Universidade do Algarve
Faculdade de Ciências do Mar e do Ambiente

Follow up on the local implementation of an MPA in the small fishing village of San Felipe, Yucatan: environmental changes and community-based management issues

Dissertação apresentada por

Ana Cristina Martins de Jesus

Para a obtenção do grau de

Mestre em Biologia Marinha, na especialidade de Ecologia e Conservação Marinha

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Dissertação co-orientada por

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Faro, 2007

A la gente de San Felipe, que tanto me
ha enseñado y que tanto ha
compartido.

Universidade do Algarve
Faculdade de Ciências do Mar e do Ambiente

Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional
Unidad Mérida
Departamento de Ecologia Humana y Departamento de Recursos del Mar

The most vital task of the present age is to formulate a social basis for civilization, to dethrone economic ideals and replace them by human ones.

(Sir Julian Huxley)

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Abstract

At the small fishing village of San Felipe, Yucatan, southeast Mexico, a group of people from the fishing cooperative supported by the local authorities decided to establish an MPA, in 1995, in an area acknowledged by the locals for its natural high productivity, as a response to the overexploitation of fisheries resources. The present study emerged to better understand such a bottom-up initiative, having two specific objectives: (1) update the benthic habitat map of the Actam Chuleb MPA and compare it, in terms of submerged aquatic vegetation areal extent and spatial distribution, with a 2000 map (before the hurricane Isidore hit the area); and (2) analyse the perceptions and attitudes of the Actam Chuleb MPA stakeholders considering the benefits and obstacles that influence the MPA development and co-management. The main tools used in this study involved remote sensing technologies to perform the classification of multispectral imagery from 2000 and 2005, using ground-truth data acquired with a towed underwater video camera, an in-depth stakeholder survey, participant observation, and a participatory community workshop. Although the results have shown differences in the areal extent, spatial distribution and composition of seagrass meadows between 2000 and 2005, according to the local fishermen the MPA seems to preserve its breeding and nursery functions. Considering the management of the MPA, it is important to highlight that so far no local organization representing the interests of the several MPA stakeholder groups has emerged, which severely undermines the possibility of developing an equitable co-management partnership between the government and the local users. Therefore, although recognizing the importance of the MPA and its benefits, the majority of stakeholders are currently unmotivated. This case study emphasizes the need to adopt interdisciplinary research approaches to better understand the complex social-environmental systems, where the management of natural resources takes place.

Keywords: MPAs, community-based management, benthic habitat mapping, SAV, remote sensing, baseline data, interdisciplinary research

Resumo

Em San Felipe, uma pequena comunidade pesqueira localizada na costa norte do estado do Yucatão, México, o crescente declínio das pescas associado à exploração indiscriminada dos recursos pesqueiros e à constante ameaça de furacões leva a que um grupo de pescadores experientes, membros da cooperativa pesqueira local *Pescadores Unidos de San Felipe*, apoiados pela Câmara Municipal e outras autoridades locais, proponham em 1995 a delimitação de uma AMP que contribua para a protecção dos recursos costeiros e que funcione como área alternativa de pesca, especialmente durante a veda da lagosta e do polvo (principais espécies capturadas) e durante os períodos de mau tempo. A escolha da área a proteger baseou-se no conhecimento ecológico local dos pescadores, uma vez que esta área é um berçário natural para várias espécies marinhas de elevado valor comercial, sendo muito rica em termos de cobertura vegetal submersa, nomeadamente em ervas marinhas. Oficialmente, a AMP Actam Chuleb é considerada como uma das componentes marinhas de uso restringido da Reserva Estatal de Dzilam, decretada em 1989, mas cujo plano de gestão só foi aprovado em 2006, prejudicando e condicionando em termos legais a gestão local da referida AMP. A realização deste estudo interdisciplinar surge como resposta à necessidade de entender as condições que estão na base e que alimentam o surgimento de uma iniciativa de *bottom-up* para a conservação dos recursos naturais, num contexto global onde cada vez mais se acredita que é necessário envolver proactivamente os usuários locais na gestão dos recursos e também da necessidade de compreender melhor a dinâmica dos ecossistemas costeiros, no sentido de gerar informação sócio-ambiental de base para sustentar a necessidade constante de conhecimento tão característica de um processo integrado de gestão dos recursos naturais. Assim sendo, o presente estudo procurou atingir dois objectivos específicos: (1) mapear a vegetação aquática submersa da área marinha protegida Actam Chuleb e comparar as percentagens de cada classe de cobertura do mapa obtido (2005) com as de um mapa gerado no ano 2000, antes da passagem do furacão Isidoro em 2002; e (2) analisar as percepções e atitudes dos vários grupos de actores sociais (*stakeholders*) relativamente aos benefícios da implementação da AMP Actam Chuleb e aos obstáculos que têm influenciado o cumprimento dos seus objectivos e a sua co-gestão. Para cumprir com o primeiro

objectivo, foi empregada uma metodologia de detecção remota, através da qual se classificaram supervisionadamente duas imagens de satélite, uma de 2005 (SPOT 5) e outra de 2000 (ETM+), com o objectivo de gerar dois mapas de cobertura bentónica vegetal de dois períodos distintos, para posteriormente proceder à sua comparação. Tendo esta sido reforçada pela análise de determinados índices utilizados em ecologia da paisagem. Os dados de campo necessários para supervisionar o processo de classificação das imagens foram adquiridos ao longo de 93 estações, através da realização de videotransectos subaquáticos. Para atingir o segundo objectivo, utilizou-se uma abordagem essencialmente característica das ciências sociais, que incluiu, primeiramente, a revisão de fontes secundárias de informação. Posteriormente, implicou viver na comunidade durante vários meses, ao longo dos quais se realizaram 48 entrevistas profundas aos *stakeholders* considerados mais relevantes no processo de gestão da AMP e entrevistas informais a informadores chave da comunidade e do governo municipal e estatal. Adicionalmente, levou-se a cabo a aplicação, via correio electrónico, de um curto questionário a 9 agentes externos de relevância no processo de gestão da área. Escusado será dizer que a técnica de observação participativa foi complementar e essencial para melhor entender as percepções e atitudes dos vários intervenientes e o próprio processo de gestão em si. Para finalizar o trabalho de campo, efectuou-se um *workshop* participativo, ao qual assistiram 26 pessoas, com o objectivo de devolver os resultados obtidos à comunidade, confirmar dados e principalmente esclarecer dúvidas e fomentar a comunicação entre os vários grupos de usuários. No que diz respeito às alterações ocorridas na vegetação submersa da AMP entre 2000 e 2005, verificou-se que a única classe que perdeu percentagem de cobertura foi a classe 'ervas marinhas 50-90%'. Dentro desta classe observou-se que a espécie *Thalassia testudinum*, considerada uma espécie clímax em termos de sucessão ecológica, perdeu representatividade, sugerindo a sua fragilidade em condições de perturbação física. Associada a esta perda verificou-se uma expansão na classe 'macroalgas 50-90%', um grupo pioneiro no que diz respeito à recuperação de áreas danificadas. Considerando os resultados obtidos pensa-se que grande parte das alterações observadas poderão ter sido provocadas pela passagem do furacão Isidore em Setembro do ano 2002, durante a qual os ventos atingiram os 220 km h^{-1}, provocando a redistribuição dos sedimentos. No entanto, de acordo com os pescadores locais, a zona tem vindo a recuperar-se, tanto em termos de vegetação

