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Marine Protected Areas in fisheries MANAGEMENT



Synthesis on the State of the Art



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Foreword

If the stakes of conservation are being structured in the establishment of many Marine Protected Areas (MPAs) in the SRFC region, the growing fishing pressure calls for strengthening of a space-based management of fishing activities. MPAs constitute spatial management tools that are available, and which are to be valorised. Likewise, it is also important to improve the application of the other existing spatial management instruments.

Given a growing demand in the sub-region for the creation of MPAs, it is necessary to better plan their implementation so that they can be efficient and become fisheries management tools. In this context, the SRFC must be a crucial stakeholder that should enable fisheries to benefit from this dynamics and ensure that MPAs efficiently achieve their objectives of sustainable exploited resources.

A workshop held from 13 to 15 December 2011 specified the expectations of participants who notably acknowledged the SRFC as an institution capable of:

- centralizing information and harmonizing some instruments at the sub-regional level ;
- focusing the attention of its member States around recommendations and establishing regional projects or taking a proactive stand towards partners and donors ;
- boosting work dynamics and focusing the attention of its member States, partners, and donors around issues and recommendations raised in this report ;
- pursuing its role as experience sharing and good practice framework towards regional harmonization.







INTRODUCTION

1.1 An international Analysis on MPAs and Fisheries

☞ *The international context shows that many MPAs overall objectives, identified in international Conventions, were not achieved in 2012 and consequently were repeated: “By 2020, at least ... 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes” (CBD Strategic Plan 2011-2020, Goal C, Target 11, CBD CoP10, Decision X2, Nagoya 2010).*

The present document aims to present the results of an analysis of the world literature, draw lessons from learned experiences, and share relevant recommendations with regard to situations experienced in the SRFC zone on the best ways and means to use MPAs as fisheries management tools.

Through the future programs of the SRFC and States of the region, the challenges will be the best utilization of the recommendations contained therein in order to, on the one hand, improve the relations between the governances of coastal management, fisheries, and MPAs and, on the other hand, to develop solutions enabling a better integration of the concerns of fisheries in the management of MPAs and of the MPAs in the management of fisheries..

The work, conducted by a group of experts from the University of Brest (UMR Amure) – Agrocampus from Rennes (fisheries) – the IUCN-CEM Fisheries Expert Group coordinated by BRL Engineering and EBCD and supported by many international contributions, has highlighted a series of illustrative examples and case-studies on MPAs in three main documents:

- A “technical report” in french representing the State of the Art made up with 4 volumes dealing with “Governance”, “socio-economic and bio-economic modelling”, “bio-ecological and bioecological modelling”, and “Element of Reflection for the SRFC and its partners” in support to the regional Workshop;
- The present “Synthesis Report” ;
- A ten-page note summarizing the outcomes of the study (www.spcsrp.org).

These works as well as the supporting document and thoughts they produced enabled the holding of a regional workshop in December 2011 in Dakar during which the outcomes of the review were presented. Exchanges with several representatives of fisheries and environmental institutions and other stakeholders throughout the sub-region (fishermen, funders, scientists, etc..) led to confirmation of the relevance of the supporting documents of the Workshop and specified further the recommendations presented in this document.

☞ **Three main questions are asked in this study:**

- *Are MPAs tools preferable to conventional fishery management tools when it comes to promoting :(1) the particular protection of certain areas, habitats or, species; (ii) the, allocation of resources; and (iii) the participation of communities in the decision-making process?*
- *What lessons have been learned on the effects of MPAs on fishing and on the tools associated to the measurement of these effects?*
- *Are there any lessons to be drawn from the international experience on governance of MPAs in relation to fishing that could lead to improvements in management?*

72 examples are highlighted in the study

Map 1 Map of MPAs considered in the study

Europe - Mediterranean	
21	OS MINARZOS
22	CABO DE PALOS
23	TABARCA
24	BENIDORM
25	COLUMBRETES ISLAND
26	MEDES ISLANDS
27	LA GRACIOSA
28	LA RESTINGA
29	RN. DES BOUCHES DE BONIFACIO
30	PARC NATUREL MARIN D'IROISE
31	RÉSERVE NATURELLE DE CERBÈRES BANYULS
32	PARC NATIONAL DE PORT CROS
33	CÔTE BLEUE
34	COLUMBRETES ISLAND
35	SINIS MAL DI VENTRE
36	GOLF DE CASTELLAMARE
37	TUSCANY ARCHIPIELAGO
38	RDUM MAJJIESA / RAS IR RAHBED MPA
39	MEDITERRANAN MPAs
40	FORMIGAS
41	MONTE DA GUIA / FAIAL
42	DARWIN MOUNDS
Americas -Caribbean	
61	AMERB
62	EASTERN TROPICAL PACIFIC SEASCAPE
63	SEAFLOWER
64	GALAPAGOS ISLANDS
65	CAYOS COCHINOS
66	PORTLAND BIGHT
67	ISLA NATIVIDAD
68	BAJA CALIFORNIA
69	MPAs NETWORK OF PUERTO PENASCO (GOLF OF CALIFORNIA)
70	SOUFRIÈRE
71	BIG CREEK RESERVE, CALIFORNIA
72	GREAT SOUTH BAY MC AREA



📌 Main Characteristics of the 72 MPAs Illustrated in this Study

In addition to the analyses from meta-reviews which often focused on tens or hundreds of MPAs, 72 specific MPAs have been particularly scrutinized in this study so as to highlight the impacts of MPAs on fisheries across the different chapters and themes. 80% of these MPAs have been created before 2000 and thus provide a rich experience.

Among these 72 MPAs, 48% are small (<100 km², half of which are < 10 km²); 38% are average size (from 100 to 1000 km²); 15% are large (1000- 20 000 km²) and 5 % are very large, (> 20 000 km²) and exclusively located in the open ocean . Among these MPAs, 40% are associated to islands, 54% to coastal sites, and 6% to offshore sites.



A summary of the situation of MPAs in the world

According to IUCN, in 2010^{1,ii}, the existing 6800 MPAs accounted for 1,17% of the surface of the oceans and 7,2% of the coastal areas (within the 12 nautical miles limit). The countries of Oceania followed by countries of Southeast Asia and Latin America are among those who have the more developed MPAs over the last years.

Nevertheless, 0,01% of the oceans consist of areas known as “Reserve-MPAs” or “no-take zones”. One study has shown that out of 255 reserves only 12 were regularly controlled and therefore efficiently managedⁱⁱⁱ.

Africa – Indian Ocean

- 1 KOSI BAY (NATURAL RESERVE)
- 2 SANTA LUZIA, BRANCO E RASO
- 3 RN. MARINE DE L'ÎLE DE LA RÉUNION
- 4 BOLAMA - BIJAGOS
- 5 UROK
- 6 CACHEU
- 7 KISITE - M'PUNGUTI (MARIN PARK)
- 8 MOMBASA (RESERVE)
- 9 WATAMU (MARIN PARK)
- 10 NOSY HARA (RESERVE)
- 11 BANC D'ARGUIN N.P.
- 12 BAMBOUNG
- 13 DELTA FLEUVE SENEGAL
- 14 JOAL - FADIOUTH
- 15 COUSIN
- 17 CHUMBE
- 18 MAFFIA
- 19 MNAZI BAY - RUVUMA (MARIN PARK)
- 20 5 MPAs IN TANZANIA

Pacific – Asia - Oceania

- 43 GREAT BARRIER REEF
- 44 RESERVES OF TASMANIA
- 45 SANYA
- 46 NAVAKAVU (FIDJI)
- 47 ARNAVON ISLANDS
- 48 KARIMUNJAWA
- 49 WAKATOBI
- 50 BUNAKEN (INDONESIA)
- 51 PARC KOMBO
- 52 LEIGH RESERVE
- 53 TWIN ROCKS
- 54 SAN SALVADOR
- 55 TUBBATAHA (NATIONAL PARK)
- 56 RESERVES OF PHILIPPINES
- 57 APO ISLAND
- 58 SUMILON
- 59 CLAVERIA
- 60 MPAs NETWORK OF VANUATU

Legend

List of MPAs used as examples in the study / Colour related to main thematic

- 1 MPAs and Fisheries Governance
- 2 Bio-ecological effects of MPAs
- 3 Socio-economic effects of MPAs

1.2 An Analysis Integrating the Regional Context of the SRFC Zone

To better understand the changes to be initiated, all the review work, the analyses and the selected illustrative examples have taken into account the main characteristics of the SRFC zone of relevance to the topic being dealt with, namely:

- 1. An Essential Fisheries Sector from the Socio-Economic Viewpoint:** The fisheries sector in the SRFC zone is characterized by the coexistence of local and regional artisanal fisheries (often with a free-access regime) with industrial fisheries (often foreign). It represents a sector in which employment and foreign currencies drawn from the export of products represent important political stakes.
- 2. A Weak Governance:** The legal and institutional framework in place enables neither the efficient protection of ecosystems nor true regulation of access and users' rights. In addition, MPAs are often created in a rather opportunistic way without much involvement of local populations, without proper management mechanism or without effective management, have become, for the larger part, "paper MPAs". The weak research mechanisms (degradation of financial

and human means) are also less mobilized and adapted to management needs. The conclusions drawn from the analyses of fishery systems in 2005 still remain relevant to characterize the SRFC zone: the overcapacity and the absence of regulation of access to resources explain the continuing degradation of the stocks which are now overexploited.

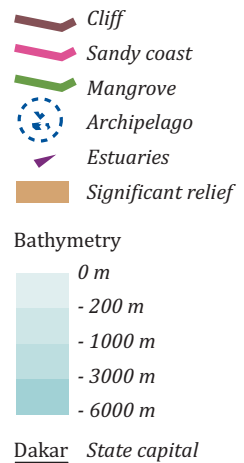
- 3. A Very Productive Environment in Constant Degradation:** The SRFC zone is located around one of the 4 great upwelling zones of the planet, thus explaining its extraordinary abundance and productivity (in sandy area, mangrove, and oceanic zone). Studies of the Large Marine Ecosystems (LME) networks of the region confirm the constant degradation at the regional scale.
- 4. Diversified fishery Resources and Migrations:** Resources consist of a mix of demersal species and small and big pelagic species with acute migratory behaviour, explaining the regular migratory phenomena of fishermen.

☞ Governance within the SRFC zone remains less efficient notably because of: (i) limits of the conventional approach to fisheries management when applied to MPAs; (ii) lack of stability and financial sustainability; (iii) the disproportionate role played by international NGOs and external financing; (iv) incomplete decentralization process and (v) the fragmented or weakened State and civil society.





Map 2
The area and ecological zones covered by the SRFC and its seven member countries



1.3 Definitions of the MPAs used in the Study

Several definitions are mentioned in the technical report “Introduction and Governance Aspect”. The notion of MPAs is not precise in that: (i) there are many definitions of the term; (ii) there are many types of MPAs, corresponding to different management objectives and approaches; (iii) the same type of area can have different names according to countries and publications, including in official texts.

The IUCN categories, albeit progressively validated by countries, are more complicated than would require a debate around MPAs and fishing. Some confusion on their nomenclatures complicates cross-cutting analyses and comparisons. Moreover, IUCN does not recognize as MPAs, the closed areas and other time-space restrictions implemented in fisheries.

This situation has prompted us to specify the nomenclature chosen for this study so as to avoid unconstructive debates on the topic. We use the term MPAs, in the sense of IUCN, to refer to an area that is designated for conservation of nature (ecosystem and biodiversity) whereas spatio-temporal restrictions (STRs) are developed for the optimization of fishery system.

Definitions of MPAs for the purpose of this study

- **Reserve MPA:** or no-take zones, integral reserve, totally protected conservation areas, where removals are prohibited or are negligible.
- **Multi-use MPAs:** space designed for conservation, used by several types of stakeholders and generally presenting, over its total area, or in some of its zones access restrictions and different regimes for each type of user. They generally contain a part of their surface that is totally protected as no-take zone.
- **Fishery MPAs:** The term is used to refer to an IUCN-type MPA used in a fishery as fishery management tool. Spatio-temporal restrictions (STRs) include “fishing reserves” and aim at protecting sea resources and optimizing fishing grounds.



2

SYNTHESIS OF LESSONS AND RECOMMENDATIONS ON BIOECOLOGICAL ASPECT

2.1 Generalities on Bio-ecological Effects of MPAs

A worldwide analysis of the literature highlights several positive effects of Reserve-MPAs notably in species under high fishing pressure at the top of the trophic chain (predators). The outward movement of adult individuals (spillover effect) may contribute to increase biomasses around reserves, but always at a limited distance from the reserve whereas the diffusion of larvae out of the MPAs may contribute to a greater resilience of ecosystems. The enclosure of some areas as reserves may have unexpect-

ted and highly variable effects from one site to another, particularly on habitats.

However, in the present state of knowledge, theoretical predictions of MPAs effects are often different from the really observed ones for many reasons (diversity of MPAs and situations, socio-economic context). So, the type and amplitude of impacts that have been observed for a given example cannot always be replicable elsewhere and forecasts must always be made with precaution.

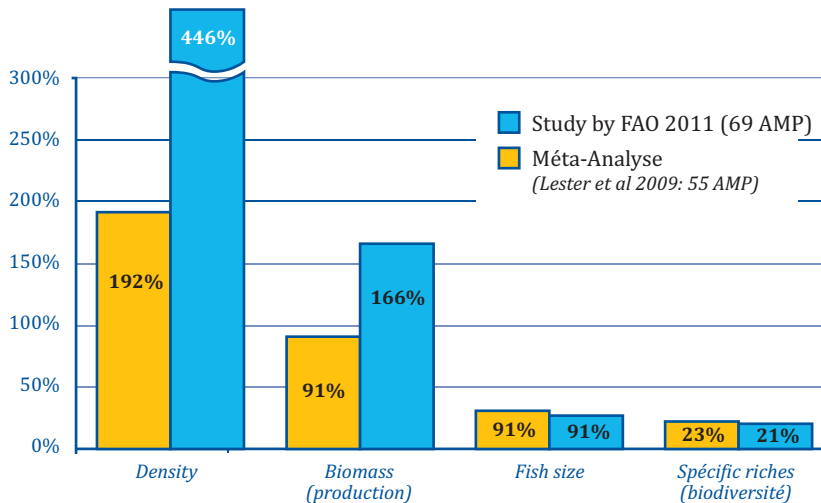


Figure 1
Comparison of improvements within Reserve-MPA and the outside for fish, invertebrates, and seaweeds ^{v,vi}

2.1.1 Effects inside Reserve-MPAs

UNDENIABLE POSITIVE EFFECTS

Generally, literature confirms the following positive biological effects of reserve MPAs:

- **On Abundance, Biodiversity and the Average size of Species, notably Predators:** The protection of an area leads to the increase of species richness, abundance, and the average size of fish and marine invertebrate within Reserve-MPAs. These effects are visible for species undergoing high fishing pressure outside the reserve and for species at the top of the trophic chain (predators), but

there does not appear to be any significant difference in the case of non-targeted species (gobies for example).

- **On Resilience and Stability of Ecosystem:** The increase of the reproductive potential (bigger specimen, which are more abundant in Reserve-MPAs are more fertile and have a longer spawning period) and the maintenance of the features of life story contribute to better population resilience.

- **On different geographical areas:** the effects on size and specific richness are identical between the tropical and temperate zones; by contrast, the effects on biomass and diversity are slightly more important in temperate zones.

☞ *Some studies show that the best results of MPAs on fishing are obtained when the efficiently protected surface is at least 10 to 35% of the area exploited by the fisheries sector^{VII}. The optimal size of a reserve-MPA increases with the intensity of fishing effort.*

The species which have a larger maximal size show a stronger positive answer to protection and their density may, in some cases, be 33 times more important inside the reserve^{VIII}.

VARIABLE EFFECTS (POSITIVE, NEGATIVE) ACCORDING TO SPECIES AND SITES

However, it is essential to keep in mind that while the positive effects of reserves widely observed, they do not happen in all of the reserves. Species interactions lead to complex effects. Sometimes, some MPAs can see their small size, sedentary and non-targeted species decrease inside after their creation because of an increase in predators or modifications of inter-species interactions (trophic cascades).

Thus, the fact that some areas have been turned into re-

serves can have unexpected and very variable effects from site to site. Likewise, the effect of reserves on habitats is difficult to understand and remains today nearly unknown. The instances when the effects of reserves are nil or negative are not well-documented.

A global study made in 2004 confirmed the difference in fish response to the creation of a reserve, with 61% of fish species becoming more abundant inside the MPA (often predator) whereas 39% of fish species become more abundant outside (mainly species without any commercial value).

☞ **Example of Trophic Cascade Effect:**

Abalone, initially protected in six MPAs in the USA, have finally seen their populations decreasing because of (unexpected) predation by sea otters protected by the new MPAs. In another MPA in New Zealand^{X, XI}, the same phenomenon has been observed on sea urchins, the preferred preys of lobster. The example of abalone in Tasmania also confirms this observation (cf. examples below p.20).

2.1.2 Effects of MPAs outside their borders

AN INTERESTING AND LIMITED SPILLOVER EFFECT

The movement of adult and juvenile individuals towards the surrounding environment (spillover effect) and the outward spreading of larvae produced within the reserves can contribute to the increase in the biomass of the surrounding reserves. The spillover effect, although difficult to study, can be detected by the analysis of the distribution of catches as a function of their distance from the reserve boundary.

THE EFFECT OF LARVAL DIFFUSION IS MORE IMPORTANT THAN THE SPILLOVER EFFECT

There are very few studies in the field of larval diffusion and the creation of a network of MPAs remains relevant, for the moment, only from a theoretical point of view. However, some examples of oceanic MPAs or of tight networks show results on the diffusion of larvae that contribute to confirming their interest. In addition to the spillover phenomenon, the diffusion of larvae outside reserve-MPAs can contribute to a reduction of the risk of

stock collapse and to the improvement of catch rates in some fisheries. At population scale, export of larvae and eggs effect is generally more important than spillover of biomass (through migration of adults and juveniles).

☞ *Spillover phenomena are limited, and their effects on fisheries are perceptible only in the neighbourhoods of MPAs, that is:*

- *From 200 to a few hundred meters maximum (in coral reefs or small MPAs like Bamboung)*
- *Between 500 m and a few kilometers (in big MPAs like the Banc d'Arguin).*

☞ *Small MPAs, if well managed, may have some effects on neighbouring fisheries. On Apo Island (Philippines), the effects were 45 times higher in the 200 meters area around the reserve boarder than in other fishing areas of the island. The fact that several small MPAs have been turned into reserves in Santa Lucia (USA) has led to 46 to 90% increases in catch in neighbouring fisheries depending on fishing gears.*

2.1.3 Long-term Positive Effects that Can Be Very Rapidly Suppressed

On average, the direct effects inside reserve-MPAs start to be visible after 5 to 7 years, whereas indirect effects (resulting from interactions among species) are detected after 11 to 15 years^{xii}. The full benefits of an MPA are generally observed only after a long time (10 to 40 years). Several studies show that restoration/stabilization of biomass to the carrying capacity of the area requires a protection over a long time (several decades) because the effects continue to be generated over several decades.

☞ A monitoring of the reserve effects over 17 years in the Sumilon and Apo reserves (Philippines) shows that biomass of large predators is still increasing exponentially after 9 and 18 years of protection respectively. The study concludes that the period of total restoration of biomasses may reach 15 years for the reserve of Sumilon and 40 years for that of Apo islands^{xiii}.

☞ The positive effects can be lost within one year in case of suppression of the Reserve-MPA independently of the duration of the MPA management (5-10 years or more)^{xiv}. So, the management of an MPA must be effective and maintained over a long term so as to take into account both the long time that is required for the restoration of ecosystem balance, and the extreme rapidity with which pressures can occur and suppress years of efforts and public investments.

2.1.4 Bio-ecological Considerations for Networks of MPAs and Management of MPAs

Very few studies exist on MPAs networks. The institution of MPA-reserves and managed zones in large multi-use MPAs can improve the impact of an MPA on fishing (e.g.: the Great Barrier Reef, in Australia) and may represent an alternative to a big MPA-reserves. From a practical point of view, the creation of several small reserves is often the only option that can be envisaged along highly urbanized coasts, and remains the most realistic option in a context of strong constraints on the coastal area^{xv}.

☞ The structuring of networks of MPAs (e.g. is size of reserves and distance between them) should be grounded on the functional relations between MPAs and their connectivity (the vicinity of MPAs that is necessary to facilitate the spreading of larvae/juveniles is variable and depends on species, environment, and currents).

☞ The study of biological effects of zoning within Great Barrier Reef Marine Park shows that most benefic effects for fish populations are observed within integral reserves whose access is strictly prohibited. However, a simple network of integral reserves could not have achieved the same effects on the whole ecosystem because the framework offered by multi-use MPAs allows an optimization of management in the areas between reserves. The zoning of the reserve and the management of fishing effort avoid the mere displacement of the effort outside integral reserves. Moreover, while the zoning of the Marine Park can contribute to spatial management of fishing effort, it is widely completed by a non-spatial fisheries management system in authorized fishing areas and a by-catch reduction effort.

2.1.5 Effects of STRs, MPAs, and Management of Mobile Species

Spatial management of marine resources can be organized in the form of closures that may be permanent (fishing reserves), seasonal (biological “rest”) or ad hoc (real-time closures). The effects of these spatio-temporal restrictions (STRs) of fishing depend on scales, species or groups of target species, degree of protection, etc. STRs represent interesting tools for the management of stocks under several conditions.

☞ *A reserve-MPA will only ensure the protection of migratory species if:*

- *The site is relevant and chosen according to species and their biology to protect one or several key phases of the biological cycle (reproduction, nursery)*
- *This MPA contributes to a reduction of the overall fishing mortality. Otherwise, the only effect of the reserve will be to displace fishing effort outside its borders.*
- *The effects of the transfers (of effort) on other species are measured and the indirect impacts of the MPA are identified*

2.2 Role of MPAs as Fisheries Management Tools

From the strict fishery and bioecological points of view, the establishment or development of Marine Protected Areas, as indeed the establishment of spatio-temporal restrictions (STRs) of fishing activities may, in general, have the following consequences:

- **A limited increase of exploitable biomass**, related to the spillover effect, mainly close to reserves. This effect will be more important for large-size MPAs and species migrating between the reserve area and the outside environment. It might be significantly superior to the catch potential inside the reserve catch, foregone by fisheries with the establishment of the reserve (cf. socio-economic section).
- **An increase and greater stability of recruitment** related to the protection of breeders in the reserve or to the exportation of larvae, spawns or first juvenile stages. This effect can be significant for intensively exploited species, provided that the reserve is very judiciously localized on critical habitats (reproduction area or nursery area for larvae and small juvenile stages).
- **Global reduction of fishing mortality**, when the reserve is located in areas with high concentration of biomasses and/or high catchability. Even when the fishing

effort remains constant, MPAs reduce the fishermen's efficiency and their impact on resources and hence the effect of overcapacity. This effect is limited though, and thus this reduction is effective when general measures are in place to limit the transfer of fishing or to directly regulate fishing capacity.

- **Establishment of a reserve of biomass as a true "risk insurance"**. One can thus imagine (the observations are rare) that in case of abruptly aggravated overexploitation or unexpected bio-climatic event, the reserve of biomass could facilitate stock restoration. However, it must be noted that this reserve biomass can fully play a role only if it is relatively important, which implies the setting large-size, naturally productive MPAs and the existence of great connectivity between the areas closed and open to fishing (resource mobility).
- **Protection of vulnerable fishery species and by-catch regulation**. This potential function of MPAs can turn out to be important for particularly vulnerable exploited species (low fecundity; dependent on vulnerable habitat, etc.), in particular when they are by-caught by different fisheries, and can hardly be subjected to specific management measures.

☞ *From the strict fisheries point of view, MPAs appear as a tool among others, not necessarily more efficient than others, and which will be fully significant if integrated into a global approach to management of the fishing level (e.g. through fishing capacity management, catch or effort quotas) of the fishing pattern (e.g. regulation of mesh size, landing sizes), and ecosystem exploitation strategy (e.g. which species to catch given their role in the ecosystem).*

☞ *In the medium term, this global approach to management should be part of a spatial planning approach in which the different forms of MPAs (reserve, multi-use) will constitute available options, together with STRs. The analysis of costs and benefits of the different options should be conducted in order to take an adequate decision (cf. socio-economic and governance sections).*

Fisheries management entails two different concerns related to the common and renewable nature of marine resources, differently developed under different circumstances: resource conservation and access regulation:

- Conservation of resources: The protection of productive and reproductive capacity of resources will require an overall limitation of fishing mortality and leads to an improvement of the fishing pattern;
- Regulation of access to resources: The sharing of resources productive and reproductive capacity among fishermen requires determining the fishermen authorized to exploit them and the portion each one can withdraw.

It remains therefore true that, **first and foremost, MPAs are conservation tools. Yet, they may aim and certainly facilitate reaching good fishery management objectives.** Even though fishermen might not draw an immediate benefit (this is likely to be the case in many situations), they have an objective interest to improve: (1) their enterprises sustainability through reconciliation of conservations imperatives with marine production objectives; (2) the social acceptability of their activity to contribute, in a context of societal environmental concerns, through their involvement in this reconciliation.



☞ **Some Issues Relating to the objectives of creating MPAs in Connection with fishing and fisheries:**

The creation of an MPA can be justified for many reasons. Before making a decision to create one, particularly in connection with fishing, it is important to specify what the expected objectives are:

- **(a) Reduction of fishing pressure, globally or on critical phases of the life cycle?**
- **(b) Protection of life cycle phases that are critical for the renewal and growth of the populations exploited by fishing (spawning areas, nurseries, etc.)? Its validity closely depends on the localization of the MPAs, the biology of species concerned, and the type of fishing (selectivity of fishing gear).**
- **(c) Creation of a “safety stock” (e.g. safe minimum biomass level, SMBL), improvement of yields and an improved productivity? This argument is valid only if the creation of the selected MPAs is large enough and can be backed-up by an effective exclusion of fishing from the reserved areas. The latter is not that obvious given the considerable number of « paper parks » that have been noted in the world. Is the area remaining open to fishing acceptable? What would, a priori, be first the impact of the transfer of effort on areas that remain open to fishing?**
- **(d) Generation of a Net Spillover Effect of Exploitable Biomass from the reserved area to the fishing area: So far, very few empirical evidences have been given showing a positive average balance between new biomass transfer and losses due to restriction of fishing area. This assessment can turn out to be particularly difficult in countries where overcapacity of the fisheries sector constitutes an issue widely beyond the scope of the sole fishery sector (a situation characterizing a number some developing countries).**
- **(e) Maintenance of a Trophic Network and Biodiversity – protection of areas with strong primary production – protection of habitats (mangroves and seagrass beds in particular)**

2.3 Indicators, Monitoring System, and Bio-Ecological Models

The analysis of bio-ecological effects is often made through data from field studies^{xx}. The monitoring of MPAs requires non-destructive observation methods such as in situ observation through visual counting, sub-marine photos/video, acoustic techniques (fixed or trolled) and monitoring & evaluation of fisheries (monitoring of catch/efforts of professional and/or recreational fishing). At the level of fish stock, the two indicators that are mostly used are fishing mortality and spawning stock biomass, with the more or less explicit objective to maintain fishing pressure to a sustainable level permitting the maintenance of the stock reproduction capacity. There are also other associated indicators of spatial distribution and movement which could prove useful in the future for the monitoring of MPAs.

