organisms in samples) by a factor of 4, in biomass by a factor of 18, and in production by a factor of 4. The greater increase in weight (biomass) than in numbers indicates that the mean size of organisms has increased. Evidence of recovery is clear, although changes in the functional value of the habitat are not well documented or understood.

A project to assess recovery after earlier experimental, intensive repeated trawling on the **Great Barrier Reef** (northeast Australia) used video recordings to document changes in the seabed habitat fauna. Selected areas were trawled repeatedly in 1995 and then resurveyed by video camera on four occasions over the following five years. There was apparent recovery for all 20 species analysed in the study (and for the multispecies composition of the assemblages). However, recovery rates varied greatly, and the predicted time frame for recovery of large benthos was more than five years, for some up to many decades.

Sources: Collie *et al.*, 2005; Pitcher *et al.*, 2008.

23 percent (Halpern, 2003; see Figure 4). Also, if the MPA provides a sanctuary for rare species, or species low in numbers, which then disperse outside the MPA as their abundance increases, it will increase biodiversity outside the MPA. However, estimates of species richness are sensitive to sampling intensity and exact measurements of changes are difficult to make. While it seems reasonable to expect an increase in species richness within MPAs, careful experimental design to demonstrate this type of MPA effect will be required.



Source: Botsford *et al.*, 2006; Halpern, 2003.

3.3 HOW DO MPAs AFFECT FISHERY PRODUCTION OUTSIDE THEIR BOUNDARIES AND CAN THEY CONTROL FISH MORTALITY?

MPAs may contribute to higher fishery production by their effect on the amount of fishery resource available to fisheries outside the MPA. As was seen previously, this may happen in two ways: improved recruitment and the spillover effect:

- Increased reproduction within an MPA can result in increased recruitment to the population external to the MPA and consequently an increase in the number of fish available to the fishery(ies). The evidence that this occurs is limited and ambiguous, although it is reasonable to expect that it may occur in some instances.
- Fish afforded protection by MPAs grow within the areas and some of them (unless they are sedentary species that lack mobility) spill over beyond MPA boundaries and become available to fisheries.

While there is evidence that the spillover of animals from MPAs to the area around them can contribute to yield from fisheries (see examples in Box 8), in most cases there is little empirical evidence indicating that these increases make up for the loss of fishing area within MPAs (i.e. that there is a net gain as a result of spillover from MPAs). However, one example of where this was demonstrated was a recent study that discussed an increase in number combined with an increase in biomass of lobsters (*Palinurus elephas*) within an MPA in the Mediterranean which more than compensated for the loss of fishing area in the location studied (Goñi *et al.*, 2010).

Modelling studies²⁴ exist that address the potential sustainable yield using MPAs as a fisheries management tool – compared with other conventional management tools, such as setting TACs or using other measures to control fish mortality. Some of these studies indicate, under the assumptions made in the models, that the potential number of fish caught sustainably can be the same for management using MPAs or conventional fisheries management. However, the models also show that conventional fisheries management would result in 10–50 percent more yield in weight than management that relies solely on MPAs to control fish mortality (again, depending on model assumptions).

Moreover, the elimination of fish mortality on a portion of the population (within MPAs) means that, to maintain yields, fish mortality on the remainder of the population (outside MPAs) must be higher than it would need to be with conventional fisheries management, resulting in a lower catch per unit of effort (CPUE) and a higher cost per unit of catch for a lower total yield.

Understanding how resource users may respond to area-based management such as an MPA is key, not only to impact assessment, but may have important implications for MPA design. Closing or restricting access to a particular area, like an MPA, will most likely cause resource users to displace their activities

²⁴ See, for example, NRC, 2001; Hastings and Botsford, 1999; and Hilborn, Micheli and De Leo, 2006.

BOX 8
Examples of spillover effects

An example of empirical evidence of the spillover effect for one MPA and the fisheries concerned is the experience of the **Apo Island Marine Reserve** in the Philippines. The fishery benefits that have developed from the reserve over the last 20 years include “higher catch rates, less fishing effort, and enhancement or at least maintenance of total catch of Acanthuridae and Carangidae”. Spillover is thought to occur outside the Apo Reserve for several reasons: the biomass of two main species increased closer to the reserve more than it did farther away; catch per unit effort of Acanthuridae was significantly higher closer to the reserve; and the percentage of these two main species in fisheries catch increased from 42.5 percent in 1980/81 to 73.5 percent in 2000/01, showing a change in the pattern of fishing by fishers, who no longer needed to travel far from the island.