como de fauna marinha. Um aspecto interessante de salientar em termos de dinâmica dos sedimentos foi a manutenção de 2000 para 2005 da forma característica das línguas de areia localizadas na parte ocidental da área de estudo, indicando a existência de padrões oceanográficos constantes, capazes de restabelecer o equilíbrio no transporte de sedimentos. No que diz respeito às percepções e atitudes dos vários grupos de *stakeholders* em torno da reserva, um dos principais problemas detectados foi a falta de comunicação entre os grupos, nomeadamente entre a associação civil Actam Chuleb e os restantes grupos. Explicando claramente uma série de mal entendidos, desconfianças e consequente desinteresse da maioria dos usuários no que diz respeito à AMP. Sendo maioritariamente aqueles que vêem na reserva potenciais oportunidades económicas, os mesmos que revelam algum interesse em participar na sua gestão e assegurar a sua vigilância. De salientar que a associação Actam Chuleb foi reformulada em 2004, com o apoio do governo estatal, no sentido da integração dos vários grupos de usuários locais num comité local responsável pela vigilância e, eventualmente, também pela gestão da reserva caso surgisse um acordo de co-gestão entre os usuários e o governo estatal. No entanto foi exactamente o fracasso dessa tentativa que levou à actual falta de comunicação e cooperação entre os grupos. Factores que hoje em dia limitam a possibilidade de desenvolver acordos de co-gestão que promovam a participação de todos os grupos de usuários, uma vez que não existe a estrutura adequada para tal. Doze anos após a criação da AMP, este estudo revela a importância da legitimação e da representatividade do grupo que deverá representar os interesses dos usuários locais na gestão dos recursos naturais perante o governo. Além do mais, sugere que este grupo não deverá ser de natureza privada e que os processos de capacitação locais somente atingirão os seus objectivos de empoderamento caso produzam um efeito multiplicador dentro da comunidade. Para concluir, é de salientar a importância de integrar tanto a componente biológica como a social em estudos de gestão dos recursos naturais, uma vez que estas são inseparáveis.

Palavras-chave: AMPs, gestão de base comunitária, mapeamento de habitats bentónicos, VAS, detecção remota, estabelecimento de linhas de base, interdisciplinaridade

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Acronyms and Abbreviations

CARICOM	Caribbean Community and Common Market
CBM	Community-Based Management
CBD	Convention on Biological Diversity
CB-MPA	Community-Based Marine Protected Area
CBNRM	Community-Based (Natural) Resource Management
CCAD	*Comisión Centroamericana de Ambiente y Desarrollo* (Central American Environmental and Development Commission)
CINVESTAV	*Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional* (Centre for Research and Advanced Studies, National Polytechnic Institute), Mexico
CIRNAC	*Centro para el Manejo Integrado de los Recursos Naturales, A.C.* (Centre for the Integrated Management of Natural Resources), Mexico
COP7	Seventh Meeting of the Conference of Parties of the Convention on Biological Diversity
CPR	Common Property Resource
CRIPY	*Centro Regional de Investigaciones Pesqueras Yucalpetén* (Yucalpetén Regional Center of Fisheries Research), Mexico
CONAPESCA	*Comisión Nacional de Acuacultura y Pesca* (National Commission for Aquaculture and Fisheries), Mexico
DOS	Dark Object Subtraction
DN	Digital Number
ETM+	Enhance Thematic Mapper Plus
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
FMCN	*Fondo Mexicano para la Conservación de la Naturaleza*, *A.C.* (Mexican Fund for Nature Conservation), Mexico
GCP	Ground Control Point
GPS	Global Positioning System
HRG	High Resolution Geometric
ICM	Integrated Coastal Management

IDRC	International Development Research Centre
ISODATA	Iterative Self-Organizing Data Analysis Technique
INEGI	*Instituto Nacional de Estadística, Geografía e Informática* (National Institute of Statistics, Geography and Informatics), Mexico
LEK	Local Ecological Knowledge
LGEEPA	*Ley General del Equilibrio Ecológico y la Protección al Ambiente* (General Law for Ecological Balance and Environmental Protection), Mexico
LPAEY	*Ley de Protección al Ambiente del Estado de Yucatán* (Law for the Environmental Protection of the Yucatan State), Mexico
MPA	Marine Protected Area
MSL	Mean Sea Level
NGO	Nongovernmental Organization
OECD	Organization for Economic Co-operation and Development
PAN	*Partido de Acción Nacional* (National Action Party), Mexico
PRI	*Partido Revolucionario Institucional* (Revolutionary Institutional party), Mexico
PRIMER	Plymouth Routines in Multivariate Ecological Research
PROFEPA	*Procuraduría Federal de Protección al Ambiente* (Federal Department of Environmental Law Enforcement), Mexico
RGB	Red, Green, Blue
SAGARPA	*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación* (Secretariat for Agriculture, Livestock Farming, Rural development, Fisheries and Nutrition), Mexico
SECOL	*Secretaría de Ecología del Gobierno del Estado de Yucatán* (Secretariat of Ecology from the Yucatan State Government), Mexico
SEMARNAT	*Secretaría de Medio Ambiente y Recursos Naturales* (Secretariat for the Environment and Natural Resources), Mexico
SPOT	Le Système Pour l'Observation de la Terre
SPSS	Statistical Package for the Social Sciences

UADY	*Universidad Autónoma de Yucatán* (University of Yucatan), Mexico
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Program
UTM	Universal Transverse Mercator
VIMS	Virginia Institute of Marine Science, USA
XS	Multispectral

1. Introduction

1.1 Research Background

According to the statistics generated by the Food and Agriculture Organization of the United Nations (FAO 2006), world marine fishery resources show a clear downward trend as a consequence of stocks' decline due to overfishing and, to some extent, to environmental factors affecting stock productivity. From 1974 to 2005 there was a constant declining trend in the proportions of stocks offering potential for expansion, the proportion of overexploited and depleted stocks increased from about 10 percent in the mid-1970s to around 25 percent in the early 1990s, where it has stabilized until the present, while the proportions of fully exploited stocks show an overall increase from 50 percent in 1974 to 52 percent in 2005 (FAO 2006). Small-scale fisheries, which operate in nearshore coastal waters using a multitude of fishing gears focused on small multispecies stocks, although not as well documented in terms of statistics nor managed as commercial or industrial fisheries, contribute significantly employing 50 of the world's 51 million fishers, mainly from developing countries, and producing more than half of the world's annual marine fish catch in terms of total landings and value (Berkes et al 2001; Hempel & Pauly 2002). Concern exists about the future of fish stocks considering that they are the main source of both protein and income for coastal communities especially in developing countries (Berkes et al 2001; Hempel & Pauly 2002). In response to worldwide public concerns caused by stocks decline and the inefficiency of conventional management tools towards the sustainable exploitation of fishery resources, especially in small-scale fisheries, governments, researchers and stakeholders have been encouraged to reinvent fisheries management exploring creative, multidisciplinary collaborative strategies to maintain sustainable yields, focusing ecosystems rather than single fishery stocks (FAO 2006; García Allut 1998; Hempel & Pauly 2002).

One emergent management approach recommended to both protect vulnerable marine biodiversity and enhance the productivity of marine resources for sustainable use is the establishment of marine protected areas (MPAs) (Belfiore et al 2004; Pollnac &

Crawford 2000; Salm et al 2000). The benefits provided by MPAs and their importance to conserve marine biodiversity have been continuously advocated and put forward by several international fora and agreements. In 2004, the Seventh Meeting of the Conference of Parties (COP7) of the Convention on Biological Diversity (CBD) agreed that marine and coastal protected areas, implemented as part of an integrated coastal zone framework, are essential components of both national and global strategies for the conservation and sustainable use of biodiversity, and a means to manage conflicts, enhance the economic well-being and improve the quality of life of local communities (CBD 2005). Consequently, in order to achieve a significant reduction in the rate of biodiversity loss, parties of the CBD embraced the overall goal of bringing at least 10% of the world's marine and coastal ecological regions under protection by 2012, through the establishment and maintenance of ecologically representative and effectively managed protected area systems (CBD 2005). However, such target is probably too ambitious, since, as the World Conservation Monitoring Center noted, in 2006, only about 4000 MPAs existed worldwide, covering around half of one percent of the world's ocean surface. Besides, most of them are very small, many are not managed effectively and several are merely paper parks (Belfiore et al 2004). According to Salm et al (2000), the management of an MPA frequently fails because its surrounding land uses and social context are not taking into account, and because most of the times there is not wide cooperation from agencies, stakeholders (including local user groups) and impacters. These are huge issues limiting the success of MPAs that definitely need to be overcome in the nearest future.