At ecosystem level, several indicators may be generally required to assess the state of an ecosystem component potentially impacted by the establishment of an MPA. On the opposite, a single indicator is sometimes proposed to assess the state of several ecosystem components^{xxi}.

☞ A bio-ecological indicator of MPAs performance must be sufficiently complex to capture the main ecological information, but also sufficiently simple to be understandable and regularly updated. Several recent research programs have identified lists of potentially interesting indicators for the assessment of MPAs performance.

There is no predefined unique list of indicators, and for each MPA objective, relevant indicators must be adapted. The ecosystem indicators lists are numerous (and not yet stabilized) and some examples are mentioned in the technical document. **Studies on indicators propose two types of indicators that are useful to the ecosystem approach of fisheries: state indicators and pressure indicators.**

Moreover, empirical indicators (observed and calculated from observations) are distinguished from simulated indicators (model-based). The former are “local” in space and in time whereas the latter are “global” (they most often encompass the whole community) and can cover the entire time vector (past and future). Many indicators can be regrouped according to the scale of time they cover and the effects they address.

It must also be noted that information on habitat, and generally the components of spatial variability must be integrated into models and interpretations in order to

reduce variability.

The models, their limits, and their characteristics are described in the appendix together with recommendations regarding their development.

☞ The indicators and monitoring mechanisms should be used for management, to help the stakeholders to make decisions related to space-based restrictions (zoning) or to the regulation of fishing effort ...and to consult each other in order to adapt MPAs management plans as required.

The monitoring of an MPA through time requires the creation of a database organizing a set of indicators which will serve for the periodical monitoring and evaluation of performances as well as continuous management. These indicators themselves will represent a dashboard to be used by those responsible for managing MPAs towards the stated objectives.

☞ There are several monitoring networks at the global, national, and local level, for fisheries or MPAs (Natura 2000, EUROPARC, MEDPAN, ICCAT, etc.). All of them have the same objectives: to help managers and decision-makers in the decision-making process and raise awareness of stakeholders and users.

Prompted by the CBD Aichi Targets, a majority of transnational MPA networks are presently elaborating their monitoring mechanisms and changes are fast. The main challenges these networks are facing are generally:

- *The slowness and complexity of the harmonization of the mechanisms of collection, monitoring and indicators face to the differences of cultures and means between MPAs, fishing systems, and among countries.*
- *The difficulty relating to centralization of data and that which consists in specifying who is in charge of processing and property of information.*

The main utility of these large scale monitoring networks and systems are:

- *Their capacity of exchange of experiences among managers*
- *The presentation of the change at the different scales of stocks and ecosystems, and the measurement of global phenomena (climate changes, migrations)*
- *The positioning of each [site] within the global system and the comparison of a particular country, MPA, or fishery with regard to the overall system.*

Table 1 List of Potential Ecological Indicators for the Assessment of the Efficiency of MPAs. Additional Metrics (not stemmed from literature) are suggested in *italics* (Pelletier et al. 2008)

Time scale	Effects	Empirical indicators	Mathematical model-based indicators
Short term effects	Protection of critical spawning stocks	Total biomass, biomass by family	Biomass (total or by patch)
		Total density, density of exploited species, density by trophic group, by family or by maturity phase of species	Abundance (total, by patch or by sub-population)
		Distribution of species by size group	Spawners abundance and biomass
		Biomass species or genera, density by species or genera, CPUE by species	Asymptotic growth rate (Leslie model) Risk of collapse of the population (performance)
	Restoration of populations age-structure	Distribution of species by size group	Spawners abundance and biomass
		Average size by species or genera	Stable distribution by age (Leslie model)
		Biomass by species or genera	
	Restoration of the assemblage structure	Spectrum of density by species	Catch or biomass by community component (trophodynamic models)
		Specific richness by family	Size or biomass spectra
	Exportation of biomass	Data on movements, life-cycle domain, fidelity to sites	Abundance (by subpopulation or by patch)
			Biomass (by subpopulation or by patch)
			Catch by patch
	Mid-term effects	Protection of biodiversity	Total specific abundance
Other clues of diversity			Size or biomass spectra
Indirect effects on seaweed and invertebrate		Benthic coverage	Abundance of invertebrates
		Density by species or by genera	Abundance of seaweeds
Increase of catch rates by species		CPUE by species	Equilibrium yield (based on Y/R models), short term yields as a function of effort and economic metrics
Increase of stability and resilience of populations		Variation of density	Risk of collapse of populations
		Variation of CPUE	Asymptotic growth rate (Leslie Model)

2.4 Recommendations on the “Bio-Ecological“ Aspect

☞ *In order to face the emerging bio-ecological challenges regarding the establishment of connections between MPAs and fisheries, it is particularly recommended to:*

- *Spatialize information and management*
- *Analyze the relevance of using the MPAs tool in fisheries management before establishing an MPA; prioritize objectives*
- *Establish a minimum state of reference and cooperate for its elaboration*
- *Establish a long-term bio-ecological monitoring system (inside and outside the MPA) relying on relevant and restricted set of indicators*
- *Limit oneself to a restricted number of indicators regarding optimized costs/benefits that are synthetic and easily replicable, reliable, and easy to interpret*
- *Strengthen research and national monitoring of MPA management performances and reinforce coherence between fishing and MPAs in the monitoring systems*

2.4.1 Evaluation of the relevance of establishing an MPA for fisheries management

The use of MPAs and Spatio-Temporal Restrictions (STRs) (including fishing reserves) and their respective roles, as well as the prospect of their introduction into a Marine Spatial Planning, **raises forcefully and with a sense of urgency, the issue of spatialization of fishery management.** Recommended for a long time but rarely implemented, this spatialization is at the basis of ecosystem management, the allocation of territorial use rights in the coastal area, and the articulation between fishing and MPAs.

However, the space-based data on fishing and exploited ecosystems (habitats, resources, stakeholders, users) are generally missing or incomplete. This may contribute to errors in the siting of MPAs and in the management strategies selected for a given fisheries management systems and MPAs. **In the majority of cases, MPAs have been established in an opportunistic way and both their limits and zoning have not taken into account functional links or essential stakes for ecosystems and fisheries.**



☞ Recommendations:

“To spatialize information and management”

- To promote the development of spatial management and the production of national atlases coordinated at regional level
- To reinforce the production of local space-based databases covering both inside and outside the MPA. In terms of bio-ecology, this should include :
 - ✓ Identification of vulnerable or critical habitats
 - ✓ definition of distribution areas of the identified stocks, strong biodiversity/productivity areas, exchange rates and migrations, allocation of fishing effort and catches;
 - ✓ Zoning of spaces where spillover effects are expected or foreseen.
- To take into account network objectives of coherence and representativeness; notably in relation with gap analyses and eco-regional analyses
- To capitalize information and valorize knowledge: These mapping efforts do not systematically require the conduct of specific studies because traditional knowledge as well as information produced by former projects have not yet been fully valorized and still remain under-used if not confidential
- To digitalize information in GIS format so as to valorize regional data and atlases.

☞ Recommendations:

“To establish a minimum state of reference and cooperate for its realization “

So as to measure the performances of MPAs and support management, it is necessary to:

- Establish a thorough, robust inventory (reference state) inside and outside MPAs aiming at pragmatism and reliability:
 - ✓ Maintain coherence with the subsequent monitoring. The latter will be based on the same information and spatialization criteria as those mentioned in the recommendation relating to monitoring.
 - ✓ Initially, mobilize more important in order to build a solid database allowing the establishment of a lighter and regular monitoring mechanism.
 - ✓ Rely on the analysis of long and complete historical series in order to take into account both of trends and natural variability of the system studied as well as its components.
 - ✓ Valorize empirical communities knowledge to complement in situ short-term (annual) measurements for optimized cost/effectiveness and appropriation of the approach by the stakeholders
- Give priority both to existing MPAs and new MPAs: it is important for the sub-region (SRFC) that existing MPA which do not have reliable « reference state » should be able to develop one in order to support management in the long term.

☞ Recommendations:

“Ask good questions before establishing an MPA and prioritizing objectives”

- To analyze the relevance and feasibility of the establishment of an MPA associated to fisheries management in the light of target objectives: Before establishing any MPA, a study of relevance and impact will explain the reasons of the creation of an MPA and its fisheries interest (whether fisheries concerns relate to the whole MPA or only a part of it). The benefits of using an MPA rather than a conventional STR will be specified. This study should necessarily specify the protection issues and objectives as well as the objectives of fisheries and MPA management, the expected minimum size, etc..
- To prioritize ecological and resource management objectives related to MPAs: this should go beyond registering declarations of intent, often vague and less poorly prioritized, found in official texts and documents of international organisms. It should be based on the analysis of local issues and constraints.

2.4.2 Biological State of Reference (baseline)

The absence of “zero state” (baseline situation before the creation of MPAs) is nearly systematic, which reduces the possibilities to assess management performances, makes it difficult to promote MPAs, and greatly affects exchanges with the populations concerned by management strategies. Reference data are particularly weak and insufficient regarding the spatio-temporal mobility of species that are exploited beyond the limits of the MPAs, where most effects expected by stakeholders should take place. In the few instances where baseline studies and zero state have been established, the geographical scope of the data collection has often been limited to the MPAs boundaries itself, while interactions between resources and users of MPAs take place on spaces that are necessarily wider.

N.B : Interferences between direct effects of protection and natural system variability may bias the assessment of an MPA efficiency. However, methods involving regular samplings before and after the establishment of the MPA, both inside and outside its borders, and in several points of control outside it, can limit these biases. Thus, multiple control points must be established in order to distinguish the effect of natural variability from that of MPAs.

2.4.3 Local Monitoring Based on a Few, Reliable, Replicable and Simple Indicators

While there is consensus on the necessity to monitor the effects of MPAs, very few stakeholders take the time to clarify the objectives of the monitoring and the recipients of the results. In addition, many MPAs indicators concerning fishing are not documented, affecting management decisions and the functioning of the MPAs as well as the estimation of benefits. The lessons learned from biological indicators are becoming adequate while those relating to management efficiency and socio-economics aspects are still insufficient. The cross-analysis [multi-disciplinary] of information that would be necessary for a good analysis is often missing. The lack of centralization of monitoring and information constitutes a major weakness for an analysis of temporal data. MPAs remains experimental stocks management tools, and require important information. The monitoring and their communication of performance could enable an adaptation of zoning and of management as well as ensuring stakeholders' involvement. Monitoring undertaken only inside MPAs is only partly relevant in that it overlooks one major part of the effects, those on fishing which operates outside the reserved areas.

Recommendations:

“To limit oneself to a restricted number of indicators with optimized cost/effectiveness, that are synthetic, easily replicable, reliable, and easy to interpret (reality principle) for example:

- *At the population (stock) level: basic indicators such as indicators of abundance, biomass and mean size inform about populations, and yield.*
- *At the biological communities level: the indicators that are mostly used are: specific abundance (useful to compare effects), average asymptotic size, and the trophic level. The monitoring of associated and target species leads to a better understanding of the effects.*



☞ Recommendations:

“To establish a long-term biological monitoring (internal and external) relying on a restricted number of relevant indicators”

- **To adapt monitoring to objectives and means available:** *The nature and complexity of the system will vary depending on whether it wants to achieve strictly scientific objectives or pragmatic management objectives as well. To strive for optimized cost/effectiveness, it should cover both inside and outside MPAs, on the basis of a robust but yearly light monitoring, and an in-depth multiannual monitoring at a more spaced intervals (4 -5 years). The latter will specify the performances and effects of MPAs.*
- **To simplify the lists and types of indicators** while maintaining robustness and regularity of that is useful management information (cf. chapter on “monitoring” of the “bioecology technical report”).
- **To rely as much as possible on pre-existing and standardized information and to harmonize methods:** *to use the good data collection grid or to adapt it, to harmonize monitoring methods and indicators (update methodological manuals), at the national and regional scale. The work on indicators should provide, at least, a manual for the interpretation of indicators variation and the centralized registration of the results (memory).*
- **To ensure the monitoring is budgeted in the long term** in order to guarantee its regularity.
- **To ensure the conditions for transparency and communication towards local stakeholders:** *In any case, monitoring should be defined with the stakeholders. To establish progressively a mechanism of information processing and to institutionalize the feedback of monitoring outcomes to stakeholders. To disseminate the main results of monitoring in local language and with adapted communication aids.*
- **To take the habitats into account:** *In fact, habitats represent an important source of variability for fish communities.*

2.4.4 Support to Monitoring-related Research

At any step in the MPA or STR management cycle (planning, implementation and management), knowledge constitutes a fundamental basis for decision-making. Research and monitoring mechanisms are essential in order to deal with trade-offs at local, national, and regional levels, or to help involved communities to establish reliable mechanisms. Yet, research mechanisms in the SRFC area remain weak with regard to the needs in fisheries management and MPAs. National monitoring of fishing systems remain rather poorly connected with MPA research and yet a combination of means available to each could be beneficial to both management systems.

☞ Recommendations:

“To strengthen research and national monitoring of the management performances of MPAs and to reinforce coherence between fisheries and MPAs”

- **To strengthen means of intervention of national structures** responsible for regular fisheries monitoring in order to provide users and fisheries and MPA managers with useful information;
- **To mobilize fisheries research on MPAs issues and to promote integration** with national monitoring and research. *To involve both scientists and decision-makers in the monitoring structures. To provide articulations with pre-existing standardized systems (e.g.: fisheries monitoring systems), including by ensuring the smooth integration of the different scales. To promote the convergence of scientific and empirical approaches initiated by local stakeholders (co-construction of [information]) and to valorize traditional knowledge.*
- **To promote the integration of fishery research/monitoring programs with those on MPAs:** *To combine means and information likely to clarify the evolution of the local situation and its effects on the global level; to develop joint monitoring systems. This research should in particular participate in the assessment of the contribution of MPAs to the state of the exploited resources as well as to the state of health and resilience of ecosystems.*

3

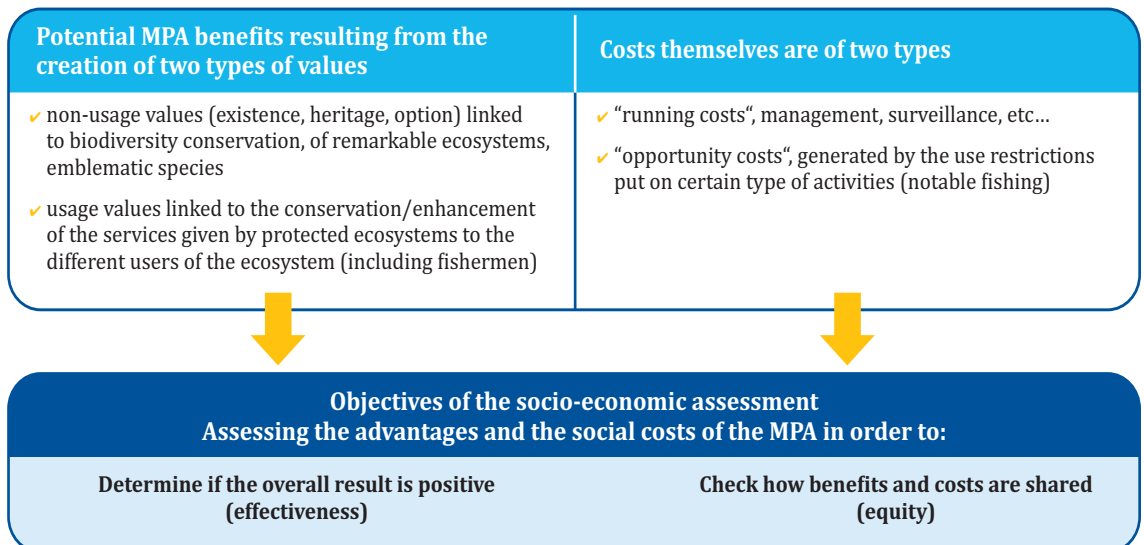
SYNTHESIS OF LESSONS AND RECOMMENDATIONS ON THE SOCIO-ECONOMIC ASPECTS

3.1 General Information on Socio-Economic Analysis of MPAs

The evaluation of the efficiency of an MPA for fisheries is difficult because the potential benefits of fishing essentially accrue outside of the reserved area. The difficulty is due, in part, to the insufficiency of data concerning the effect of larval diffusion on recruitment, the mobility of resources between the reserve and the fishing areas, as well as the behavior of fishermen. It can also be explained by the lack of attention to the socio-economic aspects inside and outside MPAs (at the scale of a wider territory corresponding to the fishing grounds affected by the area). The positive effect that is sometimes observed (increase of catch per unit effort (CPUE) around MPAs) in the long term does not always compensate the negative effect of the fishing closure on fishing (opportunity cost of the reserve) that is observed in the short term. The complexity of the analysis of socio-economic effects does not only concern the benefits of the closure for the populations (and the equity in their distribution), but also the relevance and effectiveness of the compensation and supporting measures (including Alternative Income Generation Activities, AIGAS).

3.1.1 Objectives of the Socio-economic and Cost-Benefit Analysis

From the economic point of view, an MPA represents an investment of the society in the conservation of its natural resources. Thus, the socio-economic analysis of MPA mainly aims to assess the costs and benefits of this investment for the society, and to characterize the allocation of these cost and benefits over time, in space, and among social groups. It also aims to analyze the financial viability of the investment and the economic and social implications of compensation measures.



3.1.2 Socio-Economic Analysis Tools

The socio-economic analysis of MPAs falls within three categories of tools:

- **Project Appraisal & evaluation Methods**, which include a set of procedures aiming at the establishment of an overall balance and distribution of project impacts on communities [cost-benefit analysis (CBA), cost-effectiveness analysis (CEA), and multi-criteria analysis (MCA)] ;
- **Bio-economic Models**, which propose a simplified and formalized representation of interacting biological and economic processes within areas impacted by protection measures; several bio-economic models are presented in the study.
- **Socio-economic Indicators**, which are intended to characterize the level of the different effects of MPAs on the economic and social situations of impacted individual groups (monitoring).

These three categories of tools are complementary in principle. However, the application of the first two categories to the analysis of MPAs impacts is often hindered in practice by huge difficulties, which include the following ones:

- Regarding CBA assessment methods, the expression in monetary terms of non-market values (utilization value related to non-market activities and also non-utilization values) is a problem ; CEA, a weaker variant of the CBA, helps to partially address this difficulty but requires to set a priori quantitative conservation objectives;
- As far as the MCA-based assessment methods are concerned, the weighting of the different criteria to be taken into account (political problem of the definition of the group of individual that determines the weighting factors; technical problem of the non-transitivity of collective preferences) ;
- For bio-economic models, the insufficiency of scientific knowledge on bio-ecological process and on user behaviors, on ecosystem services, as well as the weak quality and robustness of monitoring and databases.

In these conditions, the socio-economic analysis of MPAs is often based in practice on “dashboards” of indicators operating in an autonomous way. However, this practice presents some drawbacks, in particular:

- Difficulty to isolate the impact of protection measures from other factors affecting the levels of observed indicators;
- Difficulty to produce a synthetic evaluation the MPA efficiency and to integrate adjacent territories.

Precautions to take concerning the use of socio-economic tools:

It is recommended not to overestimate the operational capacity of assessment tools theoretically available, and match the costs of their implementation to the budgets and available human capital (cf. Appendix: modeling recommendations). On the socio-economic plan, it seems more realistic to privilege an approach based on frequency indicators and perception of MPAs by users and local populations, provided that the protocol of elaboration of these indicators meet some requirements of transparency and neutrality, and that the results be cross-checked with available statistical data (fisheries information systems, demographic and economic data at the national and regional scales). Priority must be given to the capacity of MPA managers to sustainably feed the indicators system (with data) and to interpret the results by themselves, with a minimum of external technical and financial support.



3.2 Socio-economic Analysis of MPAs as Fisheries Management Tools

From the fisheries point of view, the creation of an MPA is based on the imposition of restrictions on fisheries activities that are more significant inside the protected perimeter than outside it. As fisheries management tools, MPAs enter into the category of conservation measures even though their regulatory systems can include an aspect relating to access regulation (reserving the right to fish in some areas to certain categories of fishermen for example). This characteristic suggests that in the absence of adequate regulatory mechanisms of access to resources in the areas impacted by MPAs, the expected benefits of the latter for fishing risks to be jeopardized.

☞ *It is important not to overestimate the efficiency of MPAs as fisheries management tools. In fact, like the “bio-ecological” aspect, it seems difficult, a priori, to consider MPAs as a global alternative to “conventional” methods of fisheries management, and it appears important to agree that MPAs are only one of the management tools among others.*

MPAs are conceived as conservation tools and even though their fishery benefits might be real, they are generally difficult to quantify and, in any case, they largely depend on the degree of control of fishing mortality exercised outside the protected perimeter.

☞ *According to literature, the reliability of data and associated methods measuring socio-economic effects on fishing still remains weak. The major difficulty concerning the assessment of the fisheries efficiency of an MPA is due to the fact that its potential benefits for fishing are essentially located outside the protected area, contrary to benefits for other uses (particularly activities related to tourism) which are measured inside. Further, all these difficulties explain why bio-economic modeling of MPAs as fisheries management tools has not yet reached the operational phase. Such modeling is generally hindered by the insufficiency of knowledge concerning the effect of larvae spreading on recruitment, as well as the mobility of exploited resources between reserves and fishing areas. This obstacle is frequently reinforced by the insufficiency of knowledge relating to the spatial mobility of fishermen.*

3.2.1 Explanations of the Weakness of Studies on Socio-economic Effects

☞ *Going beyond the strict framework of MPAs, several recent reports have attempted to assess the economic value of services offered by marine ecosystems, particularly for fishing^{xxii, xxiii, xxiv, xxv}. These studies mainly deal with coral reefs. Yet, within the framework of the meta-analysis conducted on 52 studies providing sufficient statistical information (over a total of 166 listed), Brander et al. (2007) worry about the quality of these assessments, which they consider as often weak.*

Faced with multiple difficulties relating to the collection of socio-economic information, field studies that aim to assess the fisheries efficiency of AMPs generally adopt one of the two following methods:

- **Estimate of spatio-temporal CPUE gradients:** This first approach is hindered by the necessity to take into account the adaptive behavior of fishermen, which impacts the CPUE. Moreover, the fact an increase in the CPUE in the fishing area may be observed does not necessarily indicate a positive overall effect of MPAs on catch. The negative effect of the closure of an area to fishing (opportunity cost of the reserve) and the limits of the spillover effect. must also be taken into account
- **Perception surveys aiming to understand the way in which fishermen appreciate the effect of MPAs on their activities:** These methods are often conducted in order to make up for the absence of socio-economic monitoring of fishing in MPAs. Their methodological difficulties are also related to whether a fisherman's declaration corresponds to the reality (inadequate perception, strategic declarations). They often mix the effect of protection on marine resources with the global effect of MPAs on fishing activities (cf. for example the study of Pollnac et al., 2000, on 45 MPAs in Philippines)^{xxvi}. Results vary according to the surveyors, the moment of the survey, local strategies, etc. For instance, some surveys are conducted using « experts' opinions » that is the views of the MPAs managers themselves. However, the perceptions of managers and those of the fishermen do not always converge, as is shown by McClanahan et al. (2005)^{xxvii} in Kenya. Yet, these surveys sometimes enable researchers to detect a trend, and they can complement other studies that are more precise. The available results generally show mitigated perceptions of fishermen who have been

interviewed.

Irrespective of the methods used, methodological weaknesses or even the absence of methodological descriptions are often mentioned.

3.2.2 Key Elements on Socio-economic Effects and Fisheries Efficiency of MPAs

Despite the overall difficulties mentioned, including the lack of data or the low reliability of results, the literature as well as progress made in model development over the past fifteen years have clarified some aspects of the debate relating to the efficiency of MPAs in fisheries.

☞ *The scientific difficulties in assessing the socio-economic balance of MPAs are compounded by institutional difficulties related to the financing of their development "by project". Assessments are often made by funders or project managers, which does not always guarantee the rigor and/or independence of the conclusions. In addition, the temporal horizon of assessments is too brief to allow for the evaluation of the long-term effects of MPAs, on either fisheries or variability of AIGAs that have been planned in the project (see below).*

Socio-economic effects of the MPA on fishing

Potential benefits of the MPA

- ✓ **Positive biological effects on the resource :** creation of a "safety stock" within the reserve; larval spread from the reserve, export of the exploitable biomass from the reserve to fishing zones.
- ✓ **Participatory and spatial management of fishing and other usages** of the MPA ecosystem, favoring conflicts reduction.
- ✓ **Development of alternative income-generation activities (AIGA)** to fishing, in order to reduce pressure on fishing resources. It also contains several limitations.

Costs of the MPA

- ✓ **Management costs** which includes surveillance, monitoring, and expenses induced by participatory management. On the top of these management costs comes the cost of compensatory measures and other alternative income-generation activities. These costs are to be compared with the implementation costs of "traditional" management measures
- ✓ **Costs of opportunity for fishermen** change according to the level of use of the zone and it is immediate for fishermen when the benefits they could have are not immediate (it is estimated that the spill-over effect of an MPA reserve is between 6 to 9 years)
- ✓ **Indirect costs resulting from a displacement of the fishing effort** towards other areas/or other fisheries



- ✓ Few studies assess the cost of MPAs. Available results show that sometimes the effect is positive, sometimes it is negative. Nevertheless, as a rule and except for a few little atolls, studies show that **spill-over effects are not very often sufficient to compensate** direct catch losses due to an access restriction to fishing zones. MPAs can still slow down the decrease of the yields while ensuring an overall balance of the system.
- ✓ **No effect on price** (increase of the prices due to the decrease of the production linked to the creation of an MPA) which could improve the fishermen's income in the context of a catch decrease has been shown.
- ✓ For an overexploited fishery, if the fishing effort can be similar to the one before the creation of the MPA, the MPA can participate in the increase of the catch but can also improve the resource rent. The optimal size of the reserve must increase with the fishing effort.

