# EXPERIENCES IN THE USE OF MARINE PROTECTED AREAS WITH FISHERIES MANAGEMENT OBJECTIVES - A REVIEW OF CASE STUDIES

**by**

*Kirsten Martin, Melita A. Samoilys, Andrew K. Hurd, and Carl Gustaf Lundin*[1]

**A report for the Food and Agricultural Organization of the United Nations**
**May 2006**

## Summary

Global fish stocks are in decline and associated habitats are being damaged at an alarming rate, both within Exclusive Economic Zones (EEZs) of states and increasingly also in areas beyond national jurisdiction. To date, conventional fisheries management approaches have typically focused on managing single species rather than maintaining the health of marine ecosystems – the basis for current and future production. However, current management theory and practice clearly point towards implementation of "an ecosystem approach to fisheries that strives to balance diverse societal objectives by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions..." (Garcia & Cochrane, 2005). The concept of an ecosystem approach to fisheries management has gained ground in a number of international fora and its elements are now engrained in several international agreements and guidelines (e.g. the United Nations Fish Stocks Agreement, FAO Code of Conduct for Responsible Fisheries). Similarly, several global commitments have been made to establish marine protected areas (MPAs) and representative networks. In recent years, MPAs are increasingly being considered as an important tool for achieving an ecosystem approach to fisheries management.

MPAs are a flexible tool encompassing a range of management options, from smaller, strictly protected no-take reserves to larger, zoned multiple use areas where different activities are carefully managed. Their objectives and characteristics may vary but should, importantly, be clearly defined. MPAs may be viewed as a complement to other fisheries management tools and integrated with sustainable management practices over the wider marine environment. They must be carefully planned and designed in order to achieve realistically defined goals.

Worldwide experience with MPAs provides a number of useful lessons and case studies. The seven case studies described in this paper illustrate different success features with which MPAs can support fisheries management objectives, and they point out challenges and limitations of this potential according to the respective setting. Some key 'ingredients' are extracted from their lessons learnt. They broadly refer to MPA designation and stakeholder processes, to the legal and institutional frameworks, and to management aspects for sustaining MPA benefits.

Overall, a thorough case-to-case assessment and further empirical evidence is needed to define MPA benefits and limitations for managing the diverse array of fisheries around the world. There is broad international consensus of recognizing the potential of MPAs as a fisheries management tool for some tropical demersal fisheries, while MPA benefits for sub-tropical/cold water and pelagic fisheries are still less understood and need to be fully explored. The aim of this paper is to move one step closer towards the identification of the role of MPAs for fisheries management, through a desk review of MPA case studies from a range of different scenarios, as well as a brief analysis of the literature.

---

[1] The views expressed in this paper are solely those of the authors, Kirsten Martin, Melita A. Samoilys, Andrew K. Hurd, and Carl Gustaf Lundin, all IUCN – The World Conservation Union. Principle author contact: kirsten.martin@lycos.com , kirsten.martin@iucn.org

## 1. INTRODUCTION

A rapid and often persisting decline in many key commercial fish stocks, together with a global increase in fishing pressure have resulted in a historical collapse of many fisheries (Halpern 2002; Hutchings 2000; Rowe and Hutchings 2003). This has led marine conservationists and fisheries managers to re-assess the exclusive value of conventional management measures such as gear regulations and catch quota adjustments for sustaining fish stocks (Carr and Raimondi 1999). Indeed, "the scientific literature contains numerous diagnoses of the widespread [fisheries] management failures [...]" (Garcia and Grainger 2005). Carr and Raimondi (1999) note that "taken together, the natural, analytical, and social causes of uncertainty in projecting stock trends and adjusting fishery yields have prompted great concern and a more conservative approach to ensuring sustainability of marine resources." Marine protected areas have potential as an important component of a more traditional fisheries management approach.

MPAs are seen to provide one of the most tangible means for achieving broad protection across the biota and habitats of an ecosystem. The fundamental distinction between MPAs and other tools such as spatial fisheries closures is the MPA's principle objective of biodiversity conservation. Particularly with regard to implementation of an ecosystem-based approach and in the light of increasing acceptance that conservation and fisheries management goals are not mutually exclusive, MPAs (as well as gear restrictions) are considered to be crucial tools (e.g. Murawski 2000). MPAs are thus being increasingly promoted as a tool to fulfil both broader conservation goals and fisheries management objectives (Compass 2004; Salm *et al*. 2000; Allison *et al.* 1998; Lauck *et al.* 1998).

However, opinions still differ widely between conservationists, scientists, fishing sectors and other stakeholders over the effectiveness of MPAs for fisheries management compared to other fisheries management tools (Martin 2005; Hilborn *et al.* 2004; Agardy *et al.* 2003), when applied in a variety of different contexts.

A clear trend in the peer-reviewed literature is, that MPAs are increasingly being considered to be an important *complement* to existing fisheries management regimes (e.g. Bohnsack 1998; Guénette *et al.* 1998; Russ 2002; Gell and Roberts 2003; Halpern and Warner 2003; COMPASS 2004). Assessments based on existing case studies and the literature have confirmed this potential of MPAs to complement, *although not to supplant,* the range of existing fisheries management practices (e.g. FAO 2005; FAO Code of Conduct 1995; Sainsbury and Sumalia 2003; Russ 2002; Carr 2000; Allison *et al.* 1998; Lauck *et al.* 1998). "Their [MPA] performance in relation to fisheries resources and livelihoods thus depends greatly on the type of resource requiring protection and the situation of the fisheries exploiting them." (FAO (a) COFI/2005/8). A thorough case-to-case assessment and further empirical evidence is needed to define MPA benefits and limitations for managing the diverse array of fisheries around the world (e.g. Hilborn 2004; Martin 2005).

MPAs should therefore not be considered as a one-way street to success by themselves, but rather as an important tool in the fisheries management 'toolbox' that simultaneously addresses habitat and biodiversity conservation.

Initiatives to design, implement and test MPAs as a tool for fisheries management and marine conservation are under consideration internationally (e.g. WSSD, CBD, UNGA, UNFSA and related international agreements) and are starting to be pursued within a regional fisheries management context. The ecosystem approach to fisheries management set forth by the Food and Agriculture Organization of the United Nations (FAO) (Code of Conduct, 1995) creates opportunities to integrate MPAs as a management tool, and to assist states in achieving their recent international commitments. At its 26$^{th}$ session in March 2005, FAO's Committee of Fisheries (COFI) recommended that FAO develop technical guidelines on the design, implementation and testing of MPAs and agreed that FAO

should assist its members to achieve the World Summit on Sustainable Development (WSSD) goal with respect to representative networks of MPAs by 2012 (COFI Report, para. 103, 2005).

Section 2 of this paper provides a brief overview of MPA definitions, their main characteristics and potential roles for both biodiversity conservation and fisheries management. This sets the stage for a case-by-case exploration of MPAs in a fisheries management context, described in Section 3. Seven case studies have been highlighted as examples of a range of ecosystems and social, economic, institutional and governance contexts: high seas MPAs development in Antarctica, the Channel Islands stakeholder process in California, community-based management in the Philippines (Bohol) and Tanzania (Tanga), the Great Barrier Reef Marine Park adaptive zoning, resident indigenous fishing communities in Banc d'Arguin National Park in Mauritania, and territorial use rights in MPAs (in its wider sense) along the Chilean coastline. The case studies consider a variety of area-based management measures (strict protection zones, multiple-use areas, management and exploitation areas) and institutional settings, that have been or have further potential to be integrated with other fisheries management measures by using different approaches. Successes and challenges encountered by each MPA in contributing to fisheries management objectives and the distilled lessons learned are discussed. The context is a progressing international commitment to applying an ecosystem approach in fisheries management, and the increased interest expressed by COFI 2005 in integrating MPAs in the set of existing fisheries management tools. Section 4 then gives some key elements for consideration when designing, developing or revising MPAs in a fisheries management context, as they emerge from the case studies. It also highlights needs for research and management if MPAs are to be efficiently applied as a fisheries management tool. Both the elements and the needs are not complete, but compiled as a basis for further consideration and discussion in the context of the preparation of technical guidelines by FAO.

## 2. OVERVIEW OF MPAS

### 2.1 What is an MPA?

The term MPA is increasingly used in a context of fisheries management (e.g. FAO 2005), and it is important to clearly define it when assessing the role of a given MPA or network of MPAs for fisheries management. The MPA is a tool, which encompasses application of a whole range of management options. Strictly protected, no-take reserves lie at one end of the spectrum (see the Channel Islands case study of this paper). Zoned, multiple use areas form the other end, with various combinations and options in between (e.g. the establishment of buffer areas). The Great Barrier Reef Marine Park shows that within a single multiple-use MPA strictly protected no–take zones may occur. Different management strategies can be developed through zoning and networks of smaller management areas. Small collaboratively managed areas by user communities in Tanzania, Chile and the Philippines show that the particular focus of the MPA may vary from protection of one key species or species group to targeted resource maintenance. The actual choice, size, and spacing of these areas depend on the characteristics of the specific ecosystem targeted as well as management and conservation objectives.

To identify what role MPAs may play in a fisheries management context, it is important to be clear about the type of MPA that can be designed and the grade of protection necessary to meet the key goal of the MPA: see TABLE 1 (IUCN 1994; IUCN 1998; Kelleher 1999).

**TABLE 1. Overview of the IUCN Protected Area category system, their principle purpose of protection and an example from United States waters.**

| Category | Protected area managed mainly for . . . | Examples. . . |
|---|---|---|
| I | science or wilderness protection | Strict Nature Reserve/Wilderness Area, e.g. Fisheries Reserve |
| II | ecosystem protection and recreation | National Park |
| III | conservation of specific natural features | Natural Monument |
| IV | conservation through management intervention | Habitat/Species Management Area |
| V | landscape/seascape conservation and recreation; | Protected Landscape/Seascape |
| VI | the sustainable use of natural ecosystems | Managed Resource Protected Area, e.g. Area for Management and Exploitation of (benthic) Resources (Chile) |

It should be noted that a discussion about the application of the Protected Area (PA) categories to a marine context (MPAs) has been ongoing since 2005. An amendment to the definition of an MPA is equally considered.

There is no consistently applied definition for an MPA. IUCN in 1994 defined a marine protected area as '*any area of 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.'* (The 2003 IUCN World Parks Congress discussed an amendment of the IUCN definition to include subtidal terrain.) An analogous definition has been adopted by the 188 parties to the Convention on Biological Diversity[2].

The following list identifies some characteristics of MPAs, based on the presented case studies.

- The key objective of an MPA is the conservation of biodiversity and ocean productivity, providing a fundamental difference to the objective of e.g. the various fisheries closures types. This is often coupled with the protection of a defined feature of high biodiversity or habitat value, such as a coral reef, seamount or seagrass bed (see also below). Fisheries management objectives are, depending on setting and context, increasingly integrated in the design and implementation of MPAs. [3]
- An MPA has some form of protection, which is usually legally established but can also be established by custom or tradition. There are examples from the South Pacific where tradition led to protection of single species, e.g. giant clams through MPAs. Case studies from California, where no-take MPAs are established in state waters under state law but not federal

[2] CBD COP7, 2004, Decision VII/5 reflects the MPA definition to be: *'any defined area within or adjacent to the marine environment, together with its overlaying waters and associated flora, fauna and historical and cultures features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoys a higher level of protection than its surroundings'*.

[3] For the purpose of this review and to show the variety of approaches, we also described areas with the principle objective of resource management such as shown in the Chilean AMEBR.

law, and from Mauritania, where the MPA has its own law established through direct support from the prime minister, provide examples for differing legal frameworks within which MPAs are established.

- The degree of protection is not necessarily the same throughout the area; indeed most large MPAs are zoned into areas of different usage and ecosystem impact, such as shown by the Great Barrier Reef and the Antarctic case study.
- The MPA (and its management provisions) often covers not only the seabed but also at least some of the water column with its flora and fauna. An example from a Tasmanian seamount reserve shows that vertical zoning is also possible (e.g. as a vertical buffer zone; FIGURE 1). Although still a rarely implemented tool, these MPAs show potential for offshore and pelagic MPAs, and those which cover areas deeper than 100 meters (Simard, pers. com.).
- MPAs are not just relevant for natural features but also for protecting cultural features (such as wrecks, archaeological sites, lighthouses, jetties), and *traditional use/cultural practices*. The Mauritanian case study describes an approach to protect traditional fishing activities of a local community indigenous to the park area, further to biodiversity protection *per se*.
- MPAs may be permanent as their terrestrial counterparts, but their boundaries or management plans should be subject to review and modification at least after five to ten years. Flexible handling of MPAs may permit uses to be further restricted or expanded, with appropriate safeguards to ensure sustainable use with minimal habitat impact. As in the case of the Great Barrier Reef Marine Park, re-zoning and boundary adjustment on the basis of the management plan is done every five years. This leaves significant room for integration of fisheries objectives into MPAs with an existing/exclusive focus on biodiversity conservation. It is important to define the degree of MPA flexibility from the beginning, e.g. if an area is permanently or temporarily closed to fishing (depending on species distribution and factors such as the 'life span' of a particular ecosystem feature like e.g. a hydrothermal vent).
- MPAs work at, and across, different scales. For example, the Tanga MPA includes a network of spawning grounds and feeding areas spread over a wider area, while the Philippines case study describes a very small scale MPA context of protecting what is probably one critical spawning ground. The Antarctic and Great Barrier Reef examples work at a large marine ecosystem scale, whereby a variety of MPA tools and other conservation and management mechanisms complement one another under a broad management framework.

Closing areas of ocean to specific human activities for a defined period of time is commonly used for both nature conservation (MPAs) and for fisheries management (Fisheries management or area closures). However, the terms have sometimes been used in a confusing way in the past.

Area Closures are fisheries management tools, often in combination with other measures, to support the management of fish stocks for use and exploitation, or as a restoration tool for a fishery that has been over-exploited. They can encompass areas closed to all fishing activities, areas closed to fishing for single species, or areas with gear or vessel restrictions - both as temporal or permanent measures to manage fishing effort. Area closures usually aim at stock enhancement or recovery, but also include recovery for sensitive habitats and avoidance of specific vulnerable species. Broader ecosystem objectives are increasingly taken into account. The legislative basis for area-based fisheries management tools will be with fisheries government departments or adequate structures.

Area closures can provide benefits for conservation and may have positive effects on organisms associated with the target species for the duration of the closure. Generally open for renewal once or twice a year, they may thus not provide permanent protection. MPAs on the other hand can contribute to fisheries management objectives and provide benefits for the fishers (e.g. through protection of spawning and nursery grounds, spillover effects of fish outside the MPA, alternative income opportunities). Both area closures and MPAs are tools for objectives which can overlap and complement each other in a range of different beneficial ways. An effective combination of both objectives should thus be possible when applying either area closures or MPAs, bearing in mind the

importance of a thorough analysis of the respective resources, socio-economic and ecological context *(FAO (a) COFI/2005/8)*.

There is growing potential for establishing pelagic MPAs which would focus on oceanographic features such as fronts, convergence zones or eddies. Where these features are relatively fixed, they could be demarcated as a permanent MPA with traditional boundaries. Where features are temporary and dynamic, area-based protection (such as through closures) would be temporary or follow the natural shift of these features. Satellite tracking and remote sensing enable such features to be monitored on a close to real time basis (Norse *et al.* 2005).

## 2.2 Potential roles of MPAs

The overall goal of MPAs is to contribute to the conservation of the biological diversity and productivity of the oceans, including ecosystem processes. The Convention on Biological Diversity (CBD), for example, states MPAs have an "effect that its marine and/or coastal biodiversity enjoys a higher level of protection than its surroundings". However, a range of existing MPAs developed with biodiversity conservation objectives provide significant benefits for certain fisheries (e.g. Russ *et al.* 2004; McClanahan and Mangi 2000), however the extent and expected incidence of benefits to fisheries is still an open question (Halpern and Warner 2003; COMPASS 2004). Conserving an area of relatively low diversity but high productivity, such as a seagrass bed, may be equally vital for maintaining viable populations of threatened or endangered species as maintaining biological productivity to contribute to human welfare and food security (Kelleher 1999). The Mauritania and Philippines case studies provide good illustrations for this. Conserving an area of high diversity like the Tanzanian coral reefs can safeguard species and genetic diversity for the future, and help to secure the livelihoods of the local communities. By protecting critical breeding, nursery and feeding habitats of fish populations, MPAs can make a contribution to healthy fisheries beyond MPA boundaries. MPAs can protect the spatial complexity of bottom habitats like seamounts, coral and sponge habitats, seagrass beds and mangroves, which are particularly important in sustaining biodiversity as well as species of commercial and socio-economic importance. Some of these habitats might also serve to mitigate the effects of coastal storms and tsunamis (see e.g. Kathiresan & Rajendran 2005; Kerr *et al.* 2006 for differing views on the mitigating potential of mangrove habitats). It is this ecosystem-based approach to marine conservation that, if an MPA is appropriately designed and implemented, will provide significant benefits for biodiversity and also achieve fisheries management objectives (Halpern and Warner 2003; Willis *et al.* 2003).

