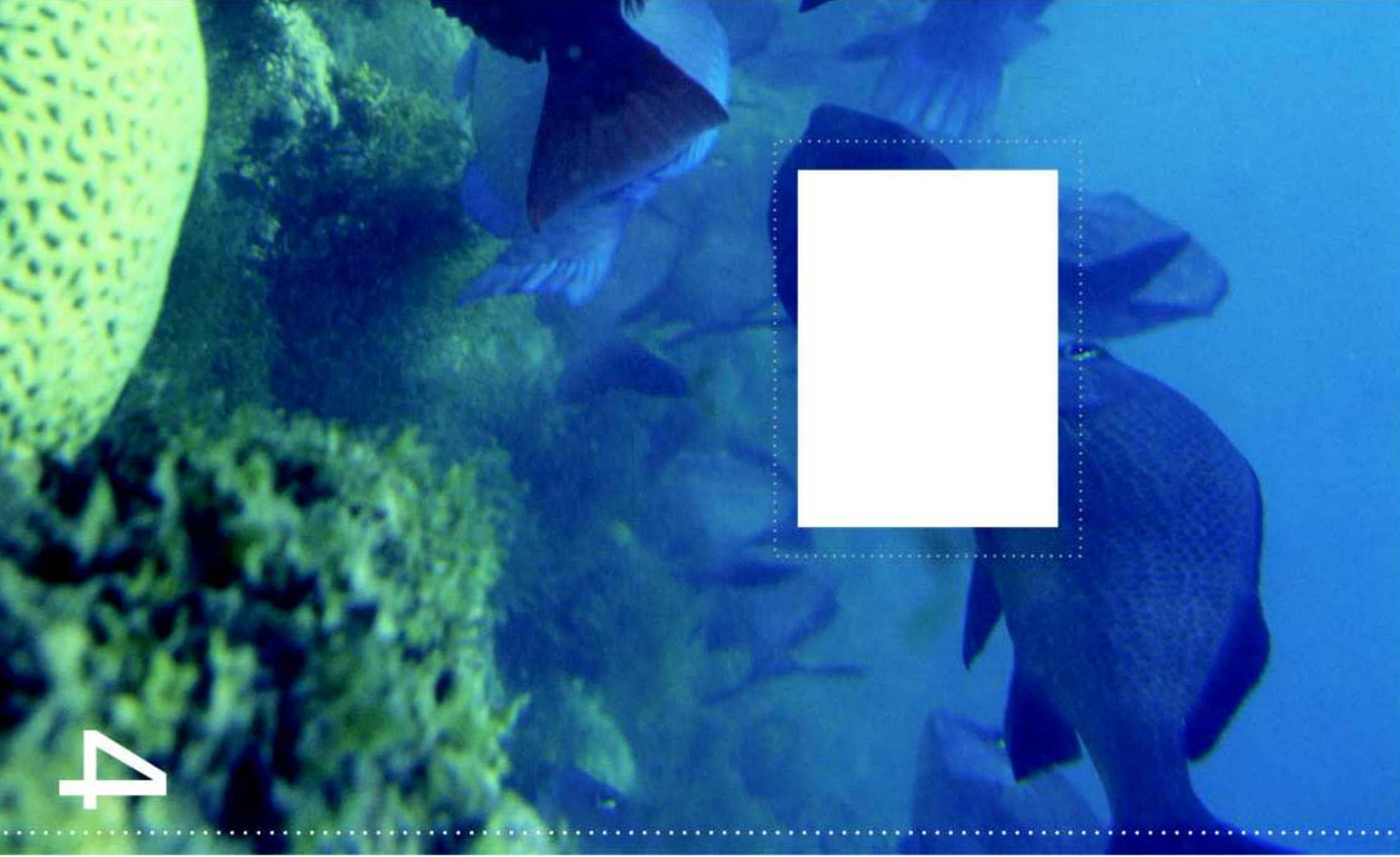


PROTECTED AREAS OF BRAZIL

Aquatic Protected Areas as Fisheries Management Tools

Brasília
2007

PROTECTED AREAS OF BRAZIL

Aquatic Protected Areas as Fisheries Management Tools

Protected Areas of Brazil Series, 4

Federative Republic of Brazil
President: Luiz Inácio Lula da Silva
Vice-President: José Alencar Gomes da Silva

Ministry of the Environment
Minister: Marina Silva
Executive Secretary: João Paulo Ribeiro Capobianco
Secretariat for Biodiversity and Forests
Secretary: Maria Cecília Wey de Brito

Marine and Coastal Zone Division
Coordinator: Ana Paula Leite Prates

Protected Areas Directorate
Director: Maurício Mercadante

Biodiversity Conservation Directorate
Director: Bráulio Sousa Dias
Fishery Resources Management
Manager: Roberto Gallucci

Brazilian Institute for the Environment and Renewable Natural Resources
President: Marcus Luiz Barroso Barros
Fauna and Fishery Resources Directorate
Director: Rômulo Fernandes Barreto Mello
Fishery Resources General Coordination
Coordinator: José Dias Neto
Floodplain Natural Resources Management Project
Coordinator: Mauro Luis Ruffino

Ministry of the Environment
Secretariat for Biodiversity and Forests
Marine and Coastal Zone Division

Aquatic Protected Areas as Fisheries Management Tools

Protected Areas of Brazil Series, 4

Brasília
2007

Protected Areas of Brazil Series, 4

Edition: Marine and Coastal Zone Division

Ana Flora Caminha (Graphic Design), Ana Paula Prates (Coordination), Ângela Ester Magalhães Duarte (Graphic Production), Danielle Blanc (Organization), João Luis Fernandino Ferreira, Maria Carolina Hazin, Mariana de Sá Viana e Paula Moraes Pereira.

Translation: Empório das Letras.

Catalogação na Fonte
Institute of the Environment and Renewable Natural Resources

A656 Aquatic protected areas as fisheries management tools / Ana Paula Prates, Danielle Blanc, organizers; Translation: Empório das Letras. – Brasília: MMA/SBF, 2007.
268p.: colored illust.; 29 cm. (Protected Areas of Brazil Series, 4)

Tradução de: Áreas aquáticas protegidas como instrumento de gestão pesqueira.
Bibliography.
ISBN 978-85-7738-082-4

1. Aquatic Areas. 2. Environmental Management. 3. Fishery Resources. I. Prates, Ana Paula. II. Blanc, Danielle. III. Ministry of the Environment. IV. Secretariat for Biodiversity and Forests. V. Marine and Coastal Zone Division. VI. Title. VII. Series.

CDU(2.ed.)502.742:567

Summary

Foreword

Foreword

Ministry of the Environment - MMA

During the 4th Brazilian Congress on Conservation Units, held in Curitiba, Paraná in October 2004, the Ministry of the Environment through its Protected Areas Directorate - DAP of the Biodiversity and Forests Secretariat - SBF launched the Series 'Protected Areas of Brazil'. The aim of the series is to register the results of studies and experiments, disseminate information, discuss ideas and in this way heighten the efficiency of actions related to the creation and implementation of Protected Areas.

In offering supporting elements for the discussions of the various government sectors and society at large around the theme of Protected Areas, the Ministry of the Environment hopes to contribute within its own sphere of action to transforming its directives - Strengthening the National Environment System - into reality.

The series "Protected Areas of Brazil" can already boast of three publications: "Knowledge and Social Representations of Conservation Units of the Delegates to the National Conference on the Environment", "Participative Management of the National Conservation Units System" and "Guidelines for Visitation in Conservation Units".

Continuing the series, the Biodiversity and Forests Secretariat jointly with the DAP and IBAMA's ProVárzea Project has organized the publication of another volume with articles seeking to make Brazilian experiences in the use of protected aquatic areas as an instrument for fisheries management widely known. The object of the present publication is to broaden and disseminate this new management concept and knowledge of such practices to other protected areas and related sectors.

There has been increasing dissemination of the concept that protected aquatic areas are essential to conserve the biodiversity of the oceans and the continental waters and allied to that, ever since the nineties, has been the idea that they are also essential for maintaining fishery productivity. Various authors and specialists have pointed out that establishing these protected areas is an excellent instrument for recuperating collapsed stocks or those considered to be threatened, serving as they do, as nursery areas and sources of individuals that emigrate to adjacent areas.

Such studies have already been incorporated in international directives and commitments as in the recommendations of the Durban Accord of the 5th World Parks Congress – IUCN/2003, in the recommendations of the Technical Group of Specialists in Marine and Coastal Protected Areas of the Convention on Biological Diversity, the recommendations of the 26th meeting of the FAO Fisheries Commission (Rome 2005), in the resolutions

of the 9th meeting of the Conference of the Parties on Internationally Important Wetlands – Ramsar Convention, (Uganda 2005) and internally, in the National Protected Areas Plan (Decree5.758/06). More recently, the process of updating priority areas for conservation, sustainable use and sharing of biodiversity benefits has incorporated the concept in its initial design for a representative system of marine and coastal protected areas (Decree 5.092/2004 and Ministry of the Environment Decree Nº 9/2007).

In Brazil's case, the vast extension of the coastline allied to a great diversity of ecosystems and species led to the idea of an inexhaustible potential for exploitation and consequently to the adoption of development policies with little or no concern for sustainability of the use of its resources. As a result, recent data have shown that although marine fisheries contribute over 63% of the total Brazilian fish production, 80% of the resources economically exploited are over-fished (REVIZEE data).

On the other hand, the socio-economic importance of fishing activities in Brazil is undeniable, not only as a supplier of animal protein for human consumption, but also in generating around 800,000 jobs in the marine areas alone making up a contingent of about 4 million people who depend directly or indirectly on the sector.

The Coastal and Marine Zone Division (Nucleus) began its debate on the importance of using marine and coastal conservation units and no-take (areas) zones as instruments for fisheries management to be intermediated by a variety of means. That approach is aimed at pooling the efforts of traditionally used instruments as well as introducing an ecosystemic vision into Brazilian fishing. Incorporating as it does, all other protected aquatic areas, this articulation extends to the implementation of the principles of the Ramsar Convention and the spreading of information on advances obtained in protected inland waters.

Outstanding among the challenges to be faced are those actions inherent to changing a paradigm like disseminating the concept, demonstrating case study evidence, implanting participative management of fishery resources, undertaking capacity building for technical staff and administrators, and convincing decision makers.

Furthermore, co-responsibility for running the conservation units shared with the fishermen and other social actors that depend on such areas is very important and to that end it is necessary that information, communication and above all, the organization of those segments should be efficient.

The Ministry of the Environment invited researchers and technical staff that work in this field to contribute to this publication by sending in their experiences and scientific papers and these have been incorporated in the present volume. Thus we have an initiative that brings together various

papers and articles some of which have already been published and others which are being published for the first time, in order to reveal Brazilian experiences in this field to the target public.

It is with much honor that we present volume 4 of the Protected Areas Series *Protected Aquatic Areas as Fisheries Management Tools*.

João Paulo Ribeiro Capobianco
Executive Secretary

Brazilian Institute for the Environment and the Natural Renewable Resources - IBAMA

The need for protecting the terrestrial environments is a widely acknowledged issue. Therefore, several categories of conservation units have been established.

The creation of protected area for aquatic environments is more recent and most of them aim at conserving the biodiversity of those environments, while trying to holdback the process of environmental degradation, and maintain the natural habitats.

The debate on the role played by protected areas as management tools is increasing in Brazil and abroad, as well. In Brazil, the theme is approached by academic institutions, entities belonging to the so-called third sector, fishermen's communities and specific governmental policies at the state and federal levels.

More recently, those areas have also been perceived as one of the managerial tools to the use of fishery resources, mainly at those sites with multi-specific fisheries, where the traditional management has not succeeded.

In that sense, IBAMA (Brazilian Institute for the Environment and the Natural Renewable Resources) has developed and expanded the social participation, by sharing both powers and responsibilities. That action is streamlined to the national and international directives, in an attempt towards establishing an area for protecting and safeguarding the aquatic biodiversity and its habitats, based on the principles and concepts defined in the Strategic National Plan on Protected Areas (Plano Estratégico Nacional de Áreas Protegidas - PNAP) prepared by the Brazilian Ministry of Environment.

For illustrative purposes, we could mention the Environmental Protection Area of Costa dos Corais, in Pernambuco and Alagoas, and the many Marine Extractive Reserves established along the coast; integral protection areas such as the Atol das Rocas Park, the Biological Reserve of Arvoredo and the National Park of Fernando de Noronha. These experiences have attained successful results in recovering and protecting the fishery stocks in those areas.

Additionally to the protected areas known as conservation units, IBAMA has been using another managerial tool, mainly in the Amazon region, employed by the Project on the Meadows' Natural Resources Management ProVárzea, which involves riparian communities, fishermen colonies and NGO's. That tool is widely known and governed as "Fishery Agreements".

Fishery agreements are, in fact, the formal setting up of the usage rules established by the fishery communities, in a process that started with the environmental conflicts dealing with the competition for the use of fishery resources in the Central Amazonia. Those conflicts ended up by generating a legal tool, the IBAMA Normative Rule 29/2002, which set the criteria for establishing such agreements.

This publication, which specifically approaches the Brazilian experiences in this theme, provides a systematic and critical assessment that should facilitate the understanding on the negative and positive aspects of using the protected aquatic areas in Brazil as a managerial tool for the sustainable use of fishery resources.

Rômulo José Fernandes Barreto Mello
Director of Fauna and Fishery Resources

National Plan for Protected Areas
Marine and Coastal Areas Context

Ana Paula Leite Prates[1]

The establishment of a representative and effective system of protected areas is part of a global strategy for biodiversity conservation, also being agreed as a goal to be reached by the signatory countries of the Biological Diversity Convention - BDC. The rough percentage of terrestrial protected areas corresponds to over 10% of the planet.

Only more recently has this strategy also been used for the marine environment. Of more than the 5,000 protected areas of the world, only 1,300 include marine and coastal components, corresponding to less than 1% of the oceans (WCPA/IUCN, 2003). This unbalance is due to several factors such as difficulties to access the marine environment, the notion that the marine environment is a community which is property to all, being available for exploration, and the idea that its resources are infinite (Salm & Clark, 1984; IUCN, 1995 e 1999).

According to decisions from the Seventh Ordinary Meeting of the Conference of the Parties (COP 7) to the Biological Diversity Convention, the Brazilian Government has undertaken the responsibility for the implementation of a National Plan for Coastal and Marine Protected Areas as part of the Working Programme of Protected Areas assumed by all parties. The main purpose of this Plan is to establish representative and effective terrestrial protected areas by 2010 and marine protected areas networks by 2012. This plan considers indigenous areas and quilombola lands. During the design of the National Plan for Protected Areas (NPPA) a group was formed to work on specific actions to coastal and marine areas, including the use of protected areas as a tool for fish management.The design of this plan took into account the contributions of all the actors such as stakeholders, non-governmental organizations, universities and research institutes from

[1] Fisheries Engineer, PhD. - Coordinator of the Marine and Coastal Zone Division – SBF/MMA.

different regions of the country[2]. The following premises have been agreed upon:

- The marine and coastal protected areas must be designed for biodiversity conservation and as fisheries management tools;

- The system must be representative;

- The final percentage of each coastal and marine ecosystem to be protected will be defined after the accomplishment of representativeness studies;

- The network design must include the pressure, threats and conflicts from the coast to the Exclusive Economic Zone, with a priority map.

The Representative Network is a protected area network with the components showed in Figure 1, as follows:

- The Representative network must be composed by: highly protected areas where extractive uses are prevented and other significant human pressures are removed (or at least minimised) to enable the integrity, structure, functioning and exchange processes of and between ecosystems to be maintained or recovered[3];

- An ancillary network of areas that supports the biodiversity objectives of the highly protected network, where specific perceived threats are managed in a sustainable manner for the purposes of biodiversity conservation and sustainable use;

- Sustainable management practices over the wider coastal and marine environment.

---

[2] Groups's Composition: Ana Paula Leite Prates (coordination – NZCM/SBF/MMA); Livia de Laia Loiola (NZCM/SBF/MMA); Maria Carolina Hazin (NZCM/SBF/MMA); Rogério H. Vereza de Azevedo (DAP/SBF/MMA); Roberto Ribas Gallucci (DCBio/SBF/MMA); Ricardo Castelli Vieira (GERCOM/SQA/MMA); José Luiz Jeveaux Pereira (GERCOM/SQA/MMA); Júlio Gonchorosky (CGFAU/DIFAP/IBAMA); Silvia Lucato (CGRPE/DIFAP/IBAMA); Adriana Carvalhal Fonseca (DIREC/IBAMA); Eduardo Godoy (DIREC/IBAMA); Gabriel Botelho Machioro (DIREC/IBAMA); Angela A. Roma Stoianoff (CNPT/IBAMA); José Arribamar de Carvalho (CNPT/IBAMA); Alexandre Cordeiro (SEAP); Vanessa Marcet Mancini (SEAP); Celso Moraes Peixoto Serra (SECIRM); Flávio Luiz Giacomazzi (SECIRM); Fernando Sérgio Nogueira de Araújo (Comando da Marinha/MD); Luiz Alberto Marins Nascimento (Comando da Marinha/MD); Guilherme Fraga Dutra (Conservação Internacional); Soraya Tupinamba Vanini (Instituto Terramar); Bruno Gueiros (CNPT/IBAMA-MA); Beatrice Padovani Ferreira (UFPE); Roberto Sforza (TAMAR/IBAMA), Monica Brick Peres (CEPERG/IBAMA e Instituto Igaré) and Luis Henrique de Lima (consultant).

[3] According to the recommendations of the working group, this primary network must reach at least 20% to 30% of each marine and coastal ecosystem. These areas must be replicated and distributed according to biogeography criterion. Besides that, this objective will be reached in stages (such as 10% by 2008 and 20% to 30% by 2012).

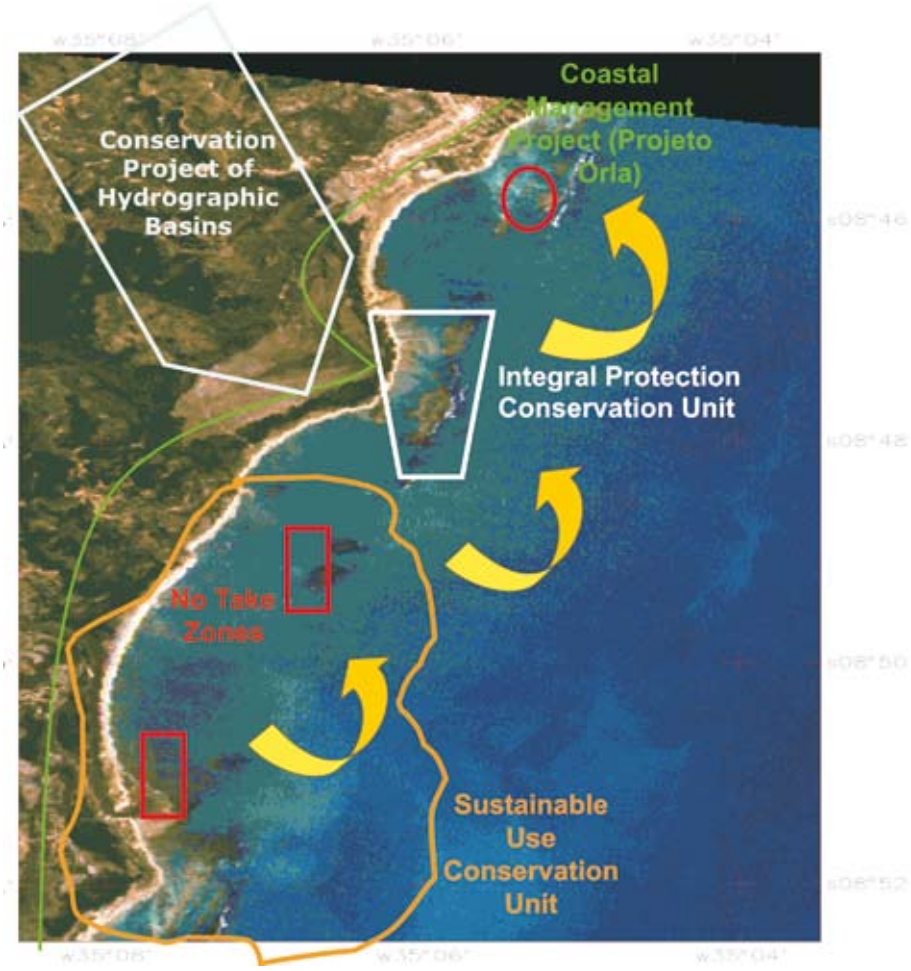


Figure 1 - Hypothetical Representation of a network of marine and coastal protected areas.

The principles and directives of the Brazilian National Plan were recognized by Decree n° 5758, of 04/13/2004 and showed the intention of joining biodiversity conservation and socio-economic demands, and the awareness that reaching sustainable development is crucial to establish conservation mechanisms.

Besides those principles, the Plan contained the strategies to reach an effective system of protected areas.

The dissemination of the concept that marine protected areas are essential to conserve the biodiversity of the oceans has been increasing, since the 1990s, together with the idea that it also serves to keep productivity, especially of supplies of fisheries stocks. Several authors agree that the establishment of marine reserves can help the recovery of collapsed or threatened supplies, serving as nurseries and exportation sources of mature individuals to the adjacent areas (Roberts & Polunin, 1993; Roberts, 1997; Russ, 1996; Ballantine, 1996; Bohnsack, 1998, 2000; Lubchenco, 2003; Ferreira, 2001).

In the case of Brazil, the size of the coastal zone and the large ecosystem and species diversity produce a false idea of an inexhaustible exploitation potential, causing the adoption of development policies that are not concerned about the sustainable use of the resources. As a result, recent data show that despite the 63% contribution of the Brazilian fishery total production, 80% of the resources are under-exploited (MMA/REVIZEE, 2006).

However, the socio-economic importance of the fishery activity in Brazil is undeniable, not only for animal protein production, but also for the job market, creating more than 800.000 jobs for 4 million people who directly or indirectly depend on the sector.

This situation is not different from the rest of the world and, because of that, the *American Association for the Advancement of Science* recommended that 20% of the seas, by the year 2020, must be declared no take zones. This recommendation was ratified by the Durban Agreement - V World Park Congress – IUCN/2003 and in the recommendations of the "*Technical Advice on the Establishment and Management of a National System of Marine and Coastal Protected Areas*". (CBD, 2004).

The reports and diagnoses produced for the Assessment and Priority Actions for the Conservation of Biodiversity on the Marine and Coastal Zone Workshop that took place in 1999 confirmed the situation of the main impacts and indicate recommendations related to the necessity of establishing no take zones as a tool of recuperation and conservation of fishery stocks (MMA, 2002). The revision of these areas show that, in a total of 102 marine protected areas, 31 areas show the indication of no take zones or creation of a protected area. (MMA, 2007, in print).

In the Brazilian costal zone, the protected areas represent a good portion of the national territory, but in the marine part (summing the territorial sea and the economic exclusive zone) less than 0,4% of the area is under some kind of protection (Prates & Pereira, 2000 updated by the National Protected Area Registration – Brazilian Environment Ministry).

Even with low representativeness, it is possible to point case studies where measures of fish management inside sustainable use, or in the boundaries of integral protected areas, are showing local possibilities of using this tool. In the same way, the protected areas established in continental waters show that the share management of the fisheries resources could be potentialized when accomplished in a way of planning management and consequently the areas "reservation".

It was with this intention that the 4th volume of the Brazilian Protected Areas Series *Aquatic Protected Areas as Fisheries Management Tools* was released.

In the scope of the NPPA, it is important to emphasize another strategy, already completed, related to the indication of the propitious areas to the creation of new protected areas. Brazil has identified Priority Areas for the conservation, sustainable use and benefit sharing of the Brazilian Biological Diversity and recently concluded the revision and updating process of these areas as one of the objectives of designing a protected area system to the different Brazilian biomass, including the marine and costal zone.

506 priority areas were indicated as coastal zones (each one with interfaces with the continental biomass) and 102 in the marine zone, where, for the first time, the country manages the Exclusive Economic Zone using the conservation, sustainable use and benefit sharing of the marine and coastal zone biodiversity as a premise (Figure 2 - next page). It is important to say that, in a large number of these areas, fisheries management were indicated, and also the creation of no take zones. These areas were recognized by Decree n° 5.092, of 03/21/2004 and MMA Official Document n° 09, of 01/22/2007. They are available at the website : www.mma.gov.br/portalbio.

Thus, in Brazil, the application of the concept of aquatic protected areas to protect specific habitats for larvea and young fish pledge the recruitment and stock maintenance. It was incorporated in the governmental speech by means of principles and directives of NPPA, as well as in the indication of priority areas. For now the challenge is implementing the creation and effectiveness of these areas.

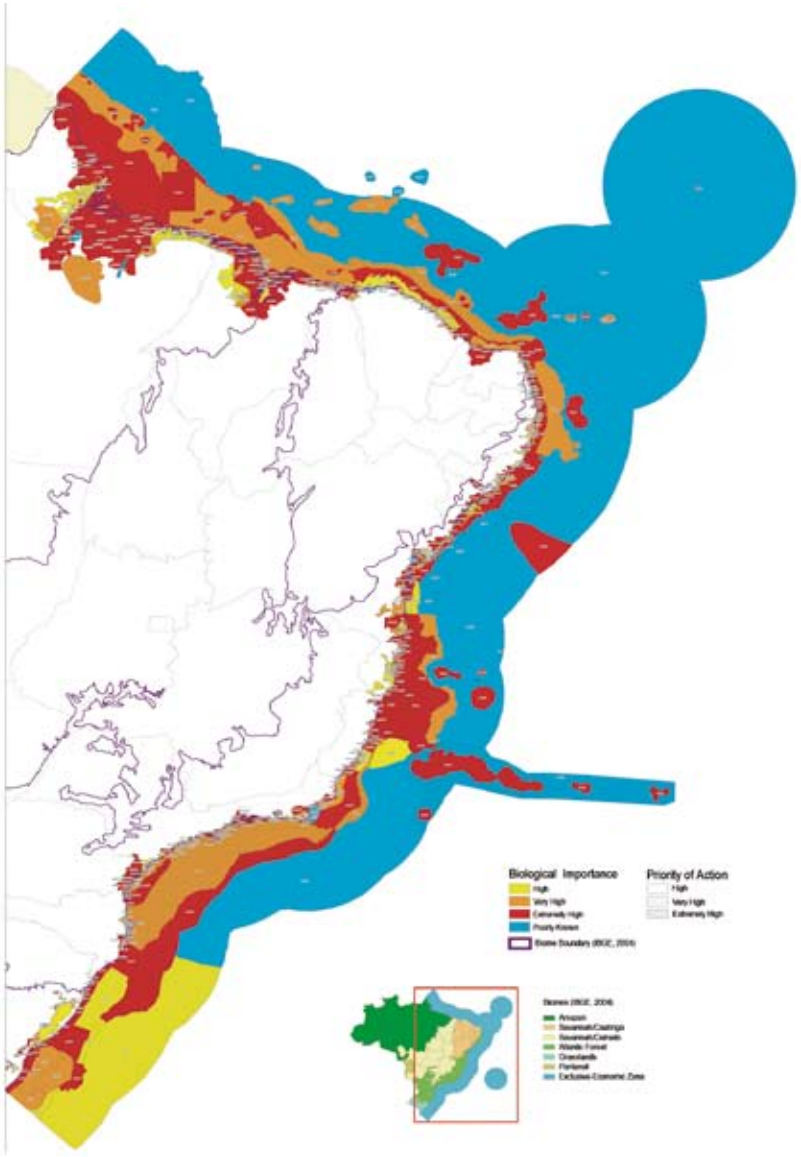


Figure 2 - Map of priority areas for the conservation, sustainable use and benefit sharing of marine and coastal zones.

References

BALLANTINE, W. J. 1996. **"No-take" Marine Reserves Networks. Support Fisheries.** In: 2nd World Fisheries Congress. p. 702-706.

BOHNSACK, J. A. 1998. **Marine reserves, zoning and the future of fisheries management.** Fisheries, 21(9)14-16.

BRASIL – Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal. 1997. **Diretrizes Ambientais para o Setor Pesqueiro. Diagnóstico e Diretrizes para a Pesca marítima.** Brasília,DF.124 p.

CBD – Convention on Biological Diversity. 2004. **Technical Advice on the Establishment and Management of a National System of Marine and Coastal Protected Areas.** CBD Technical Series no.13, 40 pg.

FERREIRA, B. P. & MAIDA, M. 2001. **Fishing and the future of Brazil's Northeastern reefs.** InterCoast 38:22-3.

IUCN. 1995. **The global representative system of marine protected areas.** Vol. II. Wider Caribbean, West Africa and South Atlantic. The World Bank, IUCN, Washington DC. 93pp.

IUCN. 1999. **Guidelines for Marine Protected Areas.** Best Practice Protected Area Guideline Series nº 3. 107p.

LUBCHENCO, J.; PALUMBI, S. R.; GAINES, S. D & ANDELMAN, S. 2003. **Plugging the hole in the ocean: the emerging science of marine reserves.** Ecological Application, supplement. 13(1): S3-S7.

MMA – Ministério do Meio Ambiente. 2002. **Avaliação e ações prioritárias para a conservação da biodiversidade das zonas costeira e marinha.** Fundação Bio-RIO, SECTAM, IDEMA, SNE, Brasília. 72pp.

MMA – Ministério do Meio Ambiente. 2006. **Programa REVIZEE: avaliação do potencial sustentável de recursos vivos na zona econômica exclusiva: relatório executivo/ MMA, Secretaria de Qualidade Ambiental.** Brasília: MMA,2006.

MMA – Ministério do Meio Ambiente. 2007(no prelo). **Sumário Executivo das Áreas Prioritárias para a Conservação, Utilização Sustentável e Repartição de Benefícios da Biodiversidade Brasileira.**

PRATES, A.P e PEREIRA, P.M. 2000. **Representatividade das Unidades de Conservação Costeiras e marinhas: Análise e Sugestões.** In: II Congresso Brasileiro de Unidades de Conservação, 2000, Campo Grande. Anais II Congresso Brasileiro de Unidades de Conservação. Curitiba : Rede Nacional Pró-Unidades de Conservação/Fundação O Boticário de Proteção à Natureza, 2000. v. 2. p. 784-793.

ROBERTS, C. M. 1997. **Ecological Advice for the Global Fisheries Crisis.** TREE. V.12, n.1, jan.

ROBERTS, C. M. and POLUNIN, N. V. C. 1993. **Marine Reserves: Simples Solutions to Managing Complex Fisheries?** AMBIO. v. 22, n. 6, set.

RUSS, G. R. 1996. **Fisheries management. What chance on coral reefs?** NAGA. The ICLARM Quarterly, Jul: 5-9.

SALM R. V., CLARK, J. R. & SIIRILA, E. 2000. **Marine and coastal protected areas: a guide for planners and managers.** 3rd Ed. IUCN. Washington D. C. 371pp.

WCPA/IUCN. 2003. World Parks Congress. 2003. Durban. **Benefits Beyond Boundaries.** CD-Rom.

Coastal and Marine Sustainable Use Protected Areas as Tools for Fisheries Management[1]

Ana Paula Leite Prates[2]
Alexandre Zananiri Cordeiro[3]
Beatrice Padovani Ferreira[4]
Mauro Maida[5]

Abstract

The establishment of a representative system of protected areas is an important part of the global strategy for the conservation of biodiversity. Marine Protected Areas are essential to conserve the oceans' biodiversity and to maintain the productivity of fishery resources. This paper discusses coastal and marine protected areas as important tools for fisheries management, using two experiences in Brazil.

Introduction

The need to protect terrestrial environments has been recognized all over the world and as a consequence many kinds of protected areas have been created. Among the 4,500 protected areas in the world only 850 have included coastal and marine components. This unbalance has occurred due to several factors: the inaccessibility of marine environments prior to 1950; the prevalent feeling that the marine environment is common property, open to exploitation and that its resources are unlimited (McNeill,1994; Agardy,1994, *apud* Pereira, 1999).

In the case of Brazil, the size of its coast line, plus the huge diversity of species has created the false idea of an infinite potential for exploitation that has consequently led to the adoption of development policies which have little or no commitment to sustainability (Brazil, 1997). There is no doubt about the socio-economic importance of fishing in Brazil, not only as a source of protein, but also for the maintenance of 800,000 jobs involving a total of around 4 million people who depend on the activity, directly or indirectly (Brazil, 1997).

---

[1] Article published in "Procedings from the II Brazilian Congress on Protected Areas"/ Campo Grande/MS - November 5 - 9, 2000. V. II. p. 544-553

[2] Fisheries Engineer, Dr. (UnB). Ministry of the Environment. ana-paula.prates@mma.gov.br

[3] Agronomist. National Center of Traditional Peoples - CNPT/IBAMA

[4] Biologist, PhD (Australia). Federal University of Pernambuco

[5] Oceanographer, PhD (Australia). Federal University of Pernambuco

The result is that nowadays, although marine fisheries contribute 63% of the total Brazilian production of fish, 80% of Brazilian marine fishery resources are overexploited (Brazil, 1997).

This does not only happen in Brazil. A great number of measures would be needed to protect marine fishery zones from over-fishing and to ensure sustainability for future fishing activites. These would include the establishing of fishing limits, changes in catching methods, reduction of waste, aquaculture expansion and the creation of marine protected areas (CMIO, 1998).

Due to their vital importance in the reproductive cycle of certain migratory/ threatened species, many coastal and marine habitats have merited special protection in many countries, which is particularly important when it is hoped that species presently threatened may come to increase their numbers and their areas of distribution thereby serving the protected areas as valuable genoplasm banks for the process of reconstituting populations (Salm e Clark, 1984).

The establishment of protected areas (PA) or conservation units is one of the most fundamental instrument for biological conservation and at the same time seeks to retard the process of environmental degradation. Brazil presents a relatively extensive system of protected areas whereby 8% of its territory is registered under some category of protection (MMA, 1998).

In regard to the coastal and marine zones, we can say that establishing protected areas has been a recent fact with the majority's having been created with the aim of conserving biodiversity and maintaining habitats. Recently, such areas have been seen as a tool for managing fisheries, especially in areas where they are multispecific and conventional methods are ineffective (Roberts e Polunin, 1991). Many authors suggest that the establishment of marine protected areas can help to recuperate threatened stocks and serve as nursery areas and sources of individuals for exportation (Roberts, 1997; Russ, 1996 and Ballantine, 1996).

The *American Association for the Advancement of Science* has recommended that 20% of all seas need to be declared no-take zones by the year 2020. Recently the World Wildlife Fund – WWF gave priority to the establishment of such areas within the Endangered Seas Programme and in England, the National Federation of Fishermen's Organizations has included permanent no-take zones as one of the measures to be adopted to ensure the sustainability of the British Fishing Industry (Mills and Carlton, 1998 and Roberts, 1997).

The IUCN (1995 and 1999) recognizes that protected areas are essential to conserve the biodiversity of the oceans and to maintain their productivity, especially that of the fish stocks. At present, there are very few marine protected areas in the whole world and even fewer have any kind of effective management.

In Brazil the idea of applying the concept of marine reserves to specific habitats to protect larvae and juveniles thereby ensuring stock recruitment and maintenance has only recently been incorporated into governmental thinking (CIRM, 1999).

The reports and diagnoses made for the workshop "Evaluation and Prority Actions for Conserving Biodiversity of the Coastal and Marine Zones" of the Ministry of the Environment's PROBIO project confirm the situation of major impacts and define 164 priority areas for biodiversity conservation in the coastal and marine zones. Specifically in regard to conservation units, 128 areas have been designated, including everything from the creating of new conservation units, to the expansion, re-classification and implementation of already created units (PROBIO, 1999). The outstanding recommendation however, made by the various specialists present at the event, was on the need to establish no-take zones as a mechanism for recuperating and conserving fishery stocks.

Different management categories have arisen in accordance with new studies and alternatives for natural resource conservation. Nowadays, the Brazilian National Conservation Units System (SNUC in Portuguese), instituted by Law n° 9.985/2000, gathers all categories into two major groups: those suitable for direct use of their resources and those for indirect use. Those that come under full protection, or indirect use are aimed at protecting fragments of natural ecosystems from any human interference and in those suitable for sustainable use, or direct use, the exploitation of their resources is permitted (Brasil, 2000).

In the coastal and marine zones, the protected areas for sustainable use represent a significant part of the total. In spite of there being lower numbers of them, federal units have a bigger area under their protection: 46 Federal PA's, with 26 of them being under full protection, total area 1,224,506 ha and 20 of sustainable use, with a total of 1,641,229 ha (Pereira, 1999, updated by MMA, 2000).

This paper sets out to analyze two protected areas of sustainable use as examples of possibilities in the management of fishery resources.

Methodology

Two categories of protected area were selected for analysis: a RESEX[6] (Extractivist Reserve) and a APA[7] (Environmental Protection Area): the Marine Extractive Reserve of Arraial do Cabo and the Environmental Protection Area of Costa dos Corais.

Marine Extractive Reserve of Arraial do Cabo

The Cabo Frio region encompasses the municipalities of Arraial do Cabo and Cabo Frio in the State of Rio de Janeiro. It is part of the region known as "Região dos Lagos" (Lakes region) which is flat with some low elevations and sand dunes near the coast which is predominantly formed by large oceanic beaches interrupted by rocky shorelines. There are islands and small to medium length sand beaches and the region has two lagoon systems of great importance, Saquarema and Araruama, and some almost untouched spitland vegetation known as Restinga da Massambaba. The rocky cliffs have endemic, rare xeromorphic vegetation related to Atlantic Forest formations. The region is the only one along the entire Brazilian coast benefited by the phenomenon of upwelling characterized by the surging upwards of cold waters of polar origin bearing large quantities of nutrients and responsible for the incredible transparency of the region's waters and the area's great abundance of fish.

The Marine Extractivist Reserve of Arraial do Cabo was created on January 3 1997, at the request of the local community in an area where fishing has been done for centuries and the upwelling phenomenon helps to minimize the unpredictability of the different kinds of fishing carried out in the region. The Reserve has an area of around 56,769 ha of water surface and is located along the Arraial do Cabo coast line, stretching from Massambaba to Pontal beach, near to the boundary with the municipality of Cabo Frio.

Inside the RESEX, only Arraial do Cabo's traditional local fishing boats are allowed to fish. The Plan for Use was published in 1999[8] with the objective of "guaranteeing the sustainability of the reserve through the regulating of natural resource exploitation and determining the procedures to be followed by the extractive community in regard to technical and legal conditions for

---

[6] Extractivist Reserve (RESEX) is an area used by traditional extractivist populations, whose subsistence is based on the extractivism and, complementarily, in the subsistence agriculture and the raising of small animals, and its basic objectives are to protect the ways of life and the culture of these populations, and to ensure the sustainable use of the natural resources of the unit. (Art. 18. of the Law nº 9,985, dated July 18 2000 - SNUC).

[7] Environmental Protection Area (APA), in general, is an extensive area, with a certain degree of human occupation, with no-biological, biological, aesthetic and/or cultural attributes especially important for the quality of life and well-being of the human populations, and has as basic objectives to protect the biological diversity, to discipline the occupation process and to assure the sustainability of the use of the natural resources. (Art. 15 of the Law nº 9,985, 18 of July of 2000 - SNUC).

[8] Portaria IBAMA nº 17-N, de 18/02/99 (legal instrument).

the rational exploitation of marine resources, and the tourism and leisure activities of other users".

Environmental Protected Area of Costa dos Corais

The Environmental Protection Area of Costa dos Corais was created by Federal Decree on October 23rd 1997. It is located along the south coast of Pernambuco state (PE) and the north coast of Alagoas state (AL) extending from the municipality of Tamandaré in the south of Pernambuco, to the municipality of Paripueira in the north of Alagoas, and from a line 33 meters inland from the high tide mark to 18 miles out to sea and takes in the continental shelf as far as the edge of the continental slope. It encompasses an area of around 413,563 ha and is the first federal conservation unit to have included coastal reefs and also Brazil's largest marine protected area (see Ferreira et al., in this congress).

The presence of coral reefs is the region's main characteristic and they support a great diversity of forms of life represented by algae, coral polyps, fish, crustaceans, mollusks and others, including the manatee (*Trichechus manatus*), a mammal under threat of extinction. In association with the mangrove, the reefs offer the main support for the maintenance of traditional fishing activities.

As a result of the joint efforts of several institutions Oceanography Department/UFPE, CEPENE/IBAMA, Centro Peixe-Boi (Manatee Center), IBAMA offices in the states of Pernambuco and Alagoas and ten local city halls, in February of 1998 the project "Initiative for the Integrated Management of Coastal Reef Systems between Tamandaré and Paripueira" or simply "Coastal Reefs Project" was initiated, managed by Fundação Mamíferos Marinhos (Marine Mammals Foundation) and financed by the Inter-American Development Bank.

One of the project's main objectives is to provide a scientific basis and technical support for the elaboration of the Environmental Protection Area of Costa dos Corais a Management Plan. The activities foreseen in the elaboration of the project are divided into three components: 1) Elaboration and implementation of the Inter-institutional work frame for studying the formation of the Marine Protected Area Management Committee; 2) Elaboration of the Environmental Protected Area Management Plan including studies designed to offer supporting elements for the elaboration itself such as biophysical surveys, studies and surveys on traditional and commercial fishing and the carrying out of demonstration experiments in zoning management, recovery of degraded areas and the re-introduction of manatees in the PA and 3) Community Training and Environmental Education.

Evaluation and Results

Within the sphere of the Interministerial Commission for Marine Resources, the theme of Protected Areas (or conservation units) was mentioned for the first time in the preparatory documents for the 5th Sectorial Plan for Marine Resources-PRSM covering the period 1999 to 2003. The plan set out the following action strategies: 1) an analysis of the ecological representativity of the set of protected areas in regard to the ecosystems and macroprocesses existing in the marine and coastal zones; 2) use of the PA's as privileged points for developing an Environment Monitoring Network and for experiments which demand protection from direct anthropic actions; 3) utilization of the sustainable use categories, mainly APA's and RESEX's for pilot-experiences in fishery management and 4) improved exploitation in PA's as core points for dissemination of conservation concepts, sustainable use of natural resources, environmental education and awareness and a "maritime mentality".

As they are mostly terrestrial, the majority of the Brazilian PA's is made up of private areas. In such territories control is only exercised over activities, with a view to minimizing impacts that might affect important aspects of their ecosystems. Because of these characteristics, the process of implantation and management of an APA is quite complex as it involves various considerations which are often in direct conflict with one another (Herrmann, 1999, *apud* Pereira, 1999).

Due to these characteristics, the APA's are susceptible to all kinds of use demanded of them by human beings. According to Corte (1997, *apud* Pereira, 1999), "one of the difficulties in making APA's feasible or effective is the excess of restrictions imposed on private properties by environmental legislation that ends up hampering attempts to strike a balance between social-economic objectives and ecological ones". On the other hand, according to Soler, 2000, with the establishment of the APA's, innumerable possibilities for the emergence and promotion of economic activities are created, mainly those related to tourism, leisure and to historic and cultural heritages.

In the case of the Marine APA's, the aforementioned difficulties are diluted because they are not private areas but rather areas of "common-pool property"[9]. On the other hand, with many possible activities making use of such assets, there is the need for an integrated and ecosystemic management of these activities that would allow for the conciliation of traditional activities like fishing and both seasonal and off-season tourism.

---

[9] The Federal Constitution sets out in the terms of Article 20, some assets of the Union considered common-pool assets for public use: "... IV -... the maritime beaches, the oceanic islands and the coastal ones, excluded those pertaining to States (cities and others); V - the natural resources of the continental shelf and the exclusive economic zone; VI - the territorial waters; VII - the 33m strip of shore above the high tide line attributed to the navy.

In the case of the Environmental Protected Area of Costa dos Corais (APA Costa dos Corais), the first steps in regard to area zoning have been the identification of two no-take zones in order to propitiate the recovery of biodiversity and fishing potential of the PA as a whole. Accordingly, the areas have been delimited, through an IBAMA decree'[10] (a legal instrument), with the prohibition for a period of three years of "all types of fishing, nautical and tourism activities, visitation and with only scientific studies and monitoring done by teams duly authorized by IBAMA being allowed in the selected areas".

Some problems inherent to inspection and surveillance have cropped up. However, with the closing of the areas, local fishermen can already perceive some positive results. According to preliminary data (see Ferreira, *et al*. in this congress), in just one year, fishery resources of commercial importance have increased their populations in the closed areas as compared to adjacent areas open to fishing. The results corroborate the theory that the environments are capable of recovering and, consequently, the idea of keeping the areas closed for collective benefit is increasingly shared by the local population.

In 1989, the RESEX modality was created with the characteristic of sheltering social groups that depend on the exploration of a determined natural resource for their survival (ELI, 1995). In the marine area there are three reserves: one in Santa Catarina – Pirajubaé, one in Rio de Janeiro - Arraial do Cabo and, more recently, one in Bahia – Iguape Bay and several studies are underway for the creation of others[11].

The Extractivist Reserves (RESEX) have been established in Brazil since the 90's as an instrument for promoting compatibility between land settlement issues and the specific system of access to and use of natural resources of the rubber tappers as a part of the struggle for agrarian reform and as a way of settling land tenure conflicts in the context of the natural rubber tapping areas. Thus they are noted for their recognition of the peasant modality of appropriation of natural resources that combines agriculture and extractivism (Almeida, 1994). The RESEXs are based on the notion of the effective right to use[12] and their purpose is to lend support to self-sustaining exploitation and conservation of renewable resources, by extractivist populations[13]. Bound up as they are, with the idea of sustainable development, not only do the RESEXs seek to preserve the environment, but the local populations also use their traditional processes of production which are not harmful to nature (Murrieta & Rueda, 1995).

---

[10] IBAMA Decree nº 14-N, dated February 11 1999 (legal instrument).

[11] Added note (2007): since the publication of this paper, 16 new coastal and marine resex were created, summing up, currently, to 19 RESEXs.

[12] Art. 7 Law-Decree 271, 28/02/67

[13] Art. 1 Federal Decree 98.987/90.

In this context, the marine RESEXs are areas where the National Center of Traditional Populations – CNPT/IBAMA, through presidential decree[14] can allocate the right to exploit fishery resources of certain marine areas to populations that continue to fish using traditional processes, to guarantee their development and the improvement of environmental conditions in the interior of these RESEXs.

In its annual report for 1996, FAO (*apud* Kant, 1989) recommends the implantation of this form of natural resource use, not only for its local results, but for the potential that it represents for ecosystems with a worldwide outreach, particularly in marine environments.

Implementing marine RESEXs is related to empowerment of populations of traditional fishermen. This is why, unlike the case of APA's, in RESEX, the govern concede the use of Union public land to a population group, hence the state is here supporting an entirely new process of constitution of public spaces and elaboration and application of rules for such use. To that end, the fishermen are led to elaborate, in assembly, the rules to be applied for the use of resources which then become obligatory for all, including the rest of the population, after having been published in the Official Gazette. They are in fact local rules but with federal authority which are thereby equally applicable to all, in contrast to legal tradition whereby general rules are first elaborated and then later particularized according to each case (Kant, 1998; Brito, 1998).

In the case of the Arraial do Cabo Marine RESEX, the marine resource management tools, which stem from of the implementation of the plan of use, with clear ethnographic contents in the elaboration of norms and administration of inherent conflicts, show themselves to be potentially rich in offering supporting elements that clarify and guide the formulation of new experiences directed towards the protection of the environment.

After the first year of the plan of use's implementation, important changes were observed in some types of fishing activities, such as an increase in the catches of commercial species, like squid, octopus and of fish shoals (mullet, gray mackerel and common jack). It is believed that this improvement is related to the reduction of trawling activities and a reduction in the catching of live bait by tuna boats which are forbidden by law to carry out this activity inside the RESEX area (Fábio Fabiano, personal.comment.[15]).

The management carried out by the traditional fishermen of the region of Arraial do Cabo includes meetings for each fishing category to discuss

---

[14] The RESEX belongs to the public domain, with the right to use granted to the traditional extractivist populations according the Article 23 of that law and in specific regulations, whereby private proprietors within the enclosed areas must be dispossessed in accordance with terms set out in the law (paragraph 1 of Art. 18. of Law nº 9,985, dated July 18 2000 - SNUC).

[15] Added note (2007): RESEX manager of Arraial do Cabo RESEX– RJ (1997- 2002).

specific subjects as, for example, the introduction of improved technology in the case of using battery-powered lamps in fishing for squid, and the establishment of the areas of integral protection defined in the zoning done together with the fishermen, like the Pedra Vermelha/Maramutá areas. The implementation of these decisions does not occur without conflicts, mainly in regard to the various other users like the amateur divers who are frequently caught diving in the closed area, or in other areas that hamper traditional fishing activities, or sportsmen that ride their jet-skis into forbidden areas, all of which call for considerable efforts of vigilance and supervision.

Some problems have been encountered whenever the question of the "ownership" of the area is mentioned, which leads to conflict with other users of the unit and neighboring fishermen. These conflicts are consequences of the application of norms and regulations inherent to fishing activities that restrict the numbers of fishermen with the aim of easing the pressure on stocks and furthermore, favor fishing to the detriment of the other activities.

In short, the biggest problems are related to the invasion of industrial trawlers to catch live bait for their tuna fishing, the real-estate pressure on the surrounding areas and the sluggishness of the process for transferring proprietorship over assets.

These problems are further aggravated by the lack of interinstitutional cooperation among some of the agencies responsible for licensing, inspecting and training processes in the three spheres of government. The agencies rarely act together in finding a solution for conflicts.

Conclusions and Recommendations

According to CIRM (1999) "capacity to measure, study, sytematically observe and evaluate biological diversity needs to be strengthened on a national and international scale. This being so, efficacious national actions need to be adopted and interinstitutional cooperation needs to be established for the protection of ecosystems and the conservation of biological and genetic resources. The participation and the support of local communities are essential elements for the success of such actions". This passage demonstrates, once more, the importance for the marine environment of establishing protected areas of sustainable use.

These new management tools engaged in the establishment of coastal and marine protected areas have come to fill the gaps left by government in the implementation of its policies on fisheries management and the social development of populations of small scale fishermen. This gap is an opportunity to heighten awareness of such populations in regard to actions of organizational development and their participation in the actions of control over the natural resources on which they depend, reflecting the need for public policies directed at these segments.

The participation of fishermen and all stakeholders who depend on those areas in the management of the MPAs, is very important and for this it is necessary that information, communication and, especially the organization of these segments be efficient.

The Management Council is a mechanism used in the administration of Federal APAs, in the same way as as the Deliberative Councils are used in the RESEX, and this makes possible the public representation of many segments of civil society, agencies, research institutions and companies, in elaborating, planning and acting in the management of the area and they should be increasingly made use of.

Given the positive results of the recent experiences with fishery management in the Arraial do Cabo RESEX and in the Costa dos Corais APA, it can be seen that the establishment of zoning with the identification of no-take zones, is one of the main instruments for the recovery of fish stocks and to ensure the sustainability of fishing activities. Thus the recommendations set out above should be reiterated in regard to the establishing of no-take areas that can serve as ecological corridors[16].

The units for sustainable use, especialy the marine ones must have their dominion conceded by the Union to the managing body so that the mangement measures may enjoy proper legal support. The majority of these areas are territorial waters so that the costs of disappropriation are practically nil. Therefore it suggested that the legal documents creating them should include in their texts clear mention of the abovementioned concession. This measure would greatly facilitate the implementation of such conservation units.

Another conclusion that we can draw concerns the possibility of incrementing the "mosaics" of protected areas which could come to compose interesting situations with combinations of protected areas enjoying integral protection with those of sustainable use and their respective no-take zones.

Moreover, it is recommended that other categories of protected areas be experimented with in regard to the management of the fishery resources such as sustainable development reserves and fauna reserves.

[16] Ecological corridors "make gene flow and the movement of fauna and flora possible, facilitating the dispersion of species and the recolonization of degraded areas, as well as the maintenance of populations that demand, for their own survival, areas with bigger extensions than those of the individual conservation units". (sub-heading XIX of Article 2 of Law nº 9,985, dated July 18 2000 - SNUC)

Photo: Manoel Veiga

Maragogi - Alagoas State

Photo: Manoel Veiga

Maragogi - Alagoas State

Photo: Manoel Veiga

Maragogi - Alagoas State

References

ALMEIDA, A. W. B. de, 1994. **Carajás: A guerra dos mapas.** Belém, PA. Ed. Falangola.

BALLANTINE, W. J. 1996. "No-take" Marine Reserves Networks. Support Fisheries. In: **2nd World Fisheries Congress.** p. 702-706

BRASIL. 2000. **Lei Nº 9.985, de 18 de Julho de 2000**, institui o Sistema Nacional de Unidades de Conservação - SNUC.

BRASIL - Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal. 1998. **Primeiro Relatório Nacional para a Convenção sobre Diversidade Biológica – Brasil.** Brasília, DF.

BRASIL, Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal. 1997. **Diretrizes Ambientais para o Setor Pesqueiro. Diagnóstico e Diretrizes para a Pesca Marítima.** Brasília, DF.124p.

BRITO, R. C. de C. 1998. **Modernidade e Tradição - Pescadores de Arraial do Cabo.** Niterói, RJ. Ed. EDUFF.

CIRM - Comissão Interministerial para os Recursos do Mar. 1999. **V Plano Setorial para os Recursos do Mar (1999-2003).** Brasília, DF.

CMIO. 1999. **O Oceano - nosso futuro.** Relatório da Comissão Mundial Independente sobre os Oceanos. 248p.

ELI. 1995. **As Reservas Extrativistas do Brasil: aspectos fundamentais da sua implantação.** Environmenatl Law Institute. Washington, DC. 112 p.

FERREIRA, B. P.; MAIDA, M. e CAVA, F. **Características e perspectivas para o manejo da pesca na APA Costa dos Corais.** Artigo submetido para a apreciação do II Congresso Brasileiro de Unidades de Conservação. Agosto/2000.

IUCN. 1995. **A Global representative system of marine protected areas.** Vol. II. Wider Caribbenan, West Africa and South Atlantic. The World Bank. The World Conservation Union (IUCN) Washington DC. 71-86.

IUCN. 1999. **Guidelines for Marine Protected Areas.** Best Practice Protected Area Guideline Series nº 3. 107p.

KANT, R. de L.1998. **Pescadores de Itaipú: meio ambiente, conflito e ritual no estado do Rio de Janeiro.** Niterói, RJ. Ed. EDUFF.

MILLS, C. E. e CARLTON, J. T. 1998. **Rationale for a System of International Reserves for the Open Ocean.** Conservation Biology. v 13, n. 1. 244-247pp.

MURRIETA, J. R. & RUEDA, R. P. (eds.) 1995. **Reservas Extrativistas.** UICN/CCE/CNPT-IBAMA. 133p.

PEREIRA, P. M. 1999. **Unidades de Conservação das Zonas Costeira e Marinha do Brasil.** http://www.bdt.org.br/workshop/costa/uc

ROBERTS, C. M. and POLUNIN, N. V. C. 1993. **Marine Reserves: Simples Solutions to Managing Complex Fisheries?** AMBIO. v. 22, n. 6, set.

ROBERTS, C. M. 1997. **Ecological Advice for the Global Fisheries Crisis.** TREE. V.12, n.1, jan.

RUSS, G. R. 1996. **Fisheries management. What chance on coral reefs?** NAGA. The ICLARM Quarterly, Jul.

SALM, R. V. & CLARK, J. R. 1984. **Marine and Coastal Protected Areas: A Guide for Planners and Managers.** Gland, IUCN, 302p.

SOLER, A. C. P. 2000. **Pela Autogestão Ecológica das Comunidades.** www.agirazul.com.br

Characteristics and Perspectives for Fishery Management in the Coral Coast Marine Protected Area[1]

Beatrice Padovani Ferreira[2] e
Mauro Maida[2]

Abstract

This paper describes the fishery characteristics in Tamandaré, Coral Coast MPA, resulting from an intensive monitoring of the fishery activity. The variations of fishery efforts and catch per unit effort (CPUE) are analyzed and discussed based on interactions with the season, abiotic variables and tourist flow in the region. We also disclose the results of the first management experiment on no-take reef areas in Brazil.

Introduction

The Coral Coast Environmental Protection Area - APA[3] was created through a federal decree in October of 1997, aiming at organizing the use of reef ecosystem located along the 130km of coast, from Tamandaré (in the state of Pernambuco) to Paripueira (in the state of Alagoas). The Costa dos Corais APA was the first federal protected area to encompass part of the coastal reefs distributed along 3000km of the northeast coast, and was also the largest federal marine protected area in length.

The Brazilian coastal reefs are highly diversified ecosystems, rich in natural resources and of great ecological, economic and social importance. Nevertheless, in Brazil there are still few examples of experiences in managing the use of those ecosystems, and in special, few attempts to reverse the alarming scenery of degradation caused by the intensified use of those ecosystems during the last century.

Among the different ways of using the reef environment, fishery is the most important exploratory activity, not only in terms of total yield, but also for its great social importance, since fisheries products are the main source

---

[1] This work was partially published in FERREIRA, B.P., MAIDA, M. e CAVA, F. 2000. Características e perspectivas para o manejo da pesca artesanal na APA Marinha Costa dos Corais. Anais II Congresso Brasileiro de Unidades de Conservação. Campo Grande – MT and in FERREIRA, B.P., MAIDA, M., CAVA, F e MESSIAS; L. 2003. Interações entre a pesca artesanal e o turismo em Tamandaré, APA Costa dos Corais, Resumos expandidos do IX Congresso da Associação Brasileira de Estudos do Quaternário

[2] Department of Oceanography, Federal University of Pernambuco, Campus Universitário, ZIP 50740-550. (beatrice@ufpe.br)

[3] In Brazil, under the National System of Protected Areas, there are two main categories of protected areas; fully protected and of sustainable use. An Environmental Protected Area (APA) is a sustainable use protected area, where extractive uses are also allowed but should be regulated and/or zoned by the management plan.

of income for the fishery communities (Ferreira *et al*., 1998). Estimates point out that about 80% of fishery resources with commercial importance in the Northeast come from the fauna associated to the coral reefs in the region. Since reef fishery - mainly that for subsistence – is characterized by the great variety of gears used and the great diversity of captured species (Sparre, 1989), it is hard for the responsible authorities to monitor and control fishery activities.

Aiming at providing scientific information and technical assistance to serve as basis for a participative development of a management plan for the Coral Coast Marine Protected Area, the Coastal Reefs Project (PRC) started in July 1998, as result of joint initiatives developed by the Department of Oceanography of the Federal University of the State of Pernambuco, the Center of Research and Fishery Extension in the Northeast – IBAMA, the Aquatic Mammals Center – IBAMA and the Marine Mammals Foundation, with funds from the Inter-American Development Bank – IADB and the Pew Fellows Program in Marine Conservation.

Among the many aspects targeted by the project, one of the main goals was to conduct surveys and experiments to subsidize a management system for the Coral Coast MPA fisheries, not only to sustain the level of current catches, but also to allow the recovery of fish populations to levels reported by the traditional fishery communities in the region. Fisheries surveys and demonstrative experiments on management and reef recovery with the creation of no-take zones in reef areas were the two main strategies in this direction.

Traditionally, fishery and agriculture are the main activities in the region. Tourism, however, is an activity that has increased over the last decade. Most of the municipalities have a high proportion of second residences, occupied only during the summer in what is frequently referred to as “summering”. Although most of the coastal municipalities originated from old fishery villages, dating back to the 18th Century, the relations between tourism and the fishery activity are seldom taken into account in tourism development plans for the Northeast coast.

This paper presents the results achieved during the initial period of surveys on artisanal fisheries in the municipality of Tamandaré, at the north part of the Coral Coast MPA, and the fluctuations in fisheries catch and effort in relation to season, abiotic variables and tourist flow in the region.
The results after one year of monitoring the reef area closed in Tamandaré, state of Pernambuco, are also presented and the perspectives of fishery management discussed, based on those results.

Methodology

Artisanal Fishery Survey

The municipality of Tamandaré, state of Pernambuco, at the North of the Costa dos Corais APA, with 14 km of coastal extension, was selected for the design of the fishery survey. Initially, interviews with local fishermen were carried out to determine the potential sources of sampling variability which should be considered in the final design.

In the final survey schedule, the 14km of Tamandaré coast were divided in four sectors, named from North to South, Carneiros, San Peter Church, Tamandaré and Mamucabas. Six field agents, all of them local fishermen were selected, hired and trained by the project to carry out the surveys on artisanal fishery in those 4 sectors. They participated in the design of a sampling strategy and provided the information on the operational characteristics of several fisheries in the region.

From October 1998 to September 2000, the PRC carried out 227 fishery surveys at four sites along Tamandaré's 14km of coast.

Data on fishery effort and catch per unit effort by gear was recorded. The effort was represented by the number of fishers/day, while catch per unit effort (CPUE) was represented by catch in weight or number/fisher/day. Tides and prevailing winds were recorded. Measures on the salinity, water temperature and transparency were taken using the Secchi disk. For the analysis purposes, months were grouped into seasons of the year. The average monthly domestic consumption of electrical energy was used as a measure of tourist flow.

Reef Areas with No-Take Zones (closed areas)

After a survey of the coastal reefs in Tamandaré, state of Pernambuco, the reef area known as Ilha da Barra, located in the Tamandaré Bay, was selected as adequate to the experiment, due to it representativeness in relation to surrounding reefs, its use by fishery and tourism, and the location, rigth in front of the Center of Fishery Studies and Extension of the Northeast, IBAMA (Figure 1). After several meetings held with the local fishery community – which approved the initiative in a popular assembly – the PRC forwarded to IBAMA a request for prohibiting, for three years, all kinds of fishery and exploitation, visitation, nautical and tourism activities in the selected reef area. The Administrative Act was issued in February 1999 and the area was effectively delimited and closed in April 1999.

Photo: Antonio Henrique

Figure 1 - Ilha da Barra Reef, low tide, Tamandaré, Pernambuco.

The establishment of the closed area, delimited with buoys, was the starting point to a monitoring program for those areas. The abundance of fish, octopuses and lobsters was monitored along the first year after closing, through underwater visual censuses (UVC) using SCUBA, both inside and outside the area.

During the underwater censuses, fishes were identified and counted by experienced divers, who swan along 20 x 2 meters belt transects placed along the third reef line of Tamandaré (Maida & Ferreira, 1997). Two field agents who were experienced spear fishers and also members of the local community, were selected and trained by the project to carry out the surveys which was also conducted by the authors.

The UVC were carried out at sampling sites located inside the closed areas and in sites located in reefs outside the closed area, that is, in areas which were open to fishery. The reefs selected as controls were similar to the closed reefs in terms of topographic characteristics. Forty-three censuses were carried out in the closed area and 52 in the control area (open reefs) during the first year of monitoring.

Variance analysis (ANOVA) and Kruskall-Wallis' non-parametric tests were used to characterize the fisheries and compare the open and closed reef areas. The significance levels considered were lower than 0.05.

Results

Abiotic factors

The climate in Tamandaré is hot and humid tropical. Seasons are marked by two distinct periods: a rainy period from March to August, and a dry period from September to February. The highest annual average precipitation occurs in July (about 520mm), while the lowest happens in December (about 80mm) (Infoclima PE). The analysis of the monthly variation of those parameters confirms that seasonality in the region is marked by two distinct and two intermediate periods: December to February, summer months, reporting higher temperatures, salinity, with clearer waters and predominance of winds from the NE quadrant; and from March to May there is a transition period, followed by a drop in such values, reaching the minimum levels during the winter months (June to August), with higher precipitation levels and lower temperatures, salinity and average water transparence, prevailing winds from the SE quadrant. After the winter, the spring months characterize a new transition period, where those values raise again (Figures 2 and 3).

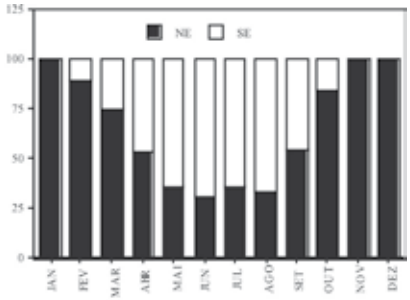


Figure 2 - Percentual frequency of winds of NE and SE quadrants by months of the year.

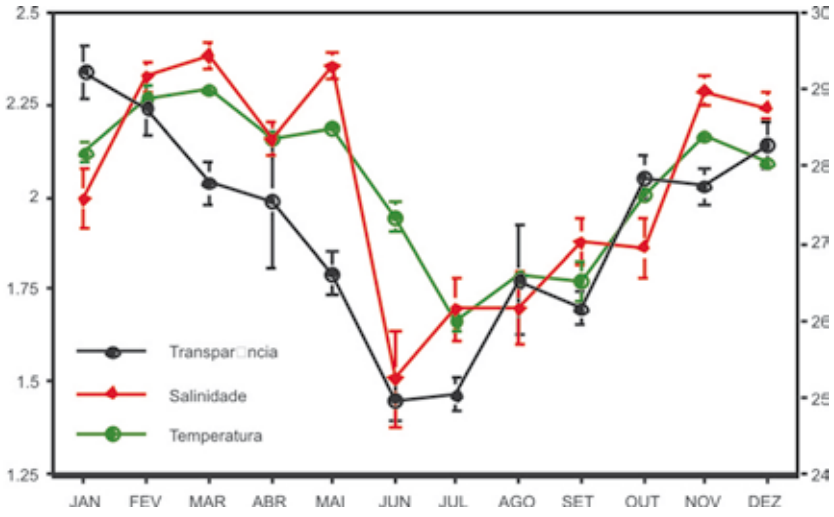


Figure 3 - Monthly average variation of transparency, temperature and salinity.

The Fishery

Although all fisheries practiced in the region comprised by the project are defined by IBAMA as artisanal fishery due to small storage capacity of the boats, fishery could be subdivided into two kinds: commercial fishery, that uses motorized or sail boats and operates all over the shelf to the upper break of the continental slope; and the second type, subsistence fishery, occurring nearby the coast in shallow waters and reefs formations and where fishing point may be reached by swimming, using rowing or sailing canoes or even walking during low tide (Figure 4). While landings from commercial fishery go direct into trading places such as fishery associations or fish shops, of the small individual landings from the subsistence fishery can go to many different places from households to restaurants. Because of that characteristic and since that fishery is made up of small individual captures, the official records on subsistence fishery are often incomplete and largely underestimated.

Photo: Yara Tibiriçá.

Figure 4 - Subsistence Artisanal Fishery in Tamandaré, APA Costa dos Corais.

During the sampling period, 17 categories of fisheries were identified in Tamandaré, according to the fishery gears used. Hand-line was the most common in terms of numbers of fisher/day (40.8%), followed by spear (25,1%), octopus hook (10.2 %) and gill-net (9.1 %).

The fishing effort in Tamandaré was in average 49 fishermen/day, distributed along a 14km stretch of coast. The average daily catch of fish, octopus and lobster per fisherman, totaled 2.367kg that, multiplied for the daily average number of fishermen result in an annual total capture of 42 tons/year.

The interaction analysis showed an opposed pattern of variation concerning fishery efforts and CPUE (Figure 5). The fishery effort was smaller in the summer despite the records of CPUE values significantly higher than those for other seasons. During winter, the fishing effort was higher and the average CPUE was the lowest.

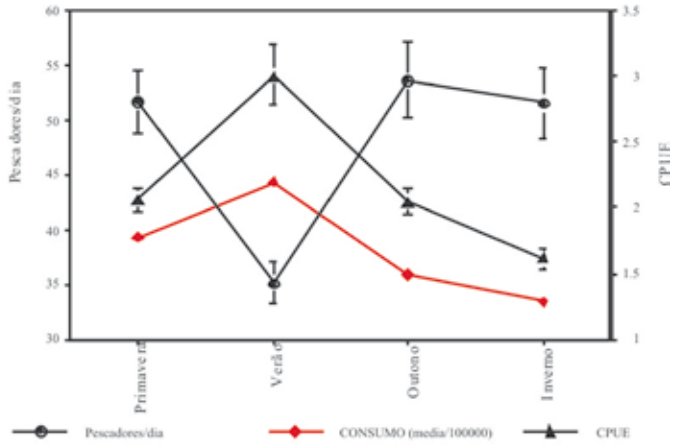


Figure 5 - Variation of fishery efforts, CPUE and average energy consumption by season. Primavera (spring), Verão (summer), Outono (Autumn), Inverno (winter). Fishers/day Consumption (average/1000000) CPUE

The monthly average consumption of energy was higher during the summer, which concentrates the summer tourism flow and when most of the secondary residences are occupied.