On the **west coast of Hawaii**, a network of fish replenishment areas (FRAs) was designated in 1999. The FRAs were primarily established to help resolve conflicts between different resource users – aquarium fishers and dive tour operators – but have also proved to have a spillover effect on populations of yellow tang, the main target species for aquarium fish collectors. Researchers have found that while the densities of yellow tang were similar in all areas before the closures, the closed areas had five times the density of target-sized fish in 2007. Spillover effects were noted in boundary areas (open areas within one kilometre of an FRA boundary), with significantly higher densities of adult yellow tang than in open areas further away. The number of aquarium fishers along the coast has doubled between 1999 and 2007 and total yellow tang catches have increased. This increased exploitation has led to a considerable decrease in juvenile fish in open areas – which is the size targeted by fishers – but the availability of reproductive adults supports the population and appears to constitute a buffer against overexploitation.

Sources: Williams et al., 2009; Russ et al., 2004.

to a second-choice fishing area. These issues are further discussed in the next chapter on the social and economic impact of MPAs.²⁵

²⁵ See Chapter 4, Section 4.5, “How are MPAs likely to affect fishers’ behaviour, fishing effort and fishing capacity?”.

3.4 WHAT HAPPENS IN MPA NETWORKS WITH REGARD TO SUSTAINING FISH POPULATIONS AND SUPPORTING FISHING YIELDS?

Some marine populations, due to their life histories and exchange rates with other communities, exist with only limited – but important – interactions across regions, resulting in heterogeneous populations. Other species have higher levels of interaction that result in a more homogenous marine community across a region. Matching the migration capacity to regional oceanographic processes facilitates understanding of how marine populations function. If these types of interactions can be determined, then creating a network that offers protection to communities with significant links may be important in sustaining populations.

The life cycle of many species involves stages that include production of eggs and larvae, dispersal, settlement and growth before the individuals themselves reproduce. Different factors affect mortality at each stage of the life cycle and often life stages take place in different areas or habitats. The nursery area for a particular species, for example, may be in a sandy area with eelgrass, while the adult stage may occur over a coral reef, and spawning in yet another type of habitat. Thus MPA networks can constitute a useful method to protect species at their various life stages by providing protection for different areas or types of habitat.

MPA networks can be useful when a large amount of space must be covered by using many smaller MPAs, rather than one large one. This could potentially provide protection for various subpopulations in order to increase resilience.

The networks could potentially have positive effects on fishing yields where spillover is thought to occur due to the larger boundary area available for fishing – and hence access to animals that move across the boundary. This could be beneficial to fishers and their communities, as the costs and benefits are likely to be spread across a wider group of stakeholders, but high spillover means lower protection, so an appropriate balance needs to be sought.

The implementation of MPA networks is only just starting to yield evidence of the effects on regional fish populations. Notwithstanding the limited number of scientific publications in this area, the use of networks is likely to provide a complementary management tool for sedentary targeted species, for specific life stages of more mobile species and for the preservation of ecosystem function. For mobile species, in particular, the use of conventional fisheries management measures (i.e. quotas or effort limits, gear restrictions, limits with regard to the size of fish landed, etc.) will be required.

3.5 HOW DO MPAs WORK AS A HEDGE AGAINST UNCERTAINTY?

Depending on the particular circumstances, MPAs can provide a buffer against the failure of other fisheries management measures. They may be less susceptible to the inherent imprecision of resource assessments, although it is still necessary to know enough about the spatial distribution of fishery resources and their movements to effectively design MPAs for fisheries management purposes. In some cases, they may be more easily enforced than other forms of fisheries management.