Already recognized by Agenda 21, chapters 17[1] and 26[2] (UNCED 1992), it has become obvious that coastal resources conservation benefits from decentralization of authority. In the particular context of MPAs it is crucial to emphasize the currently generalized assumption that one fundamental prerequisite to achieve sustainability in MPA management is promoting ongoing stakeholder equitable participation in decision-making, through the establishment of co-management arrangements with the governmental authorities (Salm et al 2000).

[1] Chapter 17: "Protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources".
[2] Chapter 26: "Recognizing and strengthening the role of indigenous people and their communities".

Let us now focus on the Mexican strategy to implement MPAs. According to Bezaury-Creel (2004; 2005), the implementation of coastal and marine protected areas in Mexico has resulted from independent initiatives taken over the last 80 years by distinct presidential administrations, through various federal agencies with jurisdiction over fisheries, wildlife, forestry or the environment. Therefore, the existing MPAs are not the outcome of a systematic approach. As it would be expected, under a scenario of institutional fragmentation and lack of coordination, the legal framework that regulates the access and use of coastal resources in Mexico is considered, by several experts (Bezaury-Creel 2004; 2005; Quijano-Poumián & Rodríguez-Aragón 2004; Saavedra-Vázquez 2004; Vidal 2005), to be highly fragmented, incomplete, overlapping, and at some points inconsistent, being dispersed among numerous legal instruments[3] that were formulated from a sectoral perspective.

In March 2007, Mexico had 61 federal MPAs with valid establishment decrees, occupying 13,336,387 ha (4,502,145 ha marine[4] and 8,834,242 ha coastal) or 58.7% of the total area under federal protection (CONANP 2007). However, according to the available data, in May 2005, only 22 (or 37.3%) out of 59 MPAs, covering an area of 7,402,047 ha (or 57.4% of the total marine and coastal area under protection) had an official management plan and administrative rules defined within it (INEGI 2005a). Precisely to increase management capacity, and following contemporary global trends towards stakeholder participation in natural resources management, MPAs in Mexico have now the possibility of integrating stakeholder participation in their design and management. Since the revised version (1996) of the General Law for Ecological Balance and Environmental Protection (LGEEPA) states that the federal government will promote responsible participation of society in planning, executing, evaluating and supervising compliance with the environmental and natural resources policy (DOF 05/07/2007). To accomplish it, the Secretariat for the Environment and Natural Resources (SEMARNAT) considers the possibility of establishing partnership arrangements with several types of organizations, indigenous

[3] E.g., Mexican laws, regulations, decrees, secretarial agreements, official Mexican standards, and international conventions and agreements.

[4] The 4,502,145 ha comprehended by the marine component of the total area under protection represents 21.5% of Mexico's territorial sea, 11.4% of its continental shelf and 1.4% of its exclusive economic zone (EEZ).

people and community groups for establishing, administering and managing protected areas, and forming advisory councils to make recommendations and support the directors of protected areas in their functions (DOF 05/07/2007).

Though Mexico is working towards the decentralization of environmental management functions, and despite all its 31 States have created their own environmental legal instruments, jurisdiction over the coastal zone is mainly centralized at the federal level. As a result, until 2004, only three of its 17 costal States had established coastal protected areas (Baja California Sur, Sonora, Veracruz), and only four (Campeche, Chiapas, Quintana Roo and Yucatan) had established MPAs, reaching a total of 15 MPAs being run by the state governments, occupying 512,273 ha; at the municipal level only two Municipal Governments, La Paz, in Baja California Sur, and Tampico, in Tamaulipas, had established protected areas in coastal ecosystems; as for private land protection efforts, only four small private protected areas had been established to protect coastal lands (Bezaury-Creel 2004; 2005). As Bezaury-Creel (2005) predicts, states and municipalities (mainly responsible for land related jurisdictions) are likely to have minimal influence on policy in the near future, since these areas primarily remain under federal jurisdiction. Therefore, it is extremely important to reverse this situation towards an integrated coastal management strategy.

Even if the environmental sector has now a normative framework that enables the implementation of public participation instruments, it is necessary to recognize that there are still major issues constraining the development of mere consultative actions into co-responsible decision-making mechanisms that truly influence policy-making (SEMARNAT 2007). According to Robles et al (in press), it is impossible to achieve an efficient decentralization when there is a lack of technical and juridical capacities, infrastructures, inter- (municipal, state, federal) and intra- (sectoral) institutional coordination, and political will to ensure that the mandate given to local governments might be efficiently and effectively exercised. On the other hand, as pointed out by Bezaury-Creel (2005), a great deal of stakeholder capacity-building needs to take place, to achieve positive and long lasting results from public participation processes.

Even though Mexico's protected areas have existed for over a century, most of them have kept a paper status until the last decade (Bezaury-Creel 2005; SEMARNAP 2000). According to the former Secretariat for the Environment, Natural Resources and Fisheries (SEMARNAP 2000), until 1994, the majority of the Mexican protected areas did not have a management plan, staff, nor funding. Moreover, such areas have always suffered from the lack of community involvement in conservation strategies, along with many other shortcomings (Fraga et al 2006a). Before 1994 (and even now), the establishment decree was all that some protected areas had protecting their "virtual" existence.

That was precisely the case of the Dzilam State Reserve, which was decreed in 1989 and remained a "paper reserve" until the late promulgation of its management plan, in 2006. Meanwhile, in 1995, ignoring the existence of this reserve, a group of fishermen, supported by the local authorities of San Felipe, Yucatan, decided to establish a municipal marine reserve in a coastal shallow area, acknowledged by the experienced fishermen to provide spawning and nursery grounds for several commercially valuable species due to its ecological richness (see Fraga et al 2006b; 2006c; 2006d; Chuenpagdee et al 2002; 2004).

Motivated by a strong dependence on the increasingly overexploited fishery resources, the community of San Felipe, from which 55% of the economically active population were fishermen (INEGI 2000), organized itself towards the enforcement of such initiative, particularly to patrol the area currently named Actam Chuleb MPA. Initially, this was done in a voluntary basis, but, in 1997, the fishing cooperative, in collaboration with an environmental nongovernmental organization (NGO) from Mérida, managed to get funded. In 1999[5], in the sequence of these projects, the fishing cooperative got in touch with the Secretariat of Ecology from the Yucatan State Government (SECOL) to hand in a potential management plan for the municipal MPA, and the guidelines for what could have been a potential partnership arrangement between the state and the local government to manage the Dzilam State Reserve and within it the Actam Chuleb MPA. Unfortunately the cooperation attempt fell through. This happened despite the Law for the Environmental Protection of the

[5] After two years of negotiations with SEMARNAP and SECOL trying that one of these governmental agencies officially recognized the area that was decreed as a municipal marine reserve in 1997.

Yucatan State (LPAEY) stating that the state government and the municipalities would promote the participation of civil society in the formulation of environmental policy and in associated activities, particularly through the celebration of partnership arrangements with NGOs to establish, administrate, and manage natural protected areas[6] (since 1999, Article 87). Eventually, in 2007, the SECOL and an NGO from San Felipe, the *Asociación Civil* Actam Chuleb, ended up celebrating a general partnership arrangement to co-manage the natural protected areas of the Yucatan State, which enabled the future establishment of specific co-management agreements.