Management and control of access are compulsory around MPAs:

Today, everyone agrees that the major part of the failures in fisheries management is caused by the insufficiency and inadequacy of effective mechanisms regulating the access to resources so as to neutralize the trend towards overcapacity of fisheries. Generally, overcapacity results in negative externalities among exploiters of common resources, and which also engenders overexploitation of these resources and conflicts among resource exploiters.

The absence of management and control of access to fisheries undermines conservation measures, which will be incapable of mastering the phenomenon of overcapacity. The problem is all the more acute because the technical effectiveness of fishing and the socio-economic pressures on fishermen are strong.

In the absence of control of access to fishing areas, the creation of a reserve-MPA is not likely to restore fisheries yield (net income generated by sustainable exploitation of resources); yet, in certain circumstances, it can increase the global size of sustainable catches (effect that is all the more likely when the fisheries technical effectiveness is high).

In the case of reef fisheries, several authors^{XXVIII, XXIX} note that the increase of catch by unit area observed is not enough to compensate for the loss of income caused by the closure of part of the fishing area.

On the basis of an estimate of productivity of artisanal fishing by km², Emerton (2000) estimates the opportunity cost of creating two contiguous MPAs (the national marine reserve of Kiste and the national marine reserve of Mpunguti) in Kenya from 1973-1978. Then, he compares the opportunity cost with the turnover generated by fishing (in 1998) in these two MPAs. The author concludes that the opportunity cost is superior (by a factor of 5). Yet, the creation of MPAs seems to have slowed down the decrease in yield resulting from a significant level of overexploitation.

Are MPAs contributes or represent a factor in reducing conflict ?

While it is interesting to envisage MPAs (coastal) as an element of Integrated coastal zone management (ICZM), they do not constitute a magic panacea to resolve user conflicts. MPAs can even bring about certain conflicts, which can be mitigated in part with good governance mechanisms, followed, where possible, by an adequate compensation system (cf. Chapter below on alternative activities). Nevertheless, the main potential conflicts are those among fishermen due to the displacement of fishing effort or conflicts between excluded fishermen and other users who are beneficiaries of MPAs.

It must be kept in mind that the creation of an MPA is, in itself, inefficient in relation to the major cause of user conflict in the fishery sectors which stems from fishing overcapacity.

3.2.3 Key Elements on Socio-economic Monitoring and Reference States

Monitoring systems and socio-economic reference states are often of weak quality due to methodological gaps and lack of liability. Yet, their reliability contributes both to the efficiency of management and financing capacity of MPAs (valuation of socio-economic results, services offered by ecosystems).

The key elements of synthesis drawn from the bibliographical analysis confirm the importance of space-based information both on land and at sea, and the consideration of specific attributions for indicators.

Socio-economic baseline studies which present a certain robustness, all use a dynamic approach, completed by qualitative and quantitative data characterized by their dynamic and zoned presentation, and more particularly by:

- Quantitative information, notably fishing effort, catch, touristic frequentations (overnight stay, volume of recreational activities offered by tour operators).
- An assessment of the socio-economic context in the land area that is directly impacted by MPAs (cf. figure below- T1-T2): demography, health, poverty, markets, equipment, etc.
- Consideration of spatio-temporal changes in the areas concerned: they integrate different human dimensions (economic, social, cultural, historical, etc.) of spaces and fisheries concerned. They present a dynamic vision of territorial change and stakeholders in order to specify how indicators evolved before the creation of and after the



An in-depth socioeconomic state-zero (baseline study) inside and outside the MPA

	Zoning at sea	Zoning at land	Fishing activities on the zoning at sea	Other activities performed at M1, T1, T2
Administrative zoning	M1. Area (s) where specific fishing restrictions (and, where applicable, other uses of the marine ecosystem) are intended to be applied to	T1. Area (s) where compensatory measures and specific regulations will be provided	Types de pêche pratiqués : pêche artisanale, industrielle, récréative. Flottes, effort, métiers, captures	Other activities related to services provided by the ecosystem of the MPA (including recreational activities: ecotourism, diving ...)
Biological zoning	M2. Area (s) where significant spillover effects from these measures are expected		Saisonnalité des activités de pêche	
Socioeconomic zoning	M3. Area (s) of fishing activity may be negatively impacted by these measures (including area of potential displacement of the fishing effort)	T2. Area (s) of employment and housing affected by the measures taken in relation to the MPA (if not identical with T1)	Origine géographique des pêcheurs et degré d'inféodation à la zone	Other major economic activities in areas T1-T2

Required properties for indicators

- ✓ Provide reliable information on the operation of the MPA, in particular the achievement of the objectives assigned to it.
- ✓ Being easily interpretable by the MPA manager and stakeholders
- ✓ Once set, indicators should be updated regularly by the manager of the MPA (collection, analysis), without or with minimal external assistance. This implies that the indicators are not too many, and they can be updated with realistic cost and technology.

Objectives

Indicators

1. MPA's impact on fisheries	✓ Fishing effort, catches, employment (jobs) and revenues (income) (zones M1-M2-M3)
2. Development of AIGAs (Alternative Income Generation Activities)	✓ Jobs and income by activity type (zones M1-T1-T2)
3. MPA's impact on space-based use management	✓ Use conflicts in zones M1-M3 (frequency and severity perceived by the actors)
4. MPA financial viability and self-sufficiency	✓ Ratio between recurrent resources and running costs of the MPA, and part of the own resources (assets) entering recurrent resources
5. Social and economic context	✓ Relevant elements that could be routinely collected from pre-existing databases (e.g. demography, health and living conditions): zone T2 or immediately higher geographical scale

consolidation of the MPA (change of activities taking place in these areas, nature of activities and fleets, employment, vocations, landed volumes, seasonality, geographical origin of fishermen, touristic visits, conflicts etc.)

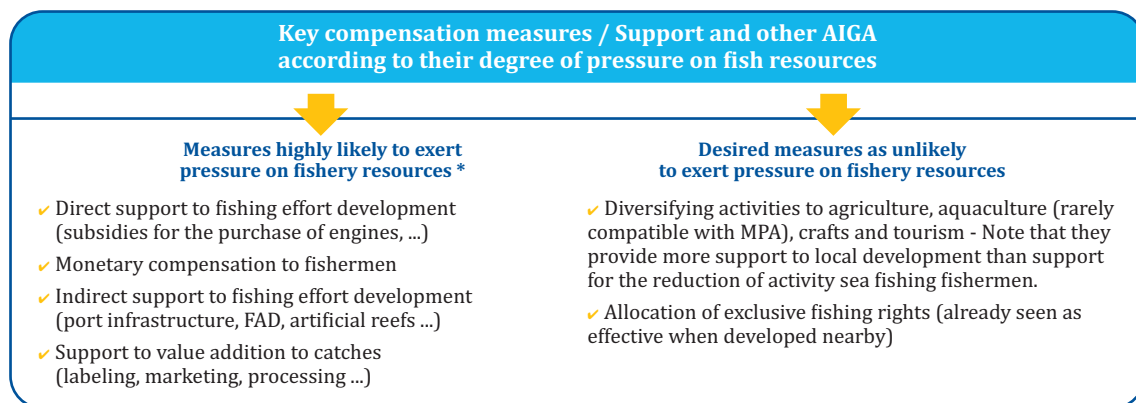
3.2.4 AIGAs, Compensation and Accompanying Measures– Many precautions to take

There is an obvious spatio-temporal imbalance between the costs and expected benefits of MPAs. That is why particular attention is given to their benefits for the local populations and to the compensation measures that may be implemented regarding these populations. Known as « Alternative (or additional) Income Generating Activities », the AIGAs can be classified into three major categories according to the rationale behind their establishment:

- **Transitional accompanying measures associated with general territorial development:** The creation of MPAs often boosts the development of touristic and recreational activities (diving, naturalist and cultural outings, snorkeling, etc.) but this does not necessarily mean that local populations are the main beneficiaries. These AIGAs are proposed until the MPA benefits are fully realized and the MPAs are well received.
- **Measures compensating restrictions on fishing areas (compensation of opportunity costs):** To compensate for the restrictions on ocean use, MPAs provide either direct compensation (e.g. donations, purchase of

gear) or indirect assistance (e.g. through port infrastructures, provision of fish aggregating devices (FADs), or valorization of catch). Generally, direct assistance contributes more strongly to the increase in fishing effort than indirect assistance. Compensation through allocation of exclusive Territorial Use Rights in Fisheries (TURFs) remains the only positive example of measure that do not increase fishing effort..

- **Measures contributing to the reduction of fishing effort while reducing poverty:** To limit the pressure on fishing areas, projects or NGOs propose alternative income-generating land-based activities to fishermen such as development of eco-lodges; land-based animal or vegetal production (wildlife, aquaculture) or use of canoes for tourism instead of fishing.



** In descending order of likelihood of increased pressure*

☞ *Fleet-reduction programs are generally disappointing; this is mainly due to the fact that the effective decrease of fishing capacity is often sharply inferior to the decrease of the nominal decrease because it is the less performing vessels which leave the fleet. When such programs are recurrent (as in Europe in the 90s), they are finally anticipated by fishermen and no longer produce the expected effects.*

☞ *Projects of AIGAs developed for the benefits of fishermen remain often anecdotal or weakly sustainable, and rarely present positive economic results for the stakeholders involved (inaccuracy on the monitoring of many projects), and do not have any effect on the reduction of local fishing pressure that their objectives led to expect.. When some examples of recreational-fishing or guided visits yield an apparent slight reduction of fishing pressure, it always involves a very limited number of stakeholders, and the attractiveness of the sites leads to an increase in the demand of fish consumption by tourists, and therefore to an increased fishing pressure on some local species. Collective projects implemented by women (welcome, eco-lodge) remain effective for local development when they are well supported and managed in the long term and when a market exists for those services. However, these projects have little impact on fishing and fishermen, and can be considered merely as local development initiatives.*

Yet, the donors and institutions engaged in the strengthening of an MPA, rarely take into account the duration that is necessary for the building new collective governance change, or consolidation of social processes and socio-economic activities. Actually, the short duration of projects (3-4 years) the disruption of the financial flows and the weakening of the support with time contributes in part to the non-sustainability of local economic development projects in MPAs.

☞ *With a view to acknowledging that the fishermen that are negatively impacted by the establishment of a reserve are those who will ultimately benefit from the positive effects of this measure, the Italian law reserves the access to adjacent fishing areas only to professional fishermen so that they can withdraw the eventual benefits of fish spillover from the reserve towards adjacent fishing areas. These can take the form of catch quotas or territorial exclusive use rights^{xxx},^{xxxii}. This type of regulation is not always easy to implement, in particular in the case of migrant fishermen.*

☞ **Measures relating to AIGAs raise many issues:**

- *their financial cost and who bears this cost (the determination of which is sometimes difficult). The agreement of “winners” to pay for the cost can be difficult to obtain;*
- *their impact on resource conservation that MPAs are supposed to promote;*
- *the long term economic viability of AIGAs, whose initial development is frequently financed as part of MPA creation projects ;*

In general, the success of AIGAs and AIGAs projects or components depends on three factors: (i) existence of a market (realism of the market must be considered), (ii) qualitative and quantitative adaptation of supply to this market, and (iii) a return of a substantial part of the generated benefits towards local populations.

The meeting of the first two conditions can face various obstacles: the local market is not large, coastal communities are landlocked, and the lack of capacity of available manpower.

The third condition is not often well met in the case of tourism. In addition, in some cases, the latter generates negative socio-cultural and environmental impacts for local populations. It can even be a hindrance to conservation objectives, urging for example fishermen to fish under-sized lobster in order to meet the demand of restaurant managers in Belize. It can also bring about tensions in local markets or conflicts relating to access to common resources (water, space, coast), as recent studies show in Madagascar.

Sources : Chaboud et. Al (2004)^{xxxii}, King (1997)^{xxxiii}, Pascal (2011)^{xxxiv}



3.3 Recommendations on the “Socio-economic” Aspect

3.3.1 Developing a Rationale (justification) for the Creation of MPAs

In addition to the usual justification, relating to protection of resources and habitats, the creation of a “secure stock” and the spillover effect, it seems important to realize that the establishment of an MPA has an impact on the economic development of local populations. This impact will not be limited to the MPA's potential impact on local fishermen because the MPA also affects the activity of the fishery sector upstream (suppliers, builders etc.) and downstream (market, processing) which have induced effects on the local economy and on other activities related to services offered by ecosystems. Unfortunately, the necessary studies are seldom undertaken.

☞ Recommendation:

“To produce spatial information and management”

- *To promote the development of a spatially-driven management and the production of national atlases that are coordinated at the regional level: This management should value the dynamics of use (surveys) and migrant fishermen.*
- *To reinforce the production of local databases covering areas both outside and inside MPAs. Regarding socio-economic matters, it should include notably:*
 - ✓ *Biological zoning, confirming spaces affected by spillover*
 - ✓ *Administrative and regulatory zoning on land and at sea*
 - ✓ *Zoning of fisheries activities (fleets, efforts, strategies, catch) and other coastal activities*
 - ✓ *Origins of stakeholders and their degree of dependence on the area*
 - ✓ *Migratory phenomena and seasonality of activities*
- *To capitalize and valorize socio-economic elements and fishing strategies*
- *To digitalize information in a GIS format so as to valorize the regional data and develop an atlas.*

☞ Recommendation:

“To analyze the relevance of the establishment of an MPA and specify its objectives”

- ***To analyze the relevance and feasibility of the establishment of an MPA that is intended for fisheries management:*** *To rely on a study of the opportunities and impacts and to specify the advantages of such MPAs with regard to a conventional Space-time Restriction (STR). This study should :*
 - ✓ *Specify if there are similar examples that can enable the development of reports on other fishing areas and their impacts*
 - ✓ *Estimate the relevant size of MPAs taking into account migrations and fishing movements , administrative frameworks, and the socio-cultural context (to take into account the migrant fishermen in the area)*
 - ✓ *Ensure that the MPA will be financially viable and specify mechanisms to be established in order to ensure its effective management in the long term. In fact, without financing, management will remain ineffective and the MPA will become “a paper MPA”.*
- ***To prioritize management objectives and sustainable economic development activities associated with MPAs:*** *The analysis of problems, regulations and proper constraints on MPAs and their broader environment should rely on surveys among stakeholders in order to facilitate the concerted definition of management and economic development objectives. This also implies that the list of these “stakeholders” has been defined beforehand, through a process that is not only technical (definition of who will be really impacted by MPAs), but also political (specification of who are the legitimate stakeholders).*

3.3.2 Definition of a Socio-economic State of Reference (baseline)

Socio-economic Baseline studies (“Zero state”) or “Socio-economic states of reference” are unfortunately mostly missing or very weak. Yet, such studies remain an essential element to inform the creation of an MPA, to support management measures, and to allow the adaptation of management measures to the local context. They facilitate consultations and decision-making processes that have a co-management objective. The success of these operations depends not only on the monitoring of performance and impacts on local populations, but also on

the quality of the evaluation of the services offered by ecosystems and MPAs. Thus, such quality is useful to facilitate access to financing, mobilize policy-makers and decision-makers, and support the financial sustainability of the MPA management. In addition, such agreed “state of reference” also help improve coherence between MPAs and measures regulating access to fishing areas, for example through an institutional mechanism linking the Ministry of Fisheries and that of the Environment (cf. governance), often greatly coveted by stakeholders. The absence of standard methods or adapted to the national level also contributes to the lack of development of these studies.

📌 Recommendation:

“To establish a minimum socio-economic state of reference and cooperate for its realization”

- **To establish a thorough and robust inventory** (Baseline study-state of reference) inside and outside MPAs based on pragmatism and reliability :
 - ✓ To maintain coherence with subsequent monitoring efforts integrating the influence zone outside the MPAs boundary. It will be based on the same information and spatially-driven criteria such as those mentioned in the recommendations on monitoring.
 - ✓ To go beyond simple monitoring and ensure close collaboration among stakeholders (biologists, socio-economists, managers, stakeholders).
 - ✓ To measure potential impact: to identify, locate, and quantify activities (existing or future) likely to be positively or negatively impacted by MPAs
 - ✓ To develop a dynamic approach of spatio-temporal analysis at the level of stakeholders and territory, using quantitative and qualitative data (cf. chapter 3.2.3)
 - ✓ To adopt a standard nomenclature and simple, robust and standardized protocols for surveys and analysis, adapted to local contexts. The building of a common vocabulary and conceptual reference is required to enable meaningful dialogue between disciplines.
 - ✓ To take into account fishing migrations by insisting in particular on their differences and the typology of the migrants;
- **To give priority both to existing MPAs and to new MPAs** : A state of reference that is established even after the creation could encourage a new starting point, and support long-term management as well as financing on the basis of results.

3.3.3 Establishment of Sustainable Socio-economic Monitoring and Evaluation Tools

All the stakeholders agree on the relevance to establish a socio-economic monitoring system covering both inside and outside MPAs. This system should be developed in the long term and be based on pertinent indicators. Experience on socio-economic indicators and monitoring of management efficiency show dramatic weaknesses both at the methodological level, in the effort to collect and analyze data, and in the involvement of financial institutions. Despite the existing experiences (notably within the framework of the BioCos and CEPIA projects at the level of the SRFC region), no sustainable mechanism is operational. It is also often noted that cross-checking of information to ensure a better analysis of results is often overlooked.

📌 Recommendation:

“establish a sustainable socio-economic monitoring and evaluation inside and outside MPAs”

- **To be judicious in the use of perception surveys and ensure their reliability**: To use them as the preferred method of analyzing the impacts of MPAs on fishing and zoning of uses, the development of AIGAs, and governance. To avoid consulting involved experts and managers for this analysis so as not to distort results.
- **To optimize cost-effectiveness through two levels of monitoring**: defined along with stakeholders and adapted to available means; they should be conducted inside and outside of MPAs:
 - ✓ An annual low-cost and robust monitoring conducted by managers concerning: (i) spatio-temporal dynamics and quantification of utilization on formerly defined area ; (ii) perception surveys of the effects of MPAs conducted on representative samplings ; (iii) self-evaluation of governance by the monitoring team with feedback provided to stakeholders.
 - ✓ A more detailed framework survey at spaced intervals (4-5 years) to specify look at: (i) Costs and benefits as well as their allocation among stakeholders, and (ii) governance and efficiency of management (functioning of consultation bodies, control measures, allocated means), but also global changes occurring in the territory.
- **To establish a long-term budgeted monitoring** based on a limited number of operational and spatial indicators.



- **To simplify mechanisms, capitalize on past efforts and harmonize methods.** *The existing experiences can serve as a basis (cf. AMPHore project or SocMon method), but the elaboration and implementation of monitoring systems should be realized in a cooperative manner (scientists/managers/user), and should correspond with the objectives of MPAs. The definition of a reference area, as similar as possible to the MPA will be also useful.*

- **To rely on pre-existing or otherwise available information and promote the integration with national monitoring systems and research:** *To provide articulations with pre-existing standardized information systems (fisheries monitoring system), and ensuring that different scales are interconnected. These studies should also enable the evaluation of the contribution of MPAs to the local and national economy. National capacity of socio-economic research on MPAs and fishing should be strengthened.*

- **To restrain the system to a small number of indicators, aiming at optimized cost/effectiveness, synthesis, easy replication and reliability as well as easy interpretation.**

- **To ensure transparency and communication with local stakeholders:** *The modalities of feedback on results (stakeholders, periodicity, etc.) will be specified from the system elaboration stage. To process the results and to communicate in a transparent manner (disseminate monitoring results in local languages and with adapted communication aids).*

3.3.4 Precautions in the Implementation of AIGAs

In principle, the consideration of AIGAs remains useful because they are supposed to facilitate the acceptability of the project by taking into account either compensation or measures intended to reinforce the local socio-economic fabric. However, the development of AIGAs is often anecdotal or unsustainable; it does not present positive economic results and even increase fishing pressure. The possibility for fishermen to sustainably undertake alternative income generating activities is often nearly inexistent, because either there is no market or this market is not adapted to their wishes and capacities. When such activities correspond to the needs of stakeholders (tourism, market gardening, etc.), supports are often not professional enough to be sufficient. Errors are often repeated in this matter because past lessons are not taken into account. AIGAs successful establishment requires long-term

support (more than 3 years) and this is incompatible with the short-term nature of donors' projects financing. In addition, experiences have shown that compensatory measures may have often had negative effects on fishing activity and thus require precaution.

Recommendation:

“To clarify the role and nature of compensatory and accompanying measures, and particularly AIGAs “

- *To avoid inducing transfers of fishing efforts: AIGAs measures should not have effects that are potentially contrary to the objectives of MPAs (no farming of introduced species for instance) and/or contrary to the sustainable management of fisheries (inducing effort transfer) (cf. above chap. 3.2.4).*

- *To focus more on management improvement and economic performance of the fisheries sector rather than on secondary actions (until now called AIGAS for fisheries) that often produce perverse effects and mobilize substantial resources. Focusing on control and surveillance, stimulation of fisheries dialog mobilizing fishery sector will produce in the long term more significant impacts on the local fishing area than AIGAs.*

- *To realistically secure the economic viability of relevant socio-economic projects. The feasibility and commercial markets of AIGAs should be assessed in a realistic way and with professionalism by specialized structures. If the technical support is relevant, it should be provided beyond 5 years so as to secure the learning process and self-sufficiency of stakeholders.*

- *To ensure that MPAs benefit the local community: taxing new uses (tourism) can be an element enabling the transfer of benefits towards collective activities carried out by fishermen or the local sector, thus increasing the acceptability of the project.*

3.3.5 Financial Viability and Sustainability of MPAs

While political commitment and the institutional framework are fundamental, it has been noted throughout the world that in the absence of adequate or sustainable financing mechanisms, MPAs often are inefficiently managed, and therefore lead to a poor level of conservation and non-sustainable use of resources.

Financing of fisheries management like MPAs is often limited to its launching phase while it remains a crucial factor of sustainability and performance. The development of autonomous management of an MPA will take at least

12 -15 years (even more depending on local cultures) and should be financially supported during establishment and transition phases (renewal of co-management bodies).

Insufficiency of human and financial resources (mainly at the decentralized level) is a major factor of failure.

The search for external funding is not easy, and if it succeeds, it will create a potentially dangerous dependency on donors. Complementarities of local, national, public, and private financing sources and their diversity allow for limiting risks and ensuring sustainability of the operation of MPAs.

📌 Recommendation:

“To develop sustainable financing of MPAs that are integrated into central financing mechanisms “

■ **To take into account financing beyond the launching period of MPAs:** *At the creation of MPAs, the financing plan should take into account in a realistic way the needs and permanent costs of MPAs (surveillance, monitoring, and expenditure induced by participatory management), and this should be done beyond the launching phase. A budget for the first 5 years should be provided along with a support budget during the transition period leading to self-sufficiency (the subsequent 5 years at least).*

■ **To develop economies of scale:** *Very large MPAs (whether multi-use or not) require substantial budgets and combination of resources from the Navy, conservation, fisheries, tourism, as well as other sectors which should be organized and negotiated. Since the major part of the problems and solutions are common both to fishing and to MPAs, economies of scale are possible through operational collaborations, or in some justified cases, integration of the two systems of governance.*

■ **To study the possibility of realistic self-sufficiency,** *knowing that this can never take in charge all the costs related to management. Nevertheless, it is worthwhile to study the possibility of establishing a sustainable mechanism contributing to the financing of MPAs by those who draw real benefits from them and have sufficient capacity (tour operators, visitors, and collectivities). All the possibilities of development of self-generated resources of MPAs must be exploited.*

■ **To analyze and promote in a realistic way the different mechanisms known as sustainable financing** *(taxation of ecosystem services, trust funds, etc.). Services provided by MPAs regionally generate benefits that are global in nature. The global context is not conducive to broad financing but nonetheless, international beneficiaries should participate and national ones as well including in reinforcing national institutions. Local fishermen and States should develop mechanisms that are adapted to local and regional means to participate in this management even though the measures might not cover all the costs. Such mechanisms are being established in forestry and increasingly developed in coastal MPAs (see MARFUND, Banc d'Arguin, MedPAN...) and could serve as source of inspiration. National taxation mechanisms associated with transportation, cruise, and national gambling, or those relating to the establishment of trust funds do exist throughout the world, and could also provide inspiration.*



4 SYNTHESIS OF LESSONS AND RECOMMENDATIONS ON THE GOVERNANCE OF MPAS AND FISHING

The conceptual frameworks of fisheries management and conservation have progressed separately and their relative failure is largely due to the same causes. The two systems of governance present today synergies that are quite stronger than in the past, and mutual interests, which may facilitate the development of institutional links. Recommendations to improve the management of MPAs and the performance of fishing are similar: e.g. implementation of “good governance”; institutionalization of management plans and establishment of effective users’ rights. In both cases, the form of governance that seems more efficient for the management of natural resources is “shared” governance or co-management, at the regional, national, and local level.

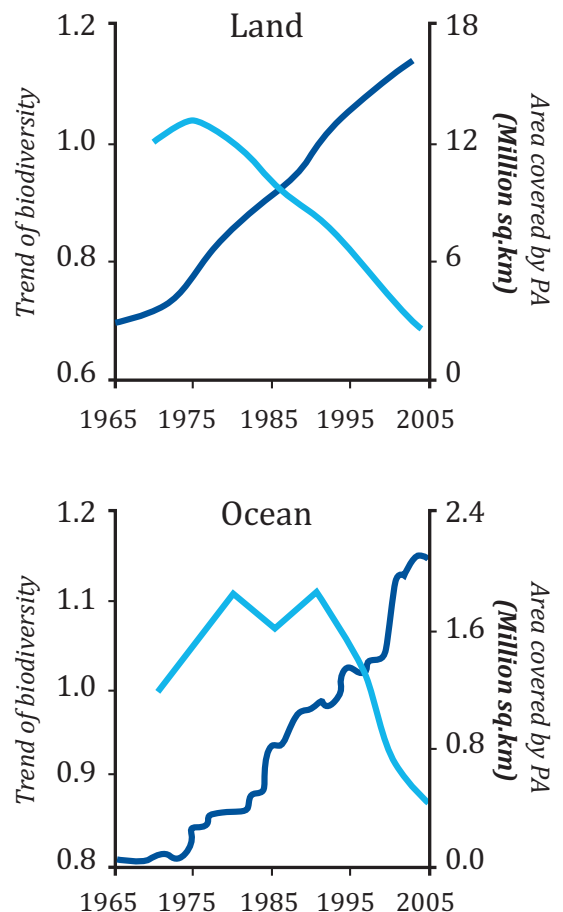
4.1 Weak Performance of MPAs and Fisheries Management

Several authors including Mora and Sale (2011) show that despite a sharp increase in the number of marine protected areas at the global level, terrestrial and marine biodiversity are declining, since the 1970s on land and since the 1990s in the oceans.