Another way of looking at the role of MPAs is to consider how they help sustain a marine ecosystem's ability to provide essential goods and services. These can include fish and fish products, habitat provision, maintenance of biodiversity and biological resilience, products like medicinal or chemical compounds from marine genetic resources, tourism potential and revenue, nutrient cycling, carbon sequestration and waste assimilation. By protecting the health of marine ecosystems, MPAs can help to preserve future options, thus acting as an 'insurance policy' against management failures elsewhere.

MPAs can provide widespread benefits as reference sites for long-term scientific research and monitoring, to improve the understanding of a species population dynamic. As in exploratory fisheries, they may be used to test both conservation and management techniques (Kenchington *et al.* 2003). The still largely unknown Antarctic ecosystem is a good example for the importance of scientific reference areas to complement area-based measures for fisheries management.

The role of MPAs in fisheries management has been extensively discussed in the scientific literature. A range of theoretical assessments have concluded that MPAs have great potential to complement other commonly used fisheries management practices (Sainsbury and Sumalia 2003; Carr 2000; Allison *et al.* 1998; Lauck *et al.* 1998), and that they have positive effects for fisheries (Russ *et al.* 2004; Gerber *et al.* 2003; NFCC 2004; Halpern 2002; McClanahan and Mangi 2000). MPAs are,

however, not a panacea for fisheries management problems (Hilborn *et al.* 2004; FAO (a) COFI/2005/8; Murawski *et al.* 2004; Kaiser 2004).

A very limited number of long-term empirical studies exist which are able to demonstrate either MPA benefits, costs or shortcomings (Halpern and Warner 2003; COMPASS 2004), but documented evidence from single MPA sites is growing (e.g. Russ *et al.* 2004; McClanahan and Mangi 2000; McClanahan and Kaunda-Arara 1996). The case studies in this paper summarize some of the benefits and limitations encountered for MPAs in a fisheries management context.

It is worth noting that the majority of existing studies on the potential of MPAs are today based on coral or temperate reef systems in which target species show high site fidelity. The case studies from Tanzania and the Philippines are good documentations for management of the fisheries (both artisanal and industrial usually operate relatively close to the shore) through MPAs. For temperate, or polar, marine ecosystems and especially pelagic fish stocks, the effects of MPAs are still largely unknown (e.g. Kaiser 2004; Hilborn *et al.* 2004). This is partly because most pelagic stocks of commercial importance are more mobile during their life cycle, spawning and nursery areas are often unknown, and exploitation patterns can be widely dispersed. However, a number of studies are emerging that review the effects of various MPAs and closed areas for selected species (e.g. Pascoe and Mardle 2006; Cefas 2005; Sweeting and Polunin 2005; studies for Defra, in 2006). Recent research is also helping to identify distribution patterns such as migratory corridors and open ocean hotspots where pelagic species may congregate to feed, breed, spawn, and possibly also spend their juvenile stages (Hyrenbach 2000; Norse *et al.* 2005; Worm *et al.* 2005). Since many deep sea species, may have defined restricted ranges due to hydrographic or topographic barriers (ICES 2005), similar benefits as seen in nearshore reef areas could possibly apply. More long-term and empirical studies are however needed (Sale *et al*. 2005; Willis *et al.* 2003).

MPAs are seen as particularly crucial tools for achieving an ecosystem approach to fisheries management (Murawski 2000), and as one of the most tangible means to date for conserving habitats and a broad band of the biota within an ecosystem, thus benefiting both fisheries and marine biodiversity as a whole (Bohnsack 1998; Murray *et al.* 1999; Pinnegar *et al*. 2000 in Carr 2000). At the same time, while most efforts have been directed towards detecting their effects on single species comparatively little is still known to date about MPA effects on community or ecosystem-wide levels (COMPASS 2004; NRC 1999, 2001).

## 3. CASE STUDY REVIEW: SELECTED EXPERIENCES

This chapter describes certain management aspects from seven MPAs, or sets of MPAs across the globe, which are in one way or another of relevance to fisheries management. The cases span a range of ecosystem types and social, economic, institutional and governance contexts. They also vary in MPA type and its degree of protection. See TABLE 2 for an overview.

For each case study, a couple of key characteristics from planning and designation, implementation or assessment processes are highlighted. The main characteristics are then discussed on the basis of the key lessons learnt for each MPA.

The fourth chapter will then build on the cases and suggest a list of key elements or 'ingredients' for further discussion of the FAO technical guidelines, and for consideration when designing, developing or revising MPAs in a fisheries management context.

### 3.1 Case study A: Lessons from the stakeholder process of the Channel Islands Marine Reserves, California, United States.

This case study describes the stakeholder process to designating no-take MPAs (reserves of IUCN category I) in a developed country setting characterised by a multitude of uses such as tourism, transport and fishing, by a large array of user groups. The site designation process with stakeholders is known for its high potential for conflict during the consensus negotiations and the way in which science advice guided the conditions for these negotiations. The case study also stresses the importance of integrating participatory reserve design with the fisheries management system. The below summary largely references a United States-based MPA assessment report by Bernstein, Iudicello and Stringer (2004).

### *3.1.1 Background*

The reserves are part of the Channel Islands National Park and the Channel Islands National Marine Sanctuary, covering about 4 350 $km^2$ of coastal waters. The islands are fished commercially and also provide extensive recreational activities such as sport fishing. They are situated close to a major shipping lane and regular United States military training activities. The main marine habitat features are kelp forests and rocky inter-tidal habitats (FIGURE 2).

In 1978 the U.S. Supreme Court recognized the state's authority to manage the seabed out to three nautical miles. The marine resources of the islands are managed by a variety of state and federal jurisdictions of which many are overlapping. They include the Californian Fish and Game Department, the California State Lands Commission, the National Parks Service, the National Marine Sanctuary Program, the National Marine Fisheries Service, and the United States Coast Guard.

The Channel Islands Reserve designation followed three principle objectives: to protect ecosystem biodiversity, achieve sustainable fisheries, and to maintain long-term socio-economic viability. The designation process is characterised by a search for consensus amongst stakeholders on the basis of a long-term monitoring programme, running in parallel for United States state waters and for federal waters. It was initiated in 1998 by a group of recreational fishermen who were concerned about the potential over utilization of fish stocks around the islands, and who proposed a no-take reserve for 20 percent of the first (one) nautical mile off the shore. The development of reserves in state waters and federal waters was soon split into two separate processes because of differences in jurisdiction.

A long-term research and monitoring programme involved regular, intensive and often confrontational discussions on all aspects of MPA designation with a stakeholder working group. The concentration of resource use in the small Channel Islands area, the variety of resource users, and a complex institutional setting for consultation and decision-making complicated the consensus-finding.

The highly participatory approach for site designation included a multi-stakeholder public working group, supported by a science advisory panel and a socio-economic advisory panel (NOAA 2003). The science panel, as a separate entity from the stakeholder group, was tasked with developing overall guidelines that framed the design work of the stakeholder group.

The stakeholder process in the Channel Islands is considered both a success and a failure, depending on the individual or group one talks to and on the criteria used in the evaluation. While a network of reserves was successfully designated for state waters in 2002, the process for a complementary set of reserves in federal waters is not yet complete. The designation process furthermore led to valuable lessons learnt, some of which are documented here. The following lists some of the perceived successes and challenges.

### *3.1.2 Key successes of the process*

The process ultimately led to the implementation of a network of reserves in state waters that considers fisheries issues.

- Despite not finding consensus for site designation in federal waters, the stakeholder working group

developed alternative scenarios that were formed into recommendations to the Fish and Game Commission for a network of reserves in state waters.

- A new approach was developed for applying reserve theory to reserve design: as a prominent example, an interactive mapping tool was created that helped stakeholders evaluate the biological and economic implications of multiple design scenarios. (see Robinson *et al.* 2005 for a description and future recommendations)
- Scientific advice was used as the basis for the stakeholder group's design negotiations.
- Concrete economic data from stakeholders was used to estimate the economic effects of alternative reserve designs.

### *3.1.3 Challenges of the process*

The stakeholder working group did not reach consensus on a single reserve design that could be applied for state and federal waters, due to several constraints:

- The complexity of roles and relationships involved in the process were not adequately considered [e.g. separation of science advice from stakeholders resulted in perception of an elitist process, one that potentially undermines collaboration].
- Reserve goals were adaptively changed, but without the full agreement of all stakeholders.
- High potential benefits for fisheries were stated while the full range of fisheries science issues had not been explored [e.g. analyses underlying the reserve design did not account for existing fisheries management regulations outside the reserves, including other extensive closures]. This ended up amplifying resistance and undermining the credibility of the reserve design with fishermen, the Pacific Fisheries Management Council, and the state and federal fisheries agencies. There was no long-term progress monitoring towards the sustainable fisheries goal.
- Reserve design did not plan for experimental situations that would allow for scientifically testing key expectations about reserve performance on both conservation and fisheries goals.
- Limited communication between the stakeholder working group and the science panel
- No effective monitoring program was implemented (no long-term fisheries or fish stocks monitoring).
- A local commercial fishermen's association and the California Fish and Game Commission still challenge the legitimacy of the reserve, and filed a suit against the Commission in charge. The fishermen's arguments are: failure to adequately address mitigation of negative reserve consequences; procedural failures; and lack of authority by the agency to enforce fishing regulations.

### *3.1.4 Lessons learnt from the designation process with stakeholders*

- It is a common phenomenon that the goals of an MPA shift over time. It is important to periodically re-assess the goal and objectives, and equally important to inform and adapt the process to it. For the Channel Islands, efforts should be made to inform stakeholders of planned and eventual shifts in MPA objectives, and to jointly reformulate new goals through consultations. A long-term management plan should describe implementation of an adaptive management process for the MPA. There also needs to be clear but not overly simplified communication of the rationale for protection and reserve design, as well as other key assumptions provided by scientific recommendations. Roles of working groups and panels need to be clearly defined, regularly evaluated and adapted. Communication and exchange opportunities between panels and working groups are essential to prevent misconceptions and concerns amongst stakeholders.

- The Channel Islands process emphasises the importance of integrating reserve design with the fisheries management system. Especially where a key goal is to promote sustainable fisheries, it is vitally important to include fisheries management and stock assessment expertise in the relevant working groups and to ensure that fisheries management agencies, who will be responsible in whole or in part for implementing policies regarding fishing, are fully involved and committed to the process (Bernstein *et al.* 2004) to prevent conflicts. It is of special importance for the Channel Islands where there were parallel designation processed for state and federal waters.

- Monitoring is a crucial tool to determine the role of the Park for fisheries resource conservation. Although the Channel Islands national Park has a long-term monitoring programme, it did not include the fish stocks that were fished commercially or recreationally (this has been modified and they are now included). More broadly, it is important to incorporate experimental monitoring and evaluation into the reserve design, to be able to draw comparisons and controls, to measure outcomes and adapt. Monitoring is an important tool to document that stakeholder 'sacrifices' and behaviour modifications are worthwhile.

- Identifying consensus as the single criterion of a successful process can promote unrealistic expectations, be difficult to achieve and provide an opportunity for political lobbying and other gaming behaviour that might undermine the decision-making process. A variety of measures for decision-making should be considered (for example majority or super-majority votes).

- The role of science against economic and social aspects of reserve designation remains a balancing act. In hindsight, some of the stakeholders involved stated that potential benefits of the reserve were probably oversold in the process, while financial costs for planning and consultations were underestimated. While the designation of reserves in state waters is a significant event, it remains a solution in flux in a dynamic scientific, social, and policy context. Events have continued to move forward since the designation of reserves in state waters in 2002. There are ongoing efforts to find funding for monitoring and a continued planning process of reserves in federal waters. Local fishermen have meanwhile filed suit against the Fish and Game Commission and organized collaborative and community-based data gathering and management initiatives. New efforts are being made for integrating conservation (reserve) science and fisheries management.

## 3.2 Case study B: User-driven fisheries monitoring and management in the Tanga Collaborative Management Areas, Tanzania

In Tanga region, on the northern coast of Tanzania, six contiguous collaborative management areas (CMAs) have been established, two being gazetted, with the primary objective of sustainable fisheries and marine resource extraction. Their main characteristic is full participation and ownership by local stakeholder groups, including a user-based monitoring programme.

### *3.2.1 Background*

Taken together the areas span 1 600 $km^2$ of marine and coastal habitats comprising coral reefs, mangrove forests and some seagrass beds (FIGURE 3). Around 500 000 people live scattered along the coast neighbouring these CMAs, in 49 main villages and two principal towns, Tanga (pop. ~246 200) and Pangani (pop. 6 000).

The force behind the establishment of the CMAs was concern from local government officers and local communities in the mid 1980s about the degradation of the coral reefs from dynamite fishing and other illegal and destructive fishing techniques, and uncontrolled cutting of mangroves.

After a long phase of consultations, the Tanga Coastal Zone Conservation and Development Programme (TCZCDP) was formed in 1994 in response to this concern, with funding from Ireland and technical support from IUCN. The TCZCDP aims to improve the integrity of the Tanga coastal zone

ecosystem so that its resources support sustainable development. This is being achieved by improving collaborative coastal and marine resource management by district administration, resource users and other stakeholders. The primary tool developed to achieve these objectives are the collaboratively managed multiple-use MPAs– the CMAs– the first of which were established in 1998.

The selection process for the collaborative management areas was based on common natural resource use, primarily fishing, by neighbouring villages, and did not necessarily overlap with political boundaries of villages or districts. This was innovative for its time and was a result of a lengthy and thorough consultation phase in the TCZCDP (Makoloweka and Shurcliff 1997).

A significant element of the CMAs is that one or two reefs were fully closed to fishing in five of the six CMAs. After monitoring and assessing the impacts of these fisheries closures (see below), the villagers voted to maintain them as permanently closed reefs in recognition of their benefits to local fisheries (TABLE 3a,b).

On an institutional basis, Central Coordinating Committees (CCCs) comprised of village and district government representatives, have been formed to manage each CMA and to develop a management plan, with the assistance of regional government officers. Regular patrolling of the CMAs is carried out by joint community and government patrol teams, and this was for many years done in partnership with the Navy. TCZCDP from the onset has placed a strong emphasis on female participation and has increased the involvement of women in the CCCs and overall management of the CMAs with 30-40 percent representation of women in key decision making positions, a marked increase from the beginning of the Programme.

The main fisheries management activities carried out within the CMA frameworks are patrolling and monitoring, subsequent review and analysis by the CCCs, and the review of the CMA plans in an adaptive management cycle.

A monitoring and evaluation programme was established in 1998 to monitor the coral reefs, fisheries, mangrove forests, patrols and socio-economic status of the villagers. The CMA management plans are reviewed every three to five years and the analysis of monitoring data is used to inform and adapt the plans (Pabari *et al.* 2005). However, analysis of monitoring data has been infrequent and not very thorough, though has indicated that the CMAs have had a positive impact on habitats and neighbouring fisheries (Verheij *et al.* 2004). A recent thorough analysis of the long-term data sets has revealed that the impacts of the CMAs on the surrounding fisheries are not immediately obvious. Nevertheless analysis of trends in catch rates (catch per unit effort, CPUE) over six years are encouraging for two of the primary artisanal fisheries of the region: the basket trap fishery for rabbitfish and the hook and line fishery for snapper and emperors.

The hook and line fishery for snapper and emperor remained stable and CPUE increased in 2004 (FIGURE 4a); in contrast the basket trap fishery for rabbit fish declined initially but CPUE has increased since 2003 (FIGURE 4b). Both recent increases may be interpreted cautiously to be an improvement of the fishery as a result of the CMAs which had almost eliminated destructive fishing methods and contain fully protected reefs. A recently increasing CPUE in these two fisheries when the coastal population has increased by 60 percent from 1994 to 2005, can be seen as a positive outcome of the CMAs. Another monitoring study (McClanahan *et al.* 2006) found that overall fish biomass on the Tanga reefs has increased from 260 kg/ha in 1996 to 457 kg/ha in 2004, indicating that the CMAs are successfully increasing fish stocks within the managed area. The increase was most noticeable in the herbivorous group of species, which included parrotfish (Scaridae) and rabbitfish (Siganidae), but there was a significant decline in the carnivorous group comprising snappers, emperors, and grunts. These results differ somewhat from the catch rate analyses by the TCZCDP, but do provide some support for positive fisheries impacts from the CMAs.

The CMAs are managed by three district government offices in Tanga region, with advice, facilitation and funding from the regional government office. The CCC is the actual management body which

manages each CMA, develops and maintains the existing management plan with the assistance of regional government officers. Regular patrolling of the CMAs is carried out by joint community and government patrol teams. CMA Plans have been enacted through village by-laws, but have now been approved nationally by the Director of Fisheries. These are reviewed every two years. The Director has suggested that the CMAs and their management bodies change their terminology to Beach Management Unit to comply with the new Fisheries Act (2003), which would give the CMAs legal backing.