In terms of the effectiveness of MPAs as a hedge against failure of conventional management, hypothetical models demonstrate that MPAs could be effective in controlling fish mortality. However, this required protection, in these examples, of an unrealistically large portion of the area inhabited by a species (i.e. at least 50 percent and much more as management uncertainty increases) (Lauck *et al.*, 1998). A study using a model for Icelandic cod demonstrated that combining catch quotas with a large MPA effectively reduced the risk of stock collapse, while simultaneously maintaining a reasonably high yield (Stefansson and Rosenberg, 2005). However, the best performance was still achieved by simply setting the target fish mortality rate low.

Fish and animal distribution patterns change over time, particularly in a world experiencing unprecedented global climate change. Thus an MPA established today that provides enough protection to sustain a population, may be inadequate later as climate changes and populations shift. In addition, the effectiveness of MPAs as a tool to sustain a population may be more susceptible to disasters, such as an oil spill, than conventional fisheries management, which protects a population over a larger geographical area. A network of MPAs that spreads protection over a broad geographical area and along a gradient of climatic regimes may be more robust to climate change and disasters than MPA protection concentrated in one or a few places. For sedentary species with sporadic recruitment events in both time and space, rotating area closures can be used to protect concentrations of recent recruits until they grow to the optimal size for harvesting. This requires close monitoring of recruitment events but the benefits may be worth it (Hart and Rago, 2006; Williams *et al.*, 2006).

KEY CONCLUSIONS AND RECOMMENDATIONS No. 3

MPAs and MPA networks have biological and ecological effects both within and outside their boundaries. Many aspects of the potential effects on fishery resources and fish populations are not clearly understood, and in most cases MPAs should not be the sole fisheries management tool, but one that complements other, more conventional measures.

- ◆ The protective effects inside an MPA or MPA network will depend on a number of factors, including MPA location, size and number (in a network), the nature of protection, movement of animals in and out of the protected area(s), and activities outside the MPA. Inside MPAs, it is likely or possible that there will be more and bigger animals of some species, more reproductive output – potentially sustaining fish populations – preservation of genetic diversity, protection of habitats, increases in biodiversity and reduction of bycatch and discards.
- ◆ Outside MPAs, the potential positive effects include spillover of animals and dispersal of fish eggs and larvae from within MPAs. MPAs may contribute to higher fishery production by making this spillover available to catch and by an increase in reproductive output, contributing to recruitment to the fishery. However, there is little evidence that there is a net gain in yield compared to the situation without MPAs. Available information indicates that management of fisheries using solely MPA spatial approaches results in a lower potential yield than if the fishery is regulated by conventional fisheries management. Likely negative effects include an increase in fishing pressure outside the MPA, and high costs per unit of catch.
- ◆ Experience of the effects of MPA networks on fish populations is limited, but they are likely to constitute a useful management tool for sedentary target species, specific life stages of species and preservation of ecosystem functions.
- ◆ Combining MPAs with other fisheries management tools will probably make fisheries management more robust to uncertainty and management failures. However, relying solely on MPAs as a fisheries management tool may require protection of unrealistically large areas and lead to appreciably lower total yields and higher costs than are potentially achieved by conventional management.

4. SOCIAL AND ECONOMIC IMPACT: THE HUMAN DIMENSIONS OF MPAs

The previous chapter discussed biological and ecological effects of MPAs and MPA networks in a fisheries context. MPAs also create positive and negative socio-economic impacts and will affect different groups of resource users in different ways, depending on how they are planned, designed and implemented, and according to the case-specific context. All management measures – for fisheries management and for biodiversity conservation – are about directing and influencing human behaviour. Thus this behaviour needs to be understood. Stakeholder involvement is crucial, and MPA objectives, to be successful, must reflect a balance between scientific, social and economic needs and realities.

This chapter looks into the social and economic effects of MPAs and how the human response may affect their outcomes. The institutional, legal and policy frameworks needed to support MPA planning and implementation – ensuring that processes are integrated and holistic and taking both the bioecological and human dimensions into consideration – are discussed in Part 2.

The Code of Conduct for Responsible Fisheries establishes that fisheries management and biodiversity conservation decisions should take relevant economic and social factors into consideration and recognize the important contributions of artisanal and small-scale fishers to employment, income and food security.