No-take zones monitoring

To analyze the differences between closed and open areas, only those fish species target of fisheries activities were considered during the UVC. The selected families were: Lutjanidae, Serranidae, Acanthuridae, Holocentridae, Scaridae (individuals larger than 10cm), Holocentridae (larger than 10cm) and Chaetodontidae. Considering total numeric abundance (including all the indicator species), closed areas (no-take zones) reported figures 4 times higher than those of the open areas (ANOVA; $p<0.0001$, Figure 6). In closed (no-take) areas, averaged one individual at every m^2, while in the open area the occurrence was one individual at every $4m^2$. When some species were analyzed separately in specific sites of the closed and opened areas, there was an increase of up to 11 times, as in the case of the Lutjanidae family (ANOVA; $p<0.0001$).

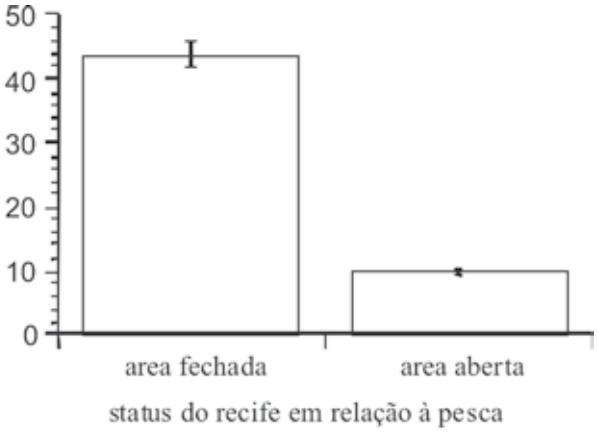


Figure 6 - Average number of fishs by transect (20x2) observed during researches in a closed area for fishing and in an equivalent area opened for fishing.

Another difference esteeming from the no-take zone establishment was a change in the fish behavior, which notably became less unsociable. Also, species that had not been observed in the area in previous years (prior to the no-take zone establishment) were observed inside the area, but not in control areas: and that had not been recorded for the control area: *Lutjanus analis*, *Lutjanus cyanopterus, Epinephelus itajara, Sphyraena barracuda*, and *Scarus trispinosus* TP.

Discussion

Subsistence fishery is made up of small individual catches with no specific landing site and records of landings are often missing or incomplete. The present results showed that the total catch of the artisanal fishery is very significant, not only in terms of total yield per area but also in relation to the number of people involved.

The monthly variation patterns observed during the period under analysis indicated that the number of fishermen during the summer months is reduced, although captures are better in that time of year, as proved by the CPUE analysis. The reduction in effort coincides with the increase of the number of summer tourists, (as indicated by the increase in the electric power consumption), what generates more employment offer both from the formal and informal economic activities. In those times, many fishermen are devoted to other activities, such as temporary jobs or informal commerce. It is worth to mention that the increase in individual catches observed when total effort is smaller could also be an effect of the better skills of the fishermen who remain in the activity and take advantage of the best prices paid for fishery products. The less experienced fishermen usually prefer to guarantee an income engaging in other available activities. Also, effort reduction may be a consequence of conflicting activities, as net fishermen have reported difficulties in operating when a large number of motorboats circulates in the inter reef area.

The results disclosed herein are an evidence not only of the interaction between fishery and tourism activities, but also evidence the social relevance of artisanal fishery as an alternative source of job, income and survival during winter months, when rains reduce the tourism flow to its lowest levels. Such interactions are of special relevance in a multiple use area, such as the Costa dos Corais environmental protection area. The patterns observed in Tamandaré are probably the same as those found in many other sites along the Northeast coast.

The difficulty in getting accurate information on fishery, added to the lack of control over the increasingly demanded effort, fostered by the population increase, has been considered one of the main causes of the collapse and decline of several kinds of fishery all over the world (Russ & Alcala, 1994). Such factors are particularly relevant in the context of the subsistence artisanal fishery, largely unaccounted in official statistics, hard to control, and practiced by low-income populations. The Coastal Reef project in partnership with IBAMA has proposed the establishment of a system to register and license fishermen in the area comprised by the APA, to serve as a system to control both fishery effort and production.

The use of marine no-take zones firstly appeared in the tropics and, since then, the use of those areas have been increasingly acknowledged as one of most efficient strategies for fishery management (P.D.T., 1990; Williams & Russ, 1991). Evidences point out that the long-term closing of fishery areas lead to an increase in the density, biomass, average size and fecundity of fish (Russ, 1991). Moreover, the fishery reserves allow the reef fish population to reach and maintain natural levels, facilitating the maintenance and even increase catches in adjacent areas (Alcala & Russ, 1990). The space arrangement of coral reefs represents an excellent field for research on the efficiency of that strategy (Hilborn & Walters, 1992). Those are mainly characterized for the ecosystem-oriented management and inexistence of isolated species, thus making them an important tool that takes into consideration the ecological complexity, thus overcoming that core failure in the traditional management (Roberts, 1997).

The fast recovery in abundance observed for some species living in the Tamandaré no-take zone points out the potential of that strategy to the fishery management in the region. The change on the behavior of fish living in no-take zones has probably contributed to the results achieved. Fishes response to this sanctuaries is very positive and they become less shy and more visible to divers (Kulbrick, 1998). Within the area, species that were hardly found such as jewfish, black grouper, snappers and barracudas have since been frequently sighted, indicating that the area has attracted those fishes from other regions. In face of the interaction between fishery and tourism, that characteristic brings about good possibilities for the integrated management of those activities, through the future creation of other areas zoning the activities.

In order to build a Brazilian marine area management system comprising regulation and zoning mechanisms, it would be necessary to carry out gradual experiments to adjust the working methods to local reality, and to assess and consider how the community will accept those methods, prior to outlining a final plan. The measures adopted up to now were mainly oriented to trying the effects entailed by the eventual reduction of fishery and tourism activities on the reefs selected for zoning. If those actions prove to be effective, they are expected to result in the outlining of a zoning plan for the other municipalities comprised by the APA. The participation of local communities, entrepreneurs and tourists is crucial to the zoning process, and shall guarantee the effective implementation of those measures, as well as the awareness on the rights and responsibilities assigned to each one in what regards preserving the coral reefs in the Costa dos Corais Environmental Protection Area[3].

Acknowledgments

This project is the joint effort of the Department of Oceanography - UFPE, CEPENE/IBAMA and The Peixe-Boi Center, supported by the IBAMA Offices in the states of Pernambuco and Alagoas, the Costa dos Corais APA and 10 local governments of the towns comprised in the area. It is administered by the Marine Mammals Foundation and funded by the Inter-American Development Bank (IADB) and the Pew Fellows Program on Marine Conservation. We would like to thank all field agents of the Coastal Reefs Projects and the interviewed fishermen.

References

ALCALA, A. C. and RUSS, G.R. 1990. **A direct test of the effects of protective management on abundance and yield of tropical marine resources.** J.Cons. Int. Explor. Mer., 46, 40-47.

DIÁRIO OFICIAL. 1999. **Portaria nº 14-N, 11 de fevereiro de 1999.** Brasília-DF.

DIEGUES, A.C. and ARRUDA, R.S.V. 2001. **Saberes tradicionais e biodiversidade no Brasil.** MMA- USP. 176pp.

FERREIRA, B., MAIDA, M. and SOUZA, A. E. 1995. **Levantamento inicial das comunidades de peixes recifais da região de Tamandaré-PE.** Bol. Téc. Cient. Cepene, Tamandaré – 3 (1): 211-230.

[3] In November 2006 the Coastal Reefs Project submitted to the Brazilian Institute for Environment - IBAMA a Management Plan proposal to the Costa dos Corais APA. The proposal included the establishment of no take areas in each municipality comprised by the APA, based on Tamandaré's experience.

FERREIRA, B., CAVA, F. and FERRAZ, A. 1998. **Relações morfométricas em peixes recifais da zona econômica exclusiva brasileira, região nordeste.** Bol. Téc. Cient. Cepene, Tamandaré – 6 (1): 61-76.

HILBORN, R. and WALTERS, C. J. 1992. **Quantitative fisheries stock assessment.** Chapman and Hall Inc., New York, 570pp.

KULBRICK, M. 1998. **How the acquired behaviour of comercial reef fishes may influence the results obtained from visual censuses.** Jour. of Exp. Mar. Biol. and Ecol. 222, 11-30. Elsevier.

MAIDA, M. and FERREIRA, B. 1997. **Coral reefs of Brazil: An overview.** Proc. 8th Int Coral Reef Sym – 1:263-274.

PDT- PLAN DEVELOPMENT TEAM. 1990. **The potencial of marine fishery reserves for reef fish management in the U.S. Southern Atlantic.** NOAA Tech. Mem. NMFS-SEFC-261, 40pp.

ROBERTS, C. 1997. **Ecological advice for global fisheries crisis.** TREE 6 (1). Elsevier Science Ltd.

RUSS, G. R. 1991. **Coral reef fisheries: effects and yields.** In P.F.Sale (ed), The ecology of fishes on coral reefs. pp. 601-635. Academic Press, Inc., Orlando.

RUSS, G. R. and ALCALA, A. C. 1994. **Sumilon Island reserve: 20 year of hopes and frustations.** 1994. July 8-12. NAGA, The Iclarm Quarterly.

SAMOILY, M. and CARLOS, G. 2000. **Determing methods of underwater visual census for estimating the abundance of coral reef fishes.** Env. Biol. of Fishes, 57: 289-304. Kluwer Acad. Publishers.

SPARRE, P., URSIN, E. and VENEMA, S. C. 1989. **Introduction to a tropical fish stock assessment. FAO Fisheries Technical Papers.** Nº 306.1, 337pp.

WILLIAMS, D. MCB and RUSS, G. 1991. **Review of data on fishes of commercial and recreational fishing interest on the Great Barrier Reef.** Report to the Great Barrier Reef Marine Park Authorithy, Townsville, Queensland.

Municipal Councils for Environment as Integrated Manegement Tools: An Experience in APA Costa dos Corais (AL/PE)

Beatrice Padovani Ferreira [1]
Mauro Maida [1]
Leonardo Tortoriello Messias [2]

Abstract

Municipalization as a government strategy has grown in the last decade in Brazil. As part of this process, the creation of environmental councils has been stimulated by the government as well as multilateral agencies. The city of Tamandaré is a coastal municipality located 120 kms south of Recife, the capital of Pernambuco state. The coastal zone of Pernambuco has a high population density and a diversity of ecosystems of great importance for local economy such as mangroves and coral reefs. Tourism is important to local economic and much effort has been put by the government to promote and develop the activity. The existence of three partially overlapped protected areas in the region - namely the marine Federal APA Costa dos Corais, the State APA Guadalupe and the REBIO Saltinho - reflects the importance of the ecosystems under protection (including Atlantic Forest, mangle, sandbanks, estuaries, sea grass prairies and coral reefs) and human dependence on those environments. Also, the fact that two of them are under the sustainable use category, where resource extraction is allowed, indicates potential user conflict and the need for management. The present work relates the experience of the Tamandaré Municipal Council of Environment, created in May 1999, focusing in the decisions concerning a no-take zone as well as solutions proposed for fisheries and tourism conflicts. The case of Tamandaré represents a practical example of participatory management of a coastal area with a high conflict potential and reinforces the importance of community organization and development planning.

Municipalization in the decentralized management process

The municipalization of several actions of the Federal Government actions is a growing tendency - a reflex of the incentive to the decentralization of the management of the Union's public assets. It also represents a way to increase administrative efficiency and incorporate actions adapted to local needs To achieve this objective it is necessary not only to increase the capability of the State and Municipal Government, but also to reduce the concentration of power, through the development of mechanisms which allow the participation of local segments in achieving compatibility between the uses and the conflicts of interest.

---

[1] Department of Oceanography, Federal University of Pernambuco
[2] Ministry of Fisheries and Aquaculture

In that process, the creation of municipal councils equally represented by public power and society has been encouraged by the Federal Government, which has conditioned the granting of funds to the municipality to the presence of those councils. Health and Education Municipal Councils are good examples, which since the enactment of Federal Constitution in 1988, went through a process of organization to qualify for collecting funds like the School Meal Programa and the Public Health System- SUS (Bosco, 2002).

The regulations of the National Environmental System - SISNAMA have been approved twenty years ago, including the creation of the National Environmental Council – CONAMA and its replicas in the states and municipal governments. The CONAMA is a deliberative organ, presided by the governmental entity - the Ministry of Environment – MMA, having representatives of the civil society and federal, state and municipal governments. The CONAMA's decisions are acts of law and are applicable in a national level (Brasil, 1988).

In the beginning of the ninety decade, the National Environmental Fund had launched procedures similar to the other funds. The direct association between funds granting and municipal councils triggered the creation of several councils, which were however, largely controlled by municipal and state governmental power (Brasil, 1988).

Along the years, the municipals council's profile has evolved to allow a more effective participation of the civil society, including a deliberative character, as well as the election of its president through votes from the council members, in some cases with no attachment to the local government. This change is contributing to guarantee a larger independence and autonomy to the councils, strengthening the social control process and facilitating positive experiences in environmental management shared between the executive power and the civil society.

The multilateral banks -as financing sources of large projects which generate environmental impacts - have encouraged for the last two years or more, the parties who receive the loans to incorporate in the developing strategies analysis of environmental issues including conservation priorities. It has been also encouraged the participation of socially organized groups in the project planning, implementation, monitoring and evaluation (Barros et al, 2001).

The Projeto Orla, or Coast Project, of the Ministry for Environment, aims increase management efficiency in the coast, through the decentralization of procedures of destination of uses of the Union's assets to the municipalities, including supervision mechanisms, regulations of use and settlement and stimulus to economical activities. That project includes the establishing of coast management's committees, collegiate forums that would support the municipal entities to manage the areas of the Union's Assets (MMA, 2002).

Coastal Ecosystems and Urban development

According to the V Sectorial Plan for Sea Resources, elaborated by CIRM, the Inter Ministerial Commission for Sea Resources (CIRM, 1999) the human impact on coastal ecosystems has caused serious damage not only to the adult populations of aquatic species but mainly to the juvenile populations - which present higher vulnerability particularly in nurseries areas commonly located in estuarine areas. The estuaries - the transition zone between continental and seawaters - are one of the ecosystems most affected by human impact. The real estate speculation and the consequent disordered occupation of the coastal areas, and more recently, the use of those areas to the shrimp farming, have resulted in the destruction of mangroves, which constitute in essential ecosystems to life's cycle of countless species, besides exercising the fundamental roll in the coastal ecosystems enrichment.

The presence of mangroves still contribute to soften the floods processes, the silting up process and sea erosion, absorbing also, a large part of the impact from the effluent discharge of the urban pollution (domestic sewage, garbage, etc), industrial (PCB, heavy metals, etc) and agricultural (toxics from agriculture in general).

Additionally, according to V PSRM, the disordered occupation of the coastal areas has also caused the destruction of dunes and the building of ridges, consequently worsening the sea erosion problem besides affecting the fishermen villages. The residents are forced to move to other places and frequently to change their work activity resulting in the evasion of skilled labors from fishing activity.

The human activities that affect the Brazilian coral reefs are the same ones that globally threaten the most part of the coral reefs, such as: soil use practices that increase the erosion, domestic and agricultural pollution, overexploitation of reefs' resources and uncontrolled tourism activities.
Damages from the inadequate practices on soil use date back to he European colonization. Since the discovery of Brazil, more than 500 years ago, the flow of sediments towards the sea has significantly increased due to the higher erosion of coastal areas due to Atlantic Forest deforestation for timber exploitation and sugar cane plantations (Leão, 1994).

Currently, the sugar cane plantation in the Northeast region account for a "belt" of 60km in width and almost 1,000 km in length. That extensive monoculture is located few kilometers far from the coastal reefs. Sedimentation, jointly with agricultural pollution produced by the sugar cane plantations, are the main factors for the degradation of reefs in some areas (Maida and Ferreira, 1997).

Reefs are degraded around highly populated cities, such as the states capitals, mainly due to domestic pollution and the direct influence of human activities. Due to its proximity, most of the coastal reefs underwent

intensive exploitation by both artisanal and commercial fishery. The coastal population in those areas is highly depended on the reef's resources for consuming proteins. In some sites, illegal fishery practices are employed, such as the use of explosives and toxic products (Maida and Ferreira, 1997; 2003).

More recently, the uncontrolled tourism and urban development along the northern Brazilian coast are ranked among the major threatens. The coast from Natal (state of Rio Grande do Norte) to the south of Bahia State is a common tourism destination. In some coastal cities, the population increases several folds during the summer months, demanding an urban development typically associated to environmental degradation. As happens in other parts of the world, tourism can represent either an opportunity or a threath to the ecosystems' integrity, whether for the poor infrastructure that leads to collapse if services provided at coastal areas, or for the direct impact entailed by usage, such as undue anchoring, oil leak from motor-boats, wastes, walking on the reefs and unwatchful divers (Cesar, 2003).

The occupation process in the Northeast coast and the origin of coastal municipalities

The Brazilian Northeast Coast is one of the most populated in the country, where Pernambuco stands out as the epicenter of that concentration, with one of the most dense coastal populations in Brazil (Moraes, 1999). According to Ribeiro (1995), when the Europeans arrived in Brazil, the Indigenous groups living on the coast totaled about 1 million individuals. The Indians depended on hunting and fishing for eating and, therefore thus increasing the importance of privileged sites, where abundant resources could guarantee the group's survival and allowed for the establishment of bigger settlements. In some particularly rich sites on the coast, exceptional settlings reached up to three thousand individuals (Ribeiro, 1995). The coast of Pernambuco, housing several highly productive ecosystems, such as the Atlantic Forest, mangroves, estuaries and coral reefs probably was one of such sites.

Fishery has always played a core role in the region and, according to Diegues and Arruda (2001), the current artisanal vessels using sail and rudder for open-sea fishery result from several adaptations made by Europeans and Africans. Some records dating back to early in the sixteenth century reveal that the African slaves used that sort of boat in Pernambuco (Silva, 1993). Câmara Cascudo (1957), states that the fishermen settlements firstly appeared in the eighteenth century. The current coastal towns developed from those old villages. Nowadays, although there are clear interactions between tourism and fishery in several coastal towns in Pernambuco (Ferreira et al., 2003; 2006; Alcântara et al., 2005), those interactions are seldom considered when dealing with tourism in the Brazilian coast (Ferreira et al., 2003). In several states in the Northeast of Brazil, fishermen's access to the beach has been restricted due to the urban development of secondary residences (Diegues and Arruda, 2001).

The integrated coastal management process

The Environmental Protection Area (APA) Costa dos Corais was created by federal decree on October 27, 1997. Located in the south coast of Pernambuco and north of Alagoas, it comprises from the 33 meters line of high tide up to 18 miles from the coast, including the entire shelf until the edge of the continental slope, additional to the manguezais. The APA area has about 413,563 hectares in length. It is the first and largest (in extension) federal protected area aimed at protecting part of the coastal reefs distributed along the 3,000km of the Northeast coast, and the largest federal marine protected area in length. The area encompasses 13 municipalities.

In July 1998, the Inter-American Bank approved the project "Initiative of Integrated Management for Coastal Reefs System between Tamandaré and Paripueira", or simply "Coastal Reefs Project" (www.recifescosteiros.org.br), based on the initiatives of the Oceanographic Department from Federal University of Pernambuco-UFPE, the Fishing Research and Extension Center for Northeast - IBAMA, the Aquatic Mammals Center - IBAMA and the Marine Mammals Foundation.

Among several aspects dealt by the Coastal Reefs Project, one of the main objectives is the creation of an institutional structure of integrated littoral administration. The importance of the municipal executive power in the process of environmental administration is quite clear, hence the municipal district is in direct contact with the problems and daily conflicts, and if qualified and organized, it could act in an effective way in the search of appropriate solutions.

The initial idea was the creation of an Administration Committee for the Coral Coast MPA. Nevertheless became quite clear that, due to the diversity of municipal districts in relation to several aspects, the representativity and the effectiveness of a managing council would depend upon the capacity of each one to represent the interests and local needs in a wide way.

Therefore, the Projeto Recifes Costeiros adopted as a strategy the capacitating municipal institutions through the establishment and operation of the Municipal Councils for Environmental Defense –COMDEMA in the Coral Coast MPAs municipal districts. Up to now COMDEMAs were established in four municipal districts, as follows: Tamandaré and São José da Coroa Grande in the State of Pernambuco and Maragogi and Paripueira in the State of Alagoas. These municipal districts were selected due to their strategic location concerning: geographic distribution, human occupation and potential of the region, mainly concerning to the interest of the municipal district, represented by the municipal administration and the organized civil society for the development of public policies of environment protection. There are COMDEMA's units already structured in the municipal districts of Tamandaré and Maragogi. The first one is the older with more than three years of creation and the second one was established almost two

years ago. The municipal districts of Paripueira and São José da Coroa Grande created COMDEMA's units but failed so far in going ahead towards implementation.

With the purpose of supplying technical advice to the interested municipal districts, the Coastal Reefs' Project offered in the first step, the logistic structure and the necessary human resources for the development of actions from the executive department, besides the support to the technical work groups for the elaboration of diagnoses, reports and opinions. Associated to COMDEMA is the operation of the Municipal Environmental Fund, with resources originated from experimental activities of sustainability proposed by the Coastal Reefs Project, executed in partnership with organs of the three spheres of the public administration and the community.

The Municipal District of Tamandaré

The Municipal District of Tamandaré is located on the south coast of Pernambuco, about 110 Km far from Recife, the capital of the state. It occupies a 98.9km area, and its total population is 17,064 inhabitants, of which 11,538 live in the urban area and 5,526 in the rural area, corresponding to a demographic density of 173.22 hab/km^2 (Census, IBGE 2000).

The economy in that Brazilian region is traditionally based on the growing of sugar cane, coconut and fishery activities. As of the 1950's, the town growth was intensified, due to the summering activity expansion. Tourism, despite being a recent activity, has reported significant increases in the last few years. The region is part of the tourism interest region called Costa Dourada, which is considered a priority in the Program on Tourism Development – PRODETUR of the Government of the State of Pernambuco.

Part of the municipal district area is within the limit of three conservation units: Proteção Ambiental Costa dos Corais (Coral Coast's Environmental Protection Area), Área de Proteção Ambiental de Guadalupe (Guadalupe's Environmental Protection Area) and Reserva Biológica do Saltinho (Saltinho's Biological Reserve). The area where the municipal district is located was considered a hotspot in the the Brazilian Coastal Zone Biodiversity Conservation Workshop, taken place in 1999. Although there is need to protect those environments - which include Atlantic rain forest, mangroves, sandbanks, estuaries sea grass beds and coral reefs- the level of occupation and human dependence of these environments is high, so the two larger conservation units are designed for sustainable use (SNUC).





Municipal Council of Environmental Defense of Tamandaré

The COMDEMA of Tamandaré was instituted by the Municipal Law 7299, of May 17, 1999, amended by the Complementary Law 01/99, of June 17, 1999. COMDEMA is a collegiate body that represents the community, holding deliberative, consultative, ruling and supervisory duties. It is composed by governmental representatives of governmental entities and the civil society. Higher authority for municipal environmental politics, COMDEMA is part of the National System of Environment (SISNAMA), for protection, natural resources conservation, improvement of life quality and sustainable development purposes.

When the COMDEMA was established, there were five town councils working in Tamandaré. Six years later, there are ten councils at different implementation stages and work at the municipality. Among those ten councils, only two have not been created through any sort of administrative rule issued by the Federal Government; only two are of deliberative nature; and, only one is of non-mandatory deliberative nature. CONDEMA is the only one among the three exceptions.

Additionally to representatives of the civil society and NGOs dealing with the town's quality of life (amongst which representatives from the local Fishing Colony and the Association of Jangada Sailors), the COMDEMA: Municipal Government, Chamber of Councilmen, IBAMA, Cia. Pernambucana de Meio Ambiente, and the Judiciary Power and the Environmental Police (the last two are considered as special council members, with no right to vote). Currently, the members of COMDEMA are: the Association of Jangada Sailors of Tamandaré - AJT; Coastal Reefs Institute - IRCOS; Gilberto Freire Foundation; Association of Barraqueiros; Parish of São Pedro; Fishing Colony Z-5; Union of Agriculture Workers; Association of Hotels, Inns, Restaurants and similar - AHPREST; Tamandaré Local Government; APA Costa dos Corais - IBAMA; APA of Guadalupe - CPRH; Public Prosecution Service; CIPOMA; Biological Reserve of Saltinho - IBAMA; Northeast Center of Fishing Extension - CEPENE; e the Chamber of Councilmen.

As managers of the three conservation units comprising the town, where two are Federal (APA Costa dos Corais and Rebio do Saltinho) and a State one (APA de Guadalupe), COMDEMA has served as the main – and sometimes the only participative forum of debates on several issues and actions related to those Units.

Since it was established, COMDEMA has held monthly meetings. Among the environmental issues concerning the town of Tamandaré and discussed within CONDEMA scope, the most relevant (additionally to those dealing with conservation units) are those dealing with land sharing and urban condominiums, irregular occupation of coastal areas, implantation of agricultural rural settlements, PRODETUR/NE projects, creation and management of the Marine Municipal Park of Tamandaré and issues related to fisheries, among which the renewal of the Administrative Rule that provides fro the establishment of a no-take zone for tourism and fishery.

COMDEMA Actions

PRODETUR

The PRODETUR-NE was conceived as an auxiliary program in the development of tourism activity in the Northeast region. Considering the potential ensuing from its natural characteristics, tourism appears as an economically feasible solution to smooth the serious social problems that affect the region (PRORENDA-GTZ). The program provided for the implantation of multiple infrastructure works and public utilities such as basic sanitation, solid waste treatment, roads, recovery of environment and of the historic heritage. The total program, comprising all the Northeast sates, was estimated to cost US$ 800 million, of which US$ 400 million would be financed with external resources from the Inter-American Development Bank (IADB) and the remainder amount would be granted by the Federal and State Governments, as counterpart contribution.

In Pernambuco, the State Executing Unit (UEE) of PRODETUR signed an agreement with the Bank of Northeast to make investments in Recife and in the cities of Rio Formoso, Sirinhaém and Tamandaré. For Tamandaré, it was foreseen the construction of three roads, recovery of the main road of access to the city and the constructing of a bridge linking that town to Rio Formoso. The elaboration of the managing plans for the three cities was also part of the investments. Those works and services are comprised in the Pernambuco State Government's plan to the region, as well as the Tourism Center (TC) of Guadalupe.

The first discussions on PRODETUR in the town of Tamandaré were developed within the scope of forums on the management plan outlining. By that time, the plan coordination team informed that part of the municipality already rested on the zoning project proposed by the State Government of Pernambuco, due to the institutional interest in that area for developing the constructing of resorts.

The subject then became recurrent in COMDEMA, and culminated in the approval of a protest motion against how the works on the Guadalupe's Tourism Center road system were being executed, based on the following arguments: a) the impacts of those works on coastal environment – Atlantic Forest suppression, manguezal areas' embankment, removal and vegetation and the sandbank's sand, silting up of the estuary and increased sedimentation of the coral reefs; b) the conduction of and disregard to the environmental licensing process; c) the Pernambuco Government's unwillingness towards discussing with and listening to the communities' voices; d) the predicable environmental and social problems resulting from the road system constructing. In September 2000, the aforementioned motion was forwarded to the State Government Secretariats dealing with that subject, as well as to IADB, the Bank of Northeast, Federal and State Public Prosecution Service and to the IBAMA. In February 2001, the Public Prosecutor's Office of Formoso filed a Public Civil Inquiry to investigate

the environmental damages esteeming from the works, particularly in two conservation units: the APAs Costa dos Corais and Guadalupe. The year of 2001 was devoted to the negotiation meetings to outline the baseline document to Conduct Adjustment Term (TAC, in Portuguese). The TAC is an agreement entered by the parties to avoid the Public Civil Inquiry and the filing of a Criminal Proceeding that could lead to rending liable the parties involved in the environmental degradation.

The discussions on that topic held within COMDEMA scope were not only aimed at mitigating and compensating the impacts; rather, they aimed at suggesting alternative models to the old-fashioned development model currently developed, since other works carried out by PRODETUR at the Brazilian coastal area have degraded the coastal ecosystem, failed in assisting the local communities' development, besides having brought opportunities only for big size entrepreneurs in the tourism sector. The mitigation alternatives discussed, among which the establishment of a conservation unit of indirect use and the capacity-building of local community to work in the field of ecological protection, where oriented to yield benefits to the municipality and a differentiated tourism.

In face of the UEE difficulties concerning an item of the TCA dealing with the establishment of a State Park, as a measure to compensate the environmental damages, COMDEMA proposed the establishment of a Municipal Park, in a different public-owned area, where the only duty assigned to the State Government would be to facilitate the assignment of the Santo Inacio Fort area to the town of Tamandaré. The proposed area currently belongs to the Brazilian Navy.

Now, 6 years later, partially due to delays in the program that underwent deep changes required by several State mechanisms, as will be further discussed, the TAC is yet to be consolidated. Among the main issues additionally to the Municipal Park as the main compensatory measure, it sets forth that the resources to implement the conservation unit should amount to, at least, 0.5% of the global price of the undertaking, pursuant to CONAMA Resolution 002/96.

The Park

In September, 2003, the town of Tamandaré established the Municipal Park of Santo Inácio Fort (Fort of Tamandaré) and obtained the Navy's permission. The Park includes a marine area located within the APA Costa dos Corais that, according to IBAMA Administrative Rule, should be devoted to recovering the coral reef environment, as will be further discussed.

The National System of Protected Areas - SNUC Law, in Article 17, § 6, foresees that for the implemented Municipal Conservation Units the existing Municipal Councils of Environmental Defense could serve as the unit's manager. The decree establishing the Park, issued in September 2003, assigns to COMDEMA the role of consultative council. However,

in November 2004 the local government issued another decree, changing that previous one and allowing the local government, as the managerial authority, to make consultations to COMDEMA. That change, jointly with some events held in the Park area with no prior consultation to the council, brought about debates that have recently resulted in the proposal of a TAC intermediated by the State Public Prosecutor Service. That TAC is now under elaboration and discussion by the parties and, if they reach a consensus, it will be further submitted to the Local Government, COMDEMA and the managers of the Conservation Units involved for their analysis and approval.

Fishery Management

COMDEMA always had representatives from the fishing sector. Initially the Fishers Colony only held a seat but the Association of Jangada Sailors, later created, formally asked to join the council. Participation depends on availability of vacant places, which are created whenever an association leaves or fails to participate in a regular manner. The new member is chosen by older members, who vote in the candidate entities.

During COMDEMA meetings several issues are brought to attention by counselors or the general public. Regarding fisheries, reporting of illegal practices such as predatory fishing and capture of threatened species are recurrent. Conflicts with other activities are also often discussed, especially traffic of motor boats in estuaries, rivers pollution, mangrove deforestation and loss of access to beaches and rivers by fishers. The reports are followed by procedures that generally include technical evaluation and formal request to the authorities to take the required measures. Those topics are directly related to issues concerning the use of coastal resources and space by the local fishing community that has, therefore, the opportunity of receiving technical and legal assistance throughout the debates and further procedures.

The COMDEMA has also served as a forum of debates on the procedures towards establishing no-take zones for fishery. The creation of those areas in the municipality was part of the Coastal Reefs Project's management and recovery strategy. When the no-take zone was created in Tamandaré in 1999, COMDEMA had not yet been created, and the Project then held several public meetings with the fishing community of Tamandaré. As the fishermen agreed on the establishment of a closed area, the project submitted to IBAMA a request for the prohibition, for a 3-year period, of all types of fisheries and exploration, visitation, nautical and tourism activities in a selected reef area. The area, known as Ilha da Barra, used to be intensively visited by fishermen and tourists. The Administrative rule was issued in February 1999, and the area was effectively delimited and closed in April 1999. Three years later, in 2003, new discussions were held, this time during COMDEMA meetings. The council was considered the appropriated forum for the discussions as it has representatives from different sectors affected, including the fishery and the tourism sector. The results

of the monitoring exercise were presented and the representatives agreed on an extension for an additional 3-year period of closure. In 2005, the Administrative Rule was again extended, after discussion and deliberation within the COMDEMA scope, and the request was then forwarded to IBAMA. Although the Park establishment in 2003 included a no-take area within its borders, it was decided that, as the municipal management process was still under construction, the renewal of the Administrative rule was fundamental to ensure the maintenance of the benefits that had already been entailed, mainly concerning the reef recovery (Ferreira et al., 2000; this volume).

Conclusions

Integration among the federal, state and municipal spheres, as well as the integration of local community, public in general and users of resources, are considered the bases for the coastal and marine integrated management process (Turner, 2000).

The IADB carried out an analysis on the social and environmental impacts caused by PRODETUR I showed that the great majority of the municipal City Halls lacks of technical know how and resources to implement actions concerned to planning and environmental administration. Frequently those municipal districts don't possess qualified structure to deal with environmental issues. The creation of COMDEMAs in most of the cases is not followed by the provision of operational resources, and as result, most of those councils are inoperative or working under serious difficulties, since they do not possess nor the structure, nor the necessary environmental conscience for their operation.

The case of Tamandaré has been mentioned as an exception in this scenery - an example that there are precisely these shortages that harms the true implantation of the Councils. The main change in the outlining of the second phase of PRODETUR specifically aims at mitigating that deficiency, providing for the establishment and implantation of COMDEMAs. That stage is to be financed under the component on strengthening the municipal capacity for tourism management. That is considered a core action to quality the municipalities and make them eligible to the financing of PRODETUR II.

Undoubtedly, COMDEMA experience contributed to start a new stage of dialogue between the civil society and government, where the debates are to be more focused on the planning stage than on the accounting of losses and gains entailed by the results achieved. The institutions dealing with integrated coastal management usually suffers from lack of authority resulting from administrative barriers. Legislation uses to be complex, involving more than one agency, and thus generating conflicts of authority and jurisdiction (Baird, 1996).

Parity collegiate and deliberative bodies, composed by representatives of different institutions and agencies in charge, could catalyze at the municipal

level some processes that, at federal level, would require much longer procedures. That is a clear advantage ensued by the decentralization of the decision-making process also for environmental management. Nevertheless, the municipal capacities are still being built. For fishers, it has been a new approach as although conflicts with other activities are often debated in fishers forums organized by government and NGOs, forums where fishers participate in decisions concerning costal management with other users are extremely important. Acknowledging the legitimacy of collegiate bodies that employ effectively participative decision-making mechanisms stands for a crucial step towards improving the managerial efficiency. Such initiatives should also be supported at federal and state levels to be strengthened, as happens in the COMDEMA of Tamandaré.

References

BAIRD, R. C. 1996. **Toward New Paradigms in Coastal Resource-Management - Linkages and Institutional Effectiveness.** Estuaries 19: 320-335.

BOSCO DE LIMA, A. 2002. **Os Conselhos Municipais na educação e a participação da sociedade civil.** Resumenes del Primer Congresso Nacional de Politicas Sociales. Universidade Nacional de Quilmes, Argentina, Resumenes pag. 34.

BRASIL. **Federal Constitution. 9 ed. 1988. Law N° 7,797, enacted in 1979, instituted the National Environment Fund (Fundo Nacional do Meio Ambiente – FNMA).** 9 ed

BRASIL. **Federal Constitution. SISNAMA Law N° Lei nº 6,938, on August 31, 1981.** 9 ed. 1988..9 ed

CIRM. 1999. **V Plano Setorial para os Recursos do mar (1999-2003).** (V Sectoral Plan for Marine Resources) Brasília.

DIEGUES, A. C. and ARRUDA, R. S. V. 2001, **Saberes tradicionais e biodiversidade no Brasil.** Brasília, Ministério do Meio Ambiente, USP, 176p.

FERREIRA, B. P. and M. MAIDA 2001. **Fishing and the Future of Brazil´s Northeastern Reefs.** InterCoast 38:22-23.

FERREIRA, B. P., CAVA, F. C. and M. MAIDA. **Ictiofauna Marinha da APA Costa dos Corais: lista de espécies através de levantamento da pesca e observações subaquáticas.** Bol. Téc. Cient. do CEPENE. 9(1):167-180.

MAIDA, M. and FERREIRA, B. P. 1997. **Coral Reefs of Brazil: an overview.** Proc. 8th Int. Coral Reef Sym. v. 1; p. 263-274.

MMA. 2002. **Programa Nacional de Gerenciamento Costeiro (GERCO).** (National Coastal Zone Management Program) http://www.mma.gov.br.

MORAES, A. C. R. 1999. **Contribuições para a Gestão da Zona Costeira do Brasil: elementos para uma geografia do litoral brasileiro.** Hucitec, Edusp. (Contributions to the Coastal Zone Management of Brazil – elements for a geography of the Brazilian coastline). São Paulo. 229p.

PRORENDA-GTZ, 2000. **Sobre o Impacto das Obras do Prodetur na Costa Nordeste.** Relatório do Programa PRORENDA-GTZ.

RIBEIRO, D. 1995. **O Povo Brasileiro.**Companhia das letras, São paulo, 476 pp.

TURNER, R. 2000 **Integrating natural and socio-economic science in coastal management.** Journal of Marine Systems 25: 447-460.

Marine Protected Areas Conservation and Social Justice: Insights from The Common Property Theory

Daniela C. Kalikoski [1]

Introduction

World-wide fisheries are going through a drama of the commons, not only the fish resources are decreasing sharply but also the livelihoods of many fishers ranging from small-scale to industrial fishers are being disrupted resulting in loss of biodiversity, increased poverty and decline in cultural cohesion in fishing communities (Ostrom, 1990). Such crisis have led to the recognition of the need to change the basis of resource management and to the redesign of institutional regimes upon which fish resources are managed.

Responding to this crisis a set of different approaches to the governance of fisheries are in place including co-management, community-based management, ecosystem-based fisheries management and marine protected areas (hereafter MPAs) (Agardy, 1997; Lam, 1998; Roberts and Howkins, 2000; Pollnac *et al.*, 2001). MPAs have been receiving a high political attention worldwide. During the World Summit on Sustainable Development in Johannesburg 2002, governments agreed to create networks of MPAs before 2012 in order to improve the governance of the world's oceans.

MPA involves institutional change for managing fisheries in a sense that new body of rules and regulations must be designed, implemented and complied with the ultimate goal of recovering marine resources from collapse and/or depletion and in some cases with a more proactive role of avoiding such collapses. The World Conservation Union (IUCN) defines MPAs as "*any area of intertidal, or subtidal terrain, together with its overlying water and associated fauna, flora, historical or cultural features, which has been reserved by law, or other effective means, to protect part of all of the enclosed environment*". There are many different types of MPAs around the world, with different levels of protection and use, and implemented through different jurisdictions (from international to local; formal to informal institutions that sometimes may overlap). A MPA can be zoned to support multiple uses, including zones providing full-protection. Some authors have argued that the possession of at least one fully protected zone should be a minimum standard for MPAs (Agardy, 1997). A fully protected MPA is called Marine Reserve (known also as No-take zone) and it represents the most restrictive type of MPAs where "an area of the sea is completely protected from fishing and other extractive or harmful human uses" (Roberts and Hawkins, 2000). Although a Marine Reserve is one where fishing and extractive use (e.g. mining, dredging or curio collection) are not permitted,

[1] Department of Geosciences, Federal University of Rio Grande (FURG), Brazil. (danielak@furg.br)

some forms of non-consumption uses such as swimming, scuba diving, snorkeling, recreational boating, passage of shipping can be allowed up to levels which do not harm the environment (Roberts and Hawkins, 2000).

Marine Reserves are one of the most restrictive types of institutional arrangements to manage common pool resources. Common pool resources, such as fish, are those characterized by the difficult exclusion of users that share, extract and compete for the same resources (Berkes and Folke, 1998). MPAs establish the legal rights to exclude extractive activities within a particular area moving in many cases from a situation of free access to all to a situation of no access at all.

The problematic of access rights to resources has been the focus of more than three decades of studies on common property resources. The common property theory (McCay and Acheson, 1987; Berkes, 1989; Ostrom, 1990; Bromley, 1992; Hardin, 1968;1998; Berkes and Folke, 1998; Ostrom *et al.*, 1999; Berkes *et al.*, 2001; Jentof and McCay, 2003; Pinkerton, 2003) has enabled researchers to understand the factors and draw new insights about problems and conditions to favor sustainable use of common-pool resources, looking at changes of arrangements and how crisis has been adapted over time (McCay and Acheson, 1987; Ostrom, 1990; Jentoft and McCay, 1995; Ostrom *et al.*, 1999; Seixas, 2000; Steins *et al.*, 2000; Jentoft, 2000). Also relevant has been the literature on co-management, or power-sharing between government agencies and non-governmental groups (Pinkerton, 1989; Jentof and McCay, 1995), as well as the field of participatory and action research (Pinkerton, 1989; Jentof and McCay, 1995; Campbell and Salagrama, 1999; Jentoft, 2000; Berkes *et al*., 2001; Berkes, 2002; O'Riordan, 2003; Wilson *et al.*, 2003; Kalikoski and Satterfield, 2004) whereby scientists, fishermen and other community members collaborate in various dimensions of fisheries research and management. The lessons drawn from such theories can be very useful to the debate around MPAs and, consequently, to their successful implementation as a way to reconcile fisheries with conservation. Much of thinking about the role of MPAs in fisheries management has been concentrated on its advantages and usefulness as a tool to resources conservation, with less attention to its actual and potential problems to fishing livelihoods. Focusing not only on the resource itself but also on the resource user, the theory of common property resources can bring to the debate about MPAs a set of principles for designing and evaluating institutional failure and success in common pool resources management, and organizing principles for guiding responsible solution for sustainable fisheries management.

In this paper I discuss under which circumstances can MPAs reconcile fisheries with conservation, focusing on the problem of rights to the use and prohibition of fishing in opposition of only addressing resources conservation and protection, in a dichotomy between society and nature. The main assumption is that MPAs must strengthen participatory policies that fully incorporate fishing communities and their ecological/traditional/local knowledge into their design and implementation process, otherwise

in many cases, and notably in developing countries, such a conservation instrument may cause a series of unintended socio-economical problems related mainly to the rights to exclude people/cultures from their means of subsistence that, in many cases, have been key to the conservation of fisheries, as identified in Johannes *et al*. (2000).

The issues briefly discussed below are elements for debating the role of MPAs for reconciling fisheries with conservation in the light of the common property theory debate.

Marine Protected Areas and the Issue of Access Rights

As identified by Ostrom (1999), closing and/or limiting the boundaries and prohibiting resource extraction within an area are key for fisheries conservation as it represents a first step in fisheries management. When resource use is under a free access regime, the difficulty to maintain life support systems and resource users livelihood increases. By defining boundaries for the common pool resources and rights for exclusion, resources users are more likely to benefit from their efforts to manage the resources (Ostrom, 1990; Pinkerton, 1989). MPAs have an impact on this very issue as its fundamental initiative is the closure of boundaries to resource use. An important question to be made that should be more broadly discussed in the MPA debate relates to the issue of exclusion, i.e. how boundaries of resources use should be closed and by whom? This question can be further articulated as follows (Folke *et al*., 1998):

- right to what? What resource or ecosystem attribute is the right over? (What is the valuable property in question) and what are its spatial and temporal scales?

- right for what? What are the legitimate uses or actions which are permitted (relative to the resource)? This involves the rights of use, transfer, and administration.

- for how long? The temporal scale of the right includes the customary length of tenure, which may be for a season, for a lifetime, or until some specified conditions hold. There are several attributes that will govern the temporal scale of the right, relating to the time scale of the resource (lifespan, rates of movement), the period of tenure (allowable season of harvest, lifespan of the holder) and the time scale of the right guarantor.

- for whom? Who holds the right? Who could potentially hold the right? Is it an individual or a collectivity? How is the collective specified? This is a question of scale also, as measured by numbers of actual and potential stakeholders, or by the territory that they occupy.

- against whom? Who is excluded from using the resource because of the property right?

- upheld by whom? Who guarantees that the right may be exercised and that others may be excluded? The spatial scale of the guarantor is most probably specified by political rather than ecological boundaries".

The experience in many developing countries is that protected areas are implemented by top-down approaches influenced by national and international organizations such as World Bank, WWF, IUCN, Greenpeace. In the sea, the areas prone to be closed are usually coastal areas of high biological diversity and productivity (such as coral reefs) which for the same reason, also provide the means of subsistence and livelihoods of small-scale fishers. Therefore very often they are the ones that have their resource use rights suppressed in favor of a conservationism that benefits other groups, including tourists, governmental elites, environmental NGOs and natural scientists (Guha, 1997 *apud* Diegues, 2000).

Marine Protected Areas, Territories and the Issue of Power

Implementing MPAs involve redefining fishing territories. Human territories are fundamental methods of controlling space and resources (Malberg, 1985). Territoriality can happen in different scales (individual, family, race, community) and under different forms of resource control (points, bays) (Begossi, 1998). The territoriality in human populations is not necessarily an aggressive behavior, in many cases, resources are obtained through disputes, but in others, there are local norms such as kinship relationships that regulate access to resources through informal fishing accords (Begossi, 1998).

Territories are created based on knowledge of the location of a good fishing ground and legitimized by devising formal or informal organization (institutions) based on the best way to use and maintain resources extraction over time. Fishing rights and fishing territories are important institutions that deal directly with the issue of power, because those who define and control fishing territories detain also the power to control the management of such natural capital. Territories have been used in many cases to develop more restrictive institutions that control the way resources are extracted from the sea: laws and regulations to the distribution, use and transfer of rights with relationship to the commons.

Therefore by redefining who can fish and where (use and exclusion rights), MPAs can affect the power relationship established to use marine territories in a given location. For this reason when MPAs are created and imposed from top-down without the involvement of fishing communities, they become an instrument of marginalization and disruption of small-scale fishing communities. The history of centralized institutional arrangements for fisheries management worldwide is included with examples of how state control management can weaken and disrupt local institutions that could in turn have negative effects to resources conservation (Jentoft and McCay, 2003). Policies devised by the State regarding the exploitation of marine resources (how?, when?, and by whom fish should be allowed?) were

made not free from conceding privileges to some particular interests groups (industrializing fishing sector) over others (small-scale fisheries) (Diegues, 1995). As discussed by Becker (2000) "*the appropriation of decisions concerning the use of territories and environment as value reserves, or in other words, without an immediate productive use, constitutes a means of control of natural capital for the future*".

In practice, small-scale fishing communities worldwide have been disempowered and largely marginalized from the process of decision making in the management of local resources. The tendency has been to point at small scale fishers as the culprits for resource decline and stock collapses. Even though the proper involvement and representation of fishers in the governance of fisheries resources is a pre-condition for the design of MPAs and to design policies that are acceptable to local communities and are consequently supported by those communities (Roberts and Hawkins, 2000). A comparative evaluation on the spread of MPAs in the Philippines have shown that only 20% of the MPA approaches were in fact successful, as compared to those other 80% that took top-down centralized approaches that have been suffering the consequences of lack of community involvement, and support (Pollnac *et al*.,2001). Decades of accumulated research has demonstrated that local community-based management initiatives is key to deal with such global impacts and may be the best approach that should be taken into consideration when implementing MPAs (Ostrom, 1990; Cordel and McKean, 1992; Gadgil and Guha, 1992; Berkes and Folke, 1998; Johannes *et al*., 2000; Wilson *et al*., 2003; Hilborn *et al*., 2005; Kalikoski and Vasconcellos, 2006).

Marine Protected Areas and the Issue of Resource Use Legitimacy

The involvement of communities in the management of common pool resources carries with it legitimacy and respectability. The merits of involving the public in management are that greater participation by user groups in management enriches the regulatory process by providing a broader base of information (Ostrom, 1990; Jentoft, 2003; Jentoft and McCay, 2003; Pinkerton, 2003). Inclusion of the users in the MPAs increases the legitimacy of the regulations. Increased legitimacy results in enhanced adherence to rules and regulations, which contribute to more efficient MPAs, and can be greatly important for reconciling fisheries with conservation (Agardy, 1997; Allison *et al.*, 1998; Roberts and Hawkins, 2000). Local users learn the unique aspects of a local environment and may fit rules to such conditions. Legitimacy also refers to the extent of government recognition that allow for the rights of resource users to organize their own rules to manage the resources without being challenged by government officials (Ostrom, 1990; Folke *et al.*, 1998; Kalikoski *et al.*, 2002). In this sense it may involve the transfer and/or delegation of rights to use and manage MPAs accordingly and in a dynamical fashion. Legitimacy occurs when the legislation in place enables the decentralization and sharing of management authority. In this context it is important that the legal framework that regulates the use of marine areas

takes into account mechanisms of participation and adaptation of rules to the different realities and to the changes through time of local resources conditions and communities' livelihoods circumstances. The international legal regime for the use of the oceans is the UN Convention on the Law of the Seas. The Convention establishes the rights and responsibilities of coastal States to use and manage resources within the Territorial Sea and the Economic Exclusive Zone.

In Brazil, for instance, marine areas within the 200 miles zone, although considered of public domain for common use, are ultimately controlled by the State which establishes through specific legislation the norms and rules controlling the use and management of marine resources. The Brazilian National System of Conservation Units defines the types of protected areas that can be implemented for the protection and conservation of terrestrial and marine ecosystems. This legislation has been adapting over time from centralized top-down authoritarian conservation approaches to a coexistence of localized community-based approaches, where more efficient conservation strategies shown to be compatible with sustainable resource use and extraction. On the other hand, the first case already shows failures to conserve resources and maintain sustainable uses (Diegues, 2002). As pointed by Diegues (2000), the change in the approach for conservation during the last two decades resulted from the large scale failure of classic conservation approaches that separate human societies from nature and the paradigm shifts in the conservation science which has been increasingly recognizing the role of traditional ecological knowledge for biodiversity conservation and the birth (or rediscover) of a new conservation (ethnoconservation), based on a non dichotomized relation between society and nature (Diegues, 2000).

The Role of Traditional Knowledge in the Creation of Marine Protected Areas

Communities can and have designed management regimes to achieve sustainability and to minimize fisher's vulnerability. They have the mechanisms to apply adaptive management more efficiently as they read, interpret and respond to natural signs and have the conditions to rapidly adapt management strategies. For centuries, artisanal fisheries have played an important role in maintaining fisheries sustainability. The knowledge-practice-belief complex of fishing communities has been termed traditional ecological knowledge (Berkes, 1999). This complex incorporates not only the knowledge about resources and ecosystems but also forms of resource management systems, social institutions (norms, rules, accords) and value systems that shape the interaction with the environment. The use of traditional knowledge in fisheries management regimes is a fact in small-scale fisheries around the world, and its relevance for improving the understanding of natural resources and ecological systems upon which fishing livelihoods depend should not be neglected if MPAs are to be successful (Kalikoski and Vasconcellos, 2006; Kalikoski and Satterfield, 2004; Berkes, 1999, Cordel and McKean, 1992). We can see different roles

for fisherfolk knowledge when dealing with the issue of rights in the process of implementing MPAs. As highlighted before, traditional knowledge define access rights through the set of practices, tools, techniques, territories, codes of conduct and rules in use that determine forms of access to resources. Recognizing the ecological knowledge that fisherfolks pursue as well as their traditional management systems (such as territories) lead to local empowerment because it legitimates those who detain the knowledge to act in the process of deciding where, how and by whom MPAs are to be established. As put by Diegues (2002) in his analysis on the myth of wilderness "not all inhabitants are born conservationists," but among them there exist traditional populations with a vast store of empirical knowledge of the workings of the natural world in which they live. Despite that, "traditional populations rarely participate in debates and decisions about conservation management" (Diegues, 2002).

Discussion and Final Comments

The particular issue of property rights vastly debated on the literature on common pool resources (CPR) is of extreme relevance to the discussion about implementing MPAs around the world. The CPR literature presents a framework for achieving sustainable use of natural resources looking at the institutional dimension of fisheries management. MPAs are one type of institutional arrangement for fisheries management with particular effect on the issues of rights: resource use and exclusion. Fishing exclusion is a delicate issue in fisheries management because it may affect directly the means of subsistence of many fishing livelihoods and consequently impact their human security.

Human security is defined by the Global Environmental Change and Human Security Program (GECHS) when individuals and communities (1) have the options necessary to end, mitigate or adapt to threats to their human, environmental, and social rights; (2) actively participate in attaining these options and (3) have the capacity and freedom to exercise these options. The question here is how can one implement MPAs that focus on reconciling fisheries with conservation in a way that allows reconciling human uses with their natural environment while allowing a responsible extraction of the resources in a resilient fashion? It is the assumption of this paper that MPAs will have a role in reconciling fisheries with conservation if it does not pose a threat to fishing livelihoods and their human security.

The worldwide experience in fisheries management during the last three decades has shown a general failure of governance systems in managing fisheries for conservation. Massive disruptions have impacted coastal and marine regions and what were previously sustainable fishing livelihoods are now becoming unviable. Technological change, structural adjustment reforms, global markets, political and economic marginalization of small-scale producers and global environmental change are all pressures which are leading towards a redefinition of fisheries management and of who has rights to resources. All of those factors are directly associated to the

institutional dimensions of resources management. One important factor that contributed for the failure of fisheries management was top-down centralized approaches to management that led to the industrialization of fishing, aggravating the race for fish, and shaped a productive industrial sector in detriment of fishing communities and conservation of resources. As put by Folke *et al*. (1998), part of the management problem that we face today is caused due to a disruption of community-based formal and/or informal institutions that have managed many resources in a sustainable fashion for centuries. We cannot afford to make the same historical mistake and exclude resource users from taking part in the discussion about the implementation of MPAs. In the debate about the role of MPAs in fisheries management much attention has been given to issues of size and design in relation to the characteristics of resources with less attention to its human dimensions (Hilborn *et al*, 2004). This paper attempted to make explicit some important institutional aspects of MPAs as fisheries management tools and consequently to contribute with theoretical elements for the evaluation of its role in reconciling fisheries with conservation.

Acknowledgements

The author thanks the Brazilian National Council for Scientific and Technological Development (CNPq) and the Coordination of Improvement of the Personnel of Hugh Education (CAPES) for the travel support to present this paper at the opening session on Reconciling Fisheries with Conservation and Protected Areas at the 4° World Fisheries Congress in Vancouver, Canada, from May 02-06, 2004. The author of this paper was the leader of this session.

References

AGARDY, M. T. 1997. **Marine protected areas and ocean conservation.** Academic Press, San Diego, California.

ALLISON, G. W., J. LUBCHENCO & M. H. CARR. 1998. **Marine reserves are necessary but not sufficient for marine conservation.** Ecological Applications 8 (Supplement): S79S92.

BECKER, B.K. 2001. **Amazonian frontiers at the beginning of the 21st century.** P: 299-324. In: Robin, D.J. & Tolmasquim, M.T. (eds). Human Dimensions of Global Environmental Change: Brazilian Perspectoves. Academia Brasileira de Ciencias, Rio de Janeiro, 392 pp.

BEGOSSI, A. 1998. **Property rights for fisheries at different scales: applications for conservation in Brazil.** Fisheries research 34: 269-278

BERKES, F. & FOLKE, C. 1998. **Linking Social and Ecological Systems. Management practices and social mechanisms for building resilience.** Cambridge University Press, UK, 459 pp.

BERKES, F. 1989. **Common property resources. Ecology and community-based sustainable development.** Belhaven Press, London, 302 pp.

BERKES, F. 1999. **Sacred ecology. Traditional ecological knowledge and resource management.** Taylor & Francis, Philadelphia, PA, USA and London, UK

BERKES, F. 2002. **Cross-scale institutional linkages: Perspectives from the bottom up.** In: The Drama of the Commons (E. Ostrom, T. Dietz, N. Dolsak, P.C. Stern, S. Stonich and E.U. Weber, eds.) National Academy Press, Washington DC, pp. 293-321.

BERKES, F.; MAHON, R.; McCONNEY, P.; POLLNAC, R. & POMEROY, R. 2001. **Managing Smallscale Fisheries. Alternative Directions and Methods.** IDRC, 320 pp.

BROMLEY, D.W. 1992. **The commons, property and common property regimes.** In: Making the commons work: Theory, Practice and Policy, pp. 3-15, ed. D.W. Bromley, San Francisco: Institute for Contemporary Studies.

CORDELL, J & M.A. McKEAN. 1992. **Sea tenure in Bahia, Brazil.** In Bromley, D.W. (Ed.), Making the commons work: Theory, practice, and policy. ICS Press, San Francisco, pp. 183–205.

DIEGUES, A. C. 2002. **The myth of wilderness and the fate of traditional communities in the Brazilian Amazon.** IASCP CONFERENCE-VICTORIA FALLS ZIMBABWE.

DIEGUES, A. C. S. 1995. **Repensando e recriando as formas de apropriação comum dos espaços e recursos naturais.** In: DIEGUES, A C. S. Povos e Mares: leituras em sócio-antropologia marítima. São Paulo: NUPAUB -USP, p. 209 -236.

FOLKE, C., L. PRITCHARD Jr., F. BERKES, J. COLDING & U. SVEDIN 1998. **The problem of fit between ecosystems and institutions.** IHDP Working Paper No. 2, Human Dimensions Programme on Global Environmental Change, Bonn, Germany.

GADGIL, M. & GUHA, R. 1992. **This fissured land: an ecological history of India.** New Delhi: Oxford University Press.

HARDIN, G. 1968. **The tragedy of the commons.** Science. 162:1243-8.
Haggan, N., Neis, B. & Baird, I.G.(eds.). 2006. Fishers' Knowledge in Fisheries Science, Coastal Management Sourcebooks 4. UNESCO: Paris,437 pp.

HILBORN, R.; ORENSANZ, J.M. & PARMA, A. 2005. **Institutions, incentives and the future of fisheries.** One contribution of 15 to a Theme Issue 'Fisheries: a Future? Philosophical Transactions: Biological Sciences, Volume 360, Number 1453, pp: 1471-2970.

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

JENTOFT, S.; McCAY, B.J. 1995. **User participation in fisheries management. Lessons drawn from international experiences.** Marine Policy, 19, 227–246.

JENTOFT, S. 2003. **Co-management: the way forward.** In: Wilson, D.C.; Nielsen, J.R. & P. Dengbol (eds) The fisheries co-management experience. Accomplishments, challenges and prospects. Kluwer Academic Publishers, London. Pp: 1-13.

JENTOFT, S. & McCAY, B. 2003. **The place of civil society in fisheries management: a research agenda for fisheries co-management.** In: Wilson, D.C.; Nielsen, J.R. & P. Dengbol (eds) The fisheries co-management experience. Accomplishments, challenges and prospects. Kluwer Academic Publishers, London. Pp: 293-305

JOHANNES R.E.; FREEMAN M.M.R.; HAMILTON R.J. 2000. **Ignore fishers' knowledge and miss the boat.** Fish and Fisheries, 1 (3): pp. 257-271(15) Blackwell Publishing

KALIKOSKI, D.C. & SATTERFIELD, T. 2004. **On Crafting a Fisheries Co-management Arrangement in the Estuary of Patos Lagoon (Brazil): Opportunities and Challenges Faced through Implementation.** Marine Policy, 28, pp: 503-522.

KALIKOSKI, D.C. & VASCONCELLOS, M. 2006. **The Role of Fishers' Knowledge in the Co-management of Small-Scale Fisheries in the Estuary of Patos Lagoon, Southern Brazil.** In: Fishers' Knowledge in Fisheries Science and Management. (eds Haggan, N., Neis, B. and Baird, I.G.), Coastal Management Sourcebooks 4. UNESCO: Paris, pp. 289-312.

KALIKOSKI, D.C.; VASCONCELLOS, M. & LAVKULICH, L.M. 2002. **Fitting institutions and ecosystems: the case of artisanal fisheries management in the Patos lagoon**, Marine Policy, 26 (03), pp: 179-196.

LAM, M. 1998. **Consideration of customary marine tenure system in the establishment of marine protected area in the South Pacific.** Ocean and Coastal Management, 39: 97-104

MALBERG, T. 1985. **Territoriality at sea: preliminary reflections on marine behavioral territories in view of recent planning.** Man-Environment Systems 15:15-18.

McCAY, B.J.; ACHESON, J.M., ed. 1987. **The question of the commons.** University of Arizona Press, Tucson, AZ, USA.

O'RIORDAN, T. 2003. **Deliberative democracy and participatory biodiversity.** In: T. O'Riordan & S. Stoill. Biodiversity, Human Livelihoods and Sustainability: Protecting beyond the Protected. Cambridge University Press.

OSTROM, E. 1990. **Governing the commons. The evolution of institutions for collective action.** Cambridge University Press, Cambridge, UK

OSTROM, E.; BURGER, J. FIELD, C.B., NORGAARD. R.B. & POLICANSKY, D. 1999. **Revisiting the commons: local lessons, global challenges.** Science 284: 278-282

PINKERTON, E. 2003. **Toward specificity in complexity: understanding co-management from a social science perspective.** In: Wilson, D.C.; Nielsen, J.R. & P. Dengbol (eds) The fisheries co-management experience. Accomplishments, challenges and prospects. Kluwer Academic Publishers, London. Pp: 61-76.

PINKERTON, E., ed. 1989. **Co-operative management of local fisheries: new directions for improved management and community development.** Vancouver: University of British Columbia Press.

POLLNAC, R.B.; CRAWFORD,B.R.; MAHARLINA L.G. & GOROSPE. 2001. **Discovering factors that influence the success of community-based marine protected areas in the Visayas, Philippines.** Ocean and Coastal Management, 44: 683-710.

ROBERTS, C.M. & J.P. HAWKINS. 2000. **Fully-protected marine reserves: a guide.** WWF Endangered Seas Campaign, 1250 24th Street, NW, Washington, DC 20037, USA and Environment Department, University of York, York, YO10 5DD, UK.

SEIXAS, C. 2000. **State-Property, Communal Property or Open-Access? The Case of Ibiraquera Lagoon, Brazil.** Presented at "Constituting the Commons: Crafting Sustainable Commons in the New Millennium", the Eighth Conference of the International Association for the Study of Common Property, Bloomington, Indiana, USA, May 31-June 4 (http://dlc.dlib.indiana.edu/documents/dir0/00/00/10/28/index.html).

STEINS, N.A.; RÖLING, N.G. & EDWARDS, V.M. 2000. **Re-'designing' the principles: An interactive perspective to CPR theory. Papers of the International Association for the Study of Common Property**, June 2000, Bloomington, Indiana, USA. (http://www.indiana.edu/~iascp2000.htm.)

WILSON, D.C. 2003. **The community development tradition and fisheries co-management.** In: Wilson, D.C.; Nielsen, J.R. & P. Dengbol (eds) The fisheries co-management experience. Accomplishments, challenges and prospects. Kluwer Academic Publishers, London. Pp: 17-29.

Fisheries Co-Management in The Cananéia, Iguape and Ilha Comprida Estuarine-Lagoons Complex and Adjacent Coastal Area

Ingrid Cabral Machado [1]
Jocemar Tomasino Mendonça [1]

The Work Area

The Cananéia, Iguape and Ilha Comprida Estuarine-lagoons Complex and adjacent coastal area are situated immediately to the south of the Tropic of Capricorn, on the south coast of the State of São Paulo. In São Paulo territory, the estuarine area is approximately 2,500 sq. km, and is influenced by the Basin of the Ribeira de Iguape River, and by sets of other rivers, forming an extensive mosaic of islands, tide channels, rocky shores, mangrove swamps and beaches. Its larger islands (Cananéia Island, Cardoso Island and Comprida Island) form a natural barrier of protection from maritime turbulences and the action of the winds, protecting the balance of the salt waters and the deposited sediment, and propitiating the occurrence of extensive areas of mangrove swamp (Sales and Moreira, 1996). The predominance of mangrove vegetation propitiates a natural nursery for diverse marine species, and this area is recognized by the World Conservation Union (IUCN) as the third most important environment for the marine productivity of the South Atlantic. The region in question encompasses three cities of São Paulo's south coast: Iguape, Cananéia and Ilha Comprida. Cananéia and Iguape, two of the oldest cities in the country, were once important mining, shipbuilding and rice growing centers which endowed these cities with considerable economic prosperity between the 17th and 18th centuries. However, due to innumerable factors, the region did not keep up its initial prosperity and nowadays presents a low human development index (HDI). Ilha Comprida became an independent municipality in 1994, and its economic base is tourism, with fishing as one of the attractions of that sector. Increasing urbanization as a consequence of summer residence tourism can be verified in the city, due to the 75 km of beaches. The city still preserves its natural characteristics, with a population divided into *caiçaras* (traditional local residents) and tourists. Difficult access has contributed towards a certain isolation of the region, which has favored the conservation of its natural resources. It is been internationally recognized as a World Natural Heritage (UNESCO, 1999), and it is a Nuclear Zone of the Atlantic Forest Biosphere Reserve (UNESCO, 2005).

According to Sales and Moreira (1996), in the sixties, the State investment in infrastructure in the region provoked an accentuated increase in land values, unleashing processes of illegal occupancy of land, and real estate

[1] Fisheries Institute (São Paulo) - Marine Fisheries abd Agrobusiness Technology Research Center. Division of Research and Development of South Coast. Email: ipcananeia@yahoo.com

speculation, that have affected the community significantly. Added to this pressure, several protected areas have been created in the region, restricting access of the resident community to traditionally practiced activities, mainly subsistence agriculture. With the implementation of protection measures for native forest vegetation, the community has turned increasingly toward fishing which has started to become the main economic activity of the region.

This panorama has been favorable in fortifying and consolidating the "caiçara" culture (the local term for the way of life of the Southeastern coastal peoples), characterized by obtaining a livelihood based on seasonal extractivist activities of various natural resources.

Up until the end of 2002, the following protected areas existed on the São Paulo south coast and contiguous area: Cananéia-Iguape-Peruíbe Federal Protected Area (APA-CIP/IBAMA), Ilha do Ameixal (IBAMA/Area of Relevant Ecological Interest), Juréia-Itatins Ecological Station (SMA-SP), Chauás Ecological Station (SMA-SP), Ilha do Cardoso State Park/SMA-SP, Jacupiranga State Park (SMA-SP) and Ilha Comprida State Protected Area (SMA-SP). In December, 2002, the Mandira Extractivist Reserve was created.

Fishing in the Region

Fishing is the economic base of Cananéia and Iguape and represents a very important source of income for Ilha Comprida. Tourism appears as an alternative that is undergoing expansion in Cananéia and Iguape, and is the main activity generating income for Ilha Comprida.

The region's great variety of fish, crustaceans and shellfish has led to the diversification of fishing techniques practiced by the local communities. Some of these practices are: collecting shellfish like oysters, mussels, cockles and lucines; catching crustaceans like crabs and shrimps; and catching several types of fish like the great shoals of migratory fish, or fish from the populations of the Complex itself.

Amongst the fishing techniques practiced in the estuary we can mention: drag seines, gillnets and vertical longlines, to catch various types of fish; the "gerival" for catching shrimps; the "puçá", for catching blue crabs; the "corrico" or "manjubeira", for catching broadband anchovy, covered pots for catching prawn and lobsters and the "iriko" net, for "iriko" fishing (Mendonça *et al*, 2000; Mendonça and Katsuragawa, 2001; Cardoso, 2004). Coastal fishing makes use of beach drag nets and various drag nets for shrimp and fish; gillnets; horizontal longlines, etc.

The main fishing activity in this region is small scale and simple, involving approximately five thousand fishermen, with the estuary and coastal regions being the main places for their activities. Most of the fishermen work in an independent way, with their own means of production, alone, with their families, or in partnership with other fishermen. In general,

these fishermen have not evolved in their small scale fishing, so they tend to become employees of boat owners, or they abandon their profession altogether, and migrate to urban centers (Neiva, 1990). Currently, already indications of over-fishing several fishing resources of the region due to deficient management of the activity (Mendonça and Katsuragawa, 1997 and 2001).