### *3.2.2 Key successes to date*

- The main success of the TCZCDP has been the development of a collaborative system that is broadly satisfactory to both communities and the government for preparing fisheries management plans based on multiple use MPAs, the CMAs. Management plans are key tools for sustainable fisheries, recommended by the FAO Code for Responsible Fisheries (FAO 1995) and are described in Tanzania's national 2003 Fisheries Act as 'management agreements'.
- A second key success is that the TCZCDP has explored structures for collaborative management within Tanzania's political and institutional framework, developed a collective natural resource management system within communities, and in so doing has introduced a strong sense of ownership of resources in the face of what was has been largely open access. Of particular note is the establishment of management units (the CCCs) which span villages and correspond to fishing grounds rather than political boundaries.
- The fact that reef closures are included in all the CMAs, that these are being established for increasingly long periods or permanently, and that most communities see them as an acceptable fisheries management tool, is also a key success.

### *3.2.3 Challenges encountered*

- One of the key challenges for Tanga is that there is no specific legal framework for the CMAs as established at present. The Fisheries Division approvals of the most recent plans have included the recommendation that once the by-laws have been approved, they should be considered as operational beach management units (BMUs). This will give them legal backing because BMUs can be established under the 2003 Fisheries Act. However, unlike the CMAs, BMUs are based around individual landing sites and operate at village level (Ogwang *et al.* 2004), which the TCZCDP has demonstrated is not a suitable management unit for coastal fisheries. This advice was provided by the TCZCDP who had significant input to consultations during the development of the Fisheries Act.
- Other challenges include difficulties in demonstrating a clear increase in catch rates as a result of closed areas, and the difficulty in completely eliminating destructive fishing methods, especially the use of dynamite (e.g. *Latimeria* fishing has been repeatedly reported.)
- Tropical multi-species fishery monitoring is difficult – the data are highly variable and indicator species are still poorly understood, thus demonstrating a casual link between the closed zones and improved fisheries is difficult. Analysis of indicator species from datasets around the world could provide interesting insights.
- Empirical data on the link between improved fish resource management through MPAs and improved livelihoods or alleviation of poverty is not really available – the socio-economic monitoring and analysis lags behind the bio-physical – this gap needs to be filled.
- Understanding the suitability of the governance model of the MPA for the socio-economic, cultural and political context is lacking and would provide an interesting analysis to assist in the establishment or improved management of MPAs.

### *3.2.4 Lessons learnt*

Several lessons can be drawn from the Tanga collaborative management experience.

- Collaborative co-management between local communities and local government were a crucial factor for success in Tanga. It led to the conclusion that local fisher participation and consultation is extremely important from the onset, and that government participation in MPA designation and management is essential at all levels (local to national).
- The long consultative phase and local community involvement in all aspects of the programme, as well as monitoring of resources and their distribution by the local fisher groups themselves created a sense of resource ownership by the local communities. Accurate and regular monitoring of key fishery indicators (based on sound science) is vital to demonstrate causal relationships between MPAs and improved fisheries. In this particular case, monitoring of important socio-economic factors started only late in 2004.
- Management area fisheries plans based on resource use (fishing grounds) have proven to be more relevant than village-based management plans, leading to the establishment of resource-based management units.
- Enforcement by village teams in collaboration with government and police, with financial support from government is one key aspect of the co-management principle put into practice. Importantly, dynamite fishing has resurfaced in 2005 indicating that current enforcement and compliance have not fully succeeded to address the problem.
- A weakness of the Tanga Collaborative Management Areas is inadequate recognition of the management programme at the national level and a resulting lack of legislative support and backing.

## 3.4 Case study C: Establishment of a spectrum of fisheries management activities in Banc d'Arguin National Park, Islamic Republic of Mauritania

The case study from Banc d'Arguin National Park showcases how fisheries management objectives may be added to existing MPAs with conservation objectives. It highlights the need for full integration of needs of residential communities and their traditional resource use patterns inside an MPA, as well as the utility of an efficient enforcement and compliance scheme for new and existing regulations.

### *3.4.1 Background*

The Banc d'Arguin National Park (PNBA) covers an area of approximately 12 000 $km^2$, of which 6 300 $km^2$ are marine and 5 700 $km^2$ are terrestrial. It stretches along ca. one third of the Mauritanian coastline. Its shallow but steadily nutrient-rich waters provide a habitat for hundreds of fish species, crustaceans, molluscs, marine mammals, turtles, birds and other marine organisms. The main ecological habitat features are seagrass beds (important role as nursery grounds for fish), sand islands and islets, mudflats and sand dunes (FIGURE 5).

The Park also houses ca. 1 500 people, the Imraguen, in nine traditional fishing communities, on the sandbanks and the adjacent desert area.

Declared as National Park in 1976 by the Mauritanian government, the PNBA became a Ramsar site in 1982 and listed as a World Heritage site in 1989 (together with Satellite Reserve Cap Blanc to its north). The PNBA is commonly known as the oldest and most extensive MPA in West Africa.

The Park is managed by a government-associated institution (tutored by the prime minister) and technically, as well as financially, supported by international partnering institutions. A special law for the Banc d'Arguin National Park (2000/024) was passed in 2000, which takes into consideration habitat and species conservation objectives and for the first time legally recognizes the Imraguen people as resource users.

The initial objective of the Park was to conserve the Park's landscapes, and an important ornithological site in the region. Its potential as an equally essential tool for fisheries management has been revealed successively over the last ten years. Due to its large size, the Park has a significant impact on the national fisheries of Mauritania.

The main activities of the Park (described in detail below) with relevance for fisheries management include (1) surveillance, (2) research and (3) supporting the traditional fishing of the local Imraguen population, including rehabilitation of the 'lanche' (these are sailing boats used by the Imraguen since the middle of the 20th century for the meagre fishery, originating from the Canary Islands).

1) Due to constantly rising external fishing pressure and illegal fishing, surveillance is the most important management activity inside the Park. A surveillance system has been active since 1998, and comprises three small motorized boats stationed at control points, and three radar stations. Current resources permit ten to twelve surveillance trips per month per boat. The Park works in collaboration with the Delegation for Fisheries Surveillance and Maritime Control (DSPCM, which forms part of the Mauritanian military), and the Mauritanian Oceanographic and Research Institute (IMROP). The DSPCM runs the three radar control stations and reinforces the surveillance system with its own surveillance boats. The radars efficiently localize and track motorized boats entering the Park. Each surveillance boat in the Park includes a team of DSPCM staff, a Park guard and a member of the Imraguen community.

   Illegal boats entering Park waters are fined up to Mauritanian ouguiya (~UM) 35 million (100 000 Euros) for industrial trawlers, and UM 2–10 million for freezer vessels. Most illegal fishing in the Park now comes from motorized pirogues, which are fined between UM 50 000 and UM 200 000 (140 – 570 Euros) if caught.

   The system of surveillance and the follow-up to ensure the conviction of those caught illegally fishing within the Park is implemented successfully. The Park administration reported that the system was able to significantly decrease illegal activities since put in place in 1998. The threat particularly from large commercial trawlers entering the Park's waters seems to have been effectively minimized.

   However, local Imraguen fishermen state that a threat from illegal fishing persists and that more surveillance is needed. Full coverage and enforcement of the 6 300 $km^2$ of marine area in the Park is limited by the capacity of the operating surveillance vessels. The surveillance boats and radar stations also need repair and replacement. A major drawback in this context is that money raised through fines via the State Treasury does not come back to the Park authority for covering the costs of surveillance. There is room to enhance the collaboration and regular communication flow between the partners (on technical and material aspects between Park Authority and DSPCM, and including relevant capacity development with the local communities).

2) Research and monitoring of fish populations in the Park area is steadily increasing. Since the very beginning the Park area has been considered a nursery ground for juvenile fishes, given that they are the source for feeding the populations of over two million waders, ~40 000 nesting birds and a huge quantity of migrating birds. Active research and monitoring of fish species however began only in the late 1990s with a project on the conservation and ecosystem-based management of the Banc d'Arguin ('ACGEBA', supported by the French Cooperation and led by the Mauritanian Oceanographic and Fisheries Research Institute 'IMROP'). Local fish capture data have been collected in the Park since 1997 with the aim to study the Imraguen fishery in the PNBA. Special efforts have been undertaken to monitor cartilaginous fish, mullets (*Mugil cephalus*, *Liza amata*) and meagre (*Argyrosomus regius)* since 2000, with implementation of three projects that supported the fisheries monitoring system in PNBA until 2005: sharks and rays; support of the re-orientation of the Imraguen fishery – Project ARPI; and conservation and sustainable use of the

mullet in Mauritania. Since 2006, they have formed an integral part of the 'monitoring system for artisanal and coastal fisheries' which is executed by IMROP along the entire coast of Mauritania.

The fisheries monitoring system for PNBA will allow for a more regular and representative track record of monitoring data, encompassing oceanography, fish biology, ecology, fisheries technology and a socio-economic survey.

The findings of the monitoring efforts seem to confirm an important role of the park area as reproduction and nursery ground for a number of fish species. All outcomes (scientific data collected, development of management measures) are discussed at annual inter-institutional stakeholder meetings, which were established in 2001. Unfortunately, most of the information and results are not publicly accessible, complicating a quantitative estimation of the stated success to outsiders.

An important sub-region wide role of the PNBA is the protection of several shark species such as scalloped hammerhead (*Sphyrna lewini)*, nurse shark (*Ginglymostoma cirratum)* and spinner shark (*Carcharhinus brevepinna)*. One previously undiscovered species of guitar fish, *Rhinobatos cemiculus*, was found in 1998 and described in 2006 by the French Natural History Museum.

Practical and strategic application of the monitoring data is still limited. The main problem at this point stems from the isolation of the Park administration from other institutions, including from the Ministry of Fisheries.

Recommendations that can be formulated in this context are that

- analysis of the collected monitoring data should be done in close collaboration with and between partners and relevant institutions in Mauritania.
- the results from the analysis should feed into strategic planning of the Park area, i.e. to develop a long-term strategy that specifically addresses fisheries issues.
- additional efforts should strengthen institutional collaboration with the aim of harmonizing and integrating the fisheries management strategy of PNBA with the national management plan for artisanal and coastal fisheries in Mauritania (PADPAC).

3) The Park successfully supports traditional fishing practices of the local Imraguen population. However, efforts need to be made to improve the living conditions of local residents of the Park.

The Imraguen have a centuries-old tradition of subsistence fishing in the Park area. Formerly, their mainstay was fishing for grey mullet. The original tradition shifted however, as huge quantities of mullet were harvested south of the Park in association with external operators and merchants in the 1980s. Today, the Imraguen fisheries have moved from subsistence to small-scale artisanal fishing. While motorized 'pirogues' are being used for artisanal fishing activities outside the park boundaries, motorized fishing is prohibited inside the Park and local fishermen use sail boats instead.

Ray and shark fishing developed in the park through economic incentives provided by wholesale fish merchants: the Imraguen received fishing equipment on loan and attractive prices for their elasmobranch captures for shipping to the Southeast Asian fin market. Declines in captures of sharks and rays appeared rapidly, but were compensated for by increased fishing effort with new fishing nets. This accelerated overexploitation in the Park finally resulted in increased fishers' debts towards the merchants.

Over the past seven years, more environmentally friendly fishing activities have been developed inside the Park, such as abandoning of certain fishing gear, financial incentives, and increased valuation of local fish products. Buy back of unsustainable fishing gear and stakeholder consultations have ultimately led to a ban on ray and shark fishing inside the Park in 2003, based on an agreement with local fishermen.

Up to 110 traditional fishing boats are authorized to operate within the Park today and there is international support for the restoration of these boats. The local annual fish catch inside the PNBA is around 2 000 tons, of which (very roughly) one third are mullets, one third are meagre and one third remain smaller species of sharks and rays. Sharks and rays are still caught as bycatch in the meagre fishery, or through uncontrolled Imraguen fishing practices, while illegal fishing for sharks is controlled.

Despite these successes in supporting traditional fishing, the social and economic well-being (i.e. health, access to water, education) of the resident Imraguen population remains unsatisfactory.

There is plenty of movement between the village communities inside, and the villages outside the Park. Management action to improve the socio-economic conditions of the Imraguen population as well as regulations should be applied for all villages, inside and outside the Park. In regard to the application of Park rules and regulations, 'the Park resident' status needs to be clearly defined. Supporting the living conditions (e.g. funding partnerships; alternative income opportunities other than tourism; capacity development) is urgently recommended.

There is a feeling of discontent among some villagers over recreational fishing activity by Park visitors, although this activity is unlikely to have any significant impact on the fish stocks if properly regulated. The PNBA very recently produced a sport fishing 'chart' with the aim of regulating this activity.

### *3.4.2 Successes of the Park*

The Park has provided a concrete (legal and administrative) framework for:

- A Park surveillance system and enforcement of specific fisheries regulations.
- Involvement of the residential Imraguen community in Park activities from the very beginning, and the establishment of a community cooperation scheme with stakeholders.
- A range of successfully implemented projects through international cooperation, and funding support dedicated to Park management resulted in a first track record of monitoring data, and finally supported establishment of a national fisheries monitoring system. A participatory research and monitoring programme on fish captures now exists, and is advised by a scientific committee.
- New fisheries management measures were established within the Park's boundaries, based on stakeholder agreement. They led to the protection of certain fish species and all species of sharks and rays.
- The large size of the PNBA management area can be seen as an advantage for extending the application of management measures to a national level. It also enables conservation of Park-endemic species, including species that may produce fisheries benefits beyond the Park's boundaries.

### *3.4.3 Challenges*

- Tough, unsatisfying living conditions of the local Imraguen residents (health, access to water, etc.), and high poverty levels due to lack of alternative income opportunities and changes in fishing activities are a significant challenge that needs to be tackled.
- Involvement of the full range of stakeholders can be improved through ongoing communication between actors and institutions involved in shared activities, and regular consultations with fisheries managers. For example, the PNBA regulates merchandizing and trading of fisheries catches inside the Park. Integration of all actors involved in the fishery into the stakeholder consultation system and thus in fisheries management, including the merchants and other fisheries stakeholders from outside the Park boundaries can be optimized. Ownership from residential

communities of the management issues inside the Park may be difficult due to the deficient living conditions and a lack of local managing capacity, but can be further promoted. Lastly, monitoring data collected should be publicly available to all stakeholders, to prevent time delays in consultations and potential distrust.

- An effective legal and governance scheme needs to be put in place. Currently there is a lack of implementation schemes for existing Park legislation (i.e. there is no decree to apply the Park law 2000/024), and unclear legal formulations that may lead to illegal activities (e.g. for people moving between the Park and its surroundings). A formalized residential status has not been established for the Imraguen, which makes it difficult to apply existing regulations. Changes in the national support system for the Park and leadership issues may pose a challenge for the overall Park management, stressing the need for collective and concerted support from the Ministries for Fisheries and Environment.
- There is a lack of long-term financial sustainability to maintain and extend surveillance measures, as well as to implement research and communication strategies. The current system is highly dependent on foreign financial support.

### *3.4.4 Lessons learnt for fisheries management*

- The Park serves as a tool for habitat and species conservation which, through protecting the ecosystem on which fisheries depend, also enhances the local fisheries. It serves as a refuge for critical stages in the life cycles (e.g. breeding, juvenile) of fish species which migrate or whose ecological range exceeds the Park boundaries during other phases of their life cycle. This is the case for the commercially important mullet, meagre and some shark species.
- The PNBA constitutes an important shark sanctuary within the sub-region and as such may serve as a pilot site for using a participatory approach and joint research programme towards implementing a shark fishing ban.
- Fisheries scientists recognise the protective value of the Banc d'Arguin National Park but also recommend that other measures should urgently be implemented to ensure protection at a national or regional level for economically and ecologically important fish species.
- The Park was originally established for conservation purposes, but has also demonstrated significant benefits for fisheries. Where fisheries rules and regulations on national/regional levels did not exist, the Park provided an opportunity to apply other measures, while existing legislation could be more easily enforced in the context of the National Park.

## 3.5 Case study D: Integrated, multiple use perspectives for the Great Barrier Reef Marine Park, Australia

The Great Barrier Reef Marine Park provides an example of a large multiple-use MPA which is zoned to allow for different uses and human activities by sub-area, to an extent that ensures a healthy condition of the overall ecosystem. Zones include fishing limitations as well as no-take areas or closures where no extraction of any sort is permitted (FIGURE 6). Development and adaptation of a zoned management plan with stakeholders has recently increased the area closed to fishing from 4.5 percent to an overall 33 percent of the Park area.

### *3.5.1 Background*

The Great Barrier Reef Marine Park, encompassing an area of 344 400 $km^2$, was authorised to be established in 1975 through the Great Barrier Reef Marine Park Act by the Australian Commonwealth Government. The Marine Park covers the entire Great Barrier Reef (GBR) of eastern Australia with the outer boundaries extending to straight lines approximating the 200m depth contour. The GBR is also a World Heritage Area and the largest barrier reef system in the world stretching for over

2 300km along the Queensland coast. Consequently there was little doubt as to its significance, bio-physical uniqueness and need for conservation, protection and wise management.

A wide number of fisheries occur in this multiple use Marine Park, ranging from bottom trawling for prawns and scallops, to line fishing for demersal reef fish and pelagic species. The fisheries focus in this case study will be the coral reef fin fish fishery taken by hook and line, which is almost wholly contained within the Marine Park, operating around the ~2 500 individual coral reefs.