These authors have highlighted the contrast between many studies emphasizing the advantages of MPAs and other studies showing that these effects are not universal.

According to them and to meta-analyses conducted by the World Bank, several systematic reviews indicate that the failure of MPAs is more the rule than the exception. This situation strangely reminds us of what is happening in the fisheries sector. The impact on people and on their livelihoods is also less systematically documented and restricted activities are hardly replaced and compensated. When the socio-economic impact is negative, it tends to undermine the possible positive results on resources. The realization of positive impacts is highly dependent on factors that are external to MPAs such as the politico-economic framework, demography, neighboring activities, user s culture, etc. In these conditions, even though the possibility for an MPA to produce a positive effect is relatively well established, there is no guarantee that such effect will be obtained (Botsford, 2010), or that the positive effects will sufficiently compensate the potentially negative ones, even if they have not been thoroughly studied.

Figure 2
Global Change in Biodiversity (light blue) and the spaces covered by marine protected areas (dark blue).
Source: Mora and Sale (2011).
Retraced from Science Daily (2011)



While acknowledging the progress achieved, these authors suggest that MPAs, which are important as emergency and functional if they are well managed, are not able, alone, to stop the degradation of biodiversity. New complementary approaches are necessary, attacking more specifically the known causes of this degradation: e.g. overpopulation and excessive consumption of resources. In addition, the authors have underscored the lack of evaluation of the performance of MPAs for decades, as well as known limitations, of strategies based on MPAs: (i) very slow growth of their coverage; (ii) inadequate size and connectivity ; (iii) efficiency limited to some human threats; (iv) insufficient financing; (v) conflict with the development needs.



☞ *One century of “protection” by human exclusion (zones turned into sanctuaries) did not prevent a strong erosion of biodiversity and one century of fisheries management (under open access) did not prevent over-exploitation of resources. It is clear that MPAs are considered by some people as a fundamental tool, despite a dramatic failure rate (“paper MPAs”, weakness of management), while the same can be said of fisheries and the conventional tools they use. Yet, convergence points do exist today because in both fields we have modified their paradigm:*

- *From conservation of species or populations to that of spaces, structures, and functions (ecosystem approaches, space-based management, marine spatial planning);*
- *From top-down to participative management with the inclusion of stakeholders in the governances and allocation of exclusive user rights.*

☞ **Efficiency of the management of MPAs in Brazil** ^{xxxv}

In Brazil, in 2008, among the 299 federal protected areas, 210 did not have a management plan, 184 had no established Management Council, and 161 did not have any infrastructure. The analysis of Brazilian MPAs illustrates the situation and shows the high level of pessimism, an acute perception of the weakness of the national system and weak results achieved on the field. The main identified weaknesses are as follows:

- *poor institutional coordination between coastal and oceanic management coupled with an administration and management system that is much bureaucratic ;*
- *Mismanagement of individual MPAs and problems with the management of regional networks of MPAs ;*
- *Insufficiency of financial means which generates structural problems;*
- *Lack of connection between MPA policy and its implementation; and*
- *Lack of professional motivation.*

The further designation of additional MPAs without resolving these problems may not enable Brazil to fulfill its international commitments in terms of marine biodiversity.

4.2 An Historic Change towards more Synergy and Coherence between “fishing” and “MPAs” systems

Although the conceptual framework of fisheries management and MPAs have emerged at the same time, in late 19th century, during practically one century, conservation and fisheries management have evolved separately to ultimately face their relative and respective failures, particularly since CNUCED (1992). Formerly dominated by the concepts of preservation through exclusion of use, MPA management has progressively changed towards concepts of integration and sustainable resources use.

Fisheries, formerly dominated by “growth and expansion”, have moved towards the concept of sustainable development and, more recently, of responsible fisheries and ecosystem approach to fisheries, thus reinforcing its biodiversity conservation rules.

☞ *Until the 1970s, fishery management measures that are qualified today as “technical” or “conventional” were known as « conservation measures » as opposed to more modern measures such as limitation of catch, effort, or introduction of fishing rights.*

There are still tensions both between the two management systems (of fisheries and of biodiversity) as well as within each system, and between those who believe in radical strategies and those who believe in more moderate consensus-building strategies. Notwithstanding, the common ground or convergence points that are explained below are more important nowadays than ever, and should lead to greater convergence between fisheries and environment officials:

- **The two systems of “MPAs” and “fisheries” management share the same management process steps:** decision-making, implementation planning and evaluation of performance. The two management mechanisms take place with a degree of active participation of the stakeholders concerned; more or less sophisticated scientific support, integrating traditional knowledge; and information management. The decision-making process is greatly facilitated and more effective if it takes place in a national framework that sets the modalities and objectives, deadlines and resources;

- **The two systems of “MPAs” and “fisheries” management have often failed for similar reasons** and require corrections that largely depend on the same

principles. In both cases: governance is a problem; excess fishing capacity should be eliminated; increase of human pressure and degradation is more rapid than the development of corrective measures; the state of uncertainty is permanent, and information is incomplete. The other common difficulties are notably natural variability, demographic growth, absence of recognized and defensible user rights, insufficient institutional investment, and lack of participation and legitimacy;

- **The technical recommendations to improve management performance are similar:** (i) implementation of « good governance » ; (ii) systematization of management plans and their implementation ; (iii) and establishment of effective user rights;

- **The synergies between the two systems studied on a case-by-case basis are made possible** by combining approaches, by carefully placing Reserve-MPAs in fisheries and integrating fisheries in large multi-use MPAs. However, these synergies should be convincingly analyzed ex ante, in their specific context and integrated in a federal spatial framework.

☞ *The role of fisheries reserves need reconsideration.*

For centuries, the concept of “fisheries reserves” or “refugia” has been a key factor in fisheries management because of their importance for ensuring reproduction, food and protection of juveniles.

These refuges are now less used in many areas and when envisaged, they have been, like MPAs, often urgently established without any assessed objectives or indicators in a context dominated by no control of fishing capacity, thus preventing the objective analysis of their effectiveness.

Caricatured positions that encourage growth and increased exploitation of resources or those tending towards human exclusion for conservation are outdated, and moderate stances present a growing set of options on which a general consensus can be found, provided that quick generalizations are avoided, and people acknowledge that : (i) each fishery and each MPA is a particular case deserving a particular examination and an adapted solution ; and (ii) the introduction of a reserve.MPA in a fishing area may or may not be an appropriate solution depending on the specific case. In both situations, dogmatism is not useful for the resolution of problems.

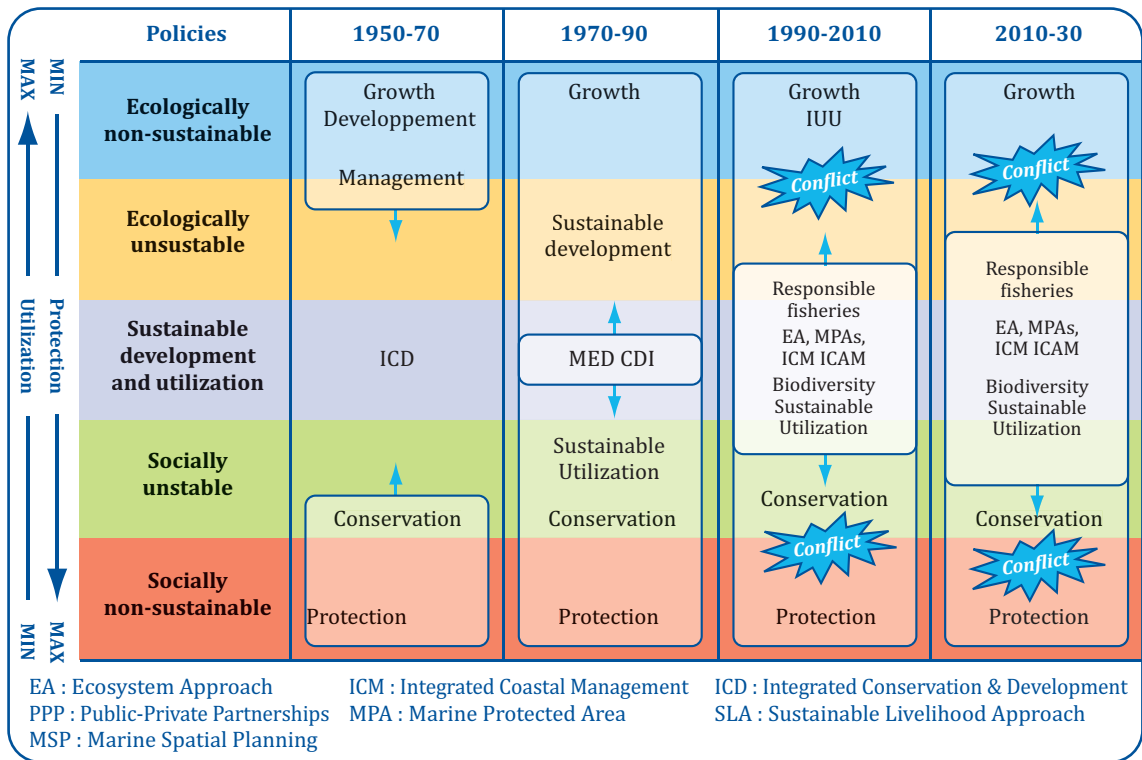


Figure 3

Evolution of the concepts of fisheries and conservation management (Modified from Garcia, SM 2010). Conflicts indicated are internal to both governances, between extremists and moderates

☞ **The connection between MPAs and fishing raises an issue of “cross-governance” and a classical challenge in the management of complex systems.** The main questions arising in the debate are as follows:

- The role of MPAs as a fisheries management tool: are the effects and benefits for fisheries obvious? Do fisheries reserves present advantages for fisheries or conservation? Isn't there any risk of confusion between the two? (cf. “Socio-Economic” aspects)
- Tolerance of MPAs with regard to fisheries varies. How could it be better developed?
- Spatio-temporal dynamics of complex fishery and MPA systems imply an adaptive and space-based management. How to establish it and what are its consequences?
- How can fisheries management contribute to fulfill the international political commitments and achieve national objectives in the matter of establishment of MPAs while optimizing potential cost-benefits?

Table 2 Shift in the MPA paradigm. From Phillips (2003) cited by Lee and Middleton (2003)

Topic	As it was: protected areas were...	As it is becoming: protected areas are...
Objectives	<ul style="list-style-type: none"> ✓ Set aside for conservation ✓ Established mainly for spectacular wildlife and scenic protection ✓ Managed mainly for visitors and tourists ✓ Valued as wilderness ✓ About protection 	<ul style="list-style-type: none"> ✓ Run also with social and economic objectives ✓ Often set up for scientific, economic and cultural reasons ✓ Managed with local people more in mind ✓ Valued for the cultural importance of so-called “wilderness” ✓ Also about restoration and rehabilitation
Governance	<ul style="list-style-type: none"> ✓ Run by central government 	<ul style="list-style-type: none"> ✓ Run by many partners and involve an array of stakeholders
Local people	<ul style="list-style-type: none"> ✓ Planned and managed against people ✓ Managed without regard to local opinions 	<ul style="list-style-type: none"> ✓ Run with, for, and in some cases by local people ✓ Managed to meet the needs of local people
Wider context	<ul style="list-style-type: none"> ✓ Developed separately ✓ Managed as ‘islands’ 	<ul style="list-style-type: none"> ✓ Planned as part of national, regional and international systems ✓ Developed as ‘networks’ (strictly protected areas, buffered and linked by green corridors)
Perceptions	<ul style="list-style-type: none"> ✓ Viewed primarily as a national asset ✓ Viewed only as a national concern 	<ul style="list-style-type: none"> ✓ Viewed also as a community asset ✓ Viewed also as an international concern
Management techniques	<ul style="list-style-type: none"> ✓ Managed reactively within a short time scale ✓ Managed in a technocratic way 	<ul style="list-style-type: none"> ✓ Managed adaptively in a long term perspective ✓ Managed with political considerations
Finance	<ul style="list-style-type: none"> ✓ Paid for by taxpayer 	<ul style="list-style-type: none"> ✓ Paid for from many sources
Management skills	<ul style="list-style-type: none"> ✓ Managed by scientists and natural resource experts ✓ Expert led 	<ul style="list-style-type: none"> ✓ Managed by multi-skilled individuals ✓ Drawing on local knowledge

4.3 Principles of Good Governance

There are many convergent definitions of governance. The term was coined to reflect the extension of the public decision-making process of the State to representatives of civil society and the private sector. It refers to the decision-making process, definition of objectives, responsibility, organization, and evaluation of results. The whole notion of governance is perfectly integrated today with the principles (if not in the facts) of governance in fisheries (Garcia, 2009) and MPAs (Graham et al., 2003).

4.3.1 Governance typologies

Generally, there is a distinction between, on the one hand, “top-down” conventional governance or State governance, seen as interventionist and paternalistic and, on the other hand, self-governance (or self-management), which is popular and community-based and referred to as “bottom-up”. Different examples of typologies are mentioned in the technical report.

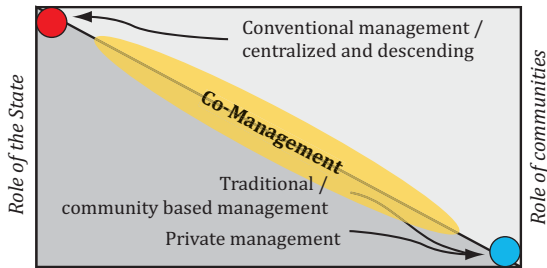


Figure 4
Representation of the types of governance

MPAs can be characterized by three main types of governance:

- **Co-management:** It is a partnership agreement in which stakeholders (e.g. fishermen, State institutions, other stakeholders of the sector or territory, NGOs, and researchers) share responsibility and authority over the management of a fishery. Through consultation and negotiation, partners develop a formal agreement specifying their respective roles, responsibilities, and rights in the management – their negotiated power. This is presently the most recommended form of governance and the most efficient for the management of natural resources, fisheries, and MPAs. It can intervene at the regional (among States), national (among ministries), and local scales (among sectors). It has been progressing slowly but surely since at least two decades.
- **Private management** is extremely rare in the maritime field, but it exists for MPAs. In this case, benefits can be drawn from activities taking place within these reserves, and tax reductions can encourage such a type of governance.
- **“Ghost management”** is unfortunately the most frequent in artisanal fishing as they are in MPAs. It is characterized by a lack of interest of the State (unwilling or incapable to manage) and also a lack of social cohesion of user groups who are hardly capable of organizing themselves. However, should we examine closely this apparent form of governance, we can realize that it is nothing but a failed bottom-up or top-down governance.

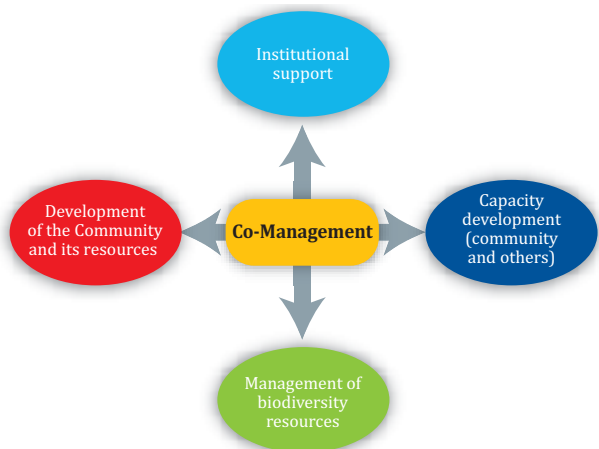
4.3.2 Co-management

☞ *Co-management is not a formula, but rather an adaptive process that changes, grows, and matures with time. It implies the democratization of the process, the social emancipation of stakeholders, decentralization, sharing of power, and social empowerment. In short, the principles and characteristics are those of « good governance ». Its implementation generally contains 4 interconnected components.*

Shared governance is an approach that is greatly recognized and practiced in several types of national fisheries (in particular when they include allocation of fishing rights), and international ones (in Regional Fisheries Management Organizations, RFMOs) where it is a legal requirement that UNCLOS¹ imposes on States. It is particularly recommended for community protected areas.

Numerous authors have pointed out the paradox of the development of a rhetoric of decentralization and empowerment of local communities by developing States, NGOs and funding agencies, while putting in place legal and regulatory systems which, through co-management and standards, in fact strengthen the central authority. Several examples are given in the technical report.

Figure 5
Simplified diagram of the co-management of natural resources



1 - United Nations Convention on the Law of the Sea

In Figure below one can note the change (not necessarily linear) of community-based traditional management, characterized by limited State presence and little or no science, but with local knowledge towards: (i) a historical increase of the role of scientists (often instrumental); (ii) intrusion of NGOs into core mechanisms, in connection with fishermen, scientists, and policy-makers; and (iii) intrusion of media and tribunals (in D). In the various aspects of the changes, one can note the possible changes in the relative importance of the main interacting components.

Figure 6 Relation among decision-makers (D), fishermen (F), scientists (S), NGOs (N), tribunals (T), and media (M) in various types of fisheries governance. The relative size of circles reflects the relative importance of roles. By extending the group of fishermen to that of stakeholders in general, the figure easily applies to multi-use MPAs.

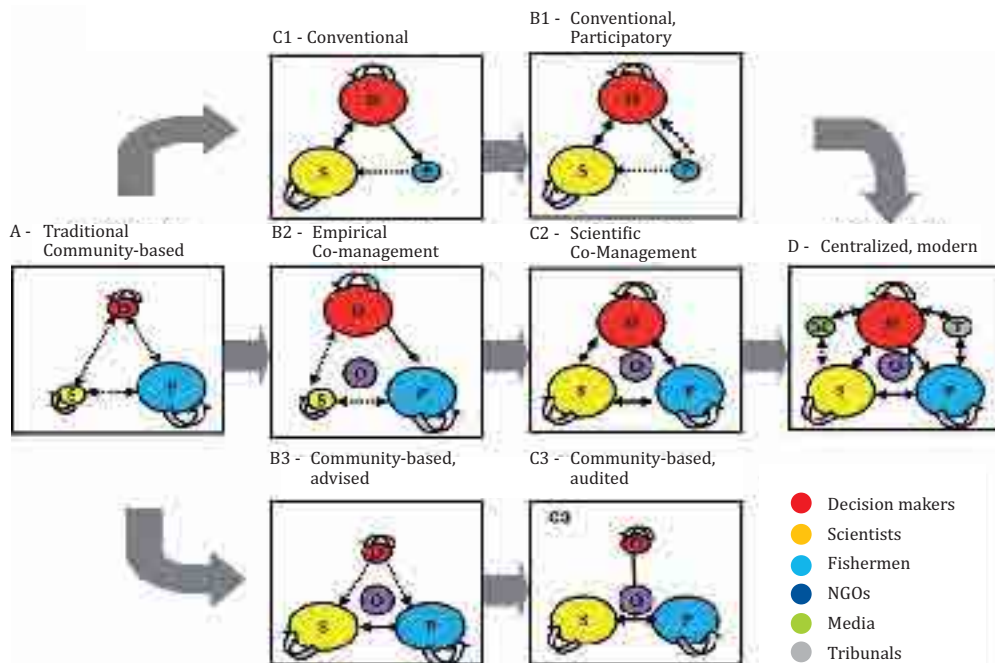


Table 3 Advantages and disadvantages associated with co-management

Some advantages of co-management	Some potential drawbacks of co-management
<ul style="list-style-type: none"> ✓ Consideration and conciliation of particular interests ✓ More transparent arbitration ✓ Increase of the interests of stakeholders ✓ Sharing of responsibilities in case of failure ✓ Better data on stakeholders' activities ✓ Regulations are more adapted to local conditions, more efficient ✓ Better legitimacy (acceptability) and respect of measures ✓ Lesser cost of control and surveillance 	<ul style="list-style-type: none"> ✓ Additional institutional adjustments ✓ Building of additional local/central capacities ✓ Increase of transaction costs ✓ Longer and more difficult negotiations ✓ Risk of manipulation by influencing stakeholders ✓ Risk of growing marginalization of the most needy

Development of Co-management in the reserve of San Salvador (Philippines) ^{xxxvii}


In late 1970s, the fishery of San Salvador island (Philippines) showed signs of overexploitation (decrease of catch; scarcity of highly-valued species, utilization of poison and dynamite). The fishery was de facto a free-access one and not managed. The central government was too distant and fishermen were not organized enough to be able to react. Following a serious crisis, an NGO had provided subsequent support programs enabling the improvement in community management and the creation of a no-take zone and a regulated zone (1987, 1989). A local decree was passed in 1989, establishing reserves and sanctuaries, prohibiting fishing in sanctuaries and destructive fishing in reserves. These programs have enabled the development of a management plan, the organization of the community, the generation of new incomes, the introduction of regulations, and the education and training of stakeholders. Mobilized local stakeholders have become active in the control and surveillance, and participation has increased. Although no management was decided at first, it emerged naturally with the municipal government. Thus, in 1991, the political support for management was reinforced by the adoption of the Municipal Government Code, granting to municipalities the jurisdiction over coastal waters. This has enabled the: (i) development of legislation required for sanctuaries and control; (ii) resolution of conflicts among internal users and external ones; (3) provision of vessels and equipment for patrol activities; (4) creation of a team of municipal guards, and (5) support for community initiatives.

4.3.3 Key Elements of Good Governance and Management in the Context of Uncertainty

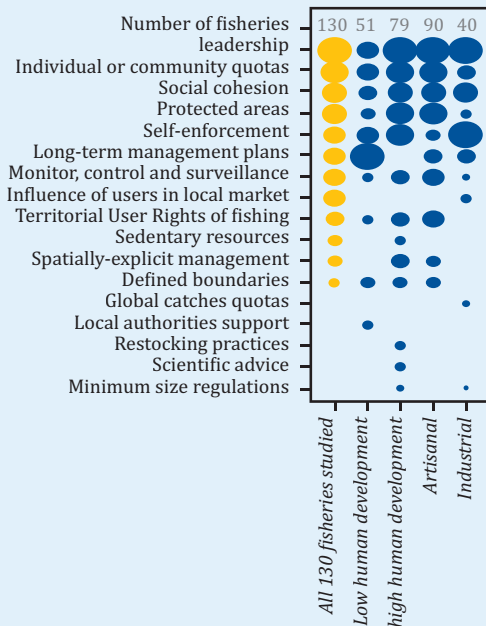
The establishment of MPAs or fisheries management measures in the context of poverty presents some challenges that are often more important than in other countries because of social and economic pressures which can be exercised. Without underestimating these constraints, examples of several developing countries having formerly developed good governance approaches despite poverty contexts demonstrate the opportunities offered by this approach to stakeholders and policy-makers in particular. Political frameworks and the development of specific local solutions, or regulation mechanisms that take into account the general interest for sustainable development are necessary.

Need for an adaptive management:

Phenomena stemming from the complexity of fisheries systems and to which managers should be prepared, raise questions regarding the ability of governance mechanisms to accurately predict the impacts of the measures they decide and therefore their capacity to thoroughly control the events. In return, they prompt managers and leader to adopt an adaptive management approach (cf. Chapter on “planning of management”).

 Based on the above, good governance can be characterized by (inspired by UNDP, 1997; Dudley, 2008):

- Based on a real political commitment and clear and hierarchical objectives : it rests upon a strategic vision, a leadership capacity and clarification of each others' roles
- Considered as legitimate: operating in a legal framework that is consistent with fundamental rights and impartially implemented in compliance with a robust process ; participation of stakeholders in decisions of concern to them
- Looking for consensus and resolves conflicts between interests
- Empowering stakeholders and allocating responsibilities: delegating management authority to capable institutions that are closer to resources at stake and building the capacity of stakeholders
- Trustworthy, reliable, adapted to contexts, ensuring reactivity of institutions and process in the face of requests of stakeholders and crises, widely reporting the results of actions
- Ensuring transparency through information and direct access of stakeholders to institutions
- Fair and/or Impartial: in the allocation of responsibilities, benefits and opportunities or penalties resulting from management
- Efficient: mobilization of institutions in the achievement of objectives and active quest of performance
- Enlightened: uses science and knowledge and is cautious in the face of uncertainty
- Economically viable: proper resources; striking, a balance between costs and incomes



☞ *Gutiérrez et al. (2010) have analyzed 130 fisheries that are co-managed, artisanal, and industrial in 44 developing countries. The result is a bit surprising because ultimately only 5 really seem closely linked to successful management:*

- *Recognized and dynamic leadership: presence of a respected leader in the community who is convinced and willing to support management;*
- *Strong social cohesion: based on common standards such as mutual confidence and communication ; enables the maintenance of institutions and their operation and resistance to crises;*
- *Property rights: the existence of individual or community quotas helps to solve the overexploitation problem by ensuring the security of resource allocations;*
- *Role of MPAs and long-term management: they participate in the reinforcement of co-management through compliance with socio-ecological dynamics and the close involvement of communities in their implementation (decentralization, process of co-management strengthened, and clarification of access rules and management);*
- *Self-control and surveillance mechanisms: they significantly contribute to the efficiency of co-management notably when they are about clear particular interests and are associated with strong mechanisms of penalties implemented by fishermen themselves, social organizations and clear restrictions of access.*

4.3.4 Basics – A Clear Institutional and Legal Framework and Institutional Links to Develop

States are legally legitimate to organize and regulate the access to resources and to marine areas for the conservation of general interest. The State has the monopoly of legal competences, but political, economic, and social texts and relationships between stakeholders (national and internal scales) impact the content of the rules. Rules constituting MPAs are: (i) definition of an administrative perimeter; (ii) obligations and rights in force within these perimeters; (iii) status of users and public property within these perimeters; and (iv) compensation policies. Beyond formal law and active integration of some traditional laws into the formal law, there is often in MPAs a syncretic law that has stemmed from practice. The framework for fisheries is generally summarized in a Fishery Code (or Fisheries Act). Long limited to so called “conservation” measures (modifying the exploitation pattern), this framework tends to be enriched nowadays by measures enabling a better control of fishing capacity and exploitation level.