According to Instituto de Pesca/SAA-SP data, that monitors the unloading of catches in the estuary and coastal areas, the products found in this region are: white sea catfish (*Genidens barbus*), Southern kingcroaker and Gulf kingcroaker (*Menticirrhus americanus* and *M. littoralis*), Caribbean sharpnose shark (*Rhizoprionodon porosus*), Smalleye hammerhead (*Spyrna tudes*), green weakfish (*Cynoscion virescens*), broadband anchovy (*Anchoviella lepidentostole*), Caitipa mojarra (*Diapterus rhombeus*), Whitemouth croaker (*Micropogonias furnieri*), King weakfish (*Macrondon ancylodon*), Itajara (*Epinephelus itajara*), Common snook (*Centropomus undecimalis*), fat snook (*Centropomus parallelus*), Castin leatherjacket (*Oligoplites saliens*), Coco sea catfish (*Bagre bagre*), seabob shrimp (*Xiphopenaeus kroyeri*), Sand tiger shark (*Odontaspis taurus*), guitarfish (*Rhinobatos horkelli*), southern white shrimp (*Litopenaeus schmitti*), pink shrimp (*Farfantepenaeus brasiliensis* and *F. paulensis*), dusky grouper (*Epinephelus guaza*), Jamaica weakfish (*Cynoscion jamaicensis*), grey mullet (*Mugil platanus*), white mullet (*Mugil curema*), Largehead hairtail (*Trichyurus lepturus*), acoupa weakfish (*Cynoscion acoupa*), Atlantic tripletail (*Lobotes surinamensis*), Smooth weakfish (*Cynoscion leiarchus*), black margate (*Anisotremus surinamensis*), Western Atlantic seabream (*Archosargus rhomboidalis*), Madamango sea catfish (*Arius spixii*), Atlantic sabretooth anchovy (*Lycengraulis grossidens*), Smalleye croaker (*Nebris microps*), mangrove land crab (*Ucides cordatus*), Blue swimming crab (*Callinectes danae* and *C. sapidus*); mangrove oyster (*Crassostrea brasiliana*), *Mytella falcata and M. guianensis* (mangrove mussels), *Perna perna* (rocky shore mussel), Pointed venus (*Anomalocardia brasiliana*), Thick lucine (*Lucina pectinata*), among a variety of other products.

The CONAPA CIP as a Sphere of Fishery Governance in the Region

The process of composing the Management Council for the Cananéia, Iguape and Peruíbe Federal Protected Area – CONAPA CIP / IBAMA, carried out with ample participation of the sectors involved in the area, begun in 1994 with the holding of the first public consultations and workshops for the elaboration of the Protected Area Management Plan, which was completed in 1996. The process evolved until, in 1998, a Provisional Management Committee was formed. In October, 2001, a meeting for the formation of the Management Committee of the CONAPA CIP was held, and in November, 2001, the Council started work with its first ordinary meeting. In 2002, the Deliberative Council of Cananéia, Iguape and Peruíbe Protected Area - CONAPA CIP - was officially constituted by IBAMA Decree number 64/02.

The Council of the Cananéia, Iguape and Peruíbe Federal Protected Area - CONAPA CIP represents the main sphere for discussing, planning and management of fishery resources, in the region of the Cananéia, Iguape and Ilha Comprida Estuarine-lagoons Complex, and adjacent coastal area. In the council, agreements, rules and orientation for the actions to be undertaken are established, thereby reducing conflicts and impacts, and aiming at the sustainability of the available resources, by means of a shared process of management. In this sphere of management, proposals are elaborated and discussed, regarding normatizing, inspection, zoning, conservation and protection, improvement of income and sustainable development of fishing activities, in compliance with the policies in place within the scope of the region.

In the CONAPA CIP Technical Chamber of Fisheries, a forum for open debate with participation of the public, there are representatives of the Fishing communities and other Fishing organizations such as the Pastoral da Pesca (Religious Fishery Social Movements) that work with fishing populations of Cananéia and Iguape; the Municipal Authorities and the Local Council members of the Iguape, Cananéia and Ilha Comprida town councils, the Instituto de Pesca/SAA-SP (Fishery Institute), the Iguape and Ilha Comprida. Casa da Agricultura/SAA (Agriculture Agency) as well as civil organizations operating in the region. There, proposals for alterations to the decrees that regulate fisheries and proposals for the production and distribution of environmental education material are elaborated and proposals for the management of fishery resources and for regulating fishing in the region are debated.

The Fisheries Management Project

The Fisheries Management Project (Sustainable Use of the Cananéia, Iguape and Ilha Comprida Estuarie-Lagoons Complex and Adjacent Coastal Area, financed by the Fundo Nacional do Meio Ambiente [National Environment Fund], and executed by the Fisheries Institute jointly with partner entities), started in May, 2004, and covering a period of 2 years, was elaborated within the sphere of the Fisheries Technical Chamber - CONAPA CIP between December 2002 and April 2003, and had as its main base the priority proposals of the Fisheries Management Plan of that same body. The Coastal Fisheries Management Plan consists of an orientation document of the CONAPA, in which fisheries in the region are described and debated, including the production data, the socio-economic and environmental characterization of the activity since 1995 (biology of endangered species, fishing seasons, structure of commercialization and incomes, productive chain, production of each city, socio-economic profile of the users of fishery resources, fishery problems, fishery legislation in the region, conflicts in the use of resources, official programs on fishing issues in the region, priority actions for the activity and the possibility of introducing economic alternatives).

To structure fisheries co-management, the Fisheries Management Project proposed some goals which involve the consolidation of the recently created Extractive Reserve (the Mandira RESEX) to serve as a possible alternative management model; expansion and structural organization of the monitoring and evaluation of the region's fishing production statistics; consolidation of the CONAPA CIP as the management authority for fishing affairs in the region; the elaboration and execution of a participative inspection and surveillance program; the creation of a training and environmental education program, as well as publicizing the activities being carried out, and the implementation of proposals for the management of natural resources aimed at the sustainability of productive activities. The resources that had been contemplated in the management proposals were mangrove mussels, rocky shore mussels, blue crabs and pink shrimp, functioning as models for the study and proposal of management plans for other exploited resources.

Outstanding among all the proposals of the Fisheries Management Project, the setting in motion of the process establishing regulatory order in fishing activities through the revision, substitution or formulation of legal instruments to regulate fishery resource use, is the main basis for the management process now underway whose main justification is the administrative regime of legally protected areas (conservation units).

It is expected that the implementation of this proposal will intensify integration among the various entities in the region in such a way that the dynamics of fisheries management will fortify the permanent staff that conducts the process, generating expertise and legitimacy in their management, sustainability of productive activities and preservation of the quality of the environment.

Results

The Fishery Management Seminar

The Seminar on Fishery Management in the Cananéia, Iguape and Ilha Comprida Estuarine-Lagoons Complex was the opening event of the Fisheries Management Project, in March, 2004. The purposes of this event were: i) the presentation of the project; ii) acquiring knowledge of and debating alternative models of fisheries management, through the presentation of projects from other regions and iii) the determination of procedures and premises of fisheries management in the working region.

The following institutions and entities were present at the Seminar: Fisheries Technical Chamber of the Management Council of the Cananéia, Iguape and Peruíbe PA – CONAPA-CIP (APA CIP), Fisherman Association of Cananéia, Fisherman Association of Iguape, Religious Fishery Social from Cananéia and Iguape, SOS Mata Atlântica Foundation, Municipal Fishery and Environment Department of Ilha Comprida, Municipal Fishery and Environment Department of Iguape, Fisheries Institute, Iguape Agriculture

House, Ilha do Cardoso State Park and the Tupiniquins Ecological Station; representatives of the industrial and cooperative fisheries sector in the region; representatives of IBAMA (Federal Environment Agency); Federal Protection Areas of Guaraqueçaba and of Cananéia, Iguape e Peruíbe; Environment Ministry; Fishery Ministry; and AVINA Foundation.

As a product of this meeting, a plenary document was constructed, indicating the procedures for participative fisheries management in the PA CIP area, so that normative instructions put in force in the region may be backed and guaranteed by the local management authority (CONAPA-CIP).

The alternative models of fisheries management selected to provide supporting elements for the debate at this event were: the Federal Protection Area of Costa dos Corais Fisheries Management Program – Pernambuco and Alagoas States, presented by Dr. Mauro Maida (Federal University of Pernambuco), whose main objective is the protection of the reef system; and the Lagoa Mirim and Lagoa dos Patos Fisheries Management Program – Rio Grande do Sul State, presented by Dr. Hamilton Rodrigues (CEPERG/ IBAMA), whose main objective is the protection of fishery stocks. Of these models, the Lagoa Mirim and Lagoa dos Patos are not in a conservation unit, thereby presenting many ecosystemic similarities to the working region of the Fisheries Management project, as it is one of the greatest estuarine complexes in the country.

The models of fisheries management presented showed management dynamics based on four common elements: i) profound knowledge of fishing activities in the working area; ii) construction of a local management authority; iii) implementation of a registration and licensing system to control and limit fishery users; iv) the implementation of a local system of regulations for fishing activities.

By the end of the seminar, these premisses applied to the proposed management model for the Cananéia, Iguape and Ilha Comprida Estuarine-lagoons Complex and adjacent coastal area, had generated a draft fisheries management document that was forwarded to IBAMA for validation and publication as a legal instrument, which has since been used as the basis for handling proposals for regulating fishing activities (annex I).

Since the Seminar was held, all regulatory proposals constructed in a participative manner within the sphere of the Technical Chamber of the CONAPA CIP, have been conducted in compliance with the said document, apart from occasional specific situations.

Fisheries Regulatory Proposals for the APA-CIP

Iguape's "Manjuba" fishing

Iguape's "manjuba" (*Anchoviella lepidentostole*) is one of the natural resources of the greatest economic and social importance for the city and region of Iguape, involving more than 2,500 fishermen (Mendonça *et al*, 2000). In this activity two types of fishing techniques are used: the "manjubeira", which is a fence-type seine that surrounds the shoals of fish and is then pulled in to the banks of the river (Rossi-Wongtschowski, 1990), and the "corrico" technique where a gillnet is allowed to drift in the water floated from the surface (Mendonça *et al*, *op. cit*.). (Figure 1)

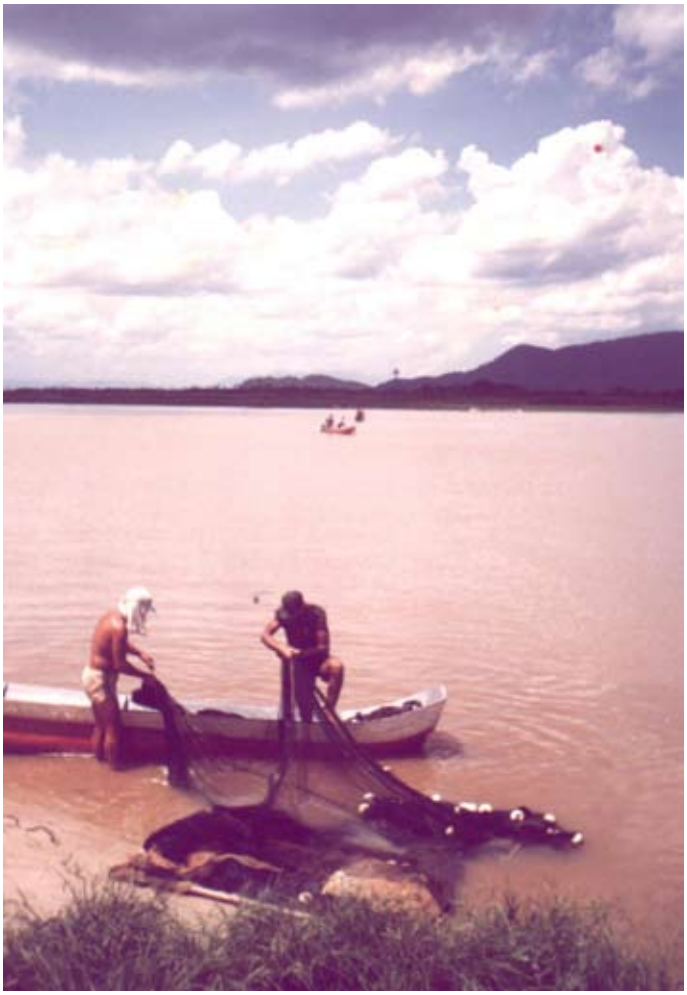


Photo: Jocemar Mendonça

Figure 1 - Iguape's "Manjuba" (*Anchoviella lepidentostole)* fishing.

The exploration of this fishery resource gained importance as an economic activity in nineteeen twenties and quickly developed so that by 1949 it was supporting 21 anchovy-salting industries installed along the Ribeira de Iguape River (Giulietti, 1992). However in the same way that it prospered, since 1970 anchovy fishing has been showing a tendency towards biological and economic decline. The main factors that have contributed to such a situation are of an administrative and environmental order. Some examples of these factors are the increase of the requirements of the health surveillance agencies, leading to the closure of some industries. In 1974, only 11 anchovy salting industries were still in operation (Giulietti, *op. cit.*). Currently, the number is only three.

Due to the importance of manjuba fishing, since 1982, several regulatory norms have been proposed and implemented aimed at resource maintenance and activity improvement. In 2003, the subject was widely debated with fishing communities, bringing together scientific knowledge of the resource and the empirical knowledge of the fishermen, for the construction of a norm to meet the need to preserve the resource, and the needs of the fishermen that depend on anchovy. In these debates, the situation of the anchovy stocks was presented, the incomes of fishermen and the entire panorama of the Iguape anchovy fishing productive chain.

On June 17th, 2004, the regulatory proposal based on the technical data of the activity and on the discussion made with the fishermen was finally published (Normative Instruction number 33, 17/06/2004). This fact was marked as the first experience of fisheries co-management in the region and that has led to the production of a legal instrument.

To consolidate the involvement of the fishermen, after publication of the normative instructions, 11 meetings were carried out with the fishermen's communities to disseminate awareness of the new law and to consider other strategies for the effective control of the activity, apart from inspection and surveillance strategies.

Beach Dragnet

The need to regulate beach dragnet fishing was perceived due to its being a non regulated activity carried out by small groups of traditional fishermen along the Ilha Comprida coast and the south of Cardoso Island probably ever since the sixties.

Beach dragnet fishing, locally called "lanço de praia", has existed in Brazil for many years, ever since the fifties, and is carried out on sandy beaches, of the low energy type, where these present gentle slopes and great extensions for stretching the net. Currently few groups practice this type of fishing. (Figure 2)

Photo: Jocemar Mendonça

Figure 2 - Beach dragnet fishing at Ilha Comprida.

Although beach dragnet fishing is a not selective modality, it is considered of low impact due to: the use of legal mesh sizes recommended for the activity in São Paulo State; the small number of fishermen involved (80 people); the low volume of fish caught; the majority of the catches being of species above of the size of first maturation; its being done without traction machinery or other devices that favor the increase of the fishing effort; and the rate of rejection is less than 1% of the catch. At the request of fishermen practicing this kind of fishing, meetings were held to debate its regulation, supported by monitoring data on beach seine fishing on Ilha Comprida supplied by the Instituto de Pesca/SAA-SP.

The regulation proposal constructed was presented to the fishermen in the form of public consultation, duly approved and then forwarded to IBAMA, for validation and publication (Normative Instruction number 49, dated September 14th, 2004).

"Iriko" Fishing

Iriko Fishing (*Anchoa* sp.) is carried out in the Ararapira channel and has been a 'Caiçara' (traditional local population) activity that has been going on from the south of Cardoso Island - SP, up to Paranaguá Bay - PR, for around 70 years. The need to regulate this activity sprang from the existence of restrictions to it in the legislation that hinder the activity and penalize the fishermen who carry it out.

The species captured in iriko fishing belong to the family Engraulidae, of the genus *Anchoa*, and the main species caught are *A. marinii* ("manjuba chata") and *A. tricolor* ("manjuba branca"), with small catches of *A. lyolepsis* ("manjuba prego" or "boca rasgada"). The total number of fishermen involved is 68, with a maximum income of one minimum salary (Cardoso, 2004).

Although they use a net of low selectivity, with a mesh of approximately 2 mm, iriko fishing is considered of low impact due to the following factors: i) it is directed at only a few species; ii) there is low presence of accompanying fauna of species that are not in danger of overfishing; iii) there is a small number of fishermen and nets active in the region.

The work directed at regulating iriko fishing was done through the Fisheries Technical Chamber of the CONAPA-CIP, which assigned to a technical committee to carry it out. This committee produced a program of technical meetings for elaborating preliminary proposals for regulating iriko fishing. Later, meetings with the communities were held to make a preliminary survey of the fishermen and make adjustments to the regulatory proposals. After the meetings, all fishermen and nets involved in iriko fishing were duly registered. With the analysis of the data the final proposal for regulating the activity was drafted.

The draft was submitted to the CONAPA-CIP for analysis, approval and forwarding to IBAMA. On June,17 2005, the Normative Instruction that regulates iriko fishery in the south of the municipality of Cananéia, was published (Normative Instruction Number 115, dated June 17th, 2005).

Tidal Fence Trap Fishing

Small scale traditional fishing with fixed fence traps is an activity carried out by estuarine fishermen along practically all the Brazilian coast, extending from the state of Paraná to the state of Amazonas (Bando, 1952). This distribution occurs mainly because these areas are under strong influence of tides, which is the basic principle for fishing with fence trap techniques. In the south of the State of São Paulo, in all estuarine-lagoon regions, fence traps have been one of the main devices for the capture of “tainha” (mullet) and other fish for more than fifty years (Ramos *et al.*, 1980).

This device is composed of traps placed along the edges of the estuary, basically made of wooden poles or bamboos (“mourão”), that serve as a base and give support to the structure. “Taquara” (*Phyllostachys aurea*) or strips of bamboo attached to each other with galvanized wire, are used to form the “panagem” or “palha”, as it is known by the fishermen, a kind of bamboo mat that covers the fence and is attached to the posts or “mourões”. The space between the bamboos strips varies according to the time of year; in the summer it is around 3 cm and in the winter 5 cm, according to the size of species being sought for. The fences can be found in the estuary throughout the year, however, there are greater numbers in the months of the mullet harvest (June to September), worked exclusively for fish. Generally this kind of fishing catches adult individuals and does not affect the fish population as a whole as the take is small. (Figure 3)

Photo: Alineide Pereira.

Figura 3 - Tidal Fence Trap Fishing at Cananeia estuary.

In Rio de Janeiro, ever since 2001, IBAMA Decree number 37, dated March 6th, 2001, has established norms, criteria and standards for the rights concession and regulation of fixed fence fishing in the lagoons, bays and coves of the state of Rio de Janeiro. Although the fishing activity with fence traps was developed by the local "caiçara" populations many generations ago, up until now there is no type of norm, criteria or standard established in Decree or in any another type of regulation emanating from the respective authorities in the State of São Paulo.

In the State of Paraná, IBAMA Decree number 12 dated March 20th, 2003, also deals with the regulation of diverse fishing techniques to be used in estuarine and lagoon areas, determining the methods, the modalities and devices allowed. However, as that Decree did not make any provisions to regulate fixed fence techniques, such fishing has become a clandestine activity in the eyes of the surveillance and inspection bodies and liable to legal sanctions in Paraná territory.

The situation described here for the state of Paraná has given rise to fears that the same treatment would be meted out to the fishermen in the State of São Paulo. In view of this risk, the Council of Cananéia-Iguape-Peruíbe Environmental Protection Area (CONAPA CIP) decided to undertake a study for the elaboration of regulations for this kind of fishing in the region.

Through a careful study on activities involving fence traps in the APA-CIP, together with the public hearings held in the fishing communities of the region, a regulatory proposal was elaborated for this activity, which was approved by the Council of the APA-CIP and forwarded to IBAMA for analysis and publication. This proposal is currently being processed by that agency.

Estuarine Shrimp Fishing

Shrimp fishing in the estuary is carried out on three species of Peneids (*Litopenaeus schmitti, Farfantepenaeus paulensis and F. brasiliensis*), with the use of a net called a "gerival". The activity takes mainly immature individuals that have not reached sexual maturity or completed their growth cycles.

One of the main problems of shrimp fishing in the estuary is the disrespect for the Decree curently in force (Decree nº 42, of March 15th, 2001), which prohibits the "gerival" fishery using an outboard engine. The use of the engine makes possible the execution of a bigger number of drags during the period of fishery and causes a significant rise of the effort fishing boat on the resource.

Another fact is that the activity is carried out on a resource in immature state, causing the withdrawal of individuals that have not yet made the first spawning (D'Incao, 1991; Haimovici and Mendonça, 1996b).

Beyond the professional fishing sector, shrimp fishing using the "gerival" subsidizes amateur fishing, in virtue of supplying live bait and thereby involving another very important sector in the region, that of tourism.

For the reasons set out above, estuarine shrimp fishing using the "gerival" is causing great concern in the region in regard to the sustainability of the fisheries and of tourism activity.

This concern was taken to the CONAPA CIP and forwarded to the Fisheries Technical Chamber for the proposal of a regulation that could adjust the current norms to local reality. Several meetings were carried out to collect all the technical information available to provide supporting elements for the actions and debates with fishermen. A proposal was constructed aimed at meeting the demands of the sector and preserving the resource, and it is in the final phase of discussion with the fishermen and will be sent to the CONAPA-CIP, for evaluation and to undergo the legal processes of the regulatory agencies.

Summary of Fisheries Management Activities on the South Coast of São Paulo State

Fisheries management on the south coast of São Paulo is carried out by the Management Council of the APA-CIP, involving diverse agencies. The activities developed so far have sought improvements and adjustments in the fishing regulatory structure, statistics on the activity (data base) and inspection and management of the resources. A summary of the activities follows below:

ACTIVITY	SITUATION ON JULY 30 2005
Adjustments in the regulations governing regional fishery resources	
1. Decree for fishery management of the estuarine - lagoons of Cananéia, Iguape and Ilha Comprida Complex	In analysis on DIREC / IBAMA
2. Regulation of "manjuba" fishing at Iguape	Publication of IN nº33, June17th, 2004
3. Regulation of beach seine fishing	Publication of IN nº49, September 14th, 2004
4.Regulation of "iriko" fishing	Publication of IN nº115, June 17th, 2005
5. Regulation of fence trap fishing	In analysis on CEPSUL / Itajaí (SC)
6. Regulation of "gerival" fishing (estuarine shrimp)	Final proposal in phase of public consultations
Fishery statistics	Magnifying the collections for all professional and amateur fisheries activity

Discussion

Performance of the management strategy by means of the APA CIP

In spite of the existence of regulations and licensing for the legal exercise of professional or amateur fishing it can be stated that in Brazil, access to such resources is practically unrestricted as difficulties occur in the establishing of effective norms and also in the inspection and surveillance of compliance with existing laws.

There are various factors causing these problems and mention can be made to the structural difficulties in the managing institutions, the prevalent understanding of the exploitation of these recourses as being freely available to every citizen, together with the erroneous idea of their abundance in view of the vastness of the Brazilian coastline.

Further to those aspects, there is persistent contradiction among the various government bodies who in the case of some authorities adopt policies of incentive for increased fishing effort thereby worsening the general panorama of the activity.

Among the environmental agencies, the handling of fisheries in Brazil has mainly been done through planned measures and implemented in a centralized manner using traditional methodology such as establishing closed seasons and regulating mesh sizes of nets. In very few cases is there any participation of the users (communities, fishermen, amateurs) as co-administrators of this process. Consequently, the regulatory and normalizing measures end up by becoming just one more element of social conflict instead of contributing towards the sustainability of live resource exploitation (IBAMA, 2001).

Making use of the status of areas under institutional protection (conservation units) as a management tool has been the theme of discussions in several technical meetings held in this country. The implantation of conservation units (protected areas), no-take fishing zones and systems of artificial reefs stand out as alternatives for handling fishing activities and they have been shown to be efficient strategies for managing fisheries.

In the year 2003, the Coordinating Body for Marine and Coastal Resources of the AVINA Foundation promoted a round-table in the city of Tamandaré-Pernambuco on Brazil's Marine Protected Areas. The event generated a series of reflections on the theme, which demonstrated to the authorities concerned the need to recognize Conservation Unities as model areas for promoting the sustainable use of natural resources and that they should be subject to specific licensing and control processes considering their legally protected condition (special administration regime).

Some working premises discussed at that meeting were adopted by the team formed at the Cananéia, Iguape and Ilha Comprida Estuarine-Lagoons Complex, strengthening the management proposal then being implemented. In this sense, the project now underway on the south coast of the State of São Paulo is becoming a fishery management model that is made feasible through a Preserved Area for Sustainable Use and consolidated by the expansion of the participation in the management processes of the users of the fishing resources.

In regard to the performance attained by the present regulatory proposal, it must be pointed out that although the authority responsible for expediting affairs is in effect the Managing Council of the APA CIP, the process of administration has become involved in areas beyond the domain of the APA as for example in the case of the regulatory process for beach seine fishing and for "iriko" fishing. In both the respective published normative documents the conservation unit (preserved area) shows itself to have been responsible for regulating fishing beyond its own boundaries. Such results have significantly widened the work prospects.

The great problem, not rarely verified in the co-management fisheries projects in the country is the not recognition on the part of authorities at a higher level (Regional, State and Federal fishery Management Agencies) of the legitimacy of the process. This generally causes discontinuity in the conducts of the fisheries problems discussed with the society. In function of this impediment, the publication of legal instruments that guarantee the fisheries co-management, as the Draft Decree for the Fisheries Co-management for the Cananéia, Iguape and Ilha Comprida Estuarine-lagoons Complex is necessary for maintenance of the fishing activity.

References

BANDO, 1952. **Revista Bando**, Natal, RN. Ano IV- Vol III, n°3. p.254-268.

CARDOSO, T. A., 2004. **Subsídios para o manejo participativo da pesca artesanal da manjuba no Parque Estadual da Ilha do Cardoso, SP.** Dissertação de Mestrado do Programa de Pós-graduação da Universidade Federal de São Carlos. 101p.

D'INCAO, F., 1991. **Pesca e biologia de Penaeus paulensis na Lagoa dos Patos, RS.** Atlântica, 13(1): 159-170.

GIULIETTI, N. 1992. **A pesca e a industrialização da manjuba em Iguape, litoral sul do Estado de São Paulo.** Dissertação de mestrado. Faculdade de Filosofia, Letras e Ciências Humanas, Depto. de Geografia, USP. 160p.

HAIMOVICI, M. & MENDONÇA, J. T. 1996 b. **Descartes da fauna acompanhante na pesca de arrasto de tangones dirigida a linguados e camarões na plataforma continental do sul do Brasil.** Atlântica, Rio Grande, 18:161-177.

IBAMA, 2001. **Ata da Reunião Técnica sobre Ordenamento da Pesca de Arrasto na Região Sudeste-Sul**; CEPSUL/IBAMA, Itajaí – SC; 07 a 11 de maio de 2001

MENDONÇA, J. T. & KATSURAGAWA, M. 1997. **Desembarque da pesca costeira em Cananéia (São Paulo), Brasil, durante 1995-1996.** Nerítica, Curitiba, v. 11, p. 165-190, Editora UFPR.

MENDONÇA, J. T.; PIRES, A. D.; CALASANS, G. C. & XAVIER, S. C. 2000. **Projeto Pesca Sul Paulista–Diagnóstico da atividade pesqueira nos municípios de Cananéia, Iguape Ilha Comprida. Comunidades tradicionais e manejo dos recursos naturais da Mata Atlântica**, 156 p.

MENDONÇA, J. T.; KATSURAGAWA, M. 2001. **Caracterização da pesca artesanal no complexo estuarino-lagunar de Cananéia-Iguape, Estado de São Paulo, Brasil (1995-1996)** – Acata Scientiarum, v. 23, n.2, p. 535-547.

NEIVA, G. de S, 1990. **Subsídios para a política pesqueira nacional.** IBAMA, Doc. Téc. único. 55-67 p.

PACHECO, A. A. M. & WAHRLINCH, R. 2003. **Estudo do emprego de motor na pesca do gerival na Baía da Babitonga, Santa Catarina.** Notas Técnicas da FACIMAR. Itajaí 7: 37-46.

RADAZEWSKY, A. 1976. **Considerações sobre a captura de peixes por um cerco-fixo em Cananéia -SP - Brasil**, Bol. Inst. Oceanográfico - USP - São Paulo - V 25 (11):1

RAMOS, E. B.; GALLO, J. E.; VERRONE, V. M, A. 1980. **Áreas da região lagunar Cananéia-Iguape susceptíveis da exploração pesqueira segundo diversos tipos de tecnologia, I - Pesca com cerco-fixo.** Bol. Inst. Oceanográfico - USP - São Paulo, V. 29 (2): 329 - 335p.

ROSSI-WONGTSCHOWSKI, C. 1990. **A manjuba no Rio Ribeira de Iguape: biologia, comportamento e avaliação do estoque.** IBAMA/IOUSP/IP-SAA/SEMA.125 p.

SALES, R. R. & MOREIRA, A. C. C. - 1996. **Reservas Extrativistas no Complexo Estuarino-Lagunar de Iguape e Cananéia - Domínio Mata Atlântica.** Série Documentos e Relatórios de Pesquisa, Núcleo de Apoio à Pesquisa sobre Populações Humanas e Áreas Úmidas Brasileiras (NUPAUB). São Paulo, NUPAUB - USP. 77 p.

UNESCO, 1999. **World Heritage Nomination – IUCN Technical Evaluation Atlhantic Forests (southeast) Brazil.** UNESCO 1-8p.

UNESCO, 2005. **World Network Of Biosphere Reserves** – SC/EES – June 2005. The MAB Program. 19 pp.

Annex I

Draft Fishery Management Decree for the Cananéia, Iguape and Ilha Comprida Estuarine-Lagoon Complex

Whereas the special administration Regime of the Conservation Units, as set out in Article 2 of Law no. 9.985, dated July 18th, 2000, that instituted the SNUC;

Whereas the ecological importance of the southern coast of the State of São Paulo and the Cananéia-Iguape-Ilha Comprida (Lagamar) Estuarine-Lagoon Complex;

Whereas the existence of Conservation Units on the southern coast of the State of São Paulo– Cananéia, Iguape and Peruíbe Federal Protect Area, Mandira Resex, Queimada Grande and Queimada Pequena ARIE, Juréia Ecological Station, Tupiniquins Ecological Station, Ilha Comprida State Protect Area and Ilha do Cardoso State park, and their vocation for marine conservation;

Whereas the great number of boats and the fishing effort that onerate the local fishery stocks, the increasing number of extractivists of mangrove swamp resources and the need for the sustainability of such activities;

Whereas impacts can and must be minimized by adopting norms to define specific regulations for fishing activities in the region of the Cananéia, Iguape and Peruíbe Federal Protected Area and in the buffer zone of the Tupiniquins Ecological Station, the Ilha do Cardoso State Park and the Juréia Ecological Station described as highly important for the biodiversity of the coastal region;

Whereas the Areas of Environmental Protection (APA's) are endowed with an Administering Council whose constitution is provided for under the terms set out in Federal law number 9.985, dated July 18th, 2000, that the Council of the Cananéia, Iguape and Peruíbe Federal Protected Area – CONAPA-CIP, duly instituted on April 19th, 2002, by IBAMA Decree number 64, enjoys the effective participation of the Public Authorities (Federal, State and Municipal) and of organized civil society (productive sector and civi society associations), being the sphere wherin the process of participative Fishery Management is being effectively implemented in the region;

Whereas the CONAPA-CIP presents the Fishing Technical Chamber as a participative instrument for planning and execution that suggests the agreements and orientates the actions to be undertaken in the process of managing fishery resources with a view to the sustainability of fishing and aquaculture;

Whereas the justifications and records set out in IBAMA Process Number XXXXXXX/XX-XX, It is hereby resolved:

Article 1. To establish a system of Specific Fishing Registration and Licensing for fishermen, collectors and aquaculturalists in the Cananéia, Iguape and Peruíbe Federal Protected Area within the ambit of the esturine-lagoon complex;

Single Paragraph - The development and implantation of the system mentioned in the heading of the present article shall be run and regulated by the APA CIP together with the fishing commmunities and the fishing settlements of Iguape, Ilha Comprida e Cananéia and the Instituto de Pesca (SAA-APTA), monitored by the CONAPA-CIP, and made known to the SEAP and to the state environmental bodies;

Article 2. To establish a system for Normatizing Fishing and Aquaculture activities in the APA CIP to be conducted by the Cananéia, Iguape and Peruíbe Federal Protected Area guaranteeing participation and sharing in the process and dealing with every theme related to the activities (fishing agreements, decrees, closed seasons, special licences by species, among others), and obeying the sequence that follows:

§ 1 The elaboration of technical participative fishery diagnoses on each specific matter, making and describing the statistics related to the activity;

§ 2 The holding of participative events with the administrators and identified users for the discussion and dissemination of pertinent issues in the light of the information obtained under the terms of § 1;

§ 3 The registration in document and forwarding of the processes to the relevant authority spheres of IBAMA, for analysis, validation and ratification of the proposed norm with the subsequent publication of the official legal instrument;

§ 4 To value the fishing communities and their culture as instruments for consolidating the process.

Article 3. In the Specific Fishing Registration and Licensing System for the APA CIP shall be granted a maximum period of 1 (one) year for its implantation counted from the date of publication of the present Decree after which period only persons and/or groups duly registered and licensed will be able to carry out fishing and collecting activities inthe APA CIP.

Article 4. This Decree shall come into force on the day of its publication.

Article 5. All provisions contrary to those of the present decree are hereby revoked.

Project "Santa Catarina's Rocky Reef Fish" Contributions for Conservation

Eduardo Aires de Souza Godoy [1]
Felippe Alexandre Daros [2]
Leopoldo Cavaleri Gerhardinger [3]
Paulo R. K. Bertuol [4]
Leonardo Francisco Machado [5]
Áthila Bertoncini Andrade [6]
Maurício Hostim-Silva [7]

Abstract

This work presents the first results of a partnership between third sector, public and private institutions. The objective of this cooperative work was to contribute to the conservation of a fish reef located at Santa Catarina's shore (BrazIl). The specific objects of this work were: i) to monitor on a seasonal basis rocky fish reef communities' structure from four different sites along Santa Catarina's shore; ii) to compare those communities structures and iii) to evaluate and diagnose the conservation conditions of those four sites, which were: 1- Arquipélago das Graças in São Francisco do Sul (AQG); 2- Ponta da Sepultura in Bombinhas (SEP); 3- Toca da Salema (TSA); 4- Porto do Brás (PBR). Two sites are located within the Arvoredo's Biological Marine Reserve, a no-take zone: Toca da Salema (TSA) and Porto do Brás (PBR); the other sites are non-protected zones located nearby the cities of São Francisco do Sul (AQG) and Bombinhas (SEP). Underwater visual census methodology was employed to investigate fish reef species richness and abundance, as well as physical and biological characteristics of the substrate. The most abundant species were the sergeant major Abudefduf saxatilis, the comb grouper Mycteroperca acutirostris, the damselfish Stegastes fuscus and the dusky grouper Epinephelus marginatus. Whereas both sites located at Arvoredo's Biological Marine Reserve (TSA e PBR) presented the best conservation conditions, São Francisco do Sul Island (PBR) presented the most impacted reef fish community. The only coastal site sampled, Bombinhas (SEP), was considered a nursery area, specially for Scarids and Serranids species. A matrix was developed crossing physical, biological and environmental data in order to classify the vulnerability of each area. As a result, TSA e PBR were considered less vulnerable sites, whereas SEP and AQG were detected as highly threatened by human activity. Therefore, urgent conservation measures are recommended, specially

[1] MSc. Biologist - VIDAMAR Institute
[2] Oceanographer - VIDAMAR Institute
[3] Oceanographer - Associação de Estudos Costeiros e Marinhos dos Abrolhos
[4] MSc. Biologist
[5] Oceanographer, IMAR/ Universidade dos Açores
[6] Oceanographer, PhD student - Universidade Federal de São Carlos
[7] PhD Biologist, Professor – Universidade do Vale do Itajaí

*towards Bombinhas (SEP) and São Franscisco do Sul (PBR), as these two sites presented traces of overfishing and decharacterization of the environ*ment.

Key-words: ichthyofauna monitoring, Arvoredo Biological Marine Reserve, fish visual census, vulnerability matrix.

Introduction

Monitoring and evaluating are fundamental tools to Marine Protected Area (MPA) management. In order to achieve this purpose, easily-measurable indicators that show biophysical, socioeconomic and governance data should be used (Pomeroy, *et al.* 2004). Monitoring results bring out the needed subsidies for evaluate and later to propose changes on the way MPA is managed.

The use of fish as indicators in monitoring programs has become usual due to the general public knowledge about these animals and due to the facility to identify most species, among other reasons (Karr, 1981). Another good indicator of environmental quality are monitoring and cataloguing of organisms that occupy rocky substrates (e.g. sessil invertebrates and macroalgas), as well as physical characteristics of the substrate (e.g. the inclination and structural complex) (Ferreira *et al*., 2001).

Despite the vast literature about fish communities, the majority of the research of the area is being produced on coral reefs; little has been produced on rocky reef (Falcón *et al*., 1996; Hostim-Silva *et al*., 1999; Barreiros *et al*., 2004). The authors on Jameson *et al*. (2001) publication suggested a Biotic Integrity Indicator to identify more quickly and efficiently coral reefs conservation conditions, taking into consideration the characteristics of the community of sessil invertebrates, benthonic macro invertebrates, fish, macrophytes, phytoplankton and zooplankton. Hawkins and Roberts (1992), while studying the impact of recreational dive in the Red Sea, reckoned that for each type of coral reef there are different vulnerabilities to the impacts caused by divers. These differences were quantified to each of the dive spots studied by the establishment of punctuation to a list of attributes previously defined (e.g.: coral reef community composition, size and shape of the reef). Hence, the methods used to study coral reef environments provide subsidies to develop research on rocky reef fish.

In Brazil, there are 61 federal marine and coastal protected areas (IBAMA, 2006). Eleven of them have management plans and only a few possess an effective monitoring process. The Arvoredo Biological Marine Reserve (ABMR) had its management plan approved in 2004 (IBAMA Law Number 081/04) and represents an excellent opportunity to study the whole of MPAs concerning the protection of Brazilian marine biodiversity. Nevertheless, this kind of research is not easy to undertake once there is not much written about Santa Catarina's rocky reef fish (see Godoy, 1987; Cannella and Frutuoso, 1993; Bertoncini *et al*., 2003; Machado *et al*., 2003; Godoy *et al*., 2004; Hostim-Silva *et al*, 2006).

This way, the purpose of the present study was to seasonally monitor the ichthyofauna species, present at four sites along Santa Catarina's coast, by comparing and diagnosing the conservation conditions. The proposal herein presented is a fruit of a partnership between VIDAMAR Institute (a non-governmental organization) and the University of Vale do Itajaí, aiming to gather knowledge and divulge the ecology of reef fish of Santa Catarina state, a poorly known coastal stretch of Brazil. With financial and logistic support from Project Aware Foundation, an international and public institution for the foment of studies in marine environments (an institution lead by Bombinhas Municipal Hall) and from The Diving Schools Association of the State of Santa Catarina, it was possible to conduct the study we are about to present.

Material and Methods

Studied Areas

Four sites along the coast of Santa Catarina were selected: 1-Arquipélago das Graças, at the city of São Francisco do Sul (AQG - 26°11' S e 48°29' W); 2-Ponta da Sepultura at Bombinhas city (SEP - 27°09' S e 48°29' W); 3-Toca da Salema (TSA) and 4-Porto do Brás (PBR) (Figures 1 and 2), these two last sites are located at the ABMR, by the Galés island (27°09' S e 48°29' W).

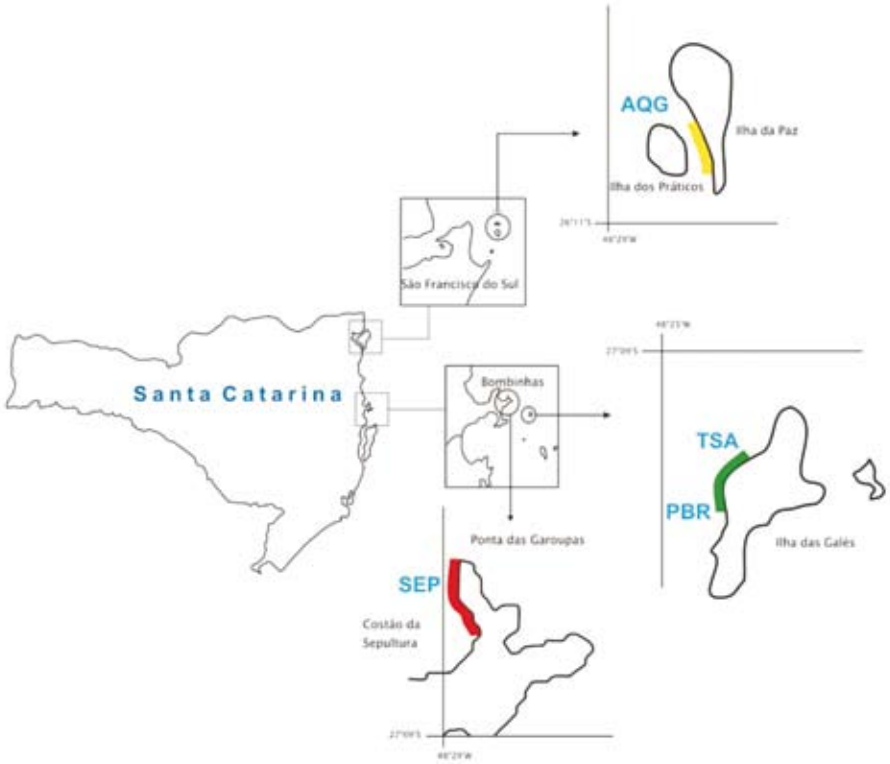


Figure 1 - Location of the studied sites: Ponta da Sepultura (SEP), Arquipélago das Graças (AQG), Toca da Salema (TSA) and Porto do Brás (PBR).

Photo: gently offered by João Paulo Cauduro.

Figure 2 - Aerial view from Galés Island and the Porto Belo peninsula.

Field Surveys

During one year (2003 to 2004), one survey was undertaken on each site, every season. In total, 12 surveys, 16 scuba dives between 3 to12 m deep and approximately 24hs of underwater observations were done.

Sampling Procedures

Underwater visual census techniques were employed to identify, quantify and estimate fish size classes (Figure 3).

Figure 3 - Visual Census Method

On this method, the researcher dived into the sea, (using SCUBA equipment), passing by a 20m measuring tape laid over the rocky bottom. Then, the researcher counted up the number of fish observed up to 1m of each side of the tape. These data gathering were mainly done next to the interface between rock and sand, in order to register a larger amount of species. Fish species were identified with the help of specialized guides, developed by Carvalho-Filho (1999) and Humann (1994). This diving data gathering was done by six well-trained researchers that took turns on their field camp outings. Each time a crew went out on a field camp research mission, at least two researchers were scheduled to participate. Moreover, on each field camp, researches gathered information of three or four different dives (census). Each explored site had its depth and substrate characteristics described, such as slope, rock size, habitat complexity; as well as biological organisms covering the substrate, such as algae, sea urchins and zoanthids. The indication of human presence was also observed, registered on the occurrence of garbage, fishing lines, gillnets and hooks.

Data Analysis

Fish species were classified by frequentness: abundant (> 75%), frequent (50 - 74,9%), mild frequent (25 - 49,9%) and rare (< 25%) (Relini *et al*., 1994). The calculus of richness, density and diversity averages were done using the number of species and the abundance verified in each census. Specifically, to obtain the diversity average, the formula used was Shannon indice (H')Pi ln Pi $\sum$: $H' = -$, where pi is the proportion of beings of the specie i (Magurran, 1988). The overall community parameters analyzed such as diversity, abundance and richness were compared amongst all research areas and within each season, through the bifactorial variance analysis (ANOVA - two way), using significance level = 0,05 of with the aid of STATISTICA 5.0 computer program.

A comparison between size classes of two species of commercial interest amongst the studied sites was conducted, in order to investigate the existence of overfishing (see Ferreira and Gonçalves, 1999). These species are the comb grouper, *Mycteroperca acutirostris* (Figure 4) and the dusky grouper (Figure 5). These fishes were considered good environmental quality indicators due to three aspects: i) they are top trophic level predators; ii) are abundant in the studied area and iii) are targeted by amateur and professional fishermen. An environmental indicator matrix (with physical, biotical and environmental quality indicators) was developed as a mean of classifying the studied sites in terms of their vulnerability (adapted from Hawkins and Roberts, 1992).

Figure 4 - Comb grouper, *Mycteroperca acutirostris.*

Figure 5 - Dusky grouper, *Epinephelus marginatus.*

Results

Sixty-eight fish species, belonging to 33 families, were catalogued during the study period. The most representative families were Haemulidae (grunts), Pomacentridae (damselfishes), Scaridae (Parrotfishes), Serranidae (groupers and sea basses) and Syngnathidae (pipefishes and seahorses) (Table 1).

Table 1 (part 1) - Frequency of fish occurrence recorded in each site studied (Ponta da Sepultura – SEP, Arquipélago das Graças – AQG, Toca da Salema – TSA and Porto do Brás – PBR) [abundant (AB) – more than 75%; common (FR) - 50 to 74%; less common (PF) - 25 to 49% and rare (RA) – less than 25% (Relini et al., 1994)].

ORDER	FAMILY	SPECIE	FOLK NAME	SEP	AQG	TSA	PBR
Rajiformes	Dasyatidae	*Dasyatis* sp.	stingray			RA	RA
	Myliobatidae	*Aetobatus narinari* (Euphrasen, 1790)	spotted eagle ray			RA	RA
Clupeiformes	Engraulidae	*Anchoviella* sp.	anchovy		RA		
Aulopiformes	Synodontidae	*Synodus synodus* (Linnaeus, 1758)	diamond lizardfish		RA	RA	
		Synodus foetens (Linnaeus, 1766)	inshore lizardfish	RA			
Lophiiformes	Ogcocephalidae	*Ogcocephalus vespertilio* (Linnaeus, 1758)	longnosed batfish			RA	
Beryciformes	Holocentridae	*Holocentrus adscensionis* (Osbeck, 1765)	squirrelfish	RA	RA	PF	
		Myripristis jacobus Cuvier, 1829	blackbar-soldierfish			RA	
Syngnathiformes	Syngnathidae	*Hippocampus reidi* Ginsburg, 1933	longsnout seahorse	PF			
		Syngnathus folletti Herald, 1942	pipefish	FR	RA	RA	PF
		Micrognathus crinitus (Jenyns, 1842)	banded pipefish	RA			
		Cosmocampus albirostris (Kaup, 1856)	whitenose pipefish	RA			
	Fistulariidae	*Fistularia* sp.	cornetfish	RA			
		Fistularia tabacaria Linnaeus, 1758	cornetfish				PF
Scorpaeniformes	Scorpaenidae	*Scorpaena brasiliensis* Cuvier, 1829	barbfish	RA	RA		
Perciformes	Centropomidae	*Centropomus undecimalis* (Bloch, 1792)	common snook			RA	RA
	Serranidae	*Epinephelus marginatus* (Lowe, 1834)	dusky grouper	AB	RA	AB	AB
		Mycteroperca acutirostris (Valenciennes, 1828)	comb grouper	AB	AB	AB	AB
		Mycteroperca bonaci (Poey, 1860)	black grouper	RA			
		Mycteroperca microlepis (Goode & Bean, 1879)	gab	RA			
		Serranus flaviventris (Cuvier, 1829)	twinspot bass	RA	FR	PF	
	Mugilidae	*Mugil* sp				RA	RA
	Carangidae	*Carangoides crysos* (Mitchill, 1815)	blue runner			RA	
		Seriola lalandi Valenciennes, 1833	yellowtail amberjack			RA	RA
	Lutjanidae	*Lutjanus analis* (Cuvier, 1828)	mutton snapper			RA	RA
		Lutjanus cyanopterus (Cuvier, 1828)	cubera snapper		RA	RA	RA
	Haemulidae	*Anisotremus surinamensis* (Bloch, 1791)	black margate		RA	RA	RA
		Anisotremus virginicus (Linnaeus, 1758)	porkfish		FR	FR	AB
		Haemulon aurolineatum Cuvier, 1830	redmouth grunt	RA	RA	AB	AB
		Haemulon parra (Desmarest, 1823)	sailor's grunt			RA	RA
		Haemulon steindachneri (Jordan & Gilbert, 1882)	latin grunt	FR	FR	PF	AB
		Pomadasys sp.	grunt		RA		
	Sparidae	*Archosargus rhomboidalis* (Linnaeus, 1758)	western atlantic seabream	RA		RA	RA
		Diplodus argenteus (Valenciennes, 1830)	silver porgy	RA	PF	AB	FR
	Sciaenidae	*Odontoscion dentex* (Cuvier, 1830)	reef coraker		FR	FR	RA
		Pareques acuminatus (Bloch & Schneider, 1801)	high-hat	AB	FR	AB	FR
	Mullidae	*Pseudupeneus maculatus* (Bloch, 1793)	spotted goatfish	PF	PF	RA	FR
	Pempheridae	*Pempheris schomburgkii* Müller & Troschel, 1848	glassy sweeper		RA		
	Chaetodontidae	*Chaetodon striatus* Linnaeus, 1758	banded butterflyfish	FR	AB	FR	AB
	Pomacanthidae	*Holacanthus tricolor* (Bloch, 1795)	rock beauty			RA	RA
		Pomacanthus paru (Bloch, 1787)	french angelfish	FR		FR	RA
	Kyphosidae	*Kyphosus* sp	chub			RA	RA
	Uranoscopidae	*Astroscopus y-graecum* (Cuvier, 1829)	southern stargazer	RA			
	Pomacentridae	*Abudefduf saxatilis* (Linnaeus, 1758)	sergeant major	AB	AB	AB	AB
		Chromis multilineata (Guichenot, 1853)	brown chromis			RA	RA
		Stegastes fuscus (Cuvier, 1830)	brazilian damselfish	AB	AB	AB	AB
		Stegastes pictus (Castelnau, 1855)	yellowtip damselfish	RA		RA	RA
		Stegastes variabilis (Castelneu, 1855)	cocoa damselfish			RA	PF

Table 1 (part 2)

ORDER	FAMILY	SPECIE	FOLK NAME	SEP	AQG	TSA	PBR
	Labrisomidae	*Labrisomus nuchipinnis* (Quoy & Gaimard, 1824)	hairy blenny	AB	RA		RA
		Malacoctenus delalandii (Valenciennes, 1836)	blenny	AB	FR	FR	FR
		Paraclinus spectator Guimarães & Bacelar, 2002	blenny	RA	RA		RA
	Chaenopsidae	*Emblemariopsis signifera* (Ginsburg, 1942)	flagfin blenny	RA	RA	RA	RA
	Blenniidae	*Parablennius marmoreus* (Poey, 1876)	seaweed blenny	RA	RA	PF	RA
		Parablennius pilicornis (Cuvier, 1829)	ringneck blenny	PF	FR	AB	PF
		Scartella cristata (Linnaeus, 1758)	molly blenny	RA			RA
	Gobiidae	*Coryphopterus glaucofraenum* Gill, 1863	bridled goby	RA	AB	RA	PF
		Gobiosoma hemigymnum (Eigenmann & Eigenmann, 1888)	goby	RA			
	Ephippidae	*Chaetodipterus faber* (Broussonet, 1782)	atlantic spadefish			RA	RA
Pleuronectiformes	Bothidae	*Bothus ocellatus* (Agassiz, 1831)	eyed flounder	RA			
Tetraodontiformes	Monacanthidae	*Stephanolepis hispidus* (Linnaeus, 1766)	planehead filefish	PF		RA	FR
	Tetraodontidae	*Sphoeroides greeleyi* Gilbert, 1900	caribbean puffer	RA			
		Sphoeroides spengleri (Bloch, 1785)	bandtail puffer	FR	PF	FR	FR
		Sphoeroides testudineus (Linnaeus, 1758)	checkred puffer	AB	RA	RA	RA
		TOTAL		**42**	**33**	**48**	**47**

The site that contained a greater variety of species was TSA (n=48). On the other hand, AQG (n=33) presented less variety of species. The following species were abundant in all sites: sergeant major *Abudefduf saxatilis*, comb grouper *Mycteroperca acutirostris* and damselfish *Stegastes fuscus*. The dusky grouper *Epinephelus marginatus* was abundant in all sites, except in AQG, where it was considered rare. Therefore, it is possible to note: i) the presence of four Syngnathidae species at SEP; ii) the observation of the glassy sweeper *Pempheris schomburgki* at AQG and; iii) the high occurrence frequency of Scaridae at Galés Island (TSA and PBR).

The observed pattern behaviour of richness, density and diversity (H') was extremely seasonal, presenting higher marks in spring and summer (Figure 6). Although the sites were visually different, there were no remarkable difference showed by the resultant graphics of richness and diversity. Only density averages (Figure 6B) in PBR were significantly superior to those of SEP and AQG during winter and spring of 2003 ($F = 2{,}65$, $p<0{,}01$).

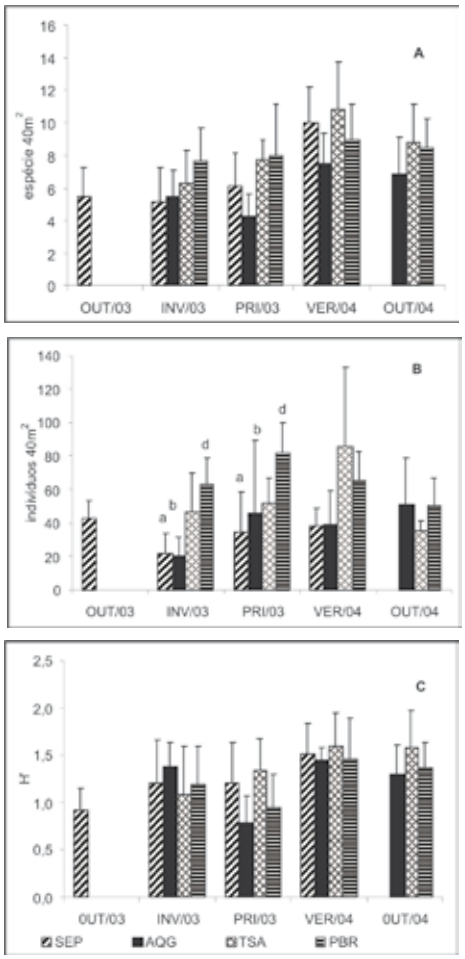


Figure 6 - Fish richness (A), density (B) and diversity (C) per season in each study site (Ponta da Sepultura (SEP), Arquipélago das Graças (AQG), Toca da Salema (TSA) and Porto do Brás (PBR). The bars are mean values ± SD and the letters (a, b and d) highlight the remarkable differences.

The size class analysis of two commercially important species (*M. acutirostris* and *E. marginatus*) revealed important information (Figure 7). The majority of fish observed of both species had less then 20cm, especially at SEP and AQG. By the Galés island (TSA and PBR), largest size classes of these species were frequently observed (>20cm). Individuals larger then 30cm were rarely seen – in PBR such size classes were seen occasionally.

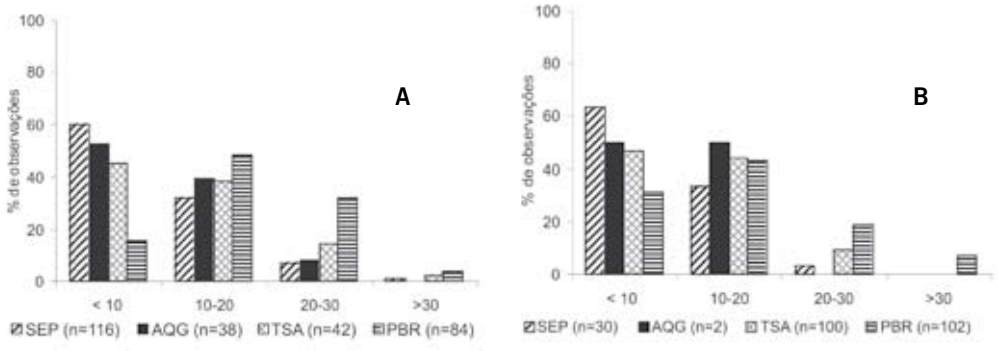


Figure 7 - Size class (in centimeters) of the comb grouper Mycteroperca acutirostris (A) and dusky grouper Epinephelus marginatus (B) in each study site (SEP, AQG, TSA and PBR). The number of fish registered was emphasized in parenthesis

The research team invested a large effort to divulge the project through photographic exhibitions, panel presentations and a website (www.vidamar.org.br/peixesdecostao) (Figures 8 and 9). Furthermore, a thematic reef fish telephonic card series was launched in partnership with "Brasil Telecom" (telephone operator company). More then 1.200.000 units of this telephone card composed of 11 rocky reef fish species photographs and information were printed and distributed throughout Santa Catarina State.

Figure 8 - Project website www.vidamar.org.br/peixesdecostao.

Figure 9 - Phone cards decorated with pictures of rocky coast fish found in Santa Catarina.

Discussion

The study revealed few significant differences amongst the reef fish communities' structures of the studied sites. However, it is possible to conclude that the following dissimilarities tend to become more evident if the monitoring process continues: i) in general, species richness, density and diversity at SEP and AQG were inferior to those at protected sites such as Galés Island (TSA and PBR) (Figure 6); ii) larger size classes of commercially targeted fishes are observed at protected sites (TSA and PBR) (Figure 7).

The only coastal site, SEP, presented typical nursery environment characteristics. The other island sites are located far from the continent (AQG=3km; TSA and PBR=9km from the coast). Therefore, it was expected that the reef fish community of SEP were different from the other sites. The AQG site, although being an island one, presented an impoverished ichthyofauna. At this site, human activity is probably higher.

Both São Francisco do Sul and Bombinhas cities, which are located at the buffering zone of the ABMR, suffer from non-organized tourism and fishing

activities. The AQG site, besides being a traditional fishing and tourist site, suffers from the transit of large cargo ships and Babitonga bay polluted waters. At this site, an exotic marine fish species was recently registered. Probably the species was brought by international cargo ships (through ship fouling) (Gerhardinger *et al*., 2006).

The present study corroborates the proposal of Gerhardinger *et al*. (2006) to implement a MPA at the AQG, in order to properly manage fishing activities. It is worth mentioning that nowadays a MPA proposal to protect Babitonga bay is being carried, encompassing the AQG.

The Galés Island, although a protected and distant place, also suffers from non-organized tourism and illegal fishing activities (Table 2). At the present time, it is extremely important that ABMR reinforces inspection and promotes the monitoring of underwater tourism, according to regulation established by ABMR management plan.

Considering the presented environmental overview and vulnerability matrix (Table 2), it is possible to conclude that the protected sites (TSA and PBR) are the most preserved and less vulnerable. Better conservation status of the fish community, distance from coastal urban areas and current legal protection contributes to achieve lower values in the matrix. The AQG and SEP areas were in the opposite side of the matrix, this way presented as highly vulnerable sites. Lower species richness, predominance of generalist fish species, low size classes of commercially targeted species and proximity of urban areas were all responsible for the high matrix values presented by these sites.

Table 2 - Vulnerability matrix (adapted from Hawkins and Roberts, 1992).

	SEP	AQG	TSA	PBR
Depth (m)	3	2	1	2
Rocky coast slope	2	2	1	2
Rugosity	3	3	2	3
Diversity of organisms cover	2	3	2	2
Fish richness	2	3	1	1
Presence of large size class fishes	3	3	2	2
Proximity of rivers or estuaries	2	3	1	1
Proximity of urban centers	3	2	1	1
Garbage and waste of fishing objects	2	1	2	2
Marine Protected Area	2	2	1	1
TOTAL	**24**	**24**	**14**	**17**

Classification

Depth (m)	0-5=3	5-10=2	>10=1
Rocky coast slop e	Low=2	Medium=1	
Rugosity	Low=1	Medium=2	High=3
Diversity of organisms cover	Low=3	Medium=2	High=1
Fish richness	Low=3	Medium=2	High=1
Presence of large size class fishes	Rare=3	Less comm.=2	Comm.=1
Proximity of rivers or estuaries	<1 Km=3	1-3 Km=2	>3 Km=1
Proximity of town or village	<1 Km=3	1-3 Km=2	>3 Km=1
Garbage and waste of fishing objects	Rare=1	Less comm.=2	Comm.=3
Marine Protected Area	Yes=1	No=2	

Suggestions of actions to protect the rocky reef areas studied, especially AQG and SEP, which presented indications of overfishing and decharacterization of the environment:

1. Elaborating a project of environmental education to amateur fishermen and submarine fishing practitioners subsidized by projects profits;

2. Informing local government offices, the IBAMA (Brazilian Institute of Environment and Renewable Natural Resources), Environment Police, fishermen communities and submarine fishing associations about the project results, to reinforce the need of practical protective measures to preserve rocky reef;

3. Creating an MPA at “Arquipélago das Graças”, in order to render possible shifts of closed and opened sites for fishing, corroborating Gerhandinger *et al*. (2006) proposal;

4. Restraining shipping circulation and prohibiting submarine fishing at “Ponta da Sepultura”, which is a nursery area of marine life;

5. Strengthening inspection and monitoring diving in Galés Island (Arvoredo Biological Marine Reserve), in accordance to regulations, established on the management plan;

6. Enhancing the practice of ichthyofauna monitoring, started by the project, to confirm the hypothesis raised by this study; and

7. Developing a series of studies on Syngnathidae, especially in SEP. It would also be interesting to develop a series of studies on the biology of *Mycteroperca acutirostris*, which is abundantly found at the region, highly appreciated by fishermen, although poorly known.

Conclusion

This study represents a significant step towards the deepening of knowledge on the Santa Catarina ichthyofauna.

The project was pioneer at monitoring reef fish during the period of a whole year. Besides, some species might have had its geographical distribution amplified as *Cosmocampus albirostris* and *Micrognathus crinitus*.

The conservation status of the protected sites, TSA and PBR, was higher than other studied locations. The occurrence of large groups and fish densities inside the no-take area suggests that the ABMR is protecting the diversity and increasing fish biomass. However, the continuity of this project will subsidize more information and, therefore, will clarify this situation. It is worth to consider that many fish species, when young, live close to the coast and then migrate as adults to deeper and further sites, such as coastal islands. As a result, biological characteristics of the studied fish species should be isolated from the negative outcomes of human activities. In 2005, the project Santa Catarina’s Rocky Reef Fish was broadened and restructured. The next step will consist of ABMR effectiveness evaluation. Promptly, the project shall include several sites along the southern coast of Santa Catarina, in order to compare reef fish communities throughout a latitudinal gradient and register the geographical range of reef fish species in the Southwest Atlantic.

Ackowledgments

We would like to thank Project Aware Foundation and Costão do Santinho Resort, for financing our field trips; local government of Bombinhas city, the Diving Schools Association of Santa Catarina (AEOMESC) and the

Submarine dive company, for logistical support; Institute of Environment and Renewable Natural Resources (IBAMA) for allowing the work in ABMR; Brasil Telecom company, Portal da Ilha, ColorClic Digital and Achei Molduras companies, for spreading information about the project. We are grateful to Dr. João Pedro Barreiros, Dr. Emanuel Gonçalves and Dr. Carlos Eduardo Leite Ferreira for their contributions to the development of this study.

References

BARREIROS, J. P.; BERTONCINI, A.; MACHADO, L.; HOSTIM-SILVA, M.; SANTOS, R. S., 2004. **Diversity and seasonal changes in the ichthiofauna of rocky tidal pools from praia Vermelha e São Roque, Santa Catarina.** Brazilian Archives of Biology and Technology, 47(2): 291-299.

BERTONCINI, A. A.; MACHADO, L.F.; HOSTIM-SILVA, M.; BARREIROS, J.P., 2003. **Reproductive biology of the dusky grouper *Epinephelus marginatus* (Lowe, 1834) Perciformes: Serranidae, Epinephelinae) Santa Catarina, Brazil.** Brazilian Archives of Biology and Technology, 46(3): 373-379.

CANELLA, G.; FRUTUOSO, J. L., 1993. **Telesteos marinos de la coleccion ictiologica de la Universidade Federal de Santa Catarina, Florianópolis, SC.** 1. Observaciones sobre nuevas espécies para el estado de Santa Catarina (Pisces – Osteichthyes). Boletin de la Sociedad Zoologica del Uruguay, 8(2):111-120.

CARVALHO-FILHO, A., 1999 **Peixes: costa brasileira.** São Paulo: Melro, 320p.

FALCÓN, J.M., BORTONE, S.A., BRITO, A.; BUNDRICK, C.M., 1996. **Structure of ans relationships within and between the littoral, rock-substrate fish communities off four islands in the Canarian Archipelago.** Mar. Biol., 125: 215-231.

FERREIRA, C. E. L.; GONÇALVES, J. E. A., 1999. **The unique abrolhos reef formation (Brazil): need for specific management strategies.** Coral Reefs, 18: 352.

FERREIRA, C. E. L, GONÇALVES, J. E. A.; COUTINHO, R., 2001. **Community structure of fishes and habitat complexity on a tropical rocky shore.** Env. Biol. Fish, 61: 353-369.

GARCÍA-CHARTON, J.A; PÉREZ-RUZAFA, A., 1999. **Ecological Heterogeneity and the evaluation of the effects of marine reserves.** Fisheries Research, 42 (1999) 1-20.

GERHARDINGER, L. C.; FREITAS, M. O.; BERTONCINI, A. A.; RANGEL, C. A.; 2006. **Omobranchus punctatus (Teleostei: Blenniidae), an exotic blenny in the Southwestern Atlantic.** Biological Invasions, 00:1–6.

GERHARDINGER, L. C.; MEDEIROS, R. MARENZI, R.C.; BERTONCINI, A.A; HOSTIM-SILVA, M. 2006. **Local Ecological Knowledge on the Goliath Grouper *Epinephelus itajara*.** Neotropical Ichthyology, 4(4): 441-450.

GODOY, M. P., 1987. **Peixes do estado de Santa Catarina.** Florianópolis: Editora UFSC, 571p.

GODOY, E. A. S., GERHARDINGER, L. C., DAROS, F. HOSTIM-SILVA, M., 2004. **Utilization of bottom trawling and underwater visual census methodologies on the assessment of the fish communities from Arvoredo Biological Marine Reserve – SC, Brazil.** Proceeding of the International Costal Symposium, Itajaí.

HAWKINS, J.P.; C.M. ROBERTS. 1992. **Can Egypt´s coral reefs support ambitious plans for diving tourism?** Proceedings of the 7th International Coral Reef Symposium. University of Guam Mangilao, 2: 1007-1013.

HOSTIM-SILVA, M.; BARREIROS, J. P.; SANTOS, R. S.; BERTONCINI, A. A.; FIGNA, V.; MACHADO, L.; LÓPES F. 1999. **Sazonalidade da Ictiofauna da Praia de Canto Grande, Município de Bombinhas, Santa Catarina, Brasil.** VIII COLACMAR, Trujillo. Libro de Resumos Ampliados. v.I, p. 205-206.

HOSTIM-SILVA, M.; BERTONCINI, A. A.; MACHADO, L. F.; GERHARDINGER, L. C.; DAROS, F. A.; BARREIROS, J. P.; GODOY, E. A. S. 2006. **Peixes de costão rochoso de Santa Catarina: Arvoredo.** Itajaí: Universidade do Vale do Itajaí, 134p.

HUMANN, P., 1994 **Reef fish identification.** Florida: New Word Publications. 396p.

JAMESON, S. C.; ERDMANN, M. V.; KARR, J. R.; POTTS, K. W., 2001. **Charting a course toward diagnostic monitoring: a continuing review of coral reef attributes and a research strategy for creating coral reef indexes of biotic integrity.** Bull. Mar. Sci. 69(2): 701-744.

KARR, J. R., 1981. **Assessment of biotic integrity using fish communities.** Fisheries, 6(6): 21-27.

IBAMA, 2006. Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais Renováveis. http//www.ibama.gov.br

MACHADO, L. F.; ANDRADE, A. B.; HOSTIM-SILVA, M.; BARREIROS, J. P., 2003. **Habitat use by the juvenile dusky grouper Epinephelus marginatus and its relative abundance, in Santa Catarina, Brazil.** Aqua 6(4):133-138.

MAGURRAN, A. E., 1988. **Ecological diversity and its measurement.** New Jersey: Princeton University Press. 179p.

POMEROY, R. S.; PARKS, J. E.; WATSON, L. M., 2004. **How is your MPA doing? A guidebook of natural and social indicators for evaluating the marine protected area management effectiveness.** IUCN, Gland, Switzerland and Cambridge, UK. 216 pp.

RELINI, M.; TORCHIA, G.; RELINI, G., 1994. **Seasonal variation of fish assemblages in the Loano artificial reef (Ligurian Sea Northwestern-Mediterranean).** Bull. Mar. Sci., 55(2-3): 401-417.