The Great Barrier Reef Marine Park Act (1975) constitutes the legislative framework for the GBR and this is administered by the Commonwealth Great Barrier Reef Marine Park Authority (GBRMPA), a statutory authority within the Ministry of Environment and Heritage. GBRMPA acts as the principle adviser to the Commonwealth Government on the management of the GBR.

There is no specific mention in the GBRMP policies and legislation that the no-take zones have a fisheries management function. Their function is described as biodiversity protection and conservation. However, the Great Barrier Reef Marine Park Act (1975) does require that ecological sustainability is ensured, so all uses, including fishing, must be ecologically sustainable within the GBR Marine Park. Consequently, GBRMPA works with the Queensland State Fisheries Agency, the Department of Primary Industries and Fisheries (DPI&F) to ensure that fisheries in the GBR Marine Park are ecologically sustainable. Through the legislation the GBRMPA can request DPI&F to take action if a fishery is deemed unsustainable or has unacceptable impacts on other species, habitats and other users. As federal legislation the GBRMP Act overrides conflicting State legislation including fisheries legislation.

Contrary to the GBRMP under federal law, the primary legislation for the coral reef fin fish fishery is the Queensland State Government's Fisheries (Coral Reef Fin Fish) Management Plan (2003) through the Fisheries Act (1994). The Plan invokes many standard fisheries input and output controls such as minimum and maximum size limits, limited entry (licenses), gear restriction, vessel restrictions, etc. and DPI&F manages all fisheries in accordance with the principles of ecologically sustainable development. The Coral Reef Fin Fish Management Plan makes no mention of the GBRMP closures with which the fishery must comply; however, the zoning plans of the GBRMP do identify reef line fishing as a reasonable use within certain zones of the Park.

Further relevant legislation is contained in the Commonwealth Government's Environment Protection and Biodiversity Conservation Act (EPBC) 1999. All fisheries that export products from, or that occur in a World Heritage Area, or that interact with endangered or protected species must comply with the EPBC Act and demonstrate that they are sustainably managed before they can operate. In 2004 the coral reef fin fish fishery was approved as a Wildlife Trade Operation (WTO) which allows for the continued export of reef fish. This approval acknowledged that 33 percent of the GBR (up to 30 percent of reef habitat) is protected through no-take zones and that this contributes to ensuring the fishery is being managed in an ecologically sustainable manner.

Since inception the GBRMPA has focused on strong participatory input from all users and other stakeholders of the GBR in managing the GBRMP, particularly in the formulation and review of the zoning and management plans. To engage stakeholders the GBRMPA employs different communication and consultation methods for four target groups: i) users of the GBR (e.g. fishers); ii) local communities that live adjacent to the Marine Park; iii) the broader Australian public who view the GBRMP as a national heritage; and iv) the global community.

The first zoning plan for the GBRMP was developed in the 1970s for the southern Capricorn-Bunker section of the Park which covered 12 000 $km^2$. Subsequently, additional sections were added over several years and zoning plans were developed for each section in which permanent no-take zones or closures were established with the primary objective of biodiversity conservation (Lawrence *et al.* 2002, FIGURE 6). Adaptive re-zoning of the Park generally every five years has been an ongoing periodic process.

In the early 1990s GBRMPA's management plan review process identified that there were several problems with the zoning, and that the increasing pressures on the GBR, from, among others, tourists/recreational users, fishing and pollution, were inadequately addressed through the number and size of no-take areas within the Park. In addition, the closures were focused on coral reefs with little regard to the other major habitats in the Park (Fernandes *et al.* 2005). The latest rezoning of the GBR, completed in 2004, was a massive undertaking and has increased the number of fully protected no-take areas for biodiversity conservation from 4.5 percent to 33 percent of the Park (Fernandes *et al.* 2005).

Compliance and enforcement of the closures (and all other regulations of the GBR Marine Park Act) is delegated to the Queensland Environment and Protection Agency – the Queensland Parks and Wildlife Service. This is primarily done through boat patrols and plane surveillance conducted by a number of agencies (Queensland Parks and Wildlife Service; Queensland Boating and Fisheries Patrol (DPI&F); Customs; Coastwatch; and State and Federal Police). These agencies are coordinated on a risk-based intelligence assessment. Thus, the likelihood of a particular infringement in a particular area/time causing environmental harm is assessed and patrols target those areas and times. At the same time the Queensland DPI&F conduct boat patrols to enforce the Coral Reef Fin Fish management plan within the GBR Marine Park.

The Minister of Environment offered a compensation package for fishers rather late in the recent re-zoning process, after strong lobbying from the fishing industry. (The package was offered by the Ministry of Environment to compensate for restricted access to fishing areas and potential loss of revenue from fishing, given that the main aim of the closures was biodiversity conservation rather than effort control or yield management.) Commercial fishers can now have their licenses bought out (a total package of around AUD 30 million), while they do not have to demonstrate a direct impact from the re-zoning. However, DPI&F provided information on the potential level of impact and the level of fishing effort for each fisher who applied for compensation. Licences were selected by the Department of Environment & Heritage (DEH) in part on this basis so that those licences that applied significant fishing effort in the Marine Park would be removed and compensated. Contrasting to this, people requesting compensation from fishing related business impact due to closures had to demonstrate the impact. The total package available for restructure package is about AUD 80 million to cover all fisheries in the GBR Marine Park (trawl and line fisheries, i.e. prawn, scallops, coral reef fin fish, crab, pelagics, etc). Clearly the DEH have demonstrated a commitment to compensating the fishing industry for the increase in closed areas in the Park.

### *3.5.2 Successes of the Park*

- One of the key successes of the GBR Marine Park is the recent re-zoning that has resulted in 33 percent of the Park now closed to fishing and other extractive uses, a substantial increase from 4.5 percent. This increase was promoted on the basis that it is generally accepted that at least 20 percent of a multiple use MPA should be closed to conserve biodiversity (Fernandes *et al*. 2005). Modelling studies have suggested that the percentage should be as high as 40-50 percent to maintain sustainable coral reef fisheries (Russ 2002).
- Education campaigns on the new zoning plan ensured that 78 percent of the Queensland population knew about the plan when it became effective and consequently the incidence of infringement was significantly lower than during previous re-zoning times.
- A better understanding of the Park's potential and value by local authorities enabled effective coordination of enforcement and compliance between various agencies and the risk based approach to surveillance. This has increased the number of infringements reported and increased the number of prosecutions. In 1999 the Minister for Environment increased the level of fines significantly, up to AUD 220 000 to an individual fisher for illegal fishing and up to AUD 1 million to a company. In addition, investigators are now able to build cases against environmental crimes. This has been accompanied by training of the judiciary and strong awareness campaigns in

the media. The recognition by the EPBC Act assessments of ecologically sustainable management by GBRMP through closures is also seen as a success.

- A strong scientific information basis justifying closures, their location, size and number, added significantly to the stakeholders' recognition of the Park's benefits (with exception of the fishing industry). Despite the fact that the two authorities responsible for the sustainable management of exploited coral reef fishes of the GBR employ different legislative approaches, and do not formally acknowledge each other's legislation, collaborative research between these authorities and others (e.g. James Cook University) has demonstrated benefits of the closures by showing increases in the biomass of fishery target species within the closed areas. Although likely, benefits through spillover effects for the surrounding fishery were however not evidenced.
- This research, on the effects of line fishing by the Cooperative Research Centre for the GBR World Heritage Area, has shown that two main target species of the reef fin fish fishery, the common coral trout and the red throat emperor, were significantly more abundant, larger and older in areas zoned closed to fishing than in adjacent areas that have always been open to fishing (Mapstone *et al.* 2004). The magnitude of these differences varied in relation to levels of fishing effort and natural patterns in abundance of these two species. Thus where fishing effort is high and population abundance is naturally high the difference between closed and open reefs was greater - closures were more effective. Experimental manipulations of reef zoning status and fishing effort provide further evidence that the Marine Park zoning strategies have been effective in protecting sub-populations of the reef fin fish fishery resource from the impacts of harvest. The impacts of fishing effort were felt within a year of opening previously closed reefs indicating rapid decline in densities and size from fishing on these target species.
- Lessons learnt from over 40 years of engaging with stakeholders have recently led to a new approach of building relationships between individuals within local communities and Authority staff, to strengthen trust between the two and hence engage in collaborative management. Strong community links have been developed via the establishment of Local Marine Advisory Committees and Regional offices. Encouraging signs can be seen in the Keppell Islands, southern GBR, where a community group called "Capreef" (Capricorn Reef monitoring group) representing the recreational fishery, are supportive of the reef closures and want to monitor them with GBRMPA. They supported a total closure of >20 percent of their area and helped GBRMPA select areas that represented both healthy and depleted fish populations and habitats. They recommended closed zones for both replenishment (depleted fish stocks) and conservation (healthy fish stocks).

### *3.5.3 Challenges*

- A critical challenge to the GBR Marine Park is poor acceptance of closed areas by the fishing industry. This is compounded by the fact that despite extensive research, conclusive evidence that high biomass of target species in closed areas will benefit the surrounding fishery is not readily apparent. The commercial and recreational coral reef line fishers are already regulated through the Queensland state's fisheries management plan, and therefore they are understandably unsympathetic to further regulation through closures which are primarily established for the purposes of conservation of biodiversity.
- The real benefits of closures as a fisheries management approach have not yet been well-enough demonstrated on the GBR. Research to demonstrate benefits of closures to surrounding fisheries needs to be carefully designed to tackle this issue. It would be important to look at spillover (larval supply and adult movement of fish) and catch rates in surrounding areas open to fishing. Information is equally needed on fisher behaviour in relation to closures. Monitoring of key indicators in the reef fin fish fishery (e.g. population density and biomass) in response to closures before and after is essential for measuring impacts.
- Clear and synthesised publication of research results is needed, e.g. on the effects of line fishing experiments, to help fishers understand the benefits of closures to the reef fin fish fishery. Awareness raising through educational materials such as videos is an option.

- It is clear that the results of the Effects of Line Fishing experiment need to be communicated carefully back to the fishing industry so that the results are clearly understood. It appears that there is still a large gap between researchers/managers and fishers in terms of trust and understanding. The informal understanding between GBRMPA and DPI&F staff regarding the merits of closures for fisheries management could be made more public to improve fishers' understanding of the positive impacts of closures. Further, the lack of recognition in the two legislations (GBRMPA and DPI&F) of each other's regulations does not foster a cohesive approach to the management of the reef fin fish fishery on the GBR.

### *3.5.4 Lessons learnt*

- Legislation and other management measures for closures (no-take zones) within a large multiple-use MPA such as the GBR should specify to address both sustainable (reef) fisheries management as well as biodiversity conservation. Combining the dual benefits of biodiversity conservation and sustainable reef fisheries as objectives in an MPA management plan adds value and benefits and reaches a wider stakeholder base.
- Adaptive re-zoning as an ongoing periodic process is a key requirement for successful management of a large multiple-use MPA. For example, the GBRMPA Fisheries Issues Group worked closely with DPI&F during the re-zoning of the GBRMP and it was recognised informally that closures were working for fisheries management and therefore more stringent fisheries management measures by DPI&F would not be needed.
- Monitoring the effects of closures (before and after) should combine both biodiversity monitoring and fisheries monitoring to measure impacts.
- Education and awareness material especially video should be produced to illustrate the concept of closed areas as a fisheries management tool for demersal reef fisheries, with the reef fin fish fishery operators on the GBR as the target audience.
- A fully participatory and consultative process is essential to get support from stakeholders. Users, especially fishers, should be part of the monitoring programmes so that they can directly see the effects of the GBR closures.
- The protection of sub-populations of reef fish through closures (with sufficient compliance) was seen as the most effective way to increase total spawning biomass of harvested species over the GBR (Mapstone *et al.* 2004). However, this research cannot demonstrate, though it is implied, that the high biomass within closed zones will in turn benefit the surrounding areas open to fishing through larval flow and adult spillover.
- Enforcement of closures remains essential. A focus on compliance is necessary because of the large scale of the GBR, and this is best achieved by fishers believing in the net benefits of the closures to their fishery.

## 3.6 Case study E: Territorial use rights in coastal fisheries through Areas for Management and Exploitation of Benthic Resources (Áreas de Manejo y Explotación de Recursos Bentónicos), Chile

The number of Areas for Management and Exploitation of Benthic Resources (AMEBR) has rapidly expanded in Chile over the last decade in an effort to reduce the overall fishing effort in Chilean near shore fisheries and to improve compliance with coastal fisheries regulations. The AMEBR provide an important tool for transferring management responsibilities from a central authority to artisanal fishing communities. This case represents an important and ambitious initiative of introducing territorial use rights in a coastal fishery where property rights had never been in place.

### *3.6.1 Background*

The Chilean Fisheries and Aquaculture General Law, enacted in 1991, provides for the establishment of MPAs as fisheries management tools. It lists three categories of MPAs: areas for management and exploitation of benthic resources, marine reserves, and marine parks, with different sets of objectives, management and conservation actions. Marine reserves and marine parks are scarcely applied in Chile; however, the Areas for Management and Exploitation of Benthic Resources (AMEBR) have rapidly expanded over the last decade.

The AMEBR areas aim to ensure sustainable use of marine resources by assigning exclusive territorial use rights to legally recognised artisanal fisheries organisations. Initially developed in the early 1990s as pilot experiments, AMEBRs are now a common management tool and adopted by most artisanal fisheries organisations in Chile.

The main objectives of the management area regime are:

- conservation of benthic resources (invertebrates and macroalgae)
- sustaining artisanal economic activities
- maintaining or increasing biological productivity of benthic resources
- increasing knowledge on the functioning of the benthic ecosystem
- promoting and encouraging participative management

The AMEBR areas fall into Category VI of IUCN's protected areas management categories. They can only be established within five nautical miles from the shore and in inshore areas (rivers and lakes). Over 430 declared AMEBRs with a management plan exist, and ca. 1 200 have been requested (see FIGURE 7 for region IV of Chile). The average surface extent is 190 ha; the number of fishers involved is around 16 500 out of a total number of ca. 52 000 artisanal fishers in Chile.

The legal provision for the establishment of the AMEBR is set out in article 48 of the Fisheries and Aquaculture General Law Nº 18.892. A specific regulation for management areas is set out in the Supreme Decree Nº 355/95 and outlines the rules and criteria for establishing and managing such areas.

In order to be granted an AMEBR, a community must constitute a legal organization (e.g. artisanal fishers' associations or fishers' cooperatives). There are two main steps for the establishment and implementation of an AMEBR: the first, administrative, aims to delineate the geographic area in which a management project would be undertaken. It involves extensive consultation with several governmental organizations and local communities that need to analyse the feasibility of establishing a management area and ensure compliance with existing uses in order to grant the exclusive use right to the fishers association.

After such consultation and if there are no major conflicts with other uses, the area is declared available and the implementation of a management project can start. This requires the development and execution of a proposal for a base line benthic resources assessment, and the presentation and results delivery of a management and exploitation proposal. The technical requirements for these steps are set out in the management area regulation.

Once the management and exploitation plan (hereafter management plan) of an area is approved by the Under-Secretariat for Fisheries (Subpesca), the second process involves the National Fisheries Service (SERNAPesca) establishing an "agreement of use" for a period of four years with the fisheries organization in order to transmit the obligations and privileges that the management of benthic resources of the declared area implies. Annual monitoring studies are mandatory to evaluate implementation of the proposed management objectives by Subpesca.

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. Based on the baseline assessment of the area, the management plan identifies, on an annual basis, target species, harvest periods and techniques, as well as the criteria applied to determine allowable catch rates. The most commonly targeted benthic species within the Chilean management areas are "locos" (*Concholepas concholepas)*, limpets (*Fissurella spp.*), sea urchins (*Loxechinus albus*) and macha clams (*Mesodesma donacium*). The management plan can also include aquaculture activities provided that they have no impact on natural resources and are in compliance with the national fishing regulations.

For every AMEBR, a norm for enforcement of the management plan is established, which defines individual extraction levels, rights and obligations for each member of the fishing community. By this norm a code of conduct among fishers is set independently of the external regulatory authority. The control of the fishing area is done by the fishers organization itself, generally through the establishment of a control committee (of often rotating responsibility). Typically, the executive board of the fishers association identifies potential violations of the norm and establishes the appropriate sanctions (Palma and Chávez 2004).

The implementation of the management plan is controlled indirectly through the evaluation reports by Subpesca. SERNAPesca has the mandate to undertake inspections and sanctions. The presence of SERNAPesca during the fishing operations is necessary to certify that the resource was extracted from the management area in accordance with the management measures in place. The fishers' organization might lose the exclusive right to manage the area if the exploitation is in infringement of the management plan.

In Chile, there are several local studies on the effectiveness of the management area as a fisheries management tool, particularly on positive effects such as increase of size and abundance on the target species *Concholepas concholepas* (Castilla 1996, 1999; Castilla and Fernandez 1999; Orensanz *et al.* 2001; Stotz 1997), and on some economic and social improvements to artisanal fishers (Barros and Aranguez 1993; Subsecretaria de Pesca 2004).