☞ **Traditional rights:**

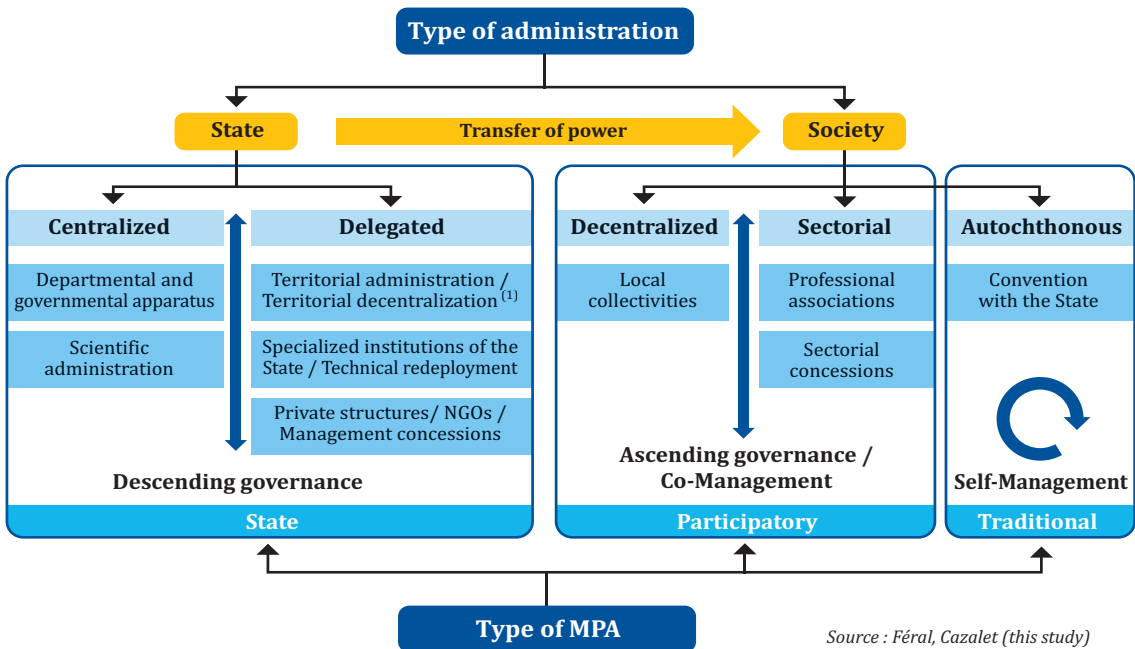
In the management of coastal MPAs (as in the management of artisanal fisheries) traditional rights, long neglected if not fought, are progressively recognized. In the case of MPAs, there is a large consensus on the necessity to protect traditional populations and to recognize: (i) their rights to use and manage their resources; (ii) their institutions; (iii) their conservation measures; and (iv) their own development priorities, provided that they are consistent with the conservation objectives of protected areas.

INFLUENCE OF NATIONAL FRAMEWORKS

Management of MPAs and fisheries aim at objectives that overlap largely with regard to sustainability of resources and services, as well as ecosystems producing them. There are clear-cut differences in focus and in priorities of these two systems of management. Often, there are tensions between the respective central administrations concerned (fights for influence, for budgets, and in media) and also tensions that are internal to each administration, between those in favor of radical strategies and those in favor of moderate strategies. Thus, in spite of the “One State” principle which should bring coherence between administrations, in practice, the different administrative

Figure 7

Types of national administration and corresponding typology of MPAs (Developed from the examples provided by F. Feral and B. Cazalet)



Source : Féral, Cazalet (this study)

“cultures” and practices lead to tensions among them. These tensions undermine the efficiency of the States’ action in the absence of an effective arbitration system.

Further, many analysts note that international policies of structural adjustments over the last twenty years under the aegis of International Monetary Fund (IMF) and the World Bank (WB) aiming at reducing budgetary deficits and giving a new impulse to economies (through liberalization of exchanges), have led to a sharp decrease of the State’s capacities and roles, in particular its role of providing incentives and support in relation to the main issues faced by society.

☞ *Despite convergent rhetorical developments on responsible fisheries and conservation, the prevailing legal layering, from regional to local scale, requires clarification. Actually, international and regional organizations and States allocate, with a somewhat confusing distribution of mandates, overlapping responsibilities to actors that have variable power and capacity. The system remains very often incomplete, fragmented, and complex with many partially overlapping tools. The lack of coherence at the national level often leads to a lack of coherence in the decisions made by a given country in various international institutions.*

The reduction of central power has led to significant de-regulation and a transfer of responsibilities from centralized institutions towards the periphery (Subsidiarity Principle), but also an increased dependence (often fed by all parties) on external support, and in particular from NGOs. However, paradoxically the reduction of States’ intervention tools has automatically diminished their capacity to implement this decentralization in a tidy and effective manner. This has resulted in a notable weakening of decentralized administrations (involved in the management of MPAs).

It is within this changing context that is situated the management of MPAs over these last 20 years with five main difficulties:

- **Insufficient financial resources:** The establishment of MPAs or large MPAs, likely to tolerate and/or have an impact on fishing, requires corresponding financial and administrative effort for management and monitoring. The use of traditional knowledge and participative management should reduce operations costs but the latter remain significant. Under such conditions, unilateral law-making and regulations stand for administrative control, while the means needed to enforce them, are lacking, resulting in weak policies or enforcement, and related drawbacks

■ **Weakness of the State:** Given the weakness of the State in many countries, presenting MPAs as pilot projects for a new form of governance, as is often the case, appears complex and even questionable. The introduction of MPAs as privileged means of fisheries management in a context dominated by weakening of peripheral management capacities risks diverting the State from their other sovereign functions of management of resources integrated in the general development of EEZ resources.

■ **Administrative Confusion and Layering:** An administrative system characterized by an inextricable layering of institutions has been established. MPAs appear to be supported by a multitude of institutional competences operating in a weakly transparent framework with little or no precise directions. Administrations' objectives are often unclear; publicly available data is often absent; budgetary allocations are weak or difficult to access; compounding the confusion..

■ **A chaotic and uncoordinated legal-institutional framework:** Straddled between land, water, and forests, coastal MPAs have an operational and potential interface with several specialized agencies, making their governance more complex than that of fisheries. The latter is generally under one authority only. The Integrated Management of Coastal Areas (IMCA) has not been very successful, and the more recent concept of Maritime Spatial Planning (MSP) is still to demonstrate its efficiency. So, the respective legal and institutional frameworks of fisheries and conservation remain with little or no coordination and numerous difficulties will result from the fact that the respective legal-institutional frameworks have not been developed to facilitate the collaboration between fisheries and conservation or between MPAs and fisheries management. This will result in a potentially conflictual scattering of decision responsibilities.

■ **Lack of adhesion of the populations and (sector):** It is difficult to obtain adhesion of the populations to a project that imposes to them changes which are likely to negatively affect their incomes, their livelihoods, and their traditions, in name of a "general interest" that does not always appear equitable or on other bases hard to decipher by local actors. Faced to this reality, public protection action, in its relation with MPA stakeholders, progress on a narrow path between resistance to change and new expectations for livelihoods.

☞ *Gerhardinger et al. (2011) underline that in Brazil the multiplicity of MPAs in a given region, each one having its consultative committee, leads to an overload of stakeholders meetings and to loss of interest for mechanisms due to redundancy of issues examined. These authors consider that a higher level of governance (at the level of a set of or a ("network" of MPAs) or at the level of an MPA Agency would be more effective from this point of view.*

☞ *The integration of biodiversity conservation (through MPAs) and fisheries management raises problems of adaptation, assessment of common decisions, and of the fundamental differences to compromise with, after an objective analysis of the advantages and drawbacks. Thus, the developments of bridges at all scales, among different institutions represents one of the major stakes of the coming years, certainly with innovative experimentation at the institutional level.*

Even though many NGOs have facilitated the establishment of MPAs and the maintenance, through their presence, of local co-management mechanisms, the prominent role played by large NGOs and their financial Foundations did not facilitate, in many cases, local governance or the reinforcement of the State.

The chain of financing has been organized by Northern NGOs responsible for mobilizing funds and Southern ones responsible for spending it in local communities. The State is often de facto "short-circuited" and the resulting confusion is aggravated by the fuzziness in the roles and responsibilities of these institutions, the articulation of their authority, the weakness or absence of formal consultation mechanisms, and conflicts for influence. In the absence of an adequate framework, NGOs mushroom in an ad hoc way, establishing MPAs within the framework of projects, often operating without "on the edges" of national legislation. Problems arise at the end of projects and when pilot projects need to be extended (scaling up) and passed under a national law that has not been well prepared to receive them.

☞ *The terrestrial origin of the concept of protected area leads to conceptual "friction" when adapted to the sea. Indeed, the rules governing the utilization and property of resources as well as the needs in control and surveillance are different in the ocean, and depend on the distance to the coast.*

☞ In Senegal for example, MPAs have been created under the responsibilities of the Ministry of Environment (National Parks Department), Presidency, Governor of region, Ministry responsible for fisheries (Direction of Communitarian Affairs).

In Philippines, MPAs are under the responsibilities of three jurisdictions: Department of environment and natural resources, Department of agriculture (Bureau of fisheries and aquatic resources), and local governments (Cf. FAO, 2011:71). As a result, there are a plethora of institutions and high costs of interactions.

☞ **Institutional relations in Australia: the Great Barrier Reef**

The management of the Great Barrier Reef is under the responsibility of a federal independent Authority which has an exclusive mandate for regulations of access to and utilization of the area, according to the principles of sustainable utilization. The establishing act provides that the Authority should be assisted by consultative committees and have specialized staff in the matter of tourism and indigenous populations, but apparently not in the matter of fisheries management. Since 1999, it is also assisted at the local level by community consultative committees composed of volunteers enabling local communities to contribute to management and providing discussion forums of issues relating to marine resources. The area is managed with the support of a Zoning Plan which is adopted and can be amended and revoked by Parliament. The Management Plan is also a legal instrument. In practice, the management of this multi-use MPA is based on relations between the Federal Australian State (official management Authority) and the federate State of Queensland which implements daily management, aiming at most of the objectives set by the management authority, including in fisheries. All is based on « agreements » between these two levels of authorities. In short, the federal State pays and the federate State executes (by delegation) by using its own human and logistic means for control, surveillance, communication, etc.

A fragile consensus is emerging which needs to be analyzed by objectively recognizing the strong points and flaws of each system, the meeting points related to changes in their own governance and management systems. So far, the biggest opportunities for collaboration and synergies between « fishing » and « MPAs » are as follows:

- In multi-use MPAs where acceptable modalities of regulation and enforcement of standards of responsible fishing can be developed.
- In high sea MPA where the absence of well defined territories for fisheries and conservation opens some better perspective of coherence.
- In the creation of new institutional bridges in States being restructured or showing a strong political will towards the creation of linkages between fisheries and environment administrations for improved effectiveness and optimization of costs

Table 4 Some success factors of good governance of MPAs in relation to fisheries

Some factors of success of good governance of MPAs-cum-fisheries		
At the supra-communitary level	At the community level	At the individual level
<ul style="list-style-type: none"> ✓ Political will and clear institutional frameworks ✓ Creation of institutional bridges to improve governance and decision-making ✓ Right for the community to organize, in clarifying responsibilities ✓ Presence of external agents (NGOs, financing and research institutions) which support and help to find solutions, etc. ✓ Integration of projects into national legal and institutional framework 	<ul style="list-style-type: none"> ✓ Well defined and transparent limits of jurisdiction ✓ Strong co-management institutions ✓ Group cohesion and good participation via appropriation of the process and greater responsibility of stakeholders ✓ Support of the local leadership ; good local organization ✓ Users' rights on resources ✓ Adequate financial resources 	<ul style="list-style-type: none"> ✓ Adhesion of individuals ✓ Positive perception of the of the costs/benefits ratio ✓ Fair, legitimate management rules and credible deterrent control



4.4 Fisheries management through MPAs or STRs?

☞ As reserve-MPAs are often considered as nothing else than a conservation tool [to be used for fisheries management], it is possible to compare them with other fisheries management tools (STRs for example). From that perspective, fishery-MPAs should meet fisheries requirement.

It should be noted, however, that multi-use MPAs are also space-based integrated cross-sectoral management frameworks.

4.4.1 Marine Protected Areas (MPAs)

MPAs aim to contribute to regional and national strategies of conservation and to be used within a system of « good governance ». Conservation is ensured by exclusion (in Reserve-MPAs) or reinforced management (in multi-use MPAs). The question of the management of fishing activities in MPAs is rather recent and is still subject to intense debates.

Different MPA typologies are described and analyzed in the technical report: (i) jurisdictional; (ii) oceanographic; (iii) according to governance. States use many terms to describe a wide range of areas benefiting from a special administrative status and a particular protection (theoretical or real), more important than that applying in their immediate environment: MPA, marine reserve, sanctuary, natural reserve, community conservation area, managed marine area or locally managed marine area (MMA or LMMA), ecologically and biologically significant area (EBSA), vulnerable marine ecosystem (VME), etc.

One of the particular complexities of MPAs stems from their localization in the ocean and in particular their position in relation to the jurisdictional zones established by UNCLOS : in internal and territorial waters; in the EEZ; in the areas beyond national jurisdiction (ABNJ); between two EEZs; straddling between one EEZ and the high sea; on a continental shelf beyond 200 nautical miles, etc.

☞ The majority of large MMAs (measuring tens of hundreds of km²) are protected in a permanent way. The smaller ones (smaller than 100 km²) are closed only seasonally and according to our nomenclature; they are similar to fisheries space-time restrictions (STRs). The efficiency of these areas is not well known as only 2% among them have a monitoring system with data and baseline reference data enabling a comparison between the evolution in the MMA and outside ^{xxxviii}.



Figure 8

Main types of imaginable MPAs, depending on their position in the competent jurisdiction, in the water column and on the bottom. Areas beyond national jurisdiction (ABNJ) are delimited by dashes.

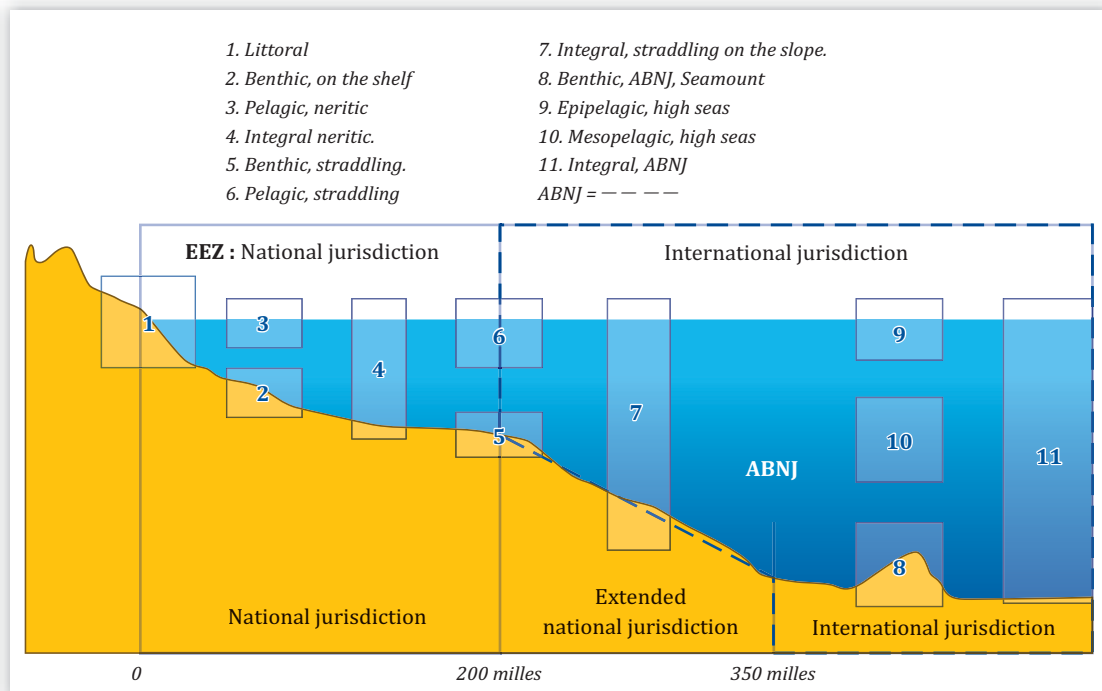


Table 5 Types of governance of MPAs, Adapted from Féral and Cazalet (2011, Unpublished).

Criteria	State-managed	Participative AMP	Traditional AMP
Main characteristics	Classical, centralized, and bureaucratic State management practiced also by federal States (Australia) and delegated (autonomous) governments operating as States in terms of international public law	A forum of users-oriented management, in which the State is voluntarily a minority-stakeholder, while conserving sovereign competencies and an executive role in relation to implementation of agreed decisions. It is the French Marine Park Model.	Locally-based model, reinforced by geographical isolation (e.g. pacific islands): villages manage the MPA themselves, alone or with the support of scientists and NGOs, but they are "recognized" by State organs.
Legitimacy	Stately	Societal	Autochthonous
Governance, process, and organization	Centralized, bureaucratic top down (vertical)	Co-managed, interactive, participatory, forum	Decentralized, community-based, horizontal, social discipline
Function	To control marine space through science and administration	Mixed : recreational and commercial	Livelihoods and occasionally commercial
Decision	Unilateral	Reflecting balance of power	Consensual
Cost	Costly	Costly	Inexpensive
Operation	By professionals	By corporations, or user categorizes	By clan leaders
Information	Science	Negotiated knowledge	Experience
Relation with other participants	Open	Open	Closed

Collaborative Management Areas of Tanga (Tanzania) ^{XXXIX}

The Collaborative Management Areas (CMAs) of Tanzania are emerging as a result of the State's and communities' concerns about the degradation of coral reefs through the use of dynamite and other destructive fishing practices as well as mangrove overexploitation. These areas contain permanent no-take zones. CMAs are formally managed by three district government offices. The management of each CMA and the monitoring and evaluation of performances are assigned to a Central Coordinating Committee (CCC) composed of representatives of the States and communities which sometimes calls upon experts. Patrols are ensured by the State and communities. Participation of women at the decision-making level in CCC is important (30-40 %). Plans are formally adopted in village by-laws and approved by the Director of Fisheries. The review of management plan, which is initially due every 3 to 5 years, remains very occasional and more superficial than expected. A temporary disappearance of destructive practices has been noted (but they have recently been resumed). Yields have improved for some fisheries and not for others. Herbivorous species have increased whereas carnivorous ones have decreased.

This example brings elements in favor of the establishment of reserves in fisheries. One of the advantages has been to match the governance scale to the scale of the fishing grounds, thus creating real management units. One part of the positive effects results from active participation, including participatory planning. This result is not related to the status of the MPA but to the implementation of rules of "good governance". The fact that villagers accept reserves as management tools is a success indicating that for them MPAs bring more advantages than drawbacks, either in terms of resources (even though they are "mixed") or in terms of new distribution of benefits and responsibilities.

MPAs Efficiency and fisheries co-management:

Hilborn et al. (2004) have underlined that reserves seem to be a promising tool for fisheries management and conservation of biodiversity, but they are no magic panna.

- Negative impacts of MPAs: (i) an increase of fishing intensity in open areas (if capacity is not reduced), including on other vulnerable species that had not been threatened so far; (ii) additional negative impacts on human populations who are often already stressed. According to these authors, the advantage of MPAs on modern management measures would be weak in the case of mono-specific fisheries on mobile species, without by-catch and without any impact on habitat.

- Advantages of MPAs: A positive contribution would be more likely in the case of multi-specific fisheries on secondary species having a significant impact on habitat. Their success rests on good understanding, case by case, of the structure of fisheries, the ecosystem, and the human communities who use them.

Associated with modern conventional measures of management, reserves can help achieve conservation and biodiversity objectives provided that they are well planned and carefully evaluated in order to draw lessons. Otherwise, the risks of disillusion and loss of credibility of a potentially useful tool are high.

4.4.2 MPAs Networks

There is a growing interest to take MPAs to a higher level by connecting them with networks, in particular in order to take into account representativeness of ecosystems and species at the level of each eco-region, but also valorize the possibility of creation of ecological corridors guaranteeing connectivity among protected areas on the terrestrial model.

The term "network" is often wrongly used to indicate the whole set of MPAs in the region (RAMPAO, MedPAN) instead of a set of MPAs designed to be functionally interconnected. Truly functional MPA networks have the advantage of connecting MPAs at the ecosystem level, thus enabling an integrated consideration of utilization, protection, and governance. Networks can facilitate management, by reducing (for the same degree of protection) the proportion of to be closed to fishing and through providing a more affordable and equitable distribution of costs and responsibilities.

Networks can be particularly useful for migratory species, ensuring their protection all along their life cycle migration. In that regard, it is particularly obvious that in a situation of overcapacity and overfishing, such a network would be totally useless because mortality of target species between the MPAs of the network would be higher than the protection provided to them in the PAs. Networks are a good example of the necessity to combine MPAs with conventional measures. Very wide and transboundary networks can raise particular problems relating to coordination of measures and will require complex international agreements to implement in the absence of an existing institution such as Regional fisheries Management Organizations (RFMOs).

☞ The efficiency of ecologically operational and relevant networks of MPAs remains to be tested, but the situation in the SRFC area requires reinforcing the effective management of existing MPAs before developing an MPA network approach. On the contrary, valorization of structures like the regional network of MPAs managers (e.g.: MedPAN or RAMPAO) contributes to improving exchange of experiences, promotes the involvement of national policy-makers and, consequently, plays a role in the upgrading of the management performances of MPAs.

4.4.3 Spatio-Temporal Restrictions (STRs) in Fisheries

Fisheries management aims to regulate the exploitation rate (fishing pressure) and the fishing pattern (its distribution of fishing pressure on ages and species). Spatio-Temporal Restrictions (STRs) aim to modify the fishing pattern by protecting juveniles, breeders or certain particular fish species. They are also used to reduce conflicts for space and to reduce fishing pressure (with doubtful efficiency).

STRs TYPOLOGY

- Permanent spatial restrictions (fisheries reserves or parks) can reduce impacts on critical habitats and species. They most often prohibit all forms of exploitation, but certain areas can be prohibited to trawling and open to angling, for example.
- The periods of “biological rest” are temporal restrictions (and often simultaneously spatial).
- “Refuges” spatial restrictions that are often permanent, and sometimes used on a rotating basis.

☞ Reserve-MPAs seem to be a promising tool for fisheries management and conservation of biodiversity, but they are no panacea. It has been demonstrated in East Africa that traditional management systems of reef fisheries based on STRs were more efficient in terms of resources conservation than larger permanent MPAs, promoting tourism and weakly or not controlled: it was also shown that a combination of MPAs and traditional STRs could turn out to be successful.

Simulation models suggest also that in a sub-optimal fishery management context, classical fisheries management measures are more performing than MPAs^{XL}.

☞ Utilization of biological rest: Octopus in Morocco^{XLI}

Faced with the increase of fishing capacity and decrease of yields it was decided in 1989 to close fishing for one month. In the course of the following years, this so called “biological rest” had to be progressively extended from 1 to 7 months without any improvement on the situation of resources. The causes of this inefficiency were recognized by the authorities: (i) excessive removals; (ii) uncontrolled fleet development; and (iii) perverse economic incentives to promote added value.

In order to correct this situation, complementary measures have finally been taken : (i) freezing of investments ; (ii) abrogation of the Code of Investments ; (iii) establishment of a Total Allowable Catch (TAC) ; (iv) withdrawal of 30 freezing vessels (probably the least efficient) and freezing of new registrations and allocation of transitory fishing licenses for other species for some ships ; (v) progressive extension of biological rest which practically becomes a moratorium; (vi) tougher controls and penalties, up to complete withdrawal of fishing license. In conclusion, without control of capacity and effort, no biological rest will be effective.

Regional Fisheries Management Organizations (RFMOs) such as CCAMLR, NEAFC, ICCAT, and GFCM have established areas permanently closed to trawling aiming to protect resources and biodiversity (e.g. the trawling ban beyond 1000 m depth in the Mediterranean Sea since 2005 decided by GFCM). The Sub-Regional Fisheries Commission (SRFC) could do the same thing, but this decision could be applicable only to its members since it is not an RFMO.

Efficiency of STRs:

Ad hoc STRs (established in real time) and seasonal STRs (established to protect recruitment) will be efficient if they are correctly placed (optimal opening and closure dates). Seasonal closures established to protect breeders can bring a temporary respite to fish but this does not resolve the problem of overcapacity. Longer temporary closures (temporary reserves) that are used in some communities to restore exploitation reserves are apparently also efficient. Seasonal closures placed according to industry operational convenience rather than on biological criteria are obviously incapable of protecting resources. Even perfectly placed, seasonal closures, will be ultimately doomed to fail if fishing capacity is not controlled. The success of STRs established to reduce conflict depends on the difference of value between protected areas and not protected ones, as well as on economic alternatives offered to those who are excluded.

Success of permanent closure (Australia) ^{XLII}

One of the most illustrative and most studied examples of successful utilization of permanent closures is shown by multi-specific fisheries management on the Northwest Australian shelf. In this ecosystem modified by fishing (in terms of biodiversity, dominant species, and benthic habitats), the establishment of a system of closures to trawling has been combined with the use of fixed gears (lobster pots, traps). Results include: (i) in the areas closed to trawling: an important increase of abundances of highly-value species and small benthic species, and stabilization of abundance of large epibenthic species, (ii) in the areas open to trawling, reduction of fish and all benthic species. It has been demonstrated that it was possible to restore highly-valued fish communities by protecting habitats, and that the restoration of epibenthic populations (sponges and others) was slower than expected (taking 15 years instead of the expected 6-10).



4.5 Planning and Management of MPAs-Fisheries

4.5.1 A common Cycle of Adaptive Management

Decision-making processes relating respectively to fisheries and to MPAs management have adopted de facto very similar decision cycles characteristic of decision-making in an uncertain environment and in complex systems.