4.1 WHAT ARE THE SOCIO-ECONOMIC BENEFITS ASSOCIATED WITH MPAs?

MPAs can lead to both positive and negative socio-economic outcomes. These effects can be both direct and indirect and include impacts on incomes, livelihood opportunities, migration, cultural habits and ecosystem services. Some positive effects may only be apparent in the longer term, and special efforts to address or mitigate potential negative impacts are often needed so as not to undermine benefits. Diverse sectors and stakeholder groups may be affected in different ways. Depending on the local circumstances and the

design of the MPA, commercial, artisanal and recreational fishers, the tourism sector, shore-based industries, biodiversity conservation interests and others will not gain the same benefits or bear the same costs.

Well-designed MPAs that are planned through a participatory process and use the best available information can offer important benefits to specific user groups and local communities, in addition to longer-term benefits to governments and to the common good. The biological and ecological benefits discussed in the previous chapter provide valuable ecosystem services – mostly within MPAs, but sometimes beyond them as well. Such benefits include maintenance of or increase in fisheries productivity, maintenance of biodiversity and stock structure and protection of habitats. MPA establishment can also spur economic development or poverty reduction if the revenues generated from visitor use or payment for environmental services (PES)²⁶ are funnelled back to local communities. In some cases, MPAs are used to gain certification for fisheries products, adding value to those fisheries and increasing profit margins for fishers.

MPAs can also empower marginalized communities or user groups, especially if co-management arrangements exist.²⁷ Similarly, drawing stakeholders into MPA planning processes can create opportunities for better government and civil society engagement in general. In areas where traditional uses are at risk, MPAs can safeguard them, as well as areas of cultural importance. From a governance perspective, multiple-use MPAs can provide a demonstration of how to effectively integrate management across sectors (and bridge the worlds of fisheries management and biodiversity conservation). Finally, MPAs – by flagging the special value of specific places – can be used to generate political will for more-effective marine management in general.²⁸

4.2 WHAT ARE THE KEY SOCIO-ECONOMIC CHALLENGES WHEN ESTABLISHING MPAs CLOSE TO FISHERY-DEPENDENT COASTAL COMMUNITIES?

MPAs relatively close to the coast can either help or hurt the local people and communities. Diverse groups within a community or within the fisheries sector may be affected in different ways. For example, resource users that have

²⁶ See Box 27 in Chapter 7. See also Chapter 7, Section 7.9, “How can long-term political commitment and sustainable resourcing for MPAs be addressed?” in Part 2.

²⁷ See also Chapter 6, Section 6.8, “What are the key MPA design considerations?” in Part 2.

²⁸ See also Chapter 2, Section 2.5, “In what situations are MPAs useful as a fisheries management tool?”

relatively high economic mobility (such as large-scale fleets that can move their fishing operations to other areas) are affected differently from small-scale fishers, who may be dependent on nearby fishery resources. Subsistence or traditional fishers, depending on fishing for their livelihoods, are more vulnerable to restrictions in resource access than recreational fishers. When certain fishing activities continue to be allowed (e.g. with small-scale passive gear), while others are prohibited (e.g. trawling), there may be a significant reallocation of benefits among diverse groups of fishers.

An important distributional issue for MPAs is that the benefits tend to be diffuse while costs are concentrated. A potential cost to the fisher is that catch (and revenues) may be decreased, at least in the short term, as a result of the implementation of a closure. Coastal communities adjacent to the MPA, especially those with a high economic dependence on the fishery, may face a disproportionate impact as a result of aggregate reduction in fishing revenue. On the other hand, they could also potentially capture most of the benefits in the form of reduced variations in aggregate catch levels, increased total catches or more valuable larger-sized fish catches owing to spillover effects. Such benefits may not occur immediately, although there are cases in which the biological response – and hence the socio-economic impact – is quite rapid. Examples include coral reef MPAs or where the establishment of an MPA limits the use of destructive fishing methods.