### *3.6.2 Key successes*

- The increase in numbers of management areas requested by fishers organizations demonstrates that acceptance of the system within the artisanal fishers communities has been highly successful.
- The Chilean Management Area system emerged in response to the need for alternative solutions that would ensure sustainability of benthic fisheries resources after their severe overexploitation by the end of the 1980s. Artisanal fishers themselves realised the need to change exploitation practices and introduce access regulations for optimized resource use. The results and effects of these access regulations and exclusion of human impact on coastal ecosystems have influenced artisanal fishers in Chile and strengthened their acceptance of the AMEBR concept.
- Shifting from common property fisheries (characterized by a lack of property rights and economic over-exploitation) to exclusive use right in the Chilean coastal fisheries has created a sense of ownership and responsibility for the management of the resource.
- During this process fishers learned to acquire new skills for managing the fisheries resources, while the authorities delegated certain responsibilities and found new collaborative ways of working with the resource users.
- The management areas allow for improved interaction between the fishers, the management authorities and the scientific community. The system is participatory and transparent enough to build and reinforce trust between the different stakeholders.

### *3.6.3 Challenges*

- The main challenge of the system is to ensure enforcement of the management regulations. Involving the fishers in managing the resource aims at reducing the need for external control, implying the commitment of fishers to control illegal practices themselves in order to increase their benefits.
- Current regulations, however, focus only on the biological and technical aspects of the fishery exploitation, while economic considerations, which are crucial to understanding the fishers' strategic behaviour, are largely ignored. The Chilean Fisheries and Aquaculture Law, for example, do not inquire about norms and internal regulations used by the community to guarantee the compliance of the management plan. Fishing associations need to take into account the potential problems associated with self-regulation prior to being granted full user rights (Villena and Chavez 2005).
- The new co-management regime of the fishery did not empower fishers in advance to enable them to manage the resource effectively. Today there is a clear need for capacity building in the implementation of the management and exploitation plans, equipping the fishers with better tools for the management of the resources.
- Research, and especially studies that relate these areas to broader conservation objectives or to the status of the resources at the national scale are lacking. There is also a need for interdisciplinary research, considering biological, social and economic factors to develop an improved understanding of the various determinants of success in use rights arrangements.

### *3.6.4 Lessons learnt*

- Establishment and administration of the AMEBRs promote and strengthen the development of fishers unions that are then linked with both government institutions in charge, and with the scientific community.
- AMEBRs can have a high educational value, as they allow for direct interaction between scientists, managers and users. Targeted capacity building, however, still needs to be made (see above).
- The AMEBRs provide an interesting opportunity for implementing different fishery management experiments. A synthesis of lessons learned and comparison of effectiveness of the different management schemes would be needed to provide a basis for structural improvement of the system. A comprehensive evaluation of the system at a broader scale needs to be conducted.
- Surveillance, sanction and control are key elements for AMEBRs to work effectively, and need to be enforced by strengthening the control capacity of the relevant authorities.
- There is a need to conduct studies that relate these areas to broader conservation objectives or to the status of the resources at the national scale. There is a particular need for interdisciplinary research, considering biological, social and economic factors to develop an improved understanding of the various determinants of success in use rights arrangements.

## 3.7 Case study F: Community-managed coral reef sanctuaries in Bohol, central Philippines

This case study provides an illustration of nineteen no-take MPAs that are fully implemented, managed and enforced by local subsistence fishing communities across Danajon Bank in Bohol, in the central Visayas of the Philippines.

The no-take MPAs have been established, by the communities with the support of a non-government organisation and its local counterpart foundation. The first sanctuary, Handumon, was proposed in 1995 and enforcement commenced the same year. Reports of good experiences elsewhere in the

country, and increasingly good reports in Bohol have prompted subsistence fishing communities to support the development of these areas.

### *3.7.1 Background*

All MPAs are small in size and function as no-take marine sanctuaries, primarily protecting shallow, fringing reefs, seagrass beds and mangroves within the inshore coast of the Danajon Bank reef complex (FIGURE 8). At the periphery of the Camotes Sea, the Danajon Bank is a distinctive double barrier reef complex of reefs, inshore islands, seagrass beds and mangroves. The Danajon Bank reef complex comprises of a total area of 2 476 $km^2$ and is historically reported as the most habitat-rich fisheries ecosystem of the Central Visayas (Green *et al.* 2004). The Danajon Bank is suffering from declining fish stocks primarily because of overfishing, and increasingly critical habitat status due primarily to destructive fishing methods notably the use of trawls and dynamite. Reef conditions span the entire spectrum of high to low quality due to both environmental and human impacts. In addition, this region presently contains one of the highest recorded fisher numbers in the Central Visayas and the majority of these fishers are dependent on the fisheries for their livelihood and direct consumption. The fisheries of the region have changed drastically over the last several decades with CPUE declines associated with all fishing grounds (Green *et al.* 2004).

The reasons for the establishment of these sanctuaries were to promote rebuilding of marine life, for both conservation and economic purposes; to manage important local artisanal fisheries, such as the seahorse fishery (Martin-Smith *et al.* 2004), but also fisheries for demersal reef fish particularly rabbitfish and parrotfish; and to comply with national legislation that stipulates Municipalities must establish marine protected areas (MPAs).

The impacts of five of these small coral reef sanctuaries have been analysed in some detail. All five sanctuaries are small (< 1 $km^2$) spread through three municipalities, over a distance of approximately 40 km (see FIGURE 8), and comprise shallow coral reef habitat, but some include dense beds of the brown algae *Sargassum,* which may have been promoted by extensive coral destruction from dynamite fishing (Marcus *et al.* in press).

Legislation for the protection of coastal waters is very progressive in the Philippines. The National Integrated Protected Area System (NIPAS) Act (RA 7586), was enacted by Congress in 1992 to respond to the profound impact of human activities on all components of the natural environment in the Philippines (DENR, BFAR and DILG, 2001). Of greater relevance to the Bohol sanctuaries are the complementary Local Government Code 1991 (RA 1760) and the Philippines Fisheries Code 1998 (RA 8550), which provide municipalities, termed local government units (LGUs), with legal frameworks and mandates to manage their 15 km municipal waters and to establish MPAs. This is a relatively quick process requiring the passing of a municipal ordinance. To get an area protected under the NIPAS act requires either an executive action (Presidential Proclamation) or congressional action (house and senate bill). Under RA 7160, the LGUs can use their internal revenues to support coastal resource management initiatives including MPAs. They may even use these resources to build up their own capacities in Coastal Resource Management. These LGU-codified MPAs are fully protected no-take MPAs, locally referred to as *sanktwaryo (*sanctuaries). Under Philippine law, taking of any sort is not allowed in these sanctuaries.

The Bohol marine sanctuaries are legally gazetted through municipal ordinances and resolutions. Management plans for the five sanctuaries are included in coastal resource management plans produced by the Municipality in consultation with village management teams. Village natural resource management (NRM) plans may also include management plans for the sanctuary. The majority of the MPA management plans include goals that focus on the improvement of fisheries yields outside the sanctuary for food security and income. Activities have included participatory coastal resource assessment, on-site consultations, fulfilment of legal requirements, management council establishment, management plan formulation and community-based monitoring.

Encouraging compliance of sanctuaries involves a number of different steps: placing marker buoys and posts so that the sanctuary is clearly delineated; the building of a guard house in the sanctuary; and a patrol team established with a daily guard assigned to guard the sanctuary from the guard house, and this may be 24hr or at night only depending on the fishery. Finally, where there is good enforcement, patrols by boat are also conducted.

Legally, enforcement can commence as soon as a municipal ordinance or resolution is passed as it is the municipality who owns the municipal water (Fisheries Code of 1998). In reality local communities often take enforcement into their own hands before the ordinance is passed, and have some powers through formally delegated village police and fish wardens.

Starting in 1998, teams comprised of biologists, local fishers and volunteers have developed and conducted bi-annual surveys that now include visual census of fish abundance, seahorse surveys and quantitative benthic assessment. The long term monitoring programme tracks the effectiveness of MPAs in providing protection to coastal habitat, enhancing fish abundance and biomass, and conserving seahorse populations. Changes in eight MPAs are now surveyed using permanent transects inside and outside the MPAs, and at five distant control sites. The biophysical monitoring is reported to local MPA communities and municipal governments on an annual basis for their assessment of MPA success.

### *3.7.2 Key successes*

- Strong and active community and fisher participation in all aspects from sanctuary site selection, management planning and monitoring has been a feature of most of the Bohol sanctuaries (Meeuwig *et al.* 2003) and this has meant communities feel a strong sense of ownership, responsibility and therefore generally comply with sanctuaries. Each of the villages associated with the five Bohol sanctuaries has a Peoples' Organisation (PO) which is involved in all aspects of sanctuary management. Community participation has and will continue to provide important insights with regard to interpretation of the monitoring data for adaptive management.
- Activities focused more on people than marine life in designing and planning MPAs, using community development specialists called Community Organisers (COs) to facilitate strong Peoples' Organisations, in partnership and with support from biologists.
- Technical and financial support with a strong presence on the ground has provided communities and local governments with help, encouragement and guidance, as well as technical input, training and funds (Project Seahorse).
- Analysis of monitoring data of reef fishes over seven years provides some convincing evidence of positive impacts of the sanctuaries though the results are complicated by natural variation. Positive impacts were, not surprisingly, primarily seen in the three sanctuaries (Handumon, Batasan and Asinan) that are well enforced. In these, the densities of groupers (Serranidae) and breams (Nemipteridae), key target species in the local fisheries, increased significantly in the sanctuaries compared to distant unprotected (control) sites. These density increases in the sanctuaries over time were also seen just outside the sanctuary boundary though at lower densities, providing some suggestion of spillover of these two fish groups. These positive impacts no doubt contribute to community acceptance of MPAs. A further point for acceptance might be the small size of the sanctuaries, so that spatial reduction in the overall fishing area is less significant, and easier to manage in logistical terms (Samoilys *et al.* 2006).
- A strong legislative framework to complement community management activities, with increasing financial allocation to MPAs was essential for the success of MPA implementation.
- Extensive awareness campaigns on the benefits of sanctuaries for improved fisheries and hence improved livelihoods, and activities such as cross-visits to well-established sanctuaries (e.g. Apo Island) have been an effective tool for building awareness and understanding.

### *3.7.3 Challenges*

- Long-term financial sustainability is one of the key challenges that the Bohol sanctuaries face, because many of the sanctuaries have relied on external aid for financial support. To address this issue, recently drafted MPA ordinances now specify that the LGU should allocate funds from its annual budget for MPA management. With the codification of budget allocation, communities can now claim a yearly allocation from municipal governments.
- Technical capacity is still lacking at the village level and to some extent at the municipal level, given that guidance has largely been provided by outside partners in the past. Development of a local technical resource institution would be recommended.
- Another key challenge for the Bohol sanctuaries is compliance. Three of the five focal sanctuaries were found to be well enforced. Illegal fishing in the sanctuaries continues to be a problem: poor or non-existent enforcement in the other two may reflect a lack of resources by villagers to keep outside offenders out since village management teams often state that poachers are fishers from neighbouring villages. It may also reflect local social infrastructure – those MPAs that were well enforced are those with relatively strong POs.
- Monitoring of CPUE in the fisheries surrounding the MPAs started late in 2003 – well after sanctuaries were established, and therefore direct improvement in neighbouring fisheries cannot yet be empirically demonstrated.
- Government participation has been weak.
- Rapidly increasing local human populations negate many of the MPA benefits.

### *3.7.4 Lessons learnt*

- Local fisher participation and consultation is important from the onset. It should continue during all stages of planning and implementation, with an emphasis on capacity building.
- Building capacity should target local communities, MPA managers, municipal government units, and MPA technical resource institutions.
- Accurate and regular monitoring of key fishery indicators (bio-physical, socio-economic and fisheries) is essential to demonstrate causal relationships between sanctuaries and fisheries. Local communities must be involved in this including the interpretation of monitoring data. A global analysis of key indicators relevant to these sanctuaries would be very helpful.
- The impacts of MPAs on different sectors of the community (poorest, inshore, women, children) need to be assessed and disproportionate efforts adapted.
- Adequate funding, logistics, and institutional support must be provided for ongoing enforcement by local communities and fisheries management agencies. Detailed measures of enforcement, compliance and community participation in sanctuaries are important to fully understand the factors that contribute to successful sanctuary management.
- Strengthen other fishery legislation such as gear restrictions and licensing needs to be put in place to complement, and be integrated with MPAs.
- The adaptive management cycle in which sanctuary plans are reviewed and revised based on analysis of monitoring data (bio-physical and socio-economic) needs to be put in place and supported (financially and technically).

## 3.8 Case study G: Incorporating MPAs into a set of existing fisheries management measures in Antarctic high seas areas

Experience in Antarctica provides a useful case study on recent progress and remaining challenges of developing marine protected area (MPA) systems within an existing regional fisheries management

framework. At the same time it provides one of the very few concrete examples for establishing area-based measures in waters beyond national jurisdiction (i.e. on the high seas). This case study highlights the recent recognition by a regional fisheries management body that MPAs have considerable potential as a tool for use towards the implementation of an ecosystem-based approach to marine conservation and fisheries management, in an area that is characterized by a highly industrialized commercial fishery. This article largely references a recent article by Susie Grant (PARKS 2005).

### *3.8.1 Background*

The Southern Ocean, bounded by the Antarctic Continent to the south and the Antarctic Polar Front to the north, comprises around 10 percent of the world's oceans. It is characterized by highly seasonal primary productivity leading to huge quantities of herbivore species such as copepods, salps, and euphausiids (especially the Antarctic krill). Their predators have been major target species for human exploitation historically and until today. The benthic fauna of Antarctica is highly adapted and species rich, with exceptional levels of endemism.

The Antarctic Treaty System (ATS) provides the basis for the protection of the marine ecosystem. Development of MPAs falls under the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), and the Antarctic Treaty and Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol) (FIGURE 9). Both instruments have developed area-based measures for protection and management in marine areas.

The two main tools for area protection and management under the Madrid Protocol are: Antarctic Specially Protected Areas (ASPAs) and Antarctic Specially Managed Areas (ASMAs).

ASPAs correspond to IUCN Category I protected areas (Strict Nature Reserve), and require a permit for entry and other activities such as scientific study. There are currently six marine ASPAs (as well as nine terrestrial areas with small marine components), covering a total marine area of approximately 1 800 $km^2$, or 0.012 percent of the marine area south of 60° S. These are some of the few high seas MPAs currently in existence worldwide, however the majority are *ad hoc*, coastal areas of limited extent. None are located in areas in which there is any fishing activity, and none have been designated as "representative examples of major marine ecosystems" as required by the Madrid Protocol (Annex V, Article 3.2).

ASMAs correspond to IUCN Category IV protected areas (Habitat/Species Management). They are designed to help manage and co-ordinate activities based on a non-mandatory code of conduct for multiple uses. Three current ASMAs include marine components (although one of these has not yet been formally adopted), but this tool has the potential for much wider use to strengthen management and provide codes of conduct in areas of intensive use. These areas do not require a permit for entry.

CCAMLR is a pioneer of the ecosystem approach to fisheries management, aiming at the conservation and rational use of Antarctic marine living resources. These include populations of fin fish, mollusks, crustaceans and all other species of living organisms found south of the Antarctic Convergence (CCAMLR 2004, Article I, II). It has a wider conservation mandate than any other Regional Fisheries Management Organization (RFMO). A Commission and a Scientific Committee oversee implementation of the Convention.

The entire area covered by the Convention can be classified theoretically as an IUCN Category IV protected area (Habitat/Species Management), because of the level of overall management it provides: Conservation measures defined by CCAMLR include closed seasons, catch and effort limits for particular species, restrictions on the number of vessels permitted to fish in each season, gear restrictions, limits on by-catch of other fish species, and measures to mitigate the effects of fishing on associated and dependent species. CCAMLR also has a variety of area-based management tools that provide protection.

Amongst these area-based tools are Closed Areas for the purposes of scientific study or conservation, including special areas for protection and scientific study. Closed Areas have to date been implemented only on a species-specific basis, although two areas off the Antarctic Peninsula remain closed to all fin-fishing to allow stock recovery. Other Closed Areas include regions closed to fishing by species and season, and areas for protection of benthic habitats where fishing is prohibited in depths of less than 550 m. Areas may also be closed immediately once catch limits or by-catch limits for fish or seabirds have been reached (FIGURE 10).

Additional tools include geographically defined units used to assist with the implementation of fisheries management measures. Small Scale Research Units (SSRUs) are used to apply catch restrictions and research requirements for new and exploratory fisheries for toothfish (*Dissostichus* spp.), defining catch limits of zero (thus effectively closing the area to fishing for these species) in several locations. Small Scale Management Units (SSMUs) are used to facilitate management of the krill fishery, and aim to distribute fishing effort and reduce the potential for localized depletion of krill populations and impacts on land-based predators. No areas of fishing activity have been permanently closed to all types of living resource extraction.

The provisions and restrictions of individual area-based management measures applied here build a useful starting point for the development of MPA tools and implementation systems, whereas no MPA as such has been officially declared in Antarctic waters yet (areas have been declared due to their importance for science rather than conservation). The following describes recent progress towards rather than results from MPA effectiveness assessments.