Twelve years after the bottom-up initiative of establishing the MPA many things have changed internally, in the community's social dynamics, and externally, with periodic changes in municipal and presidential administrations, with the interventions of academics through research projects[7] and with the interventions of international development agencies. Unfortunately, some of these changes did not occur as fast as they needed to and others probably did not occur in the most "desirable" direction, which would have been towards the implementation of an equitable and participatory decision-making mechanism to co-manage the Actam Chuleb MPA, as advocated by several local user-groups.

As Fraga et al (2004) had already underlined, following the development of such a bottom-up initiative using a interdisciplinary approach gives valuable insight into the variety of interests being negotiated in the process of consolidating an MPA and into the key factors that might trigger and constrain the establishment of a co-management partnership in a specific context. Which, according to Berkes (2004), is precisely what we need to keep deepen our knowledge about, in the context of natural resources co-management.

Considering the global and local context above described, this thesis emerged to fulfil the need of better understand co-management of natural resources as a complex process with certain requirements. Therefore, the research questions that initially

[6] The State Government and the Municipalities might celebrate these partnership arrangements alone or in coordination with the appropriate federal authorities.

[7] An important three-year multidisciplinary research projected was carried out in San Felipe, from 2000 to 2003, focusing on the community-based management of the Actam Chuleb MPA, funded by the International Development Research Center (IDRC).

guided this research were: How did the bottom-up initiative of establishing a community-based MPA in San Felipe evolved along the subsequent 12 years? What are the factors that trigger, and constrain the sustainable development of the Actam Chuleb MPA co-management process? What are the perceptions of the MPA stakeholders regarding its benefits and obstacles? What major environmental changes have occurred in the ecosystem encompassed by the MPA along these 12 years? And how do these changes have affected the livelihoods of the MPA stakeholders?

1.2 Research Objectives

1.2.1 Main Objectives

The aims of this research were to: (1) contribute to the understanding of the factors that might trigger, and constrain the establishment and subsequent development of a co-management arrangement, through the analysis of the strengths, weaknesses, opportunities and limitations of the co-management process of the Actam Chuleb MPA; and (2) establish a socio-ecological baseline, to inform future management decisions, and nourish community involvement.

1.2.2 Specific Objectives

1. Update the benthic habitat map of the Actam Chuleb MPA and compare it with a 2000 map (before the hurricane Isidore hit the area) in terms of submerged aquatic vegetation composition, areal extent and spatial distribution;

2. Analyse stakeholder attitudes and perceptions on the benefits of the MPA and on the obstacles to its functioning and co-management, 12 years after its implementation, and identify the key issues that influence stakeholder support, indifference or opposition to the MPA.

1.3 Plan of Thesis

As noted above, this thesis intended to explore the factors that might have influenced the establishment and development of a community-based MPA in the fishing community of San Felipe. Up to this point (Chapter 1), the subject of the thesis has been presented and nested in the global context, research questions have been introduced and the aims stated. Subsequently, the subject will be deepened from an interdisciplinary point of view. In this sense, Chapter 2 consists of a theoretical and conceptual overview of the current challenges and alternative approaches in coastal management, introducing the increasingly popular concepts of co-management and community-based management, and exploring key related concepts like community, stakeholders, common property resources, institutional arrangements and collective action. Chapter 3 presents a detailed description of the fishing community of San Felipe and introduces the story of the Actam Chuleb MPA towards a better understanding of the research setting. Chapter 4 carefully describes the methodology used to update the benthic habitat map of the MPA and analyze the ecological changes that have occurred in the area from 2000 to 2005, and to explore stakeholder perceptions regarding the benefits and obstacles affecting the MPA and its management. Chapter 5 presents the obtained results concerning the MPA benthic habitat characterization and change detection, and summarizes the findings generated by seven years of participatory research in the community of San Felipe, from 2000 to 2003, in the context of a multidisciplinary project funded by the IDRC, and, from 2006 to 2007, in the ambit of the present thesis. Chapter 6 discusses the ecological importance of the Actam Chuleb MPA, and the main strengths, weaknesses, opportunities and limitations of the current MPA management system, in the context of the previously reviewed concepts of co-management, institutional arrangements and collective action. To conclude, Chapter 7 presents the overall final considerations.

2. Theoretical and Conceptual Framework

2.1 Coastal Management: Challenges and Alternative Approaches

"Coastal zone" can be defined as the area at the interface between land and sea, suffering both land and sea influences, what is generally difficult is to define its boundaries, which depend on biogeographical conditions, the variety of socioeconomic and cultural uses, existing problems, and the legal system (Cicin-Sain & Knecht 1998). The coastal zone contains many different types of coastal systems, including freshwater and brackish water wetlands, mangrove forests, estuaries, marshes, lagoons and salt ponds, rocky or muddy intertidal areas, beaches and dunes, coral reef systems, seagrass meadows, kelp forests, nearshore islands, semi-enclosed seas, and nearshore coastal waters of the continental shelves, which are among the most highly productive systems in the world, but unfortunately also among the most highly threatened, and subject to major environmental changes (Agardy & Alder 2005; Cicin-Sain & Knecht 1998). According with available global data, approximately 35% of mangrove area has been lost or converted, about 20% of coral reefs have been destroyed, with more 20% being degraded in the last few decades, in addition coastal wetland loss in some places has reached 20% annually, putting worldwide coastal ecosystem highly valued services at great risk (Agardy & Alder 2005). Moreover, about 60 percent of the world population lives in this extremely diverse, productive, high valued, dynamic, and very susceptible area, and along with growing urbanization, industrialization, and transportation this percentage is likely to increase, putting even greater pressure on the living and non-living resources of the coastal areas (Agardy & Alder 2005; Cicin-Sain & Knecht 1998; Lindeboom 2002; UNCED 1992). Pollution, erosion and siltation, urbanization, land reclamation, eutrophication, overfishing, mining, and tourism continuously menace the future of coastal ecosystems (Cicin-Sain & Knecht 1998). Therefore one of the greatest challenges currently faced by humankind is to sustainably manage the human use of coastal areas, in order that future generations can also benefit and enjoy its

environmental and cultural features, and edible products (Lindeboom 2002). However, in spite of international, national, regional and local efforts, current approaches to the management of coastal resources have seldom proved capable of accomplishing sustainable development, and consequently these resources are being quickly degraded in many parts of the world (UNCED 1992). According to Lindeboom (2002), the complexity of coastal ecosystems and the interactions between all their components demands the implementation of a system-based management. Therefore, the challenge for science is to define and understand the natural and socioeconomic boundaries and limits of these systems, and one thing is for sure, coastal management as a means of sustainable co-evolution of environmental and socioeconomic systems mainly relies on the underpinning multidisciplinary science (Lindeboom 2002).

2.2 Integrated Coastal Management

Following the United Nations Conference on Environment and Development (UNCED) in 1992, and the consequent formulation of the Agenda 21 Chapter 17, there has been a sudden focus on integrated coastal management (ICM) as the most potentially successful response to the accelerating transformation of the world's coastal areas. This interest has been demonstrated by all the major international agreements on oceans and coasts, and on the agendas of the donor organizations, national governments, NGOs and universities (GESAMP 1996; Olsen 1996). Although the concept of ICM can have multiple definitions according to specific perspectives, contexts and objectives, a fundamental principle of ICM is that ecosystem functioning, anthropogenic forces, and the sustainability of human societies are interrelated and should be holistically managed through the collaboration of all groups (Gilmam 2002). One definition of ICM commonly found in the literature is the one presented by Cicin-Sain and Knecht (1998, p. 39), which states that:

> ICM can be defined as a continuous and dynamic process by which decisions are made for the sustainable use, development, and protection of coastal and marine

> areas and resources…the process is designed to overcome the fragmentation inherent in both the sectoral management approach and the splits in jurisdiction among levels of government at the land–water interface.