The MPA can also lead to changes in the local economy, providing unexpected opportunities. New types of visitors can lead to diversification of the local economy through businesses, jobs, and income and tax revenues. Potential increases in revenue from these visitors could eventually offset immediate losses to fishers due to the MPA, and could contribute to building a sustainable local economy less dependent on an uncertain fishery resource. MPAs can reduce potential conflicts between fishers and other users by providing areas in which non-fishery users can pursue non-consumptive uses of the resource. MPAs may also alter migration patterns by restructuring economic opportunities, drawing people to local communities in the case of some reserves and displacing them from adjacent communities in others. These shifting migration patterns frequently change the demographic profile of user groups and coastal communities.

The way costs and benefits are distributed will depend on the particular circumstances and the way the MPA has been designed – including access and tenure arrangements. Resource reallocation can be an explicit objective of the MPA. By prohibiting or limiting certain activities and regulating access to a protected area, benefits and costs among diverse resource users

are redistributed and the interests of, for example, traditional or small-scale fishers can be protected.²⁹ If the benefits are likely to be generated only in the longer term for certain groups of fishers or other community members, it is important to combine resource management with the promotion of livelihood opportunities that provide economic benefits in the short run to address any economic disruptions to the individual or household. However, the local context must be considered, as viable alternative livelihoods are not always feasible or not socially and culturally desirable.

4.3 WHAT ARE THE SOCIO-ECONOMIC IMPLICATIONS OF DESIGNATING MPAs IN A POVERTY CONTEXT?

Implementing MPAs in fishery-dependent communities requires a very good understanding of the local situation. The livelihoods of stakeholders may be vulnerable to changes, in particular if poverty is an issue. Research suggests variation in the social impacts of MPAs on four principal dimensions of poverty: wealth, health, political empowerment and education (Mascia, 2004). With respect to wealth, MPA establishment generally induces shifts in resource access and use and hence has – as mentioned earlier – a reallocation effect within and among stakeholder groups. For those gaining preferential resource access, MPA establishment tends to result in increases in income, food security and material assets, while those losing access may suffer corresponding losses or have to adopt mitigation strategies by shifting resource-use patterns or livelihood strategies.

Resource users engaged in mobile forms of use have greater flexibility to respond to shifting marine resource governance regimes (such as MPAs), and are therefore better able to mitigate negative outcomes and to capture benefits. Poor, small-scale fishers are often at the end of the scale, with limited powers to adapt satisfactorily. If the MPA implies a significantly reduced area available for fishing, this may result – at least in the short term – in higher levels of congestion, or fishers may be forced to travel to other, sometimes more distant, fishing grounds. The effects could be higher fuel, labour and other operating costs and a potential increase in capital expenditures in the fishery (e.g. the need for larger boats and engines and new technology, such as the Global Positioning System [GPS]). This could increase the hardships on local fishers, especially the poorest among them. Moreover, shifts in fishing grounds and travel time as a result of the MPA may potentially result in increased occupational risks to

²⁹ Ibid.

fishers. The combination of inadequate vessels and lack of experience of the displaced fishers in operating in the new environments poses the potential of greater occupational risks.

MPA design in a poverty context needs to take these circumstances into account and to ensure that poorer stakeholder groups are not negatively affected. This could include securing resource-use rights for specific groups of fishers, or researching alternative or supplementary livelihood opportunities.

The social impact of MPAs on health, political empowerment and education would generally follow shifts in patterns of access to fishery resources. However, variation (spatial, temporal and across MPAs) in the magnitude and extent of these social impacts remains largely unexamined and unexplained, highlighting the need for further study to better understand MPAs in relation to poverty reduction.

4.4 HOW ARE MPAs PERCEIVED BY FISHERS AND OTHER STAKEHOLDERS?

Whether fishers support or oppose MPAs depends on their perception of the risks and opportunities, and on the process by which MPAs are introduced, designed and managed. Although there are many instances of fishers establishing MPAs or seeking help in doing so, either as a way to establish preferential use rights (i.e. reduce competition with 'outside' fishers), to catalyse transition out of a fishing economy (through tourism) or to protect habitats or marine resources that they feel are in peril, fishers more often than not oppose the establishment of MPAs. This is due to the issues discussed earlier, as well as to fishers' experience with past management measures, their natural antagonism towards and suspicion of managers and regulators, and their concerns about resource-use rights and access reallocation. Any management measure is, rightly or wrongly, often perceived by fishers as being costly to them by limiting their ability to fish and earn a living. Any proposal to restrict use of the sea, as is also true on land, will always be controversial. Perceptions of MPAs are shaped and reshaped into many forms by diverse stakeholder groups, and they are often difficult to change once positions have been established.