### *3.8.2 Recent progress*

Discussions on the development of MPAs within the CCAMLR context have recently advanced acceptance of conservation objectives into the fisheries management regime, and of fisheries no-take reserves: a workshop held in September 2005 identified specific conservation objectives for potential Antarctic MPAs, priorities for the types of areas to be considered for protection, and the types of scientific information required for the development of representative MPAs. The potential benefits of MPAs for biodiversity conservation, minimization of impacts of harvesting on non-target species, and protection (including restoration) of stocks and life history stages of target species were noted by CCAMLR Members. The positive workshop outcomes furthermore indicate an increasing willingness by CCAMLR Members to take action towards developing and testing new approaches for establishing MPAs that further the objectives of CCAMLR.

### *3.8.3 Challenges and lessons learnt*

- There is a need for interaction and coordination between the two ATS instruments on the development of marine protected area strategies. Parties to the Antarctic Treaty and the Madrid Protocol do not have the authority to manage harvesting of marine living resources however with CCAMLR's approval it can designate ASPAs that would restrict marine living resource harvesting (no ASPAs have yet been designated where this is the case). Further interaction and coordination between the two instruments could include the development of networks of protected areas to achieve both fisheries and biodiversity conservation objectives, and the designation of representative MPAs throughout the Southern Ocean.
- The CCAMLR area extends north of 60°S, thus covering a much larger area than the Antarctic Treaty and the Madrid Protocol. ASPAs and ASMAs cannot be applied in the entire area north of 60°S. There is a need to develop a strategic approach to MPA design and implementation throughout the CCAMLR area, and any regime for protection of the marine environment should be harmonized with measures already taken under the Antarctic Treaty and the Madrid Protocol.
- Although progress is being made, long-term biological data on the ecosystem and its functions is still very sparse. More information is needed with which to identify areas for protection.

- Year-round enforcement of the regulations established remains a challenge in the Antarctic environment.
- Although CCAMLR has designated Closed Areas to support its precautionary approach to managing fin-fisheries, these have not been established for broader purposes relating to MPAs.
- Recent CCAMLR discussions and decisions also have relevance for high seas marine protected area development worldwide: there is potential for concepts and models currently developed by CCAMLR to be used for high seas development elsewhere, and to appropriately apply them in relation to other management measures, particularly for fisheries. The concept of MPAs established under fisheries management frameworks (such as CCAMLR) but within a wider conservation context (such as that provided by the Antarctic Treaty with the Madrid Protocol) may be particularly applicable for high seas MPAs worldwide.
- Priorities for future work on MPA development within the CCAMLR context include wide consultation with appropriate interest groups and stakeholders, and the development of flexible decision-making and review procedures. To achieve maximum benefits, MPAs must be implemented within, and contribute to, the wider framework of sustainable fisheries management.

### 3.9 Discussion of the case studies

The case studies described throughout this paper illustrate different success features which MPAs can provide for achieving fisheries management objectives, as well as their challenges and limitations. Given the variety in scope, ecosystems, social, economic, ecological and governance context of MPAs covered, and not least availability of supporting data and information, the first point they make is that there is no standard recipe for identifying their individual role and determining their set up.

A common feature that reappears throughout is the idea of developing MPAs that complement existing fisheries management regimes, and vice versa, towards implementation of an ecosystem-based approach to both conservation and fisheries management. Recent advances have been made in Antarctica of developing MPAs in Antarctic high seas areas where multiple-state industrial fisheries are regulated through existing fisheries management regimes.

The stakeholder process of designating no-take MPAs in the Channel Islands emphasises the importance of integrating reserve design and science with the fisheries management system. A cost-intensive process that included a large array of user groups from different sectors has been put in place for this reason. Given the wealth of lessons learned, this case study focuses entirely on stakeholder processes.

Several of the other case studies also highlight the need for full participation and ownership by local stakeholder groups to make MPAs work and meet sustainable fisheries objectives. While the Philippines case study provides an illustration of nineteen small-scale no-take MPAs that are fully implemented, managed and enforced by local subsistence fishing communities (villages), a series of collaborative management areas are established by user-groups in Tanzania in combination with a long-term fisheries monitoring programme.

Careful monitoring of the fisheries and their associated bio-physical and socio-economic context in and around MPAs is also documented in other cases, and should ideally lead to adaptations in MPA management if changing states are documented. The Great Barrier Reef Marine Park provides an example of where such adaptive management is practiced at the scale of a large multiple-use MPA. It is zoned to allow for differing human activities, including limited fishing and no-take areas, to an extent that ensures a healthy condition of the overall ecosystem.

The case study from Banc d'Arguin National Park showcases how fisheries management objectives may be successively integrated into MPAs with conservation objectives, even if conservation objectives have been long established and conditions for efficient monitoring and enforcement are

difficult. Full integration the residential communities and their traditional resource use patterns inside an MPA is a key characteristic of this case, as is the role of the large-scale MPA for protecting critical life stages of commercially important fish species.

A crucial issue for all the case studies presented is that legal tools for MPA management be embedded within existing legal frameworks, and that new tools be also developed. Granting territorial use rights to local fisher communities in Chilean near shore zones has led to a rapidly increasing number of management areas for sustainable exploitation of benthic resources in Chile. A clear sense of local ownership could thus be established that led to overall improved conditions for fisheries management.

MPAs are emerging as a significant tool in the toolbox of fisheries management options. They can complement other fisheries management options and provide an additional safety net or insurance policy in case other options fail (Guénette *et al.* 1998; Russ 2002), or even an opportunity for other restrictions to be less severe.

The following section will present key elements, or 'messages', that have been extracted from the presented case studies for consideration and further discussion during this workshop.

## 4. RECOMMENDATIONS FOR TECHNICAL GUIDELINES AND FUTURE DIRECTIONS IN MPA RESEARCH

### 4.1 Key elements for consideration and recommendations

This section provides a set of recommendations and 'ingredients' for consideration when developing technical guidelines focused on MPAs as a tool for fisheries management. Given the wealth of lessons and recommendations resulting from MPA experiences globally, this listing does not seek to be complete. It rather provides a set of 'conventional' experiences that can be complemented with more innovative approaches (such as vertically zoned, migrating or rotating MPAs for example). It is recommended that the FAO consultative workshop improves, expands and agrees on this list on the basis of further information and reviews available (e.g. Defra 2006 for North Sea and Northeast Atlantic; Bernstein *et al*. 2004 for MPAs in United States waters; or e.g. Simard and Lundin 2005). Further research and testing is needed, and the paper concludes with a brief discussion of the most pressing needs.

### 4.2 The MPA planning and designation process

#### *4.2.1 Well defined goals and objectives*

MPA goals and objectives need to be clearly defined when the MPA is in the planning stage. The role of the MPA in fisheries management needs to be captured in these objectives. Many MPAs are established with biodiversity conservation objectives, but they can also have significant benefits to fisheries, which are often not recognized or articulated by the conservation community.

Fisheries as well as MPA managers should take advantage of such MPAs and strive to ensure that they do also capture defined fisheries management objectives in their plans and design. On the other hand, MPA management should be realistic and critical to what stock enhancement can be achieved by the MPA, and where other, complementary fisheries management measures are likely to be more effective. There is abundant evidence that area closures for fisheries can also benefit benthic biodiversity and enhance habitat complexity (e.g. Sweeting and Polunin 2005). An individually adapted combination of tools seems thus to be the most practical way to go.

MPAs that include fisheries management objectives in addition to conservation objectives can help to bridge the gap between MPAs and tools specifically designed for fisheries management. They

therefore may create synergies between the practitioners and management authorities, which can also pool resources and synergize monitoring so that it is consistent and includes fish stocks/fisheries.

### *4.2.2 Full stakeholder involvement*

Stakeholder engagement in MPAs is critical to their success, whether in the developed or developing world. The engagement needs to start from the very beginning at the conceptual/design phase of the MPA and continue throughout the review, evaluation and adaptive management cycle.

Representatives from all stakeholder groups need to be involved regardless of who is the driving force behind the MPA, whether government, community group, or other, must consult all stakeholders likely to be affected at different scales, and bring them into the MPA planning, implementation, monitoring and assessment process. Mechanisms for doing this will vary greatly from one situation to another, but advisory committees or coordination committees are obvious mechanisms and can comprise representatives from as broad a base of stakeholders as is relevant. If this step is ignored, or only partially considered due to financial or management constraints, the chances of opposition and resistance are great. For an MPA to be successful local stakeholder support must be guaranteed (otherwise they are likely to undermine the whole process).

Direct interaction between scientists, managers and users is particularly important in the monitoring, evaluation and adaptive management cycle (see below), but also more broadly to ensure stakeholder relations are cordial and that trust is built and maintained. This takes time and effort, trial and error, but will be important to prevent a breakdown of relations between stakeholders which can undo all the management on the ground. It is of key importance that stakeholders both within and beyond MPA boundaries are included. A fully open debate on the appropriate application of MPAs is often necessary to avoid public distrust and political manipulation that has recently dogged fisheries scientists and managers (Kaiser 2004).

There is an evident lack of synergy between fisheries and environment legislation, which is often also reflected in lack of interaction between the managers of both sectors. A strong commitment from governments and their institutions, cohesion and working together needs to be fostered if all sectors, including the fishing industries, are to understand the potential of MPAs as part of a comprehensive ecosystem-based fisheries management scheme, in order to develop the most effective and efficient means of achieving responsible fisheries. An analytical and honest approach towards MPA potential and limitations for sustaining fisheries *vis-à-vis* other fisheries management tools, free of all uncritical advocacy from the sectors involved, can significantly strengthen these synergies.

### *4.2.3 Building capacity*

It is clear that the building of capacity in local communities as MPA managers, and in local government as MPA technical resource institutions, is vital for the long term sustainability of MPAs. Training programmes and long term funding support need to be generated so that capacity can continue to be built in an inter-disciplinary way. This would also include enhancing knowledge and understanding of fisheries measures and objectives by MPA managers and conservation and biodiversity considerations for fisheries officials. Technical training in monitoring, evaluation and adaptive management is particularly helpful to local resource users and managers in developing countries and needs to be done on a regular basis (e.g. yearly).

## 4.3 The legal and institutional frameworks

### *4.3.1 Enforcement*

Illegal, unreported and unregulated (IUU) fishing creates significant challenges to fisheries managers. MPAs offer a (smaller scale) opportunity to address IUU through establishing a strong enforcement/compliance scheme, though this requires strong commitment and resources. Such a

scheme can provide an opportunity to enforce national/regional fisheries regulations (e.g. gear restrictions) that may otherwise not be enforced against both local and foreign fishers due to inadequate resources or poor commitment.

#### *4.3.2 Harmonizing MPAs with other fisheries management legislation and existing legal frameworks*

The MPA manager should incorporate existing fisheries legislation into the MPA management plans wherever possible. MPAs that manage to enforce previously un-enforced national fisheries legislation will enhance the sustainability of local fisheries (assuming national legislation is appropriately designed for this). This is particularly so in developing countries (see Mauritania, Tanzania and Philippines case studies). Conversely, in the absence of fisheries rules and regulations on national/regional levels, MPAs can provide an opportunity to apply an area-based, ecosystem-based approach which will protect sub-populations of certain stocks. This can create refuges of spawning stock biomass, as well as protect breeding and/or nursery grounds. It is thus crucially important that legal tools for MPA management be developed or embedded within existing legal frameworks. In this way governments are not overly challenged to incorporate them and community initiatives can be given legal support from a national level.

#### *4.3.3 Institutional frameworks*

One of the challenges will be promoting and strengthening synergies between fishery legislation and environment/conservation legislation. In many countries fisheries management responsibility is within one Ministry (e.g. of Agriculture) whereas environmental management with a more conservation/protection focus comes under another Ministry (e.g. Environment), although institutional responsibilities vary.

Research that assesses the relative merits of different governance systems for MPAs in different cultural, political and socio-economic situations would be very useful for developing guidelines for legal frameworks for MPAs (on a regional scale, this could for example include examining the potential of inter-governmental commissions and similar governance units).

### 4.4 Sustaining MPA benefits

#### *4.4.1 Monitoring and evaluation*

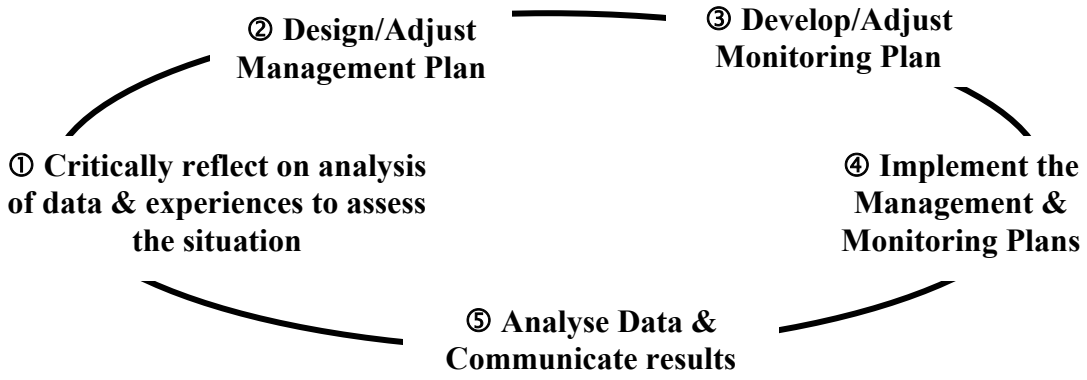
Careful monitoring of the fisheries and their associated bio-physical and socio-economic context in and around the MPA must be put in place. This needs to be done before and after MPA establishment if MPA effects are to be assessed, and the predominating gap in before-and-after change impact analysis (BACI) needs to be addressed (see Sweeting and Polunin 2005). The importance of monitoring and assessment is generally well recognized, although MPA managers often fail to seek suitable advice and expertise to put the right monitoring programme in place. A number of factors must be considered including resources, technical capacity and the long term sustainability of the programme, since the latter is crucial. For example, an MPA might be established with financial support from a donor. However, donors rarely want to fund long term monitoring programmes. Therefore such programmes need to be considered during financial sustainability assessments and built into local MPA budgets (often government funds).

Choosing suitable indicators is integral to an effective monitoring programme. Indicators need to be specific to the objectives of the MPA, relevant to the resource managers, measurable (in terms of cost, logistics and replication), sensitive to change, and responsive within a reasonable time period (Pabari *et al.* 2005). Deciding on suitable indicators may require research (see Future Research section below), and certainly requires input from relevant experts.

*4.4.2. Adaptive management*

Although the concept of adaptive management is now well documented, it is regrettably still rare to find it being used properly. Adaptive management "*incorporates research into conservation action*. Specifically, *it is the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn"* (Salafsky *et al.* 2002).

Effective adaptive management requires managers to complete all steps in the cycle illustrated below (taken from Pabari *et al.* 2005):




This adaptive management cycle needs to be incorporated into the MPA management plan, supported by monitoring and data analysis. One of the steps that is often not given due consideration is critical reflection on the results of the data analysis. This should also involve consultation with stakeholders to verify interpretations of the results are plausible and practically applicable in the respective socio-economic context. In this way recommendations for management changes, where needed, are based on critical assessment and collaboration. Options for management change need to be a formal part of the MPA's management plan – e.g. to be reviewed every three years.

This is even more important in the face of rapidly changing climate conditions that affect species compositions and habitats as well as fish stocks.

There is a need and demand for new innovative approaches to fisheries management and appropriate combinations of established tools and new approaches (FAO Code of Conduct 1995; FAO 2005). Continuously adaptive and participatory management processes with the broadest possible array of stakeholders will be needed to best assess and validate such approaches (Agardy *et al.* 2003; Carr and Raimondi 1999).

*4.4.3. Financial sustainability*

One of the major limitations in effective MPA implementation (usually within a biodiversity conservation context) is funding. Funding mechanisms need to be set in place early in the design of an MPA, with long term sustainability in mind. Often, MPA plans are over-ambitious and consequently not realized due to inadequate funding. Priorities, for example for enforcement and monitoring, need to be considered and a regular source of funds identified. If this is through local or national government, the merits of the MPA often need to be justified. Management of fisheries and the link with peoples' livelihoods may be a better message to send to the government than biodiversity conservation alone.

Revenue generation, e.g. from fishing levies, cost sharing among stakeholders and other fund generating ideas, needs to be put in place at the start of the MPA. A wide range of funding options

exist, and they will vary widely from country to country and between fisheries. Generally, three sources of funding are available: government, donors, and self-generating activities. The following mechanisms for financial sustainability can be considered: (i) cost effective implementation; (ii) revenue collection from use of the MPA (may be fisheries, tourism, etc); (iii) equitable revenue sharing that reinforces local management efforts; (iv) precautionary instruments that provide safety nets; and (v) sharing of revenue between MPAs (Ruitenbeek *et al.* 2005).