Local Ecological Knowledge in the Planning and Management of Marine Protected Areas and in the Conservation of Fish Spawning Aggregations
The Experience of Meros do Brasil Project

Leopoldo Cavaleri Gerhardinger [1]
Rodrigo Pereira Medeiros [2]
Rosemeri Carvalho Marenzi [3]
Eduardo Aires de Souza Godoy [4]
Matheus Oliveira Freitas [5]
Áthila Andrade Bertoncini [6]
Maurício Hostim-Silva [7]

Abstract

In face of the current challenges in the field of marine ecosystem conservation and management, several approaches are emerging and increasingly deserving attention by the academia, governmental and non-governmental institutions. These new ways of dealing with conservation and management are responses to the failure of conventional approaches in solving conflicts. It clearly evidences the rise of an interdisciplinary field for natural resources management, including the use of collaborative methodologies. In this paper we initially discuss the potentialities and limitations of using fishermen's ecological knowledge as a tool for the planning and management of marine protected areas. We present, in the light of this theoretical discussion, the experiences of "Meros do Brasil Project" in the research of spawning aggregations of goliath groupers Epinephelus itajara (Lichtenstein, 1822), a critically endangered marine fish. Finally, we suggest and argue that the use of fishermen ecological knowledge might be a useful and fundamental tool for establishing a process of researching, monitoring and managing marine fish spawning aggregations in Brazil.

Key-words: Marine protected areas, co-management, traditional ecological knowledge

Introduction

The Brazilian coast presents, throughout its extension, a society highly benefited with the environmental services provided by marine ecosystems (e.g. food, transport, protection against storm). Increasingly, efforts aiming

[1] Oceanographer, Associação de Estudos Costeiros e Marinhos dos Abrolhos (leocavaleri@gmail.com).
[2] Oceanographer, Univali, CTTMar – Environmental Education Laboratory, Doctor's degree student in Political Sociology.
[3] Forest Engineer, PhD, Univali, CTTMar – Conservation Areas Planning and Management Laboratory.
[4] Biologist, M. Sc., Vidamar Institute.
[5] Biologist, Instituto Vidamar.
[6] Oceanographer, Vidamar Institute, PhD student in Ecology and Natural Resources, UFSCAR.
[7] Biologist, PhD, Univali, CTTMar - Environmental Sciences Laboratory.

to conserve our oceans become imperative in a world of increasing rates of population growth and development logically centered in economical parameters (Morin and Kern, 2000; Vieira *et al*, 2005). In response to the environmental problems, researchers of different scientific fields, along with governmental and non-governmental organizations, pursue ways of developing alternative programs and instruments for coastal environmental management.

Within the scope of fisheries resource management, conventional methods of fisheries biology have ruled in the last decades regarding the subsidy of technical information for formulating fisheries management. While these techniques failed in considering all the complexity of socio-ecological systems (Seixas and Berkes, 2003; Medeiros, 2004), they have not overcome the evident crisis in fisheries resource management (Coleman *et al*, 1999; Roberts, 2000; Sadovy and Cheung, 2003), and therefore a crisis in the natural resources management still remains (Holling *et al*, 1998; Berkes *et al*, 2003; Berkes and Folke, 2003). Within this perspective of developing and structuring alternative approaches, a widespread debate arises on the use of marine protected areas, an ecosystem-based tool to marine environmental management (Aswani and Hamilton, 2004). Despite its theoretical limitations – which are rapidly being fulfilled by incoming new researches – this tool is widely accepted for fisheries management and marine biodiversity conservation objectives (Roberts and Hawkins, 2000).

The implementation of a marine protected area in Brazil according to the categories offered by the National System of Conservation Areas (SNUC - Sistema Nacional de Unidades de Conservação, law 9985/2000) should be based on an open dialogue with those who will be directly affected by this process. It is also true that the western science cannot be itself the only source of information and be dissociated from the community's ecological knowledge in such process (Johannes, 1998; Seixas and Begossi, 2001; Berkes and Folke, 2002; Sadovy and Cheung, 2003). The study of the Fishermen's Local Ecological Knowledge is an emerging science that gathers the interest and efforts of human and natural scientists (Davis and Wagner, 2003). The potential role of such approach ranges from direct application to environmental information survey, to a more participative role of the community – notably the fishermen - in the management process of resources which they depend on (Baelde, 2001).

In this paper we intend to discuss the potentialities and limitations on the use of fishermen's ecological knowledge as a tool for planning and managing marine protected areas, with special focus on the conservation of marine fish spawning aggregations. Thus, we initially present a brief conceptual basis on marine protected areas and local ecological knowledge, discussing the potential interface between these science fields. Subsequently and in the light of this initial context, we discuss the experiences of the "Meros do Brasil Project" on the use of local ecological knowledge to identify and conserve spawning aggregations of the goliath grouper *Epinephelus*

itajara (Figure 1), a critically endangered marine fish. Finally, we suggest some research actions that stimulate and justify the use of local ecological knowledge in the process of spawning aggregation conservation in Brazil.

For the purposes of this paper, "planning and management of marine protected areas" means the decision-making process on: i) setting up the objectives and targets of a marine protected area, and also the coordination of the means and resources to attain them (planning) and ii) routine questions involving the management, administration or direction of marine protected areas (management).

Photo gently given by the CBCS (Confederação Brasileira de Caça Submarina).

Figure 1 - *Epinephelus itajara*, 328 Kg, caught in the city of Jaguanum, Rio de Janeiro state (6th December 1997), by Gilberto Bombieri. Brazilian spearfishing record.

Local Ecological Knowledge

The term Local Ecological Knowledge (LEK), widely employed in the related literature, constitutes a "body" and a "system" of "comprehensions" and "know how" built through time by individual and collective experiences and observations, mediated by culture, considering environmental factors, behavioral attributes and ecological dynamics (Davis and Wagner, 2003). The major content in LEK systems is frequently associated to aged persons, since it presumes accumulated experiences in the co-existence and relationship with "nature" and natural resources (Davis and Wagner, 2003). Although it is not the main focus of this article to provide an in depth conceptual discussion, one should be aware that the option for Local, Traditional or Indigenous, among other definitions, is often controversial and passive of criticism (Berkes, 1999). The decision for the term Local instead of Traditional was made because Local does not necessarily imply the existence of cultural transmission throughout generations, according to the definition of Berkes (1999, p. 8).

Throughout the last two decades, the interest on LEK has significantly increased (Huntington, 2000; Diegues and Arruda, 2001; Davis and Wagner, 2003). Such works have been seeking for methodologies for documenting and facilitating the LEK (Davis and Wagner, 2003). In Brazil, the research on fishermen's LEK has gained much attention in the last 10 years (Begossi *et al*, 2000; Diegues and Arruda, 2001; Faulkner and Silvano, 2001, Silvano, 2004; Begossi, 2006; Gerhardinger *et al*, 2006a,b).

We usually find a complex LEK system on the following aspects of a given fishing resource: i) where fish and other organisms are found in large quantities (habitat classification); ii) traditional species nomenclature system (ethnotaxonomy); iii) when fish is found in a given locality (seasonality, lunar period, tide phase, time during the day) and iv) behavioral and movement details of fish (Johannes and Hviding, 2000; Diegues, 2004). In the view of natural scientists, such knowledge is translated into information regarding abundances and behavior of target-species on inter-annual, seasonal, lunar and daily aspects related to tides and habitat.

The most employed methodologies to document LEK are: semi-structured interviews; questionnaires; participative field research; mental maps and discussion forums, among others (see Huntington, 2000; Silvano, 2004; Seixas, 2005). Recently, several publications in Portuguese language have facilitated the access to methods (recording, analyzing and applying) and ethical issues involved in LEK research (Drumond, 2002; Diegues, 2004; Sillvano, 2004, Vieira *et al*, 2005). However, several factors of methodological nature and cultural barriers still limit the broad acceptance of LEK in the research and management of natural resources, challenging the development of LEK science field (Table I).

Table 1 - Review of some limitations and methodological challenges posed to a broad development and acceptance of research efforts approaching the Local Ecological Knowledge (LEK).

The knowledge system is of qualitative , narrative and holistic in spite of sectorial nature, subjective in spite of objective [5];
Methodologies that disturb familiar and comfortable methods, many times demanding ecologists to adapt themselves to a new paradigm [4];
Intolerance specifically on regard to the use of LEK, criticizing the methodology's reliability, doubts on its political correctness, which would apparently replace scientific rigor [4];
Unfamiliarity to human science research methods, lack of skills to document and deal with LEK information [4,2];
Social scientists usually lack biological training to collect and apply LEK on management in an effective way [6];
There is an exaggerated concern with statistics. Some believe that illiterate people 's LEK is not appropriate and unfavorable to the statistical analysis [6];
The implementation of the LEK research process c an be time consuming, sometimes reaching results that are not worth for justifying their application, or the community involvement may be insufficient;
Overlapping social and cultural barriers damage the communication and collaboration among fishermen, sc ientists and managers. Social and cultural gaps between science (collectively accepted by society and legitimized through objective and rigorous rules) and LEK (subjective, not scientifically tested and sometimes perceived as "altered" or "vested" with ind ividual interests) [5];
Methodological problems of LEK systematic research and publication of results . Lack of minimum and crucial descriptions of methodologies. [3];
Necessity of a s ystematic selection of LEK experts [3];
There is a need to i mprove the delivery of results, that are currently presented on a non systematic, nebulous way, thus hindering their application for management purposes [3,7];
The geographic scope of each fisherman LEK is limited. It is unevenly distributed among fishermen. It is an oral rather than written knowledge and, therefore, is subject to memory lost [1];

Note: Adapted from Gerhardinger *et al*. (2004), who summarize the information found in Neis *et al*. (1999)[1], Hamilton and Walter (1999) [2], Davis and Wagner (2003) [3], Huntington (200 0)[4], Baelde (2001) [5], Johannes (2001b) [6] and Ruddle and Anuchiracheeva (2003) [7].

Marine Protected Areas

The idea of restricting human activity in the marine environment is quite old in many parts of the world. This is not a management strategy invented by western science. Several ancient cultures used such protected areas to limit the access to local marine resources (Aswani & Hamilton, 2004; Diegues, 2004), also known as "tenure" systems. Marine Protected Areas (MPA) can be defined as any marine area under some degree of restriction on its resources. In Brazil they can be framed into the categories established at the SNUC (Sistema Nacional de Unidades de Conservação) or even in military areas (Brazilian Navy); around oil platforms; sites where extractivism management is practiced and other situations where human activity is somehow controlled in coastal and marine areas. In general terms, MPAs have been fixed to: i) assist in maintaining fisheries resources inherent to the protected area; ii) protect vulnerable habitats and threatened species; iii) increase fishery productivity by protecting reproduction areas; iv) reduce the impact of tourism and other human activities of potential impact; v) provide "insurance" against failures of other management strategies and vi)

maintain the culture and socioeconomic practices of traditional marine and coastal communities (Lubchenco *et al*, 2003; Rodrigues *et al*, 2004).

Problems related to a noticeable lack of a theoretical basis to the implementation of "marine reserves"[8] (e.g. criteria for site selection, technical justification) are common and usually quoted by several authors (Allison, 1998; Halpern, 2002). However, this science field has been rapidly advancing during the last few years. Regular publications such as "MPA News: International News and Analysis on Marine Protected Areas" (http://depts.washington.edu/mpanews) and books on this topic (e.g. Roberts and Hawkins, 2000; National Research Council, 2001; Polunin, 2002; Pomeroy *et al*, 2004) bring about lively discussions related to the global experiences on MPAs. There is also an increasing debate on the social barriers and effects implying the restricted stakeholders' access to marine resources (Christie *et al*, 2004; Jones, 2006). In this sense, Brazil stands out in the international scenario, in what regards the application of MPA categories that seek to match the maintenance of extractive communities' culture and socioeconomic practices with fisheries resource conservation, the so-called Marine Extractive Reserves (MMA, 1998; Rodrigues *et al*, 2004; Secretariat of the Convention on Biological Diversity, 2004).

In Brazil, the debate on MPAs has already been introduced into national environmental policies, by the academia and by strategic cross-institutional actions leaded by the third sector. During the 7th Conference of the Parties (COP 7) of the Convention on Biological Diversity, held in February 2004 in Kuala Lumpur, Brazil has signed the convention thus becoming committed to the establishment of a broad system of MPAs until 2012. The Brazilian Ministry of Environment has created, in 2004, the Marine and Coatal Zone Division, which is articulating several institutions and initiatives oriented to the maintenance and sustainable use of marine and coastal ecosystems, including an expressive effort towards promoting a sound policy for the Brazilian MPAs.

In 2004, two "consensus statements" urging a national policy and outlining priorities for MPAs in Brazil were published in outstanding technical-scientific events. These events led people (academia, governamental and non governamental) to discuss the future of Brazilian marine ecosystems (Brazilian Congress of Conservation Areas, Curitiba; Coastal Management Meeting – ENCOGERCO, Salvador). During the XVI Brazilian Meeting of Ichthyology (João Pessoa, 2005), among a wide range of important debates, there was a demand for a broad discussion on the potential role of the MPAs in fish conservation in Brazil (Ferreira *et al*, 2005).

Recently, MPAs were discussed in the II National Environmental Conference (Brasília, 2005), where important proposals for a national policy were

[8] "Marine reserves" or "no-take zones" is a kind of MPA where every extractive practice is forbidden.

deliberated. Among the most important proposals, two stand out: i) to promote the elaboration, designation and implementation of a National Plan for Coastal and Marine Protected Areas, especially for coastal and oceanic islands, coastal lakes and freshwater lagoons, with broad participation of the organized civil society and ii) redefine the existing framework of Protected Area categories considering the specificities of the Coastal and Marine environments, promoting studies to expand and/or create new protected areas in those ecosystems, thus accelerating the process of creating the RUMAR (Network of Coastal and Marine Conservation Areas).

Among the Brazilian pioneer initiatives that stand out regarding the synergetic action between MPA research and enforcement, we find the projects developed by the following non-governmental organizations: i) Conservação Internacional do Brasil (International Conservation - Brazil) (Marine Program, Abrolhos Bank, Bahia state, http://www.conservation.org.br/onde/ecossistemas); ii) Associação de Estudos Costeiros e Marinhos dos Abrolhos (ECOMAR) and iii) Instituto Recifes Costeiros (Pernambuco state, Environmental Protection Area of Costa dos Corais, http://www.recifescosteiros.org.br).

Integrating Local Ecological Knowledge to the Planning and Management of Marine Protected Areas

One of the major contributions that fishermen could lend to the establishment of MPAs is by broadening the collective understanding on marine ecosystems and facilitating the design of MPAs, so as to convert them into effective conservation tools (Neis, 1995.) Older fishermen know fisheries history at a given locality. They can possibly know about species that were once abundant, but are now rare due to overfishing (Saenz-Arroyo, 2005). This information can sometimes be used to assist the MPA design in an attempt to reestablish such populations (Johannes, 2001a). Some traditional fishery communities rest on traditional ways to the social appropriation of the marine environment, implicit in their cultural systems (Diegues, 2004). Many times one can draw on those practices to strengthen their effective use in marine conservation (Aswani and Hamilton, 2004).

Fishermen hold detailed knowledge on small geographic scales (Hamilton, 2005). Scientists, on the other hand, have a knowledge system that is organized in the written form, allowing a broader perception of the marine ecosystem. However, in remote areas, distant from the research institutions, therefore in need of research on local ecological processes, local resources users' knowledge remains as one of the few information sources. One difficulty encountered in the management of ecosystems based solely on scientific information is that it demands a deep knowledge, even when it is known that the required body of scientific information is not easily accessible (Diegues and Arruda, 2001). In this sense, the Brazilian coast, with more than 8000km of coastline, brings large opportunities for partnership with hundreds of local communities.

The Brazilian coast, with more than 8000km of coastline, brings large opportunities for partnership with hundreds of local communities. In spite of that, many protected areas were established over the territory of coastal communities in Brazil, entailing negative impacts to artisanal fishermen's way of life (Diegues, 2004). There is little space for effective cooperation between scientific and local ecological knowledge in the management of protected areas in Brazil. Most of the times the current situation is of confront, rather than of cooperation. Some governmental environmental institutions are controlled by natural scientists who consider the western scientific knowledge as the only basis for designing coastal management, in other words, the western scientific knowledge considers itself the 'judge' of all knowledge (Diegues, 2004).

Maybe today's Marine Extractive Reserves – and potentially the Sustainable Development Reserves – can be considered exceptions, as they allow practical mechanisms (deliberative councils) and legal prerogatives for the effective inclusion of fishermen in the decision-making process. It can be said that these protected areas categories assign to fishermen exclusive access rights and responsibility over resources. Thus, the role of LEK is not restricted to fill the gaps of scientific knowledge (Baelde, 2001). These protected areas allow the active participation of fishermen, which provides specialized advice for the management of resources under their custody.

A broad research field for social scientists is on developing the ways through which LEK can be integrated, represented and validated within a co-management system (Jentoft, 1999). This paper does not aim at developing an in-depth discussion on the ways on which this participative management process occurs. However, it is important to highlight some basic points: i) there is the need of a clear and facilitated process of building trust among researchers, managers and resource users; ii) a representative and transparent governance system is also needed; and ii) scientists should assist communities in the collection, handling and use of LEK, and enforce its use on the decision-making process (Vanderlinden and Chouinard, 2002).

Managing MPAs is largely managing people, and its success depends on how cultural, economical and social values are integrated (Chadwick and Nichols, 2002). LEK research should move beyond the academia to be effectively used by management policy and decision-makers (Huntington, 2000; Davis and Wagner, 2003). In Brazil, the contribution provided by ethno-sciences in the last two decades is yet to be properly incorporated into public policies (Diegues and Arruda, 2001).

Despite the fact that the amount of MPAs in Brazil is below the levels recommended by scientists and international agreements[9], the existent

[9] 7th Conference of the Parties of the Convention on Biological Diversity, Kuala Lumpur, (2004); V IUCN World Parks Congress, Durban, South Africa (2003); World Summit on Sustainable Development, Johannesburg (2002).

MPAs have allowed for those actors involved in these processes to gather considerable experience on this matter. It is necessary now to critically and systematically think on the Brazilian past and its history on the construction of the existing MPAs, and how has the participation of coastal communities and their associated LEK in this process been. This would bring an understanding of the negative and positive patterns of this history, enabling the improvement of the paths for the future of Brazilian MPAS.

Next, we will exemplify how the collaboration of fishermen (through LEK) and scientists (scientific methods-based research) allows the elaboration of a spawning aggregation conservation strategy for the goliath grouper *Epinephelus itajara* in the South region of Brazil. In this case, LEK is being essential to set priority areas for spatial and temporal restriction of fishing efforts. Therefore, this experience represents a practical example on the use of LEK in the planning of MPAs. As observed by Cowie-Haskell (2003), information on spawning aggregations is one of those which most influence the participative planning of MPAs, being essential in defining no-take zones.

Experiences of the "Meros do Brasil Project" in the Research and Conservation of Goliath Grouper *Epinephelus itajara* Spawning Aggregations

A series of the natural history features of some species make them particularly vulnerable to fishing pressures and habitat degradation, including: high longevity; late age at maturity; sex change during life cycle; spatially and temporally predictable spawning aggregations; and demand for nursery areas in estuarine regions (Coleman *et al*, 1999). Among these characteristics, the conservation of spawning aggregations has been considered crucial for the management of reef fish species (Colin *et al*, 2003). A spawning aggregation happens when one or more fish species concentrate in specific localities and periods for reproductive purposes (Colin *et al*, 2003). Non-reproductive fish aggregations (e.g. feeding), although less quoted in the scientific literature (e.g. Teixeira *et al*, 2004), are also important and sometimes deserve the same conservation approach presented herein. When a large number of fish, which are normally dispersed, concentrate in specific places and times, they become highly vulnerable to overfishing (Figure 2) (Colin *et al* 2003). Among all species of Atlantic Ocean marine fishes, those from the Serranidae (groupers) and Lutjanidae (snappers) families receive outstanding attention concerning the spawning aggregation they form.

Photo: Marcelo Krause.

Figure 2. An *Epinephelus itajara* aggregation in south Brazil.

The goliath grouper *Epinephelus itajara* is a critically endangered marine fish species of the Serranidae family (Hostim-Silva *et al*, 2005; Ferreira *et al*, 2006). The goliath grouper inhabits tropical and subtropical coastal waters of the Atlantic Ocean, from Florida down to South Brazil, throughout all the Gulf of Mexico and the Caribbean. It also occurs at Bermuda Islands and even in the Pacific Ocean, where it can be found from the Gulf of California south to Peru (Sadovy and Eklund, 1999). They can usually be found near shipwrecks, bridge pillars, submerged rocks and rocky shores. Natural populations of *E. itajara* are highly vulnerable to fishery because they present slow growth, mature in advanced ages, show territoriality and aggregates to spawn. This species reach more than 400kg and live over 38 years (Bullock *et al*, 1992; Sadovy and Eklund, 1999).

As it happens with the majority of marine species in Brazil and internationally, the biology of the goliath grouper is little studied by the western scientific knowledge. This means that knowledge is not found in a textual and organized manner, thus not being available to managers and researchers of the marine environment. The majority of published accounts of goliath groupers' biological aspects are for Northern Hemisphere populations (Bullock et al 1992; Sadovy and Eklund, 1999). Thus, the uncertainties and urgency in understanding its biological aspects were strong arguments presented by the fishing law IBAMA n.121 (2002), which established a 5-year fishing moratorium on the species, since September 2002 to allow the development of researches to outline conservation strategies for this species. This species is also under protection in the Gulf of Mexico and the Caribbean, being classified as critically endangered by World Conservation Union (IUCN, 2004).

The "Meros do Brasil Project" (http://www.merosdobrasil.org) consist of a network of NGOs and researchers which articulates conservation and

research projects on the goliath grouper and its associated environments (mangroves, coral and rocky reefs). Despite the fact that many specific projects are developed on an autonomous basis by the partner's network organizations, a technical cooperation and strategic/integrated planning are necessary to approach the challenges of research and conservation of a species which occurs throughout most of the Brazilian coast.

In South Brazil (São Francisco do Sul, Santa Catarina), fishermen and children of the community are being involved in an environmental education program which uses the goliath grouper as an emblematic species for the conservation of mangroves and rocky reefs. Preliminary tagging/recapture trials are also being carried on a weekly basis since May 2006, trough partnerships with local Babitonga bay fishermen. These initiatives area being co-executed by the Vale do Itajaí University (UNIVALI) and the Vidamar Institute (environmental education program) with the support of ECOMAR NGO (tagging/recapture program). During 2002-2004, a main activity of the "Meros do Brasil Project" was to approach the LEK of fishermen to identify spawning aggregations in the region (Gerhardinger *et al*, 2006a,b), and therefore they are further discussed in this paper. In Southern Brazil (Cananéia/Iguape, São Paulo), Vidágua Institute has being developing since 2002 one of the pioneer campaigns on environmental awareness and management on the goliath grouper.

In Northern Brazil, ECOMAR engages fishermen on a LEK research program in the Abrolhos Bank (Caravelas, Bahia) since 2005. In 2007, this organization will be coordinating a project with the cooperation of several other institutions across the Brazilian coast (UNIVALI and Instituto Vidamar, Santa Catarina state; Instituto Vidágua, São Paulo state; ECOMAR, Bahia state; Instituto Recifes Costeiros, Pernambuco state). The major focus of this project is the study of fishermen LEK as well as the effective engagement of local fishermen and scuba divers in the conservation of goliath grouper and associated habitats. This initiative will also approach issues such as population genetics, environmental education, management, fisheries, tourism potential, biology and identification and research on the dynamics of goliath grouper spawning aggregations in four Brazilian coastal states. By the end of the project, the conservation status of the species in Brazil will be evaluated through the use of IUCN criteria, supported by the project's results after two years.

The collaboration of fishermen in the process of research and conservation of the goliath grouper is seen as an essential component of almost every approach of all partner institutions. This is in part due to the acknowledgment of the successful experiences developed in Santa Catarina from 2002-2004. During this period, a detailed study on the LEK possessed by fishermen of Babitonga bay was developed. Fishermen of the long-line fishery (submerged rocks within the bay) and underwater spear fishery (islands, submerged rocks and shipwrecks outside the bay) were involved in a LEK research through the use of methods such as "cognitive maps" (Calamia, 1999) and semi-structured interviews on several aspects of the biology, resources use, fishing technology, among other socioeconomic topics of the goliath grouper fishing activity (Gerhardinger *et al*, 2006a,b).

The use of cognitive maps adapted to understanding spatial distribution aspects, abundance and spawning aggregation sites resulted in promising outcomes, with a great potential for MPA planning processes. Each informant was given a satellite-based image (size A4) of the region and drew detailed and accurate information on the image. The main local spawning aggregation sites were identified, as well as those areas with higher goliath grouper abundance in the region. The semi-structured interview results are also being useful for the planning of other methodological approaches of the "Meros do Brasil Project". This methodology has also allowed the register of important aspects related to goliath grouper spawning aggregations. For illustrative purposes, we quote a very detailed report on the behavior of goliath groupers in spawning aggregations, provided by the elderly informant (83 years old) (Gerhardinger *et al*, 2006b):

"Then, later on, we discovered which was the male and which was the female. The male was taking care of the females, and when we dived the male would come after us to see what was that. We already knew, the female would stay down there, quiet. Thus, it was much easier to kill the female, but the male we could see when it approached and I would aim and PUM! There was always more females than males. We would only catch males. Because then we opened the belly and they would not have eggs. The male did not have eggs, the females had eggs, and when we caught them and saw that large belly with eggs, already knew it was a female, the male was thinner. Most of the times the male would come after us. It seemed that it was taking care of the females." (Translated from a Portuguese transcription of the conversation).

LEK related to goliath grouper behavior on spawning aggregations, although not homogeneously distributed among the participating fishermen, surprised us due to the high level of details accumulated by this single informant. This corroborates the results of Hamilton (2005), and shows that there are situations where the knowledge and experience of one single fisherman can reveal new and extremely detailed information on a given species. For that reason, such registers should not be disregarded.

Currently, the Babitonga Bay is been considered to the designation of a MPA of sustainable use category. The "Meros do Brasil" Project's results - which counts on an expressive volume of information from the LEK study – have been used in the elaboration of this MPA proposal. It is expected that, after the protected area creation, LEK-based information can also be employed to elaborate the management plan. One of the MPA's objectives is goliath grouper conservation. An eventual management plan could provide for the implementation of full-time or seasonal small no-take zones, which could play an important role in protecting local spawning aggregations. This MPA is expected to be fitted in one of the Brazilian's protected areas categories. This will probably demand deeper understanding on other ecosystem-related aspects and their dynamics with social and economical systems operating at a local level.

Simultaneously to this initiative, one of the local fishermen associations has already required the designation of no-take zones within the bay. These initiatives, although not yet legally defined, show the existence of an enabling atmosphere for cooperation towards marine conservation efforts among governmental and non-governmental organizations, researchers and fishermen in the region. Within this context, the likely existence of a co-management council of an eventual protected area could provide the required practical mechanism to conciliate local and scientific ecological knowledge.

Perspectives to the Study of Local Ecological Knowledge on Marine Fish Spawning Aggregations in Brazil

Most spawning aggregations known in the western tropical Atlantic Ocean are found in the Caribbean (SCRFA Global Database, 2004). However, there are evidences that such aggregations are not uncommon in the Brazilian coast, as it might appear due to the lack of scientific reports. Large shoals of the cubera snapper *Lutjanus cyanopterus*, apparently gathering to spawn, have been frequently observed in the Southern coast of Brazil until the decade of 1970's (Carvalho-Filho, *pers. comm.*). One of the "Meros do Brasil" Project's informants has also said that he has observed large shoals of *L. cyanopterus* in Santa Catarina state. The cubera snapper and other species occurring along the Brazilian coast (*Lutjanus analis, L. synagris, L. jocu, Cephalopholis fulva, Mycteroperca bonaci, M. venenosa* and *Epinephelus morio*) lie among those species with a high number of reported spawning aggregations in other parts of the world (SCRFA Global Database, 2004). Large and unusual shoals of the dusky grouper *Epinephelus marginatus*, the yellowtail snapper *O. chrysurus* and the warsaw grouper *E. nigritus* are among the informal records provided by scuba divers and fishermen along the coast (Bertoncini *et al*, 2003; LCG and MOF, *pers. obs*.). Therefore, we suggest that there is still a lot to be investigated on spawning aggregations in Brazil.

Fishermen usually discover spawning aggregations before scientists (Johannes, 2001b), becoming evident that assessing LEK of different stakeholders is probably one of the unique and feasible ways of recovering this sort of data in Brazil. Several researchers have already observed that investing in LEK brings a good cost/benefit relationship when assessing information on spawning aggregations (Johannes, 1981; Hamilton *et al*, 2005). The choice for LEK comes, among other factors, from the logistical difficulties in identifying spawning aggregations, which are usually assembled in specific sites and short periods of time (Hamilton *et al*, 2005).

In some areas of the Pacific Ocean, the non-governmental organization The Nature Conservancy invested in a broad LEK assessment campaign oriented to identifying spawning aggregations in remote areas, for which there were no scientific data available. The large amount of information gathered, today serves as a background for planning traditional ichthyology approaches (e.g. underwater visual census), allowing a systematic monitoring of several

spawning aggregation sites (Hamilton *et al*, 2005). Similarly, approaches of this nature could play an important role as first steps in the research, monitoring and management of the Brazilian spawning aggregations.

Traditionally, the LEK provides information on: i) specific sites on which aggregations are formed; ii) annual and lunar periodicity of aggregations; iii) composition of species in multi-specific aggregations; iv) reproductive behavior of aggregating fish and v) change on the status of aggregations along time (Hamilton *et al*, 2005).

Obviously, the LEK approach should not be the only tool used to study the Brazilian spawning aggregations along the coast. Not all artisanal fishermen communities possess a LEK system about spawning aggregations. Some unknown factors can interfere on the level of LEK possessed by a given community about this phenomenon. Such factors are probably related to the different environmental and cultural contexts through which LEK is built upon.

We also suggest the use of standardized methodologies to the spawning aggregation-oriented studies in Brazil (for methodological examples see Colin *et al*, 2003 and Hamilton et al, 2005). The identification, definition and characterization of a spawning aggregation must meet well defined biological criteria (Colin *et al*, 2003; Sadovy *et al*, 2005). Furthermore, Hamilton *et al* (2005) highlight some other factors influencing the success of LEK-based studies on spawning aggregations: i) willingness of local fishermen to provide the information requested; ii) field skills inherent to the researcher and iii) time spent on documenting this sort of information. Ethical principles should also be followed when carrying out LEK research, respecting the individual's and community's rights (Huntington, 2000; Johannes, 2001a).

The Brazilian Institute of Environment (IBAMA) is coordinating a two year national effort to study spawning aggregations of reef fishes in Brazil. Universities and NGOs joining the initiative will conduct research to determine the location and characteristics of these aggregations, their relevance to fisheries and propose appropriated management and conservation measures. Methods will follow those developed by the Society for the Conservation and Research of Reef Fish Aggregations (Colin *et al*, 2003), and will include monitoring of landings, studies on reproduction and recruitment, local ecological knowledge surveys and topographic studies to determine the seascape features associated to the aggregations. Thus, the experiences of the "Meros do Brasil Project" and the observations discussed herein about the potential role of LEK in studying spawning aggregations in Brazil, provides important technical subsidies for this new initiative under the coordination of IBAMA.

Conclusions

The debate on the role played by MPAs as a tool for marine ecosystem management is increasing at international level, as well as in Brazil, where discussions have been introduced in the agenda of academic institutions, third sector, fishermen communities and specific government policies. Governmental institutions and non governmental organizations, among other social actors, have already accumulated considerable experience in the implementation of MPAs in Brazil. The moment seems favorable for undertaking a systematic and critical evaluation about negative and positive patterns of this history and tracing the path for the future of MPAs in Brazil. This book, exclusively dealing with some Brazilian experiences on MPAs, is the starting point for thinking over this topic.

We have noticed that within the uprising and intensification of this debate, it is worth fostering the discussion about the potential interface and roles of combining scientific and local ecological knowledge. This should open the path for a more participative and effective marine resource management. The LEK of artisanal fishermen represents an underused source of environmental information for the planning and management of the Brazilian MPAs. To some extent, this is possibly due to the recent development of LEK study approaches, which still faces methodological and cultural barriers.

However, the situation is changing as the interest on LEK increases, especially within universities and research institutes (Diegues, 2004). The existence of hundreds of extractive communities inhabiting the vast Brazilian coast offers an enormous field for cooperation between local ecological knowledge and the marine sciences. In this aspect, Marine Extractive Reserves offer promising opportunities to develop the investigation of potential cooperation between local and scientific knowledge in the planning and, notably, in the management of MPAs.

Another important investigation topic is the development of practical tools to effectively incorporate LEK in the MPAs planning and management processes. Considering that, “cognitive maps” stand as a promising tool, since they allow for a systematic and simple way of delivering the information entailed by local ecological knowledge in a decision-making process.

The importance assigned to conservation of marine fish spawning aggregations has increased in Brazil. There is still a vast field for studying this phenomenon in Brazil, as very few spawning aggregations are known and little efforts were employed to research them. LEK emerges as a crucial tool to the initial phases of the research, monitoring and management processes of the Brazilian spawning aggregations. Such LEK’s potential comes from its capacity of supporting basic information to the identification and classification of aggregations. Based on such information, research and monitoring schemes using conventional scientific methodologies can be designed. The experience of the “Meros do Brasil Project” shows that this approach is viable, although there is still a long way to run towards

effectively integrating LEK into MPA co-management systems. However, the information and thoughts presented herein strengthen the idea that the implementation of a MPA at Babitonga Bay will provide the maintenance of both biological and cultural diversities of the area, and allow a cooperation between scientific and local expertise in the co-management of local natural resources.

Acknowledments

We acknowledge all fishermen and communities from Babitonga bay for all the lessons and insights provided during the project, and all friends and researchers involved in the project development. We thank 'Transpetro Transportes S/A' by the financial support provided for the initiatives under the coordination of 'Instituto Vidamar' in São Francisco do Sul (Santa Catarina state); 'Fundação Biodiversitas', 'Centro de Pesquisas Ambientais do Nordeste' and 'Cryctical Ecosystem Partnership Fund' for the financial support provided for the initiatives in Caravelas (Bahia state) and 'Programa Petrobras Ambiental' for the recent financial support for the project under administrative coordination of 'ECOMAR NGO' and co-execution with 'UNIVALI', 'Instituto Vidamar', 'Instituto Vidagua' and 'Instituto Recifes Costeiros'. All the fisheries research and management bodies of IBAMA (CEPNOR, CEPENE and CEPSUL) and the Abrolhos Marine National Park authority have been important partners in the conservation and research of goliath groupers in Brazil. We thank the professional photographer Marcelo Krause (www.marcelokrause.com.br), which kindly provided the illustrative photo of the goliath grouper aggregation. These partnerships have been essential for the development of the "Meros do Brasil Project" (www.merosdobrasil.org). Some discussions presented herein were partially published during the IV Brazilian Congress on Protected Areas (Curitiba, 2004) (Gerhardinger *et al*, 2004).

References

ALLISON, G. W.; LUBCHENCO. J.; CARR, M. H. 1998. **Marine reserves are necessary but not sufficient for marine conservation.** Ecological Applications, 8:79-92.

ASWANI, S. & R. HAMILTON. 2004. **The value of many small vs. few large marine protected areas in the Western Solomon Islands.** Traditional Marine Resource Management and Knowledge Information Bulletin, 16:3-14.

BAELDE, P. 2001. **Using Fishers' Knowledge Goes Beyond Filling Gaps in Scientific knowledge - Analysis of Australian Experiences.** Putting Fishers' Knowledge to Work. University of British Columbia: FCRR. pp.78-86.

BEGOSSI, A.; HANAZAKI, N.; PERONI, N. 2000. **Knowledge and use of biodiversity in brazilian hot spots.** Environment, Development and Sustainability, 2 (3-4); p. 18.

BEGOSSI, A. 2006. **Temporal stability in fishing spots: conservation and co-management in Brazilian artisanal coastal fisheries.** Ecology and Society, 11(1): 5. p. 25.

BERKES, F. **Sacred Ecology: Traditional ecological Knowledge and resource management.** Philadelphia, Taylor & Francis. 1999.

BERKES, F. & C. Folke. 2002. **Back to the future: ecosystem dynamics and local knowledge.** pp. 121-146 IN: Gunderson, L.H.; Holling, C.S. Panarchy: understanding transformations in human and natural systems. Washington (USA): Island Press.

BERKES, F.; Colding, J.; FOLKE, C. 2003. **Navigating social-ecological systems: building resilience for complexity and change.** Cambridge (UK): Cambridge University Press.

BERTONCINI, A. A.; Machado, L. F.; Hostim-Silva, M.; Barreiros, J. P. 2003. **Reproductive biology of the dusky grouper, *Epinephelus marginatus* (Lowe, 1834) (Perciformes: Serranidae, Epinephelinae) in Santa Catarina**, Brazil. Brazilian Archives of Biology and Technology, 46(3):373-381.

BULLOCK, L.H; Murphy, M. D., Godcharles, M. F.; Mitchell, M. E. 1992. **Age, growth, and reproduction of jewfish *Epinephelus itajara* in the eastern Gulf of Mexico.** Fish. Bull, 90: 243-249.

CALAMIA, M. A. 1999. A **methodology for incorporating traditional ecological knowledge with geographic information systems for marine resource management in the Pacific.** Traditional Marine Resource Management and Knowledge Information Bulletin, v.10.

CHADWICK, M. & S. Nichols. 2002. **Summary and Recommendations.** In: Science and Local Knowledge: Making the Linkages Work in Canada's MPAs. Université de Moncton, pp.32-33.

CHRISTIE, P., McCay, B. J., Miller, M. L., Lowe, C., White, A. T., Stoffle, R., Fluharty, D. L., McManus, L. T., Chuenpagdee, R., Pomeroy, C., Suman, D. O., Blount, B. G., Huppert, D., Elsma, R.-L. V., Oracion, E., Lowry, K.; Pollnac, R. B. 2004. **Toward developing a complete understanding: A social science research agenda for marine protected areas.** Fisheries 28, 22-26.

COLEMAN, F. C.; Koenig, C. C.; Eklund, A.-M.; Grimes, C. B. 1999. **Management and Conservation of Temperate Reef Fishes in the Grouper-Snapper Complex of the Southeastern United States.** American Fisheries Society Symposium, 23:244-242.

COLIN, P. L., Sadovy,Y.; Domeier, M. L. 2003. **Manual for the study and conservation of reef fish spawning aggregations**, Society for the Conservation of Reef Fish Aggregations special publications, 1:1-98.

COWIE-HASKELL, B. D. & J. M. Delaney. 2003. **Integrating Science into the Design of the Tortugas Ecological Reserve.** MTS journal, 37(1):68-79.

DAVIS, A. & J. R. Wagner. 2003. **Who knows? On the importance of identifying "experts" when researching local ecological knowledge.** Human Ecology, 31(3):463-489.

DIEGUES, A. C. & R.S.V. Arruda. 2001. **Saberes Tradicionais e biodiversidade no Brasil.** Brasília: Ministério do Meio Ambiente. 176 p.

DIEGUES, A. C. 2004. **A Pesca Construindo Sociedades.** NUPAUB, Universidade São Paulo: São Paulo. 315p.

DRUMOND, M.A. 2002. **Participação Comunitária no Manejo de Unidades de Conservação - Manual de técnicas e ferramentas.** Instituto Terra Brasilis de desenvolvimento socio-ambiental. Belo Horizonte. 81p.

FAULKNER, A. & R.A.M. Silvano. 2001. **Status of Research on Traditional Fishers' Knowledge in Australia and Brazil.** In: Putting Fishers' Knowledge to Work. University of British Columbia: FCRR, pp.110:116.

FERREIRA, C. E. L.; Gerhardinger, L. C.; Prates, A. P. L.; Ferreira, B. P.; Rosa, I. L.; Sabino, J.; Loiola, L. L.; Hostim-Silva, M. 2005. **Áreas Protegidas como ferramenta para a conservação de populações de peixes no Brasil.** Boletim Sociedade Brasileira de Ictiologia, João Pessoa, v. 79, pp. 6-8, 01 jun.

FERREIRA, B. P.; Hostim-Silva M.; Gerhardinger L. C.; Bertoncini A. A. 2006. **Research and conservation of groupers in Brazil.** Boletín Especies Amenazadas, IUCN, v. 11.

GERHARDINGER, L. C.; Freitas, M. O.; Medeiros, R. P.; Godoy, E. A.; Marenzi, R. C.; Hostim-Silva, M. (2004). **Conhecimento Ecológico Local e Biodiversidade Marinha no Planejamento de Áreas Marinhas Protegidas: Uma Análise Crítica.** In: Anais do IV Congresso Brasileiro de Unidades de Conservação. Curitiba. pp. 500-510.

GERHARDINGER, L. C.; Medeiros, R. Marenzi, R.C.; Bertoncini, A.A; Hostim-Silva, M. 2006a. **Local Ecological Knowledge on the Goliath Grouper *Epinephelus itajara*.** Neotropical Ichthyology, 4(4):441-450.

GERHARDINGER, L. C.; Bertoncini, A.A; Hostim-Silva, M. 2006b. **Local ecological knowledge and Goliath grouper spawning aggregations in the South Atlantic Ocean: Goliath grouper spawning aggregations in Brazil.** SPC Traditional Marine Resource Management and Knowledge Information Bulletin, 20:33-34.

HALPERN, B. S. & R. R. Warner. 2002. **Marine reserves have rapid and lasting effects.** Ecology Letters, 5:361-366.

HAMILTON, R. & R. Walter. 1999. **Indigenous ecological knowledge and its role in fisheries research design. A case study from Roviana Lagoon, Western Province, Solomon Islands.** SPC Traditional marine resource management and knowledge bulletin, 11: 13-25.

HAMILTON, R. J. 2005. **Indigenous ecological knowledge (IEK) of the aggregating and nocturnal spawning behaviour of the longfin emperor, *Lethrinus erythropterus*.** SPC Traditional Marine Resource Management and Knowledge Information Bulletin, 18: 9-17.

HAMILTON, R. J., Matawai, M., Potuku, T., Kama, W., Lahui, P., Warku, J., and Smith, A. J. 2005. **Applying local knowledge and science to the management of grouper aggregation sites in Melanesia.** SPC Live Reef Fish Information Bulletin 14: 7-9.

HOLLING, C.S.; Berkes, F.; Folke, C. 1998. **Science, sustainability and resource management.** In: Berkes, F. e Folke, C. Linking social and ecological systems: management pratices and social mechanisms for building resilience. Cambridge (UK): Cambridge University Press, pp. 342-362.

HOSTIM-SILVA, M.; Bertoncini, Á. A; Gerhardinger, L. C.; Machado, L. F. 2005. **The Lord of the Rocks conservation program in Brazil: the need for a new perception of marine fishes.** Coral Reefs, v. 24:74.

HUNTINGTON, H. P. 2000. **Using Traditional Ecological Knowledge in Science: Methods and Applications.** Ecological Applications, 10(5):1270-1274.

IUCN. 2003. **Recommendations of the Vth IUCN World Parks Congress, Durban, South Africa.** www.iucn.org/themes/wcpa/wpc2003/pdfs/outputs/recommendations/approved/english/pdf/r22.pdf.

IUCN 2004. 2004 IUCN **Red List of Threatened Species.** <www.iucnredlist.org>. Acessado em 12 de Janeiro de 2006.

JENTOFT, S. 1999. **Ecological Folk Knowledge: Some Methodological Remarks.** Ecological Knowledge Working Seminar. St. Francis Xavier Universtiy. Disponível em: www.stfx.ca/research/ecoknow. Acesso em 30/06/2004.

JOHANNES. R. E. 1981. **Words of the Lagoon: Fishing and Marine Lore in the Palau District of Micronesia.** University of California Press, 245 pp.

JOHANNES, R. E. 1998. **The case for data-less marine resource management: examples from tropical nearshore finfisheries.** Trends in Ecology and Evolution, 13:243-246.

JOHANNES, R. E & E. Hviding. 2000. **Traditional knowledge possessed by the fishers of Marovo Lagoon, Solomon Islands, concerning fish aggregating behavior.** Traditional Marine Resource Management and Knowledge Information Bulletin, 12:22-29.

JOHANNES, B. 2001a. **On the Need for the Study of Indigenous Fishers' Knowledge.** MPA news, 3(5), November, p.6.

JOHANNES, B. 2001b. **Summary of presentation to Introduction to Marine Protected Areas Short Course.** Disponível em: http://courses.washington.edu/susfish/2001/Johannes_info.html. Acesso em 30/06/2004.

JONES, P. J. S. 2006. **Collective action problems posed by no take zones.** Marine Policy 30(2), 143-156.

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

Medeiros, R. P. M. 2004. **Refletindo sobre os desafios à construção de uma ética ambiental.** ANAIS do II Seminário Sobre Ética em Pesquisa. Itajaí: UNIVALI, 29 de junho a 01 de julho de 2004. (Disponível em CD-ROM).

MMA. **Primeiro relatório para a convenção sobre a diversidade biológica.** Brasília. 1998.

MORIN, E. & A. Kern. 2003. **Terra-Pátria.** Porto Alegra: Sulina.

National Research Council. 2001. **Marine protected areas: tools for sustaining ocean ecosystems.** Washington, DC: National Academy Press.

NEIS, B., D. C. Schneider, Felt, L.; Haedrich, R. L.; Fischer, J.; Hutchings, J. A.. 1999. **Fisheries assessment: what can be learned from interviewing resource users?** Canadian Journal of Fisheries and Aquatic Sciences, 56(10):1949-1963.

NEIS, G., Bleakely, C.; Wells, S. 1995. **Fishers' Ecological Knowledge and Marine Protected Areas.** In: Symposium on Marine Protected Areas and Sustainable Fisheries: Second International Conference and the Management of Protected Areas. Dalhousie University, Halifax, Nova Scotia, Canada. 16-20 May 1994, pp.205-213.

POLUNIN, N. V. C. 2002. **Marine protected areas, fish and fisheries.** In: Hart PJB and Reynolds JD, editors. Handbook of Fish and Fisheries, Volume II. Oxford, UK: Blackwell Science, pp. 293-318.

POMEROY, R. S., Parks, J. E.; Watson, L.M. 2004. **How is your MPA doing ? A guidebook of natural and Social Indicators for Evaluating Marine Protected Area Management Effectiveness.** IUCN, Gland, Switzerland and Cambridge, UK. Xvi +216p.

ROBERTS, C. M. 2000. **Why does fisherymanagement so often fail?** In: M. Huxham e D. Sumner (Ed.). Science and Environmental Decision Making: Prentice Hall. Why does fishery management so often fail? pp 170–192
Roberts, C. M. e J. P Hawkins. 2000. Fully-Protected Marine Reserves: a guide: Whashington, DC, USA and Environmental Department, University of York York, UK, 131p.

RODRIGUES, E.; de Paula, A. C.; Araújo, C. M. y. 2004. **Plano de Manejo de Uso Múltiplo das Reservas Extrativistas Federais.** Roteiros Metodológicos. Brasília: Ibama. 157p.

RUDDLE, K. e Anuchiracheeva, S. 2003. In The International Conference on the Sustainable Development of the Seas of East Asia: Towards a New Era of Regional Collaboration and Partnerships: Malaysia.

SADOVY, Y. & Cheung, W. L. 2003. **Near extinction of a highly fecund fish: the one that nearly got away.** Fish and Fisheries, 4:86-99.

SADOVY, Y.; Colin, P.; Domeier, M. 2005. **Monitoring and managing spawning aggregations: Methods and challenge.** SPC Live Reef Fish Information Bulletin, 14: 25-29.

SADOVY, Y. & A. Eklund. 1999. **Synopsis of Biological Data on the Nassau Grouper, *Ephinephelus striatus*, and the Jewfish, *E. itajara*.** NOAA Technical Report, 65p.

SÁENZ-ARROYO, A.; Roberts, C. M.; Torre, J.; Carino-Olvera, M.; Enrıq, R. R. 2005. **Rapid environmental shifting baseline among fishers from the Gulf of California.** Proceedings of the Royal Society: 1957-1962, 2005
Secretariat of the Convention on Biological Diversity. 2004. Technical Advice on the Establishment and Management of a National System of Marine and Coastal Protected Areas, SCBD, 40 pages (CBD Technical Series no. 13).

SEIXAS, C. S. 2005. **Abordagens e Técnicas de Pesquisa Participativa em Gestão de Recursos Naturais.** In: Gestão Integrada e Participativa de Recursos Naturais (Editores: Vieira, P. F., Berkes, F. e Seixas, C. S.). Associação Brasileira de Pesquisa e Ensino em Ecologia e Desenvolvimento. Editora Secco: Florianópolis, Brasil, 415p.

SEIXAS, S. S. & Begossi, A. 2001. **Ethnozoology of Fishing Communities from Ilha Grande (Atlantic Forest Coast, Brazil)**. Journal of Ethnobiology, 21(1):107-135. 2001.

SEIXAS, C. S. & F. Berkes. 2003. **Learning from fishers: Local Knowledge for management design and assessment.** IN: Vieira, P. F. (org.) Conservação da diversidade biológica e cultural das zonas costeiras: Enfoques e experiências na América Latina e Caribe. Florianópolis: APED Editora. pp. 333-371.

SILVANO, R. A. M. 2004. **Pesca Artesanal e Etnoictiologia.** In: Alpina Begossi. (Org.). Ecologia de Pescadores da Mata Atlântica e da Amazônia. 1 ed. São Paulo, 2004, v., pp. 185-220.

SCRFA Global Database. 2004. **Spawning aggregation database of the Society for the Conservation of Reef Fish Aggregations.** World Wide Web electronic publication. http://www.scrfa.org

TEIXEIRA, S. F., Padovani, B. F.; Padovan, I. P. 2004. **Aspects of fishing and reproduction of the black grouper *Mycteroperca bonaci* (Poey, 1860) (Serranidae: Epinephelinae) in the Northeastern Brazil.** Neotropical Ichthyology, 2(1):19-30.

VANDERLINDEN, J. P. & O. Chouinard. 2002. **Results of the Roundtable Discussions.** In: Science and Local Knowledge: Making the Linkages Work in Canada's MPAs. Université de Moncton, pp 27-31.

VIEIRA, P. F.; Berkes, F.; Seixas, C. S. 2005. **Gestão integrada e participativa de recursos naturais: conceitos, métodos e experiências.** Florianópolis: Secco/Aped.

World Summit on Sustainable Development: Plan of Implementation: www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal.htm

Fishery Exclusion Zones Proposed by the Artisanal Fishing Communities at the North Coast of Rio Grande do Sul A Case Study

Mônica Brick Peres [1,3]
Sandro Klippel [2,3]
Manoel Augusto da Costa Vianna [1]

Abstract

This is the first experience regarding the development of fishery exclusion zones on a co-management process at the Rio Grande do Sul State. The fishery zoning proposals, presented here, were constructed and approved by the artisanal professional fishers from eleven fishing communities on the North Coast of the state (29°19' S 30°30' S), who have been both the main users of the marine resources and the main partners in the conservation efforts. Among them, there is the creation of a 130-km coastal area without industrial fishery and 5NM of width from the beach, with a total surface of 1.220km^2. Of that area, 72% will be of permanent no-take zones for fishery and extraction of macro-invertebrates (880km^2), including a single parallel area to the coast of 2MN of width (490km^2) connected to the beach through some smaller areas perpendicular to the coast (390km^2). The polygon of this mosaic includes all depths up to 30m, which guarantees a good representation of protected ecosystems and create "corridors" for species migration. Besides drastically reducing the fishery effort, the implantation of that mosaic would serve as an important mechanism to protect critical areas for biodiversity conservation. The state shallow waters are the main areas of reproductive aggregation of some commercial and endangered fish species, and high risk areas of accidental capture of Franciscana dolphin and some species of marine-turtle.

Introduction

The continental shelf of Rio Grande do Sul is one of the most productive regions of the Brazilian coast (Odebrecht and Castello, 2001). Its high primary productivity stems from the input of fresh water from both Lagoa dos Patos and the Plata River, with a strong influence of the Subtropical Convergence. That productivity, associated with extensive muddy and sandy bottoms, facilitates the development of diversified and abundant benthonic and demersal communities. Thus, the Rio Grande do Sul coast serves as an area of feeding and reproduction of many resident and migratory species of

[1] IBAMA-CEPERG, Centro de Pesquisa e Gestão dos Recursos Pesqueiros Lagunares e Estuarinos. Cx. P. 357, Rio Grande - RS CEP 96200-190. e-mail: MonicaBrickPeres@yahoo.com.br

[2] IBAMA-Escritório Regional de Rio Grande, Rua Coronel Sampaio, 119, Rio Grande - RS CEP 96.200-180. e-mail: Sandro.Klippel@ibama.gov.br

[3] Instituto IGARÉ. Rua São Borja 557, Cassino, Rio Grande - RS CEP 96.205-160

megafauna from the Argentine Province (Seeliger *et al*., 1997). The shallow waters, up to 20-30m of depth, are areas of creation and spawning for some fish species of commercial relevance (Haimovici *et al*, 2005), critical areas of reproductive aggregation and nursery of the populations of more than twenty species of elasmobranches (Vooren and Klippel, 2005a), areas of higher risk of accidental capture of the marine mammal Atlantic spotted dolphin ("Toninha") *Pontoporia blainvillei*, a small endemic cetacean of the Atlantic South-western (Secchi *et al*., 2003; Secchi *et al*., 2004) and of some species of marine turtles (Hunter, 2004). Therefore, the shallow waters of the region are extremely relevant for biodiversity conservation and the sustainability of fishery resources.

Historically, that natural productivity has supported artisanal fisheries developed in lagoons, estuaries and coastal zone of the state (Klippel *et al*, 2005a) and that sustained thousands of artisanal fishing families (Garcez, 2001). The false idea of an inexhaustible fishing potential in the region, justified the adoption of development policies for industrial fishery that disregarded the resources sustainability, at national and regional levels (Dias-Neto, 2003). From the 60's on, several multi-specific industrial fisheries have been developed on the continental shelf and slope of Rio Grande do Sul (Yesaki, 1974; Klippel *et al*, 2005b). Due to the intensive fishery efforts during the last decades, most of the traditional fishery resources is over-exploited and some species that used to support fisheries are now endangered (Haimovici, 1998; Vooren and Klippel, 2005b). There are several examples of full collapse of important fisheries on the coast of Rio Grande do Sul. Amongst mono-specific fisheries of Teleostei, it can be mentioned the disappearance of marine catfish *Genidens barbus*, the black drum *Pogonias cromis* and the red porgy *Pagrus pagrus* (Reis and Vieira, 1994; Haimovici, 1998). Moreover, there is the disappearance of beach seine for Brazilian guitarfish *Rhinobatus horkelii*, and of oceanic fisheries as the school shark *Galeorhinus galeus*, narrownose smooth-hound shark *Mustelus schimitti*, angel shark's trawling *Squatina* spp., and many others fisheries targeting Elasmobranch species (Vooren and Klippel, 2005b), considered threatened (Ministry for Environment - MMA, Act n° 5, dated May of 2004, the MMA). Bycatch is also the main threat for the Franciscana dolphin and several marine-turtles (Hunter, 2004; Secchi *et al.*, 2004), all of them, threatened (MMA, Act n° 3, dated May of 2003).

At the global level, fishery sustainability is being challenged, since 75% of the fishery resources are fully exploited, over exploited or collapsed (Garcia and Moreno, 2003). As can be observed in Rio Grande do Sul, the serious depletion of supplies in some world regions led the fisheries to the economic extinction, disappearance of populations at regional scale and ecological extinction of several species (Jackson *et al*, 2001). Besides the direct impact on the target-species, fisheries may directly or indirectly interfere on ecosystems. The by-catch of many species, the physical impacts over the bottom and its communities, the indirect effects on the trophic chain and the reduction of genetic variability of marine populations are some examples (Myers and Worm, 2003). Therefore, intensive and unmanaged fisheries is the main problem for the conservation of marine biodiversity.

The acknowledged failure of species-specific management and Maximum Sustainable Yield (MSY) approach (Ludwig *et al*, 1993) has increased the interest on Ecosystem Approach to Fisheries and, consequently, the interest in protected marine areas as a tool to manage fishery and biodiversity conservation (Kelleher, 1999; Roberts *et al*, 2001). There are several examples showing that in protected areas the diversity, abundance of species, size of individuals and reproductive success are greater (Roberts *et al*., 2001; Gell and Roberts, 2002). The term marine protected area (MPA) comprises any marine area with some sort of protection, aiming at conserving waters and habitats, and their associate flora and fauna (Kelleher, 1999). Marine reserve, sanctuary, closed area, no take fishery area, are other terms for MPA's, considering their goals and restriction levels. In the light of fishery management, no take fishery areas are defined as any area where some or all fisheries are closed, permanent or temporarily (Walker, 2004).

Background

The north coast plain of Rio Grande do Sul is drained by the Tramandaí River Basin, which connects 34 coastal lagoons and discharges into a estuarine lagoon complex, called Tramandaí-Armazem (Figures 1 and 2). For its proximity to the Serra Geral, the region serves as a biogeographic frontier between the Atlantic Forest and the coastal zone. Both regions are considered National Heritage, according to the 1988 Constitution (Marcuso *et al* 1998).

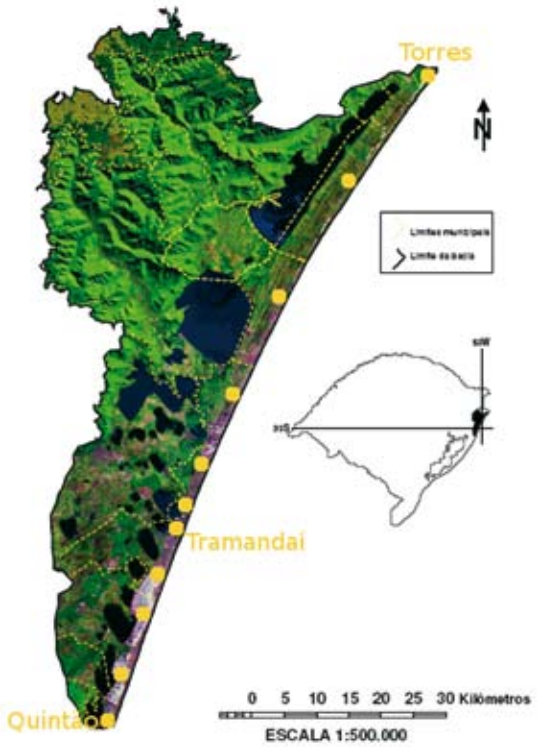


Figure 1 - Landsat image of the Tramandaí River Basin, where we can see the Serra do Mar, the string of coastal lagoons, urban conglomerates formed by the several beach resorts, town limits (yellow dashed lines) and fishing communities (yellow circles),

Photo: Sandro Klippel.

Figure 2 - General aspect of the northern coastal plain of the Rio Grande do Sul.

The North Coast of Rio Grande do Sul, between Torres and Balneário de Quintão (29°19' S – 30°30' S) is occupied by an urban conglomerate that includes the biggest beach resorts of the state. Tourism is the most important economic activity (FEPAM, 2000) and main beach uses are surf, professional and sport fisheries.

Commercial beach fishery is traditionally a small scale (artisanal), without a fishing vessel, uses a great diversity of fishing gears and methods, with low fishing yields. It uses fishing nets, bolter but, above all, nets that are fixed perpendicularly to the beach, using a system of cables and pulleys. Each fisher/family works, in general, with a single net, or fishline in the beach, that may be fixed up to 500m (0.3mm) far from the beach, and are collected by hands or with motorized vehicle (Figure 3). The nets are, on average, 50m in length, and the mesh sizes vary according to the target-species. Currently, the main fishery resources disembarked are the kingfish *Menticirrhus* spp., mullet *Mugil platanus*, king weakfish *Macrodon ancylodon*, whaitemouth croaker *Micropogonias furnieri* and the catfish *Genidens barbus*. For some families, fish-king *Atherinella brasiliensis* and *Odontesthes argentinensis* are economically important. The improvement of fish caught is made by the family itself, and the product is directly traded to the consumer. From 700 and 800 families, distributed along 11 communities, are estimated to live exclusively on the marine PPA in the region (Peres *et al*., 2005a) (Figures 1 and 4).

There is no official statistics of the PPA production, or any historical record of its efficiency, but fishers affirm that the reduction of the captures of disembarked beach fisheries in the last years is a serious issue. Confirming the technical information available, many of them report the extinction of

Photo: Mônica Brick Peres.

Figure 3 - Beach net fishery on the north coast of Rio Grande do Sul.

Photo: Mônica Brick Peres.

Figure 4 - Fishing community of the north coast of Rio Grande do Sul.

several species that used to be commercially important, 10 to 20 years ago, such as black drum, angel shark, Houndsharks (*Mustelus* spp.) and the Brazilian guitarfish. Many fishers are worried about the reduced abundance of species that are still important for their survival, such as kingfish, mullet and king weakfish. For them, the main cause of the stocks reduction was caused by excessive effort of industrial fishery, especially in shallow waters, where, according to them, the "shoals get close to the shore to spawn". The observations show that industrial fishery near to the

beach is very intensive. Despite the legal regulation forbidding the trawling within 3NM from the beach (SUDEPE Administrative Rule 26-N of 1983), the other modalities of industrial fishery have no operation limitation in coastal waters (Figure 5). The main demand of the PPA to IBAMA is the prohibition of industrial fishery along the coast.

Photo: Mônica Brick Peres.

Figure 5 - Gillnet fishery vessel working near the coast of Rio Grande do Sul.

One kind of emerging fishery identified in the region is operated from inflatable boats with an outboard engine, crewed by two fishers, leaving from the beach, using 500 to 2.000m of gillnets, placed everyday in a distance of up to 2 or 3 MN from the beach (10-30m in depth) (Figure 6). This kind of fishery is more frequent in the summer because of the atmospheric and sea conditions and is directed to newborn of hammerhead shark and spawning adults of Brazilian guitarfish – to lesser extent, there is the capture of Brazilian coddling *Urophysis brasiliensis*, whaitemouth croaker and king weakfish. In October of 2004 the number of inflatable small boats working in the region was lower than 15; today, that figure is almost 60. Most of these small boats and nets were acquired by fishers through the financing granted by the RS-Pesca and PRONAF Programs and technical subsidy of EMATER-RS.

In the north coast, the recreational fishery is intense and the captured resources are the same as those of the PPA (Peres and Klippel, 2005). Therefore, additionally to the conflict for physical space at the beach strip, there is a conflict on the use of fishery resources between the PPA and the amateur fishers. The catching of macro-invertebrates for consumption and bait purposes is made by summer tourists, low-income resident population, amateur fishers and PPA. That activity is increasing in the last years and the reduction of the clam *Mesodesma* sp, wedges clams *Donax* sp and bristle worms (*Polychaeta*) is evident. There is no regulation for fish and macro-invertebrates capture on the seashore of Rio Grande do Sul.

Photo: Mônica Brick Peres.

Figure 6 - Outboard fishery on the beach of the north coast of Rio Grande do Sul.

One of the most serious conflicts in the region is between line fishers and surfers. Since the 80's, it has been registered dozens of surfer's deaths from drowning, who are imprisoned in the nets, lines or fishing buoys in the spread zone. Last year three deaths were reported. Those accidents have generated great social pressure towards limiting and ruling the line fishery in the region. Most of the 10 towns of the North Coast have ordinances defining one or more areas for surfing, swimming or fishing. Seven of those towns demand the withdrawal of all fishlines, from 15th December to 15th March. The remaining 3 towns defined two types of fishing areas: the permanent ones – where fishline is allowed all over the year -, and the temporary fishing areas – where the lines must be removed during the summer. In general, these areas for surfing, fishing and swimming are very small, with 400 to 1.000m in length each. It is a common sense that the safe practice of surfing, especially during winter months, when the drift chains are strong, would demand bigger areas, continuous, without permanent line fishery. Converting the surfing areas in no take fishery areas, not only for fishline, could be an important measure for preserving several fish species, macro-invertebrates and megafauna, which have, at least, part of their feeding and reproduction areas in these environments.

In that context, the IBAMA Fisheries Management and Research Center at Rio Grande (IBAMA-CEPERG) and the IBAMA Regional Office at Tramandaí (IBAMA-ESREG-Tramandaí), bound to GEREX/RS, initiated in July of 2004 the process of participative management of professional artisanal beach fishery of the North Coast of Rio Grande do Sul, which includes the zoning and creation of no-take zones in the coastal and marine zone between Torres and Balneário Quintão, trying to harmonize the conflicts amongst users and protect critical areas for biodiversity conservation.

The Participative Management Process

When CEPERG effectively started working in the region, the 11 fishing communities were already organized and had their representatives in IBAMA, as a result of the organizing process of lagoon and estuarine fisheries in the Tramandaí River Basin, which culminated with the Fishery Act MMA-IN number 17 of 2004, described in Peres et al. (2005b). In the process of beach fishery management the intra-institutional partners are the Protected Areas of Lagoa do Peixe and Ilha dos Lobos. Amongst the main inter-institutional partnerships there are the Special Secretariat of Aquaculture and Fishery (SEAP/PR), the EMATER-RS, the State Environmental Police (BPA), the Fishery Unions of Tramandaí and Torres, the Igaré Institute and the Committee of the Tramandaí River Water Basin. Some of the city departments of fishes, local councilmen and fishing associations have attended the meetings in each fishing communities.

The main objective of the PPA participative management is to involve the main users of fishery resources in a social process that contributes for the biodiversity conservation and recovery of fishery supplies. Thus, it is necessary to build discussion forums and mechanisms capable of facilitating the community's and institutional empowerment, besides generating and divulging information that qualify the elaboration of the fishery regulations. Those are medium and long terms processes that involve high-complexity strategy and action. Therefore, the main short-term objective of IBAMA in the region is to elaborate fishing legislation for the beach, which could also serve as a "tool" or "means" to initiate a more comprehensive process that can even involve several segments of the local society, including, state and federal spheres, depending on the people and institutions involved. That is the reason why partnership is so important.

The professional artisan fishers, mainly those that had always lived on fishing, are the "natural partners" of any process of environmental conservation and also the most committed to the cause. In the first contacts on the beach or in the meetings, they realized the potential social and individual profits, if the proposed management process succeeds. They know, by life experience, that as higher the quality of environment and lesser the anthropic impact on coastal ecosystems, better will be the state of fishing supplies conservation and the fishery results. With rare exceptions, the professional artisan fishers deeply understand the need to protect the areas and critical seasons of feeding, reproduction and youthful growing of the populations. The majority of them clearly perceives the ecosystem complexity and the cause/effect relations of the different anthropic impacts on biodiversity. Because of that, the coastal fishery management process in the North Coast of the RS is mainly focused on the fishing communities.

The different aspects and conflicts of fishery, its economy and management, have been discussed in each fishing community. Methodologically, the communities are the forum of discussion on the diagnosis and available

information, and where the first proposals for ruling fishery are constructed. The fishing communities play a proposition and advisory role. The regulations proposals elaborated and approved in each community are assessed and organized in a draft proposal of Normative Instruction that is submitted for the fishing community Representatives Council appraisal. If there is any new proposal, they are returned to the fishing community for analysis. The final draft, approved by the Representatives Council, is then organized in an administrative process of IBAMA/Ministry of Environment, and follows the institutional procedures until its publication in the Official Gazette.

The fishing communities are also the places for fishing gears sampling and biometrical sampling of the captures. It is also in the fishing communities that local ecological and historical information of fishery is surveyed. CEPERG is integrating such information in a diagnosis for the priority areas for marine biodiversity conservation in the North Coast and are being used in different levels of the managerial process. The first contact with fishers is made on the beach, during lading procedures. The samplings of captures, gears and the questionnaires are the way for establishing partnerships and involve the fishers and their associations in the managerial process. The early discussions on the fisheries status, conflicts of use and regulation proposals take place in that working space.

The second stage comprises the organization of meetings in each fishing community. Between 2004 and 2005, two rounds of meetings in the 11 fishing communities and 5 meetings with the Representatives Council had been carried through, totalizing 22 meetings, where approximately 820 people had participated (of which, 710 were fishers) (Figure 7). The meetings in the fishing community follow a general methodological structure that includes: (1) a round for self introducing, where each one says the name or nickname and describes his/her fishery (how, where, when and what); (2) general report, where IBAMA and the partner institutions inform on the works in progress; (3) debate on general subjects, usually suggested by CEPERG; (4) debate on specific subjects, usually suggested by fishers or their associations; (5) elaboration and organization of regulation proposals (Figure 8); (6) proposals voting; (7) legal proceedings.