The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP 1996, p. 3) added to the definition that:

> ICM requires the active and sustained involvement of the interested public and many stakeholders with interests in how coastal resources are allocated and conflicts are mediated. The ICM process provides a means by which concerns at local, regional and national levels are discussed and future directions are negotiated.

In the ICM process, integration must be addressed in several dimensions: (1) intersectoral integration between costal, marine and land-based sectors; (2) intergovernmental integration among different levels of government; (3) temporal integration, ensuring coordination among short-, medium- and long-term programs; (4) spatial integration between the land and marine components of the coastal zone; (5) science-management integration among the different scientific disciplines and the transfer of science for use by management entities and decision-makers; and (6) international integration among nations (Cicin-Sain & Knecht 1998; GESAMP 1996). However, given the likelihood that many coastal management initiatives will continue to take place under the guidance of sectoral management agencies, ICM programs should emphasize coordination, harmonization, conflict resolution, integration of coastal and ocean policy, filling of gaps in management, in monitoring, and in performance assessment (Cicin-Sain & Knecht 1998).

In contrast to sectoral entities and processes, which tend to be concerned with only one use or resource of the coastal and marine environment, the ICM process is expected to address several important functions related to overall patterns of use, the well-being of marine and coastal areas, and the protection of key habitats, including area planning, promotion of economic development, stewardship of resources, conflict resolution, protection of public safety, and proprietorship of public submerged lands and waters (Cicin-Sain & Knecht 1998). Although several ways of

developing ICM programs can be found around the world, embodying each nation's particular physical, socioeconomic, cultural, and political circumstances, they generally follow a cyclical process, composed by a number of typical stages: (1) issue identification and assessment, where the environmental, social and institutional issues, as well as the major stakeholders and their interests are identified and goals set; (2) programme planning and preparation, where baseline conditions will be documented, and the programme developed involving the stakeholders in process; (3) formal adoption and funding, where formal endorsement of policies/plan should be obtained, governance arrangements should be established or improved, and intersectoral and intergovernmental coordination mechanisms strengthened, and funding obtained; (4) implementation, where the institutional and legal frameworks should be operationalized, participation of all stakeholders should be sustained, and the program monitored; and (5) evaluation, where the outcomes will be assessed, evaluated, and the program adapted to evolving conditions (Cicin-Sain & Knecht 1998; GESAMP 1996; Olsen et al 1999). However, the dynamic nature of the process continuously requires feedbacks, which may lead to the adjustment of the sequence or to the repetition of some steps. In this sense, the ICM cycle schematized in Figure 2:1, and its stages along with associated priority actions listed bellow in Table 2:1, are simply illustrative.

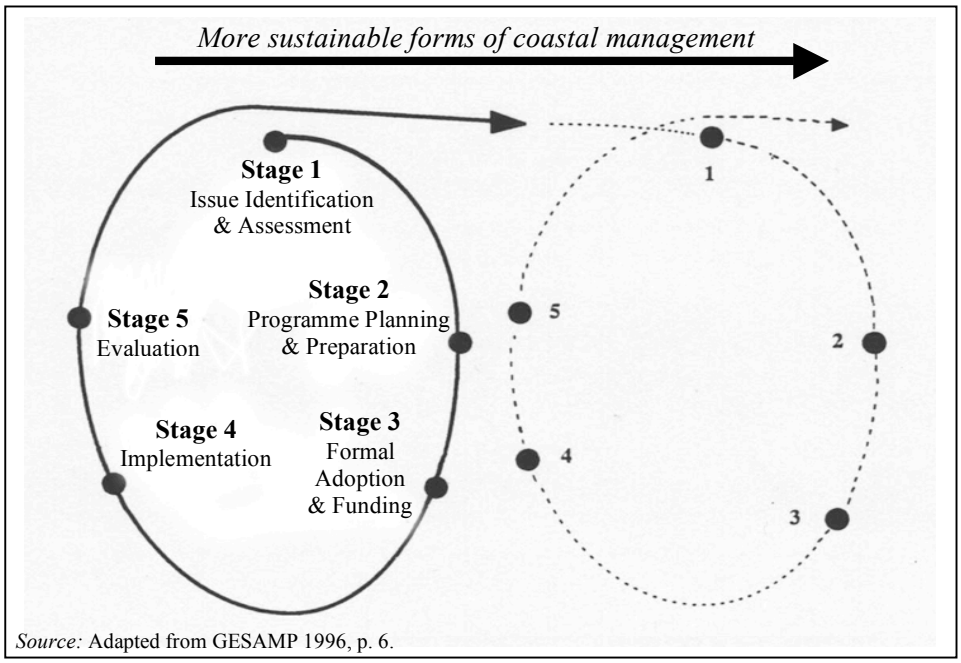


Figure 2:1 The stages of the ICM cycle

Table 2:1 Essential Actions Associated with the Stages of the ICM Cycle

Stage	Priority Actions
Stage 1: Issue Identification and Assessment	• Assess the principal environmental, social and institutional issues and their implications. • Identify the major stakeholders and their interests. • Invite review and response to the assessment. • Select the issues upon which the management initiative will focus its efforts. • Define the goals of the management initiative.
Stage 2: Programme Planning and Preparation	• Conduct scientific research targeted at selected management questions. • Document baseline conditions. • Conduct a public education program and involve stakeholders in the planning process. • Develop the management plan and the institutional framework by which it will be implemented. • Create staff and institutional capacity for implementation. • Test implementation strategies at a pilot scale.
Stage 3: Formal Adoption and Funding	• Obtain governmental mandate for a planning and policy formulation process. • Obtain formal endorsement of policies/plan and the authorities necessary for their implementation. • Establishment or improvement of governance arrangements, including establishment or strengthening of intersectoral and intergovernmental coordination mechanisms. • Obtain the funding required for program implementation.
Stage 4: Implementation	• Modify the strategies of the program as needed. • Promote compliance with program policies. • Strengthen institutional frameworks and legal authority for management. • Implement mechanisms for interagency coordination. • Strengthen program staffs' technical and administrative capacity. • Catalyse the construction and maintenance of necessary physical infrastructure. • Sustain participation of major stakeholder groups. • Implement conflict resolution procedures. • Maintain the program's priority on the public agenda. • Monitor performance and societal/ecosystem trends.
Stage 5: Evaluation	• Assess the program's impacts on the management issues being addressed. • Adapt the program to its own experience and the changing social and environmental conditions. • Conduct external evaluations at major junctures in the program's evolution.

Source: Adapted from GESAMP 1996, and Olsen et al 1997, as found in Olsen et al 1999, p. 7.

In general, experiences at different scales have shown that ICM programmes mature through adaptive learning over successive completion of management cycles, as the geographic scope increases and new and more complex issues are addressed. This learning process preferably takes place through both internal processes of analysis, reflection and adjustment, and by formal external evaluations, normally grouped in three major types: performance, management capacity and outcome evaluations, according to Olsen et al (cited in Olsen et al 1999). Therefore, the "evaluation stage" is critical if ICM programmes are to progress through a series of generations to more sustainable forms of coastal development. However, an effective evaluation can only

be conducted if the programme objectives have been clearly stated and indicators for assessing progress identified in stages 2 and 3, and monitored during the proceeding generation, hence available baseline data are crucial (Olsen et al 1999; GESAMP 1996).