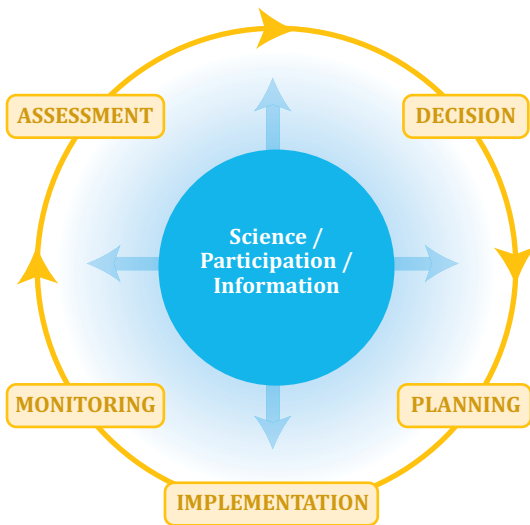
These cycles transcend scales of decision (global, regional, national, or local) and are characterized by:

- Many feedback loops which help improving performance assessment as well as the management strategy, and possibly the sector policy, at any point of the cycle;
- The constitution of a more or less formal catalogue of good practices, representing the social memory (about issues, actions and effects) that develops during iterations on the site.

Obviously, this process is more complex when MPAs are large, heterogeneous, and contain various economic activities. Beyond a certain size, managing an MPA is as complex as implementing marine spatial planning (MSP). The Australian Great Barrier Reef is an illustrative example of the latter.

In the field of fisheries, this planning process can be followed for: (i) establishment of new management measure (STRs or MPAs) in a particular fishery; (ii) development of a management plan or a pluri-annual plan of sector development; (iii) establishment of larger MPAs containing

Figure 9
Decision cycle and collaborative implementation in an uncertain environment for fisheries and MPAs



Sector and space integration:

The complexity also lies in spatial management at the ecosystem, national, or regional level. This implies that reflection should not be limited to the integration of MPAs into fisheries management, but also address the spatialization of fisheries management in a higher level federative spatial framework accounting for the following:

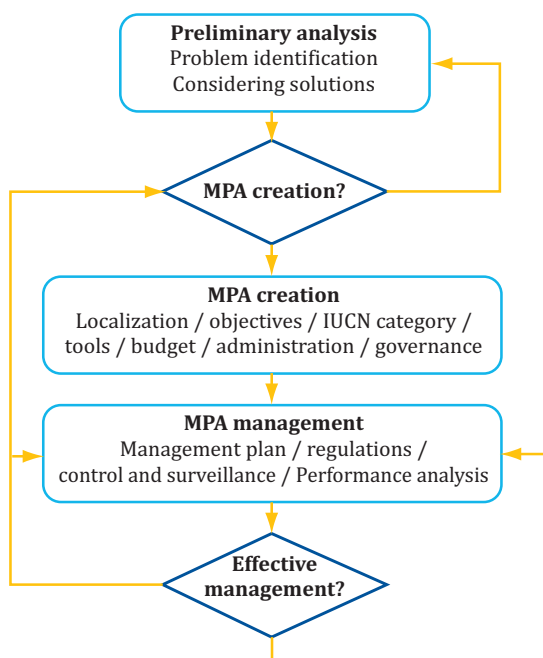
- (i) MPA and fisheries are often badly managed ;
- (ii) past experiences of integrated spatial management at a large scale turn out to be more difficult than expected;
- (iii) in most of the countries, there is not yet any higher-level framework (e.g. ICAM, ICM or MSP) under which to nest these managements, or such frameworks are just in at their starting phase, and do not therefore represent the immediate solution.

one or several fishing grounds, and possibly other uses; or (iv) for the planning of a network of MPAs in an exclusive economic zone (EEZ) or a large marine ecosystem. This general process can be found in management of Locally Managed Marine Areas (LMMAs) like for example in Fidj.

4.5.2 Management plans: a fundamental process of co-management

The road map for an MPA can be structured in 3 important phases for its success: (i) Preliminary or creation phase; (ii) Pioneer (or pilot) management phase; and (iii) Autonomous management phase. The development of sustainable autonomous management of an MPA takes at least 15 years (and even more according to local cultures) and must be supported (institutionally and financially) during establishment and transition phases (renewal of co-management organs, etc.) but this is not often the case in developing countries. All the stakeholders are concerned (researchers, NGOs, administrations, and donors).

Figure 10
Simplified cycles of creation and management of MPAs



Management plans are fundamental elements representing the social contract between authorities and stakeholders (plans are published) concerning objectives and expected results, actions and means available for implementation, roles and responsibilities, as well as measures and penalties. They also enable to mobilize and maintain the attention of the political system (at the central and local level), and to energize consultation and management mechanisms. When fisheries are concerned, they should rather be involved right from the start. Management plans present the advantage of being flexible and revisable according to local evolution.

Management plans may take different forms. They may sometimes be simple documents defining access rules and controls and penalties (e.g. in the South Pacific countries). They may also consist of more complex documents (e.g. in Europe, USA).

Meta-analyses confirm management weaknesses and the inexistence of management plans or their weak implementation in most countries. There are few industrial fisheries management plans in the SRFC region, and some artisanal fisheries plans are being elaborated. MPAs Management plans, when they do exist, are not always designed with local stakeholders and are sometimes too ambitious or not realistic enough to be implemented, even partially. Because of this, in many countries, the present priority is to act towards more effective MPAs management.

The best way to introduce an MPA in an existing fishing area would be to integrate this consideration in the elaboration process of the fisheries management plan. This implies that the authorities responsible for fisheries, who leads the preparation of the plan and its implementation, should develop it in collaboration with agencies responsible for MPAs, industry, and NGOs concerned.

Once the plan has been approved by authorities, its implementation is greatly facilitated if it is considered as legitimate and enjoys the adhesion of the majority of stakeholders. It will also be facilitated if the roles of each stakeholder group are clearly stipulated in the plan with specific tasks, schedule of activities, modalities of conflict resolution, control and surveillance, system of coercion (possible penalties), etc.

It is important that the adopted plan be formally revisable within the framework of a simple procedure, according to a schedule adopted in the plan itself, which provides the necessary authority. For this purpose, the collected data will be used for monitoring of the plan implementation. Training of the executives and of the populations concerned on fisheries management should facilitate communication, consultation, and implementation of pragmatic measures. Structures of management plans are set out in the “technical report” in the chapter relating to “Governance Aspects”.

Financing of management and management plans: insufficiency in human and financial resources for the management of MPAs is a key factor of failure. However, the budget of the State is bound to be limited and research of external funds, when it succeeds, will create a potentially dangerous dependence towards the external funding source. Complementarities of financing sources and their diversification will limit risks in that respect ensuring certain sustainability to the MPAs operations (cf. recommendation: “socio-economic aspects”).

☞ **The development of a regular audit procedure by an independent agency is most often overlooked in the management mechanisms of MPAs.**

Certainly, State's financing difficulties will progressively lead to mechanisms that strongly favor efficiency of the management of MPAs. In Italy, harmonized mechanisms of management evaluation are being created, thus enabling to ultimately envisage allocations of financial resources primarily to those MPAs that properly develop provisional plan of action and ensure effective management.

4.5.3 Decision to create an MPA and Choice of the Site

The entry point of the MPA creation process is variable. The “demand” may come from “the top” or the bottom of the decision pyramid. In the management of marine resources, the demand, even though locally expressed, should be validated by the State or its institutions. Whatever the case may be, it is important to take into account the whole set of selection criteria of selection, and the mobilization of stakeholders should facilitate the decision-making process.

Two main scenarios might be imagined for the creation of an MPA:

- **In a proactive and planned Cartesian approach**, following the international commitments of the State, competent Ministers look for adequate spaces to transform them into MPAs. With stakeholders and specialists, they identify conservation problems, ecosystems that are in a good state, and constraints, so as to trace a first map of possibilities, with the help of specialists if required and with a good representation of the actors. As discussions among stakeholders go on, potentialities and difficulties become more apparent. The fisheries sector should be integrated into this strategic analysis right from the start. During this process, conflicts are inevitable, and arbitrations (including from the State) will be required.

- **In a reactive and pragmatic approach**, the entry point can be a violent conflict among users in a region or depletion of resources important for food security. This can lead local stakeholders to request assistance from the State, an NGO, or both. This opens an opportunity to see if an MPA could be used, combined or not with other fishery management instruments in order to resolve the problem or the conflict.

☞ *The use of MPAs in the management of migratory resources raises new issues in relation to efficiency of that measure, optimal size and localization, relevance for management of the fishing grounds, etc. Serious doubts have been put forwards on the usefulness of MPAs for mono-specific pelagic stocks of highly mobile species, but even for the latter, it is recognize that the protection of nurseries might be useful (cf. recommendations). In the absence of access regulation and capacity control outside the protected area, these MPAs are even less likely to be effective than those aimed at demersal low mobility species.*

☞ *The choice of the MPA site is often opportunistic while a politico-scientific compromise based on justifications of relevance for both ecosystems protection and fisheries management through a well-informed participative process, should prevail. In the case of an MPA to be incorporated in a fisheries management plan, an analysis should examine: (i) its utility compared to that of alternative tools (cf. chapter on MPAs and STRs above); (ii) the adequacy of its location; (iii) and its operational feasibility (financial viability). Collecting space-based information, inside and outside the protected area, according to bio-ecological or socioeconomic zoning, on land and in the sea, is a prerequisite (cf. bio-ecological and socio-ecological chapter).*

☞ **To develop a strategic vision at the national and regional level**

administration should quickly develop a general framework, covering legal, and institutional aspects, conduct a national diagnosis, and develop a large scale (low resolution) typology of regions that can serve as framework for future initiatives. This will allow the integration of research in planning for a coherent network of representative and connected MPAs. For existing MPAs, their analysis would lead to identify gaps, check ecological relevance, and define priorities for new MPAs or new fishery management measures, within a national strategy and a coherent ecosystem approach.

Table 6 Criteria for selection of an MPA

MPA Selection Criteria (from Kelleher 1999)
✓ Bio-geographic criteria: rare biogeographical types; unique or unusual geomorphological elements
✓ Ecological criteria: important ecological processes; wilderness, complete ecosystem; Variety or rarity of habitats; area of concentration of larvae, juveniles; feeding areas; genetic diversity
✓ Degree of conservation: degree of protection or change of the area
✓ National/international importance: formal designation; potentially listed in a national or international register
✓ Economic importance: economic potential/economic contribution of protection; ecosystem services: recreation, subsistence, traditional use, tourism, species of economic interest
✓ Social importance: potential, local, national, international, historic , cultural, educational, and recreational values
✓ Scientific importance: Value for research and monitoring
✓ Easiness and feasibility: isolation from destructive influences; social acceptance and political support; accessibility to tourism and education ; compatibility with local usage; degree of management difficulty/ compatibility with existing management, ; duplication and replication.

4.5.4 Allocation of spaces and resources (management zoning)

The space and resources allocation rules (through zoning) require negotiations in order to be respected. Simple mechanisms implemented by stakeholders themselves and a courageous arbitration of the State, if need be, are fundamental. Optimizing the participation of stakeholders through a framework that organizes participation and the flow of information is essential. The consideration of migrants who come back each year to a site remains a challenge for management.

Zoning is only a management tool of a large MPA where other measures can be used (temporary closures, regulation of access, etc.) to reduce impacts. Similarities with fisheries management are obvious.

☞ *In highly populated developing regions, good scientific monitoring and control and surveillance systems are necessary to guarantee protection and possibly reduce the proportion of the total area to be turned into reserves.*

☞ **Zoned multi-use MPA: the Australian Great Barrier Reef.**

That MPA authorizes, within its 344.000 km2 area various commercial (including fishing) and recreational activities, but excludes mining or oil and gas prospections. In the areas where fishing is authorized, its management (e.g. allocation of licenses, control of equipment and practices, etc) is under the competence of the fisheries Authority (e.g. the local State or the federal fisheries authorities according to the distance the coast

However, these authorities should monitor their own management performances and present reports that could be submitted to reviews or external audit for verification. If a fisheries regulation appeared not to be compatible with the objectives of protected area, it is the legislative act establishing this protected area that has primacy. In general, zoning and applicable rules have been established in a collegiate manner so as to avoid incoherence, and, in the MPA, the major part of important areas for fishing has remained accessible to fishing. The constraint of sustainability is rather well accepted by fishing industry, and the danger most often comes from modern and over-equipped sport fishing. The example shows that an MPA can contain fishing activities provided that sustainability criteria and procedures of verifiable reports are established.

In less developed areas, the uncertainty and the precautionary principle would call for a more important part of the area be strictly protected.

🗨️ **“An MPA with shared governance”:
MPA of Joal-Fadiouth (Senegal) ^{XLIII}**

Created thanks to the obstinate action of a small group of fishermen, an external support, and an intelligent co-operation with local administration, this MPA, born in 2004, is now being managed according to a regime of shared governance. The original motivation has found its source in the threat of fishing gears (kilis and beach seines) on seagrass beds, and in the presence of turtles, sea birds and manatees, in particular.

The MPA is based on a simple zoning : (1) a central core where only autochthonous fishing practiced on foot is allowed ; (2) area with multiple utilization where responsible fishing is allowed with the use of angling and nets (100 mm of mesh size) ; and (3) a mangrove area with precise rules for picking. The two problematic fishing methods have been prohibited.

The MPA of Joal-Fadiouth has enabled for example to improve yields and sizes. The community is mobilized. The co-management institution exists (cf. technical report). Yet, this MPA remains weak and several improvements are required: in the frequency of General Assembly; sound finances ; elimination of confusion between the management plan and internal modus operandi; financial autonomy; Finding a balance between the MPA needs and the presence of a large neighboring fish landing center, etc.

See more in chapter 5

Yet, one of the characteristics of most MPAs is still the absence of data and multidisciplinary analysis allowing their performance assessment. This quasi chronic lack affects the political frameworks and the efficiency of MPA administration systems (centralized or decentralized) as well as the quality of consultation with local civil society. It blurs the consequences for populations of the prohibition of access to their former territories, as well as costs and benefits for the Nation and the « general interest » in the name of which MPAs are often established.

The situation is changing, and long dominated by biology and ecology, the science of MPAs has been enriched for some years by the contribution of social sciences (economy, law, political science, ethnography) which are required to analyze processes and resolve difficulties and “crises” created by their establishment on a territory.

🗨️ *Absence of requirement for systematic evaluation of the management scheme certainly explains partly the predominance of “paper MPAs” and deficient fisheries management systems. Guidelines are now clear, and progress has been noted for about one decade. There are three main types of evaluation: (i) “expert-opinion” when there is lack of means for an empirical assessment; (ii) **analytical**, when these means are available; or (iii) **mixed**, i.e. combining the first two types. Good evaluation is based on a transparent and participative process as well as on robust indicators that are adapted to local conditions.*

4.5.5 Monitoring and Evaluation Mechanisms and Scientific support

INTRODUCTION

Scientific support is generally recognized as being important if not essential to increase credibility and legitimacy of management plans. When this support is weak, incomplete, or lacking, local and traditional knowledge, which should be taken into account in any case, can play the main role. This process is practically identical for the management of fisheries and that of MPAs in as much as space-based fisheries management tends to spread.

The monitoring and evaluation process of management is of paramount importance. It prepares strategic and operational decisions and it is part and parcel of the continuing process of management. It mobilizes scientists and uses also informal knowledge, but ideally, it should not integrate experts already involved in the implementation of the plans to be evaluated. Monitoring and evaluation may address: (i) the MPA configuration; (ii) the planning development process; and (iii) the implementation of this plan. The evaluation may be institutionalized (preferably); internal or external; regular or occasional; operational (every 1 – 3 years) or strategic (every 5 – 10 years). Its form depends on the context and in particular on the required scale (local, sector-based, national, and regional) and capacities that are available to conduct it.

☞ *In the case of simple monitoring and management, exclusively organized by local populations (example of Pacific Islands), using traditions has been an asset, but experience has shown the importance of a support lasting 15 years or more so as to allow time for the evolution of practices and of mentalities in most management system components (surveillance, time management (social memory); renewal and transfers of powers; etc.).*

MONITORING SYSTEM AND INDICATORS OF GOVERNANCE

The indicators of governance are possibly the most homogeneous and also the most comparable between MPAs and fisheries. The objectives attached to governance are however rarely listed as management objectives. The latter are generally expressed (when they are) in terms of improvement of resources, ecosystem, and socio-economic conditions. However, reaching these fundamental “material” objectives imply reaching also (and often first of all) some specific governance objectives which are not less fundamental.

The methodological framework must be adapted to circumstances and can be complex or simplified. What is important, though, is to conserve the intent and spirit of integration and participation. It is also important to identify right from the start: the key questions/issues; the useful and influent actors; the required scientific disciplines; the methods to be used; the available local knowledge; the ways to facilitate the participation of stakeholders in data collection, analysis, interpretation, and in the elaboration of options, etc.

Experience shows the range of questions to be asked for a local analysis is relatively similar from one community to another.

The important elements in monitoring are presented in the “bio-ecological” and “socio-economic” sections as well as relevant Technical Reports (see FRSP website).

☞ *Still, few MPAs practice the existing rapid self-evaluation approaches or budget internal audits enabling to regularly reevaluate and improve their management.*

Indicators can be extremely numerous, but experience shows that in most cases even minimal indicators relating for instance to abundance, diversity, incomes of populations, number of infractions, amount of management budgets, or degree of satisfaction of stakeholders are not collected. It is therefore illusory to lengthen the list.

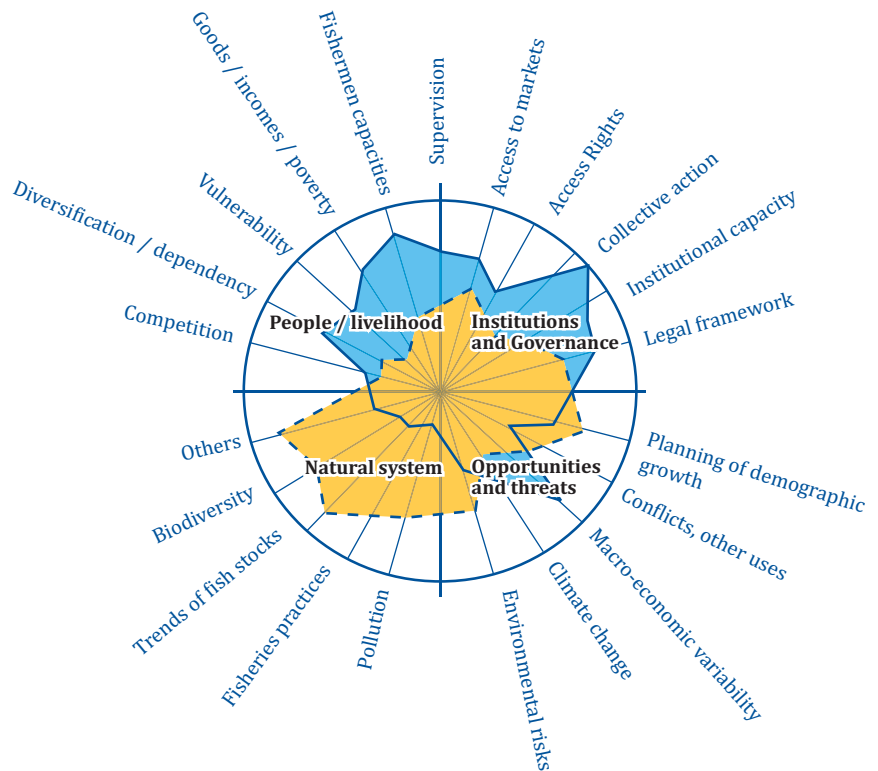


Figure 11
Radar-plot of the major issues that typically arise in a fishing community (reproduced from Garcia et al., 2011, with permission of the FAO)

The prescribed lists are often exhaustive, long, and complex and they can be compared with lists of indicators that are really collected and used, often reduced to their most simple expression and below any useful minimum. Comparison indicates that prescriptions (usually of academic nature) are often not very realistic, with high costs, whereas available resources for management are often insignificant.

☞ *On the monitoring and indicators mechanisms there is a gap between theory and practice, and between what is necessary and what is available. The problem is more serious in MPAs than in fisheries where embryos of monitoring systems often exist; they are sometimes very simple, but most often subsidized by the State. No matter how much effort is made to be parsimonious, to use qualitative indicators and non-conventional sources of information, the lists of indicators remain intimidating. There is therefore a serious risk that ideal systems that have been proposed, logical but overoptimistic in the light of available means, will not be taken into account. So, it is important to distinguish simple operational indicators (to be collected continuously for annual decisions) from strategic indicators (to be collected with a lower frequency for long-term decisions).*

☞ **Types of governance indicators**

- **Structural efficiency and strategy:** (a) Correct management planning with effective processes; (b) Clear definition of management rules; (c) organs of decision and control present, effective, and with clear responsibilities; (d) human and financial resources sufficient and well used; (e) Local governance recognized and involved (f) Monitoring and evaluation effectively conducted; (g) Plans adapted accordingly.
- **Efficiency of legal framework:** (a) Adequate legislation; (b) Formal and informal legislations are compatible; (c) Local and national legislations incorporate international provisions; (d) Local, national, regional, and international legislations are compatible; (e) Provisions in force are applicable in practice.

- **Efficiency of representation and participation:** (a) Representativeness, equity and efficiency of collaborations; (b) Sufficient capacity of participants in co-management; (c) Community organizations reinforced and empowered.

- **Users compliance:** (a) Effective monitoring, control, and surveillance (MCS); (b) Increase of responsible behaviors (sustainable development); (c) Building of local capacities in sustainable use of resources; (iv) Participation of users in monitoring, control, surveillance, and coercion; (d) Adequate enforcement of law and regulations; (e) Accessibility, transparency and simplicity of plans; et (f) Improvement of compliance.

- **Efficiency of management and reduction of conflicts:** (a) Management/reduction of conflicts among users, between them and the community; between the community and neighboring populations.

4.5.6 Mechanisms of Control, Surveillance, and Enforcement of Penalties

A mechanism of control and surveillance that is effective and optimized is a permanent challenge (a costly one too) and one of the main factors guaranteeing the efficiency of an MPA or fisheries management, and can contribute to reduction of conflicts. A lack of compliance by stakeholders can be explained in particular by absence of legitimacy, lack of means and organization as well as lack of political will.

Generally, the Ministry of fisheries is responsible for fisheries surveillance (in collaboration with the Navy). The support of the Navy is instrumental for larger MPAs. For artisanal and coastal fishing in MPAs, a shared management framework is highly recommended to increase legitimacy and reduce costs of control. The control can then be ensured by local authorities with sometimes the intervention of official guards of the Ministry in charge of MPAs and coast guards. A participatory control using community members is very useful, but requires training of guards, their formal recognition, and possibly their remunerations. Rapid intervention means that are necessary represent important investments and operating costs. Depreciation (and replacement) of logistic means is often neglected

Securing the necessary means (which should be partly drawn from MPAs revenues) should be taken into account from the start of MPA planning, and represents one of the major challenges of MPA management. Nevertheless, ba-

sing control and surveillance financing exclusively on fines can turn out to be a perverse mechanism in that fines can decrease if control is improving or often end up at the Public Treasury (without any stimulation for MPA controllers).

☞ *Progress underway in low-cost detection systems such as radar systems –Automatic Identification Systems (AIS) combined with coastal telescopes (like in South Africa), has highly increased the potential for improving detailed surveillance of fishing vessel and other activities up to several nautical miles offshore.*

The temporary reinforcement of control, for political reasons or for advertisement purposes has often a positive effect (Mascia, 2000). The main difficulty is to maintain these efforts for a long period owing to their cost.

Beyond surveillance, the judicial monitoring of offenders is a recurrent problem in MPAs and fisheries. Most often, judicial authorities do not follow-up the cases. An effective solution, when the coastal community is strong, consists in delegating this role to local communities themselves or to their leaders through payment of fines by offenders (using the social pressure of the group).

Synergy among institutional stakeholders must be developed, both in surveillance and in the mechanism of enforcement of penalties at the level of MPAs and fisheries so as to envisage economies of scale through cooperation between “fisheries” and “MPA” systems.

☞ *Decades of experience in fisheries and in MPAs lead to admit that the only way to reduce the cost of control is to ensure that human populations concerned integrate the need to comply with rules into their ethics and fully collaborate in their implementation.*

Surveillance mechanisms are improving, owing to cooperation with communities concerned (low cost mechanisms), utilization of less costly detection systems, better cooperation among administrations, and coherence between actions of central and local surveillance institutions and those in charge of enforcement of penalties (justice).

☞ **Control and Surveillance in Africa – Some Useful Examples**

Available systems of surveillance are often inadequate for effective surveillance of coastal MPAs, even more so of high sea ones. The weakness of developing countries’ institutions creates the risk that MPAs be managed with specific laws, or ad hoc ones, some of which can be in contradiction with fisheries law for example, weakening their application to fishers..

In some cases (e.g. Banc d’Arguin in Mauritania), authorities responsible for management of the Park have their own and substantial means and they conduct surveillance by their own. In other cases, this surveillance is conducted by the Navy. Incentives offered to the surveillance staff (e.g.: for time at sea, for number of reported infractions) and their remunerations are so insufficient that this negatively impacts on resources conservation. It is also difficult to motivate the militaries for the control of marine turtles.

When many NGOs are involved in various projects (e.g.: in Madagascar), with their own systems and equipment, this results in non-coordinated, useless, and expensive multiplication of surveillance facilities, participants, and procedures. Since they are built by projects, surveillance sites are often inadequate (e.g.: in Guinea-Bissau) ; built far away from the sea, without any wharf. This does not facilitate quick interventions, reduce the quality of communication and complicates their modernization.

Source : Information communicated by J-L Lauzière (2011, surveillance consultant)



4.5.7 MPAs, Migrant Fishermen, and Climate Change

☞ The migration phenomenon remains nearly unknown on account of the fact that fisheries data collection does not take it into account.

There are many forms of fishery migration, internal, across or around MPAs. Seasonal migration is not only the cause of the problems (conflicts, overfishing) encountered in the area; it is also the response of human populations to seasonal and inter-annual variations of natural productivity and living conditions.

Migrant fishermen are a relatively frequent characteristic in West Africa but also in many countries of the world and probably in most archipelagos (e.g. Philippines, Indonesia). A variable part of the fishing communities seasonally migrates towards more or less far away, attracted by better meteorological conditions, markets, more abundant resources. They represent a useful manpower to local investors and a source of incomes for chiefs of villages who issue their fishing authorizations. In addition, they are skillful competitors to sedentary farmers/fishers.

Migrant fishermen can be farmers/fishers alternating utilization of very various fishing techniques and farming activities in a complex schedule of seasonal activities. They can also be mobile for economic reasons (movement in case of climatic phenomena or conflicts). They play an important role in terms of production (volume and value), employment, and food security. They migrations have grown in number over the last decades (from Senegalese, Guinean, and Sierra Leonean households) with migrations over longer distances and durations.