Photos: Manoel Augusto da Costa Vianna.

Figures 7 - Co-management meetings in the north coast of the Rio Grande do Sul.

Figure 8: Schematic diagrams of artisanal and industrial fishery exclusion zones on the north coast of Rio Grande do Sul. (1) AEPI - industrial fishery exclusion zone, from Torres up to Quintão, with 5 NM width; (2) "AREA BRANCA" - a continuous no-take zone, parallel to the coast, located from 3 and 5 NM from the beach; (3) "AREAS DE PRESERVAÇÃO" - several discontinuous no-take zones transversal to the beach, with 3 NM of length. The location and width of theses areas (3) are still under discussion, and vary in number and width, within each.

Although the process of beach fishery regulation has not yet been concluded, and some no-take zones remain under debate, several important proposals have already been approved by all the fishing communities:

1. Creation of a no-take zone for industrial fishery (AEPI), 5 MN far from the shoreline.

2. Creation of a no-take zone for total fishing exclusion, in a continuous strip parallel to the coast, extending from Torres to Quintão, between the 3 and 5 MN of the shoreline. That parallel area is called "White Area" by fishers.

3. Creation of one or more no-take zones by town, perpendicular to the coast, from the swept zone in the beach up to 3MN of the coast, where it meets the White Area. Those perpendicular exclusion areas are called "Preservation Areas" by fishers.

4. Prohibition of fishery gears for fishing endangered fish species.

The creation of an AEPI would be one of the most important measures for the conservation of marine biodiversity and ecosystems in the region. Besides increasing the no-take zone for trawling from 3 to 5 MN, that proposal would exclude any other modality of industrial fishery, such entangle, in approximately 1,220 km^2 of coastal waters of the Rio Grande do Sul (Table 1). The creation of the White Area, with no type of fishery, would establish a 490km^2 area (Table 1) with high level of protection. For its placement in parallel to the coast, the White Area would serve as a "corridor" for migration of species towards the prevailing marine tides in the coast. Due to the batimetry of the bottom, the area comprises different

depth bands (10 to 30m), ensuring the representation of the protected ecosystems. Both proposals were unanimously approved in all meetings and by all the fishing communities.

Each community is analyzing the possibility of increasing and/or gathering the "municipal surfing areas" to create one single continuous area by each town. Although the location and current size are still under review, all the fishing communities agreed on that they would be no-take zones for all types of fishery – including the catching of macro-invertebrates as well. That is why the fishers are calling them "Preservation Areas". Although some of these areas are small in terms of coastal extension, they entail two immediate advantages concerning biodiversity conservation: one is that it allows for the migration of species perpendicularly to several points of the coast; another one is that it establishes protected areas for bivalves and Polychaeta in the swept zone. According to Caddy and Defeo (2003), the protected areas are the more effective measures for conservation and recovery of this type of organism. Since the discussion process has not been concluded in all towns, we could say that the Municipal Areas of Preservation (or perpendicular no-take zones) would totalize at least 390 km^2 (Table 1).

Table 1 – Width and area of the fishery exclusion zones suggested within the co-management process on the north coast of Rio Grande do Sul. From left to right, town (1); coastal width, in km (2) and area, in km2, of the industrial fishery exclusion zone - AEPI (3); temporary closure fishery area - PTemp (4); artisanal and industrial fishery exclusion zone, transversal to the coast - AP (5); artisanal and industrial fishery exclusion zone, parallel to the coast - AB (6) and total area of fishery exclusion zone, obtained by summing up AP and AB - AETP (7). The last column presents the percentage (%) of the total fishery exclusion - AETP (8) related to the areas of industrial fishery exclusion (AEPI), total and per town.

Municipality	Extension (km)	AEPI (km^2)	PTemp (km^2)	AP (km^2)	AB (km^2)	AETP (km^2)	%
Torres	15,8	146	4,4	43	58	102	70%
Arroio do Sal	23,8	220	9,0	123	88	211	96%
Capão da Canoa	18,3	169	1,8	96	68	164	97%
Xangri-lá	10,5	97	4,2	17	39	56	57%
Osório	3,0	28	0,0	17	11	28	100%
Imbé	10,9	101	4,4	16	40	56	56%
Tramandaí	14,5	134	4,2	39	54	93	69%
Cidreira	15,4	142	5,0	14	57	71	50%
Balneário Pinhal	8,8	81	3,5	14	33	46	57%
Palmares (Quintão)	11,0	102	3,1	11	41	52	51%
Total	**132,0**	**1221**	**39,6**	**390**	**488**	**878**	**72%**

Besides the proposals on no-take zones for fishery under elaboration with the PPA, there are also the temporary fishery areas in 3 towns, involving almost 40km^2 of no-take zone for fishline fro December 15 to March 15. That is the critical season of reproductive aggregation for most of the species that use shallow waters as spawning and birth areas.

Another important management measure for biodiversity conservation is the proposal prohibiting fishing gears directed to endangered species. The only specie comprised in the Annex I of the 2004 Normative Instruction issued by the Ministry of the Environment dealing with targeted fishery in the region, is the Brazilian guitarfish *Rhinobatos horkelii*. Although the

specie is a resource of significant economic importance for some families at the summer season, the proposal was approved. In practical terms, it means the prohibition of long-line (targeting sharks and rays on the beach) and nets with meshes bigger than 18cm between opposing knots. The prohibition of bigger meshes probably will reduce the unintentional capture of Atlantic spotted dolphins (estuarine cetacean) and sea-turtle.

During the meetings, some management proposals were presented, such as: minimum distances between the beach nets cables; maximum lengths of net; minimum mesh size for each type of fishing gear; and, maximum quota for macro-invertebrates capture by fisher. Some of these proposals will probably be discussed over again and, if considered as very important demands for all communities, they will be included in the draft legislation. Some of them have social value for the communities' organization, like that on the minimum distance between cable, but the communities failed in reaching a consensus on them. Other proposals entail from the culture created throughout decades, like the maximum length of nets that can be placed in water, per day and fisher, or even the minimum mesh size for each type of fishing gear, season and target-species. That kind of management measure demands enormous supervision efforts and makes the normative instructions complicated and hard to be understood and complied with. Above all, they bring no important impact in terms of resources conservation, specially considering the current levels of fishery efforts and depletion status of supplies in the region. It is also important to have in mind that most of the endangered marine species in the region, the elasmobranch, cetaceans and turtles, are big size species ("megafauna"), accidentally and/or intentional caught mainly in nets with large meshes. In terms of fishery resources recovery, forbidding small meshes and increasing the number of nets with large meshes would also mean increasing the mortality rates of the biggest individuals of each specie that are exactly those with higher reproductive potential (fecundity) and, therefore, with higher capacity of recovering populations.

The creation of no-take zones is the most urgent measure for biodiversity conservation in the coast of Rio Grande do Sul. That process of beach artisanal fishery management initiated in the North Coast is expanding southward, due to the demand by the fishers. That is the first experience on creating protected areas in the state, outlined and agreed on among the main users of natural resources in the region. The current proposals, if approved during the administrative proceeding of IBAMA-Ministry of Environment, will create a coastal/marine area of 5MN of width and 130km in length (22% of the coast of Rio Grande do Sul) free of industrial fishery, with a total of 880 km^2 (72%) of permanent no-take zones.

References

CADDY, J.F e O. DEFEO. 2003. **Enhancing or restoring the productivity of natural populations of shellfish and other marine invertebrate resources.** FAO FISHERIES TECHNICAL PAPER. No. 448. Rome. 159pp.

DIAS-NETO, J. 2003. **Gestão do uso dos recursos pesqueiros marinhos no Brasil.** Brasília: IBAMA. 242 p.

FEPAM. 2000. **Diretrizes ambientais para o desenvolvimento dos municípios do litoral norte.** Cadernos de Planejamento e Gestão Ambiental no. 1. Porto Alegre. 95 p.

GARCEZ, D. S. 2001. **Diagnóstico das comunidades de pescadores artesanais no Estado do Rio Grande do Sul.** Secretaria da Agricultura e Abastecimento/RS-Rural, Porto Alegre. 35 p.

GARCIA, S. M.; MORENO, I. L. 2003. **Global overview of marine fisheries.** In: Sinclair, M. e Valdimarsson, G. (Eds.). Responsible fisheries in the marine ecosystem, pp 1-24. Rome: FAO.

GELL, F.R. e C.M. ROBERTS. 2002. **The Fishery Effects of Marine Reserves and Fishery Closures.** WWF-US, Washington, USA.

HAIMOVICI, M. 1998. **Present state and perspectives for the southern Brazil shelf demersal fisheries.** Fisheries Management and Ecology 5(4):277-290.

HAIMOVICI, M.; FREIRE, M. A.; FISCHER, L.; CONCEIÇÃO, W. V. 2005. **Abundância relativa e tamanhos de teleósteos e cefalópodes em águas costeiras da Plataforma Sul.** In: Vooren, C. M. e Klippel, S. (Eds.). Ações para a conservação de tubarões e raias no sul do Brasil, pp 121-128. Porto Alegre: Igaré.

JACKSON, J. B. C. et al. 2001. **Historical overfishing and the recent collapse of coastal ecosystems.** Science 293: 630-638.

KELLEHER, G. 1999. **Guidelines for Marine Protected Areas.** Gland, Switzerland and Cambridge, UK: IUCN. 107 p.

KLIPPEL, S.; PERES, M. B.; VOOREN, C. M.; LAMÓNACA, A. F. 2005a. **A pesca artesanal na costa da Plataforma Sul.** In: Vooren, C. M. e Klippel, S. (Eds.). Ações para a conservação de tubarões e raias no sul do Brasil, pp 179-198. Porto Alegre: Igaré.

KLIPPEL, S.; VOOREN, C. M.; LAMÓNACA, A. F.; PERES, M. B. 2005b. **A pesca industrial no sul do Brasil.** In: Vooren, C. M. e Klippel, S. (Eds.). Ações para a conservação de tubarões e raias no sul do Brasil, pp 135-178. Porto Alegre: Igaré.

LUDWIG, D.; HILBORN, R.; WALTERS, C. 1993. **Uncertainty, resource exploitation, and conservation: lessons from history.** Science 260: 17,36.

MARCUZZO, S.; PAGEL, S.; CHIAPETTI, M. I. S. 1998. **A Reserva da Biosfera da Mata Atlântica no Rio Grande do Sul – Situação atual, ações e perspectivas.** Cadernos da Reserva da Biosfera da Mata Atlântica no. 11. São Paulo. 60 p.

MONTEIRO, D. S. 2004. **Encalhes e interação de tartarugas marinhas com a pesca no litoral do Rio Grande do Sul.** Monografia de Graduação. Fundação Universidade Federal de Rio Grande. Rio Grande, Brazil. 63 p.

MYERS, R. A.; WORM, B. 2003. **Rapid worldwide depletion of predatory fish communities.** Nature 423: 280-283.

ODEBRECHT, C.; CASTELLO, J. P. 2001. **The convergence ecosystem in the Southwest Atlantic.** In: Seeliger, U. e Kjerfve, B. (Eds). Coastal marine ecosystems of Latin America, pp 145-165. Berlin: Springer-Verlag.

PERES, M. B.; CAMPANI, F.; KLIPPEL, S. 2005b. **O processo de gestão compartilhada da pesca artesanal da bacia hidrográfica do Rio Tramandaí e zona costeira adjacente, no nordeste do Rio Grande do Sul.** In: Resumos. XVI Encontro Brasileiro de Ictiologia, João Pessoa – PB: Sociedade Brasileira de Ictiologia – Universidade Federal da Paraíba. p. 103.

PERES, M. B.; KLIPPEL, S. 2005. **A pesca amadora na costa da Plataforma Sul.** In: Vooren, C. M. e Klippel, S. (Eds.). Ações para a conservação de tubarões e raias no sul do Brasil, pp 199-212. Porto Alegre: Igaré.

PERES, M. B.; KLIPPEL, S.; CAMPANI, F. 2005a. **Diagnóstico da pesca profissional artesanal de beira de praia no litoral norte do Rio Grande do Sul em 2004.** In: Resumos. XVI Encontro Brasileiro de Ictiologia, João Pessoa – PB: Sociedade Brasileira de Ictiologia – Universidade Federal da Paraíba. p. 95.

REIS, E. G.; VIEIRA, P. C. 1994. **Pesca artesanal de teleósteos no estuário da Lagoa dos Patos e costa do Rio Grande do Sul.** Atlântica 16: 69-86.

ROBERTS, C. M.; J.A. BOHNSACK, F. GELL, J.P. HAWKINS e R. GOODRIDGE. 2001. **Effects of Marine Reserves on Adjacent Fisheries.** Science, 294:1920-1923.

SECCHI, E. R.; D. DANILEWICZ e P. H. Ott. 2003. **Applying the phylogeographic concept to identify franciscana dolphin stocks: implications to meet management objectives.** J. Cetacean Res. Manage. 5(1):61–68.

SECCHI, E.R., P. G. KINAS e M. MUELBERT. 2004. **Incidental catches of franciscana in coastal gillnet fisheries in the Franciscana Management Area III: period 1999-2000.** The Latin American Journal of Aquatic Mammals 3: 61-68.

SEELIGER, U.; ODERBRETCH, C. and CASTELLO, J.P. (eds). 1997. **Subtropical Convergence Environments: the Coastal and Sea in the Southwestern Atlantic.** Berlin: Springer.

VOOREN, C. M.; KLIPPEL, S. 2005a. **Os elasmobrânquios das águas costeiras da Plataforma Sul.** In: Vooren, C. M. e Klippel, S. (Eds.). Ações para a conservação de tubarões e raias no sul do Brasil, pp 113-120. Porto Alegre: Igaré.

VOOREN, C. M.; KLIPPEL, S. 2005b. **Ações para a conservação de tubarões e raias na Plataforma Sul.** In: Vooren, C. M. e Klippel, S. (Eds.). Ações para a conservação de tubarões e raias no sul do Brasil, pp 229-246. Porto Alegre: Igaré.

WALKER, T. I. 2004. **Elasmobranch fisheries management techniques.** In: Musick, J. A. e Bonfil, R. (Eds). Elasmobranch fisheries management techniques, p. 285-321. Singapure: APEC.

YESAKI, M. 1974. **Os recursos de peixe de arrasto ao largo da costa do Brasil.** Série Documentos Técnicos, n° 8. Rio de Janeiro: FAO-SUDEPE.

From Common Property to Co-Management: Lessons from Brazil's First Maritime Extractive Reserve[1]

Patricia Pinto da Silva [2]

Abstract

Marine Extractive Reserves (MER) are being established in coastal areas of Brazil to protect 'traditional' coastal populations and the marine resources upon which their livelihoods depend. This paper examines the challenges Brazil's first open-water MER is facing in trying to achieve these goals. Results from a pilot project in Arraial do Cabo, Rio de Janeiro suggest that significant social barriers to collective action exist and that local resource governing institutions are not robust. Consequently, fishermen are not becoming decisive players in the decision-making process. The implications of these conclusions for future maritime conservation policy in Brazil are explored.

Key words: Brazil, extractive reserve, collaborative management, marine protected area.

Introduction

Small-scale fishing communities worldwide have long developed local tenure arrangements that govern coastal resources based on traditional ecological knowledge [1, 2, 3]. Such institutional arrangements include limitations on resource access, gear and seasonal restrictions. It is widely acknowledged that these regimes can provide locally relevant and environmentally sustainable solutions to resource degradation [4, 5]. At the cornerstone of this model of 'productive conservation' is the long-term participation of resource users [6].

In Brazil, a new marine conservation paradigm is emerging which goes beyond crude protectionism. Maritime Extractive Reserves (MER), a new type of collaboratively managed marine protected areas, are being established in order to protect marine resources while sustaining the livelihoods of traditional resource user communities. This approach to conservation is supported by common property theory that questions the inevitable destruction of collectively managed resources.

---

[1] Work based on research carried out for partial fulfilment of a doctoral degree at the London School of Economics. The study was financed by the Portuguese Ministry of Science and Technology. Full text is available at the Digital Library of the Commons at: http://dlc.dlib.indiana.edu/. This article is a reprint of the following article - Pinto da Silva, P. From common property to co-management: lessons from Brazil's first Maritime Extractive Reserve. Vol. 28 (5) p. 419-428. Marine Policy. Elsevier Publications.

[2] patricia.pinto.da.silva@noaa.gov - NOAA Fisheries, 166 Water St. Woods Hole, Massachusetts, 02543 USA - Ph: +1 508 495 2370 Fax: +1 508 495 2258

This article explores the relationship between Brazil's first open-water MER established in Arraial do Cabo, Rio de Janeiro, and the traditional beach seining community it was created to protect. A brief review of the theoretical underpinnings of common property management through collaborative management is presented followed by a summary of the historic evolution and the creation process of MERs. This paper then investigates the quality of the institutions which have traditionally governed the beach seining[3] community in Arraial do Cabo, Rio de Janeiro, Brazil. Finally, factors that constrain or provide potential for long-term participatory conservation are presented.

Collaborative Management

Common to most definitions of collaborative or co-management is the sharing of power and responsibility between governments and communities. Co-management is often described as a middle course between pure State management and pure communal property regimes. Central to this process is the recognition and legitimization of traditional or informal local-level management systems. Co-management stresses the importance of decentralized governance and user participation in the management of natural resources. Participatory management, community based management, collaborative management or co-management are all terms used to describe these arrangements.

Within these arrangements, local resource users play a pivotal role in decision-making, implementation and enforcement. Jentoft [7: 425] notes that co-management is supported by two main premises. First, the knowledge accumulated over time by resource users is often complementary to more formal scientific knowledge producing more 'enlightened, effective and equitable remedies and solutions to management challenges.' Second, the participation of resource users in the various management stages legitimizes these arrangements, thereby contributing to their compliance and resulting in more effective conservation strategies. Partnerships with local communities may also reduce enforcement costs, a factor which makes these regimes particularly attractive for developing countries.

Types of co-management

Building on earlier work by McCay and Jentoft [8], Sen and Neilson [9] argue that a broad spectrum of co-management arrangements exists, varying significantly in terms of the balance between community and government involvement (See Figure 1).

[3] Beach seining is a type of fishing that involves a large drag net used in shallow, inshore waters.

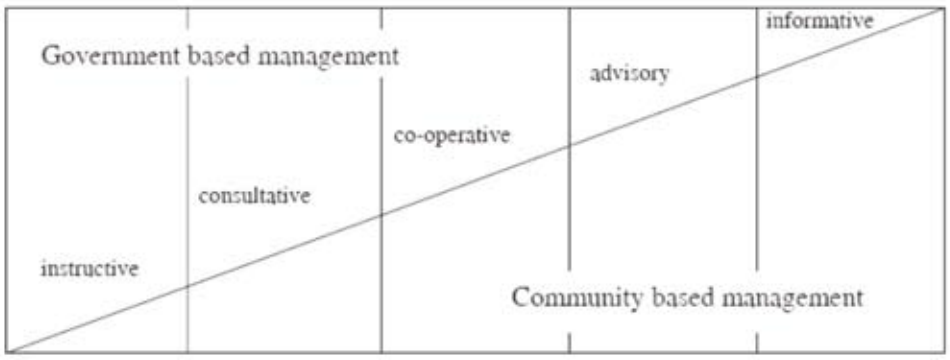


Figure 1 - Spectrum of Co-Management Arrangements [9:405]

Where co-management is *instructive*, the State creates mechanisms for dialogue with users and informs them of government management decisions. Where it is informative, user groups inform government of decisions made at the local level.

Arguably the 'truest' form of co-management, co-operative co-management is the variation that exemplifies best the goals of co-management. Ideally, under these arrangements, the State and resource users co-operate as equal partners in decision-making. These categories are clearly a simplification of how co-management arrangements function in practice where such regimes are combinations of these five types and the balance of power and involvement to change over time.

The balance of power between the partners should reflect their comparative advantage in offering different elements essential to any collaborative management regime. For example, resource users can offer local ecological knowledge as well as an insider understanding of the social and cultural context while the State can play a central role in enforcement efforts and provide a legal framework that codifies and legitimizes local identity and rights over resources.

Conditions for Success

The analysis of thriving communally owned resource regimes and co-management case studies suggests that these arrangements may only work effectively under a limited range of conditions. Ostrom [3] identifies key factors for successful decentralized management (See Table 1).

Less tangible qualities presented by Ostrom include the existence of social capital and high levels of trust and shared values as well as a sense of a community or common future. Communities that have a history of collective action seem to be better placed than those that do not. Economic dependence may also provide strong motivation to solve common problems to enhance or protect productivity over time [3].

Table 1 - Design principals for robust CPR regimes [3]

Design principle	Description
Clear boundaries	Resource users and resource must be clearly defined.
Congruence	Rules restricting harvest should be locally relevant.
Collective choice	Broad participation in rule modification by those affected.
Monitoring	Monitors are accountable to the appropriators or are the appropriators themselves.
Graduated sanctions	Sanctions exist and are applied to appropriators that deviate from the regime.
Conflict-resolution mechanisms	Low cost conflict resolution areas exist to resolve conflicts among appropriators.
Minimal recognition of rights to organize	Rights to organize and manage resources are supported by external official agents.

Maritime Extractive Reserves (MER)

Brazilian marine fisheries management has largely mirrored that of North America. Species based management using conventional management tools (quotas, seasonal and size restrictions) were applied to a radically different ecological and social context. Large scale commercial fishing benefited from generous financial incentives along with tax concessions and subsidized credit [10]. Recently though, marine and coastal zone degradation along with social concerns such as employment generation and food security, have led policy makers to seek alternatives to the *status quo*.

There is growing official recognition in Brazil of traditional resource users and their management systems as a key element in biodiversity and habitat conservation. Central in this trend is the belief that traditional resource users may be the best stewards of the resources their livelihoods depend on.

Increased attention to the potential role of resource users in conservation originated with the struggle the serengueiros or rubber tappers of Amazonia to resist the encroachment of their lands by cattle ranchers and loggers from the wealthier southern states [11]. Led by Chico Mendes and Wilson Pinheiro, both rural union leaders who were eventually murdered as a result of their leadership of the movement, the rubber tappers' collaborated to protect the rainforest. The change to democratic governance in the late 1980's coupled with international appeals to protect the rainforest provided timely support for this group. Support for the rubber tappers movement also came from interested academics and international non-governmental organizations who valued this movement as a critical defender of the rainforest.

This process culminated in 1989 with the creation of the Extractive Reserve conservation category[4]. Extractive Reserves are a type of collaborative management regime initiated by local resource users and supported by the federal government. These conservation and development initiatives have emerged as the policy instrument used by the National Centre for Sustainable Development of Traditional Populations (CNPT) within the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) for decentralizing managerial responsibility for natural resources to communities that have a proven history of sustainable use[5].

Since 1990, 16 federal Extractive Reserves have been created most of which have been land based. However, there is a significant trend towards the establishment of marine based reserves. Of 21 reserves currently in initial stages of development, 18 focus on aquatic resources, the majority (13) of which encompass open water marine environments in coastal areas (Figure 2). This policy trend is significant in that it represents the first government-sponsored effort to protect the common property resources upon which small-scale fishermen depend. Table 2 lists some of the characteristics of the four existing MERs.

Figure 2 - Present and Future Extractive Reserves [12]

[4] Since their creation, a broader reassessment of existing conservation categories has been carried out resulting in the new National System of Conservation Units [19].

[5] This effort has also been supported by the G-7 Pilot Program to Save the Brazilian Rainforests, the largest multilateral environmental initiatives to date.

Table 2 - Current Marine Extrative Reserves - MERs [12]

Name	Municipality/ State	Degree	Area (ha)	Pop.	Fishery
Pirajubaé Marine Extractive Reserve	Florianópolis, SC	N° 533-20/05/92	1.444	600	Shellfish, crustaceans, multiple fish
Arraial do Cabo Maritime Extractive Reserve	Arraial do Cabo, RJ	S/N° - 03/01/97	56.769	3000	Multiple marine fisheries and shellfish
Baia de Iguape Marine Extractive Reserve	Maragojipe/ Cachoeira, BA	S/N° - 14/08/00	8.117	1150	Multiple marine fisheries
Ponta do Corumbau Marine Extractive Reserve	Prado, BA	S/N° - 21/09/00	38.174	800	Multiple marine fisheries

Phases of Creation

There are three phases in the establishment of these conservation and development initiatives. Initially, a formal request is developed by the extractivists in a given area that describes the (social, economic, demographic, etc.) setting in which the reserve will function along with arguments in support of their proposal. If approved (by CNPT/IBAMA and then signed by the President), a plan of use is developed which defines who, when and how resources can be used, in essence representing a social contract among appropriators. This plan must then be approved by IBAMA/ CNPT and published in the federal register in order to codify the rights and responsibilities of government and resource appropriators. Finally, the plan is operationalized and strengthened to increase its long term resilience. This final phase is clearly the most challenging as it requires robust locally derived institutions sustained by long term community participation and government support.

Methodology

A case study approach was used to investigate the relationship between the newly created reserve and the traditional beach seining community in Arraial do Cabo, Rio de Janeiro, Brazil. This approach involves the empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence [13].

Twelve months were spent at the case study site living and working with local stakeholders during 1999-2000. Informal and semi-structured interviews were conducted with representatives of local, state, and federal fishing organizations. A questionnaire was administered with over half of the beach seining population (total 150) in order to obtain standardized information about the group as a whole. Focal groups were held with fishermen as a follow up to the questionnaire to triangulate information as well as to explore certain issues in greater depth. Participant observation was particularly useful for gaining an 'insiders' understanding of the case study site. Qualitative data was analyzed using Atlas Ti software and quantitative data were analyzed using SPSS.

Arraial do Cabo, Rio de Janeiro

In 1997, Brazil's first open water MER was created in Arraial do Cabo, RJ to protect the resident beach seining community and the resources their

livelihoods depend on [14]. The sustainable fishing methods used along with the formal and informal institutions that have governed this group for generations warranted the creation of the reserve. Data reveal, however, that these traditional institutions are no longer robust and that significant social barriers will need to be overcome to revitalize these and fully integrate them into the reserve structure. The following sections review some of the physical, institutional and social factors that affect the potential for long term participatory conservation.

Physical and Technical Attributes

Arraial do Cabo, a town of approximately 20,000 residents is located on a cape extending 40 kilometers into the ocean. As a result of its relative isolation, the creation of the reserve had minimal negative impacts on small-scale fishermen from neighboring areas. Fishermen have been drawn to the cape for centuries because of the rich marine environment, nourished by the up-welling of deep Arctic waters. The town is located in a small, compact area facilitating communications between resource users. Also, all fishermen included in this plan fish close to shore facilitating monitoring[6].

Because all local fishermen employ relatively sustainable methods, none were excluded by the creation of the reserve[7]. In fact, local fishing methods did not have to change at all. Although small areas were designated as biological reserves within the MER, fishermen largely recognized the need for these areas to recuperate. These characteristics made garnering support for the reserve much easier than it would have been in a situation where there would have been 'winners' and 'losers'.

Attributes of the resource itself, however, complicate the relationship between seiners from the four different beaches where seining takes place. Because they are dependent on a single flow of resources (migratory fish) that pass each beach (starting with Praia Grande), a subtractability problem exists (See Figure 3). Beach seiners spot incoming shoals visually from the hills adjacent to fishing grounds. When a shoal is spotted, the type, location and size of the shoal is communicated in silence using hand signals to the fishermen waiting below. Given this method of fishing, seiners are aware of the stocks in the area at any given time. Fish caught by seiners on one beach will, consequently, not be caught by those from another. Depleting stocks have heightened sensitivity to this natural hierarchy.

Resource Governing Institutions

Fishermen in Arraial do Cabo, as elsewhere in Brazil and beyond, live on the margins of organizational life. Although required by law, only five

---

[6] It will be interesting to see how reserve boundaries, enforcement and other institutional arrangements are fitted for off shore artisanal fishing fleets like those of the Northeast of Brazil.

[7] SCUBA fishermen

percent of fishermen are registered with the coast guard and 18 percent are registered with the federal fishing agency. Even basic participation in local formal institutions is extremely limited.

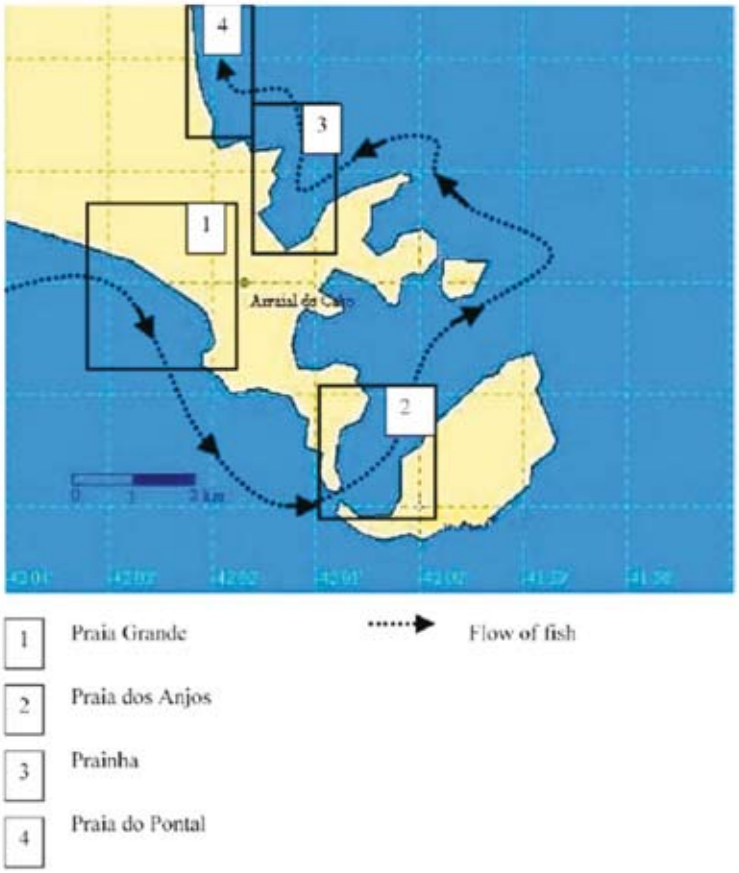


Figure 3 - Resource Flow Around the Cape [16]

Although free-association has been legal since the signing of the new constitution in 1988, the State-sponsored fishing guild (Colônia de Pescadores) still enjoys the largest membership. Even so, membership levels are at an all-time low and few fishermen feel that this organization adequately represents them. Consequently, fisherman participation in this organization is negligible. Only four percent of fishermen are members of this organization which prides itself with the broadest based membership of all local formal institutions. Fishermen complained that associations created to represent them have often been taken over by the local elite and membership who have utilized these organizations for personal benefit.

In the absence of government support and regulation, the beach seining community has been governed by a set of locally constructed and communally recognized institutions that regulate access to and use of common fishing grounds. Although originally a set of informal institutions, these rules were codified in 1921 by the local fishing guild [15][8]. Complex norms

[8] Rules were codified in the local fishing colony handbook. At the time, this mode of fishing was the most prominent and important source of employment/food in the area.

include restrictions on the type of gear, vessel and number of crew that can participate in addition to determining access to local fishing grounds.

Access to the fishing areas is defined by a set of rules called the Direito do Dia or Right of the Day system. Each beach has its own corrida or user sequence which determines who has the right of access for each day. Rules can be changed by agreements made by the owners from that beach. There is a certain number of 'fishing days' associated with each of the four local beaches that determine when each owner has the right to fish. Given the demand on fishing days on Praia Grande, if an owner only owns one day, s/he[9] will only be able to fish once every 21 days (See Table 3).

Table 3 Fishing Days Per Beach [16]

Beach	No. of days	No. of canoes
Praia Grande	21 Days	42 canoes
Praia dos Anjos	12 Days	12 canoes
Prainha	7 Days	7 canoes
Praia do Pontal	4 Days	4 canoes

Given the local understanding of the resource flow, Praia Grande, the first beach in the flow, has attracted many more fishermen hoping to get a first chance at incoming shoals. To maximize efficiency, two canoes fish each day on this beach. While one group fishes, the other sorts their fish and resets their gear. By customary law, each day must have a corresponding canoe and full gear kit[10] and a work team or companha comprised of between 9-13 men.

In the past, fewer canoes and gear were owned by multiple owners who were generally seiners themselves. In recent years too many canoes have entered the user sequence and owners have declared a moratorium on new entries. Although owners have enforced this rule vigorously, they have disregarded others. For example, there are now only 15 complete gear sets on Praia Grande when there should be 42. One of the biggest sources of conflict is that owners from Praia Grande have introduced a type of gill net which seiners complain is disrupting the flow of fish to other beaches. Table 4 presents the breakdown access to the Praia Grande fishery.

[9] There are women who own or are part owners of canoes. Often they are widows of fishermen. These canoes have a reputation of being unkempt and when ones canoe needs work, people might say, it looks like a 'widows canoe'.

[10] Required gear includes a seine with specific dimensions, paddles and rope.

Table 4 - Fishery access sequence on Praia Grande [17]

Day	Canoe	Day	Canoe	Day	Canoe
Day 1	1–2	Day 8	15–16	Day 15	29–30
Day 2	3–4	Day 9	17–18	Day 16	31–32
Day 3	5–6	Day 10	19–20	Day 17	33–34
Day 4	7–8	Day 11	21–22	Day 18	35–36
Day 5	9–10	Day 12	23–24	Day 19	37–38
Day 6	11–12	Day 13	25–26	Day 20	39–40
Day 7	13–14	Day 14	27–28	Day 21	41–42

After day 21 the user access system starts again from day one.

Social groups, hierarchies and divisions

Approximately 1,340 fishermen live in Arraial do Cabo. Of these, 150 are beach seiners. Immigrants attracted to this unregulated and low skilled source of labor have been drawn in numbers to the Cape in the last decade. Local fishermen are largely distinguished by the type of gear they use and how long they have been residents of the Cape. Recent migrants generally become hook fishermen, a type of fishing looked down upon locally because of the belief that it does not require a significant understanding of the marine environment. Locals proudly refer to themselves as Cabistas (from the Cape) and derogatorily call migrant fishermen *Caringos*[11]. Beach seiners are all Cabistas and most have come from a long line of seiners. Figure 4 depicts the different gear groups and the social divisions associated with each group.

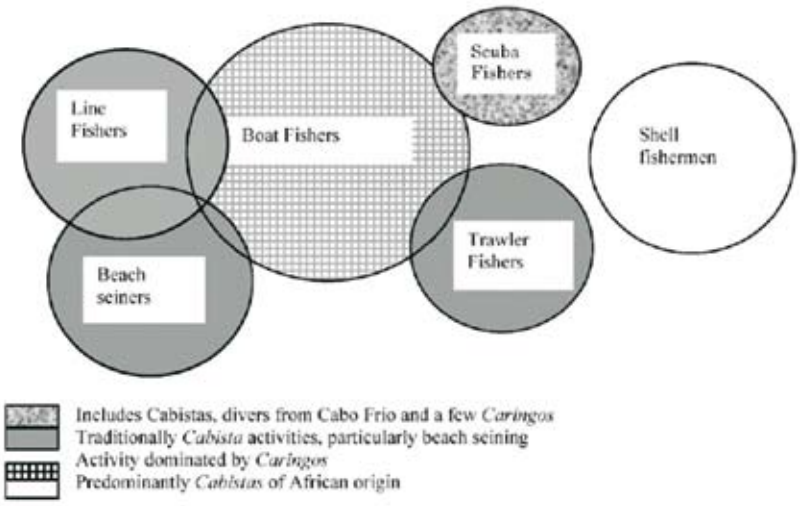


Figure 4 - Group size and ethnic divisions among A.C. fishermen [16]

[11] Caringo is a derogatory name used for recent immigrants to the cape that largely fish off the rocks or hook and line fish off small boats. No one seems to know the origin of the name but it is possibly related to the term gringo.

Although beach seiners are all Cabistas, deep divisions exist within this group. After 500 years[12], racial differences and divisions between the beaches run deep. Locals often stated that the different neighborhoods were like different tribes. Work teams are often made up of family members and historically, fishermen lived in the neighborhood they fished on. Seiners from Praia Grande, for example, are largely of Portuguese decent, those of Praia dos Anjos of French or northern European decent and Prainha's residents are descendants of Africans forced into the transatlantic slave trade. These communities exist side by side, within a minute's walk of one another.

In recent years ownership patterns among beach seiners have changed dramatically. A few individuals (largely from the same family) from Praia Grande have amassed ownership of the majority of canoes and nets, thereby controlling the associated access days to the fishing grounds. Much to the resentment of fishermen from other beaches, not only have they accumulated control over the Praia Grande fishery but they are also buying up the access days on other beaches. These owners are vertically integrated and own ice houses and fish store and therefore play an important role in setting the value of the catch. Ownership patterns on Praia dos Anjos illustrate this phenomenon.

Table 5 - Breakdown of gear/access ownership on Praia dos Anjos.

Total no. of owners on P. dos Anjos	10
No. of owners from P. dos Anjos	5
No. of owners from P. Grande	5
% of total owned by owners from P. dos Anjos	37.5
% of total owned by owners from P. Grande	62.5
% of total owned by one family (from P. Grande)	50

Beach Seiners and the Reserve

A plan of use was developed through a series of meetings with local fishermen to define the rules that represent the social contract among fishermen as well as between fishermen and government. The seiners' traditional institutions were automatically integrated into the plan. Article 5.1 of the plan states that 'beach seining is permitted according to the norms of the 'right of way system that regulates the canoe sequence [18].' The reserve, therefore, absorbed the existing beach seiners' CPR and expanded it to include all the different gear groups in the municipality.

The reserve created a new decision-making forum, whereby non owners have the same vote as owners and hook fishermen have the same say as beach seiners. This was a new concept for seiners who had grown

[12] Amerigo Vespucci landed in Arraial do Cabo in 1503 and left a group of 24 men to settle the area.

accustomed to following decisions made by gear owners. Beach seine owners felt threatened by this new power given to their employees. The establishment of the marine reserve, owners felt, bypassed their legitimacy as the final decision-makers in the seiners' CPR. As a result most boycotted the process and encouraged their employees to do the same.

In practice, their fears may not have been warranted. Since the establishment of the reserve, few beach seiners have participated in any significant way. Only 34 percent of beach seiners were aware that members of the reserve have the right to vote. Of those, only one fisherman who participated in the survey voted in any meeting at the reserve headquarters.

Dependence on the resource could provide an important incentive to participate in the reserve process. Most seiners (80%), however, have alternative sources of income outside of fishing. Many are employed by the local government and many more receive pensions from previous work with a local industrial plant. Forty-two percent of active beach seiners are over 49 years old, and significantly, 32 percent are over 60. It is not uncommon to see seiners in their 80s pulling in nets.

Many older fishermen expressed fear of participating in reserve meetings for fear of loosing their positions on canoes owned by the larger owners. Others stated they were uncomfortable with the open manner in which voting is carried out. In order for a vote to count, fishermen must raise their hands at meetings and keep them raised until all votes are counted. Given the tensions between gear groups and between fishermen and owners, seiners stated that they often avoided meetings.

The MER in Arraial do Cabo has introduced a more democratic decision-making forum for regulating fishing activities and addressing the concerns of this community. However, the system is beyond the reach of many fishermen who find themselves constrained by the middlemen and owners for whom they work. Fishermen are afraid of losing an important part of their livelihood by 'sticking their necks out'.

The creation of the MER has not yet managed to replace or strengthen the seiners' institutions. In fact, although the existence of a 'traditional population' warranted the creation of this conservation and development unit, seiner's themselves do not seem to have been seriously involved in its design. Rather, assumptions were made about the quality of their resource management institutions.

Co-management and the State

Fishermen's experiences with government have generally been negative. Fishermen feel largely abandoned by government at all levels. Fishermen view the Coast Guard as a threat to their activities rather than a source of support. Fishermen also hold a negative view of IBAMA, an organization they feel is riddled with corruption and inefficiency. This view has not

improved with the creation of the reserve since many feel that the reserve is an added responsibility placed on fishermen without sufficient support from the government. Consequently, trust in government is low.

A crucial weakness of the reserve as it currently operates rests in its ineffective monitoring system. The ability of reserve partners (fishermen and the state) to monitor the entire reserve rests on a) support from IBAMA, b) availability of resources including monitoring vessels c) collaboration of fishermen and other community members. At the time research was carried out, there was only one on site IBAMA representative (a biologist) and no monitors. Not only is the government understaffed it is also underfunded. No government vessel was available to carry out monitoring. One fisher mandescribes how he views the involvement of the State thus far, 'They've planted a seed and forgotten to water it…' Table 6 lists Ostroms' design principals and evaluates the ability of the local resource management regime to meet key design principals over time.

Table 6 - Evaluation of Institutional Strength Over Time [3,16]

Design principal	Pre-1960	Pre-reserve	Potential for	As part of the MER
1. Clearly defined Boundaries	Yes	No. Excludability problems existed and drag net shrimp trawlers commonly trawled local waters.	Yes	Yes. With the creation of the MER A.C. a three mile belt was created encompassing all existing artisanal/traditional fishing activities while making predatory fishing activities illegal. Areas utilized by beach seiners have also been clarified.
2. Congruence between appropriation and provision rules and local conditions	Yes	No. Fishers do not feel they earn enough to live on and ownership has become concentrated and too many 'days' have been added to each beach leading to rent dissipation.	Yes	No. There are a number of indicators that these rules and conditions are incongruent. Fishers do not feel that they earn enough to live on. Owners have sold their shares as too many days were added on some beaches leading to rent dissipation. In some cases this situation is getting even worse because the MER is encouraging and enabling new canoes to enter on all beaches.
3. Collective-choice arrangements	Yes	No. Few owners make decisions for everyone. Fishers have little say in changes to or the management of the regime.	Yes	No. Although there is great potential for collective choice arrangements in the MER, currently, there is very little participation in the process. There is also a risk that those gear groups with the most fishers will dominate or for other powerful stakeholders to hijack the process.
4. Monitoring	Yes	Yes. Day to day monitoring still takes place but rules are enforced selectively and rule breaking, particularly by larger owners is not uncommon.	Yes	No. Almost no monitoring is taking place within the reserve. This is due to lack of funds, infrastructure and personnel as well as lack of awareness of the rules.
5. Graduated sanctions	Yes	No. Although traditional rules do include the use of graduated sanctions, these rules are no longer applied.	Yes	No. Although the Utilization Plan does include the use of graduated sanctions these have not been applied due to lack of capacity and resources.
6. Conflict-resolution mechanisms	Yes	No. In the past, local organizations would mediate conflict between seiners. Now, seine owners take matters into their own hands.	Yes	Yes. The MER does create an important forum where different groups within the community can resolve their issues. However, because owners of multiple canoes do not recognize the authority of AREMAC or the decisions made at general assemblies, they are not a part of this important process.
7. Minimal recognition of rights to organize	Yes	Yes. Local government and local organizations recognize the legitimacy of the seiners CPR.	Yes	Yes. Although the beach seiners' CPR was recognized by the local government and organizations related to fishing, the creation of the reserve has emphasized these rights.

Potential for Successful Co-management

Clearly, the beach seining community enjoys a rich history of formal and informal resource management institutions. Access rights to the resource

are clearly defined. Resource user numbers are known and controlled. Local identity has developed around these activities and rules and the daily rituals involved in this activity constantly reinforce them. Monitoring systems are embedded in this system of rotating access and use whereby each day's user has the incentive to protect their access rights. Collective choice arrangements were secured through ownership rights and responsibilities. In terms of the type of technology used and certain aspects of local culture, this group is fairly homogenous.

Research suggests, however, that although resource governing institutions still exist, they are no longer robust. On the surface, it appears that they are still intact since fishing continues largely unchanged. A closer look reveals that institutions have weakened and have been hijacked by a handful of vertically integrated individuals to serve their own interests. Rules which continue to be adhered to are those that control access to the fishing grounds along with decision-making arrangements. Marketing structures have become increasingly consolidated along with decision-making.

Negative social capital is manifested in the hierarchical structures which have come to control this fishing activity, while a historical legacy of deep divisions within this gear group also complicates and constrains participation. Existing conflicts and hierarchies have hindered the ability of the beach seining community to articulate its needs within the reserve structure. As a result, the reserve has not significantly fortified local management institutions and has overlooked or not been able to deal with these obstacles to participation and empowerment. Currently, it is not apparent that beach seiners are decisive players in the decision-making process. An indication of this lies in the low level of participation in reserve activities.

At different stages, the MER has demonstrated some characteristics from the entire spectrum of co-management arrangements. At no stage, however, has the contribution of either group (fishermen or State) been ideal. The federal environmental organization, IBAMA, has not kept its part of the bargain. With only one representative on-site and no monitors, this group is clearly not able to meet its responsibilities. Furthermore, although fishermen have participated to some degree, beach seiners have not played a significant role in this process.

At the moment, this experience may best be characterized as a form of co-management arrangement in which both sides lack the capacity (funds, training, and experience) to support an effective system for collaborative resource governance. Greater fisherman participation and more support from the federal government are necessary in order to achieve a more equitable and effective management system.

With the creation of the MER, fishermen in Arraial, including the beach seiners have been given an enormous opportunity to control the resources on which they depend. While on the one hand this has the potential to empower local fishermen it has also overburdened them with the responsibility associated with creating and managing this reserve.

The establishment of an MER will cause change and disturb the *status quo*. Because so little government support is available, communities have been left more or less on their own to adapt to this new situation. MERs in Brazil, by definition, are located in places where traditional populations exist. Often, these groups have developed informal institutions to manage their resources. There is no guarantee however, that these institutions are effective and actualized. Given the fact that these areas have been affected by external factors (such as technology change and State fisheries policies) it is likely that many of these institutions have disintegrated over time. Therefore, although local collective resource management regimes may have once offered sustainable, democratic and participatory structures, practitioners must be careful to assume that they are still robust.

Policy Implications

MERs are being created in significant numbers in coastal areas in Brazil. Phases one and two of their creation may be relatively easy, however the challenge lies in sustaining these initiatives over the long term. Policy makers and conservation practitioners should bear in mind the following:

- Coastal communities are not organic wholes. Difference and diversity must be taken into account as well as existing power structures that may distort or constrain participation. If not, extractive reserves could potentially reinforce inequitable power structures instead of promoting broad-based participatory conservation.

- Conservation practitioners cannot assume that traditional resource management systems are just, equitable and up-to-date. An assessment of the existence and health of these institutions should be undertaken before creating the utilization plan. Information on the state of these institutions is essential in order to design effective regimes to collaboratively manage natural resources.

- Regional universities and non-governmental organizations could play an important role in building the capacity of fishing communities to co-manage reserves. Financial management, participatory research and management methods are examples of areas where external agents could play a key role.

- Communities may need to go through a process of social preparedness before reserve creation. In Arraial do Cabo this process should have involved bringing fishermen together from different gear groups and/or beaches in order discuss and resolve common problems. This process should also include secondary stakeholders such as local government and fishing associations and fisherman families. Participatory research methods could guide this process and help ensure transparency.

- In order for government to build trust with fishing communities, relationships of reciprocity need to be developed. This relationship will disintegrate quickly

if parties do not hold up their promises. Brazilian small-scale fishermen have historically lived outside the law. Negative experiences with the State have left fishermen distrustful, so that special attention should be taken to renew relationships between the State and resource user groups.

- Fishing communities are unlikely to be able to take sole responsibility for these initiatives and will not succeed in long-term conservation and development goals without external assistance. With the growing number of planned reserves, CNPT will need more funding and staff to carry out the tasks associated with this network of marine protected areas.

- Clear guidelines for voting and financial management should be in place to ensure the legitimacy and transparency of the organization. Pocket chart voting, for example, could provide the necessary legitimacy while ensuring voter privacy.

Extractive Maritime Reserves are the most significant Federal-level policy initiative to directly address the needs of small-scale coastal fishermen in Brazil to date. Extractive reserves in general represent the first protected areas in which specifically involve local communities in their design and management. These initiatives have enormous potential for conserving coastal areas and securing the livelihoods of coastal populations. This study suggests, however, that in order for these goals to be realized both parties must be willing and able to carry out their role in the process.

Acknowledgements

Many thanks to the pescadores de canoa and other fishermen from Arraial do Cabo for the time they spent painstakingly explaining their fishing rituals, culture and opinions. Special thanks Dr. Anthony Hall for providing excellent guidance from the conceptualization of this study to its final completion. Finally, I would like to thank the Portuguese Ministry of Science and Technology for funding this study and NOAA Fisheries for giving me the time to write this article.

References

1. S. FORMAN, **The raft fishermen; tradition and change in the Brazilian Peasant Economy**, Indiana University Press, 1970.

2. J. CORDELL, **Locally Managed Sea Territories in Brazilian Coastal Fishing**, FAO Conference on Coastal Lagoon Fisheries, Rome, 1983.

3. E. OSTROM, **Governing the commons: the evolution of institutions for collective action.** Cambridge: Cambridge University Press, 1990.

4. A.C. DIEGUES, **Traditional Sea Tenure and coastal Fisheries Resources Management in Brazil**, Sao Paulo: Centro de Culturas Maritimas, 1994.

5. K.B. GHIMIRE and MP PIMBERT, **Social change and conservation: environmental politics and impacts of national parks and protected areas**, London: Earthscan, 1997.

6. A. HALL, **Peopling the Environment**, European Review of Latin America and Caribbean Studies, 62, 1997a.

7. S. JENTOFT, **Social Theory and Fisheries Co-Management**. Marine Policy, Vol. 22, 423 -435, 1998.

8. B. McCAY and S. JENTOFT, **User Participation in Fisheries Management: Lessons Drawn from International Experiences.** Marine Policy, 19, 227-246, 1995.

9. S. SEN and R. NEILSON, **Fisheries Co-Management: A Comparative Analysis.** Marine Policy, Vol. 20, 357-438, 1996.

10. A.C. DIEGUES, **Camponeses e Trabalhadores do Mar**, São Paulo, Atica, 1983.

11. A. HALL, **Sustaining Amazonia: Grassroots action for productive conservation.** Manchester, UK; New York: Manchester University Press, 1997b.

12. www.ibama.org.br

13. R. YIN, **Case Study Research: Design and Methods**, London: Sage Publications, 1994.

14. BRAZIL, **Presidential Decree of January 3rd.** Diário Official da União CXXXV # 3, January 6, Brasilia, 1997.

15. V. T. de MELLO, **Regimento Interno da Colônia C. de Pescadores Nossa Senhora dos Remedios Z – 22**, Cabo Frio, Rio de Janeiro, 1921.

16. P. P. da SILVA, **From common property to co-management: Social change and conservation in Brazil's first Maritime Extractive Reserve**, Ph.D. dissertation, London School of Economics, 2002.

17. R. BRITTO, **Modernidade e Tradicão**, Universidade Federal Fluminense: Niteroi, RJ, 1999.

18. IBAMA, **Plano de Utilizacão: RESEX Arraial do Cabo**, RJ. CNPT. Brasilia, 1999.

19. BRAZIL, **Sistema Nacional de Unidades de Conservacão**, Lei No. 9.985 de 18 de Julho 2000, Brasilia, 2000.

Fisheries Management in the Marine Extractive Reserve of Corumbau - Bahia

Rodrigo Leão de Moura [1]
Guilherme Fraga Dutra [2]
Ronaldo Bastos Francini-Filho [3]
Carolina V. Minte-Vera [4]
Isabela Baleeiro Curado [5]
Fernanda Jordão Guimarães [6]
Ronaldo Freitas Oliveira [7]
Diego Correa Alves [8]

Abstract

The Marine Extractive Reserve of Corumbau (RESEX Corumbau), created in 2000, covers about 90,000 hectares in the northern part of the Abrolhos Bank, protecting a representative sample of the largest and richest coralline reefs in the South Atlantic. RESEX Corumbau explicitly targets the protection of livelihoods and culture of traditional populations that live from extractivism, whose life quality is strongly dependent upon the sustainable use of natural resources. The implementation of this protected area resulted in a considerable reduction of fishing effort, through the exclusion of fishers from other areas. Fishing occurs mainly in the reefs and secondarily in soft bottoms, with use of hand lines, longlines, spears and several kinds of nets, including bottom trawls. Nearly 260 fishermen operate approximately 100 canoes and small boats ("botes") and 80 motorized boats. Tourism and family-based agriculture also represent important activities. Fisheries management started in 2000, even before the establishment of the Deliberative Council and approval of the Management Plan (2002). Main fisheries management strategies include restrictions in effort and capture (e.g., control of gear types and sizes) and the establishment of zones with restrictions to some gears and no-take zones, supported by a continual monitoring of biological resources aiming adaptive management. Monitoring of hook-and-line and longlining fisheries, carried out between 2002 and 2005, demonstrate stable captures, with a trend of increase in 2005. Bottom trawling targets mainly penaeid shrimps, although it captures more than 90 fish species as bycatch. Fish families Lutjanidae (snappers), Carangidae (jacks), Serranidae (groupers) and Scaridae (parrotfishes) predominate in reef fisheries, this latter captured mainly with spears. Results from the

[1] Biologist, Marine Program, Conservation International (r.moura@conservation.org.br)
[2] Biologist, Marine Program, Conservation International (g.dutra@conservation.org.br)
[3] Biologist, Post Doc Fellow, Bahia Federal University and Conservation International (rofilho@yahoo.com).
[4] Ecologist, Maringá State University (cminte@nupelia.uem.br)
[5] Social Scientist, Getúlio Vargas Foundation (isabela.curado@fgv.br)
[6] Biologist, PhD Student, Paraíba Federal University (fernandajguimaraes@yahoo.com.br)
[7] Social Scientist, IBAMA (Federal Environmental Agency) (ronaldo.oliveira@ibama.gov.br)
[8] Undergrad student, Maringá State University (dalveszoo@gmail.com)

underwater coral reef monitoring, carried out at Itacolomis Reef between 2001 and 2005, show a significant biomass increase of commercially important fishes inside and near the no-take zone, indicating its contribution to the replenishment of adjacent fishing grounds. In spite of these positive effects, little improvements were seen in the life quality of the traditional population. Difficulties for storing and commercializing the catch, dependency on a handful of middlemen, real estate speculation in the coastal zone and the yet fragile social organization are among the main factors influencing this situation. Since 2003, through projects sponsored by the National Environment Fund (FNMA) and the Special Secretariat for Aquaculture and Fisheries (SEAP), also involving the participation of governmental and non-governmental organizations, the six fishermen's associations of RESEX Corumbau have been strengthened, with important implications for the co-management of the Extractive Reserve.

Introduction

The Marine Extractive Reserve of Corumbau (RESEX Corumbau), with 90,000 ha, includes portions of Prado and Porto Seguro municipalities, in the southern coast of Bahia Sate, Brazil (Figure 1). It was the first Extractive Reserve established in coral reefs, protecting a representative sample of the unique biodiversity of the Abrolhos Bank (Dutra *et al*. 2005), a region that holds the largest and richest coral reefs in the South Atlantic (Werner *et al*. 2000, Leão *et al*. 2003).

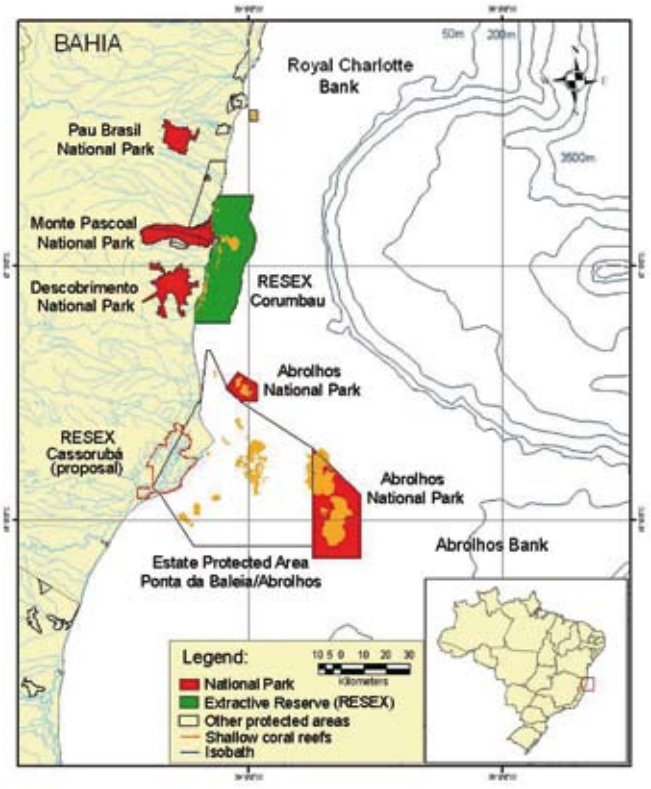


Figure 1 - The Abrolhos Bank, Southern Bahia, Brazil, and its network of coastal and marine protected areas.

This protected area (=conservation unit) encompasses only the marine environment, including beaches and mangroves. The nearly 500 beneficiary traditional families live in its adjacent coastal zone, in five main localities: Cumuruxatiba, Imbassuaba, Veleiro and Ponta do Corumbau (Prado municipality), and Caraíva and Aldeia Barra Velha - considered as the "mother-settlement" of the Pataxó Indigenous People (Porto Seguro municipality). In addition to its biological relevance, the region also has extremely beautiful scenery, attracting tourists from many parts of Brazil and the world. Tourism, especially in the summer, constitutes an important income source, especially in Caraíva, Ponta do Corumbau and Cumuruxatiba. In these places, fishermen are frequently and increasingly engaging into boat trips for recreational fishing and diving, bars, restaurants and hotels. In Veleiro, Imbassuaba and Barra Velha family-based agriculture and forest extractivism are the main activities complimentary to fisheries.

Establishment and management of RESEX Corumbau

Mobilization for the creation of RESEX Corumbau started when local fishermen began to notice a sharp decline in marine resources, mainly due to the increasing and intense exploitation carried out by fishermen from other regions. In 1998, villagers from Ponta do Corumbau made the first formal appeal for the creation of a sustainable-use protected area, advised by Prado's municipality judge. In 1999, the NGO Conservation International Brazil (CI-Brasil) and IBAMA's National Center for Traditional People (CNPT) organized biological and socioeconomic technical reports ("laudos"), in collaboration with researchers from the Zoology Museum, University of São Paulo; the National Museum, Rio de Janeiro Federal University; and the Rio de Janeiro Botanical Gardens.

Between 1998 and 1999, several meetings to inform and mobilize communities took place at Corumbau, Caraíva, Barra Velha and Veleiro, with the participation of the extractivists themselves, NGO representatives (e.g. Prado Association for Environmental Protection – APPA; CI-Brasil), IBAMA's officers and scientists. At the end of 1999, villagers from Cumuruxatiba and Imbassuaba, stimulated by the intense mobilization of the other villages, decided to adhere to the process requesting an extension of the RESEX limits to Rio das Ostras, about 30 km to the south of the originally proposed limit. However, there were few discussions on the western limit (beyond the coast line), as the inclusion of land areas would imply government spending on disappropriation and therefore hinder and slow down the process for creating the Extractive Reserve. In September 2000, in spite of some resistance inside the government, and after many lists of signatures had been collected, much publicity in the National press and tremendous support from the Ministry of the Environment and CNPT, the Decree creating RESEX Corumbau was finally published.

Back in 1999, CI-Brasil and CNPT began discussing with local communities the Management Plan for the forthcoming Extractive Reserve. Discussions included issues like the most suitable fishing methods and gears (e.g.

limits for mesh and sizes of nets), catch limits for some species, as well as the pertinence, size and limits of zones with restrictions to some gears, and no-take zones. Whilst restrictions on catches and fishing effort readily made sense to fishermen, the use of no-take areas as a management tool was a complete novelty to them. This unprecedented participatory process started empowering the communities, which readily started to assume control over marine resources. The discussion process also resulted in the unofficial establishment of some formal fishing rules even before the RESEX Corumbau officially came into being. During this period, fishermen from other regions considerably reduced their activity in the area, mainly due to increased surveillance from local fishermen.

Along 2002, with the Management Plan proposal already drafted, the Extractive Reserve's Deliberative Council formation was started. In this process, preparatory meetings were followed-up by open elections of fourteen community representatives (plus an equal number of substitutes), from the six main communities. Extractivists make up 50% (+ 1) of the Deliberative Council chairs, while the remaining include representatives of the Municipal, State and Federal government, the legal system, the tourism sector and NGO's. In September 2002, during the second anniversary of RESEX Corumbau, the Deliberative Council took office and its first act was the approval of the Management Plan. At present (2006-2007), the Management Plan is under review, benefiting from the strengthening of participation, the broader and deeper understanding of the RESEX Corumbau objectives, as well as from the considerable increase of scientific knowledge integrated with local knowledge.

Fisheries and Fisheries Monitoring

The nearly 260 fishermen who benefit from the Extractive Reserve operate about 100 canoes and small boats ("botes") and 80 small motorized boats (5-12m length; 11-22hp engines) (Figure 2; Table 1). Fisheries are carried out mainly on reefs and secondarily on mud and sand bottom. Main gears include hand lines (with one or two hooks), longlines, spears and several kinds of nets, including bottom trawling nets ("balão"). Octopus fisheries over the reefs are also remarkable in the area, with a strong feminine participation, as well as collection of mussels and crustaceans ("mariscagem") on beaches and mangroves, and sea-urchin harvesting on shallow reefs.

Hook-and-line and longline fisheries are practiced by villagers from all localities, with a greatest relative importance for Veleiro´s fishermen and smaller relative importance for Barra Velha´s fishermen, who mainly operate gill nets. The other localities´ villagers (Corumbau, Cumuruxatiba and Caraíva) use mainly hook-and-line and longlines, followed by gill nets and bottom trawls. Barra Velha, Imbassuaba and Veleiro villagers are not engaged in bottom trawling. Spearfishing, the only fisheries not yet monitored on a permanent basis, is practiced mostly by villagers from Corumbau, Barra Velha, Caraíva and Cumuruxatiba (Table 1). Both spearfishing and

bottom trawling were recently introduced in the area, from the 1990´s and 1980´s on, respectively. Bottom trawling targets mostly penaeid shrimps, although more than 90 fish species are captured as bycatch. Reef fisheries target mostly the fish families Lutjanidae (snappers), Carangidae (jacks), Serranidae (groupers) and Scaridae (parrotfishes), this latter captured mainly with spears.

Table 1 - Numbers and kinds of boats, number of fishermen, and relative importance of three fishing gears in the main communities of RESEX Corumbau. Source: Curado *et al*. in prep.

	Canoes/ boats	Motorized Boats *	Fisherfolks *	Bottom Trawl	Line	Gill Net
Cumuruxatiba	35	25	100	++	++	++
Imbassuaba	11	2	35		++	+++
Veleiro	6	0	16		+++	++
Corumbau	20	40	60	++	++	++
Caraíva	15	10	30	+	++	++
Barra Velha	8	2	17		+	+++

* estimated by fishers´ associations presidents
\+ symbols indicate relative intensity in the use of each gear.

Photo: R. B. Francini-Filho.

Figure 2 - Typical fishing boat of RESEX Corumbau.

Since 2002, fisheries landings are being monitored in RESEX Corumbau. Monitoring started as a small CI-Brasil initiative, restricted to Ponta do Corumbau (2002-2003). From 2004 on, fisheries landings´ monitoring was extended to the other localities, with support from projects sponsored by FNMA and SEAP. For the main fisheries in the area (hook-and-line and longlines – "pescarias de linha"), monitoring results demonstrate stable captures, with a trend of increase in 2005 (Figure 3). At present, an innovative participatory monitoring system is under implementation, with spontaneous declarations of fisheries yields from fishermen. Researchers only compile, analyze and present the results for collective discussion. This novel monitoring system aims to transfer the concern and responsibility of monitoring fishing captures to the community, allowing best-informed

discussions in the scope of the Deliberative Council, supporting decision-making by the locals. From 2006 on, fisheries databases started to be transferred to the fishermen´ associations (all equipped with computers and printers), contributing to the community empowerment process.

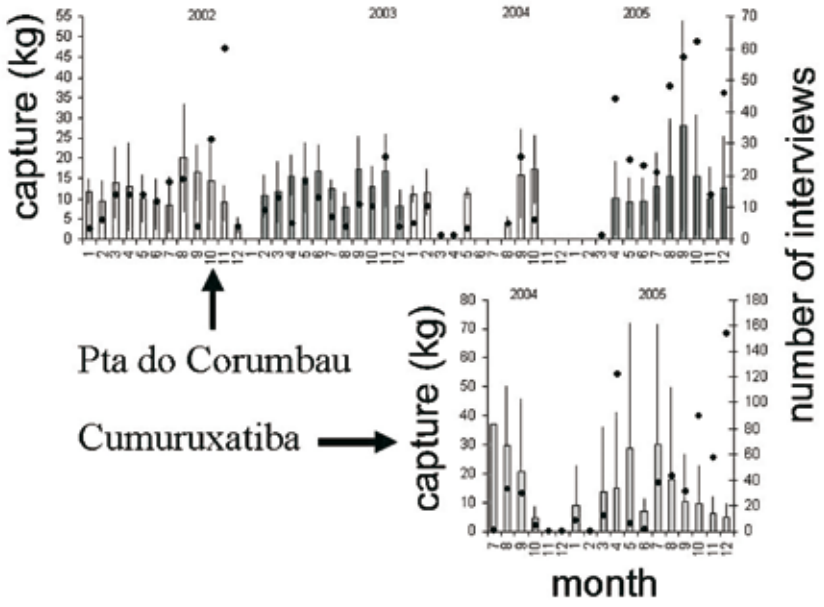


Figure 3 - Temporal trends of the main fisheries monitored within RESEX Corumbau (hook-and-line and longline – "pescarias de linha"), in the two major fishing localities. Points represent the number of interviews. Source: Minte-Vera *et al*. in prep.

Underwater coral reef monitoring: Evaluating no-take zones as fisheries management tools

The possibility of zoning the Extractive Reserve with areas of fishing restrictions and no-take zones was extensively debated during the meetings to draft the Management Plan. Fishermen´ first perception in regard to zoning was the urgent need to exclude bottom trawling from rivers´ mouths (Figure 4), which have always been well recognized as nursery areas and important fishing spots. The possibility for establishing no-take zones was further considered and approved, with the most significant no-take zone established at Itacolomis Reef (Castro & Segal 2001; Figure 5). This no-take zone extends from the central part of Itacolomis Reef as far as the eastern limit of RESEX Corumbau, with a total area of 1,850 hectares (about 20% of Itacolomis Reef total area; see Figure 4). Due to the size and relevance of this reef it was chosen for the underwater monitoring, which began in the summer of 2001. Both no-take and unprotected zones of Itacolomis Reef were monitored before (2001) and after (2002 -2005) protection begun. Unprotected reefs were selected in three categories in terms of distance from the no-take area's northern limit: 0-500 m, 500-1000 m and 1000-1500 m (see detail in Figure 4). For a quantitative characterization of reef fish assemblages, a stationary visual census technique adapted from Bohnsack & Banerott (1984) was used (cf. Moura 2004).