Communication about the purpose and intent of the MPA must be clear, transparent and presented early in the process, so that any misperceptions can be addressed. The different perspectives of individuals and local groups should be understood and considered. If people, individually or as a group, feel that they have not been part of the decision-making process of the MPA, and have not been able to actively participate in and influence the process, it will be difficult to

BOX 9**Impacts of MPAs on livelihoods – the Hangberg case study, South Africa**

The community of Hangberg is situated above Hout Bay harbour, in the Cape Town municipal area, adjacent to the Table Mountain National Park MPA. In 1950, Hout Bay was zoned as a white residential suburb under the Group Areas Act 41, while the harbour was reserved for so-called 'coloured' occupation. This marginalized harbour community became known as Hangberg, and many traditional fishers continue to live there today. Harvesting of west coast rock lobster (*Jasus lalandii*) has taken place for centuries in this area, with strong customary use rights evolving from the nineteenth century. The fishery was embedded in the social, cultural and political context of the community, but was significantly affected by the export-oriented focus of the commercial industry. With increased government restrictions on access to the lobster resource from the early- to mid-1900s, customary fishing practices were severely limited. Nevertheless, traditional fishing continued, often illegally, as a means to supply food and basic income. Thus the Hangberg community has been identified by the authorities and the commercial industry as a problem area, due to perceived high levels of illegal fishing or poaching. This is particularly evident in the Karbonkelberg Sanctuary, which is a no-take zone adjacent to the fishing community.

However, research conducted among the Hangberg fishers paints a different picture, one that highlights the injustice of being excluded from their traditional fishing grounds. Although the Table Mountain National Park MPA was only promulgated in 2004, designation of the Karbonkelberg Sanctuary simply reinforced an existing Hout Bay lobster sanctuary, which was declared a no-take zone in 1934, and all fishing was prohibited within the sanctuary zones.

Creation of this MPA in 2004 entrenched the original lobster sanctuary and completely ignored the historical rights of the Hangberg fishers to access marine resources in order to secure a livelihood. Given that these fishers use rudimentary rowing boats, most without an engine, it is extremely difficult for them to access fishing grounds outside the sanctuary.

The fishers' sense of injustice is further exacerbated by the fact that commercial vessels are permitted to harvest lobster in the Karbonkelberg Sanctuary during March of every year. The commercial fishery is allocated a research quota of 30 tons per annum, which is seen as a critical source of scientific data for monitoring lobster growth rates. While scientists argue that

(Box 9 cont.)

this experimental fishery is not suited to small-scale fishers' gear due to the location of tagged lobster in waters deeper than 30 metres (m), the Hangberg fishers have never been consulted about this fishery. Further, the fishers express anger and frustration that they are entirely excluded from any form of access to the sea adjacent to them, while they witness the extraction of lobster by holders of commercial rights. The response of the fishery authority, however, is to enhance law enforcement efforts and to address poaching by administering fines and confiscating boats, gear, bait and catches.

Source: Sowman *et al.*, 2010.

obtain support and compliance (Box 9). The process by which MPAs are planned and implemented can thus influence people's perceptions and support.

4.5 HOW ARE MPAs LIKELY TO AFFECT FISHERS' BEHAVIOUR, FISHING EFFORT AND FISHING CAPACITY?

When new management measures such as MPAs are introduced, fishers will adapt their behaviour to sustain or maximize their share of potential benefits. Closing fishing completely (or partially with regard to time and gear) by establishing an MPA is likely to displace fishing effort to areas outside the MPA if there is no other change in fisheries management to prevent it. As a result, the effect on the fish population through decreased fish mortality within MPAs may be offset by increased fish mortality outside the protected area, particularly for mobile species moving in and out of the MPA. Intensified fishing outside the MPA could also potentially have other negative effects, for example on habitats or non-target species. Moreover, as noted above,³⁰ MPAs may lead to lower CPUE when fishing effort is displaced, and the cost of fishing will thus be increased. To effectively sustain fish populations and achieve other objectives, such effects on fishing and the likely behavioural change of fishers must be understood and accounted for in management. Optimally, the MPA should be accompanied by management or other measures restricting effort or catch in the whole fishery area (Box 10). For example, this could include quotas or limitations on access by restrictive licensing or, potentially, properly

³⁰ See Chapter 3, Section 3.3, "How do MPAs affect fishery production outside their boundaries and can they control fish mortality?"