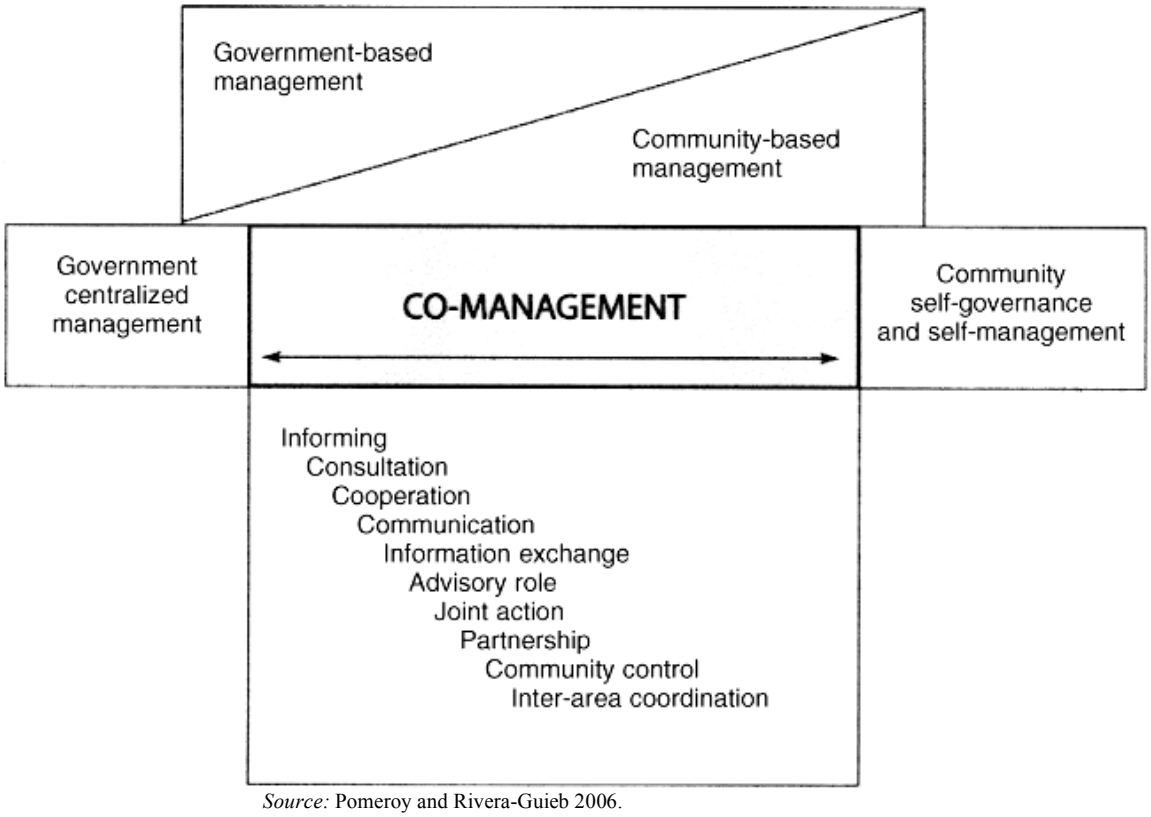
2.3 Co-management and Community-based Management

A central and increasingly adopted management approach within the ICM context is co-management[8], once it advocates a collaborative approach to resources management rather than a directive imposing one. Co-management is based on the premises that resource users are very knowledgeable about local ecological processes, due to their experience, and can add important and effective inputs to the management process; and that the active participation of resource users in decision-making enhances the legitimacy of the regulatory regime, promoting commitment, and, therefore, compliance with the management strategy and regulations (Jentoft et al 1998). According to Pomeroy and Rivera-Guieb (2006), co-management can be defined as a partnership arrangement involving power and responsibility sharing, through consultations and negotiations, between the local resource users, the different levels of government, other stakeholders, and external agents (e.g., NGOs, academic and research institutions). In this sense, co-management attempts to overcome the distrust, corruption, fragmentation and inefficiency of existing resources management arrangements, promoting aspects of democratization, responsibility, collaboration, social empowerment, equity, social justice, dialogue and communication, conflict management, and power decentralization (Pomeroy & Rivera-Guieb 2006).

Co-management comprises a whole range of partnership arrangements and degrees of power sharing and collaboration between local and government centralized management systems (see Figure 2:2), which will vary according to the nature of the resource, the political context, the expertise and skills of participating organizations, and the degree of mutual trust (Pomeroy & Rivera-Guieb 2006). In co-management

[8] Co-management is also known as participatory management, collaborative management, or joint management (Borrini-Feyerabend 2000).

there is no such a thing as a blueprint or model, furthermore "blueprint thinking" is considered by Ostrom (1994) to be a powerful threat to community governance, occurring whenever policymakers, donors, or scholars suggest standardized solutions to a wide variety of problems, clustered under a single name, based on one or more successful examples. As Pomeroy and Rivera-Guieb (2006) underlined, a healthy co-management process will change over time; partnerships, roles, and responsibilities will be accomplished, strengthened and redefined several times during the process, depending on the needs and opportunities, the legal framework, the political support, and on the level of trust, capacity, credibility, legitimacy, and success of the partners and the whole co-management arrangement. Therefore to establish and run a process of this nature can be complex, costly, and time consuming, specially at the community level, where it may take up to 3-5 years to organize and initiate activities and interventions, as well as for partners to start dealing with legitimacy, trust, accountability and transparency issues (Pomeroy & Rivera-Guieb 2006).



Source: Pomeroy and Rivera-Guieb 2006.

Figure 2:2 Co-management integrates local and centralized government management systems.

Community-based management (CBM) or community-based natural resource management (CBNRM) is considered an integral part of co-management, increasingly embraced by policymakers, analysts and NGOs in numerous fields, as a response to the poor conservation outcomes that followed decades of intrusive resource management strategies, as a consequence of a limited resource management paradigm emphasizing technical expertise, a focus on Western forms of science, and bureaucratic centralization (Agrawal & Gibson 2001; Brosius et al 1998; 2005). This approach seeks to encourage better resource management outcomes with the full participation of communities and resources users in decision-making, through the incorporation of local institutions, customary practices and knowledge systems in management, regulatory, and enforcement processes (Armitage 2005). However, CBM is not a magic potion for resource management. In practice, and considering multiple contexts, some programs may perform better than others (Pomeroy & Rivera-Guieb 2006). According to Degnbol et al (2006), one critique regarding CBM performance is that as the scope of a community is often smaller than the scope of an ecosystem, in order to cover all ecosystem processes, management should rather be carried out at a higher level or cooperatively by several communities. Another critique regards the simplification of complex concepts like community (see Section 2.3.1), property rights (see Section 2.3.2), traditional resource use systems, and historical livelihood strategies (Armitage 2005; Degnbol et al 2006). Furthermore, social divisions, disagreements and conflicts within the community actively reduce its internal management capacity. According to Pomeroy (1994) CBM may not be suitable for every community, as many may not be eager to or capable of taking on the responsibility. Therefore, although good principles underpin CBM, in practise it might be difficult to accomplish, as communities frequently add complexity and risk to the process. On the other hand, communities' management skills can be enhanced, and integrative institutions within and between communities can be built to address internal divisions and interdependencies, correspondingly. Ultimately, to increase the effectiveness of CBM programmes, communities will need government financial and legislative support, which, in many cases, would imply a reorientation of state policies and practices (Degnbol et al 2006).

2.3.1 Community and Stakeholders

The concept of "community" can often be misleading. Theoretically, community can be defined geographically, via political or physical boundaries, or socially, as a community of individuals sharing a common activity or interest in a particular resource (Pomeroy & Rivera-Guieb 2006). However, it is very naïve to think about a community as a homogeneous unit. Frequently, it will comprise subgroups of individuals differentiated by ethnicity, religion, social status, political and economic power, economic activity, gender, knowledge and intentions (Agrawal & Gibson 2001). Therefore, community members should not be considered to be similarly receptive to ideas of development and efficient resource management, progress, and modernization (Agrawal & Gibson 2001; Pascual-Fernández et al 2005; Pomeroy & Rivera-Guieb 2006). Accordingly to Agrawal and Gibson (2001, p. 2), the role of community in the context of conservation is better interpreted "by focusing on the multiple interests and actors within communities, on the process of how this actors influence decision-making, and on the internal and external institutions that shape the decision-making process". Nowadays, as Pascual-Fernández et al (2005, p. 154) point out, "the social and cultural systems of contemporary coastal communities should always be analysed considering their relationship with regional, national and international processes".