## 4.4. Ecological considerations – some aspects

### *4.4.1 Habitat protection and restoration*

It is logically evident, but difficult to quantify the benefit that healthy (protected) habitats have for certain fisheries (Sweeting and Polunin 2005). MPAs which ban fishing gear with high impact on benthic features (such as towed gears) clearly protect seafloor habitats. A recent series of case study reviews from Northeast Atlantic temperate waters (Defra 2006) describe that area closures, if combined with effort removal, generally lead to increases in associated fauna, habitat complexity and increased survival in fish species. MPAs thus play a role in preventing damage from bottom contact gear especially to biogenic, slow growth-recovery habitats (as e.g. maerl beds, deepwater corals, sponge communities). In contrast, habitats subject to frequent natural disturbance are rather unlikely to benefit from MPAs.

### *4.4.2 Spawning and nursery site protection*

The situation is somewhat different as spawning and nursery sites are concerned. MPAs can provide protection to vital breeding and nursery areas of important fishery species, and although these species may range well beyond the MPA boundaries, these critical life history stages remain protected at a time when they are particularly vulnerable and easy to exploit. The Mauritania and Australia case studies illustrate these benefits. Other examples include the protection of spawning aggregation sites. Many species migrate predictably to certain sites to spawn in large numbers. Protection of these sites is vital, particularly if the species is subjected to heavy commercial fishing pressure (Sadovy and Domeier 2005). The Nassau grouper, *Epinephelus striatus,* in the Caribbean provides a clear example of this. The species was fished to the brink of extinction because spawning aggregations were specifically targeted by commercial fisheries (Sadovy 1993). Eventually several fisheries collapsed. Some have never recovered, such as those in Cuba and Bermuda, while others have only very recently been protected, such as in Belize. In the Cayman Islands, management has been in place for a number of years and the aggregations although reduced, still exist (Sadovy 1999). The existence of spawning aggregation sites needs to be determined early in the establishment of the MPA so that zoning of the MPA can take these sites into consideration.

**In summary**, it is recommended that these technical guidelines for using MPAs are combined with the information gained from tracking the benefits of MPAs for different fisheries (see below) into a Toolkit for using MPAs for fisheries management. Such a Toolkit would provide fisheries managers with a hands-on reference tool with clear steps, guidelines, reference sources and contacts. A similar Toolkit has been developed for MPA managers in the Western Indian Ocean (IUCN 2004), but this encompasses all aspects of MPAs. Having a Toolkit that addresses fisheries specifically could be a very useful tool.

## 4.6 Future directions in MPA research

### *4.6.1 Indicators for MPA success*

It is critical that indicators for measuring the effectiveness of MPAs as a fishery management tool are developed, and these have to be based on empirical assessment. Criteria for selecting suitable indicators are discussed in the section above. All too frequently inappropriate indicators are selected and the opportunity to monitor MPA impacts will be lost. Small scale, multi-species fisheries with

multiple gear/vessel types and landing sites, typical of tropical coastal waters in developing countries (Munro and Williams 1985; Wright and Hill 1993), are particularly hard to measure precisely and therefore need to be very carefully tested to detect MPA effects for these types of fisheries. It is highly recommended as a first step that a global meta-analysis of datasets around the world on priority fisheries be conducted to determine suitable indicators. These can then be tested as new MPAs are established and trialed for particular fisheries.

In addition to developing suitable indicators based on sound science, monitoring design and data analysis protocols need to be defined for MPAs and associated fisheries. Often monitoring occurs, but data analysis is limited or absent. Analysis, evaluation and adaptive management cycles need to be put in place and this can be challenging where resources and capacity are limited (but see Pabari *et al.* 2005). Research that addresses these gaps would be extremely useful and the protocols developed could be incorporated in a Toolkit for MPA fisheries management (see section above on guidelines).

### *4.6.2 Track the benefits of MPAs for different species/fisheries worldwide*

It would be hugely beneficial if an organization such as FAO were to track and analyze fisheries management successes over a period of time, say for the next five years, and to record where MPAs have been used, and to what extent, in conjunction with other fisheries management tools. This could be assimilated into a database of information from which fishery or species specific recommendations could be derived. For example, if demersal coral reef fisheries around the world are seen to be more sustainable when MPAs are involved, then one can recommend MPAs as one key tool for the management of such fisheries. Where MPAs show no benefits to a specific fishery after thorough checking, emphasis needs to be put on more suitable fisheries management tools instead. The database would enable the relative merits of MPAs for managing pelagic fisheries to be assessed, and ultimately could determine criteria for fisheries that are best suited to be covered by area-based management.

### *4.6.3 Fisheries models*

Incorporating area-based input controls (MPAs) into fisheries models will give fisheries researchers the opportunity to assess the relative merits of MPAs among the suite of tools employed in managing a fishery. This approach has started (Cefas 2005; Guénette *et al.* 1998; Stefansson and Rosenberg 2005) but needs to expand to cover the wide range of fisheries being managed by MPAs. Such models can quantify the merits of different fishery management options and these can then be presented to fishers and the options discussed. For example, it may transpire that for a particular fishery, an area restriction or closure is in fact less restrictive to a fisher than an effort or gear control throughout the fisher's range of operation. Although either option may be sufficient for sound fishery management, the area restriction may suit the fisher better, and without the model such scenarios may not have been apparent.

Scientific uncertainty and a persisting lack of empirical data on larger, mobile marine organisms in the open ocean is another constraint. Some fish stocks may be too mobile for site-specific approaches (Kenchington *et al.* 2003). Yet the applicability of area-based ecosystem management in the open ocean context is beginning to take hold, particularly as scientists are learning more about the importance of ocean 'hotspots' such as convergence zones and above benthic features like seamounts. Norse *et al.* (2005) note that a modeling study of Mediterranean hake (*Merluccius merluccius*) led Apostolaki *et al.* (2002) to conclude that "yield and spawning stock biomass benefits can be obtained through the use of a marine reserve even for highly mobile fish and underexploited fisheries." Wherever the mobility of adults is high, reserves have often been discounted as an effective management tool in the past. But even for highly migratory species such as swordfish or tunas, MPAs that protect nursery areas or vulnerable population bottlenecks may be effective management tools (NRC 2001). Such modeling approaches need to be continued to assess the applicability of MPAs for highly mobile species.

Models can furthermore usefully assess the case-to-case applicability of new (and still rare) MPA approaches such as vertical zoning schemes of an MPA, and the benthic-pelagic coupling to determine the best-suitable form of the zoning. So far, there are MPAs which only cover the seabed (determined useful for e.g. hot vents and cold seeps), while other MPAs apply a vertical 'buffer zone' to include the above water column in the protection scheme. Designating vertical MPA categories, such as applied in Tasmanian seamount reserves (FIGURE 1; AXYS 2003 about Koslow *et al.* 1998), thus needs to consider not only the seamount habitat itself, but also some migratory pelagic species of commercial value that tend to congregate above them. Given the likeliness that more vertically zoned MPAs may be established within the coming years, it is thus necessary that the benthic-pelagic coupling of the specific feature is studied in detail and that the zoning structure be adapted to the results from these studies.

### *4.6.4 Assessing suitability of MPAs for different fisheries*

The effectiveness of MPAs for the large number of fisheries that have not yet employed area based controls such as various cold water/deep water demersal fisheries, open water pelagic fisheries, fisheries based on highly migratory species and others, needs to be properly assessed (FAO 2005; Hilborn *et al.* 2003; Kaiser 2004; McManus 2004; Agardy *et al.* 2003; Lubchenco *et al.* 2003; Jones 2002).

Research directed at assessing MPA effectiveness for fisheries management requires (i) suitable designs before and after MPA implementation; (ii) adequate replication and controls, (iii) suitably sensitive indicators defined and tested; (iv) criteria for MPA success defined; and (v) long-term evaluations and monitoring. Practically, such research tends to use a suite of fishery variables as the MPA is implemented, and through analysis suitable indicators among the variables become apparent. Such indicators may range from female spawning biomass, average fish size, egg production, yield per recruit, etc. Indicators can inform researchers and managers whether the MPA is equally effective, less effective, or more effective than other conventional management options, and analyses will quantify the relative merits of different management options. It is only through this sort of rigorous research and analysis that we will know how useful MPAs are across the broad spectrum of fisheries. Models are particularly useful for examining various scenarios, and varying the different management options including MPA type and size (e.g. Atlantic cod, Polachek 1990; prawns, Die and Watson 1992; reef fishes, DeMartini 1993; surf zone South African Fishes, Attwood and Bennett 1995).

For those fisheries that are relatively well understood in an MPA context, such as coral reef fisheries, there are still several gaps. The link between MPAs and improved livelihoods of coastal people dependent on marine resources is an area that requires quantification. Research is also needed to assess MPAs for tropical fisheries of other ecosystems such as seagrass beds and sand/mud substrates.

An ecosystem based research approach is also needed to understand the broader ecological impacts of fishing (see COMPASS 2004; Murawski 2000) in order to assess if and how various MPA types can be used to control negative habitat impacts from fishing. Another area that requires research is MPA size. Several modeling and fish movement studies have asked this question, though certainly not across the spectrum of fisheries, and the answers are likely to be fishery or species specific. This research should not only consider ecological factors but also social factors and the behaviour of fishers or the dynamics of the fleet.

### *4.6.5 Legal frameworks*

It would be very useful to assess the relative merits of different governance systems for MPAs in different cultural, political and socio-economic situations. A global analysis might reveal interesting models from which guidelines for suitable, integrated legal frameworks for MPAs and fisheries management tools could be developed in particular contexts.

### *4.6.6 Addressing financial constraints*

Availability of financial resources also remains a constraint for inventorying, managing and monitoring the effectiveness of MPAs to meet fisheries objectives. Some argue that the amounts needed to achieve major marine conservation goals worldwide are less than what is spent on fishing subsidies and would have profitable returns (Balmford *et al.* 2004). Economic valuation of marine ecosystems to date has focused almost entirely on easily quantifiable terms such as commercial fisheries and tourism, it is increasingly recognized that additional aspects need to be considered, such as exploitation of corals, mangroves and shells, 'ecosystem services', possible future uses, and values irrespective of use (cultural, aesthetic, scientific, bequest and heritage significance) (Salm *et al.* 2000). Further research along these lines could support identification and definition of the role of MPAs, and in turn identify sources of funding for MPAs.

**ACKNOWLEDGEMENTS**

A number of colleagues contributed information and ideas to this paper, to whom we are very grateful. For their valuable contributions we would like to thank Matthieu Bernardon, Amado Blanco, Alex Brown, Gustavo San Martín Catalan, Kevern Cochrane, Harlen Cohen, Kristina Gjerde, Susie Grant, Leanne Fernandes, Hassan Kalombo, Graeme Kelleher, Richard Kenchington, Brigid Kerrigan, Lee Kimball, Solomon Makoloweka, Imène Meliane, Jessica Sanders, François Simard, Keith Martin-Smith, Martin Russell, Philippe Tous, and Amanda Vincent.

Suggested citation:
Martin K, Samoilys M.A., Hurd A.K., and Lundin C.G. (2006) Experiences in the use of Marine Protected Areas with Fisheries Management objectives - a review of case studies. A report for the Food and Agricultural Organization of the United Nations. FAO, Rome, Italy. 56 pages.

**REFERENCES**

Agardy, T.; Bridgewater, P.; Crosby, M.P.; Day, J.; Dayton, P.K.; Kenchington, R.; Laffoley, D.; McConney, P.; Murray, P.A.; Parks, J.E. & Peau, L. 2003. Dangerous targets? Unresolved issues and ideological clashes around marine protected areas. *Aquatic Conservation: Marine & Freshwater Ecosystems* 13, 353-367.

Allison, G.W.; Lubchenco, J. & Carr, M.H. 1998. Marine reserves are necessary but not sufficient for marine conservation. *Ecological Applications* 8, S879-S892.

Apostolaki, P.; Milner-Gulland, E.J.; McAllister, M.K. & Kirkwood, G.P. 2002. Modelling the effects of establishing a marine reserve for mobile fish species. *Canadian Journal of Fisheries & Aquatic Science* 59, 405-415.

Attwood, C.G. & Bennett, B.A. 1995. Modelling the effect of marine reserves on the recreational shore-fishery of the south-western Cape, South Africa. *South African Journal of Marine Science* 16, 227-240.

AXYS Environmental Consulting Ltd. 2003. *Management direction for the Bowie seamount MPA: links between conservation, research, and fishing*. Report prepared for WWF Canada, Pacific Region, 72 pages.

Balmford, B.; Gravestock, P.; Hockley, N.; McClean, C. & Roberts, C.M. 2004. The worldwide costs of marine protected areas. *Proceedings of the National Academy of Sciences* 101, 9694-9697.

Barros, R. & Aranguez, R. 1993. *La Experiencia de los Pescadores Artesanales de Caleta Quintay en el Manejo de Recurso Bentónicos*, in Escuela de Ciencias del Mar, Universidad Católica de Valparaíso y Servicio Nacional de Pesca (eds.) Taller Áreas de Manejo, Valparaíso, Chile.

Bernstein, B.; Iudicello, S.; & Stringer, C. 2004. *Lessons learned from recent marine protected area designations in the United States.* A Report to the National Marine Protected Areas Center NOAA by the National Fisheries Conservation Center. XY pages.

Bohnsack, J.A. 1998. Application of marine reserves to reef fisheries management. *Australian Journal of Ecology* 23, 298-304.

Castilla, J.C. 1996. *The Chilean dived-invertebrate resources: Fishery, Collapses, Stock Rebuilding and the Role of Coastal Management Areas and National Parks*. Second World Fisheries Congress, 28 July-2 August, Brisbaine, Australia.

Castilla, J.C. 1999. Coastal marine communities: trends and perspectives from human exclusion experiments, *Trends in Ecology and Evolution* 14: 280-28.

Castilla, J. C. & Fernández, M. 1999. *Coastal marine community-ecosystem approaches in invertebrate multispecies management: "take" and "no-take" areas network and territorial use rights in fisheries (TURFs)*. In: Proceedings of the Norway/UN conference on the Ecosystem approach for sustainable use of biological diversity. Trondheim, Norway, 6-10 Sep. 1999. Pages 137-142.

Carr, M.H. & Raimondi, P.T. 1999. Marine Protected Areas as a precautionary approach to management. *CalCOFI Report* 40, 71-76.

Carr, M.H. 2000. MPAs: challenges and opportunities for understanding and conserving coastal marine ecosystems. *Environmental conservation* 27, 106-109.

Centre for Environment, Fisheries & Aquaculture Science (CEFAS). 2005. *Investigations into closed area management of the North Sea cod*. Report for United Kingdom Department for Environment, Food and Rural Affairs SFCD15. 98 pages. Web-source: http://www.defra.gov.uk/fish/science/index.htm

7th Conference of Parties on the Convention of Biological Diversity (CBD COP 7). 2004. Thematic problems of work: Review, further elaboration and refinement of the elaborated programme of work on marine and coastal biodiversity. CBD COP 7: Kuala Lumpur (Malaysia), 44 pages..

Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). 2004. SC-CAMLR-XXIII Report. CCAMLR: Hobart Australia, 680 pages.

Communication Partnership for Science and Sea (COMPASS). 2004. Synthesis of marine reserve science as it relates to fisheries management. COMPASS: USA, 27 pages.

Department for Environment Food and Rural Affairs (DEFRA). 2006. The potential role of Marine Protected Areas (MPAs) for fisheries management purposes: Fisheries Directorate's summary of the main conclusions emerging from three desk studies. Web-source: http://www.defra.gov.uk/fish/science/index.htm

DeMartini, E.E. 1993. Modeling the potential of fishery reserves for managing Pacific coral reef fishes. *Fisheries Bulletin* 91, 414-427.

Die, D.J. & Watson, R.A. 1992. A per-recruit simulation model for evaluating spatial closures in an Australian penaeid fishery. *Aquatic Living Resources* 5, 145-153.

Food & Agriculture Organization (FAO). 1995. Code of conduct for responsible fisheries. FAO Fisheries Department: Rome, Italy, 41 pages.

Food & Agriculture Organization. 1997. FAO Technical guidelines for responsible fisheries. FAO: Rome, 82 pages.

Food & Agriculture Organization. 2003. Fisheries Report No. 699. FAO: Rome, Italy, 27 pages.

Food & Agriculture Organization (a) Committee on Fisheries (FAO COFI). 2005. Marine Protected Areas and Fisheries. FAO COFI: Rome, Italy, 4 pages.

Fernandes, L.; Day, J.; Lewis, A.; Slegers, S.; Kerrigan, B.; Breen, D.; Cameron, D.; Jago, B.; Hall, J.; Lowe, D.; Innes, J.; Tanzer, J.; Chadwick, V.; Thompson, L.; Gorman, K.; Simmons, M.; Barnett, B.; Sampson, K.; De'ath, G.; Mapstone, B.; Marsh, H.; Possingham, H.; Ball, I.; Ward, T.; Dobbs, K.; Aumend, J.; Slater, D. & Stapleton, K. 2005. Establishing representative no-take areas in the Great Barrier Reef: large-scale implementation of theory on marine protected areas. *Conservation Biology* 1733–1744.

Garcia, S.M. & Cochrane K.L. (2005) The ecosystem approach to fisheries management. In: World Fisheries and Aquaculture Atlas, 3rd edition. FAO: Rome, Italy, 2005. [Z:\html\govern\capture\ecosysmng\default.htm ]

Garcia, S.M. & Grainger, R.J.R. 2005. Gloom and doom? The future of marine capture fisheries. *Philosophical Transactions of the Royal Society* 360, 21-46.