BOX 10**Changes in fishing patterns in the Baltic cod fishery**

A study looked into fishers' responses and the effects of spatial-temporal fishing closures in the Baltic Sea, introduced during 1997–2005, to protect cod stock. The study found that fishing effort displacements contributed to poor performance of the established MPAs. Based on logbook information and interviews with Swedish fishers, the study suggested that the MPA policy might have contributed considerably to increased discarding of juvenile cod by displacing effort to areas dominated by smaller fish. Swedish fishers also felt that the MPAs intensified competition between various fleet segments, and that they were unfairly treated by the fishing closures compared with fishers from other countries. They declared that they would favour seasonal fishing bans or effective effort control measures (limited days at sea) instead of spatially restricting MPAs. Such measures would be more effective and affect all fishers more equally.

Source: Suuronen, Jounela and Tschernij, 2010.

designed buy-out schemes (noting, however, that there are many examples of schemes that have been ineffective in reducing capacity in the long term).

If no additional management measures are introduced and if the MPA is a no-take zone (i.e. no fishing is allowed), its effect on fishing capacity is generally neutral; capacity – and fishing effort – is just reallocated in space. When displacement leads to lower returns in the short and medium term, further investment in fishing capacity will not be encouraged. In the longer term, investment may occur if spillover effects are very positive. In the case of MPAs in which certain types of fishing continue to be permitted (for example, small-scale fishing vessels using passive gear), further investment is likely to occur in the small-scale fleet, unless restricted by other management measures. This would be particularly likely if there are actual or perceived increased catches or larger fish giving higher returns.

Statistical or mathematic modelling techniques have been used to predict the likely reactions of fishers to the establishment of area closures, with some promising results. These models can assist managers analyse the likely effect on effort patterns of the introduction of MPAs and the possible need of complementary management measures, like overall effort reductions (see

BOX 11**Modeling effort displacement from marine protected areas**

Economic models of fishing location choice have received considerable attention particularly in assessing recreational fishing demand, but have been adapted to commercial fisheries as well. Simply put, fishers are presumed to be attracted to specific locations based on its attributes. For recreational fishers these may include catch rates, visual amenities, and distance from a launch site. In commercial fisheries the primary site attribute is assumed to be expected profit. Changing the available sites permits evaluation of the economic impact of losing preferred fishing locations and predicts which alternative locations may be most likely to be affected. Empirical applications of fishing location choice have used either statistical or math programming approaches where the former has received the majority of attention. Statistical models have been used to explore economic incentives to change fishing locations (Dupont, 1993), closures to reduce sea turtle interactions in longline fisheries (Curtis and McConnell, 2004), and time/ area closures for Stellar sea lion habitat protection (Berman, 2006). Although less commonly used, math programming approaches have been the primary analytical tool for evaluating management effects in the New England groundfish fishery. Since 1994, the groundfish fishery has been managed through effort controls in terms of days at sea. Over time, the portfolio of management controls has expanded to include trip limits and combinations of seasonal and year-round closures. The economic model that has been developed to evaluate the suite of control measures in the groundfish fishery has been used to assess the biological and economic impacts of fishery management alternatives including area closures as well as to inform managers on which areas to close and for how long.

Source: Provided by Eric Thunberg and John Walden, NOAA Northeast Fisheries Science Center.

Box 11). The need to monitor fish mortality outside MPAs is discussed in Part 2.³¹

³¹ See Chapter 7, Section 7.7, “How are MPAs monitored and what is management effectiveness?” in Part 2.