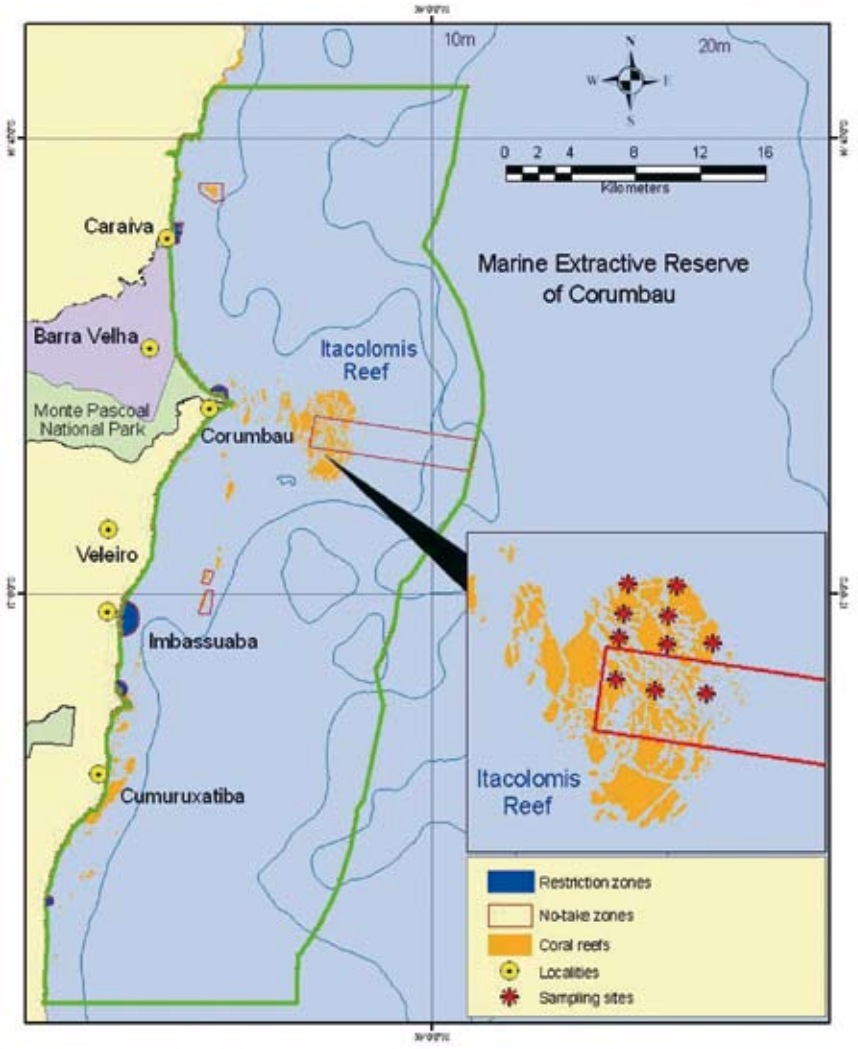


Figure 4 - RESEX Corumbau map depicting the zones with restrictions to certain fishing gears and no-take zones. The insert shows sampling points of the underwater monitoring of coral reefs in Itacolomis Reef.

Results from the reef monitoring show that biomass of the main target species (e.g. black grouper, *Mycteroperca bonaci*; Figure 6) increased significantly, both inside the no-take zone and in its neighboring reefs (Figures 7 and 8; Francini-Filho 2005, Francini-Filho & Moura in prep.). These results show that the no-take area is benefiting adjacent unprotected areas, probably through a process of fish emigration (spillover effect; cf. McClanahan & Mangi 2000). Despite such positive results, illegal fishing carried out by outsiders and locals still occurs inside the no-take zone. Furthermore, even taking into account the increases registered up to the present, biomass of target fish species in Itacolomis Reef is still considerably lower than that registered in other reef areas of the Abrolhos Bank (Francini-Filho & Moura in prep.). The high level of algal cover (~60%) and the low level of live coral cover (~10%) also show that habitat integrity has been seriously compromised in the reefs of RESEX Corumbau, probably due to global climatic changes and overfishing of large herbivorous fish (parrotfishes; Francini-Filho 2005, Francini-Filho & Moura in prep).

Photo by Enrico Marone/CI-Brasil.

Figure 5 - Aerial view of Itacolomis Reef, RESEX Corumbau.

Photo by R. B. Francini-Filho.

Figure 6 - Black grouper, *Mycteroperca bonaci*, one of the main target species at RESEX Corumbau.

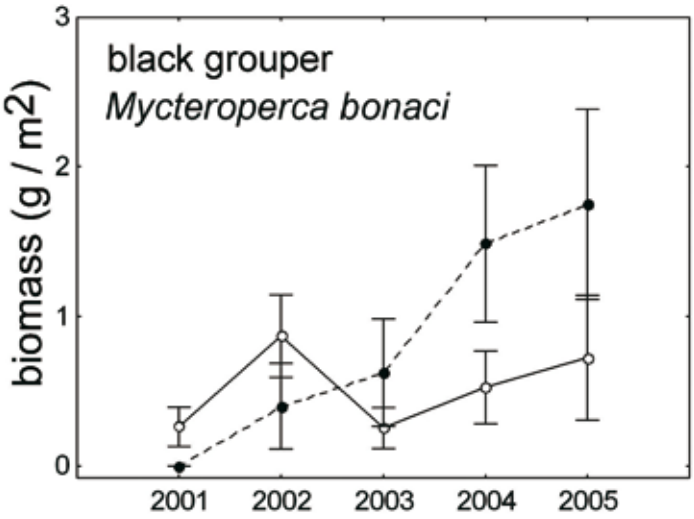


Figure 7 - Biomass of the black grouper, *Mycteroperca bonaci*, inside (closed symbols) and outside (open symbols) the no-take zone of Itacolomis Reef, RESEX Corumbau. Source: Francini-Filho and Moura in prep.

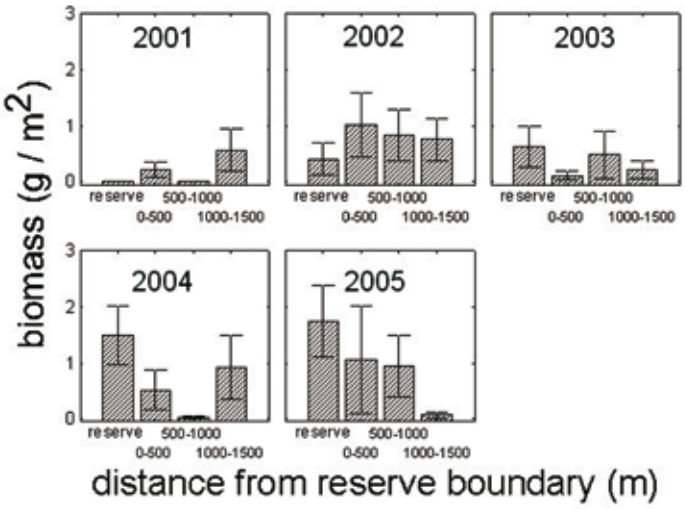


Figure 8 - Biomass of the black grouper, *Mycteroperca bonaci*, inside and outside the no-take zone of Itacolomis Reefs. Reefs outside the no-take zone are located 0-500m, 500-1000, 1000-1500 m from its northern limit. Source: Francini-Filho and Moura in prep.

Perspectives and Challenges

Results from both monitoring programs are continuously being presented in the communities, helping in the collective evaluation of conservation and management strategies, as well as the possible adoption of new measures. This is especially relevant under the present context, as the process for Management Plan review is ongoing. It is noteworthy that the restriction area at Caí River mouth has recently been expanded by a decision from the Deliberative Council, following a request from Imbassuaba's villagers (the community located near the river mouth, with only two motorized boats), emphasizing the need for adaptive fisheries management strategies.

In spite of the positive prospects for fisheries co-management in the RESEX Corumbau, there are other important and emerging challenges that still need to be faced. Basic difficulties like roads in bad conditions and the absence of electricity in most villages imperil fish storage and hinder the catches´ transportation, forcing fishermen to sell their production to a handful of local middlemen. The middlemen, by their turn, determine prices for purchasing the fish way below market prices (and many times supply fishers with expensive diesel and ice), making fishing a very low-profit activity in the RESEX Corumbau. Although access to electricity is slowly developing (a process in which the fishers associations and the Deliberative Council were deeply engaged), basic infrastructure for storage, transportation and commercialization is still lacking.

The strong pressure on coastal land from real estate speculation, with fishermen receiving offers of amounts well above local standards for the purchase of their land, has led many traditional fishermen to sell their seaside homes. Those fishermen who sold their houses have now moved further inland or illegally occupied the coastal part of the Monte Pascoal National Park. Thus the non-inclusion of the stretch of coastland occupied by the traditional fishing communities within the RESEX boundaries implies in a serious threat to their social reproduction and, in the long term, to the success and sustainability of RESEX Corumbau itself.

In 2003 FNMA approved the project "Strengthening Participatory Management of RESEX Corumbau", involving 15 institutions (NGOs - APPA, CI-Brasil, Humpback Whale Institute, and Flora Brasil; IBAMA's units - RESEX Corumbau, and Descobrimento, Monte Pascoal and Abrolhos National Parks; São Carlos Federal University; the six local fishers´ associations). Besides providing continuity for the monitoring programs, this project aims to strength associations and participatory mechanisms; to develop low-impact and profitable community-based tourism and fishing practices; to promote environmental education and communication. More recently, SEAP, in partnership with the Ministry for Agricultural Development (MDA) also approved a project proposed by one of the RESEX Corumbau fishers´ associations (Discovery Coast Artisanal Fishermens Association – APAACD, from Imbassuaba). This project aims to encourage local initiatives for sustainable development, by promoting technical assistance and access

to credit. Funding discontinuity (payment delays may reach more than one year), however, coupled with the challenges of managing projects involving 15 different institutions with diverse interests and backgrounds, are impeding the empowerment process needed for the full establishment of a co-management regime. Besides that, IBAMA's infrastructure is highly limited and there is a single officer for the entire area.

Even with such difficulties, the empowerment and co-management processes are being increasingly consolidated, showing positive effects of the initiatives. For instance, when RESEX Corumbau was created there was a single association representing fishers (AREMACO), but now there are seven such associations. These representative instances, distributed in all localities, facilitate the quest for appropriation of management process, and the defense of fishermen interests. Fishermen from RESEX Corumbau are now frequently traveling to Brasília in order to participate into meetings with governmental agencies and other Extractive Reserve representatives, as well as participating and helping with the establishment of other Extractive Reserves in Bahia State (e.g., RESEX Canavieiras and RESEX Cassurubá). We also emphasize that the Deliberative Council ordinary meetings are regularly taking place, and it is hoped that the Management Plan review is concluded yet in 2007, benefiting from the knowledge and experience accumulated during the last six years.

Acknowledgements

We deeply acknowledge the example provided by the RESEX Corumbau fishermen in their struggle to protect and manage their natural resources, as well as the various people and institutions which are directly and indirectly contributing with RESEX Corumbau. Grazyela Fiuza-Lima, Juliane Cebola, Matheus Freitas, Aneilton Carmo, Danilo Lima, Renata Melão, Alexandre Cordeiro, Paulo Oliveira, Hélio Rodrigues, Albino Neves, José Conceição, John Cordell, Omar Nicolau, Les Kaufman, Luis Fernando Brutto, Luis Paulo Pinto, Paulo Prado, Carlos Hortêncio and Francisco Souto for valuable discussions and insights. We emphasize the role of IBAMA's DISAM trough CNPT, FNMA, SEAP-PR, MDA, Gordon and Betty Moore Foundation (Marine Management Areas Science Program), São Paulo State Research Foundation (FAPESP), Bahia State Research Foundation (FAPESB) and CAPES/CNPq, all of which provided support and funding to co-management, monitoring and research projects in RESEX Corumbau. We dedicate this contribution to Mr. Milton Deocleciano do Carmo for his major role in the creation and implementation of RESEX Corumbau.

References

BOHNSACK, J.A. & S.P. BANNEROT. 1986. **A stationary visual census technique for quantitatively assessing community structure of coral reef fishes.** NOAA Tech. Rep. NMFS 41: 1-15.

CASTRO, C.B. & B. SEGAL. 2001. **The Itacolomis: large and unexplored reefs at the arrival point of the first Europeans in Brazil.** Coral Reefs 20: 18.

DUTRA, G.F., G. ALLEN, T. WERNER & S.A. McKENNA. 2005. **A Rapid Marine Biodiversity Assessment of the Abrolhos Bank, Bahia, Brazil.** RAP Bulletin of Biological Assessment. Conservation International, Washington, DC, 155p.

FRANCINI-FILHO, R.B. 2005. **Estrutura e dinâmica das assembléias de peixes recifais no Banco dos Abrolhos, Bahia: subsídios para conservação e manejo.** Tese de doutorado, Instituto de Biociências da Universidade de São Paulo, 418p.

LEÃO, Z. M. A. N., R. K. P. KIKUCHI & V. TESTA. 2003. **Corals and coral reefs of Brazil.** In: Cortés, J. (ed.). Latin American coral reefs. New York: Elsevier. pp. 9-52.

McCLANAHAN, T.R. & S. MANGI. 2000. **Spillover of exploitable fishes from a marine park and its effect on the adjacent fishery.** Ecol. Appl. 10: 1792-1805.

MOURA, R.L. 2004. **Riqueza de espécies, diversidade e organização de assembléias de peixes em ambientes recifais: um estudo ao longo do gradiente latitudinal da costa brasileira.** Tese de Doutorado, Instituto de Biociências da Universidade de São Paulo, 613p.

WERNER, T. B., L. P. PINTO, G.F. DUTRA & P. G. P. PEREIRA. 2000. **Abrolhos 2000: Conserving the Southern Atlantic's richest coastal biodiversity into the next century.** Coast. Manag. 28: 99-108.

The Effects of Fishing and Protection through Marine Protection Areas: Three Case Studies and Implications to Reef Fish Functional Groups in Brazil

Sergio R. Floeter [1]
Carlos E. L. Ferreira [2]
João Luiz Gasparini [3]

Abstract

The vast Brazilian coast harbors unique and diverse reef fish communities. Unfortunately, relatively little is known about the impact of fishing on these fish species. Here we review the effect of different levels of protection on the composition, abundance, and size structure of reef fish species along a large portion of the Brazilian coastline. Pairwise comparisons of sites with different protection status (more versus less protected) were used to determine the potential responses of reef fishes to the establishment of marine protected areas. Highly targeted species (top predators and large herbivores) were significantly more abundant and larger in size within sites with a higher degree of protection, indicating that they benefit from protection, while lightly fished and unfished species were not. These results are consistent with past work documenting the responses of species to protection. Based on these results we suggest strategies and expectations for managing and protecting Brazilian reef fisheries.

Key Words: reef fisheries, Brazil, marine protected areas, reserves, overfishing.

Introduction

The Brazilian coastline is a vast area extending nearly 8000 km from the northern edge just north of the equator to the southern temperate edge bordering Uruguay. Reef environments occur along at least a third of this coastline, with coral reefs in the north (latitude 0°52'N to 19°S) and rocky reefs in the south (20°S to 28°S). These reefs are known to harbor a large number of endemic corals (40 % – Castro, 2003), sponges (36% – Eduardo Hajdu, pers. com.) and fish species (15-20% – Floeter & Gasparini, 2000; 2001). In the last decade there was an significant increase in the knowledge about the biogeography and macroecology of Brazilian reef fishes (e.g. Ferreira *et al*., 2004; Floeter *et al*., 2001, 2004, 2005), which is the foundation to understanding the status of Brazilian reef fish populations and design appropriate management and conservation strategies. For example, the considerable endemism shown by different faunistic groups

[1] Dept. of Ecology and Zoology, Lab. of Marine Biogeography and Macroecology, Federal University of Santa Catarina, Florianópolis, SC, Brazil. E-mail: floeter@ccb.ufsc.br
[2] Dept. of Marine Biology, Fluminense Federal University, Niterói, RJ, Brazil.
E-mail: cadu@vm.uff.br
[3] Dept. of Ecology and Natural Resources, Federal University of Espírito Santo, Vitória, ES, Brazil.
E-mail: gaspa.vix@terra.com.br.

in Brazil is even more impressive if analyzed in proportion to their area of distribution. The Brazilian reefs represents only 0.4% of the global reef area, and 5% of the Atlantic reef area, however, the ratio between level of endemism and reef area in Brazil is 6.5 for fish (endemism/100 km^2 of reef area) and 0.9 for corals. In the Caribbean this ratios are only 1.5 and 0.26 respectively (Moura, 2002). The high endemism pre unit area warrants that the Brazilian reefs should be considered priority areas for conservation. Because the Brazilian biogeographic province (sensu Briggs, 1974, 1995; Floeter & Gasparini, 2000) lies entirely within the jurisdiction of a single nation (Brazil), there may be unique and significant opportunities to effectively manage and conserve these fish species.

Unfortunately, relatively little is known about the fishing or conservation status of Brazilian reef fishes. How abundant are Brazilian reef fish and are many of the species currently threatened? Are different types of spatial management (e.g. no-take areas, spatial fishing regulations) affecting species positively, and are these effects different? Are the endemic species threatened or impacted, and if so, what are the implications for managing this unique biogeographic region? Limited research suggests that both commercial and aquarium fisheries are taking large numbers of fish from Brazilian reefs, leading to significant changes in community structure (Costa *et al*., 2003; Gasparini *et al*., 2005; Ferreira *et al*., 2006), and both artisanal and commercial fisheries appear to be affecting the population size and size structure of fish populations (Ferreira & Gonçalves, 1999; Ferreira, 2005; Gasparini *et al*., 2005; Frédou *et al*., 2006). Other threats deriving from urban development and agricultural runoff along the Brazilian coast were reviewed by Leão & Dominguez (2000), although little is known about the effect of these threats to reef fishes. With Brazil's large (179 million) and growing (1.3% per year) population (PRB, 2004), half of which lives along the coast, the demand for fish protein will only increase in the coming years. The need is pressing to understand the status of Brazilian reef fish populations and design appropriate management and conservation strategies.

In the last decade or so marine resource management and conservation has focused on marine protected areas as a tool for managing coastal ecosystems and species (reviewed in NRC, 2001, Palumbi, 2002), based in part on the growing scientific literature demonstrating the recovery of species within the boundaries of protected areas (synthesized in Halpern, 2003). Cooperative and traditional (small-scale) fisheries management have also been shown to provide effective protection for fisheries in some cases (e.g. McClanahan *et al*., 1997; Ferreira & Maida, 2001). However, not all species respond positively to protection, with primarily heavily exploited species showing the strongest response (Micheli *et al*., 2005; Dulvy *et al*., 2004a). These differences in response of species to protection from fishing pressure can in turn be used as a surrogate measure for the fishing pressure, or threat, experienced by a species or group of species. As such, a lack of response by a species to protection indicates that either the species was not affected by fishing pressure, or that the protection provided (on paper or in reality) is not sufficient to protect the species from fishing.

Effects of different fishing pressures

Recent comparisons (Floeter *et al*., 2006) examined the effect of different levels of protection on the composition, abundance, and size structure of reef fish species along a 2500 km portion of the Brazilian coastline (from the Espírito Santo State to Santa Catarina State; Fig. 1 - see at the end of the article). Pairwise comparisons of sites with different protection status (more versus less protected – Table 1) were used to determine the potential responses of reef fishes to the establishment of marine protected areas. Highly targeted species (top predators and large herbivores) were significantly more abundant and larger in size within sites with a higher degree of protection, indicating that they benefit from protection, while lightly fished and unfished species were not (Figs. 2, 3, 4 - see at the end of the article). These results are consistent with past work documenting the responses of species to protection (e.g. Halpern, 2003 and references; Ferreira, 2005).

Table 1 - Characteristic features of the studied Brazilian reef sites. Sites are classified as protected (P), partially protected (PP), or not protected (NP).

Reef site	distance from coast (km)	MPA area	kinds of fisheries	reserve status	year of establish-ment	effectiveness of the reserve
Abrolhos Reefs Arquipélago (P)	50	802 km^2	None	Marine National Park	1983	Full protection. enforced since 1986
Timbebas (PP)	10	110 km^2	Spearfishing, nets, hook and line	Marine National Park	1983	Not enforced**.
Guarapari Islands						
Escalvada (PP)	11	None	Spearfishing, hook and line	None	–	Partially protected by distance
Coastal (NP)	0.5	None	Spearfishing, nets, hook and line	None	–	None
Arraial do Cabo						
Pedra Vermelha (PP)	–	500 m^2	Hook and line*	'Artisanal Fisheries Reserve'	1997	Not continuously enforced
Saco do Anequim (NP)	–	500 m^2	Hook and line, Spearfishing	None	–	None
Laje de Santos (P)	36	50 km^2	None	Marine State Park	1993	Full Protection. Not continuously enforced
Arvoredo Island (P)	11	178 km^2	None	Biological Reserve	1990	Full Protection. enforced

*= mid-water fish only. **= not enforced during the studied period. Since 2002, the Abrolhos National Park has a 45' vessel, a 12-people field staff including rangers, as well as an annual budget of more than US$150,000.00 that are also covering Timbebas.

The different responses by reef fishes to the different management strategies at the three sites provide a unique opportunity to evaluate the relative consequences of these management strategies. At Abrolhos both sites are part of a National Marine Park, but one site is effectively a "paper park"; at Guarapari both sites are open to fishing, but one site is partially protected due to its distance from the coast (11 km); and at Arraial do Cabo one site is open to all types of fishing while the other contiguous site allows only hook and line fishing of mid-water fishes like the carangids. In all cases, heavily fished species were more abundant in the site with greater protection, but results varied for lightly fished and unfished species. It is encouraging that even very small, partially protected areas can provide benefits to fishes that are heavily fished (Pedra Vermelha is only 500m^2), as was found to be true for fully protected small reserves in other places around the world (Halpern, 2003).

The effect of different management strategies on fish density and size is also confounded by spatial factors. The Abrolhos reefs are much larger than the sites in the other two regions (Table 1) and are far from developed urban centers. The Guarapari islands, on the other hand, are close to the city of Vitória (with a population of one million people), and Escalvada is partially protected from fishing only due to its distance from shore. Grouper density was lowest here of any of the sites (Fig. 4 - see at the end of the article), and average size of groupers and parrotfishes was even lower than the 'paper park' Timbebas (Fig. 3 - see at the end of the article).

The general increase in abundance of non-target fishes, particularly for the small size classes, could be related to an indirect effect of the removal of the big predators at these sites, as has been documented for other locations (Dulvy *et al*., 2004b; Ashworth & Ormond, 2005).

Efects in the functional groups

Among the different reef fish trophic groups, three are known to have great functional importance in reef systems besides being important impact bioindicators: herbivorous fishes, top predators and cleaning fishes.

Herbivores

In shallow coral reefs worldwide, herbivory is ubiquitous and intense (Steneck 1988; Hay 1991). Herbivorous fishes have a profound impact on the distribution, abundance and evolution of tropical reef algae (reviewed by Hay, 1991; Bellwood, 2003). The overfishing of herbivorous fishes seems to be responsible for the phase-shift from coral to algae dominated reefs (Hughes, 1994). On shallow reefs, fishes can take over 100.000 bites/m^2/day (Hatcher, 1981; Bruggemann, 1994), consuming almost all benthic algal production (Hay, 1991; Ferreira *et al*., 1998b). Fish are therefore the major link for energy transfer to higher trophic levels (Polunin & Klumpp, 1992).

Such a functional importance in the reef systems have been affected by the chronic overfishing of the large herbivores, mainly the parrotfishes (Scaridae). This phenomenon has been described globally as "fishing down the food webs" (Pauly *et al*., 1998), being defined as the succession of fishing pressure from the highly prized top predators to other large species from lower trophic levels, such as the scarids, after the collapse of the formers. In the Abrolhos Region (Bahia State), differences among size classes of these important herbivorous fishes have been detected when protected areas are compared to less protected areas (Figs. 3 to 5; Ferreira & Golçalves, 1999; Ferreira, 2005 - see at the end of the article). In terms of abundance, the results also show lower numbers at less protected areas (Fig. 2 - see at the end of the article). In Arraial do Cabo (Rio de Janeiro State), the largest scarid *Scarus trispinosus* (up to 60 cm) used to be abundant, but now is a rare species (Fig. 6 - see at the end of the article).

Top Predators

The ecological stability of the communities depends heavily in the predator-prey interactions. Bascompte *et al*. (2005) showed that in complex food webs in the Caribbean, top predators (Fig. 7; the ones that are usually selectively removed by fishing – Pauly *et al*., 1998 - see at the end of the article) are disproportionably important in terms of interactions in the food web. Top predators (e.g. Fig. 7) present much more trophic links than their numerical abundance could predict, thus, indicating potential effects in all the community structure.

Floeter *et al*. (2006) found higher densities and larger sizes of groupers (Serranidae) at protected areas comparing to less or non-protected areas in Abrolhos, Guarapari and Arraial do Cabo (Figs. 3 e 4 - see at the end of the article). Reproductive aggregations of serranids are known from several locations along the Brazilian coast, but unfortunately no one has any specific conservation status (Gehrardinger, L.C., pers. com.).

Cleaner Fishes

Cleaner fishes are also known by their functional importance in reef systems. Mutualistic associations among cleaner fishes and their 'clients' could affect the community health and even influence local diversity (e.g. Bshary, 2003; Grutter *et al*., 2003; Sazima & Sazima, 2004). Intensive harvesting of the cleaners may disrupt inter-specific associations such as cleaning symbiosis (Sazima & Sazima, 2004; Gasparini *et al*., 2005). The conspicuous colors and small size of reef cleaners, instrumental in their cleaning role on the coral reef (Côté 2000), are their most sought-after features for the aquarium trade. Of the ca. 25 species of cleaner fishes and eight cleaner shrimps known from Brazil's coast, all the shrimps and at least 15 fish species are regularly harvested for the ornamental trade (Gasparini *et al*., 2005). The two best studied cleaners in Brazil are the barber goby (*Elacatinus figaro*) and juvenile French angelfish (*Pomacanthus paru*), both of which clean numerous and varied client assemblages, from small herbivores to large

carnivores (Sazima *et al*., 1999; Sazima & Sazima, 2004; Floeter *et al*., 2007) including several economically-important species for reef fisheries (groupers, snappers, jacks).

Gasparini *et al*. (2005) evaluated the density of angelfishes (Pomacanthidae) in a gradient of distance from the coast, which is related to a gradient of harvesting pressure at the coastal islands of the Guarapari Region, Espírito Santo State. Densities of angelfishes were censused at three sites with progressively greater distances from the coast near through visual transects (20 m long and 2 m wide = 40 m^2) using SCUBA. Densities of the smaller size classes (juveniles and sub-adults) were greater at progressively greater distances from the coast, as expected (Fig. 8 - see at the end of the article). The trend we found is consistent with our suggestion that harvesting is greater in coastal areas and that it has the potential to reduce the overall abundance of the harvested species at local scales. These results are not to be confounded with natural variation due to habitat characteristics (authors' personal observations), since we also found that the larger size classes of these fishes (adults usually not targeted by the trade) were present in approximately equal numbers at the three sites, a strong indication that these species would be found in similar numbers at all sites were not for harvesting trade. The differences in Figure 8 exemplify the greatest pressure exerted upon the small size classes (more suitable for the trade).

Specialized cleaners generally survive for a short time in aquariums due to their distinctive feeding habits (e.g. gnathid isopods), and thus experience a high turnover in the ornamental trade (Wood, 2001).

Future Perspectives

Recent comparisons with other reefs in the Atlantic Ocean are generating comparative knowledge in terms of biodiversity, biogeography and macroecology (e.g. Ferreira *et al*., 2004; Floeter *et al*., 2001, 2004, 2005, 2007 and their references). The increase in the knowledge related to the distribution and abundance of marine species and its trophic structure patterns will certainly constitute essential tool to our greatest challenge: the sustainable management of marine resources, especially through the creation of marine protected areas.

Further investigations on actual fish densities and biomass as well as abundance and biomass of food sources (i.e. macrofauna associated to hard and soft substratum, algal turfs, seaweeds, plankton, and small fishes), will certainly help to decipher the complex patterns in reef fish distribution and trophic structure along the Brazilian coast. Also, the trophic role of cryptic species and the patterns in community structure of deep reefs are barely known, if at all. Despite the rarity of fish surveys in Brazilian deep reefs (> 50m; Feitoza *et al*., 2005), these habitats are already suffering high fishing pressure (Costa *et al*., in press).

A critic review on sampling methods as well as statistical analyses is now necessary to provide a solid foundation and standardization for future studies. This would allow the integration of datasets and a better planning of regional, national or global joint projects.

Comparisons between impacted and protected areas from fishing and tourism are of relevant practical application for environmental stakeholders. Many times, stakeholders do not have scientific basis to establish their decisions. Clearly fishing pressure has an effect on reef fish communities along the Brazilian coast (Ferreira & Gonçalves, 1999; Ferreira, 2005; Floeter *et al*., 2006) as well as in many other places in the world (Halpern, 2003). Unfortunately, very little of the coastline is under any form of protection or management (see Amaral & Jablonski, 2005 for the list and sizes of MPAs in Brazil). Huge stretches of coast (500–1500Km) between these sites remain completely open to fishing and other impacts (e.g. the Espírito Santo and Ceará coasts). Given the high levels of endemism in this region and the likelihood that a growing human population will continue to create greater fishing pressure, a large-scale conservation and management plan is urgently needed. Fortunately, the entire coastline falls within the jurisdiction of a single nation. This situation provides a unique opportunity for developing and implementing a single, coordinated plan for managing the reef fisheries, although subtropical (rocky) and tropical (coral) reef fisheries may require different specific management strategies. Standard fisheries management (e.g. gear and effort limits) will be an important component of any such plan, however, effective conservation will likely require some form of a network of marine protected areas as well.

It is important to note that the studies done so far showing the effects of fishing and protection along the Brazilian coast were performed through pairwise comparisons of fished and unfished areas (Ferreira & Maida, 2006; Floeter *et al*., 2006). These are not ideal data since habitat differences could mask fishing effects. To avoid confounding future efforts to establish networks of marine protected areas in Brazil we should include baseline studies (i.e. surveys to assess initial conditions), whenever possible. The results compiled in the present work show clear evidence of what to expect from marine protected areas in reef systems in Brazil. On average, the density of heavily fished species should increase in reserves by about 10%, but exact results will be site-specific and may range as high as a 5-fold increase in protected areas. Thus, data of this type could give support and basis for stakeholder decisions as well as awareness to the general public regarding conservation of the fishing stocks in Brazilian reefs.

Acknowledgments

Ana Paula Prates for the invitation to participate in this book. We thank B.S. Halpern, L.C. Gerhardinger, O.J. Luiz-Júnior, W. Krohling, and L.A. Rocha for reviewing earlier drafts. We thank J.L. Gasparini, O.J. Luiz-Júnior, W. Krohling, M. Hostin, J.P. Barreiros, L.C. Gerhardinger, I.R. Zalmon, A.G.V. Floeter, and IEAPM staff for invaluable help in the field and

logistical support. E. Hajdu, A.P.L. Prates and B.P. Ferreira for unpublished information. Collection of data by S.R.F. was supported by the Padi Aware Foundation, UENF and Fundação O Boticário de Proteção à Natureza, C.E.L.F. was supported by WWF and IEAPM. Support was also provided by the National Center for Ecological Analysis and Synthesis (SRF), a center funded by NSF (Grant DEB-0072909), the University of California, and the Santa Barbara campus.

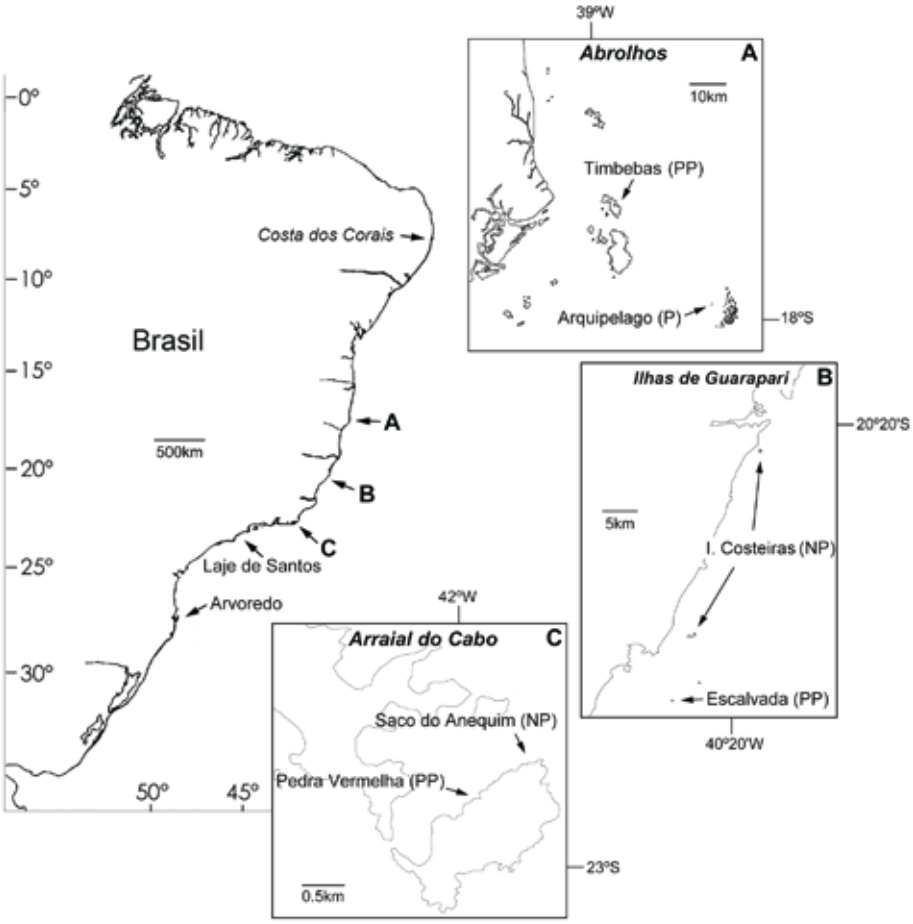


Figure 1 - Map of the Brazilian coast showing sites where surveys were conducted (sites A, B, C, Laje de Santos, and Arvoredo) and the location of another site where a similar study were done in the 'Hump of Brazil' (Environmental Protection Area 'Costa dos Corais' –Tamandaré Reefs).

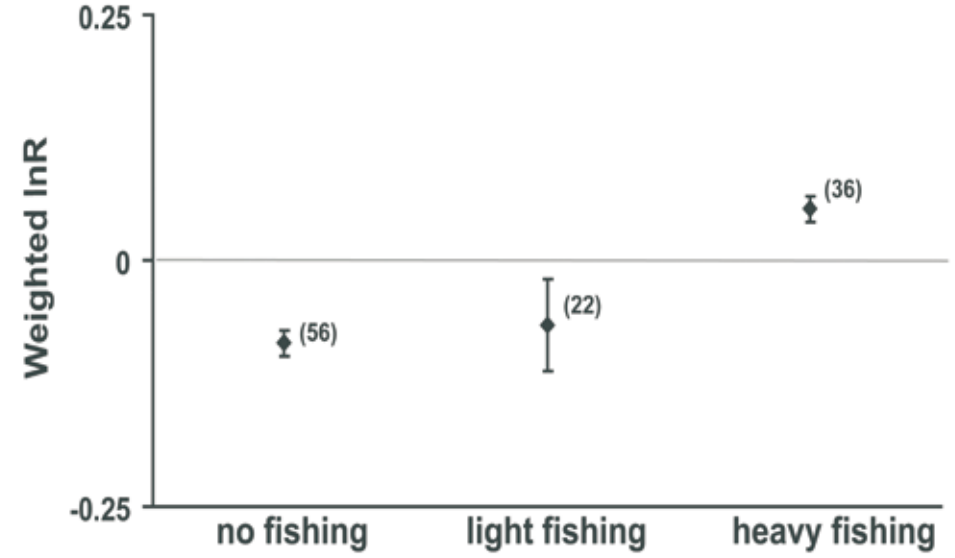


Figure 2 - Weighted response ratios for more versus less protected sites for species grouped by expected fishing pressure. Results are presented for all species across all studied sites (A, B and C of Fig. 1). The y-axis (weighted lnR) is the variance-weighted response ratio of fish density in the more protected area divided by fish density in the less protected area (reference site). A value of zero indicates no difference between protected and less protected sites. Values above zero indicate larger abundances in the more protected areas; values below zero indicate the opposite. Numbers in parenthesis are the number of species in each comparison. Details in Floeter et al. (2006).

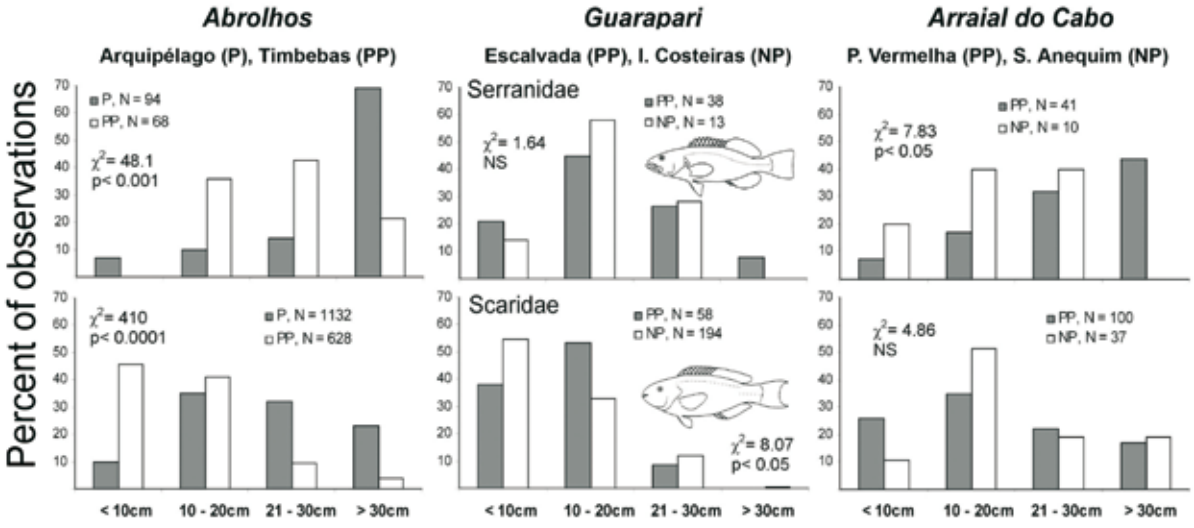


Figure 3. Size frequency distribution of serranids and scarids in more and less protected sites, based on the percent of observations in visual censuses. P = Protected from fishing, PP = Partially protected from fishing, NP = Non protected area. Modified from Floeter et al. (2006).

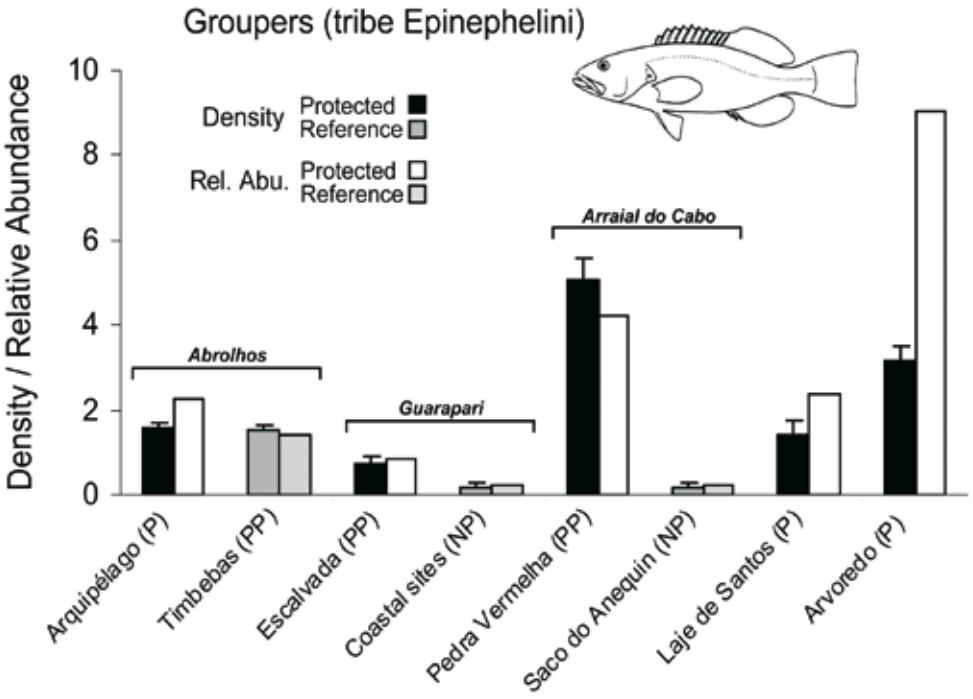


Figure 4 - Density and relative abundance of groupers (tribe Epinephelini) in more versus less protected sites. Reference sites refer to either non or partially protected sites. P = Protected from fishing, PP = Partially protected from fishing, NP = Non protected area. Laje de Santos and Arvoredo MPAs are shown for comparion. Modified from Floeter et al. (2006).

Photo: Carlos Secchin.

Figure 5 - School of parrotfishes (*Scarus trispinosus*) at the Arquipélago dos Abrolhos, BA in the eighties.

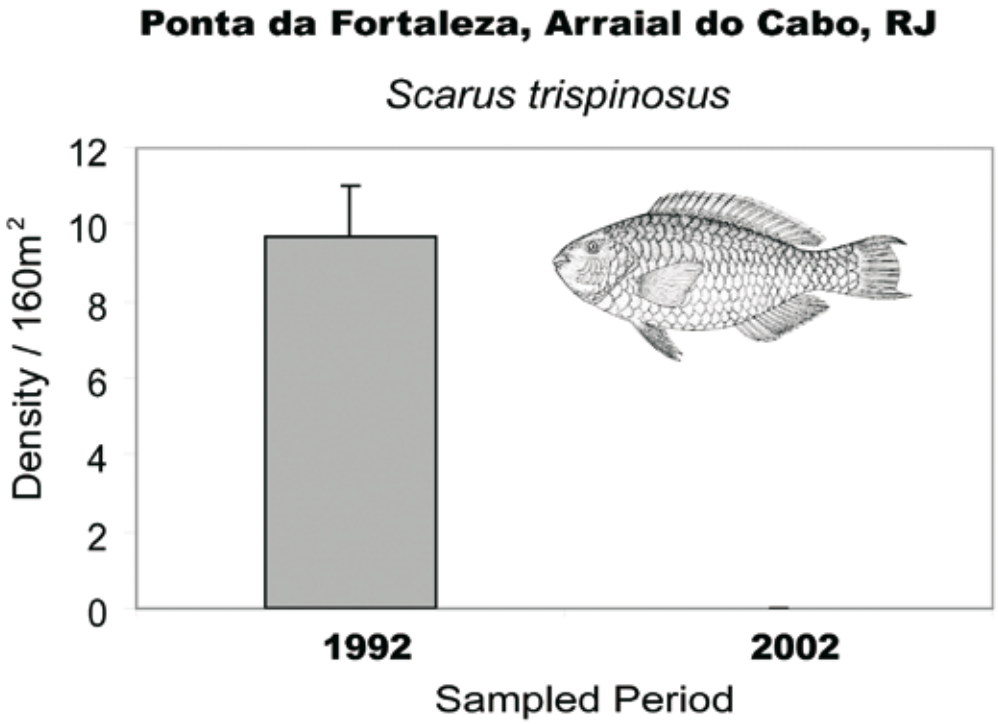


Figure 6 - Mean density (SE) of Scarus trispinosus at the Ponta da Fortaleza - Arraial do Cabo, RJ. Sampling was conducted by the same observer (C.E.L.F.) through monthly visual census (n = 5) during one year in 1992 and in 2002 (see Ferreira *et al*., 2001 for methods). The decade interval between the samplings characterizes the absence of this species today exclusively due to spearfishing.

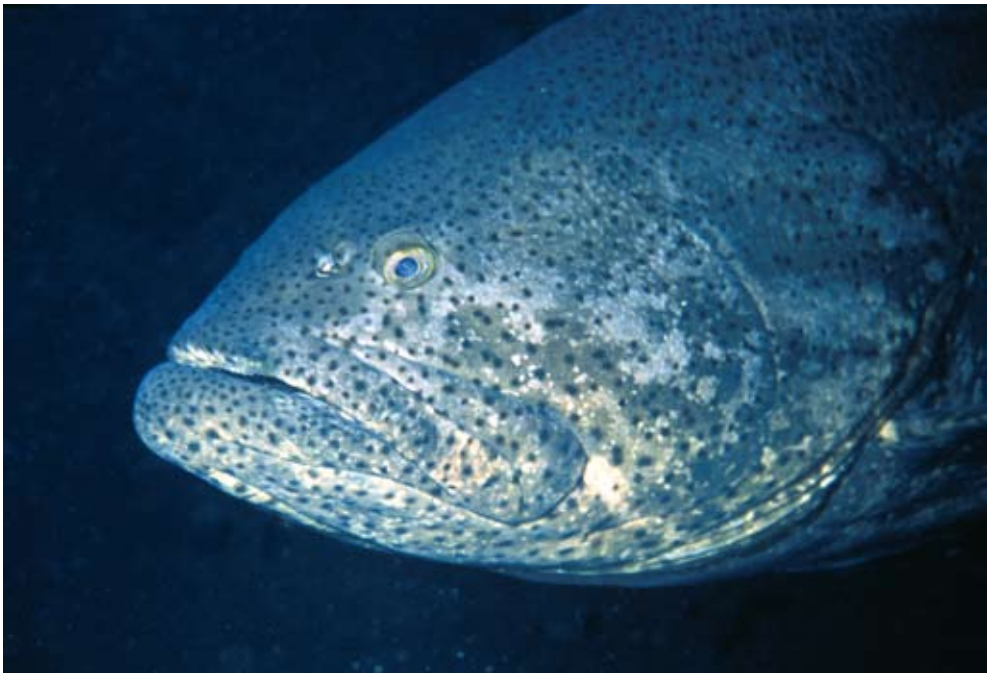


Photo: Sergio Floeter.

Figure 7 - The Goliath grouper (*Epinephelus itajara*) is the larger bonefish occurring on the Brazilian coast. This species is seriously threatened of extinction.

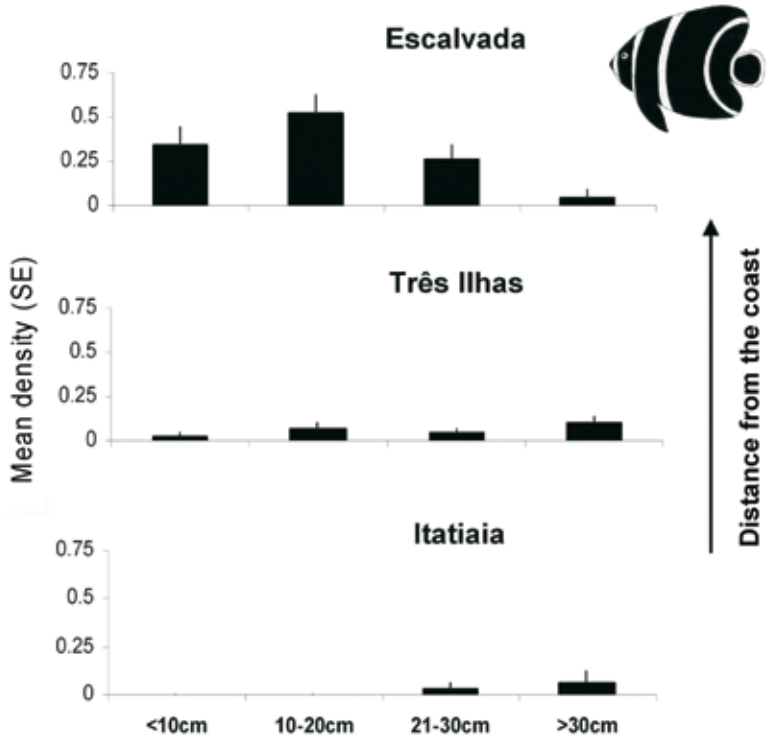


Figure 8 - Angelfish (Pomacentridae) mean densities and standard error in four size classes at three island sites near Guarapari (Espírito Santo, SE Brazil). Fish were censused in strip transects of 20 x 2 m (Itatiaia, N = 39; Três Ilhas Archipelago, N = 72; Escalvada Is., N = 55). Distance from the coast: Itatiaia = 0.5 km, Três Ilhas = 3.5 km, Escalvada = 11 km. Modified from Gasparini et al. (2005).

References

AMARAL, A.C.Z. & JABLONSKI, S. 2005. **Conservation of marine and coastal biodiversity in Brazil.** Conserv. Biol. 19: 625–631.

ASHWORTH, J.S. & ORMOND, R.F.G. 2005. **Effects of fishing pressure and trophic group on abundance and spillover across boundaries of a no-take zone.** Biol. Conserv. 121: 333–344.

BASCOMPTE, J., MELIÁN, C.J. & SALA, E. 2005. **Interaction strength combinations and the overfishing of a marine food web.** Proc. Natl. Aca. Sci. U.S.A. 102: 5443–5447.

BELLWOOD, D.R. 2003. **Origins and escalation of herbivory in fishes: a functional perspective.** Paleobiology 29: 71–83.

BRIGGS, J.C. 1974. **Marine Zoogeography.** New York: McGraw-Hill, 475p.

BRIGGS, J.C. 1995. Global Biogeography. **Developments in paleontology and stratigraphy.** v. 14. Amsterdam: Elsevier Science B. V., 452p.

BRUGGEMANN, J.H. 1994. **Parrotfish grazing on coral reefs: a trophic novelty.** PhD Thesis, University of Groningen, Netherlands.

BSHARY, R. 2003. **The cleaner wrasse, *Labroides dimidiatus* is a key organism for reef fish diversity at Ras Mohammed National Park, Egypt.** J. Anim. Ecol. 72: 169–176.

CASTRO, C.B. 2003. **Coral Reef in Brazil.** pp 25-27. In: Prates, A.P.L. (ed.) Atlas of Coral reef Protected Areas in Brazil. MMA/SBF, Brasília.

COSTA, P.A.S., BRAGA, A.C., ROCHA, L.O.F. 2003. **Reef fisheries in Porto Seguro, eastern Brazilian coast.** Fish. Res. 60: 577–583.

COSTA, P.A.S., OLAVO, G., MARTINS A.S. no prelo. **Áreas de pesca e rendimentos da frota de linheiros na Costa Central Brasileira entre Salvador-BA e o Cabo de São Tomé-RJ.** Cadernos Especiais do MMA.

CÔTÉ, I.M. 2000. **Evolution and ecology of cleaning symbioses in the sea.** In Gibson, R.N. and Barnes, M. (eds), Oceanography and Marine Biology: an Annual Review, pp 311–355. Taylor and Francis, London.

DULVY, N.K., FRECKLETON, R.P., POLUNIN, N.V.C., 2004a. **Coral reef cascades and the indirect effects of predator removal by exploitation.** Ecol. Lett. 7: 410–416.

DULVY, N.K., POLUNIN, N.V.C., MILL, A.C., GRAHAM, N.A.J., 2004b. **Size structural change in lightly exploited coral reef fish communities: evidence for weak indirect effects.** Can. J. Fish. Aquat. Sci. 61: 466–475.

EKAU, W. & KNOPPERS, B. 1999. **An introduction to the pelagic system of the north-east and east Brazilian shelf.** Arch. Fish. Mar. Res. 47:113–132.

FEITOZA, B.M., ROSA, R.S. & ROCHA, L.A. 2005. **Ecology and zoogeography of deep-reef fishes in Northeastern Brazil.** Bull. Mar. Sci. 76: 725–742.

FERREIRA, B.P. & MAIDA, M. 2001. **Fishing and the Future of Brazil´s Northeastern Reefs.** InterCoast 38: 22–23.

FERREIRA, B.P. & MAIDA, M. 2006. **Monitoramento dos Recifes de Coral do Brasil: Situação Atual e Perspectivas.** Brasília: MMA. v. 1. 120 p.

FERREIRA, B.P., D´AMICO, T.M. & REINHARDT, M.H. 2005. **Peixes ornamentais dos recifes de Tamandaré (PE): Padrões de distribuição, conservação e educação ambiental.** Bol. Téc. Cient. CEPENE 13: 9–23.

FERREIRA, C.E.L. 2005. **The Status of Target Reef Fishes.** In: Dutra, G.F., G.R. Allen, T. Werner, and S. A. McKenna. (Org.). A Rapid Marine Biodiversity Assessment of the Abrolhos Bank, Bahia, Brazil. Washington, DC: Conservation International, 38: 56–66.

FERREIRA, C.E.L., GONÇALVES, J.E.A. 1999. **The unique Abrolhos reef formation (Brazil): need for specific management strategies.** Coral Reefs 18:352.

FERREIRA, C.E.L., GONÇALVES, J.E.A., COUTINHO, R. 2001. **Community structure of fishes and habitat complexity in a tropical rocky shore.** Env. Biol. Fish. 61:353–369.

FERREIRA, C.E.L., GONÇALVES, J.E.A., COUTINHO, R., Peret, A.C. 1998a. **Herbivory by the dusky damselfish, *Stegastes fuscus* (Cuvier, 1830).** J. Exp. Mar. Biol. Ecol. 229:241–264.

FERREIRA, C.E.L., PERET, A.C., COUTINHO, R. 1998b. **Seasonal grazing rates and food processing by tropical herbivorous fishes.** J. Fish Biol. 53:222-235.

FERREIRA, C.E.L, FLOETER, S.R., GASPARINI, J.L., JOYEUX, J.C. & FERREIRA, B.P. 2004. **Trophic structure patterns of Brazilian reef fishes: a latitudinal comparison.** J. Biogeogr. 31: 1093–1106.

FLOETER, S.R., BEHRENS, M.D., FERREIRA, C.E.L., PADDACK, M.J. & HORN, M.H. 2005. **Geographical gradients of marine herbivorous fishes: patterns and processes.** Mar. Biol. 147: 1435–1447.

FLOETER, S.R., FERREIRA, C.E.L., Dominici-Arosemena, A. & Zalmon, I. 2004. **Latitudinal gradients in Atlantic reef fish communities: trophic structure and spatial use patterns.** J. Fish Biol. 64: 1680–1699.

FLOETER, S.R., GASPARINI, J.L. 2000. **The southwestern Atlantic reef fish fauna: composition and zoogeographic patterns.** J. Fish Biol. 56: 1099–1114.

FLOETER, S.R., GASPARINI, J.L. 2001. **The Brazilian endemic reef fishes.** Coral Reefs 19:292.

FLOETER, S.R., GUIMARÃES, R.Z.P., ROCHA, L.A., FERREIRA, C.E.L., RANGEL, C.A., GASPARINI, J.L. 2001. **Geographic variation in reef-fish assemblages along the Brazilian coast.** Global Ecol. Biogeogr. 10: 423–433.

FLOETER, S.R., HALPERN, B.S. & FERREIRA, C.E.L. 2006. **Effects of fishing and protection on Brazilian reef fishes.** Biol. Conserv. 128: 391–402.

FLOETER, S.R., VÁZQUEZ, D.P. & GRUTTER, A.S. 2007. **The macroecology of marine cleaning mutualisms.** J. Anim. Ecol. 76: 105–111.

FRÉDOU, T., FERREIRA, B.P. & LETOUNEUR, Y. 2006. **A univariate and multivariate study of reef fisheries in the Northeast Brazil.** ICES J. Mar. Sci. L. U.K. 63: 883–896.

GASPARINI, J.L., FLOETER, S.R., FERREIRA, C.E.L. & SAZIMA, I. 2005. **Marine ornamental trade in Brazil.** Biodiv. Conserv. 14: 2883–2899.

GRUTTER, A.S., MURPHY, J.M. & CHOAT, J.H. 2003. **Cleaner fish drives local fish diversity on coral reefs.** Curr. Biol. 13: 64–67.

HALPERN, B.S. 2003. **The impact of marine reserves: Do reserves work and does reserve size matter?** Ecol. Appl. 13: S117–S137 Suppl. S

HATCHER, B.G. 1981. **The interaction between grazing organisms and the epilithic algal community of a coral reef: a quantitative assessment.** Proc. 4th Int. Coral Reef Symp. 2:515–524.

HAY, M.E. 1991. **Fish-seaweed interactions on corals reefs: effects of herbivorous fishes and adaptations of their prey.** In: Sale PF (ed) The ecology of fishes on coral reefs. Academic Press, San Diego, pp 96–119.

HUGHES, T.P. (1994) C**atastrophes, phase shifts, and large-scale degradation of a Caribbean coral reef.** Science 265: 1547–1551.

LEÃO, Z.M.A.N., Dominguez, J.M. 2000. **Tropical coast of Brazil.** Mar. Pollut. Bull. 41: 112–122.

MAIDA, M., Ferreira, B.P. 1997. **Coral reefs of Brazil: an overview.** Proc. 8th Int. Coral Reef Symp. 1: 263–274.

McCLANAHAN, T.R., GLAESEL, H., RUBENS, J., KIAMBO, R. 1997. **The effects of traditional fisheries management on fisheries yields and the coral-reef ecosystems of southern Kenya.** Environ. Conserv. 24: 105–120.

MICHELI, F., HALPERN, B.S., BOTSFORD, L.W. & WARNER, R.R. 2005. **Trajectories and correlates of community change in no-take marine reserves.** Ecol. Appl. 14: 1709–1723.

MILLER M.W. 1998. **Coral/seaweed competition and the control of reef community structure within and between latitudes.** Oceanogr. Mar. Biol. Ann. Rev. 36: 65–96.

MOURA, R.L. 2002. **Brazilian reefs as priority areas for biodiversity conservation in the Atlantic Ocean.** Proc. 9th Int. Coral Reef Symp. 2: 917–920.

NRC (National Research Council). 2001. **Marine protected areas: tools for sustaining ocean ecosystems.** Washington, DC, National Academy Press, 272 pp.

PALUMBI, S.R. 2002. **Marine reserves: a tool for ecosystem management.** Arlington, VA, Pew Oceans Commission.

PAULY, D., CHRISTENSEN, V., DALSGAARD, J., FROESE, R. & TORRES, F., Jr. 1998. **Fishing Down Marine Food Webs.** Science 279: 860–863.

POLUNIN N.V.C., KLUMPP D.W. 1992. **A trophodynamic model of fish production on a windward coral-reef tract.** In: John DM, Hawkins SJ, Price JH (eds) Plant-animal interactions in the marine benthos. Systematics Association Special Publication. Vol. 46. Clarendon, Oxford, pp 213–233.

PRB (Population Reference Bureau), 2004. **World Population Data Sheet.** www.prb.org/pdf04/04WorldDataSheet_Eng.pdf

ROCHA, L.A. 2003. **Patterns of distribution and processes of speciation in Brazilian reef fishes.** J. Biogeogr. 30: 1161–1171.

SAZIMA, I. & SAZIMA, C. 2004. **Limpadores: saúde pública no mar**. Ciência Hoje 35: 60–63.

SAZIMA, I., MOURA, R.L. & SAZIMA, C. 1999. **Cleaning activity of juvenile angelfish, *Pomacanthus paru*, on the reefs of the Abrolhos Archipelago, western South Atlantic.** Environ. Biol. Fish. 56: 399–407.

STENECK, R.S. 1988. **Herbivory on coral reefs: a synthesis.** In Proc 6th Int. Coral Reef Symp., Townsville. J.H. Choat (ed). 1: 37–49.

SZMANT, A.M. 2001. **Coral reef algal community dynamics.** Coral Reefs 19:299–302.

WOOD, E.M. 2001. **Global advances in conservation and management of marine ornamental resources.** Aquat. Sci. Conserv. 3: 65–77.

No Take Areas for Demersal Fishery in Deepwaters of The Brazilian Coast

José Angel Alavarez Perez [1]

Introduction

Fishing for demersal resources in deepwaters off Brazil has boomed in the last six years as the result of an offshore expansion of the trawl fishing in the Southern and Southeastern regions to depths ranging from 200 to 500 meters, and the implementation of a government program directed at the occupation of the Brazilian Exclusive Economic Zone (EEZ). This program was based on (a) the chartering of foreign vessels equipped to operate in deep areas (Ministry of Agriculture, Livestock and Supply Normative Instruction-IN MAEP No 65 dated December 11th, 2002; and the Special Secretariat for Agriculture and Fisheries Normative Instruction-IN SEAP N. 4 dated October 8th, 2003) and (b) building, acquiring and converting vessels for the same purpose (National Program for Financing the Expansion and Modernization of the Brazilian Fishing Fleet - ProFrota Pesqueira, Law N. 10.849 dated March, 2004).

These initiatives have led to the establishment of new fisheries and fishing regimes, technological innovation in catching and processing fish and the opening of international markets to species formerly not exploited in Brazil (Perez *et al*., 2003). Conversely, they have aroused important expectations in regard to the development of new deepwater fisheries and the sustainable levels of exploitation of these new resources, namely, the monkfish (*Lophius gastrophysus*), the common hake (*Merluccius hubbsi*), the gulf hake (*Urophycis mystacea*), the silvery John dory (*Zenopsis conchifera*), the Argentine squid (*Illex argentinus*), the royal crab (*Chaceon ramosae*), the red crab (*Chaceon notialis*), the scarlet shrimp (*Aristaeopsis edwardsiana*), the giant shrimp (*Aristaeomorpha foliacea*), the purplehead shrimp (*Aristeus antillensis*) and the common octopus (*Octopus vulgaris*) (Perez *et al*., 2002; Perez *et al*., 2003; Perez *et al*., 2005; Perez & Pezzuto, 2006; Pezzuto *et al*., 2006a).

Deepwater fisheries development have met, on one hand, the interests of the fishing sector who wanted to gain access to these new and lucrative fisheries. On the other hand, such development has been further regarded by Brazilian authorities as a way to provide the necessary reduction in the fishing effort exerted over coastal stocks and to promote new economic horizons for the fishing industry. In that sense, targets and objectives were defined for managing such resources under the responsibility of the Ministry of Agriculture, Livestock and Supply (MAEP from 1998 to 2002) and the

[1] PhD, Centro de Ciências Tecnológicas da Terra e do Mar – CTTMar; Universidade do Vale do Itajaí – UNIVALI

Special Secretariat for Aquaculture and Fisheries of the Presidency of the Republic (SEAP/PR, since 2003). These goals were evaluated within the mandate of the Permanent Committee for the Management of Deepwater Demersal Resources (CPG/ Demersais, IN MAEP N. 2, dated January 30 2002; IN SEAP N. 5 dated May 27 2004) which relied in information produced by the Scientific Sub-committee made up of scientists active in the various aspects of demersal fishing in Brazil. During that period this Sub-committee generated concrete recommendations for regulating the emerging fisheries (SCC-CPG/Demersais, 2002; 2005) including:

- monkfish fishing with deepwater gillnets;
- fishing for deepwater crabs with traps;
- deepwater trawling on the continental slope in the south and southeast of Brazil;
- octopus fishing with pot traps and
- trawling for deepwater shrimp.

Some of these recommendations were incorporated into the Normative Instructions that established the management plans for the commercial exploitation of octopus (IN SEAP/PR N. 3 dated April, 26th 2005), of royal crab (IN SEAP-PR No 4 dated May 4th, 2005), of red crab (IN SEAP/PR N. 5 dated May 4th, 2005) and of the monkfish (IN MMA/ SEAP-PR N. 23 dated July 4th, 2004). In these plans, emphasis was laid on the innovative obligatory use of satellite tracking (VMS) and maintenance of observers on board during fishing operations. These instruments, in turn, made it possible to establish new management measures such as Total Allowable Catches (TACs) and No-take Fishing Areas"[2] (AEPs in Portuguese). These measures, presently at the implantation stage for the above mentioned fishing categories, have also been on the agenda of the CPG/ Demersais for regulating other categories of fishing in deepwaters, especially those involving the use of trawl nets (SCC CPG/Demersais, 2005).

Marine Protected Areas were shown to be powerful instruments not only for achieving targets of marine biodiversity conservation, but also for achieving the objectives of fishery management (Kelleher, 1999). Their effect on fishery stocks are equivalent to those obtained using conventional management instruments, namely, limiting the catch to an estimated fraction of the total stock. However, in more general terms, the use of protected areas appears to bring in results that are qualitatively superior to those obtained through conventional management (Roberts *et al*., 2005).

Marine Protected Areas or No Take Fishing Areas are spatial instruments for restricting fishing. Within the areas, the integrity of the marine ecosystems can be preserved as well as the natural structure of the communities and

[2] No Take Fishing Area or Zone are herein defined as those areas within which fishing is temporarily or permanently prohibited for the purpose of preserving levels of biological production and the population structures of the target species as well as the other components of the biotic community and the environment as a whole.

populations (age structure, spawning potential, genetic diversity etc.), including those populations that are liable to fishing exploitation outside of the areas' limits. Whenever the extension of the area under protection and the period of its implementation are compatible with biological demands of one or more of the managed stocks, the AEPs can prevent the complete collapse of those stocks, soften the impact of recruitment failures and provide centers of dispersion of juveniles and adults (spillover) thereby increasing the fishery production in the adjacent areas (Roberts *et al*., 2001; Gell & Roberts, 2003). Added to that is the mitigation of uncertainties that are inherent to the fishing system to which a great part of the failures of conventional fishery management have been attributed (Sumaila, 1998). The sources of uncertainty include (a) the dynamic nature of natural populations and the variability and complexity of the ecosystems they belong to, (b) the impact of fishing on those populations and (c) the difficulties that exist for monitoring and controlling catches and the fishing activity as a whole. In the fishing areas, those uncertainties can imply the collapse of the fishery associated to the inefficiency of the management strategy. In this sense, the very existence of the AEPs as a part of the overall set of management activities directed at a certain stock (also referred to as the Management Plan) serves as a way of doing comparative monitoring of density and life history patterns between patches that are subject to exploitation and those that are not (Perry *et al*., 1999).

Recently the Brazilian fisheries management model has been diagnosed as out of date and inadequate in regard to promoting sustainability in the use of the country's fishery resources (Perez *et al*., 2001). In this context, initiatives of a spatial nature including the dissemination of the potential of coastal and marine conservation units as instruments for fisheries management and the use of AEPs, have been highlighted as crucial instruments for the renovation of the said model. In managing deepwater demersal resources, these instruments have not only shown themselves to be technologically feasible, due to the satellite operated tracking systems programs and the presence of observers on board the vessels, but they are also desirable in environmental terms, bearing in mind the urgent need to protect deep ecosystems off the Brazilian coast and avoid the collapse of their resources which tends to take place more rapidly than those of the continental shelf (Perez *et al*., 2005). Indeed, the fragility of the deep benthic habitats and of their stocks of fish, crustaceans and mollusks has led to the conclusion that the AEPs may well be the only instruments cAEPble of allowing for the sustainable use of such resources (Roberts, 2002).

The present article describes the process of implanting the AEP for the monkfish and discusses new initiatives that have been proposed for other deepwater fisheries in the Brazilian EEZ. The arguments that are set out below are focused (a) on the impact of commercial fishing in deepwaters (> 100 meters deep), and (b) on the prospects for improving fishery management in such areas, by means of incorporating a clear vision of their ecosystems in management plans presently being drawn up for the main categories of deepwater fishing.

AEPs in the management of the monkfish (*Lophius gastrophysus*) stock in Southern and Southeastern Brazilian coast

Scientific background information

The monkfish (peixe-sapo in Portuguese) was the first fishing resource revealed to be sufficiently abundant to sustain profitable deepwater fishing activities that were being stimulated in the south and southeast of Brazil from 2000 on (Perez *et al*., 2003). This species was already known to be a valuable component of the catches obtained by double rig trawling along the coast of Rio de Janeiro, but biological information was scarce at the time and restricted to studies on systematics and distribution of the species, mainly conducted by exploratory fishing programs carried out in the waters of the Brazilian continental shelf and slope (Yesaki *et al*., 1976; Haimovici *et al*., 1994; Haimovici *et al*., 1997).

In 2000 the cycle of commercial exploitation of the species in Brazil began and reached a peak in the following year when 8,831 tons of fish were landed by more than 150 double rig trawlers belonging to fleets mainly based in Rio de Janeiro and Santa Catarina, and from 9 chartered Spanish trawlers operating with deepwater gillnets (Perez *et al*., 2002a; Perez *et al*., 2003; Perez & Pezzuto, 2006). In 2001, these fleets were responsible for 58% and 36% respectively, of the total monkfish production in Brazil and this involved a turnover of around US$ 20,700,000.00 in exports. The species was exploited throughout the southern and southeastern regions at isobaths of 100 to 600 meters with the Brazilian vessels concentrating their activities in the shallower waters (at 100 – 200 meters on average) and the fleet of chartered gillnet vessels in deeper areas (at 300 – 400 meters on average). This fleet progressively occupied areas further north and further south identifying particularly productive areas in topographical concavities along the edge of the continental shelf (Figure 1) (Perez *et al*., 2002a).