Coastal communities, for instance, typically comprise a multiplicity of stakeholders[9], with divergent interests, motivations, political and economic influences, ways of perceiving problems and opportunities regarding the resources and, consequently, the co-management process. Individual self-interest is a powerful force and must be taken into account in devising viable arrangements for the management of common-property resources (Feeny 1994). In this sense, the representation of different stakeholders is crucial and must be balanced properly, as the diversity of interests needs to be recognized, understood and respected in order to build an efficient and equitable management mechanism. A central question, however, is how to choose

[9] Within the context of CBM of marine and coastal resources, stakeholders are individuals, groups or organizations of people who are interested, involved or affected (positively or negatively) by the use and management of these resources (Pomeroy & Rivera-Guieb 2006).

those representatives, as a limit line must be establish, otherwise the representation of too many interests will undermine the process (Pomeroy & Rivera-Guieb 2006).

2.3.2 Common Property Resources, Institutional Arrangements and Collective Action

At the core of co-management there are issues of collective governance of common property resources, institutional arrangements, and property rights. Common property resources (CPRs) or common-pool resources, according to Ostrom (1994), can be described as resources where one person's use reduces its availability to others, and where the exclusion of potential beneficiaries is generally problematic. Because of the subtractive nature of CPRs, managing these resources requires a collective approach, particularly when there is a high dependence on the resource and its availability is uncertain or limited (Pascual-Fernández et al 2005; Runge, cited in Pomeroy & Rivera-Guieb 2006, p. 13) Therefore, all around the world, in order to regulate the sustainable use of coastal and marine resources, institutional arrangements have been extensively and diversely developed according to the local environment and social context (Ostrom 1994; Pascual-Fernández et al 2005), comprising sets of formal and informal rules and norms, laws, regulations, associations, contracts and property rights[10] (Agrawal & Gibson 2001; Feeny 1994). However, building institutions demands a great investment of time and presents costs. According to Pomeroy and Rivera-Guieb (2006), these execution costs are the costs of obtaining information about the resource and its use, of accomplishing agreements within the group of users with respect to resource use, and enforcing agreements that have been accomplished. Consequently, coordination and information activities are essential aspects of building institutions.

[10] Commons theorists, define property rights as sets of rules that determine the access, use, exclusion, management, monitoring, sanctioning, and the judgment behavior of users with respect to specific resources (Schlager & Ostrom cited in Agrawal 2003, p. 244). Property rights are an essential aspect in the description of any situation comprehending common property resources, as different types of property rights over resources, 'whether held juridically, exercised authoritatively, or both', can create varying consequences for use and management (Agrawal & Ostrom 2001). For a more in-depth discussion of property rights regimes, see Edella Schlager and Elinor Ostrom, 'Property rights regimes and natural resources: a conceptual analysis', *Land Economics*, vol. 68, no. 3(1992), pp. 249-62.

Although in some areas high levels of organization regarding the local use of CPRs have emerged, in other places processes of institutional innovation have either failed or are non-existent. Therefore, it is interesting to understand the prerequisites for collective action to take place, and what factors may influence its performance through time, since many factors may influence the behaviour and strategies of resource users, facilitating or delaying the building or maintenance of local institutions for resource management (Pascual-Fernández et al 2005). Certainly, important factors are the benefits perceived by the resource users regarding the institutional arrangements, which may or may not compensate for the costs involved, and the authority and ability to dynamically innovate institutional arrangements to fit in with evolving challenges, like new opportunities, internal growth, institutional disagreements and external pressures induced by the market, demographic transformations, tourism, etc., that may alter the preconditions for local institutions and the relationship between the environment and human beings who use environmental resources (Agrawal 2003; Feeny 1994; Pascual-Fernández et al 2005). Institution building is a long-term process, often based on trial and error, where governmental policies play a central role recognizing or not the rights of local community organizations and encouraging or not local organization (Pomeroy & Rivera-Guieb 2006).

An important aspect to have in mind about institutions is its human genesis, as underpinning their emergence there are specific social actors, whose interests may shape institutional arrangements, allowing them to obtain advantages from specific institutional changes rather than enabling societies, as a whole, to obtain its benefits (Agrawal 2003). Institutions' inclusive efficiency will depend "on the extent to which the interests of groups attempting institutional change intersect or overlap with those of the larger collective" (Agrawal 2003, p. 245). For that reason, some authors suggest that the appearance of new institutions is an extremely political matter, as it may be more likely to occur when relevant political actors perceive gains from it. That being so, the study of "power and micro-politics" within communities might be essential to understand how resources are used and managed (Agrawal 2003).

Another important aspect for understanding the dynamics of institutional arrangements is what drives and regulates individual action. As Pomeroy and Rivera-

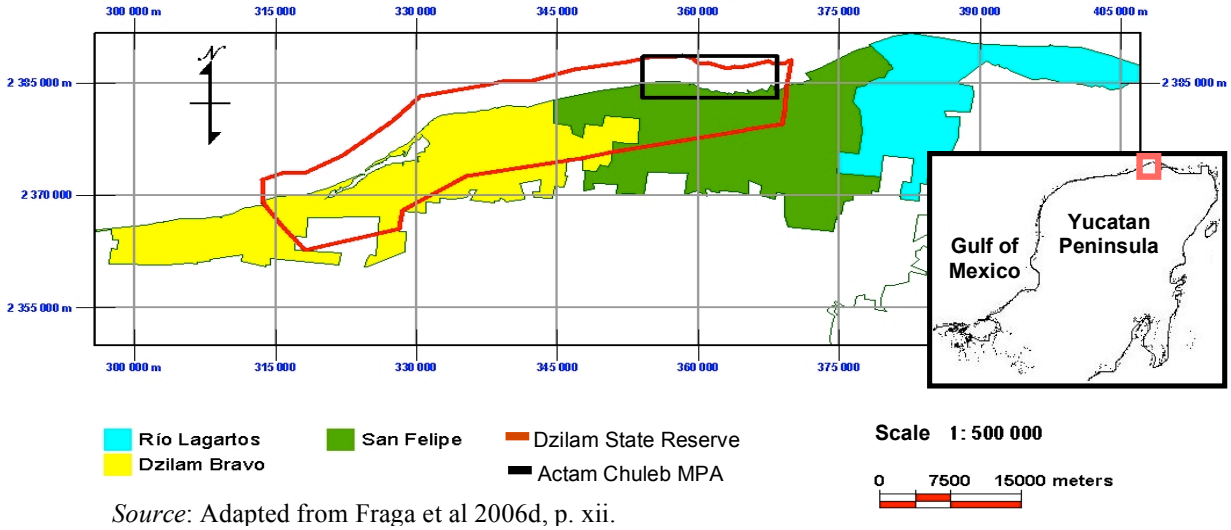
Guieb (2006) points out, individuals rely on commitment and reciprocal behaviour from others concerning compliance with the agreed-upon rules. However, their choices are frequently affected by limited information, and subsequent uncertainty, by how they weight immediate benefits against long-term benefits related to the resources, and by the expected level of opportunistic behaviour assumed by other resource users. Predictably, conflicts commonly arise between users. Hence, for institutional arrangements to be maintained over time, it is important to implement conflict resolution mechanisms and enforce against non-complying behaviour through sanctions and monitoring. Nevertheless, for these processes to be effective, resource users must support it and be proactively involved (Pomeroy & Rivera-Guieb 2006). "Ultimately, the success of institutional changes in prompting better use and governance of environmental resources may depend crucially on changes in human perceptions, interests and actions" (Agrawal 2003, p. 259).