4.6 WHAT ARE THE SOCIAL AND ECONOMIC ADVANTAGES OF MPA NETWORKS OVER SINGLE MPAs?

When MPAs are established and fishing restrictions introduced near where people live in coastal communities, the design of a single MPA could potentially be difficult, as each community will be differentially affected in relation to the distance from the protected area and its dependence on the affected fishery resources. Acquiring community support is likely to be facilitated if the benefits and costs of the MPA for the affected fishing communities are as evenly distributed as possible. An MPA network can more easily achieve this goal than a single MPA.

The ability to modify the location of an MPA with minimal loss of effectiveness is also a major benefit of implementing a network. If a site that initially was included in a proposed MPA network is found to be an important fishing ground, it could possibly be excluded and other areas selected for protection instead. A single MPA solution is likely to lack this flexibility.

Fishers may prefer several small MPAs to one large one, as this would provide more boundaries along which to fish to capture potential spillover from the closed areas. Several smaller MPAs may also allow easier, faster and more flexible transit to and from still-open fishing grounds. Complex networks with many boundaries may, however, be more difficult to enforce, and they require more resources for monitoring, control and surveillance (MCS).

4.7 WHY ARE THE HUMAN DIMENSIONS OF MPAs SO IMPORTANT?

As with other management measures, MPAs attempt to regulate human behaviour – for the benefit of humans themselves and of the environment. This can only be done successfully if the human dimensions are understood and taken into account. People have different views and values, and participatory approaches are needed for successful MPA planning and implementation. The process by which an MPA is designated is key to whether it will be accepted, respected and hence able to provide the benefits for which it has been established and to meet its objectives.

MPAs are designated with a variety of objectives, with biodiversity conservation often being a main one. International commitments have been made to designate MPAs, such as the WSSD-POI target to establish representative MPA networks by 2012, for safeguarding biodiversity, protecting marine ecosystems and promoting sustainable development. This international MPA movement takes place through multiple avenues, but not always within a broader, reconciled framework. If these efforts are to result in effective MPAs,

this issue must be resolved. There is a need to bridge fisheries management and biodiversity conservation, to see MPAs as a management tool with multiple objectives and to take both bioecological and socio-economic dimensions explicitly into consideration.

MPA planning and implementation processes must consider the human dimension and be supported by enabling policies, institutional structures and legal arrangements. In Part 2, the first chapter discusses these requirements and how MPAs should be embedded within broader management frameworks.

KEY CONCLUSIONS AND RECOMMENDATIONS No. 4

MPAs and MPA networks have social and economic impacts affecting different stakeholder groups in different ways. Successful MPA planning and implementation must build on an understanding of these impacts and how fishers and others will react to the MPA designation and its management rules and regulations. To be successful, it is crucial to take both the environmental and human dimensions into account when planning and implementing MPAs and MPA networks.

- ◆ MPAs will directly and indirectly affect people. These socio-economic impacts include effects on income, livelihood opportunities, migration and cultural habits, as well as on ecosystem services. Well-designed MPAs can offer important benefits, both to the environment and to the people concerned.
- ◆ MPAs serve as resource reallocation mechanisms and it is important to understand their distributional impact over time and among diverse stakeholder groups. This is particularly important in fishery-dependent communities or a poverty context. Vulnerable stakeholder groups should be supported, and undesirable socio-economic impacts should be addressed early in the planning process.
- ◆ To gain acceptance and support for MPA designations, effective communication and stakeholder participation strategies are important. MPA planners and managers should work closely with stakeholders to consider the different perspectives of individuals and local groups.
- ◆ Fishers' behaviour and the effects of MPAs on fishing pattern, effort and capacity have to be understood. MPAs generally must be supported by other fisheries management measures outside the protected area itself, in order to avoid displacement of fishing effort or other effects that may cancel the positive effects of closure.
- ◆ An MPA network can be more flexible than a single MPA when it comes to distributing costs and benefits. It can also help manage risk, both with regard to threats to biological and ecological values and to socio-economic benefits, but enforcement may be more difficult.
- ◆ The human dimensions of MPAs cannot be ignored, as management is about directing human behaviour. Successful MPA planning and implementation requires people-oriented processes and approaches as well as enabling policy and institutional and legal frameworks.