Gell, F.R. & Roberts, C.M. 2003. The fishery effects of marine reserves and fishery closures. WWF: Washington DC, USA, 90 pages.

Gerber, L.R.; Botsford, L.W.; Hastings, A.; Possingham, H.P.; Gaines, S.D.; Palumbi, S.R. & Andelman, S. 2003. Population models for marine reserve design: A retrospective and prospective synthesis. *Ecological Applications* 13, S47-S64.

Grant, S.M. (in press). Challenges of Marine Protected Area Development in Antarctica. In: *PARKS*, Issue 15.3: High Seas MPAs.

Green, S.J.; Flores, J.O.; Dizon-Corrales, J.Q.; Martinez, R.T.; Nunal, D.R.M.; Armada, N.B. & White, A.T. 2004. The fisheries of Central Visayas, Philippines: Status and trends. Coastal Resource Management Project of the Department of Environment and Natural Resources and the Bureau of Fisheries and Aquatic Resources of the Department of Agriculture, Cebu City, Philippines, 159 pages.

Guénette S.; Lauck, T. & Clark, C. 1998. Marine reserves: from Beverton and Holt to the present. *Reviews in Fish Biology and Fisheries* 8, 251-272.

Halpern, B.S. 2002. The impact of marine reserves: Do reserves work and does reserve size matter? *Ecological Applications* 13, S117-S137.

Halpern, B.S. & Warner, R.R. 2003. Marine reserves have rapid and lasting effects. *Ecology Letters* 5, 361-366.

Hilborn, R.; Branch, TA.; Ernst, B.; Magnusson, A.; Minte-Vera, CV.; Scheuerell, MD. & Valero, JL. (2003) State of the world's fisheries. *Annual Review of Environmental Resources* 28, 359–399.

Hilborn, R.; Stokes, K.; Maguire, J-J.; Smith, T.; Botsford, L.W.; Mangel, M.; Orensanz, J.; Parma, A.; Rice, J.; Bell, J.; Cochrane, K.L.; Garcia, S.; Hall, S.J.; Kirkwood, G.P.; Sainsbury, K.; Stefansson, G. & Walters, C. 2004. When can marine reserves improve fisheries management? *Ocean & Coastal Management* 47, 197-205.

Hutchings, J.A. 2000. Collapse and recovery of marine fishes. *Nature* 406, 882-885.

Hutchings, J.A. 2001. Influence of population decline, fishing and spawner variability on the recovery of marine fishes. *Journal of Fish Biology* 59, 306-322.

Hyrenbach, K.D; Forney, K.A. & Dayton, P.K. 2000. Marine protected areas and ocean basin management. *Aquatic conservation: Marine and Freshwater Ecosystems*. 10: 437 – 458.

International Council for the Exploration of the Seas (ICES). 2005. ICES Advisory Report 2005. Extract regarding NEAFC and OSPAR Request on Seamounts and Vulnerable Habitats. X Pages

IUCN. 1994. *Guidelines for Protected Area Management Categories*. IUCN, Cambridge, UK and Gland, Switzerland. X pages.

IUCN. 2004. *Managing marine protected areas: A Toolkit for the Western Indian Ocean*. IUCN Eastern African Regional Programme, Nairobi, Kenya. xii+172 pages.

Jones, P.J.S. 2002. Marine protected area strategies: issues, divergences and the search for middle ground. *Reviews in Fish Biology & Fisheries* 11, 197-216.

Kaiser, M.J. 2004. Marine Protected Areas: The importance of being earnest. *Aquatic Conservation: Marine & Freshwater Ecosystems* 14, 635-638.

Kathiresan, K. & Rajendran, N. 2005. Coastal mangrove forests mitigated tsunami. *Estuarine Coastal and Shelf Science* 65, 601-606.

Kelleher, G. 1999. *Guidelines for Marine Protected Areas*. IUCN: Gland (Switzerland), 107 pages.

Kenchington, R.; Ward, T. & Hergerl, E. 2003. *The benefits of Marine Protected Areas*. Australian Government Department of Environment & Heritage: Australia, 20 pages.

Kerr, A.M.; Baird, A.H.& Campbell, S.J. 2006. Comments on "Coastal mangrove forests mitigated" by K. Kathiresan and N. Rajendran [Estuar. Coast. Shelf Sci. 65 (2005) 601-606]. *Estuarine Coastal and Shelf Science* 67: 539-541.

Lauck, T.; Clark, C.W.; Mangel, M. & Munro, G.R. 1998. Implementing the precautionary principle in fisheries management through marine reserves. *Ecological Applications* 8, S72-S78.

Lawrence D., Woodley S. & R. Kenchington. 2002. *The Great Barrier Reef: finding the right balance*. Melbourne University Press in 2002.

Lubchenco, J.; Palumbi, S.R.; Gaines, S.D. & Andelman, S. 2003. Plugging a hole in the ocean: The emerging science of marine reserves. *Ecological Applications* 13, S3-S7.

Makoloweka, S. & Shurcliff, K. 1997. Coastal management in Tanga, Tanzania: a decentralized, community-based approach. *Ocean and Coastal Management* 37: 349-357.

Mapstone, B.D.; Davies, C.R.; Little, L.R.; Punt, A.E.; Smith, A.D.M; Pantus, F.; Lou, D.C.; Williams, A.J.; Jones, A.; Ayling, A.M.; Russ, G.R. & McDonald, A.D. 2004. The Effects of Line Fishing on the Great Barrier Reef and Evaluations of Alternative Potential Management Strategies. *CRC Reef Research Centre, Technical Report No 52.* CRC Reef Research Centre, Townsville, Australia.
Web-source: http://www.reef.crc.org.au/publications/techreport/techrept52.htm

Marcus, J.E; Samoilys M.A.; Meeuwig, J.J.; Villongco, Z.A.D. & Vincent, A.C.J. (in press) Benthic status of near-shore fishing grounds in the central Philippines and associated seahorse densities. *Marine Pollution Bulletin*.

Martin, K. 2005. MPAs and Fisheries: a situation synthesis from a literature review. IUCN working paper, Gland, Switzerland, 5 pages.

Martin-Smith, K.M.; Samoilys, M.A.; Meeuwig, J.J. & Vincent, A.C.J. 2004. Collaborative development of management options for an artisanal fishery for seahorses in the central Philippines. *Ocean and Coastal Management*. 47:165-193.

McClanahan, T.R. & Kaunda-Arara, B. 1996. Fishery recovery in a coral-reef marine park and its effect on the adjacent fishery. *Conservation Biology* 10:1187-1199.

McClanahan, T. R. & Mangi, S. 2000. Spillover of exploitable fishes from a marine park and its effect on the adjacent fishery. *Ecological Applications* 10:1792-1805.

McClanahan, T.R.; Verheij, E. & Maina, J. 2006. Comparing the management effectiveness of a marine park and a multiple use collaborative management area in East Africa. *Aquatic Conservation: Marine and Freshwater Ecosystems* 16: 147-165.

McManus, R.E. 2004. Protecting some fish with no-take reserves is common sense. National Fisheries Conservation Center (NFCC): Ojai, USA, 1 page.

Meeuwig, J.J.; Samoilys, M.A.; Erediano, J. & Hall, H. 2003. *Fishers' perceptions of the seahorse fishery in central Philippines: interactive approaches and an evaluation of results. In*: Proceedings of the Putting Fishers' Knowledge to Work Conference, Fisheries Center, University of British Columbia, August 2001.

Munro, J.L. & Williams, D.M. 1985. *Assessment and management of coral reef fisheries: Biological, environmental and socio-economic aspects.* In: Proceedings of the 5th International Coral Reef Congress, C. Gabrie & B. Salvat (eds), 4: 545-578.

Murawski, S.A. 2000. Definitions of overfishing from an ecosystem perspective. *ICES Journal of Marine Science* 57, 649-658.

Murawski, S.; Rago, P. & Fogarty, M. 2004. Spillover Effects from Temperate Marine Protected Areas. In: Shipley, J. B. (ed) *Aquatic protected areas as fisheries management tools*. American Fisheries Society, 301 pages.

Murray, S.N.; Ambrose, R.; Bohnsack, J.A.; Botsford, L.; Carr, M.; Davis, G.; Dayton, P.; Gotshall, D.; Gunderson, D.; Hixon, M.; Lubchenco, J.; Mangel, M.; MacCall, A.; McArdle, D.; Ogden, J.; Roughgarden, J.; Starr, R.; Tegner, M. & Yoklavich, M. 1999. No-take reserve networks: Sustaining fishery populations and marine ecosystems. *Fisheries* 24, 11-25.

National Fisheries Conservation Centre (NFCC). 2004. Integrating marine reserve science and fisheries management: NFCC consensus conference. NFCC: Long Beach (USA), 33 pages.

National Research Council Committee on Ecosystem Management for Sustainable Marine Fisheries (NRC). 1999. Sustaining marine fisheries. NRC: USA, 184 pages.

National Research Council Committee on Ecosystem Management for Sustainable Marine Fisheries (NRC). 2001. Marine Protected Areas: Tool for sustaining ocean ecosystem. NRC: USA, 288 pages.

Norse, E.A.; Crowder, L.B.; Gjerde, K.; Hyrenbach, D.; Roberts, C.; Safina, C. & Soulé, M.E. 2005. 'Place-based ecosystem management in the open ocean.' *In:* EA. Norse & LB. Crowder (eds.) *Marine Conservation Biology: The science of maintaining the sea's biodiversity*. Island Press: Washington, USA.

Ogwang, V.; Medard, M. & Nyeko, J.I. 2004. Harmonised Beach Management Unit (BMU) Operational Guidelines for Fishing Communities of East African States. Lake Victoria Fisheries Organisation. Implementation of the Fisheries Management Plan for Lake Victoria.

Orensanz, J.M.; Parma, A.M.; Jerez, G.; Barahona, N.; Montecinos, M. & Elías, I. (in press) What are the key elements for the sustainability of "S-fisheries"? Insights from South America. In N. Erhardt, ed., *Proceedings of the Conference on the Scientific Bases for the Sustainability of Fisheries*, Miami, November 26-30, 2001.

Pabari, M.; Samoilys M.; Muniu, H.; Othina, A.; Thande, G.; Mijifha, P. & Matiru, V. 2005. Using Monitoring and Assessment for Adaptive Management: A Guide to the TCZCDP Information Management System. IUCN-EARO, Nairobi.

Palma, M. & Chávez, C. 2004. *Normas y Cumplimiento en Áreas de Manejo de RecursosBentónicos: Estudio de Casos en la Región del Bío-Bío,* mimeo, Department of Economics, Concepcion University, Chile.

Pascoe, S. & Mardle, S. 2006. *Economic impact of area closures and effort reduction measures in the North Sea*. CEMARE Report to the United Kingdom Department for Environment, Food and Rural Affairs. 38 pages. Web-source: http://www.defra.gov.uk/fish/science/index.htm

PARKS. 1998. Marine Protected Areas. Vol 8. IUCN, Gland, Switzerland, 64 pages. Web-source: http://www.iucn.org/themes/wcpa/pubs/pdfs/PARKS/Parks_Jun98.pdf

PARKS (in print) High Seas Marine Protected Areas. Vol 15.3. IUCN, Gland, Switzerland.

Pinnegar, J.K.; Polunin, N.V.C.; Francour, P.; Badalamenti, F.; Chemello, R.; Harmelin-Viviens, M-L.; Hereu, B.; Milazzo, M.; Zabala, M.; D'Anna, G. & Pipitone, C. 2000. Trophic cascades in benthic marine ecosystems: lessons for fisheries and protected-area management. *Environmental Conservation* 27, 179-200.

Polacheck, T. 1990. Year around closed areas as a management tool. *Nat. Resour. Model*. 4, 327-354.

République Islamique de Mauritanie, Secrétariat Général du Gouvernement. 2004. Document de synthèse du Plan d'Amenagement et de Gestion du Parc National du Banc d'Arguin. 2005-2009. 52 pages.

Robinson, M.; Miller, C.; Hoeflinger, C. & Walker, B. Problems and recommendations for using GIS to improve decision-making in California's Channel Islands marine reserves. *MPA News*, 7(5):4-5.

Rowe, S. & Hutchings, J.A. 2003. Mating systems and the conservation of commercially exploited marine fish. *Trends in Ecology & Evolution* 18, 567-572.

Ruitenbeek, J.; Hewawasam, I. & Ngoile, M. 2004. Blueprint 2050: Sustaining the Marine Environment in Mainland Tanzania and Zanzibar. The World Bank, Washington D.C., USA.

Russ, G.R. 2002. Yet another review of marine reserves as reef fishery management tools. *In:* Sale, P.F. (ed) *Coral reef fishes: dynamics and diversity in a complex ecosystem*. Academic Press, New York, p 421-444.

Russ, G.R.; Alcala, A.C.; Maypa, A.P.; Calumpong, H.P. & White, A.T. 2004. Marine Reserve Benefits Local Fisheries. *Ecological Applications*. 14(2): 597-606.

Sadovy, Y. 1993. The Nassau grouper, endangered or just unlucky? *Reef Encounter* 13: 10-12.

Sadovy, Y. 1999. *The case of the disappearing grouper: Epinephelus striatus, the Nassau grouper, in the Caribbean and western Atlantic*. Proc. 45th Gulf. Carib. Fish. Inst. Mexico, November 1992. 22pp.

Sadovy, Y.J. & Domeier, M.L. 2005. Are aggregation fisheries sustainable: reef fish fisheries as a case study? *Coral Reefs* 24, 254–262.

Sainsbury, K. & Sumaila, U.R. 2003. 'Incorporating ecosystem objectives into management of sustainable marine fisheries, including "best practice" reference points and use of marine protected areas' in M. Sinclair & G. Valdimarsson (eds.) *Responsible fisheries in the marine ecosystem*. FAO: Rome (Italy), 343-361.

Salafsky, N.; Margoluis, R. & Redford, K. 2002. *Adaptive Management: A Tool for Conservation Practitioners.* Washington, D.C.: Biodiversity Support Program.

Sale, P.F.; Cowen, R.K.; Danilowicz, B.S.; Jones, G.P.; Kritzer, J.P.; Lindeman, K.C.; Planes, S.; Polunin, N.V.C.; Russ, G.R.; Sadovy, YJ. & Steneck, S. 2005 Critical science gaps impede use of no-take fishery reserves. *Trends in Ecology and Evolution* 20, 74-80.

Salm, R.V., *et al.* 2000. Marine and Coastal Protected Areas: a Guide for Planners and Managers, IUCN, Gland.

Samoilys, M.A.; Martin-Smith, K.M.; Giles, B.; Cabrera, B.; Anticamara, J.; Brunio, E.O. & Vincent, A.C.J. 2006. Fish responses over seven years in five coral reef sanctuaries in the central Philippines. Fisheries Centre Working Paper #2006-10. The University of British Columbia, Vancouver, Canada. [http://www.fisheries.ubc.ca/publications/working/series4.pdf].

Simard, F. & Lundin, C.G. 2005. Japanese fishing rights and biodiversity conservation. Summary paper submitted to the First International Marine Protected Areas Congress, Geelong, Australia, October 2005. 5 pages.

Stefansson, G. & Rosenberg, A.A. 2005. Combining control measures for managing fisheries under uncertainty: quotas, effort limitation and protected areas. *Proceedings of the Royal Society: B.* 360:133-146.

Stotz, W. 1997. Las áreas de manejo en la ley de pesca y acuicultura: primeras experiencias y evaluación de la utilidad de esta herramienta para el recurso loco. *Estud. Oceanol.* 16: 67-86 1997.

Subsecretaria de Pesca. 2004. Análisis del desempeño económico de las áreas de manejo 2000 – 2002.

Sweeting, C.J. & Polunin, N.V.C. 2005. Marine Protected Areas for management of temperate North Atlantic Fisheries – lessons learned in MPA use for sustainable fisheries exploitation and stock recovery. A report to Defra. 64 pages.

Verheij, E.; Makoloweka, S. & Kalombo, H. 2004. Collaborative coastal management improves coral reefs and fisheries in Tanga, Tanzania. *Ocean and Coastal Management* 47: 309-320.

Villena, M. G. & Chávez, C. A. 2005. On the enforcement of territorial use rights regulations: a game theoretic approach. *EconomiA*, Brasilia (DF), v.6, n.1, p.1–44, Jan/Jul 2005.

Willis, T.J.; Millar, R.B.; Babcock, R.C. & Tolimieri, N. 2003. Burdens of evidence and the benefits of marine reserves: putting Descartes before des horse? *Environmental Conservation* 30, 97-103.

Worm, B.; Sandow, M.; Oschlies, A.; Lotze, H.K. & Myers, R.A. 2005. Global Patterns of Predator Diversity in the Open Oceans, *Science*, vol. 309:1365-1369.

Wright, A. & Hill, L. 1993. Nearshore Marine Resources of the South Pacific. Forum Fisheries Agency, Honiara, Solomon Islands. XVI.

**ANNEX I: Figures and tables**

**ANNEX II: Abstracts from references literature – Separate Document**