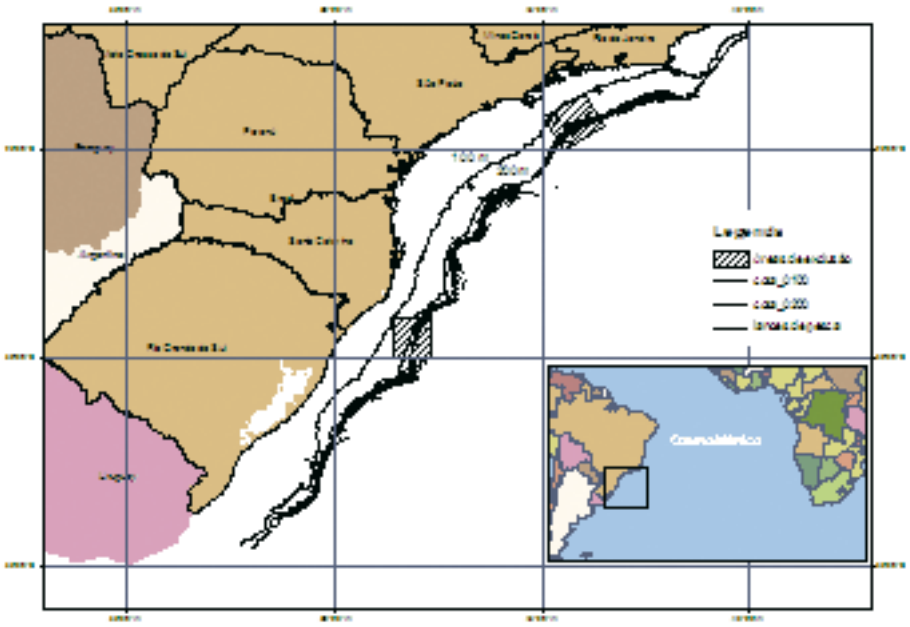


Figure 1 - Geographic distribution of fishing sets conducted by the chartered gillnet fleet off southeastern and southern Brazil in 2001 and 2002. Boxes represent the no take areas included in the monkfish management plan. Latitude and Longitude are decimal transformed.

Gillnet fishing was directed at the monkfish which represented the main component of the catch and the processing done. However, from 2001 to 2002 that activity further produced an amount of unintended catch which, considering the intensity of the fishing effort, may have led to a relevant impact on certain populations as well as on the deepwater ecosystems as a whole. Perez & Wahrlich (2005) analyzed catches of 14 fishing trips monitored by on board observers and 523 selected sets conducted between the latitudes 22°44' S and 34°21' S and longitudes 33°37'W and 52° 23'W and at depths of 132 to 607 meters. It was found that on average, the monkfish represented 40.7% of the number of individuals caught by the gillnets on each set. Among the species caught unintentionally the main representatives were crabs belonging to the family Geryonidae (mainly *Chaceon ramosae*) and spider crabs (Family Majidae), corresponding to 22.6% and 8.5% respectively, of the total number of individuals caught. The remaining 23% included both bony fish and cartilaginous fish like the beard fish (*Polimixia lowei*), the silvery John dory, the gulf hake, the common hake, the angel shark (*Squatina argentina*) and various rays (Family- Rajidae) (Figure 2). Crabs of the Gerionidae family and angel sharks were the main components of this bycatch that were retained and processed at sea (88.8 and 50.0% respectively). The discard rates were over 75% for all other bycatch species, including abundant and/or valuable species like the wreckfish (*Polyprion americanus*).

The study cited above considered that the impact of this developing fishery in the south and southeast of Brazil was concentrated on (a) deepwater demersal fish that are the targets of other directed fisheries (and already support high mortality rates) and (b) species that have a long life cycle with low chances for reproduction and low natural mortality rates (referred to here as k-strategists). In this context the royal crab deserved special

attention as it falls within both the situations described above. The species is the main target of a developing fishery using traps (covos) in the south of Brazil (Pezzuto *et al*., 2002). Furthermore, although its biology is still poorly understood, like all studied geryonids, the species is probably long lived, grows slowly ans matures after 5-15 years (Hastie, 1995). In 2001, a total of 1,770 tons were caught in the south of Brazil; 9.16% of the virginal biomass of 11,636.4 tons estimated for the entire fishery area (Pezzuto *et al*., 2002). According to these authors, the nine gillnet vessels in operation in 2001 were able to catch together around 30 tons of crab in a single month which was roughly the monthly production of one trap vessel. Considering that only two chartered trap vessels would suffice to catch the estimated MSY (Maximum Sustainable Yield) of 593.5 tons in a 12-month fishery for the species, then the unintentional mortality as caused by the deepwater gillnet fleet would essentially increase by 50% the proposed sustainable fishing effort level. Royal crab bycatch has been, therefore, an important element concerning the development of both deepwater gillnet and trap fisheries.

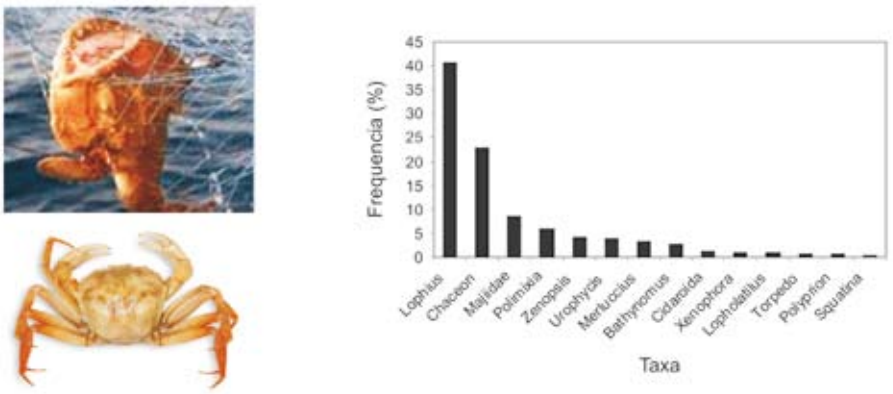


Figure 2 - Numerical composition of the catches obtained by the bottom gillnet fishing operations conducted off Southeastern and Southern Brazil during 2001 (adapted from Perez & Wahrlich, 2005). In the left column, photographs of the monkfish (*Lophius gastrophysus*) (upper) and the royal crab (*Chaceon ramosae*) (lower).

The most extreme situation found among the k-strategist species was that of the wreckfish, which is presently considered to be under threat of extinction as it has been the target of bottom long line fishing for several years in the south of Brazil (Peres & Haimovici, 1998; Haimovici *et al*., 1997). In this area, gillnet fishing directed at monkfish in 2001 may have produced the catch of 10,200 individuals of that species, around 90 tons (considering an average weight of 9 kg for the captured individuals) of which 96% were discarded on board thus characterizing an extreme example of 'high grading' (*sensu* Alverson *et al*., 1994). According to official statistics, this catch of wreckfish may have been the equivalent of around 15% of all the wreckfish landed in Brazil in 2001 (Ministry of the Environment 2003) showing that this species is another critical element to be considered in managing the monkfish fishery, especially in the south of Brazil where it concentrates and is highly vulnerable to the gillnet fishery.

The most frequently caught elasmobranch fishes unintentionally caught in the gillnet fishery for monkfish were longnosed skates (*Dipturus* spp.). Spurdogs (*Squalus* spp.), argentine torpedo (*Torpedo puelcha*), angel sharks, bramble sharks (*Echinorhinus* spp.), catsharks (*Scyliorhinus* spp.) and other species, were also significant. Although most of these species have only recently become vulnerable to multi-specific deepwater trawling (Mazzoleni & Schwingel, 1999; Perez *et al*., 2001, 2003; Perez & Pezzuto, 2006), the unintended mortality brought about by gillnets nets in 2001 may have led to a considerable impact on their sustainability given that (a) they are highly susceptible to being caught up by this kind of gear and (b) they have very limited ability to recover from population losses (Stobutzki *et al*., 2002). The bottom dwelling longnosed skates, for example, are regarded as particularly susceptible to mortality from fishing activities because they grow to a great size, mature very late and deposit a very limited number of egg capsules on the ocean floor (Brander, 1981). *Squatina argentina* is commonly found along the coast of Rio Grande do Sul throughout the year and is the least abundant of the three species captured in regional fishing (Haimovici *et al*., 1997; Mazzoleni & Schwingel, 1999). The voluminous unintentional catch provoked by fishing for monkfish in 2001, suggests that the development of that kind of fishing in the south of Brazil may produce a substantial increase in population mortality as well as introducing harmful effects on recruitment, bearing in mind that the reproductive cycle of the species may be longer than one year (Vooren & Klippel, 2005).

In general, catch rates of wreckfish, sharks and rays mentioned above, as well as of other k-strategists that were found in smaller numbers in the catches such as cetaceans, turtles and birds, were not strongly related with the intensity of the fishing effort but instead seem to have been more affected by the overlapping of the areas where such species are naturally concentrated and the area being fished for monkfish. On the other hand, catch rates of crabs of the Gerionideae and Majideae families were more directly correlated with the monkfish catches and the intensity of the fishing effort, and were explained by the spatial coincidence of the areas of concentration of both the target and non target species and by the high vulnerability of these organisms to the bottom gillnets (Figure 3). The study results suggested that minimizing unintentional mortality, not only of the large k-strategists but also of the small fish and the invertebrates, especially the crabs, could be achieved by introducing protected areas, at the northern and southern limits of the fishery area of the South and Southeast of Brazil, into the management plan elaborated for the monkfish fishery (Perez & Wahrlich, 2005; Perez *et al*., 2002b; SCC CPG/Demersais, 2002). Those AEPs would also be justified because they contribute towards preserving the integrity of the 'natural' structure of the monkfish stocks subjected, throughout the entire fishing area, to exploitation directed at both (a) juveniles by the Brazilian trawlers operating in the shallower waters of the species' distribution area and (b) adult fish by the chartered trawlers in the deeper waters (Perez *et al*., 2005).

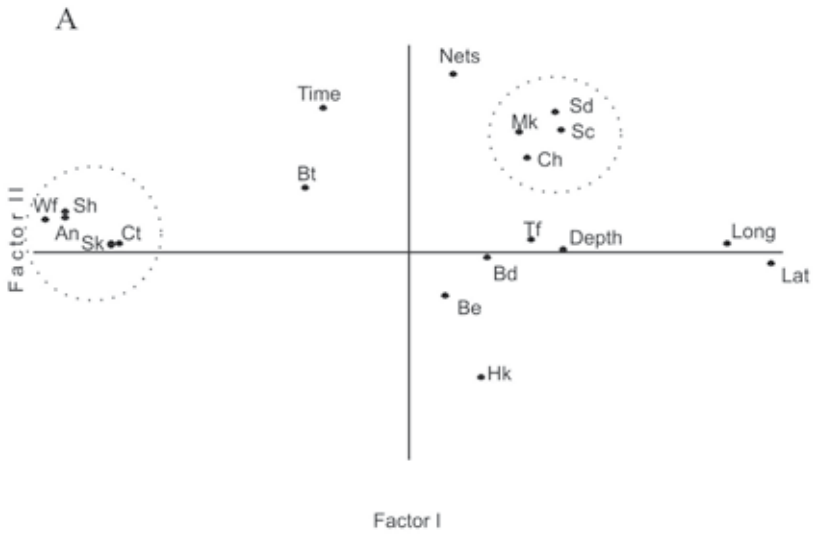


Figure 3. Spatial representation of correlations between bycatch components and geographic and effort variables scored by the first three factors obtained from the Principal Component Analysis. Tf, tilefish; Wf, wreckfish; Hk, argentine hake; Be, beardfish; Sd, silvery john dory; Sk, various skates; An, angel shark; Sh, various sharks; Ch, royal crab; Sc, spider crab; Bt, Bathynomus; Bd, seabirds; Ct, cetaceans. Dotted circles delimit two groups of monkfish bycatch species: on e composed of large species (Wf, Sh, An, Sk, Ct) strongly correlated to southern fishing areas and weakly correlated with fishing effort; the other group including crustaceans (Ch, Sc) and the silvery John dory associated with monkfish catches, effort and the northern fishing areas (adapted from Perez & Wahrlich, 2005).

Incorporating the AEPs into the management plan

Perez *et al*. (2002b), initially proposed the creation of a Protected Area for monkfish fishery to be located on the continental slope of the southern part of the state of Santa Catarina and the northern part of the state of Rio Grande do Sul (between 28° and 30° S and to the east of the 100 meter isobath). Besides the natural stock, the basic idea was to protect particularly sensitive k-strategist organisms, including the wreckfish, sharks, rays, birds, mammals and marine turtles (Perez & Wahrlich, 2005).

The proposal was analyzed by members of the SCC CPG/Demersais who inserted a second AEP located in the southeastern region between 23 and 25° S, into the structure of the proposed management plan so as to guarantee protection for smaller organisms of greater diversity being taken unintentionally in the gillnet fishing directed at the monkfish. The proposal was then formally submitted to the CPG/ Demersais accompanied by the following explanation (SCC CPG/Demersais, 2002):

"The creation of 'no take areas' where those vessels licensed for monkfish fishing are forbidden to operate, has, as its principal intention, the limitation of the proportion of the fishery stocks to be exposed to exploitation in 2003. The main object of this measure is to favor the preservation of the complete population structure of the populations within those areas and consequently, their potential for regeneration thereby incrementing the fishing yields in adjacent areas. In the same way, the measure will limit the

proportion of the populations of organisms presently being taken in the form of bycatch and limit their indirect exploitation in fishing operations directed at monkfish. Finally, bearing in mind that some of those unintentionally taken species are themselves the target of specific fishing operations (e.g.; the wreckfish),the measure may indirectly help avoid conflicts between rival fleets ..."

After two ordinary sessions of the CPG/ Demersais, in 2002 and 2003, the joint Normative Instruction IN -MMA – SEAP/PR N. 23 which sets out provisions in regard to the criteria and procedures for regulating monkfish fishing in waters under Brazilian jurisdiction was finally published. In Article 10 it includes the prohibition of monkfish fishing by licensed vessels inside the areas marked out by the two polygons presented in its Attachment II (Figure 1).

Implementation

With the publication of IN MMA – SEAP/PR No 23, the process of licensing vessels for monkfish fishing began. They had to be Brazilian vessels limited to eight in number as to comply with the estimates of the sustainable production of the stock (SCC CPG/ Demersais, 2002). By November 2005, four vessels had been authorized and began operations without however, complying with all the requirements set out in the Normative Instruction, especially those in regard to satellite tracking and on board observers (SCC CPG/Demersais, 2006). This has made any initiative for controlling monkfish fishing inside the AEPs unfeasible so that, effectively, it can be considered that they have not been implemented, and furthermore that the annual catch quota (1,500 tons) has been systematically exceeded ever since 2001. As a result, recent estimates of stock sizes indicate a biomass 50% smaller that that estimated in 2001 and the existence of a clear risk of overfishing (SCC CPG/Demersais, 2006). Part of the difficulty in complying with the rules set out in the IN MMA – SEAP/PR N. 23, stems from the failure to complete the regulatory instructions in regard to satellite tracking of the vessels or of the National On Board Observer Program. However, this has recently been achieved in the sphere of the SEAP/PR, MMA and the Naval Command after a two year-long process of elaboration (IN SEAP/PR - MMA – CM N. 2, dated September 4th, 2006). Another aspect of those difficulties has been attributed to the resistance shown by the fishing industry, particularly in regard to the installation and maintenance of tracking equipment and the remuneration of On Board Observers which is charged to the fishing companies (SCC CPG/Demersais, 2006).

AEPs in other deepwater fisheries

In 2005, the SCC CPG/ Demersais elaborated a regulatory proposal for slope trawling at depths from 250 to 500 meters which included the implementation of the same protected areas as proposed for the monkfish fisheries (SCC CPG/ Demersais, 2005). The proposal was put before the

CPG/Demersais and submitted to a process of discussion with the fishing industry. After that it became part of the proposal for the management plan of that fishery which was entering its final stages. The implementation of the AEPs for trawling had already been proposed previously however, in occasional management actions of the SEAP/PR like the one published in March 2006 (IN SEAP/PR N. 11, dated March 9th, 2006) which authorized the concession of provisional permits to pink shrimp (*Farfantepenaeus* spp.) trawlers in the south and southeast of Brazil. The permit allowed those affected by the closed season for pink shrimp to fish, during this season, for gladiator shrimp (*Plesionika longirostris*) and demersal fish along the edge of the continental shelf provided that the AEP's proposed for monkfish fisheries were respected. However, that measure demanded neither satellite tracking nor on board observers, making it effectively innocuous.

A second possibility for creating AEPs has been assessed in the light of an analysis of the process of occupying deepwater trawling areas in the northeast coast of Brazil. This process was conducted by one chartered trawler, which exploited small spaces suitable to trawl fishing on the tops of seamounts of the Ceará Elevation and the Fernando de Noronha Chain in 2002 (Perez, unpublished data). Due to the small areas involved and the probably high level of vulnerability of the target species, the black grouper (*Epinephelus nigritus*), the strategy consisted of the exploitation of various seamounts in sequence. On each one, the vessel carried out a concentrated intense fishing effort and then abandoned it when catch levels began to drop off (Figure 4). Depletion models constructed using the catch level data continually recorded in the case of two seamounts showed the presence of quite modest, highly vulnerable biomasses of black grouper (*Epinephelus nigritus*) (100 to 300 tons) on the tops of those formations. In only one month of continuous trawling, 60 to 85% of the biomass available on the seamount tops was removed. This strategy which was adopted to keep up the profitability of operations in deepwater environments, has been described in several tropical regions and is known as the "hit and run technique" (Grandcourt, 2003). It was concluded that trawling on seamount formations off the northeast coast of Brazil or in any other spatially restricted, deepwater marine environment, in Brazil's EEZ, is ecologically unfeasible and should be excluded, perhaps, by the implementation of protected areas or other instruments with the same effects. These conclusions supported formal recommendations of the SCC CPG/Demersais that served as the starting point for the process of formalizing AEPs in such environments, especially within the sphere of the National Protected Areas Program.

In addition to the initiatives highlighted above, recent contributions that describe the structure of the deepwater ecosystems of the Brazilian EEZ and the impact of commercial fishing on them have been highly useful (Lavrado & Ignacio, 2006; Amaral & Rossi-Wongtschowski, 2004; Bastos, 2004; and others). These contributions have formed a rich foundation of essential information to provide support for the new AEPs in the management plans of deepwater demersal fishing in Brazil.

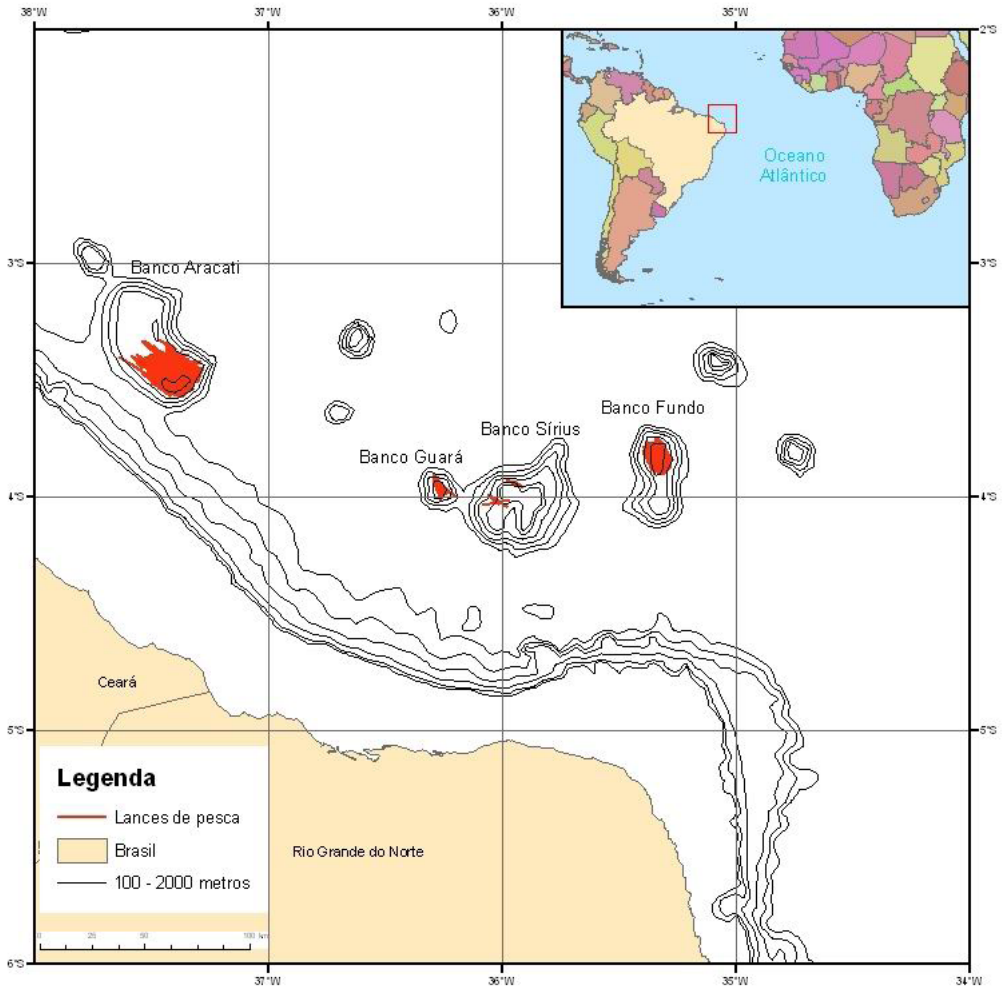


Figure 4 - Geographic distribution of bottom trawls conducted by one chartered trawler over the seamounts of the Ceará Elevation and the Fernando de Noronha Chain in 2002. Latitude and Longitude are decimal transformed.

Final Considerations

Ecosystem-based management actions such as AEPs have received solid scientific backing from the recent programs designed to evaluate fishing in the deepwaters of Brazil and acquire knowledge of their ecosystems. At the same time, the satellite tracking systems and the Program of On Board Observers developed with the fleet of chartered vessels in Brazil has shown that such measures are not only desirable in environmental terms, but are operationally feasible too. This reality has encouraged the insertion of AEPs in the process of participative decision making instituted by the Brazilian State to respond to the demands for management of the new deepwater fishing activities. The insertion of AEPs has already proved successful in the case of the Management Plan for the monkfish fishery and there are good prospects for them to achieve the same success in other fisheries presently undergoing regulatory processes. However, its effectiveness is still insufficient due to legal obstacles associated to the regulation of satellite tracking for vessels in Brazilian waters and the role of and functioning of the On Board Observers program. On top of that,

it must be added the reluctance of the Brazilian fishing industry to meet the expense of implementing these fishing control instruments. In general terms it can be stated that these instruments are conditioning factors for the use of AEPs in managing fisheries.

The process of implementing AEPs in deepwater areas of the Brazilian EEZ has been sluggish and clearly affected by (a) the evident fragility of the Brazilian State to agree to, implement and supervise fishery regulatory actions and (b) the fact that the industrial fishing sector, in spite of democratically participating in the approval of such actions at State level, have historically found ways of obtaining the tolerance of the authorities in regard to their non compliance. This would suggest that the results expected from AEPs will not be obtained over the short term which means that there will be substantial delays for positive results to appear after the measures have been implanted. This delay will tend to put the valuable deepwater fishing resources, known to be susceptible to high mortality rates, in an eminent risk of collapse (Roberts, 2002).

References

ALVERSON, D.L., FREEBERG, M.G., MURAWSKY, S.A., POPE, J.G., 1994. **A global assessment of fisheries bycatch and discards.** FAO Fisheries Technical Paper 330.

AMARAL, A.C.Z.; ROSSI-WONGTSCHOWSKI, C.L.D.B. 2004. **Biodiversidade bentônica da região sudeste-sul do Brasil – Plataforma externa e talude superior.** Sério Documentos REVIZEE – SCORE-SUL. 216 p.

BASTOS, M. 2004. **Invertebrados bentônicos capturados incidentalmente pela frota pesqueira arrendada no sudeste e sul do Brasil.** Trabalho de Conclusão de Curso de Oceanografia. Centro de Ciências Tecnológicas da Terra e do Mar. Universidade do Vale do Itajaí.

BRANDER, K., 1981. **Disappearance of common skate Raia batis fro Irish Sea.** Nature, 290: 690-692.

GELL, F.R.; ROBERTS. C.M., 2003. **The fishery effects of marine reserves and fishery closures.** WWF-US, 1250 24th Street, NW, Washington, DC 20037, USA.

GRANDCOURT, E.M., 2003. **The effect of intensive line fishing on the virgin biomass of a tropical deepwater snapper, the crimson jobfish (Pristipomoides filamentosus).** Fish. Bull, 101: 305-311.

HAIMOVICI, M.; CASTELLO, J. P.; VOOREN, C. M., 1997. Fisheries. In: Seeliger, U., Odebrecht, C., Castello, J. P. **Subtropical Convergence Environments. The Coast and Sea in the South-western Atlantic.** Berlin: Springer-Verlag, p. 183-196.

HAIMOVICI, M.; MARTINS, A.S.; FIGUEIREDO, J.L.; VIEIRA, P.C., 1994 **Demersal bony fish of outer shelf and upper slope off southern Brazil subtropical convergence ecosystem.** Mar. Ecol Prog. Ser., 108: 59-77.

HASTIE, L.C., 1995. **Deep-water geryonid crabs: a continental slope resource.** In: Ansel, A.D., Gibson, R.N., Barnes, M., (Eds.), Oceanogr. Mar. Biol. Ann. Rev.; 33,665. Hovland, M. & Mortensen, P.B. 1999. Norske korallrev og prosesser i havbunnen. John Grieg Forlag, Bergen, 155 pp.

KELLEHER, G., 1999. **Guidelines for Marine Protected Areas.** IUCN, Gland, Switzerland and Cambridge, UK, 107pp.

LAVRADO, H.P.; IGNACIO, B.L. 2006. **Biodiversidade bentônica da região central da Zona Econômica Exclusiva brasileira.** Série Livros 18. Documentos REVIZEE/ SCORE-Central. 389p.

MMA, 2003. Estatística da Pesca 2001. Brasil. **Grandes Regiões e Unidades da Federação.** Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis. Centro de Pesquisa e Extensão Pesqueira do Nordeste – CEPENE. 97 p.

MAZZOLENI, R.C., SCHWINGEL, P.R., 1999. **Elasmobranch species landed in Itajaí Harbor. Southern Brazil.** Notas Téc. FACIMAR 3, 111-118.

PERES, M.B.; HAIMOVICI, M., 1998. **A pesca dirigida ao cherne-poveiro, Polyprion americanus, (Polyprionidae, Teleostei) no sul do Brasil.** Atlântica, Rio Grande, 20: 141-161.

PEREZ, J. A. A.; WAHRLICH, R., 2005. **A bycatch assessment of the gillnet monkfish Lophius gastrophysus fishery off southern Brazil.** Fisheries Research, 72: 81-95.

PEREZ, J.A.A.; PEZZUTO, P.R. 2006. **A pesca de arrasto de talude do sudeste e sul do Brasil: tendências da frota nacional entre 2001 e 2003.** Boletim do Instituto de Pesca, São Paulo, 32(2) (no prelo).

PEREZ, J.A.A.; PEZZUTO, P.R.; RODRÍGUEZ, L.F.; VALENTÍNI, H.; VOOREN, C.M., 2001 **Relatório da reunião técnica de ordenamento da pesca demersal nas regiões Sudeste e Sul do Brasil.** In: Pezzuto, P.R.; Perez, J.A.A.; Rodrigues, L.F.; Valentini, H. Reuniões de Ordenamento da Pesca Demersal no Sudeste e Sul do Brasil: 2000-2001. Notas Técnicas da FACIMAR, 5: 1-34.

PEREZ, J.A.A.; WAHRLICH, R.; PEZZUTO, P. R.; LOPES, F. R. A., 2002a. **Estrutura e dinâmica da pescaria do peixe-sapo Lophius gastrophysus no Sudeste e Sul do Brasil.** Boletim do Instituto de Pesca, São Paulo, 28(2): 204-231.

PEREZ, J.A.A.; PEZZUTO, P. R.; ANDRADE, H.A.; SCHWINGEL, P. R.; RODRIGUES-RIBEIRO, M.; WAHRLICH, R., 2002b **O ordenamento de uma nova pescaria direcionada ao peixe-sapo (Lophius gastrophysus) no Sudeste e Sul do Brasil.** Notas Técnicas da FACIMAR, 6: 65-83.

PEREZ, J. A. A.; WAHRLICH, R.; PEZZUTO, P. R.; SCHWINGEL, P. R.; LOPES, F. R. A.; RODRIGUES-RIBEIRO, M., 2003. **Deep-sea fishery off southern Brazil: recent trends of the Brazilian fishing industry.** J. Northwest Atlantic Fish. Sci., 31: 1-18.

PEREZ, J. A. A.; PEZZUTO, P. R.; ANDRADE, H.A., 2005. **Biomass assessment of the monkfish Lophius gastrophysus stock exploited by a new deep-water fishery in southern Brazil.** Fisheries Research, 72: 149-162.

PERRY, R.I.; WALTERS, C.J.; BOUTILLIER, J.A., 1999. **A framework for providingscientific advice for the management of new and developing invertebrate fisheries.** Rev. Fish. Biol. Fisheries, 9: 125-150.

PEZZUTO, P. R.; PEREZ, J. A. A.; WAHRLICH, R.; VALE, W.G., 2002. **Avaliação da pescaria dos caranguejos-de-profundidade no Sul do Brasil.** Anos 2001-2002. Convênio UNIVALI/ MAEP (MAEP/ SARC/ DPA 03/ 2001; MAEP/ SARC/ DENACOOP/ 176/ 2002). Relatório Final. Itajaí, dezembro de 2002. 121p.

PEZZUTO, P. R.; PEREZ, J. A. A.; WAHRLICH, R., 2006. **Deep-sea shrimps (Decapoda: Aisteidae): new targets of the deep-water trawling fishery in Brazil.** Brazilian Journal of Oceanography, 54 (2/3): 123-134.

PRATES, A. P. L.; CORDEIRO, A. Z.; FERREIRA, B. P.; MAIDA, M., 2000. **Unidades de Conservação Costeiras e Marinhas de Uso Sustentável como Instrumento para a Gestão Pesqueira.** Anais. Campo Grande/MS, 05 a 09 de novembro de 2000. v. 2. pp 544-553.

ROBERTS, C.M., 2002. **Deep impact: the rising toll of fishing in the deep sea.** TRENDS in Ecology and Evolution, 17: 242-245.

ROBERTS, C.M.; BOHNSACK, J.A.; GELL, F.; HAWKINS, J.P.; GOODRIDGE, R., 2001. **Effects of marine reserves on adjacent fisheries.** Science, 294: 1920-1923.

ROBERTS, C.M.; HAWKINS, J.P.; Gell, F.R., 2005. **The role of marine reserves in achieving sustainable fisheries.** Phill. Trans. R. Soc., 360: 123-132.

SCC CPG/ Demersais, 2002. **Relatório da 1a Sessão Ordinária. Itajaí, SC, 11 – 13 de setembro de 2005.** Comitê Consultivo Permanente de Gestão dos Recursos Demersais de Profundidade – CPG/ Demersais. Secretaria Especial de Aqüicultura e Pesca - SEAP/PR.

SCC CPG/ Demersais, 2005. **Relatório da 3a Sessão Ordinária. Itajaí, SC, 14 – 16 de março de 2005.** Comitê Consultivo Permanente de Gestão dos Recursos Demersais de Profundidade – CPG/ Demersais. Secretaria Especial de Aqüicultura e Pesca - SEAP/PR.

SCC CPG/ Demersais, 2006. **Relatório da 4a Sessão Ordinária. Itajaí, SC, 3 – 5 de maio de 2006. Comitê Consultivo Permanente de Gestão dos Recursos Demersais de Profundidade – CPG/ Demersais.** Secretaria Especial de Aqüicultura e Pesca - SEAP/PR.

STOBUTZKI, I.; MILLER, M.; HEALES, D.; BREWER, D., 2002. **Sustainability of elasmobranches caught as bycatch in a tropical prawn (shrimp) trawl fishery.** Fish. Bull, 100: 800-821.

SUMAILA, U.R., 1998. **Protected marine reserves as hedges against uncertainty: an economist's perpective.** In: Pitcher, T.; Hart. P.J.B; Pauly, D. Kluwer, Reinventing Fisheries Management. Academic Publishers, London, pp. 303-309.

VOOREN, C.M.; KLIPPEL, S. 2005. **Biologia e status de conservação dos cações-anjo *Squatina guggenheim*, *S. occulta*, *S. argentina*.** In: Vooren, S.; Klippel, S. (Eds.) Ações para a conservação de tubarões e raias no sul do Brasil. Editora Igaré, Porto Alegre. pp: 57-82.

YESAKY, M.; RAHN E.; SILVA, G., 1976. **Sumário das explorações de peixes de arrasto de fundo ao largo da costa sul do Brasil.** Documento Técnico 19. SUDEPE-PDP/T, Rio de Janeiro, 37p.

Participative Management of Fishing Resources in the Amazon

Alzenilson Santos de Aquino [1]
Flavio Bocarde [2]
Natalia Aparecida de Souza Lima [3]
Mauro Luis Ruffino [4]

Introduction

In the 60's, the increasing demand for food, the introduction of new fishing technology (nylon lines, motor boats) and storage technology (ice factories) allied with the implementation of policies to stimulate the sector, and to the decadence of traditional crops like jute, led to an intensification of fishing in the floodplain regions of the Brazilian Amazon (Castro & McGrath, 2001). Since then the regulating of the region's fishing resources has been a controversial issue not only due to the centralized way in which it was originally implemented by government agencies but above all, due to its conceptual and philosophical basis which entailed a complete lack of participation of the resource users in any stage of management.

As time went by this technocratic model proved itself to be grossly inefficient, leading on one hand to the depletion of stocks of certain fish which because of their high economic value suffered more from the fishing effort, and on the other to social conflicts originating from disputes which multiplied throughout the Amazon region, over the use of fishing resources (Salati, 1983; Hartmann, 1989). As a way of meeting the demand for efficient administration and in order to defend the fishing environments from excessive exploitation resulting from the increased fishing effort, many riverside communities began, as early as the nineteen seventies, to develop and implement systems of participative community management.

In this way the so called Fishing Agreements began to appear, originally as private contracts between members of community associations and organizations and without any official validity, registered in the form of the minutes of a meeting or a list of signatures of a common-interest group. As the federal government deemed itself to be the only authority entitled to apply control measures, such private agreements were considered to be illegal.

---

[1] Biologist, Specialist in Sustainable Development, ProVárzea/Ibama representative in the pilot area of Parintins – aquino@jurupari.com.br
[2] Chemical Engineer, Masters in Geosciences, ProVárzea/Ibama geoprocessing technician – flavio-bocarde@yahoo.com.br
[3] Biologist, Masters in Botany, Environmental Analyst at Ibama – nataslimaibama@gmail.com
[4] Oceanographer, Masters in Biological Oceanography, ProVárzea Coordinator/Ibama – mauro.ruffi-no@ibama.gov.br

In recent years, the activities of extension work projects have permitted government administrative bodies and fishing communities to draw closer to one another so that in the 90's IBAMA began to debate the fishing agreements and finally to legalize the process for their implementation (Isaac *et al*., 1998). In 1997, in the region of Tefé, the first regional decree was made seeking to give legal support to the communities' initiatives (Pereira, 2004). In 1999 in the state of Pará, Ibama issued decrees regulating the fishing agreements in the region of the middle course of the Amazon river. Furthermore, Regional Fishing Councils were set up representing the sphere of negotiation among the various interested groups and aimed at guaranteeing an increased degree of democratization in the process for managing fishing resources in floodplain areas.

The center of convergence of the present article is the interaction between the traditional knowledge of the riverside communities and technical-scientific knowledge, in the planning and management of fishing resources in the flood plain lakes of the Amazon region and as a starting point for the management plans of conservation units. To illustrate this process, we present the experience of elaborating the Fishing Agreement of the Macuricanã Lakes Complex which lies within the Environmental Protected Area of Nhamundá, located within the municipalities of Nhamundá, and Parintins.

Protected Areas and Fishing Agreements

In the so called fishing agreement, communities of simple traditional fishermen (professionals and/or subsistence) and riverside communities jointly define specific prohibitions and regulatory norms thereby regulating fisheries in accordance with the interests of the local population and the sustainability of the resource.

According to the definition of Castro & McGrath (2001), fishing agreements are a set of rules established by the members of riverside communities that define rights of access to the use of fishing resources in a determined geographical area. The rules are firmly based on local ecological knowledge and monitoring is related to local social ethics.

In the view of Ibama, fishing agreements represent a set of specific norms stemming from consensual agreements among the various fishery resource users in a certain geographically defined area (DOU, 2003 - Official Gazette).

Considering that "protected areas are areas in which the fauna, flora, landscape, ecosystem and other natural occurrences that present some kind of ecological or scenic value, scientific, cultural or social importance and which due to their relevance require specific conservation and management measures in order to promote the rational management of their natural resources, enhance the value of the natural heritage, regulating interventions"; we can safely state that those areas with established fishing agreements duly regulated by Ibama are protected areas.

Study Area

The Macuricanã region (Figure 1) is located in the municipality of Parintins, and makes frontier with the municipality of Nhamundá and is part of the Nhamunda Environmental Protected Area, a state protected area created in 1990 and administered by the Amazonas Environmental Protection Institute (IPAAM). The EPA encompasses an area of 195,900 hectares of floodplain environment, 70% in Parintins and 30% in the municipality of Nhamundá. The unit does not have a management plan yet and the communities that live there are witness to the progressive degradation of the region's resources, among them, the fishing resources, given that the area is abundant in fish and attracts fishermen from nearby municipalities and also from some further places like Óbidos and Santarém in the west of Pará, among others.

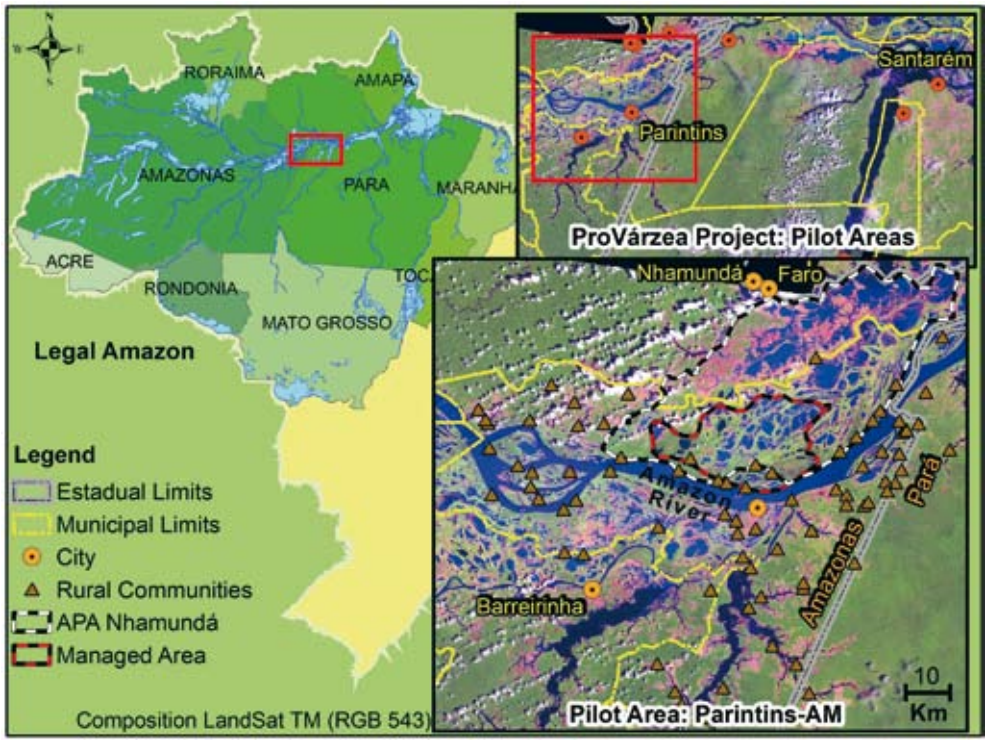


Figure 1 - Location of the study area.

There are seven communities that have a direct participation in the Macuricanã Fishing Agreement with over 310 families making a total of 1,666 inhabitants (Table 1). The environments to be found in the Macuricanã Complex are lakes, narrow channels, flooded forest, bays, riverside flood plain areas which during the dry season with the lowering of water levels in the rivers and are used mainly as pasture land for cattle. As the region is a floodplain area, its great natural vocation is for fishing. Its fishing environments are exploited by the local communities as well by fishermen from other regions. The riverside flood plain areas are characterized by the annual flooding periods and this seasonality determines the dynamics of the lives of the riverside populations. According to the flood or drought of the rivers the productive activities are intensified. During the dry season, farming and cattle rising become feasible due to the formation of areas of

natural pasture and exposure of areas for planting. Extractivism of forest products is also favored as well as fishing which becomes more intense during this period.

Table 1 - Numbers of community residents in constructing the Macuricanã Regional Fishing Agreement.

Community	N° of Families	N° of People	N° of Men	N° of Women	N° of Children
Brasília	49	315	114	81	120
Catespera	16*	79*			
Divino Espírito Santo	90	528	180	119	229
São Francisco	27	160	50	35	75
São José	50	259	79	65	115
Santa Rita do Boto	30	153	50	35	68
São Sebastião do Boto	48	172	75	44	53
Partial Total*	**310**	**1666**	**548**	**379**	**660**

Source: Parintins Municipal Health Secretariat, October 2005, excepting São Francisco communities where data was obtained from community leaders. * Data from the Community Statistic Census (ProVárzea, 2002).

Methodological Approach

The IBAMA regional office in Parintins and the Floodplain Natural Resource Management Project (ProVárzea), has been stimulating discussion and supporting the elaboration of fishing agreements as complementary instruments for regulating and managing fishing resources with a view to contributing towards the solution of social conflicts and regulating the exploitation of fishery stocks in the municipality.

According to Ruffino (2005), 59% of fishing production in Parintins comes from the region's lakes and furthermore, the production of the Macuricanã region has been falling in the last few years: 1,016 tons in 2001, 694 tons in 2002, 527 tons in 2003 and 288 tons in 2004.

Support for elaborating fishing agreements grew more intense from 2003 on, after the publication and distribution of Ibama Normative Instruction - IN nº 29/2002 and the distribution of the informative folder "Fishing Agreement: the community in charge" (Oviedo et. al., 2003) which together with the contribution represented by the work of Voluntary Environmental Agents (AAVs) in the communities, greatly increased the demand for local Ibama team members to take part meetings on the issue. The IN 29 gave a new impulse and direction to the debate on fishing agreements as it offered the possibility of acquiring a legal mechanism for this kind of management model which is founded on an association between the knowledge and participation of traditional communities and technological-scientific knowledge. The folder, which contains information on the IN 29/2002 set out in easily understandable terms has played an important role in disseminating information on the theme and has propelled the debate into various regions of the municipality.

In addition to the criteria and procedures set out in the IN 29, leading questions were used to facilitate the discussion and elaboration of the fishing agreement, namely:

- Who are the social role players (groups) that should be invited to the debate? The answer to this question is fundamental to an understanding of the interests and relations that exist among the different actors in the process. Because a Fishing Agreement involves social, economic and environmental issues, and all of them must be examined in the light of the law and of the institutions that execute public policies, it is important that the proposal should be developed in the most open and participative way possible.

- What is the reality of the region where the Fishing Agreement is being proposed? In answering this question a participative diagnosis can be made of the situation, that is to say, an understanding of the problems and the potential (social, environmental and economic), to be able to better direct the decision making. And to answer this question more properly, other more detailed questions were elaborated namely: How do the people in the area where the fishing agreement is being proposed make their living? What is the reality of the environmental situation of the area for which a fishing agreement is being proposed? Is the environment preserved or degraded? How is fishing carried out in the area for which an fishing agreement is being proposed? Is it more subsistence fishing or commercial, traditional or industrial? Is there sport fishing? What is (are) the reason (s) for establishing a fishing agreement in the area?

It is important to point out that this diagnostic process is continuous throughout the process, seeking to monitor the need to include new actors and new issues in the debate. The discussions have stimulated an integrated approach to the matter, that is, they have motivated the perception that fishing is related to several other factors which should be included in the debate (deforestation and clearing, occupation of the areas by cattle, markets, legislation, etc.), for which it is also necessary to seek ways of regulating. Furthermore, the spaces for debate have been made use of to inform and point to alternative routes and examples of other successful participative management projects, widening the visions of possibilities for use of the resource which go far beyond fishing.

- What is the proposal for the area? Answering this question initiates an extremely important phase which is the presentation of proposals by the participants.

In order to facilitate the presentation of proposals and the participation of those involved, especially during the inter-community assemblies, a standardized sequence of themes was used and were discussed in the following order:

First moment: which lakes or fishing spots (creeks, connecting channels, secondary courses of rivers) should be included in the fishing agreement and what category of use should be attributed to them. Parintins has used the following model:

- Procreation lakes and fishing spots (spawning areas): destined for the reproduction of fish; fishing in them is prohibited during certain periods which are also to be established in the terms of the fishing agreement.
- Maintenance of lakes and fishing spots: destined for subsistence fishing (fish to be consumed and any extra to be commercialized).
- Lakes and fishing areas for commercial exploitation: destined for commercial fishing and rules may be established for their use.

Second moment: types of fishing equipment and boats that are prohibited;

Third moment: quantity of fish allowed to be caught;

Fourth moment: forbidden species, should that be the case.

It is important to have in mind that although this procedure has been adopted in the present case, these stages should be reasonably flexible in regard to the time, needs and opinions of the groups involved.

It must also be stressed that at this stage a high value is attributed to traditional knowledge, that is, the wisdom of the people that know the region's environment very well but obviously also allowing scientific and technological knowledge to be added to theirs. Respecting the worth of the various categories of knowledge has enriched the debates and aroused feelings of importance and responsibility in those involved in the construction of the fishing agreement and in complying with its terms.

Fifth moment: elaboration of the draft proposal of the Fishing Agreement.

In the draft proposal, information on the legislation that supports the elaboration of Fishing Agreement was included, as well as considerations on the need to regulate fishing in the area and the proposed fishing agreement itself, organized according to the topics.

In Parintins, the draft of the Macuricanã Fishing Agreement was presented, together with a report on the entire process of its elaboration, at a meeting held in the municipal council chamber where, in addition to the presence of councilors, community members and representatives of various governmental and non governmental entities were present. During the meeting the final adjustments were made and the proposal was then approved.

After that, all the documents (reports, minutes of meetings, maps etc.) were organized and forwarded to Ibama. On August 24 2006 the Macuricanã Fishing Agreement was published in the Union Official Gazette and duly came into force.

Community and Inter-community Meetings

Official discussions began at the beginning of 2003 in the form of community meetings requested by the communities themselves. At the meetings, a team made up of staff members of Ibama, ProVárzea, the Parintins Rural Workers and Family Farmers Union and of the Z-17 Fishermen's Organization explained aspects of the legal procedures for elaborating fishing agreements and the legislation governing fishing and fisheries then in force which was based on the guidelines set out in IN 29/2002 which establishes the norms for "defining clear criteria that permit the regulation of such Fishing Agreements as a complementary regulatory instrument and as a way of preventing environmental and social harm".

Some of the communities had prior experience with community agreements that established the rules for using certain nearby lakes but they had been largely disregarded by the very community members themselves and by fishermen from outside (especially from the state of Pará).

Based on the course taken by the initial discussions in the communities where accounts were given of common problems in the use of the region's fishing resources (fishing with large dragnets, wasting the catch, catching forbidden species, failure to respect closed seasons), the decision to draw up a regional agreement was made. In the agreement the lakes included did not necessarily have to belong to the same lake systems. Although a few of the lakes included in the agreement did not belong to the Macuricanã Lakes Complex, the idea was that the communities should integrate more and strengthen their position so that the agreement proposal might have a greater outreach, thereby avoiding possible conflicts with communities that by chance may have been left out of it. On that occasion it was also stressed that in spite of the prospect of the agreement's taking in a large number of lakes, at the monitoring stage of the agreement, control could be greatly facilitated by partnerships established and consolidated among the communities and between the communities and the other bodies involved. Furthermore, it was suggested that it would not be interesting to fragment the discussion process by establishing various agreements and later specific normative instructions for each one because the problems are not restricted to one community or another.

After the individual community discussions had been held, 15 inter-community assemblies were held with an average attendance of 63 participants per assembly and whenever it proved necessary or was requested, other community meetings were held, usually to clarify issues and mediate conflicts stemming from the debates.

At the inter-community assemblies the proposals of each represented community were debated until a consensus was achieved. In only two assemblies it was proven necessary to have the recourse of voting to define items of the proposal. The communities themselves were responsible for drawing up the minutes of the assemblies and forwarding them to Ibama.

Each community elected its representatives that formed a committee in charged of motivating community members for the debate, contributing towards the mobilization (by means of printed invitations and disseminating awareness) of all the groups involved in the process (community members, local land owners, organizations and fishermen) in addition to representing their communities at the inter-community assemblies.

It was sought to promote the strengthening and autonomy of the committee in conducting the process and indeed, on some occasions it was the committee that conducted the inter-community assemblies.

With a view to guiding and standardizing the discussions and the formulation of the communities' proposals, a guide for the discussion of the proposals for the Fishing Agreement (Annex I) was jointly elaborated with the representatives of the communities involved. In spite of the weaknesses that were detected during its use, the guide was important in orientating the initial discussions on the agreement and facilitating the presentation of proposals at the assemblies.

Participative Mapping

Faced with the uncertainty that existed in regard to the vast group of bodies of water that came up for discussion in the meetings on the Macuricanã Fishing Agreement, with different names being used for the same lake, or widely separated lakes being called by the same name, it became clear that there was a need to carry out detailed mapping of the system of lakes in question. This stage of the work was important in clearing up doubts that existed as to the location of lakes mentioned in the meetings as well as to reveal the exclusion of some important large bodies of water from the discussion. These excluded bodies of water were located in the very same geographical space covered by the list of locations set out in the original proposal, however, they had not been inserted in the terms of the agreement. Added together the excluded bodies of water represented a considerable gap in the agreement under discussion. From that moment the whole process had to be revised so that the mapping that was carried out eventually changed the direction of the fishing agreement initially proposed. During the first stage various satellite images were analyzed both on dry season conditions and flood season to get a wide vision of the area's seasonality (see Annex II). Due to the great number of lakes presented in the lists drawn up by the communities, it was decided to use the dry season images as the basis for identifying the lakes as they offered a clearer delineation of the bodies of water. Among all the images available, a LandSat TM image of the dry season 2002/2003[5] was selected to serve as the reference and which therefore is the physical base on which the information was distributed. The image did not merely serve as a background for the organizing of data

[5] Mosaics at low water 2002/2003: Images 2002, obtained by the sensor ETM+ Landsat 7 bandas 3,4 e 5; Image 2003, obtained by the sensor TM Landsat 5 bandas 3,4 e 5. Source: Univesity of Maryland (USA).

but also allowed for the inference of other information that lent support to the development of other stages of the work, as for example, elaborating the routes for fieldwork excursions, pre-identifying and locating the most impacted areas, differentiating vegetation categories among other factors.

Using a print-out of the satellite image as a basis for discussion, a meeting was held with the participation of fishermen, community members and Ibama staff, to plan the fieldwork At the meeting which was held at Ibama's office in Parintins, the work area was divided into three sectors taking into account operational expenses and itineraries, these sectors became in fact, the three stages planned for the fieldwork.

In spite of all the foreknowledge of the size of the area to be worked in, it was only during subsequent stages of coming and going to the field that it became apparent that the initial division into sectors had been inadequate and the complex structure of the distribution of the lakes made it impossible to put into practice the original plan and it was at that exact moment that the criterion of "traditional knowledge" came into its own and revealed its true worth. Thus in using intuitive itineraries adopted by the local residents, technical observation had to hitch a ride from the traditional knowledge of local populations. The field incursions showed themselves to be entirely satisfactory and the data collected in the field was transferred to the base and after having undergone preliminary analysis, material from new investigations was added to correct small lapses in the coverage of the mapping work (Figure 2).

Figure 2 - Strong presence of former fishermen and local residents during the fieldwork.

Given the great diversity of Amazonian riverside floodplain areas, the work of mapping did not only take into account the lakes existing in the region but also, channels, inlets, creeks and streams, low flatlands and other hydric systems were considered as fishing spots. The mapping did not merely

consist of the visits of the team to these fishing spots and their subsequent geographical referencing using GPS technology (Global Positioning System) but also of collecting information from the participants in the activity and the elaboration of an inventory with photographic records of the region.

Later, with these spots duly spaced on the satellite image, the process of vectorizing the bodies of water that make up the Macuricaná lakes complex was begun and the associating of the polygons thus created with names used for the corresponding fishing spots. In this way a shape file[6] was crated made up of polygons that represent the spatial location of the bodies of water and associated to a database with all the information on the names used for them, the micro-region they belong to, the basic characteristics of the fishing spot (e g. abundant fish, if it dries up in the dry season, the occurrence of any very evident environmental damage), photographs and videos taken in the field, and their classification in regard to category of use in terms of the fishing agreement.

While the field excursions were going on, other meetings were held with the specific aim of discussing the work of mapping the lakes, clearing up doubts that perhaps still existed over the names given to the lakes and making known the results obtained up till then as well as discussing the agreement itself. These meetings were thought up to bring face to face, the various actors responsible for the mapping process. Seven communities (about 1,700 people), a huge number of fishermen and residents scattered around the region: a perfect situation for innumerable and repeated names for the lakes to exist or different names for the same spot. Incessant discussion went on right from the start of work in February until the middle of October 2005 and some of them were inter-community discussions held in the communities while others were held at Ibama headquarters.

Due to technical limitations, discussions of the mapping with the communities were mostly based on preliminary printed maps with the names being given to the lakes and their respective attributions in terms of the fishing agreement came up for discussion and there was always insistence on clarifying the reasons behind the classifications being made.

The meetings held at Ibama headquarters and in some of the more well-structured communities were able to make use of audiovisual equipment, which effectively enriched the discussions (Figure 3). By manipulating satellite images taken during different periods and consulting the database, all of which were operated using ArcGIS software, doubtful information was promptly checked and any new information was fed directly into the database. It could be said that this was one of the most successful moments of all the mapping work that has been narrated above.

[6] File Extension indicative of geoprocessing software.

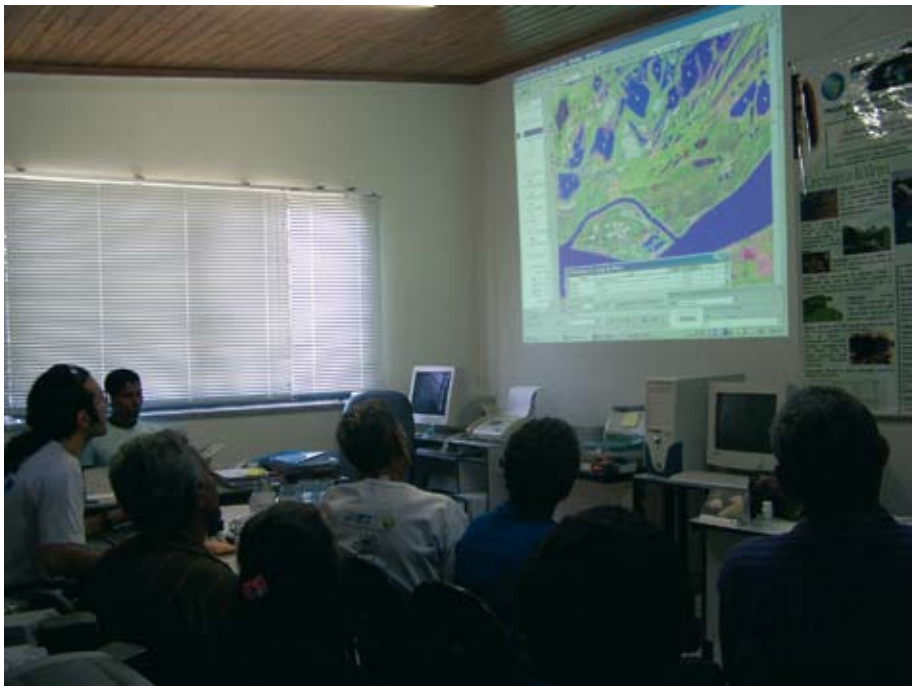


Figure 3 - Audiovisual technology being used in the discussions in the communities and at Ibama headquarters.

Altogether 94 lakes were mapped of which 27 were lakes for commercial fishing, 45 for subsistence fishing and 22 for spawning and reproduction, totaling 14,200 hectares, equivalent to 7.25% of the total area of the Nhamundá Protected Area (data based on dry season satellite image for 2003) (Figure 4).

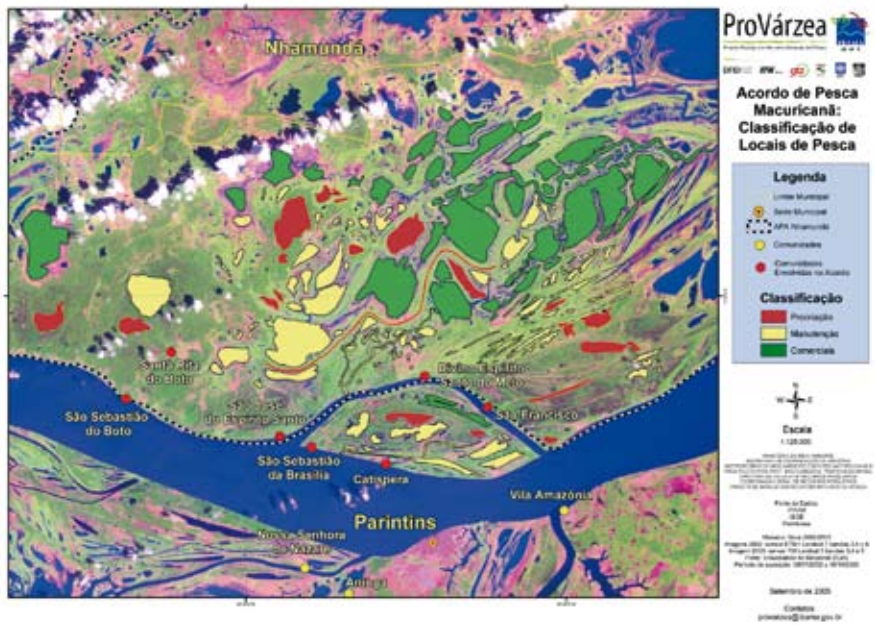


Figure 4 - Map showing locations of lakes forming part of the Macuricaná Region Fishing Agreement, by category.

Results

After roughly two years of discussions the Fishing Agreement Proposal was finally defined at an inter-community assembly with the participation of representatives of all the communities and entities involved.

The above mentioned proposal was re-written in the form of a draft document and presented at a special session of the Parintins Municipal Council and after some adjustments was duly approved.

The meeting in the Council Chamber was intended to disseminate awareness of the information that had been produced and the methodology used in the process of elaborating the Fishing Agreement (especially in regard to participative methods and geoprocessing techniques) and socialize the results of that process in the sphere of the population at large and that of the municipal authorities. Representatives of civil society organizations, the communities involved in the process, public authorities like the Office of the State Public Prosecutor, Ibama, Z-17 Fishermen' Organization, Rural Workers Union, Municipal Secretariat for Production and Supply, Coordinating Body for the Environment of the Parintins Municipal Environment, Culture and Tourism Secretariat, and of the Fome Zero (No Hunger) Program, all participated in the special session.

So after three years, IN nº 113 was finally published on August 24 2006, duly regulating the Fishing Agreement and establishing the Management categories and rules for the use of the Macuricanã lake complex (Annex III).

Discussion

The fishing agreement may have a direct effect in improving the living conditions of communities in the riverside floodplain areas and in conserving the ecosystem. In addition to seeking to regulate the fishing sector in the area in question, the process has contributed towards involving and organizing the communities in the quest for participative integrated and responsible management of the use of natural resources. However, Goulding & Ferreira (1996) have warned that the floodplain formations, the rivers and channels and the estuary are the three main components of the ecosystem that sustains the Amazonian fisheries and that each one of them sustains hundreds of species of fish using various habitats for acquiring energy, seasonal reproduction and protection from predators. And bearing in mind that it is the flooded forests, floating vegetation, phytoplankton and periphyton that sustain the tropic chains of the Amazonian fisheries, the conservation of these habitats has a significant role to play in ensuring the sustainability of the fisheries.

Oviedo & Ruffino (2003) note that in spite of being very promising, the regime of participative management proposed by the riverside floodplain communities still has to face up to some critical aspects of a practical and

conceptual nature. In regard to the practical aspects, the first question is whether the restrictions imposed on fishing techniques, controlled fishing periods, and so on, will be sufficient to conserve the resource. Is it necessary to restrict the fishing effort limiting the right to use to a restricted number of fishermen? If the answer is yes, what is to be done with the "rest" of the fishermen? This leads to another important question; how can the success of the management systems be evaluated? How can the social and environmental effects of the measures be predicted?

To respond to such questions, ProVárzea has developed a participative monitoring and evaluation system for the impacts of the community management. In this manner, data collecting on catches has begun (catch per unit of fishing effort and average size of fish) at the community level, that is, the level of direct users of the resource taking part in the monitoring process.

Another issue to be discussed is the efficacy of the community management model, which has a limited geographical outreach, in conserving stocks of migratory fish which are distributed in much vaster regions than encompassed by the local measures. Fish that migrate and use different environments in the course of their lives ought to be dealt with in a macro-regional perspective (Ruffino *et al*., 2000) and the discussions should therefore, involve various regions and would require much higher levels of social organization.

And lastly, the ability of the communities to see that the rules of management are complied with must also be questioned. Obeying the rules is much easier when the infractions involve fishermen from "outside" but it is much more difficult when the offences involve members of the community itself. The implementation of the program of Voluntary Environmental Agents who are duly registered by Ibama, has made a positive contribution in this direction. However this should not excuse the public authorities (environmental bodies in the various spheres of government) from their responsibilities in the process of environmental monitoring and inspection to guarantee compliance with the established norms and ensure the reliability of this particular management model.

For all those reasons, true knowledge and assessment of the impacts that the community management measures may have on fishery stocks and therefore on the income produced by fishing will be decisive for keeping up the efforts made in control and conservation activities. Thus, a better understanding of the consequences and implications of such forms of organization will allow an analysis of its conditioning factors and above all, contribute towards the quest for standards and models capable of being replicated in other regions of the country.

In addition, the process of intensification of fishing and local organizational development has led to the appearance of a new model of shared management. However, establishing a fishing agreement has not meant

merely a response to ecological changes (restricting the fishing effort and increasing the productivity of the lakes) but also a claim on the right of access to common property resources.

Due to the different perceptions and interests of the parties involved, the result of implementing a shared management system naturally leads to conflict. That is why it is important to bear in mind that participative management is yet another arena for negotiation where the participation and solution of conflicts are enacted. This political process is slow and full of obstacles, participative management is a fragile strategy where each participant needs to compromise a little bit in order to increase his part in the negotiation. Learning is therefore the most important process whereby information is accumulated, possibilities are tested, and alternatives are selected according to the results obtained.

References

CASTRO, F. de & McGRATH, D. 2001. **O manejo comunitário de lagos na Amazônia.** Parcerias Estratégicas, (12):112-126.

GOULDING, M. & FERREIRA, E.G. 1996. **Pescarias Amazônicas, Proteção de Habitas e Fazendas nas Várzeas: Uma Visão Ecológica e Econômica.** Relatório Banco Mundial. Brasília: BIRD. 35p.

HARTMANN, W. 1989. **Conflitos de pesca em águas interiores da Amazônia e tentativas para sua solução.** pp. 103-118. In: Diegues, A.C. (ed.) III Encontro de Ciências Sociais e do Mar no Brasil. IOUSP. Ford Foundation. USP São Paulo.

IBAMA. 2003. **Instrução Normativa nº 29.** Diário Oficial da União. Seção 1. 01/01/2003.

ISAAC, V.J.; RUFFINO, M.L. & McGRATH, D. 1998. **In search of a new approach to fisheries management in the Middle Amazon.** In: Guinn II, T.J.; Funk, F.; Heifetz, J.; Ianelli, J.; Power, J.; Schweigert, J.; Sullivan, P. & Zhang, C.I. (eds). Fishery Stock Assessment Models. Alaska Sea Grant College Program, University of Alaska Fairbanks, AS-SG-98-01: 889-902.

OVIEDO, A. & RUFFINO, M.L. 2003. **Addressing Common Demands of Community Fisheries in the Brazilian Amazon.** In: The Second International Symposium on the Management of Large Rivers for Fisheries: Sustaining Livelihoods and Biodiversity in the New Millennium. Phnon Penh. Kingdom of Cambodia. February 11-14. www.lars2.org/unedited_papers/unedited_paper/Oviedo.pdf.

OVIEDO, A. VASQUEZ, R. & RUFFINO, M.L. 2003. **Acordos de Pesca: A comunidade é quem faz.** Brasília: WWF Brasil/Ibama/ProVárzea. 24p.

PEREIRA, H.S. 2004. **Iniciativas de co-gestão dos recursos naturais da várzea. Série Documentos Técnicos nº 02.** Manaus: Ibama/ProVárzea. 132 p.

RUFFINO, M.L. 2005. **Estatística Pesqueira do Amazonas e Pará - 2002.** Manaus: Ibama/ProVárzea. 84p.

RUFFINO, M.L. & ISAAC, V.J. 1994. **The fisheries of the Lower Amazon: Questions of management and development.** Acta Biologica Venezuelica 15(2):37-46.

Salati, E. (Ed.) 1983. **Amazônia: Desenvolvimento, integração e ecologia.** CNPq / Editora Brasiliense.

Annex I

Floodplain Natural Resources Management Project
Ministry of the Environment of Brazil – MMA
Brazilian Institute for the Environment and Renewable Natural Resources – IBAMA
Pilot Program for the Protection of Brazilian Tropical Forests – PPG7

COMMUNITY: _____

DATE: _____/_____/_____

Being fishery the main food and financial resource for families from our communities and considering that that resource has become more and more rare in our lakes, there is the need to think about proposals for the elaboration of Fishery Agreement s for those who might use the lakes within our region. The Fishery Agreement is one of the alternatives to diminish the depletion of lakes and also to guarantee both the survival of many fish species in our region and the income support and food supply to many families, and last but not least to preserve those resources to future generations.

This Plan aims to give orientation and a lso patronize the discussions about Fishery Agreements at the communities.

Observation: In a Fishery Agreement, there are different uses for lakes:

- **Fish Reproduction Lakes:** in those lakes, fishery is forbidden dur ing a period established by the Agreement.
- **Maintenance Lakes:** for subsistence fishery (feeding).
- **Commercial Use Lakes**: for commercial fishery, with the possibility of ru ling their use.

The following questions must be answered collectively, during communal meetings.

Fill the gaps with information about which lakes must be part of the Fishery Agreement, including its use category (reproduction, maintenance or commercial use):

Name of the Lake	Use Category (reproduction, maintenance or commercial use)

General explanation for choosing the lakes mentioned before:

Which fishery devices the community suggests to be used at the lake s mentioned above, observing the environmental law.

Name of the Lake	Suggested Devices – Kind, size, etc.