☞ In the field of fisheries, opportunistic temporary migrants often practicing illegal fishing are less associated to sustainability of resources (seasonal or occasional phenomena of maximization of immediate benefits) whereas seasonal or regular migrants of the area, although more concerned and presenting an interest for sustainability of exploitation, are seldom associated to management decisions or to organization of fishing grounds.

One can distinguish three forms of migrations in relation to MPAs^{XLIV}: “offshore” migration targeting resources around the limits of MPAs; internal migration of MPA residents; and seasonal immigration with settlement of non-residents. Even though migrants are regular, they are generally considered as “foreigners”.

☞ In mangrove areas where marine and fresh waters mix, interactions are still more complex, with fishermen working full time (“professionals”); part time or occasional fishermen; migrants or residents; master fisher or seamen; preferring continental or marine waters. This diversity, the conflicts and synergies it breeds constitutes a factor of complexity that is very important for the management of MPAs integrating fisheries.

☞ The big challenges on the involvement of migrants in management mechanisms often lie in the:

- *Reinforcement of knowledge on fishermen’s migration in the MPA, the area around it, of within the network of MPAs, differentiating regular migrants and opportunistic or occasional migrants.*
- *Consideration of fishermen’s migrations in the establishment of an MPA or in the definition of local management rules (being careful to maintaining the local power in place).*
- *Integration of migrants into ecosystem approaches.*

Movements caused by climatic changes will affect both fisheries and MPAs, and there are also important connections between these changes and migrations:

- It is in the interest of both fisheries and conservation to see biodiversity and abundance maintained or possibly increased as a consequence of climate change;
- Displacements of fishing grounds and MPAs will have the same ecological cause. Fish stocks will move and so will economic activities depending on them. The new “map” of resources and fisheries will be progressively drawn up, and the same might be necessary for the MPAs. The fluidity of this situation is dangerous. It would be surprising that tensions do not arise. The present clashes arising from allocation of static resources and spaces can only worsen if the resources location becomes “dynamic”, leading to permanent renegotiations.
- Yet, there should be large opportunities of collaboration : (i) among interested scientists who are facing the same challenges, and will be bound to collaborate and exchange data, visions, models, and management options, etc. ; (ii) among interested managers (of fisheries and MPAs) in order to maximize their actions and thus reduce clashes.
- Lessons that are already available on viability strategies in risky situations should be taken into account both by fisheries and MPAs in a context of climatic change. Management responses include: (i) to reduce excessive rates of removal in order to facilitate breeding; (ii) to avoid reducing habitats that are potentially viable whatever the climate may be (e.g. : coastal lagoons, estuaries, hydraulic dunes, rocky reefs) ; (iii) to establish cheap monitoring systems in order to measure changes at the local level ; (iv) to provide flexible processes of assignation correction or displacement of MPAs when conditions change. This could be difficult in territories occupied by less “mobile” activities than fisheries.

☞ A reasonable precautionary approach is required to face the consequences of climatic changes. It is important to reduce stress on ecosystem to facilitate its adaptation to change. This will imply reducing fishing effort and maintain or develop reserve-MPAs to facilitate rebuilding of age structures and composition of “old” species assemblages and facilitate the establishment of new species brought in by climate changes.



4.6 Recommendations on Governance and Management of MPAs – Fisheries

The improvement of governance of MPAs and Fisheries systems and their interfaces mainly lie in the reformulation of recommendations of this document for the different categories of stakeholders concerned, especially in their implementation.

The recommendations concern, at times, small reserve-MPAs to be integrated in existing fisheries; fishing grounds to be totally or partly embedded in large reserve-MPAs or multi-use MPA, or else operating in an MPAs network. In the following, MPAs, created specifically for/in fisheries are called fishery-MPAs.

Political commitments are the starting points of decision making and good governance:

The adoption of rules of « good governance », the clarification of national frameworks (cf. chapter 5.3.4) and the development of collaborations between conservation and fisheries call for a higher-level (supra sectorial) arbitration, clear political commitments, and the development of strong local and central institutions to enforce the rules. A clear national framework should enable the attainment of the required degree of collaboration among institutions, transparency, participation, and legitimacy. In the light of the present difficulties, it appears necessary, as a matter of priority, to look for the following:

- **Joint review and harmonization of national legal and institutional frameworks** to ensure that mandates and power are in place to enforce principles of good governance for integrated management of fisheries and MPAs, and the improvement of institutional framework related to financing of management.
- **Promotion and building of institutional bridges for better coordination and integration of fisheries management and conservation.**
- **Good governance and improved management implementation for new and existing fishery-MPAs;** promotion of co-management and integration of stakeholders in a transparent process; development and/or implementation of simple management plans, regularly updated, and equipped with effective means; optimization of surveillance and regulations enforcement mechanisms.
- **Improved management of migratory resources and the development of networks of MPAs,** and secondly, develop only transboundary MPAs.

Recommendation:

“Building bridges to improve governance of fishery-MPAs and integrated management of fisheries and MPAs “

at the national and local level, strengthening the partnership, pooling resources, reducing of competence; and improving governance, decision-making and responsibility:

- If it does not exist yet, establish a **higher-level national integrated framework** which obliges/mobilizes structures to collaborate and develop a spatial integration of fisheries and MPAs, and creates supervisory, advisory and audit institutions.
- **Identify an institution** which can ensure leadership in a co-management context.
- **Develop framework agreements,** joint political declarations at local and inter-ministerial level between government agencies and stakeholders (delegating surveillance functions; pooling resources); establish coordination commissions (between MPAs and fisheries managers for instance).
- **Act to decentralize** and delegate/transfer certain State competencies locally, for participatory management of fisheries resources; Delegate State authority with cautious (Surveillance).
- **Develop hybrid institutions** that are recognized at the local and national level (e.g. between the public and private sectors).
- **Define and develop management plans in a coordinated and participative manner** (at the national level in partnership with local representatives and at the local level by promoting local innovation and adaptation capacities).

4.6.1 Legal and Institutional Governance Framework

There are big differences between terrestrial and marine protected areas (e.g. property, use, surveillance). In MPAs, the administrative prerogatives of different ministries tend to overlap and the institutional basis of governance is not always clear. MPAs sometimes develop in an ad hoc way, for example within the framework of projects operating at the edge of national law.

Furthermore, lack of convergence and collaboration is frequent between national systems of fisheries and MPA management at all geographical levels (local, national), explaining the difficulties in implementing management actions.

Recommendation:

“Review and harmonize legal and institutional frameworks of governance of MPAs –fisheries and integrated management of fisheries and MPAs “

- **Develop legal expertise** so as to promote harmonization of regulatory frameworks.

- **Clarify the legal and institutional frame**, the respective roles of fisheries and conservation authorities in MPAs, for the elaboration of management regulations, control (and its financing), judicial procedures, penalties, etc.

- ✓ Establish standards and processes for the designation of areas : specify typology and statutes of protected areas that are most practical and effective for fisheries (e.g. conservation MPAs, community-based MPAs, fishery protection zones;), considering alternatives and complementarities ; indicate applicable types of governance, looking for the most effective mechanism and taking into account the means available;
- ✓ Set the regulatory framework to be implemented by clearly indicating the connection between regulations and political objectives, nature of legal and administrative provisions (binding, non-binding ; mandatory, voluntary, etc. ;

- ✓ Clarify institutional mandates, powers, and modalities of institutional coordination;

- ✓ Specify the arenas for coordination and management and the role of each party, including in the process monitoring and evaluation ;

- ✓ Improve the financial framework and take innovative fiscal measures to finance MPAs: delegate to managers the responsibility to generate a part of the resources required for financing MPA management

- ✓ Foresee the formalization of traditional users rights and, eventually, traditional management systems.

4.6.2 Implementation of Good Governance and Co-management

The existence of an efficient co-management and consultation process is a guarantee of better stakeholder capacity to manage their areas, resources, and to resolve conflicts likely to arise. This process will develop differently in different sites according to the diversity of stakeholders, their history, and their cultures. Although it is recognized that flexible and adaptable management plans are essential, there are few fisheries management plans in the region and a few of them are really operational in the world. When they do exist, management plans of MPAs are not always prepared with the participation of local stakeholders and they are sometimes too ambitious to be applied, even partially.

Recommendation:

“Transparently Promote Co-Management“

- **Identify and take into account preexisting systems of governance** (central and local ones) so as to avoid mistakes in the decisions and organization of management

- **Clearly specify the respective roles and responsibilities** of the different stakeholders in management structures and in allocation and control of access ; avoid any brutal modification of existing situations and radical decisions (hardly reversible)

- **Establish a consultation and decision making framework** as well as a clear framework of renewal of decision-making organs

- **Identify and take into account stakeholders powers and representation systems** and existing management regulations; act on existing principles and reinforce legitimacy of local stakeholders ; take into account cultural dimension (particularly the minorities) when relevant ; distinguish between vital interests and rights of stakeholders from mere expectations

- **Analyze and take into account the various types of migrant fishermen** differentiating their respective roles and impacts (permanent/regular or opportunistic migrants)

- **Nominate a legitimate management facilitator** who will report regularly on performances, monitoring, decision-making, and mobilization of stakeholders for decision-making

- **Verify the transparency of decision making , surveillance, monitoring and evaluation processes**, and improve them if need be; verify also the degree of understanding of the processes of stakeholders

Research mechanisms in the SRFC region remain weak in comparison to the needs for management of fisheries and MPAs: However, value addition is possible through pooling of resources, for the benefit of the two systems of governance.

Compliance with management regulations by the majority of stakeholders and surveillance are essential. An adequate institutional and administrative framework and capacity are essential, especially to reinforce the perception of stakeholders concerning the legitimacy of measures constraining them.

The following recommendations aimed to improve the implementation of management and good governance on fishery-MPAs and other existing MPAs.

Recommendation:

“Elaborate and/or implement simple, formal, regularly updated and effectively supported management plans “

- **Build social, institutional, and scientific capacities** in order to prepare management plans, carry out and control closures (exclusions), take part in the management of fisheries and MPA, while also monitoring and evaluating their implementation
- **Identify and formulate with users the rules of access to resources**, as well as conventional measures that the MPAs would strengthen (e.g.: in the restoration of depleted stocks)
- **Promote the signing of formal social contracts** and other agreements facilitating the transfer of State’s management competencies
- **Study and agree on exceptional measures to put in place in case of emergency**, for instance, when detecting signs of stock collapse; needing to reduce fishing effort or to implement ad hoc closure of critical areas
- **Experiment with adaptive management** on the basis of jointly elaborated monitoring results covering both the bioecological, socioeconomic and governance aspects
- **Provide the MPA or the area concerned and its manager with the substantial means** needed to coordinate and implement management plans (including in the sea)
- **Support mechanisms facilitating sustained MPAs financing** (cf. socio-economic section)
- **Systematize periodic evaluation** of management plans and an audit system

Recommendation:

“Optimize the surveillance and regulations enforcement mechanism”

- **Specify the authority responsible for surveillance**, promoting synergy of existing authorities and establishment of optimized cost-effective systems (e.g. Radar-AIS systems combined to coastal telescopes)
- **Encourage the involvement of national surveillance institutions** in the elaboration of modalities and means of pooled surveillance (between fisheries and MPAs) and ensure an **active participation of stakeholders** in the determination of measures, fines, and in the implementation of the control system
- **Adopt strong dissuasive sanctions** and adapt them to the gravity of infractions; allow them to be improved as required along the time while reinforce the judicial mechanism associated with the enforcement of sanctions
- **Widely and openly communicate on encroachments, arrests, penalties**, their consequences for communities, etc., in order to increase the feeling of justice for those abiding by regulations
- **Establish required and recurrent resources**. Possibly, use the funds generated by fines to finance controls (at least at the beginning)

4.6.3 Utilization of MPA for Migratory Resources and Development of the Networks of MPAs

The management of MPAs associated with the management of migratory fishery resources poses new problems in terms of efficiency, localization of MPAs, relevance of MPAs as tool for the improvement of fisheries management. It must be noted that serious doubts have been expressed regarding the utility of MPAs in the case of mono-specific pelagic stocks. However, MPAs dedicated to the protection of nurseries are considered as potentially useful. In this context, MPAs remain inefficient if measures to regulate access and control fisheries capacity are not reinforced and effective. In addition, the concepts of “functional ecological network” and of “connectivity” among MPAs should be more adequately integrated. Most often, there is insufficiency (or weak use) of knowledge on biology, life histories, migratory schemes of fish communities, in the design of functional ecological networks.

☞ Recommendation:

“Improve management of mobile resources and migratory species”

Are MPAs the best management tools?

- Ascertain the relevance of the creation of MPAs to resolve the problems relating to the management of the species considered;
- Imperatively regulate fishing capacity before establishing MPAs for migratory species;
- If MPAs are the chosen tool, set them as priority in nursery areas and apply temporary closures on spawning concentrations and nurseries;
- Compensate the activity losses in fisheries located on these nursery areas, during closed periods, reducing the risk of effort transfer if the measure generate losses for the sector;
- Integrate migrant fishermen into management (cf. technical report on “governance” aspect)

In the SRFC region there exist a large number of transboundary resources for which coordinated national MPAs and transboundary networks might be useful. However, besides the usual constraints relating to the creation of classical MPAs (siting, sizing, choice of perimeter, zoning, regulations), transboundary networks raise have additional difficulties (formal signing of international agreements, coordination of national administrations, etc.). The potential for incoherencies remain high on both sides parts of the national borders, between management instruments and regulations methods and rules of management of fisheries and of stocks and protected areas. Progress in the area of fishery management of shared stocks in the region has remained extremely weak for since decades and this does not augur well for the establishment of transboundary MPAs.

☞ Recommendation:

“Develop transboundary MPAs with great caution”

- **Strengthen governance and national systems** of fisheries and of MPA management before envisaging the development of transboundary MPAs whose management is more complex;
- **Analyze legal constraints and make changes**, as needed in order to enable decision-making and signing of agreements relating to the management of straddling stocks (beyond EEZ in this area) or transboundary ones;
- **Develop collaborations between the members States of the sub-region** on the choice of management measures and tools for transboundary and straddling stocks and MPAs; contribute to the development of protocols for the establishment of MPAs for migratory and straddling species within the framework of relevant conventions (in particular Abidjan Convention and MCS);
- **Develop an addendum or additional protocol to the Regional Convention of Minimal Access Conditions (RCMAC)** concerning MPAs and their role for fisheries management ;
- **Improve the capacity of the SRFC, at the level of the Conference of Ministers**, to make binding decisions for its members in relation to the required regional agreements;
- **Evaluate costs and benefits of different options of possible collaboration.**

☞ Recommendation:

“Improve the development of networks of MPAs”

- **Aim to develop functional ecological networks** that are useful for fisheries by taking into account ecosystems and critical habitats of fish communities; develop knowledge and reflections at the ecosystems level; carry out an inventory of migratory, transboundary, and straddling resources and their critical habitats in order to determine the relevance of developing MPAs (cf. chapter on “establishment of an MPA”), with special attention to pelagic resources.
- **Reinforce the operation of the existing network (RAMPAO)** at the level of individual sites before envisaging functional network approaches justifying the creation of new MPA;
- **Formalize a SRFC - RAMPAO agreement** and deepen the systematic analysis of RAMPAO deficiencies in reference to fisheries management.



5 APPENDICES

5.1 Other Interesting Examples

5.1.1 Other Examples of the Bio-Ecological Aspect

Effects of integral reserves on mobile fish species



Effects of integral reserves on mobile fish species

*The Mediterranean hake (*Merluccius merluccius*) is one of the most important commercial fish species in the Mediterranean Sea. Immature individuals account for the bulk of the catch and undergo the highest fishing mortality rate. Hake is characterized by periods of seasonal migrations and spawning and nursery areas that are well delimited in space.*

The model developed by Apostolaki et al. (2002) describes the effects of an integral reserve on spawning biomass and on short-term yields of fishing populations. It shows that the positive effects of the reserves are registered for overexploited stocks with reduced mobility as well as for under-exploited stocks and mobile species

Best results are achieved when the protection area includes both spawning and nursery areas. But when spawning and nursery areas are separate, benefits are higher if the protected area corresponds to the area occupied by animals of the size targeted by fishing. However, the model used also shows that the establishment of a reserve in an inappropriate area can have negative effects on populations. At the establishment of an integral reserve, spatial and temporal variations of fish populations should be taken into account in order to optimize their protection.

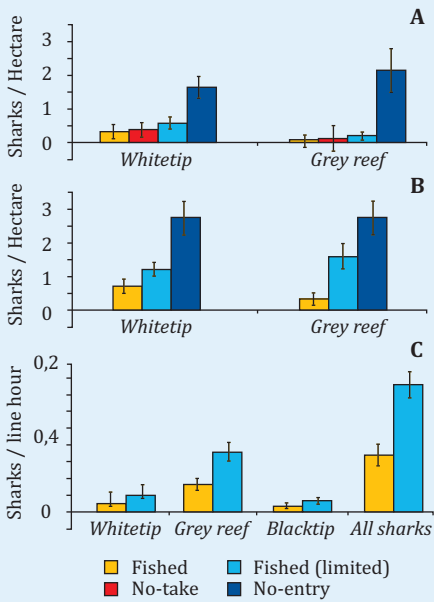
Source : Apostolaki et al. 2002 ^{XLV}



Efficiency of a Network of MPAs

The Great Barrier Reef Marine Park of Australia (Mesnildrey et al. 2010)

Abundance of reef sharks in different areas in the north and central part of the Great Barrier Reef. Abundance of sharks based on visual observations (A) and (B). (C) represents catch rates of sharks (data from samplings by long line fishing)



Abondances de requins basées sur des observations visuelles (A) et (B). (C) représente les taux de capture de requins (données issues d'échantillonnages par pêche à la palangre)



The Great Barrier Reef is an illustrative example of the combined efficiency of a network of reserves (33% of the area is in reserves) and of areas of large regulated use. However, mobile fish species (e.g.: sharks) benefit less from protection than resident species.

The density of the main species fished by angling on the Great Barrier Reef is significantly higher in the reserves than in areas where fishing is authorized. After only two years of protection, the abundance and biomass of the leopard trout (*Plectropomus leopardus*), emblematic species of importance for fisheries, have notably doubled (Russ et al 2008). These positive effects are globally the same for the many reserves of the park, even though there are variations according to regions and intensity of exploitation before closure. The increase of average size within reserves is particularly important.

Since the establishment of reserves, the frequency of starfish invasion (a cause of important coral mortality) has been about four times lower in reserves than in areas open to fishing.

This phenomenon could in part be the result of trophic cascades and a related increase of predation over juveniles of starfish in the reserves.

The populations of reef sharks, apex predators or super predators of coral reefs, show an important positive effect due to zoning with substantial benefits in terms of abundance within reserves where access which access is strictly prohibited.

Therefore, the zoning applied for the protection of the Great Barrier Reef seems to have been beneficial and contributes to the maintenance of biodiversity by impacting several species attached to the site (starfish, corals, leopard trout, etc.) or mobile (e.g.: sharks). However, ecological effects in areas where access is strictly prohibited seem stronger than in those reserves where fishing is prohibited but access is authorized.

The study of McCook et al. (2010)^{XLVI} shows that one simple network of reserves could not have enabled to obtain the same effects on the whole ecosystem. The zoning of the Park and management of fishing effort make it possible not to avoid the transfer of effort outside the reserves. In addition, even though the zoning of the Marine Park contributes to space-based management of fishing effort, the latter is significantly completed by a conventional system of fishery management with an effort to reduce by-catch.

Source : Mesnildrey et al. 2010, McCook et al. 2010 et Russ et al. 2008

Differentiation of Effects – Network of Reserves in Tasmania, Australia

The first marine reserves of Tasmania were established in 1991. They differ in size and in the ecosystems they protect. The common objectives of these four reserves were to reach biomasses populations levels close to non-exploitation levels inside their border.

After six years of protection, Maria Island reserve, the largest among the four, seems to be the most effective in terms of conservation and improvement of the state of fisheries resources. The numbers of fish species, of invertebrate and seaweed, the density of large fish and lobster, and the average size of some fish species have significantly increased in the reserve compared to the unprotected sites. Nevertheless, these improvements have slowed down after 10 years of protection: the fish specific richness and the abundance of large fish species have come back to the 1992 level

After ten years of protection, the effects on fish populations in the reserve of Tinderbox with regard to adjacent areas were the most significant. Abundance and specific richness of large fish have been multiplied respectively by 10 and by 2. After only six years of protection, however, these changes were not yet significant, showing that the effects of reserves are not immediate. These changes suggest that fishing had significantly affected the structure in size of fish species before protection. The slow restoration rate can be explained by the weak growth rate of species studied.

After ten years of protection, the abundance of lobster species of Australian coasts (*Jasus edwardsii*) has increased by 250% in the reserve of Maria Island with regard to areas remained open to fishing. Thus, the average size of individuals in the reserve has increased from 90 to 120 mm while it has stayed stable in the adjacent areas (78 mm). Biomass has sharply increased during the ten years of protection while it has stayed stable in neighboring sites. The same phenomenon has been observed in the reserve of Tinderbox. The fact the abundance of small lobster did not increase inside reserves underlines that important increase of large individuals had not have any influence on local recruitment or survival of juveniles. It is therefore possible that density-dependent processes compensated the effects of reserve over the first ten years of protection (Barrett et al 2009).

Unlike the first two reserves, no difference due to the protection of lobster has been observed in the reserves of Ninepin Point and Governor Island. The absence of effect may be due to the small size of reserves and poaching.

Like lobster, abalone is under heavy exploitation pressure in Tasmania. Thus, the same trend of increase in reserves was expected. On the contrary, in the reserve of Maria Island, the abundance of abalone decreased by half during the ten years of protection while it remained stable in exploited areas. This reduction is therefore the result of protection and may be due to reduction by a factor of 7 of the abundance of small size individuals. Several hypotheses have been put forward to explain this decrease but scientists have favored one of them: intensification of predation on abalone juveniles subsequent to an increase of a predator, the lobster. The objective of reserves was to protect populations exploited by fishing, but for abalone the result was the opposite. This result suggests that for reserves whose objective is to protect a particular (prey) species, for instance abalone, protection conditions should take into account trophic interactions and predation. Reserves do not seem to be, in this case and for the specific objective of abalone conservation, the most appropriate management tool.

Source : Mesnildrey et al. 2010, Barrett et al 2007 et Edgar & Barrett 1999 ^{XLVIII}

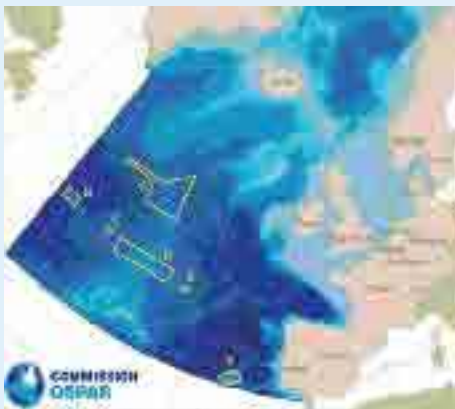
5.1.2 Other Examples on “Governance” Aspect

☞ The National Fisheries Conservation Center of the United States (<http://www.nfcc-fisheries.org>;) (NFCC, 2004) has published a statement of consensus on the role that well-managed MPAs could play for fisheries: to increase abundance, protect critical habitats; facilitate multi-specific management; reduce risks related to uncertainty (insurance, security); protect sedentary species presenting recruitment deficits and mobile species regularly sharing the same sites. Such MPAs are more likely to satisfy these expectations and to appear more legitimate in the following conditions:

- If fishing pressure has already been reduced;
- If conventional measures have failed, are more expensive, or appear to be less efficient (e.g.: for protection of habitat);
- If they are integrated with the other fisheries management measures within the framework of a coherent ecosystem approach, and not only added to existing measures (mainly applicable to Reserve-MPAs);
- If the design takes correctly into account environment and management objectives, including sustainability of exploitation. Therefore, a robust experimental design must be elaborated to evaluate performances of the reserve inside and outside the protected area, both on resources and human populations.
- If sufficient knowledge is available: there is lack of experimentation designed to measure/predict the impacts, mainly effects induced inside protected areas, on resources and human populations. Given the difficulties of an experimentation, multi-disciplinary modeling is a necessary approach to evaluate these effects;
- If particular attention is given to the effects of MPAs on allocation of resources, movements of fishing activities, needs in support research, and costs of control and surveillance.

Zones marines protégées OSPAR
dans les zones au-delà de la juridiction nationale

- A ZMP Charlie-Gibbs méridionale
- B ZMP du complexe du mont sous-marin Mine
- C ZMP du complexe du mont sous-marin Altair
- D ZMP de haute mer de la dorsale médio-atlantique au Nord des Açores
- E ZMP de haute mer du mont sous-marin Antialtair
- F ZMP de haute mer du mont sous-marin Josephine



Localization of OSPAR Marine Protected Areas beyond national jurisdictions

☞ OSPAR and high sea MPAs

OSPAR took the initiative in 2010, and after several years of political process, to create six high sea marine protected areas in the Northeast Atlantic. Yet, the mere designation of marine protected areas is not sufficient and should necessarily be followed by the adoption of binding management plans for all the MPAs, adapted to threats on ecosystems and broadly enforceable.

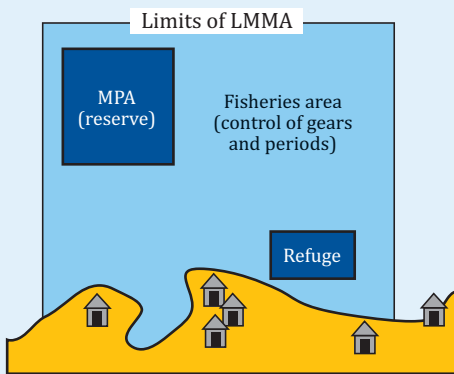
Actually, according to the present law, these areas only define areas that are ecologically sensitive (similar to FAO VMEs: cf. technical report). However, parties to OSPAR Convention do not have the competence required to regulate human activities (e.g. fishing or pollution), and the areas they have defined are not enforceable with non-contracting parties to this convention. One additional particularly thorny point is the prohibiting costs of control and surveillance. Given the stakes and the weight of maritime navigation in the world economy, the debate risk being particularly conflictual.

It would be quite irresponsible and potentially costly, given the difficulties of governance encountered in most MPAs, in a much easier EEZ context, to underestimate the obvious management difficulties of pelagic MPAs, mainly in ZAJN (cf. technical report).

Source : OSPAR, Rochette and Druel (2011).