Other Suggestions:

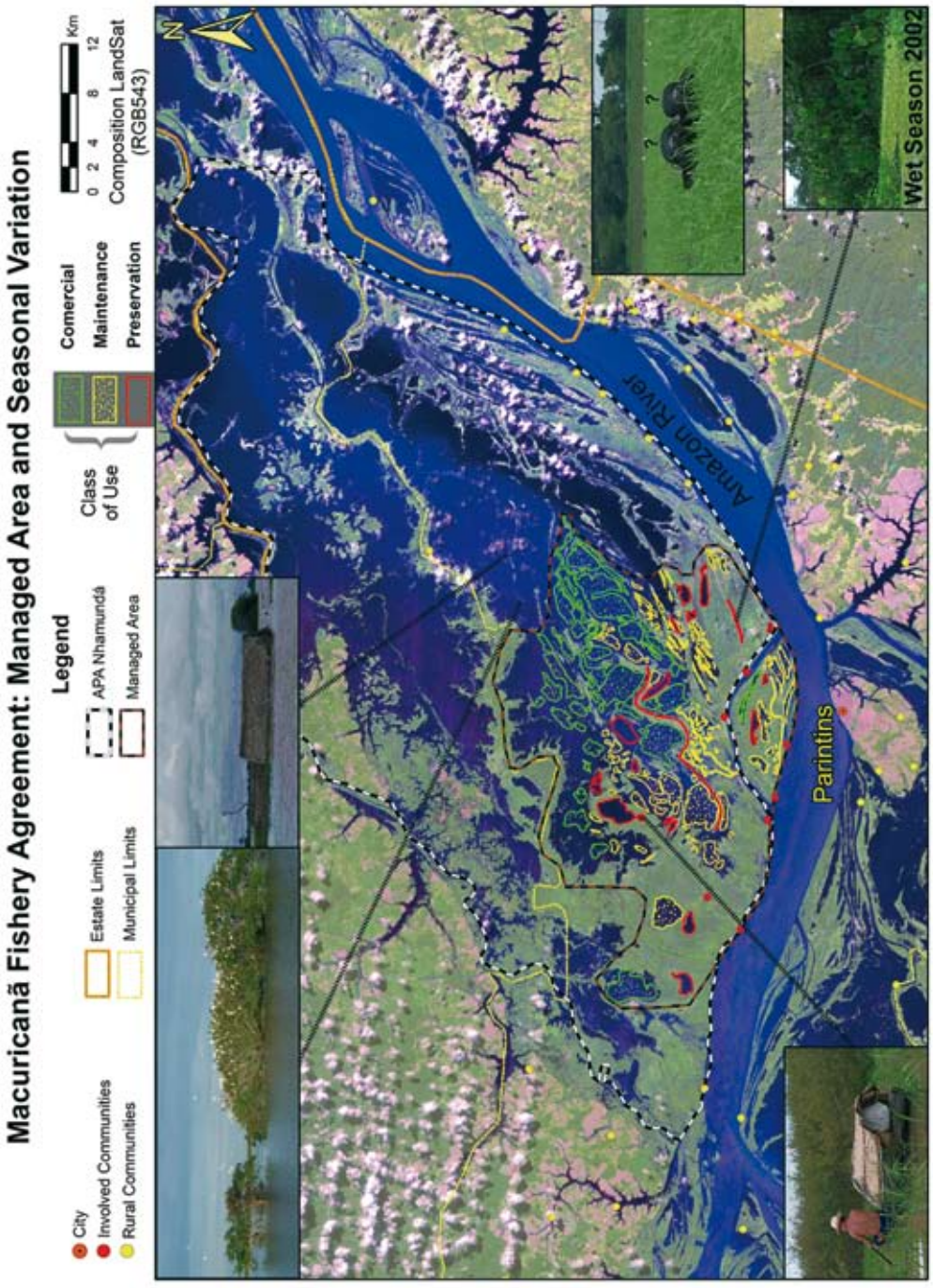
What the community suggests about the kind of boats and the amount of fish that should be caught from the different lakes' categories.

Lake Category	Amount of fish at an established period	Kind of boat allowed
Fish Reproduction Lake		
Maintenance Lake		
Commercial Use Lake		

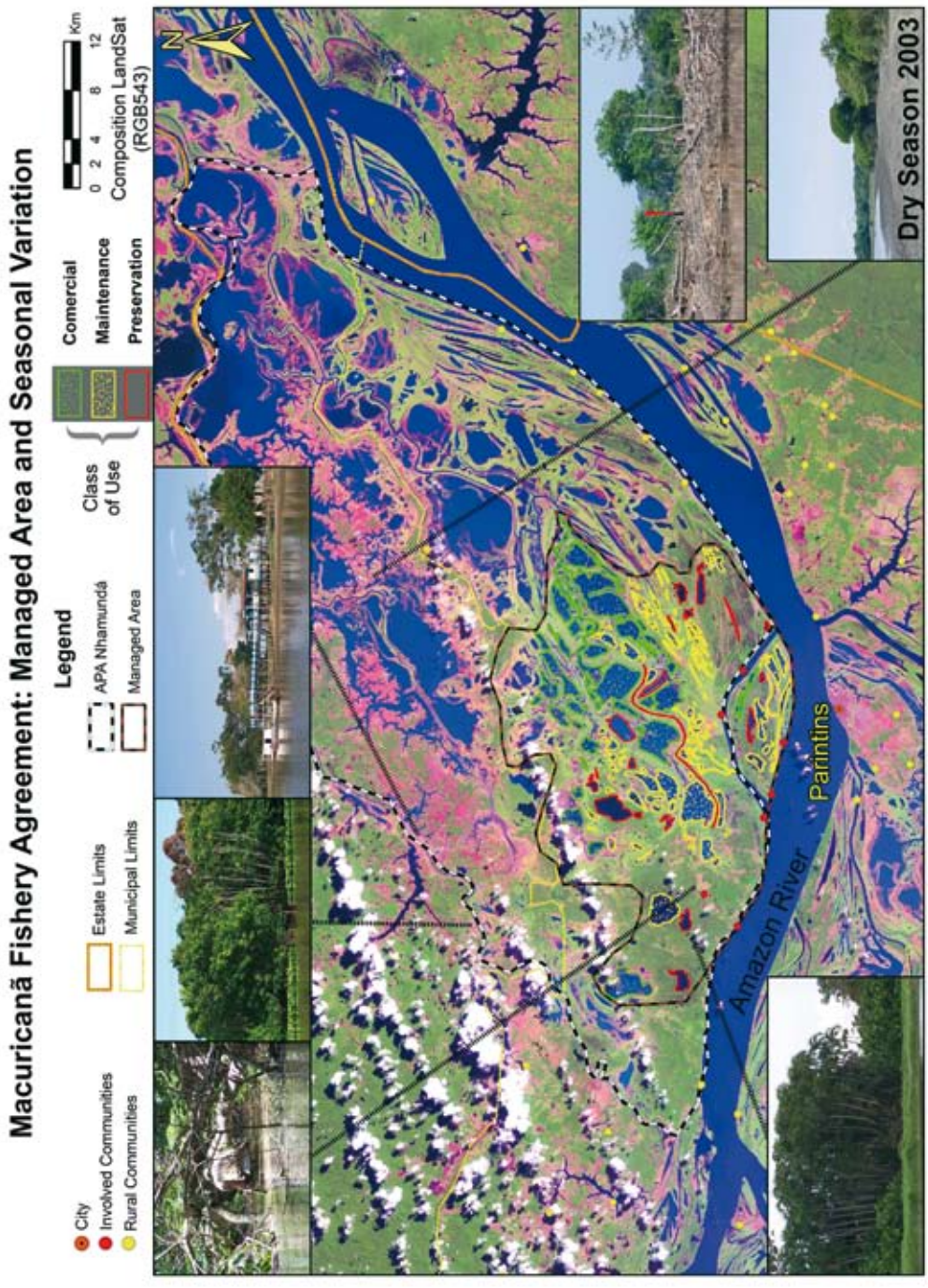
Which strategic local points the community suggests for the installing of information, orientation and observation centres th at could contribute to control/monitor what the Fishery Agreement has established.

The present suggestions have been discussed during a meeting of the _____ community at _____/_____/_____ and have been approved by all that signed below.

Annex II


Macuricanã Fishery Agreement: Managed Area and Seasonal Variation
Legend
City
Involved Communities
Rural Communities
Estate Limits
Municipal Limits
APA Nhamundá
Managed Area
Class of Use
Comercial
Maintenance
Preservation
Km
0 2 4 8 12
Composition LandSat (RGB543)
N
Amazon River
Parintins
Wet Season 2002

Annex II


Macuricanã Fishery Agreement: Managed Area and Seasonal Variation
Legend
City
Involved Communities
Rural Communities
Estate Limits
Municipal Limits
APA Nhamundá
Managed Area
Class of Use
Comercial
Maintenance
Preservation
0 2 4 8 12 Km
Composition LandSat (RGB543)
N
Amazon River
Parintins
Dry Season 2003

Annex III

Normative Instruction - IN nº 113, published on August 24th 2006, duly regulating the Fishing Agreement and establishing the Management categories and rules for the use of the Macuricanã lake complex.

Diário Oficial da União - Seção 1

Ministério do Meio Ambiente

INSTITUTO BRASILEIRO DO MEIO AMBIENTE E DOS RECURSOS NATURAIS RENOVÁVEIS

RESOLUÇÃO Nº 187, DE 17 DE AGOSTO DE 2006

RESOLUÇÃO Nº 188, DE 17 DE AGOSTO DE 2006

ANEXO I

Annex III


165 ISSN 1677-7042 Diário Oficial da União - Seção 1 Nº 163, quinta-feira, 24 de agosto de 2006
ProVárzea
Acordo de Pesca Macuricanã:
Classificação de Locais de Pesca
Nhamundá
Santa Fília do Boto
São Sebastião do Boto
São José do Baixio Santa
São Sebastião da Brasília
Caiçpera
Vila Amazônia
Parintins
Nossa Senhora de Nazaré
Localização na Amazônia Legal
Legenda
Classificação dos Locais de Pesca
Escala 1:170.000
Coordenadas Geográficas SAD 69
Fonte de Dados:
IPAAM
IBGE
ProVárzea
Parintins - AM
Setembro de 2005
Contatos:
provarzea@provarzea.ibama.gov.br

Community-Based Management of Arapaima in The Mamirauá Sustainable Development Reserve Amazonas, Brazil

João Paulo Viana [1]
Leandro Castello [2]
José Maria Batista Damasceno [3]
Ellen Silvia Ramos Amaral [4]
Guillermo Moisés Bendezú Estupiñán [5]
Caroline Arantes [4]
Gelson da Silva Batista [5]
Danielle Sequeira Garcez [6]
Saíde Barbosa [4]

Introduction

Fishery resources in the Amazon are largely underexploited and the greatest problem is the concentration of fishing pressure on a few species (Bayley & Petrere 1989). Up to the beginning of the nineteen seventies, the stocks of the main commercial species were probably in a satisfactory status, but the introduction of new fishing technologies, the availability of credit for the acquisition of boats and equipment, access to new markets and the increasing urbanization have led to a significant increase in exploitation (Costa 1992; Goulding *et al.* 1996; Crampton & Viana 1999).

The Arapaima *Arapaima gigas* (*Piraracu* in Portuguese), which can reach as much as 3 meters and weigh over 200kg (Saint-Paul 1986, Nelson 1994), is a species that has been exploited since the 19th Century (Veríssimo 1895; Menezes 1951), and it was the first commercial fish species of Amazon to show signs of over-fishing. A significant decrease in catches began to be noticed during the nineteen seventies when it became commercially extinct near large cities, and completely disappeared in some areas (Goulding 1980). In 1975 Arapaima was included in Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora – CITES. Towards the end of the same decade the Tambaqui or Black Pacu *Colossoma macropomum*, also a traditionally exploited species began to show signs of over-fishing, with a reduction in the size of fish caught (Petrere 1986). For the past few decades, detritivores like the Jaraqui (*Semaprochilodus* spp.), the Curimatã (*Prochilodus* spp.), and the catfish Dourada (*Brachyplatystoma rousseauxii*) have become the most important species in the region's fishery landings (Ruffino 2004). A cycle is being reproduced in the Amazon whereby an exhausted fishing stock is replaced by another, and it is a challenge reversing this process. In this chapter we present the results of work that has been under way for almost ten years, focused at the community-based management of Arapaima in the

[1] Brazilian Ministry of the Environment
[2] Syracuse University
[3] Fonte Boa Sustainable Development Institute
[4] Mamirauá Sustainable Development Institute
[5] Environmental Protection Institute of the State of Amazonas
[6] Rio de Janeiro Federal University

Mamirauá Sustainable Development Reserve, which has led to the recovery of Arapaima stocks in the managed areas. We present also evidence that communities participating in the management benefited economically from the activity. The experience from Mamirauá shows that the way to ensure sustainable use of fishery resources in the Amazon lies in the cooperation between technical personnel and the fishermen themselves.

The Mamirauá Sustainable Development Reserve and its Population

The Mamirauá Sustainable Development Reserve (MSDR) was created in 1990 by the government of the State of Amazonas and encompasses an area of 1,124,000 hectares of floodplains bounded by the Amazon and Japurá rivers and by the Uati-Paraná, in the middle course of the Amazon river, near the town of Tefé (600km West of Manaus, the State capital). The local population that utilizes the Focal Area of the MSDR (260,000 hectares delimited by the Amazon and Japurá rivers and by the Aranapu Paraná) was around 5,300 inhabitants in 1995, consisting of 1,700 people residing in the Reserve itself and 3,600 users of the reserve residing in communities along the banks of the Amazon, Japurá and Aranapu rivers (SCM 1996, Figures 1 and 2).

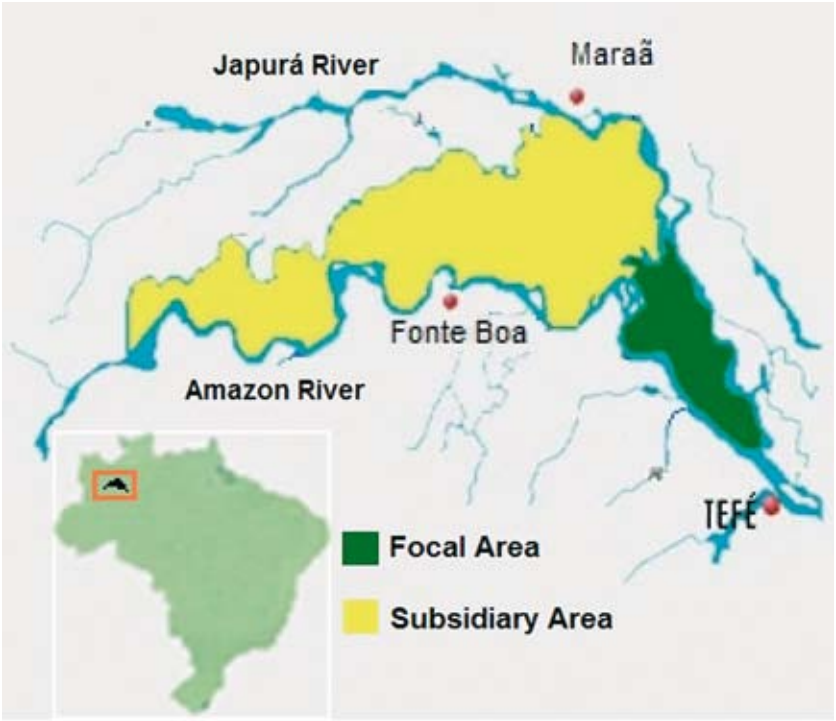


Figure 1 - Location of the Mamirauá Sustainable Development Reserve.

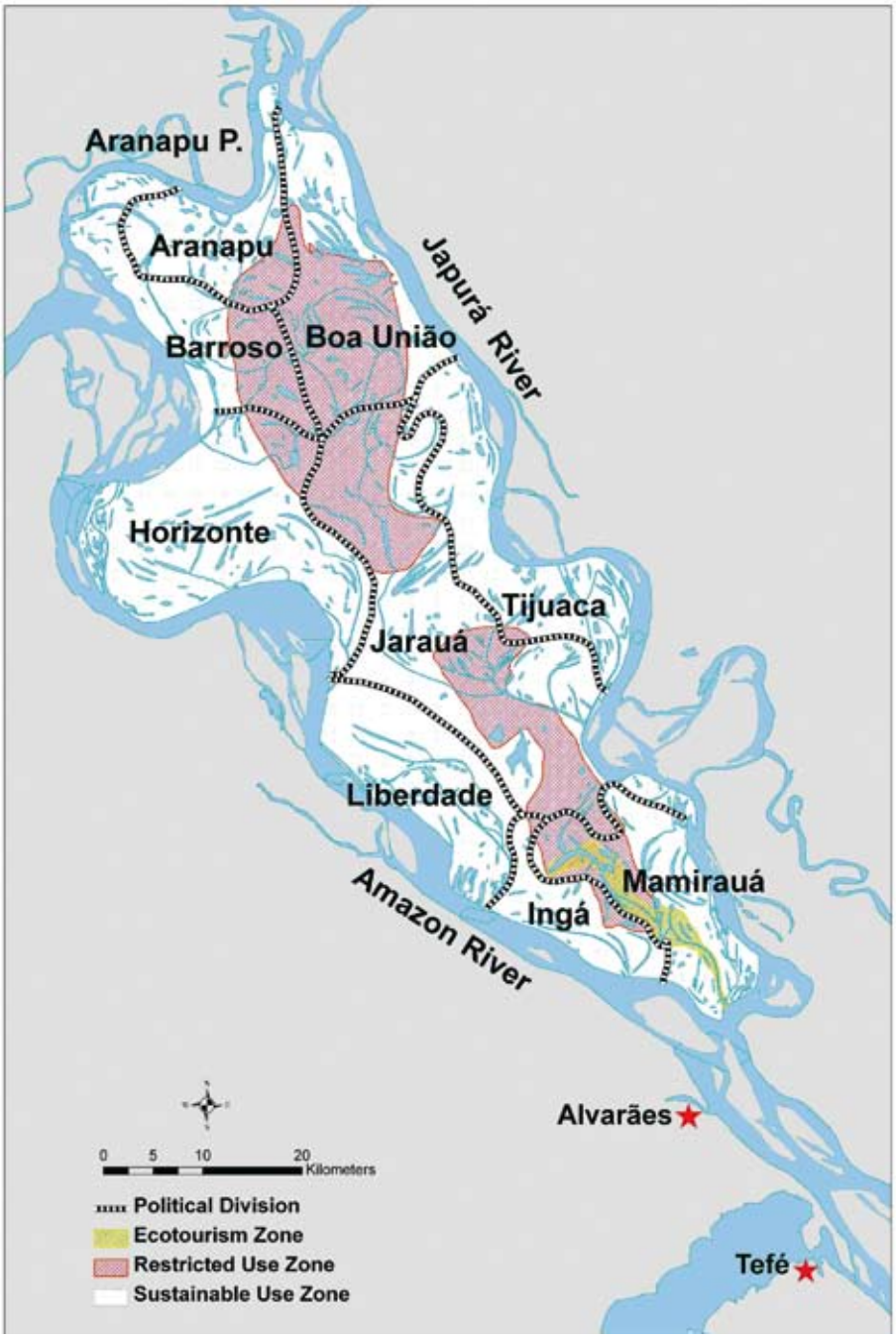


Figure 2 - Political Division and Zoning System of the Focal Area of the Mamirauá Sustainable Development Reserve.

The population's main activities are fishing, farming and logging, governed not only by seasonal factors associated with the floodplain environment but also by the characteristics of the domestic groups, since production is undertaken on a familial basis. The average annual income of the families was around US$ 900 at the beginning of the nineteen nineties, 53% of which was spent on purchasing food supplies and other basic items. Fishing accounted for most of the domestic income, which represented, in some cases, to as much as 72% of the total annual income (SCM 1996).

Studies undertaken by a multidisciplinary group of researchers at the same time as a process of consulting with the local communities was occurring,

led to the definition of the Zoning System of the MSDR and a series of regulations designed to control the use of natural resources, all of which comprise the Reserve's Management Plan. The Zoning System of the Focal Area established zones of permanent preservation located in the heart of the reserve, surrounded by zones designated for sustainable exploitation of the natural resources by the resident and user communities (Figure 2). The basic premise for elaborating the Management Plan was making the conservation of the MSDR's biodiversity compatible with the continued presence of the local resident populations (Howard *et al*. 1995, SCM 1996).

From 1997 on, with the aim of implementing the MSDR Management Plan, and also to improve the quality of life of the residents and users, the Mamirauá Sustainable Development Institute (MSDI) developed and implemented a series of pilot programs. These programs were referred to as "New Economic Alternatives", and were directed at aggregating value to local products (fish, timber, farm produce, handicrafts etc.), and at making feasible the commercialization of such products in more favorable markets. The programs involved complex activities such as organizing groups of producers, training human resources, constructing and implanting infrastructure, and developing information systems about markets with a view to commercializing local products.

The Community-Based Fishery Management Program and Its Insertion in the Communities

The Community-Based Fishery Management Program was first developed and implemented in a single sector of the reserve, the Jarauá sector (Figure 2), made up of four communities (São Raimundo do Jarauá, Nova Colômbia, Novo Pirapucu and Manacabi) comprising, at that time, about 200 people. The choice of this particular sector for beginning the work was based on its strategic importance in terms of controlling the largest system of lakes inside the MSDR, the importance of fishing activities, the level of organization of the communities, and the history of their participation in the establishment of the Reserve.

The sectors of the reserve operate as separate entities and each has a Coordinator who is responsible for organizing meetings (usually every two months) where information exchange and planning take place, and the problems of the communities that are part of the sector are discussed. This political structure is the same as the system organized by the Catholic Church in the region, for the work it carries out with local communities' religious groups. Working at sector level has helped the Program to distribute its benefits to a larger number of people as well as to increase the number of people who have undergone capacity-building to take on roles in the structure that has been introduced.

In the beginning, the management structure for handling the fisheries was established in an informal way and the functions of Technical Coordination

(which responsibility was taken on by a technical staff member of the MSDI) and Community Coordination (which responsibility was taken on by a person elected by the participating fishermen) were instituted. A "Letter of Commitment" was drawn up and discussed together with the fishermen whereby they agreed to support the fishery management efforts as for example in the tasks of maintaining the infrastructure (boat and floating fish processing plant), in the work of surveillance and inspection of the area being managed, and by respecting the regulations of the Reserve Management Plan, among others. It was left to the communities' judgment to define the best way of organizing the group given that the transition to formal status would necessarily imply its members taking on a series of responsibilities. As a result, it proved necessary to hold innumerable meetings.

Training courses were offered on fish handling and processing techniques to improve the quality of their products, and on the structure and administration of cooperatives and associations to provide the basis for the future organization of the group. Efforts were made to limit the necessary adjustments in their production system to an absolute minimum, so as to facilitate the introduction of this new production system within the existing community structures.

Following community debates and the development of the local capacity building process, the fishermen decided to formalize the Program in legal terms as a "Producers Association", which would include not only the fishermen but also farmers and handicraft artisans from the four communities of the Jarauá Sector. It was further decided that the farmers and artisans could make use of the existing infrastructure for their activities (e.g. storage and transport of farm produce and handicrafts). This opening made way for the formal entrance of women into the group, thus widening the possibilities for finding people capable of taking on formal roles in the Association. This was important as the great majority of the fishermen were illiterate. Thus the responsibilities originally assumed by the Mamirauá Institute staff were gradually transferred to the structure of the association, which was legally installed in July, 2001, as the Jarauá Sector Producers Association (APSJ in Portuguese). Currently, technical staff from the Mamirauá Institute continues to give support to the Association in its contacts with fish merchants outside Tefé as well as consolidating monitoring information for preparing the reports on the activities of community-based management of Arapaima, for the environmental agency IBAMA-Amazonas (see below).

The legal establishment of the Association, even though resulting in greater administrative complexity, allowed the Association to seek markets outside the boundaries of the state of Amazonas. The Association began selling Arapaima to a chain of restaurants in Brasília, the capital of Brazil, as early as 2001. Starting in 2003, the Amazonas State government (through its Amazonas Agro-business Agency – AGROAMAZON) also began to offer some support for fish marketing. At the beginning, technical staff had a larger role as intermediaries in the marketing of the fish, passing on information

to the President of the Association, who in turn had the responsibility of presenting and discussing it with the members for decision-making. Details on the challenges and problems involved in fish marketing are presented in the section on the results of the community-based management system.

The method of catching the fish followed the traditional system, carried out individually or in fishing teams. In the first year of work, 1999, the technical staff suggested a different system for catching Arapaima, dividing the fishermen into groups, each group with specific tasks, splitting equally the income derived from commercialization. But such a system proved to be impracticable and it was rapidly abandoned.

Fishery landings were concentrated at a single place, thereby facilitating data collection for book keeping and monitoring, as well as the post-harvest work (gutting, cleaning, and icing fish). During the first few years a small floating fish processing facility was used for this purpose, equipped with an ice box and a simple water storage and treatment system. After filling the maximum storage capacity (about 4 tons of iced fish) the production was loaded into a boat equipped with an ice box and transported to the city of Tefé, to be marketed there or elsewhere. The initial non-returnable investments made by the MSDI (with funding from the UK Department for International Development - DFID) was in the order of R$ 20,000 (US$ 15,000) and was used for building the fish processing facility and for purchasing the boat. After 2002, as production increased (see below), negotiations with the buyers involved also them providing boats to pick up the production in the area where the fishery management work was being done. The boat and the fish processing plant were offered as donations to the Association in 2002. The Association rejected the boat because their members did not want to assume its maintenance costs. The fish processing facility has been kept and was recently refurbished and adapted to be also used in another management system, which is still in a pilot stage, for the sustainable use of caimans.

This system has attempted to eliminate the middle-men, known locally as “regatões”, who as a rule impose unfair conditions in their commercial dealings, paying prices well below those practiced in the cities on transactions that normally do not involve money but rather an exchange of the fish production for goods and basic food supplies. The expenses involved in catching the fish were the responsibility of the fishermen while the expenses involved in fish marketing were discounted on a proportional basis, taking into consideration the production of individual fishermen or fishing teams. The profit was also shared proportionally, taking into account the volume of production and the type of fish caught by individual fishermen or teams. In the case of fishing teams, it was up to the group leader to pay his companions, in accordance with the arrangements agreed by them when organizing the fishing.

In exchange for the technical and logistical support provided by the Program, the Jarauá fishermen had to respect the fishing regulations established by

the law as well as by the Reserve's Management Plan (minimum sizes for capturing fish, closed season etc), particularly for Arapaima, shifting fishing pressure to other species. The great difficulty was the importance of Arapaima for the fishermen's income.

The Importance of Arapaima for Mamirauá Fishermen and the Restrictions on Its Use

Queiroz & Sardinha (1999) identified Arapaima as the fish species of greatest economic importance for the residents and users of the MSDR. In six local communities studied between 1993 and 1995 they recorded an average annual catch ranging from 1.4 to 1.6 tons and estimated that the average annual catch in the Focal Area of the MSDR could be up to 110-150 tons. Arapaima production was not uniformly distributed throughout the year but concentrated in the dry season months (September to December).

Furthermore, Queiroz & Sardinha (1999) showed that only 30% of the Arapaimas taken were over 1.5 meters long, that is to say, adult Arapaimas of a legal length. They suggested also that the species was being exploited beyond the maximum sustainable yield in some areas of the Reserve. The situation was apparently most critical in those lakes situated closest to the communities, due to greater fishing pressure. On the other hand, there were dozens of lakes that, because of their isolation and distance, probably had high quantities of Arapaima. Possibly these isolated lakes functioned as "refuges" for the species during the dry season and, with the annual flooding, and the re-connection of these lakes to the remainder of the floodplain, those lakes where exploitation had been most intense would be re-populated by Arapaimas coming from the more isolated ones.

In 1996 these studies led to the development of the Management Plan regulations for the Arapaima fisheries in the MSDR. The closed season and minimum size followed the federal legislation of that time (IBAMA Decree nº. 480 dated March 4, 1991 and nº 8 dated February 2, 1996). However, other regulations were more restrictive. For example, Arapaima is traditionally sold in large fillets, known as "mantas" in Portuguese, rather than the entire fish. These mantas correspond to the meaty portion of the fish opened out into a single cut. It was shown that the minimum size for mantas (1.0m in length, established by Decree nº 14-N dated February 15, 1993) would allow the capture of Arapaima under the also legally defined minimum total length size. Accordingly, the minimum length for mantas was set as 115cm for dried mantas and 125cm for mantas pickled in brine (SCM 1996). As Arapaima corresponded to approximately 40% of the total fish caught for consumption and sale in Mamirauá (Queiroz & Sardinha 1999), the imposition of additional restrictions on MSDR resident fishermen and users would result in negative effects on their incomes and their attitudes toward the Reserve. That was exactly what happened. In 1996 IBAMA-Amazonas completely prohibited catching and marketing of Arapaima in the state, as it suspected that stocks were in a critical condition. This prohibition would obviously make it unfeasible to exploit

the species in the MSDR, thereby having negative effects on the income of the riverine populations, not only from the Reserve, but also from the entire state of Amazonas.

Community-Based Management as a Solution for the Arapaima Fishery

From the outset the greatest difficulty faced by the Community-Based Management Program was the set of restrictions imposed on the exploitation of the species of greatest commercial value for the MSDR communities. There were also some problems with the Tambaqui, the second most important species, for which restrictions on fishing were not as severe, with the only impositions being a minimum size limit (55cm total length) and a closed season of 3 to 4 months defined by annual Decrees issued by IBAMA. On the other hand, 95% of the Tambaquis in the lakes of the MSDR are below the minimum size for capture, because it is in the floodplains that Tambaqui spends the first years of life, migrating to the rivers when it reaches the adult stage (Goulding 1979; Costa *et al*. 1999). This meant that fishing for Tambaqui was restricted but not completely impossible.

The fishermen resisted the proposals of the technical staff, to redirect fishing effort from Arapaima and Tambaqui to other species (which they referred to as “peixes miúdos” or “small fish”). They claimed it would be impossible to obtain any significant income from the fishery without the larger species, especially Arapaima. Monitoring systems were established at the beginning of 1998, to evaluate local production and to identify alternative “small fish” species suitable for exploitation. The first monitoring results made it very clear that the fishermen were right to be concerned. If the highly controlled species were excluded from their catches, what would be left were species of low commercial value, thus removing any possibility of generating sufficient income to compensate for the losses stemming from the impossibility of catching Arapaima. The solution came from the Jarauá Sector fishermen themselves, who proposed the exploitation of Arapaima through a pulse fishing scheme, a rotating fishing system in 31 of the 133 lakes located within their resource use area (equivalent to the Sector area in Figure 2). While on the one hand, the same IBAMA-Amazonas Decree that prohibited capture and marketing of Arapaima, it allowed, on the other, its use if the species was to be exploited under a management system. So, following negotiations between technical staff and fishermen, it was agreed how this management system would be implemented. A project was formulated and submitted to IBAMA-Amazonas requesting a permit to exploit Arapaima under a system involving the rotation of fishing among the lakes.

The project was approved in June 1999 and the requested quota of 3 tons of mantas for that year was granted. Given the lack of information at that time, what was done to provide a methodological basis for requesting a quota was to estimate the number of Arapaima that could be taken from the areas used by the communities of the Jarauá Sector. The basis for the calculation

of the quota was an Arapaima production estimate for the floodplains of the Peruvian Amazon, which was in the order of 0.3kg/hectare/year (Bayley *et al*. 1992). Considering that the total area of the Jarauá Sector is 56,300 hectares and that of these, about 50,000 hectares are annually flooded, the production of Arapaima was estimated to be around 15 tons per year. Furthermore, taking into account the average weight of 40 to 50kg for an Arapaima 155cm long, this area would produce roughly 375 Arapaimas a year. The quota that was requested from the IBAMA-Amazonas (3 tons of mantas) corresponded to about 1/3 of the number of Arapaimas estimated to exist in the area. The technical staff considered that it was reasonable to take this percentage of the estimated Arapaima stock. That amount would represent a significant reduction on the fishing pressure applied by the Jarauá Sector fishermen, since the monitoring data and other information obtained during the months from September to December 1998 (time of maximum production) showed that fishermen had caught approximately 800 Arapaimas, the majority of which were smaller than the minimum permitted size. Despite imposing a significant reduction in production, this solution for the Arapaima problem satisfied the majority of Jarauá Sector fishermen, who thereafter would begin to exploit Arapaima in their resource use area with a permit from IBAMA-Amazonas, following the rules set out in the MSDR Management Plan and in accordance with the legislation regulating fishing in the region. There was also a strategy to sell Arapaima in more favorable markets, which would partially compensate for losses resulting from the smaller volume of Arapaima being taken.

In 2000 an innovative tool became available for monitoring Arapaima stocks and managing their fishery, a counting method based on the knowledge of Arapaima fishermen, which assesses the number of fish on their natural environment (Castello 2004). This method is founded on the habits of the species, which need to surface from time to time to breathe air. When they are at the surface they can be detected visually or aurally by experienced fishermen, and can be counted. Comparisons made between estimates obtained from marking and recapturing experiments and the counts made by fishermen showed that their counts were accurate, with a threshold for detection of about 1 meter total length, and that the fishermen were capable of classifying individuals into two groups: juveniles (individuals from 1 to 1.5m long) and adults (individuals over 1.5m long) (Castello 2004). Counting should be done either in isolated lakes (during the dry season) or rapidly (to avoid re-counting individuals that have already been registered in surrounding areas).

From the year 2000 on, the counting method came to be used by researchers and technical staff of the Mamirauá Institute to monitor stocks in the MSDR area, and to estimate the amount of Arapaima to be caught in the Jarauá Sector. As IBAMA-Amazonas had already agreed to the principle set out in the previous project, of taking a third of the supposedly available stock, the technical staff and the fishermen requested from IBAMA a permit to capture in 2001 30% of the number of adult Arapaima (individuals over 1.5 m long) counted in 2000. There was a risk involved, due to the

limitations on the available data, but considering that the best available information at the time was being used, and that it was very close to the real situation, the requested quota represented a reasonable amount of fish, both for the technical staff and fishermen. Since the management process would be closely monitored, should any sign of a problem be detected, the proportion of the quota in relation to the counted adult stock could be revised, this being adjusted as any new situations arose. In the first year IBAMA-Amazonas did not grant the requested quota, but the principle of estimating the quota based on the number of adults counted in the previous year ended up becoming the rule of thumb for managing Arapaima by the counting method.

The counting method was also adopted when the Community-Based Management Program was extended by the Mamirauá Institute to other areas of the MSDR (Tijuaca Sector, in 2001, and the Maraã Fishermen´ Colony, in 2002) and the Amanã Sustainable Development Reserve (Coraci Sector, in 2002). In the same way as the Jarauá Sector, it was necessary to submit projects to IBAMA-Amazonas requesting permits. The counting method is also being used in Arapaima management scheme carried out by the Fonte Boa Sustainable Development Institute, which is active in a part of the MSDR that is not directly serviced by the Mamirauá Institute. For some years now the method has been applied in Guyana and Peru. The Jarauá Sector fishermen acted as instructors for the other groups of fishermen when they were being trained to use the counting method. After showing a certain resistance at the beginning, IBAMA-Amazonas conceded and began to consider the counts as a suitable tool for managing the species in the State of Amazonas (see Normative Instruction nº 35 dated June 18, 2004).

The MSDR staff, with the objective of monitoring the use of the counting method, evaluated in 2005 the quality of Arapaima counts. Fishermen from the Jarauá Sectors that participated in the development of the counting method assisted in this task. It was also an opportunity to evaluate how the method was being disseminated among the fishermen participating in the community-based management of Arapaima. Individual and group counts from fishermen of the Jarauá, Tijuaca, Coraci and Maraã localities were compared to the number of Arapaima on selected lakes, obtained from the total capture of fish in these lakes. Generally speaking, the counts made by individual fishermen indicated tendencies both for overestimation and underestimation, but such tendencies were reduced when considering the results for the group (i.e. locality) as a whole (percentage errors ranged from 2 to 20%). These results indicate that such tendencies should be considered during the management process, for each locality, and that the counting method allows an effective monitoring of Arapaima stocks at the areas under management (Arantes *et al*. under preparation).

Results of the Community-based Management of Arapaima in the Jarauá Sector

The community-based management of Arapaima in the Jarauá Sector has brought benefits both for the fishermen and for the fishery resource that they use. Table 1 shows the evolution of the various indicators that were developed with the participation of the fishermen, at the beginning of the Program, to monitor the Association's activities and the community-based management work. Although the indicators only refer to Arapaima, it should be kept in mind that other species were also caught. In 2002, for example, the fishermen earned R$ 5,377 from Tambaqui sales using the marketing channels established for the sale of Arapaima. A study made by the Community Extension Team of the MSDI that monitored the average annual income of families in the community of São Raimundo do Jarauá registered an increase in the purchasing power of this community, from $ 1,939.05 per year in 1994/95 (equivalent to 44 regional basic food baskets) to R$ 4,141.98 per year in 1999/2000 (equivalent to 88 regional basic food baskets) (Viana *et al*. 2004).

It can also be seen from Table 1 that the gross average income of the fishermen has increased over the years. In 2003 the expectation was that it would practically double. However, marketing of Arapaima in that year faced serious problems and, despite the fact that the production practically doubled in comparison with the previous year, that was not reflected in the average gross income of the fishermen, which was actually lower than that of the previous year.

Table 1 - Indicators of the community-based management system of Araipama in the Jarauá Sector, from 1999 to 2005.

Year	Juveniles (A)	Adults (B)	Total (A+B)	Quota Available[1]	Quota requested[2]	Quota Authorized[3]	Catch[4]
1999	2,149	358	2,507	-	-	-	141
2000	2,984	994	3,978	-	-	-	153
2001	5,901	1,441	7,342	298	300	200	188
2002	7,017	3,932	10,949	432	500	500	497
2003	7,296	4,327	11,623	1,180	900	900	877
2004[5]	7,159	3,135	10,294	1,227	1,230	1,230	958
2005	8,564	7,111	15,675	940	1,230	1,230	1,205
2006	12,052	8,596	20,648	2,133	1,700	-	-

[1] Corresponds to 30% of adult Arapaima counted in the previous year.
[2] Corresponds to the quota requested by the Jarauá Sector Association.
[3] Corresponds to the quota authorized by IBAMA.
[4] Corresponds to the number of Arapaimas caught during the dry season after the issuing of the IBAMA authorization.
[5] Probably the 2004 counting underestimated the numbers of Arapaima as it was done during an unusual high water period, which persisted during the dry season.

Figure 3 presents the distribution of total length of Arapaima caught between 1998 and 2005. The data for 1998 was estimated based on the length of the bony tongues of Arapaima collected from the fishermen. As mentioned earlier, around 800 fish were taken by Jarauá Sector fishermen during the dry season of 1998, that is, in the year prior to the beginning of fishery management. Based on the tongue measurements it was estimated that the average total length was approximately 126.3cm (n = 575), with 89% of them under the minimum capture size established by the legislation (1.5 meter total length). Starting from 1999, with the introduction of the community-based management system, a change was observed in the fishermen's behavior as they began to select individuals above the minimum size and the average total length of the Arapaimas caught went to over 160 cm, and in some years even above 170cm. It must be stressed that after 2001, IBAMA-Amazonas started issuing permits establishing fishing quotas in numbers of individuals instead of in total weight of mantas. This has led to an important change in fishing tactics by the fishermen: the percentage of fish under the 150cm total length size limit, which was formerly around 23 to 24%, fell to less than 6%. It was clear that a quota expressed in numbers of fish, instead of in weight of mantas, caused the fishermen to select very carefully the fish to be taken, as greater sizes meant greater weight and consequently more money at the time of sale.

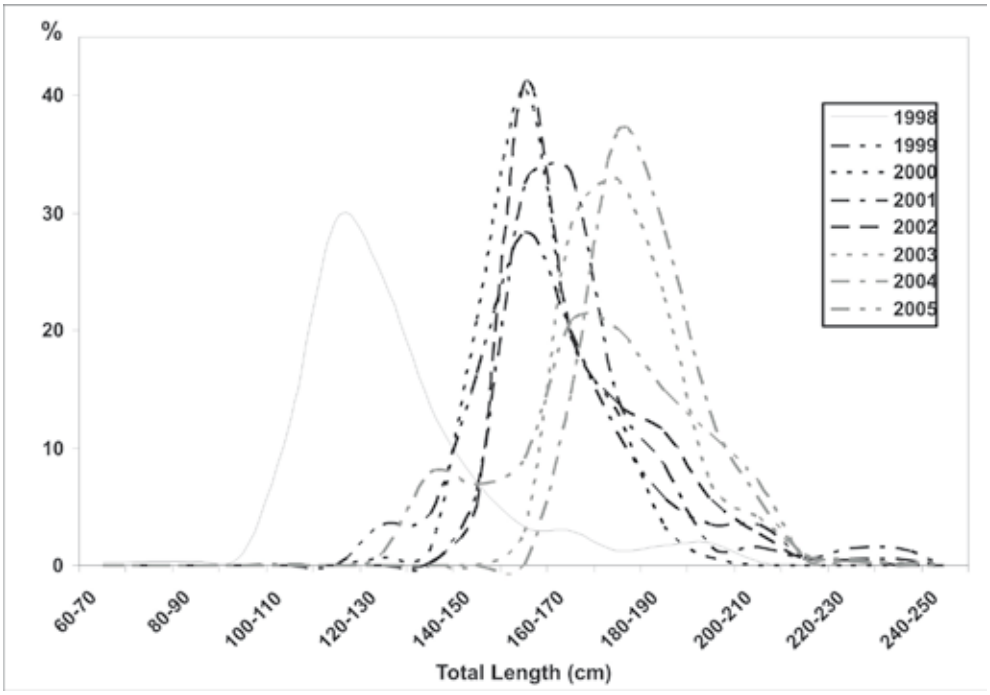


Figure 3 - Total length frequencies (%) of Arapaimas caught by the Jarauá Sector fishermen during the months from September to December, 1998 to 2005.

Up to the year 2001 data was also collected on the capture of "small fish" during the same period as the Arapaima production. However, with the end of the financial support for the Program by DFID at the beginning of 2002, data collecting was restricted to Arapaima only. Table 2 shows the average total lengths of species other than Arapaima caught by Jarauá Sector fishermen which had a minimum total length for capture established by IBAMA. During the period that was monitored fishermen respected the minimum sizes established by the legislation.

Table 2 - Average lenght of fish species other than Arapaima caught by Jarauá Sector fishermen and their respective minimum sixe limits established by IBAMA.

Species (minimum size)	1999	2000	2001
	Average ± SD (n)	Average ± SD (n)	Average ± SD (n)
Tambaqui (55 cm)	61.3 ± 5.1 (455)	59.2 ± 4.0 (610)	63.4 ± 4.6 (582)
Caparari (80 cm)	89.5 ± 8.4 (12)	86.5 ± 6.8 (147)	88.0 ± 8.4 (69)
Surubim (80 cm)	-	86.0 ± 9.4 (6)	85.8 ± 7.0 (5)
Aruanã (44 cm)	-	-	68.1 ± 4.9 (495)
Tucunaré (25 cm)	-	-	36.4 ± 3.0 (134)

Source: Viana et al. 2004.

The great majority of the fishermen agreed with the need to monitor Arapaima stocks as they understood that the information obtained was fundamental for the continuation of the management work. Up to 2001 fishermen who counted Arapaima received payments from MSDI as field assistants for research work, given that the management process was still at an experimental stage. Once the research activity was over, the Association developed its own mechanisms for paying those fishermen who did the counting, by offering a given number of fish (determined as a function of the authorized quota) as restitution for their work.

Using Arapaima to make payments had other consequences. A management scheme requires participating in meetings to debate problems and to identify solutions, in inspection and surveillance activities, and in the counting of Arapaima. All the activities related to the management process started to be evaluated by the Board of Directors of the Association and by its members. The sharing of the quota among the members (expressed in numbers of Arapaima) began with the allocation of a "basic quota" to each individual member. In some years, by common consent, a part of the quota is separated to meet specific demands such as, for example, to repair the floating fish processing facility that was used to support their work, a community party or celebration, or support for the women's groups of the communities. Active participation in the management activities meant additional Arapaimas over the basic quota for those active participants. Non participation or even breaking the rules of fishery management (as agreement to the management process is not unanimous) results in Arapaimas taken from the basic quota. Serious breaches of the regulations and non participation in management may even lead to exclusion from

the sharing of the quota. The latter case occurred to one of the Jarauá Sector communities in 2003, as their members were caught in 2002 smuggling Arapaima in their wooden canoes, including undersized fish. The transgressors tried to justify their act by explaining that they were facing difficulties, but it was suspected that it was a common practice. This system for sharing the quota was an important improvement to make a fair distribution of the resource, as it takes into consideration the differences in Association member participation in the numerous activities related to the management process. However, the share system has potential faults, because factors such as personal relations and kinship may result, for example, in different punishments being meted out for similar offences. As this quota sharing system was evolving separately and independently in each of the groups supported by the MSDI in their community-based management work, technical staff started a process to define a common set of criteria to be followed by all groups for sharing the Arapaima quota. This will not imply, of course, that local rules and criteria do not continue to be adopted by the groups for the sharing of quotas.

The Challenge of Marketing Arapaima

Marketing the production was, and still is, one of the main bottlenecks of the management system. Despite all the efforts and accumulated experience, some of them negative ones, marketing the product continues to be a source of concern . Selling a “sustainable product” is not something simple, as trading requires experience and there are different types of buyers.

Certainly, the main difficulty in marketing managed Arapaima lies in the competition with illegal Arapaima, which limits the number of potential buyers, as law enforcement is weak and the illegal product tends to be cheaper and available around the year. Also, illegal Arapaima began to be sold as “legal”. It became common to hear in commercial establishments in Manaus (the State capital) that the Arapaima on offer “came from Mamirauá”, which in most cases was not necessarily true. Another difficulty faced, as time passed and production increased, was the limited number of companies in the Amazonas state capable of purchasing the product. Furthermore, until 2003, IBAMA-Amazonas, restricted the type of buyers (e.g. fish processing plants, hotels, restaurants) to facilitate its control upon the marketed production. From 2003 on, IBAMA-Amazonas started to require that each fish should bear a fixed-tag, individually numbered, to prove the origin of the product. The tags created several problems as they frequently broke loose due to shipping and handling. This requirement also created, sometimes, delays in the start of Arapaima fishing, as the supplier failed to deliver them on time. Finally, in order to sell the production in Manaus or outside the state, where usually the best prices could be obtained, it was required to pay the ICMS tax (a tax on goods, services and trading operations) which varies from 17 to 12%, respectively. Taxes were usually a source of complaint and criticism by the fishermen when the accounts were presented to the Association. After 2004, the state government introduced a change in tax regulations and waived the ICMS tax for “Arapaima caught

in sustainable, environmental reserves, provided that the activity was duly authorized by the Brazilian Institute for the Environment and Renewable Natural Resources - IBAMA" (ICMS Agreement 149/04, dated December 15, 2004, Revenue Policy National Council - CONFAZ).

Up to 2001 there was an important role for the technical staff to play, that of facilitating communication between potential buyers and the Association. This was further justified by the fact that, at that time, the volume of production did not justify the costs of a trip for a buyer to go to Tefé to negotiate with the Association. This meant there was greater involvement of the technical staff in the trading process, which subjected them to demands for explanations whenever some trouble occurred, such as delays in payment, which were not unusual.

Beginning in 2002, the Association started to delegate to certain members the task of carrying on the marketing process. In that same year, a buyer who had heard about the increased production, made an offer to buy practically everything, and sent a representative to negotiate the deal with the Jarauá Association and with all the other associations too, as in that year two other groups supported by the MSDI entered into the managed Arapaima market. His offer was accepted, but at the last minute the terms of the proposal were altered: the price agreed for gutted Arapaima (R$ 4.00 per kilo) would be maintained, but would be applied to headed and gutted Arapaima. This change represented a reduction of around 5% of the value originally negotiated. There was not enough time to find another buyer, and so the modified offer had to be accepted. However, there was a market for the heads in Tefé, and a considerable part of them was sold there.

After the negative experience of 2002, in 2003 the Association decided to seek a different buyer, and even draw up a contract to give greater security to the deal. However, the buyer ended up not paying for the fish in full as contracted, giving only a down payment. The entire production was shipped to Manaus and kept in cold storage, without being put on the market. The buyer declared that he was having trouble marketing the product, as there was a "boycott" going on against him, which was preventing him from marketing the fish. The delay in selling off the product led to a loss of quality and the stored Arapaima also lost weight due to the long time it was kept frozen (a loss of 6.3 tons). Furthermore, there was a great expense with the storage costs.

After four months in cold storage and only with the direct intervention of the technical staff, the stored Arapaima was sold, but to another buyer and for R$ 3.00 a kilo, instead of the R$ 4.50 agreed with the original buyer. Thus, the commercialization of the product in 2003 ended up as a disaster for the Jarauá Association and for the other groups supported by the MSDI, who had closed deals with the very same buyer. The fishermen of the Jarauá sector received only 54% of the original value of their production. This incident led the technical staff and the fishermen to further improve the negotiating process, which from then on began to involve meetings

attended by prospective buyers, by the Associations, and by the technical staff, culminating by the drawing up of legally robust contracts. The consequences of the 2003 marketing still echoes in the Jarauá Sector and brings bad memories for the other fisher groups assisted by the MSDI.

In 2004, at the same time as the contracts became more reliable, there was also a greater competition in the state for selling managed Arapaima, as the fish caught in Fonte Boa entered the market. And with a greater supply the prices tended to fall (Table 1). The entire production of the Association was marketed in the form of mantas, 75% of the production being sold at R$ 4.50 per kilo. In 2005 this price trend persisted. Almost the entire production was sold in the form of whole gutted fish (95%) at a price of R$ 2.90 per kilo. The remainder, in the form of mantas, was marketed in Tefé, part during the 1st Managed Arapaima Fair, at an average price of R$ 3.74 per kilo.

The drop in the price of managed Arapaima over the years has been compensated by an increase in production, which is reflected in the annual increase in the gross income generated by the management system (Table 1). Recurrent costs have probably remained stable over time. There were certainly a reduction in costs when the buyers began to pick up the production in the communities and to meet fishing expenses (after 2001), as well as when the government waived the ICMS tax (after 2003). On the other hand, the fishermen, from 2002 on, assumed the costs involved in counting Arapaima, and in the surveillance and inspection activities of the managed areas, which up to 2001 had been met by the MSDI. From 2003 on it became unfeasible to estimate the fishermen' net incomes, which makes it impossible to assess the recurrent costs of the system for the last few years, due to a variety of individual arrangements that the fishermen started to make related to the management system. That was another consequence of the marketing problems in 2003, but there were others.

In the expectation that their income would double in relation to 2002, the Jarauá fishermen contracted debts that they expected to pay off with the 2003 production. These debts were all with a single trader, and some fishermen had still not paid them off by 2006. The trader ended up becoming the main local middleman, purchasing fish for resale. Under the pressure of debt, the number of reports of infractions of the fishery management rules in the Jarauá Sector increased, and it became necessary to set up a surveillance and inspection system together with IBAMA-Amazonas to control the situation. Many accusations of infringements in the management rules pointed towards the middleman. So, the community-based management in the Jarauá sector began to coexist again with the strong presence of a middleman, something that had practically disappeared at the beginning of the work. It may be that the middleman is an essential figure for fishing in the Amazon, as they are the individuals most specialized in providing the fishermen with the goods they need for their fishing activities, and the cost of such services is the low price the middlemen pay for the products

they acquire. Some buyers from Manaus and elsewhere, not involved with the fisheries business, have already become interested in buying directly from the Association, but they have face innumerable difficulties with the logistics involved in transporting and storing fish. However, even with the strong presence of the middlemen, the pressure of the debts, and the other difficulties that arose throughout the years, the community-based management has persisted.

Community-Based Management and the Arapaima Stocks

The response of the Arapaima stocks to fishery management has been astonishing. Neither the fishermen nor the technical staff expected it would be so fast and on such magnitude. Between 1999 and 2006 the numbers of Arapaima increased over eight-fold in the Jarauá Sector area, going from 2,507 (2,149 juveniles and 358 adults) to 20,648 (12,052 juveniles and 8,596 adults, Table 3). This increase in the numbers of Arapaima began to be noticed right at the beginning of the work. In 2001 stories started to be told about spotting lots of Arapaima coming up to the surface right in front of the community. Fishermen talked about the "return" of the Arapaima and the older people started to remember when they were young and "when the fish were not exploited as much as now". This also created a feeling of pride within the communities, and among the fishermen and technical staff, as being the result of team work. It worked also as an incentive for other regions to adopt the management system. There was no longer the type of difficulty faced initially by the technical staff, in convincing fishermen that it was worth managing the fisheries, both environmentally and financially. There was a working model in operation and, before other groups sought the assistance of the technical staff in order to begin their fishery management work, they would first visit the Jarauá Sector, to find out what was happening there.

Table 3 - Monitoring of Araipama (counts) in the Jarauá Sector from 1999 to 2006, with estimates of juveniles and adults, quotas and fish caught (numbers).

Year	Juveniles (A)	Adults (B)	Total (A+B)	Quota Available[1]	Quota requested[2]	Quota Authorized[3]	Catch[4]
1999	2,149	358	2,507	-	-	-	141
2000	2,984	994	3,978	-	-	-	153
2001	5,901	1,441	7,342	298	300	200	188
2002	7,017	3,932	10,949	432	500	500	497
2003	7,296	4,327	11,623	1,180	900	900	877
2004[5]	7,159	3,135	10,294	1,227	1,230	1,230	958
2005	8,564	7,111	15,675	940	1,230	1,230	1,205
2006	12,052	8,596	20,648	2,133	1,700	-	-

[1] Corresponds to 30% of adult Arapaima counted in the previous year.
[2] Corresponds to the quota requested by the Jarauá Sector Association.
[3] Corresponds to the quota authorized by IBAMA.
[4] Corresponds to the number of Arapaimas caught during the dry season after the issuing of the IBAMA authorization.
[5] Probably the 2004 counting underestimated the numbers of Arapaima as it was done during an unusual high water period, which persisted during the dry season.

Year after year, the counts made by the Jarauá Sector fishermen were analyzed by the fishermen and the technical personnel, for decision-making regarding the management work, and in order to define quota requests. In this process, fishing capacity was taken into account and in most years the decision was to request the Available Quota, corresponding to 30% of the number of Arapaima counted in the previous year (2003 was the only year in which the quota requested fell below the Available Quota, as it was considered that there were serious logistical constraints to deal with the quantities of fish involved). Only in the first year after the adoption of the counting system (2001) IBAMA-Amazonas did not grant the quota requested by the fishermen and technical staff. At that time the system was a novelty, and IBAMA-Amazonas opted for caution, as the requested quota would effectively double Arapaima capture from one year to another (Table 3).

On the other hand, in 2002 and 2005 the Requested Quota was greater than the Available Quota. In 2002 the fishermen considered that they had a right to request compensation from IBAMA-Amazonas for not having authorized the previous year's request. In 2005 there was another request for compensation, this time due to the water levels in 2004 (the persistent high water had made fishing difficult) and to a delay on the delivery of tags (required by IBAMA-Amazonas to identify managed Arapaima). On both occasions the requests were granted.

Invariably, over the years, logistical limitations (difficulties with the availability of transportation and ice, for example), environmental limitations (especially water levels which, when too high or too low, make fishing difficult), difficulties with organizing the communities and in preparation of reports and/or issuing permits have prevented the Jarauá Association from catching the full quota authorized by IBAMA-Amazonas.

Why the Community-Based Management of Arapaima in Mamirauá has been successful?

Although the present chapter has dealt almost exclusively with the management of Arapaima fishing in the Jarauá Sector, there are three other groups assisted by the MSDI that participate in the same activity, two of which have achieved similar successful results (the Coraci Sector of the Amanã Reserve and the Maraã Fishermen´ Colony), and another, the Tijuaca Sector, supported since 2001, which has not shown significant progress. The decision to present only the Jarauá Sector results was because it was there the work began and therefore the place from which more information is available.

To go into details of the difficulties of the work in the Tijuaca Sector and the results obtained in Coraci e Maraã would mean more chapters. Furthermore, just like Jarauá, Coraci and Maraã have their own problems. However, in essence, what distinguished Tijuaca from the other groups at the onset of the work was the independent nature of the communities, so much

that most of them preferred to market fish through their own associations, and opted to fish their own areas rather than the Sector area as a whole. Further, there were conflicts between them and the neighboring sectors (a situation that is not unique to Tijuaca). Perhaps the problem is related to the total area of the sector, which is proportionally smaller than other sectors if the numbers of communities and fishermen are taken into account. It may be also that the Tijuaca sector was not yet ready to begin the work of community-based fishery management when the fishermen were first invited. At that time, from a technical point of view, an effort was being made to benefit another sector of the MSDR with the infrastructure and technical assistance already available to Jarauá. Considering that Tijuaca is not only a neighboring sector, but is actually fairly close to Jarauá, it seemed to make a lot of sense, taking into account cost-benefit issues, to work there. There was also interest on the part of the Jarauá fishermen in intensifying their integration with the Tijuaca fishermen, as the latter were frequently caught fishing illegally in the area of the former. Seven communities of the original eight from Tijuaca are still being supported by technical staff, but the possibility is being evaluated of ceasing work in a further two communities. In only three communities are there indications that the management activity is beginning to generate results. Despite all the difficulties, the fact is that in 2005 community-based management of Arapaima of these four groups (Jarauá, Tijuaca, Coraci and Maraã) involved a total of 565 fishermen. These four groups caught 4,208 Arapaimas and produced 212.7 tons of mantas, whole gutted fish (with or without heads), carcasses and tongues (carcasses and tongues are now being commercialized as well). They generated a gross income of R$ 775,918.45 (roughly US$ 290,000), a gross average income of R$ 1,373 (US$ 507) for the three month period of fishery activities, or approximately R$ 457 (US$ 169) per month. For such an extremely poor region where the per capita income varies from R$ 874,00 (or US$ 324, Maraã) to R$ 1,846,00 (or US$ 684, Tefé) (IBGE 2000), the management system is making a considerable contribution to the local population and from what has been shown above, to the Arapaima stocks. Why is it that community-based management of Arapaima in Mamirauá has been successful?

To begin with, there was information available produced by years of research that led to the formulation of the MSDR Management Plan. There were financial resources, both national and foreign, that made it possible to build a team and supply the necessary means for work. There was also the support of other groups of technical personnel from the MSDI and their work, prior to ours. There was interest on the part of the main local leadership, which, for us, was the gateway to the sector. There was also interest on the part of the majority of Jarauá fishermen, those with fewer resources, who probably viewed the Program proposal as an opportunity to become more independent from their fishing partners. In the beginning there was resistance from other fishermen, a resistance that gradually diminished but has never entirely disappeared. Fishery management in Jarauá has never enjoyed, and probably never will, unanimous support. Yet, a general change in behavior came about. It went from a fluctuating majority of

fishermen, who, for the majority of their time exploited the most important resource for their subsistence in an unsustainable way, to a fluctuating majority of fishermen, who during most of their time started to observe a set of regulations for the use of that resource, but certainly not all the time, as needs must and the unpredictable happens (which can lead to breaking the rules). Little by little, this group of people, the Jarauá Sector Producers' Association, began to regulate this dynamic balance, and this resulted in a system that has led to the recovery of Arapaima stocks, and, as it seems, to the sustainability of the entire management system. The Association, by means of its own rules, when making any internal adjustments, gradually became independent from the technical staff towards whom it had initially turned when attempting to deal with difficult or conflicting situations.

Probably this description of the mechanisms that operated in Jarauá can also be used to explain what has happened, and is happening, with the two other areas where community-based management of Arapaima has also been showing encouraging results. However, there is a significant difference, as these two other groups never had the same degree of technical support, as did Jarauá and Tijuaca. Coraci and Maraã, as a result of their own dynamics, and independent of the technical staff, were developing local processes to conserve Arapaima stocks in their respective resource use areas, but already with expectations to, someday, start to manage Arapaima following the Jarauá style. It was left to the technical staff, once the two opportunities were identified, to merely facilitate the process, lending support to the training of Arapaima counters (undertaken by the Jarauá fishermen), running capacity building sessions on fishery management, and formulating the project proposals to submit to IBAMA-Amazonas. Probably, in the case of the Tijuaca Sector, the communities were not able to reach a sufficient degree of consensus so that internal mechanisms would start to act, because each community operated as an independent entity, and as time passed these started to be dealt with as such.

According to the original planning, everything was technically ready for fishery management in the Jarauá Sector to begin in 1998 with the original proposal of switching the fishing pressure over to the "small fishes". However, the fishermen considered that the time was not appropriate, and asked to begin only in the following year. Delaying for a year allowed the technical staff to better assess the reality of Arapaima fishing in the Jarauá Sector and to witness the extreme importance of the two most highly regulated species (Arapaima and Tambaqui). That led to the formulation of the project proposal for Arapaima fishery management using the rotation system for fishing their lakes. To get approval for the project it was necessary to negotiate with IBAMA-Amazonas due to the highly controlled status of Arapaima and due to the location of the experience, a conservation unit. This role fell to the technical staff and their role as intermediaries continues until now. The division of roles and tasks between the technical staff and fishermen, each with their own capabilities and limitations, had to reach a high degree of consensus and, equally important, of mutual trust. This took time, and as has already been stressed, it has never been a unanimous or constant process.

In expanding the relationships involved in this system comprised by technical staff and Mamirauá fishermen to include their principle external partner, IBAMA-Amazonas, there appeared a new variable, in effect a new language, the counting method. The logic of counting the number of Arapaima, estimating a quota based on the number of adults counted, and applying for a permit from IBAMA-Amazonas to catch them, ended up making sense for all three parties. Fishermen, technical staff and IBAMA-Amazonas ended up having a common language through which they communicated. And after some initial resistance, IBAMA began to consider this language in relation to other groups managing Arapaima fisheries. Counting ended up as a legal requirement for Arapaima management in the Amazonas state, so much so that the Fonte Boa Sustainable Development Institute (which is run by the government) implemented the management model for Arapaima, presented here, in several communities.

The beginning of the work to implement community-based Arapaima fishery management in the Jarauá Sector will have its tenth anniversary in 2007. What can be gathered by those who worked for and built up the system side by side with the fishermen, over these years and at different moments, is that the results that have been obtained so far were the consequence of a division of tasks, with each party, fishermen, locals, technicians and entities playing their role following their experiences and knowledge (getting it right, making mistakes, correcting them) in a continuous and reciprocal learning process, which has still not ended.

Acknowledgements

Unfortunately two people who were fundamental to obtaining the results of this work have passed away, José Márcio Ayres, who envisioned Mamirauá SDR, and that year by year followed with great interest the results of the Program. The other person, Antonio Martins, popularly known as Antonio Preto or Antonio Velho, the President of the São Raimundo do Jarauá Community, Sector Leader and Catechist, who welcomed us into his community, helped us, and who firmly believed that natural resource management was the right path to follow. We thank them both for the years we spent together and for what we have learned from them. Brendan Dalley´s comments greatly improved this manuscript. Funding was provided by the National Council for Scientific and Technological Development of Brazil (CNPq/MCT) and the Department for International Development (DFID) of the United Kingdom. We would also thank The Institute for Environmental Protection of the state of Amazonas (IPAAM) and the Brazilian Institute for the Environment and Renewable Natural Resources of the State of Amazonas.

References

ARANTES, C. C.; CASTELLO, L. & GARCEZ, D. S. **Em preparação. Avaliação das contagens de pirarucu (*Arapaima gigas*) em Mamirauá, Amazonas, Brasil, e implicações para o manejo pesqueiro da espécie.**

ARAÚJO-LIMA, C. & GOULDING, M. **Os frutos do tambaqui: ecologia, conservação e cultivo na Amazônia.** Tefé, AM. Sociedade Civil Mamirauá, Brasília-CNPq-MCT.

BAYLEY, P. B., VÁZQUEZ, F., GHERSI, P., SOINI, P., & PIÑEDO, M. (1992). **Environmental review of the Pacaya-Samiria National Reserve in Peru and assessment of project (527-0341).** Report to the Nature Conservancy. Washington.

BAYLEY, P. N. & PETRERE, M. (1989). **Amazon fisheries: assessment methods, current status and management options.** In: Proceedings of the International Large River Symposium. D. P. Dodge, ed. Canadian Special Publication in Fisheries and Aquatic Sciences 106:385-398.

CASTELLO, L. (2004). **A method to count pirarucu Arapaima gigas: fishermen, assessment, and management.** North American Journal of Fisheries Management 24 (2):379-389.

COSTA, J. M. M. (1992). **Impactos econômico-territoriais do atual padrão de ocupação da Amazônia, pp. 40-115.** In Amazônia: Desenvolvimento ou Retrocesso. A. M. Matos, ed. CEJUP. Belém.

CRAMPTON, W., Viana, J.P. (1999). **Conservação e diversificação econômica da pesca nas várzeas do alto Rio Amazonas: Uma breve revisão e sugestões para um futuro sustentável, pp. 209-226.** In. Fang, T.G., Montenegro, O.L. e Bodmer, R.E., eds. Manejo y Conservacion de Fauna Silvestre en America Latina. Ed. Instituto de Ecologia, La Paz, Bolívia.

COSTA, L. R. F., BARTHEM, R.B. & CORREA, M.A.V. (1999). **Manejo da pesca do tambaqui (*Colossoma macropomum*) nos lagos de várzea da Reserva de Desenvolvimento Sustentável Mamirauá.** In Estratégias de Manejo para Recursos Pesqueiros na Reserva de Desenvolvimento Sustentável Mamirauá. H. L. Queiroz e W. G. R. Crampton, eds. SCM/MCT-CNPq. Brasília.

GOULDING, M. (1979). **Ecologia da Pesca do Rio Madeira.** INPA. Manaus.

GOULDING, M. (1980). **Fishes and the forest.** University of California Press. Los Angeles, CA.

GOULDING, M., SMITH, N.J.H., & MAHAR, D..J. (1996). **Floods of Fortune: Ecology and Economy along the Amazon.** Columbia University Press. Nova Iorque.

HOWARD, W. J., AYRES J.M., LIMA-AYRES, D., & ARMSTRONG, G. (1995). **Mamirauá: a case study of biodiversity conservation involving local people.** Commonwealth Forestry Review 74(1): 76-79.

MENEZES, R. S. (1951). **Notas biológicas e econômicas sobre o pirarucu *Arapaima gigas* (Cuvier) (Actinopterygii, Arapaimidae).**

NELSON, J. S. (1994). **Fishes of the World.** John Wiley and Sons, Inc. Nova Iorque, EUA.

PETRERE, M. J. (1986). **Variation in the relative abundance of tambaqui (Colossoma macropomum Cuvier, 1818) based on catch and effort data of the gill net fisheries.** Amazoniana 9, 527-547.

RUFFINO, M. L. (2004). **A Pesca e os Recursos Pesqueiros na Amazônia Brasileira.** Edições IBAMA.

SAINT-PAUL, V. (1986). **Potential for aquaculture of South American freshwater fishes: a review.** Aquaculture 5: 205–240.

QUEIROZ, H. L. & SARDINHA, A. D. (1999). **A preservação e o uso sustentado dos pirarucus (Arapaima gigas, Osteoglossidae) em Mamirauá.** In: Estratégias de Manejo para Recursos Pesqueiros na Reserva de Desenvolvimento Sustentável Mamirauá. Queiroz, H. L. e Crampton, W. G. R, eds. MCT-CNPq/Sociedade Civil Mamirauá. Brasília.

SCM. (1996). **Mamirauá management plan.** SCM, CNPq/MCT. Brasília.

VERÍSSIMO, J. (1895). **A Pesca na Amazônia.** Livraria Clássica. Rio de Janeiro.

VIANA, J.P., J.M.B. DAMASCENO, L. CASTELLO & W.G.R. CRAMPTON (2004). **Economic incentives for sustainable community management of fishery resources in the Mamirauá Sustainable Development Reserve, Amazonas, Brazil.** In: K.M. Silvius, R.E. Bodmer e J.M.V. Fragoso [eds.]. People in Nature: Wildlife Conservation in South and Central America. Columbia University Press.

Marine and Coastal Zone Division
Esplanada dos Ministérios - Bloco B – 7º andar – sala 713
70.068-900 Brasília- DF
Tel.: 55 61 4009 1151 e 4009 1387
Fax: 55 61 4009 1213
E-mail: nzcm@mma.gov.br

Fauna and Fishery Resources Directorate
SCEN Trecho 2 Ed. Sede do IBAMA - Bloco B
70.818-900 Brasília - DF
Tel.: 55 61 3316 1650
Fax: 55 61 3316 1200
E-mail: difap@ibama.gov.br

Fishery Resources General Coordination
SCEN Trecho 2 Ed. Sede do IBAMA - Bloco B
70.818-900 Brasília - DF
Tel.: 55 61 3316 1480 e 3316 1481
Fax: 55 61 3316 1238
E-mail: coordenacao.pesca.sede@ibama.gov.br

Floodplain Natural Resources Management Project
Rua Ministro João Gonçalves de Souza s/n - Distrito Industrial
69.075-830 Manaus - AM
Tel.: 55 92 3613 6246 e 3613 6574
Fax: 55 92 3237 5616
E-mail: provarzea@provarzea.ibama.gov.br

ProVárzea
Projeto Manejo dos Recursos Naturais da Várzea
IBAMA MMA

Doadores

DFID kfw gtz Banco Mundial Rain Forest Pilot Program PNUD

Photos:
Cover: (Marcelo Lourenço)
Front-cover: (Projeto Tamar/IBAMA, Marcelo Lourenço, Miguel von Beher, Manoel Veiga, ProVárzea/IBAMA).

SNUC

SISTEMA NACIONAL DE UNIDADES DE CONSERVAÇÃO

Co-prodution:

ProVárzea

Projeto Manejo dos Recursos Naturais da Várzea

IBAMA MMA

Ministério do Meio Ambiente

BRASIL UM PAÍS DE TODOS GOVERNO FEDERAL