☞ Integration of Traditional Laws: Samoa Islands^{XLIX}

Samoa Islands constitute an exception to the general trend of authoritarian establishment (top-down governance) of MPAs legislative frameworks. The Fisheries Act of this country enables the recognition of community laws as long on as they are consistent with national legislation. When local leaders decide to establish an MPA, a meeting with fisheries executives allows to decide on the compatibility with the Act. Subsequently, local rules are implemented as State regulations (by-laws) and disseminated in neighboring villages through community meetings. Once the network has been set up, small MPAs can be turned into larger MPAs or multi-use MPAs, with specific benefits for communities.



Schematic representation of a Locally-Managed Marine Area (LMMA). Reserves and refuges can be temporary.

☞ LMMAs^L, as multi-use areas

(including fishing, tourism, research, and education) managed by local communities are comparable to Community Heritage Areas (Aires du Patrimoine Communautaire, in French) such as the Kawawana of Casamance Region, in Senegal).

More than 12.000 km² of marine and coastal territory of South Pacific, including more than 1.000 km² of reserves (no-take zones), are actively managed according to the LMMA concept by 500 communities of 15 different countries. This result should be compared with 14.000 km² of older « paper parks » existing under centralized management, are mentioned in regional databases, and must be imperatively reviewed.

Recent reviews on LMMAs and the examples of the Pacific region (Fiji and Salomon Islands) show that this integrated approach is feasible and less costly in comparison with centralized science-based approaches (for which cost-benefits analyses may be deficient) (cf. <http://www.lmmanetwork.org>). Thus, an exclusive focus on objectives related to creation of Reserve-MPAs would be costly and difficult to maintain sustainably. Potential benefits of no-take zones will be hard to reach if communities do not also target also other objectives, using other tools in their exploitation areas and watersheds.

Community Fisheries Reserves in Philippines (Bohol, Central province of Visayas) ^{LI}

These small-size reserves (<1km²) are a good example of potential utilization by fisheries management of small no-take zones (sanctuaries) as management tools in a coastal environment that is tropical and rural, with weak administrative capacities, and with populations highly dependent of aquatic resources. The reserves have been established in a context of resources and habitats very degraded by various human activities, including overfishing.

From a governance point of view, the Fisheries Code of Philippines and the Local Government Code provide the action framework. They give mandate to municipalities which are called Local Government Units (LGUs) and declared as owners of resources, to establish MPAs within 12 miles. The establishment of these MPAs requires a “Presidential Proclamation” or a parliamentary act published by municipal order. MPAs can be integrated into the National Integrated Protected Areas System (NIPAS).

Municipalities can generate funds to support the management of these areas, including building their management capacities. They are included in coastal resources management plans established with the participation of Village Teams. These plans include management plans of sanctuaries, an objective of which is to increase resources available outside them. Management activities include: (i) evaluation of resources; (ii) on-site consultations; (iii) compliance with legal obligations; (iv) establishment of the Management Council, (v) formulation of management plans, and (vi) monitoring of implementation at the community level. Compliance with regulations is ensured by : (a) mooring of delimitation buoys ; (b) building of a house for the security guard in the sanctuary ; (iii) a team of guards with a daily assignation sometimes using patrol vessels (in the best monitored areas). Monitoring is ensured in collaboration with scientists.

This initiative has built a high community spirit and intense participation by Popular Organizations. It is has been strongly supported at the local level. Monitoring shows clear positive impacts despite inevitable variations, particularly in the immediate vicinity of the sanctuary. It demonstrates the importance of clear legal framework, advertisement and dissemination campaigns as well as education of stakeholders.

Arising problems are relating to: (i) financial sustainability of the system that has long been financed by external subsidies even though a budgetary contribution is now provided by the municipality, (ii) insufficient capacity at the village level (iii) illegal fishing has not been totally controlled yet, (iv) absence of demonstration of positive impacts on neighboring areas, (v) weak participation of the government, (vi) increase of human population which erodes the potential benefits of MPAs, and (vii) absence of formal procedures of adaptive management with recurrent evaluation of performances.

Territorial Use Rights in Chile

This example is interesting for the SRFC since it deals with an ecosystem characterized by an upwelling zone that induces important species migrations. Over the last decade, the Areas for the Management and Exploitation of Benthic Resources (AMEBRs) (Áreas de Manejo y Explotación de Recursos Bentónicos) have rapidly mushroomed after the overexploitation period of 1980s, in order to: (i) reduce fishing effort and overexploitation; and (ii) improve the acceptance and effective implementation of management measures, owing to an allocation system of coastal spaces and benthic resources they contain.

Chilean law provides 3 types of MPA: AMEBRs, reserves, and parks. The last two categories are less applied. AMEBRs allow the allocation of exclusive Territorial Use Rights, and since their introduction in 1990s, they have become the main tool of artisanal fisheries management in Chile. The objectives are: (i) to conserve benthic resources (seaweeds and invertebrates); (ii) to support artisanal economic activities; (iii) to maintain or increase biological productivity of resources; (iv) to increase knowledge on the functioning of ecosystem; and (v) to promote and encourage participatory management. AMEBRs would therefore be similar, through their objectives, to MPAs of the IUCN category VI. There are 450 AMEBRs, established in a range of 5 miles from the coast, and 1200 other are requested. Their surface is variable (average = 190 ha), and they now support more than 30% of Chilean artisanal fishermen.

The establishment process is highly participatory, and associations or fishermen's cooperatives are entrusted with the management of AMEBRs. The process requires the establishment of reference data on benthic resources and presentation of an exploitation and management plan whose quality norms are set by regulation that have to be approved by Under-Secretariat for Fisheries (SubPesca). They specify target species, seasons and fishing techniques, as well as criteria used for the determination of Total Allowable Catches (TAC). Aquaculture is authorized in an AMEBR provided it does not impact on natural resources and abide by enforced regulations. Then, an "Agreement of Use" is established for 4 years with the National Fisheries Service which transfers obligations and privileges of the State to the said associations/cooperatives. The plan specifies rights and obligations of each member in the community who adopts its Code of Conduct. Control is carried out by the associations themselves, through a Committee of Control whose appointment system is rotating. The Executive Bureau of the Association sets vigilance norms and the amount of sanctions. Management performances are evaluated by the National Fisheries Service which can inspect fishing and management operations and take corrective measures. In case of infraction, the Association can lose its use rights.

Studies have shown improvement of resources and socio-economic conditions. From management point of view, AMEBRs seem to be a positive solution which has reduced overfishing and built local management capacities in a system of exclusive users' rights. The system is transparent, and the associations control -and conduct themselves- scientific analyses that are submitted to the National Fisheries Service.

Difficulties are faced in: (1) control and surveillance and ulterior improvement of control by stakeholders themselves; (2) absence of economic and social considerations in the elaboration of regulations; (3) ignorance of internal rules of control and coercion; (4) lack of local capacity building in planning and auto-management; (5) remoteness of AMEBRs; not replaced in the national context of conservation and fisheries management; and (6) lack of pluri-disciplinary analysis of AMEBRs performances.

An MPA with Shared Governance : Marine Protected Area of Joal-Fadiouth (Senegal) ^{LI}

Created thanks to the obstinate action of a small group of fishermen, the MPA of Joal-Fadiouth was born in 2004 and is now managed under a regime of shared governance. The original motivation was the threat represented by fishing gears (kilis and beach seines) for seagrass beds. The presence of turtles and manatees, real touristic attractions, and the need to preserve the mangrove were also determining factors.

The MPA is based on a simple zoning : (1) a central core where only autochthonous fishing practiced on foot is allowed ; (2) area with multiple utilization where responsible fishing is allowed with the use of angling and nets (100 mm of mesh size) ; and (3) a mangrove area with precise rules for picking. The two problematic fishing methods have been prohibited, but, the concern of the MPA was also to find alternative livelihoods for impacted fishermen by striving to combine conservation and equity.

Owing to the combination of strong and continuing commitment of some individuals, the support of an international NGO, a favorable international context (projects), and an intelligent cooperation with services of the local administration, the MPA has been created and delimited, and its governance organs have been set up. The analysis of the state of reference of the ecosystem has been prepared, and the internal regulation and management plan have also been developed. Surveillance is regularly ensured by active and well-trained volunteers.

No less than sixteen different stakeholders groups are actively participating in the life of this MPA in the three organs of governance : (i) Management Committee, which meets at least once a month ; (ii) Annual General Assembly, (iii) the Bureau, composed of six persons, representing the executive power of the management committee and supported by four technical commissions (surveillance, sustainable fishing, and management of conflicts; management of environment; technical and touristic development; sensitization). The Bureau meets at least twice a month.

The MPA of Joal-Fadiouth has already delivered important results: improvement of yields, increase of the average size of fish, come back of turtles and some noble species. What is more, community is mobilized. Youngsters are involved in the governance and benevolent surveillance.

However, this MPA remains weak, and many problems are persistent and require particular attention in the future : to improve co-management and frequency of General Assembly meetings; to resolve the problem relating to kilis (fishing gear) ; to eliminate confusion between management plan and internal regulations ; to improve the financial self-sufficiency of the MPA which is too dependent from donors ; to preserve MPA functions in an area close to a large landing site (high pressure) ; to support the rotation of leaders ; to further adapt governance with the integration of new community groups and the diversification of the community beyond fishing.



5.2 Synthesis on Cost-Benefits Analysis (CBA) Methods and Recommendations

Two main questions are asked in terms of information related to cost-benefit ratios:

- What is the return on investment of an MPAs project? (project approach) ;
- What is the economic impact of MPAs effects on stakeholders and on their territory? (MPAs « effects » approach).

“CBA” is a method of evaluation of the social efficiency of a public project based on the monetary evaluation of the overall positive and negative effects this project can generate for the society. The expression of such efficiency can take the form of a Net Updated Value (NUV) or an Internal Rate of Return (IRR). CBA can help in the selection or evaluation of projects, but it is also designed to apply to MPAs. Nevertheless, it is hindered by serious practical obstacles.

The first category of obstacles stems from the necessity to evaluate in monetary terms non merchant effects, which are generally very important in the case of MPAs (values related to recreational use or to the very existence of the AMP, the well-being, or the transfer towards future generations). Methods that have been developed for that purpose remain heavy and costly to implement. Their domain of validity is limited, and the risks of bias in the interpretation of their results are important. In addition, there is no consensus about the legitimacy of attempts to express non-monetary values in monetary terms

In order to minimize these difficulties, one corrective mechanism that is often used is the resort to “benefit transfer” which consists in taking, from the literature, evaluations conducted in other contexts, transferring them to one’s context. This method has the advantage of being easy and less costly, but also present obvious risks on account of the the specificity of each MPA context. One alternative to CBA is the resort to “cost-effectiveness analysis” (CEA) which is in fact a weakened variant of CBA, in which only the costs incurred for realization of one or several objectives are used. If CEA can help to circumvent the difficulty of monetary evaluation of benefits generated by MPAs, it leaves unresolved the issue of the protection levels to be decided a priori.

Concerning more specifically the evaluations of fisheries effects of MPAs, the implementation of CBA is frequently hindered by insufficiency of knowledge relating to spatio-temporal mobility of fisheries resources. Generally, this insufficiency does not allow the appraisal of the effect of biomass spillover out of the MPA, or the benefit for fishermen of a possible effect of larval diffusion from the protected area.

A subsidiary difficulty lies in the frequent ignorance of the adaptive behavior of fishermen confronted to restrictions imposed on them within the MPA framework.

The reasons which make it difficult the application of CBA to MPAs have often been worsened by the following factors:

- Insufficiency of information concerning the situation prior to the MPA establishment (« zero state » or baseline) and of implementation monitoring (particularly at the socio-economic level). This is particularly frequent in the “projects” rationale or “project based approaches”.
- Insufficient temporal perspective. The ex-post analyses are undertaken within the framework of projects, the financing of which ceases too early to allow the effects of MPAs to fully develop (in particular in terms restoration of fisheries resources).

In these conditions, CBA applied to MPAs or to projects of international donors often presents important weaknesses:

- Resort to assumptions that are not empirically well grounded (in the matter of restoration of fisheries resources in particular) or to hazardous extrapolations (uncontrolled use of “benefit transfer” approaches) ;
- “Partial” application of CBA, in which effects that are too difficult to estimate are let outside the scope of analysis, a practice which can obviously generate important biases (for instance to the detriment of non-value aspects of ecosystem conservation).

The understanding of these phenomena is sometimes made uneasy by an incomplete (partial) presentation of the tools and methods employed to calculate NUV or IRR of MPAs.

Key Recommendations on Cost-Benefit Analyses

- Ensure transparency in the description of methodologies used: explain calculations;
- Do not conduct this type of study in the absence of “Zero state” providing reliable and useful data obtained at the start of the project.
- Do not undertake these analyses if there the substantial means needed (for surveys, analysis, disciplinary teams, etc.) are not available;
- Select evaluation methods matching the empirical data available;
- Give priority to the analysis of the effects of MPAs on the socio-economic situation of local populations, who are very often impacted by negative effects of MPAs (in particular in the matter of opportunity cost for fisheries), and whose acceptance and cooperation largely determine the success of implementation.

5.3 Synthesis and Recommendations on Biological and Bio-economic Modeling of MPAs-Fisheries

An approach for the evaluation of the efficiency of MPAs consists in using dynamic mathematic models. There are many of them for fisheries whereas simple conceptual models are often used for the evaluation of MPAs, and should provide an understanding of the possible consequences of MPAs on the dynamics of resources and their exploitation. There are also more complex models, spatially explicit, including mixed fisheries, or trophodynamic ones that take into account other important process. There is sometimes a gap between assessment approaches (evaluation) based on modeling and on empirical observations. The first approach may be considered as too theoretical but the second is not sufficiently used by modelers to tune their models. Yet, dynamic models are indispensable. The development of more realistic models based on field data shows that the two approaches are complementary. One of the main improvements to the mathematic approach is to reach a compromise between parsimony (which consists in using only the minimum number of elementary causes possible to explain a phenomenon) and complexity (which increases with model realism). Another improvement is to estimate model parameters and to tune the models with real observation data.

There are three main observations relating to bio-economic or biological modeling on MPAs and fisheries

- **There is no perfect model that is replicable on any site:** for each situation, models and combinations of models are to be developed according to the specific characteristics of the areas concerned and, mainly, the questions asked (the objectives of the analyses).
- **Data required for feeding models are often missing or very insufficient:** monitoring mechanisms remain insufficient to regularly feed models. The SRFC region is therefore not mature enough to develop a space-based model to be regularly used (Europe is not capable of doing so, either).
- **Modeling the relationship between MPAs and fisheries is necessarily complex.** For an MPA, the model should: (i) have a clear-cut objective; (ii) be space-based, distinguishing spaces inside the MPA and outside; and (iii) be dynamic so as to take into account migrations of fishermen and fish species. The requirements in terms of data therefore remain too important to imagine realizing, in a near future, an operational model on MPAs of the SRFC. Moreover, data input and implementation of models require sustainable (in the short and long terms) national and regional research capacities, which are not available at the moment (cf. State of the research).

There is no precise list of models according to issues and stakes to which they respond.

Table 7 Summary of biological models that can be applied to a range of management stakes likely to be faced while managing MPAs ^{LIII}

Question asked in each model	Mono-specific models	Space-based or coupled models	MSVPA	OSMOSE	EwE	ISIS-FISH	Atlantis
Functioning of an ecosystem							
Change of state of an ecosystem							
Impact on the target species							
Restoration of depleted stocks							
Modification of habitat							
Larvae dispersion							
Spillover effect							
Trophodynamic forcing							



Table 8 Summary of biological and bio-economic models

Typology of models	Model	Objectives of the model and teachings	Maturity Possible Applications and utility in the management of MPA
Biological model	Global or production models	To measure direct effects on stocks + base of many bio-economic models	Several decades of existence - less useful for MPA
	Analytical or structural models	To define fisheries management targets - Models at the basis of many space-based models	Frequent-less application to MPA, Mostly used in management of stocks
	Mono-specific space-based models	To evaluate the effects of a spatial management measure on stocks - study of source -well mechanisms	Less used in fishing, Potential to assess effects of MPA on stocks/fishery
	Coupled model: Physical/biological	To evaluate sequences of habitat degradation on populations	Relevant to study the effects of protection of sensitive areas on recruitment/ dynamics of a stock
	MSVPA - Multi-Species Virtual Population Analysis	To estimate beforehand stock effects, mortality by predation and by fishing	Used in fisheries management in particular by CIEM since 1995
Ecosystem - tropho-dynamic model	Ecopath	To understand the organization and functioning of a trophic ecosystem, Ecotroph is complementary with Ecopath, useful when data required by Ecosim are not available (applied on Bamboung, Port Cros)	Several hundreds of applications, Analyzes the effect of an MPA inside the MPA - from primary production up to predators
	Ecotroph		Idem Ecopath. The coupling Ecopath / Ecotroph enables to analyze the impact of fishing and simulate different levels of fishing efforts
	Ecosim	To understand an ecosystem and temporal dynamics of each compartment	Several applications -To assess the effects of MPA on trophic networks. Can have an economic module,
	Ecospace (Tropho-spatial model)	To understand the organization and trophic functioning of an ecosystem in a spatial manner	idem ecosim + predicts trophic cascade effect in a spatial manner or effects of movements of populations on the efficiency of MPA,
Fisheries simulator	ISIS-FISH	To evaluate respective impacts of conventional spatial-based management measures of management on fisheries.	Recent model To evaluate the impacts of MPA on fisheries
Individual Centered Ecosystem Model (IBM)	Osmose	To evaluate for example the effects of fishing on size classes or degree to which size can limit predation	Used for analyzing the impact of different management scenarios on fisheries (on the upwelling of Peru and Benguela).
Spatial analysis instrument	MARXAN	Instrument in support to decision: estimate an ideal zonage in a cost-effectiveness optic of analysis	Used in the design of networks of MPA - examines the impact of a range scenarios of creation of MPA.
Deterministic bio-geochemical model	Atlantis	Ex-ante evaluation of fisheries management strategies	Used for the identification of indicators, assessment of vulnerability of species and management systems in place
Economic model	RUM model of simulation, dynamic, multi-specific, and stochastic	To explain the distribution of fleet effort by zone and by target species group (Georges Bank fisheries)	Applied to a sampling of individual tides - predicting model allowing to anticipate socio-economic effects of MPA
Bio-economic model	Dynamic, mono-specific model, age-structured	Optimization for a constant level of fishing effort. Used for analyzing the impact of different management scenarios on fisheries	Allow to analyze the effects of an MPA according to its size and to assess for how many years positive effects can overtake negative ones
	BioEconomic Analysis of Marine Protected Areas (BEAMPA)	Dynamic model, multi-specific and multi-activities (fishing activities and non extractive activities geared to recreation)	Designed to assess the effects of MPA, Tests hypotheses on stock mobility and fishing effort; the impact of protection measures on activities;

Description of the model				Difficulties and main input variables
Inter-species interactions	Spatialisation	Economic module	Fishers' behaviors module	
No	No	No	No	Average difficulty: should present the record of catch and fishing effort (fishing pressure)
No	No	No	No	Very costly observation and sampling system (catch by age, recruitment, selectivity by fishing...)
No	Yes	No	No	Requires many spatial -based data and end time steps (seasons) + on mobility of stocks
No	Yes	No	No	Requires campaigns on breeding areas / nurseries + a model of oceanic circulation covering the area of larvae drifting,...
Yes	No	No	No	Requires many samplings of stomach in order to calculate predation exercised on each prey by age class of predators.
Yes	No	No	No	Requires several parameters for each functional group (biomass, catch, consumption rate...)
Yes	No	No	No	Requires several parameters for each functional group
Yes	No	No	No	Requires many additional parameter with regard to Ecopath (adjustment of historic series,...)
Yes	Yes	No	No	Requires many data for each functional group (...+movement rate, trophic interactions, and preferential habitats,...)
Yes	Yes	No	Yes	Requires many data on populations(distribution, migrations, reproduction,...), fishing activity by sector (catch/species, gear,...), rules of management, spatial data
Yes	Yes	No	Yes	Requires many data by species (breeders, distribution by age class,...) and advance knowledge in modeling
Yes	Yes	Yes	Yes	Requires some cost items, ecological and spatial characteristics
Yes	Yes	Yes	Yes	Many data series in order to parameter and standarize the model :ecological, marine, socio-eco (costs, duration of outings ...)
No	Yes	Yes	Yes	Requires in-depth knowledge of today and past, tides by vessel and total effort, journey time, surface area of fishing zone, CA/day,...
No	No	Yes	No	Important quantitative and qualitative data: Applied to vivaneau US fishery of the Gulf of Mexico
Yes	Yes	Yes	No	Requires important quantitative and qualitative data: quality of ecosystem, fishing effort/species, touristic activities,... Applied to: AMP of Medes Isles

☞ Recommendations :

Meet prerequisites before developing a national or regional MPA cum Fisheries model at the national or regional level

It is not recommended to develop such a model at the level of a country or an MPA, given the situation of the SRFC and the different weaknesses mentioned in the countries in relation to the lack of local expertise and accurate empirical data.

Before implementing a model, it is necessary to:

- *Develop as a priority, the efforts on robust and regular monitoring systems, in particular in the sub-region. Monitoring mechanisms remain often insufficient to regularly feed models, which implies that:*
- *If modeling remains a chosen avenue, specify the objectives of the model which can be of three types :*
 - ✓ *Evaluate the impacts of MPAs on each of the stocks – mono-specific models;*
 - ✓ *Evaluate the ecological effects on a portion of MPAs – tropho-dynamic and ecosystem models ;*
 - ✓ *Evaluate the effects on fisheries economic performances – bio-economic models. The model should also take into account the feedback loops of the reserve-effect on spatial distribution of fishing effort, and notably on socio-economic variables (RUM model). The model should also enable to calculate the net economic effect of the MPA creation for the fisheries (positive effects due to the protection, reduction of the reserve opportunity cost to fishers, of the cost of surveillance and of possible indirect negative effects)*
- *Examine the conditions for constructing and running a bio-economic model:*
 - ✓ *Output should answer questions relating to the impact of MPAs on fishing;*
 - ✓ *Are data accessible at acceptable costs ? At this point, the reinforcement of the national and regional research infrastructure and the realization of important scientific activities (survey cruises) seems to be fundamental in order to answer the main questions that should provide the required data (mobility, benthos and food chain, catches and productivity by area, situation inside and outside the MPAs, etc.).*
- *Consider undertaking To envisage only experimental programs: It is possible to envisage developing a a research program at the level of the sub-region and within an the framework of international collaboration frameworks aiming at experimenting assessment and modeling of MPA geared to experimentation on the impacts on the ecosystem valuation and modeling of the functioning of MPAs on ecosystem by taking 1 or 2 MPAs with different characteristics and whose management already exists and is recognized (in priority a large MPA so as to have an impact on a fishing system).*



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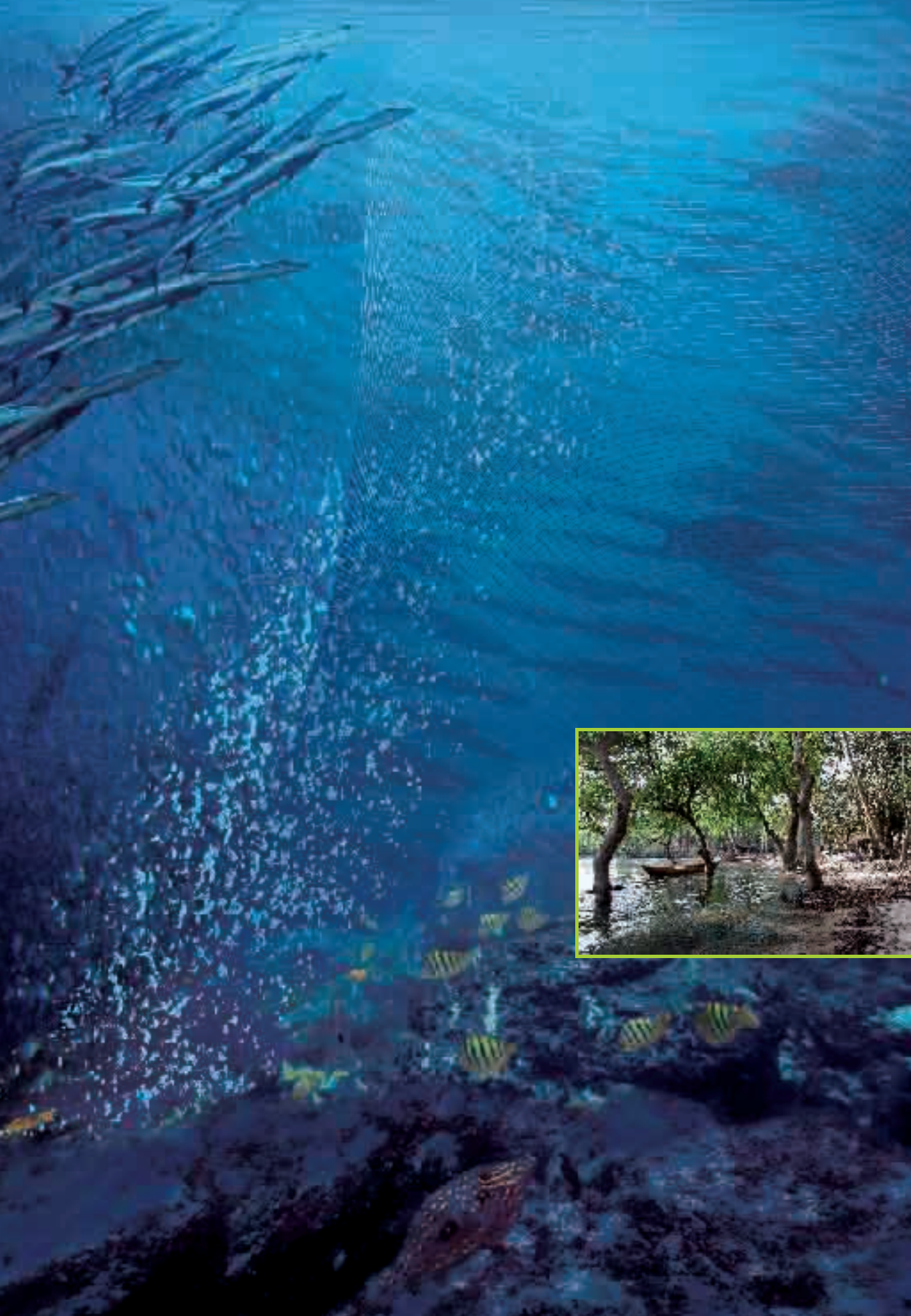
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Marine Protected Areas in fisheries MANAGEMENT

Synthesis on the State of the Art



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