3. Study Area

3.1 The Fishing Community of San Felipe

3.1.1 Location and Climate

Settled in mangrove swampland, San Felipe is a small fishing village of colourful wooden houses built on top of reclaimed, filled land, located on the Gulf coast of the Yucatan state, 195 kilometres northeast from the capital Mérida, southeast Mexico (21º34'02''N, 88º13'52''W) (see Figure 3:1). The municipality of San Felipe is part of the Coastal Biologic Corridor[11] of the North of Yucatan, and consequently part of the Mesoamerican Biological Corridor conservation strategy initiated in 1997 by the Central American Environmental and Development Commission (CCAD).



Source: Adapted from Fraga et al 2006d, p. xii.

Figure 3:1 Spatial location of the Actam Chuleb MPA and Dzilam State Reserve regarding the coastal communities of Dzilam Bravo, San Felipe, and Rio Lagartos, Yucatan, Mexico.

[11] A biological corridor is a delimited geographical area connecting countries, ecosystems and habitats, (natural or disturbed), which guarantees the maintenance of the biological diversity, ecological and evolutive processes (CCAD-PNUD/GEF 2002).

The municipality is enclosed by two natural reserves, the Ría Lagartos Biosphere Reserve and the Dzilam State Reserve, this one encompassing a small, bottom-up implemented MPA called Actam Chuleb, a Mayan expression which means the "area were the *Chuleb*[12] drinks water", which was San Felipe's village former name. Both natural reserves are classified as wetlands of international importance by the RAMSAR convention, since the area comprises a highly biodiverse and biologically productive coastal lagoonal system (very rich in mangrove forests and submerged aquatic vegetation), salt and fresh water marshes, sub-perennial, sub-deciduous, deciduous and floodable forest, and coastal dune vegetation. Providing habitat for a significant number of species and subspecies (including endangered and endemic) of flora (e.g., sisal, *Agave sisalana*; Mexican silver palm, *Coccothrinax readii*; Florida thatch palm, *Thrinax radiata;* cherry palm, *Pseudophoenix sargentii)*, and fauna, including birds (e.g., American flamingo, *Phoenicopterus ruber rubber*; bare-throated tiger-heron, *Tigrisoma mexicanum*; boat-billed heron, *Cochlearius cochlearius*), mammals (e.g., black-handed spider monkey, *Ateles geoffroyi*; jaguar, *Panthera onca*; ocelot, *Leopardus pardalis*; tree ocelot, *Leopardus wiedii*; eyra cat, *Herpailurus yaguarondi*; northern tamandua, *Tamandua mexicana;* manatee, *Trichechus manatus,* from which there have not been recent records), amphibians (e.g., treefrog, *Agalychnis sp.*), and reptiles (e.g., hawksbill turtle, *Eretmochelys imbricata*; loggerhead, *Caretta caretta*; green turtle, *Chelonia mydas*; leatherback turtle, *Dermochelys coriacea*; crocodile, *Crocodylus acutus* and *C. moreletii*) (Carabias et al 1999).

Among the commercially most important marine species common in the area are the red grouper (*Ephinephelus morio*), the red snapper (*Lutjanus campechanus*), the lane snapper (*Lutjanus synagris*), a few shark species (Carcharhinus sp., Sphyrna sp., *Rhizoprionodon terranovae*), a few snook species (Centropomus sp.), the white grunt (*Haemulon plumieri*), sea trout species (Cynoscion sp.), the king mackerel (*Scomberomorus cavalla*), the Spanish mackerel (*Scomberomorus maculates*), the little tuna (*Euthynnus alletteratus*), the spiny lobster (*Panulirus argus*), and the octopus (*Octopus maya*) (Carabias et al 1999; Salas et al 2006).

[12] *Chuleb* is the Mayan name for a characteristic bird of the area.

Culturally, the area also possesses great value, since five kilometres west of San Felipe and 500 meters away from the coast stands *Isla Cerritos*, a small island of about 200 meters in diameter, which the archaeologists believe to be the remains of a pre-Hispanic port complex, a "prominent and strategic" trading port, believed to be the main port of the city of Chichén Itzá, the Itzá mayan capital (Andrews et al 1988).

The area has a semi-arid climate BS_0(h')w(x')iw' (according to the Köppen climate classification), where the mean annual temperature rounds the 26 ºC and the total annual precipitation is about 550.0 mm. The raining season lasts from June to November, generating 70% of the total precipitation. The northeasterly Alize winds predominate all over the year. Cold fronts (*nortes*) are common from October to April, and are usually accompanied by rain. San Felipe is located in a high-risk hurricane area, with the high-risk hurricane season running from September to November, with winds potentially exceeding the 120 kilometres per hour (Carabias et al 1999). The latest hurricane to severely impact the community was Isidore, which hit the area in September 2002, causing significant damage to the village infrastructures, due to floods.

3.1.2 Population and Public Infrastructures

According to the last census carried out in 2005 (INEGI 2005b), the municipality of San Felipe had a population of 1825 inhabitants, 52% male and 48% female, predominantly young people, since 94% were under the age of 65. Considering the population 'older than fifteen years old' (1289 persons), 93.3% were literate, 17.2% had completed the basic education (9 years), and the average level of education was 6.29 years of schooling. Spanish was the main spoken language, and only a few people (9.2% of the people older than 15 years old), mainly adults and elderly, were able to speak Maya, the indigenous language spoken in the Yucatan Peninsula.

In 2007, San Felipe had all the basic infrastructures, such as electricity, potable water supply, basic sanitation, paved roads, public transport services (buses and vans),

telephones, two Internet places, pharmacy, and a public medical centre. There was no bank, nor an official post office. Nevertheless, there was one lady villager in charge of postal services. In terms of education services, the municipality provided kindergarten, primary (six years) and secondary education (three years), and an educational centre for children with special needs. Additionally, San Felipe had a small public library with computers and Internet connection. By the time the census was carried out, the municipality consisted of 512 families, with an average of 3.6 persons per family, and had 493 inhabited houses, from which 90.7% had electricity, along with public water supply, and septic tanks, since the municipality did not have a sewerage system. 70% of these houses had wooden walls, zinc roofs and concrete floors. In terms of possessions, 86.8% of the inhabited houses had television and most even had basic cable offering five channels, 72.0% had refrigerator, 70.4% had washing machine, and 2.6% had a computer. Only 7.7% of the houses did not have any of these possessions (INEGI 2005b).

San Felipe is recognized for its high social organization, probably due to close kinship relations and religious homogeneity, illustrated by the widespread of the Catholic religion[13]. Close kinship relations resulted from San Felipe's geographic isolation during the first half of the twentieth century, when its domestic economy was based on self-consumption of locally grown crops (e.g., corn, grasses, and tubers). Farming yielded to extensive livestock ranching in the 1950s, currently the second most important economic activity, regarding the primary sector of economic activities, after small-scale fisheries. Fisheries received a boost in 1970 with the establishment of the first local fishing cooperative, named the United Fishermen of San Felipe (*Pescadores Unidos de San Felipe*). Fisheries growth accelerated the community's economic development, extended communications with the outside world, drew peasant farmers into fishing, and generated technological innovations in fishing methods, boats and port infrastructures (Fraga et al 2006c).

In terms of politics, San Felipe has been experiencing a very strong bi-partisanship since the National Action Party (PAN) won the municipal elections in 2003. Until then there was only one political party in the village, the Revolutionary Institutional

[13] In 2000, 95.7% of the population of San Felipe older than 5 years old was Catholic (INEGI 2000).

party (PRI). This political scenario has strongly influenced the social organization of the village, being responsible for the splitting up of the fishing cooperative into two, during the 2002-2004 administration. The second fishing cooperative to emerge in the village was called the Legitimate Fishermen of San Felipe (*Pescadores Legítimos de San Felipe*), and it was founded in 2005.

3.1.3 Economic Activities

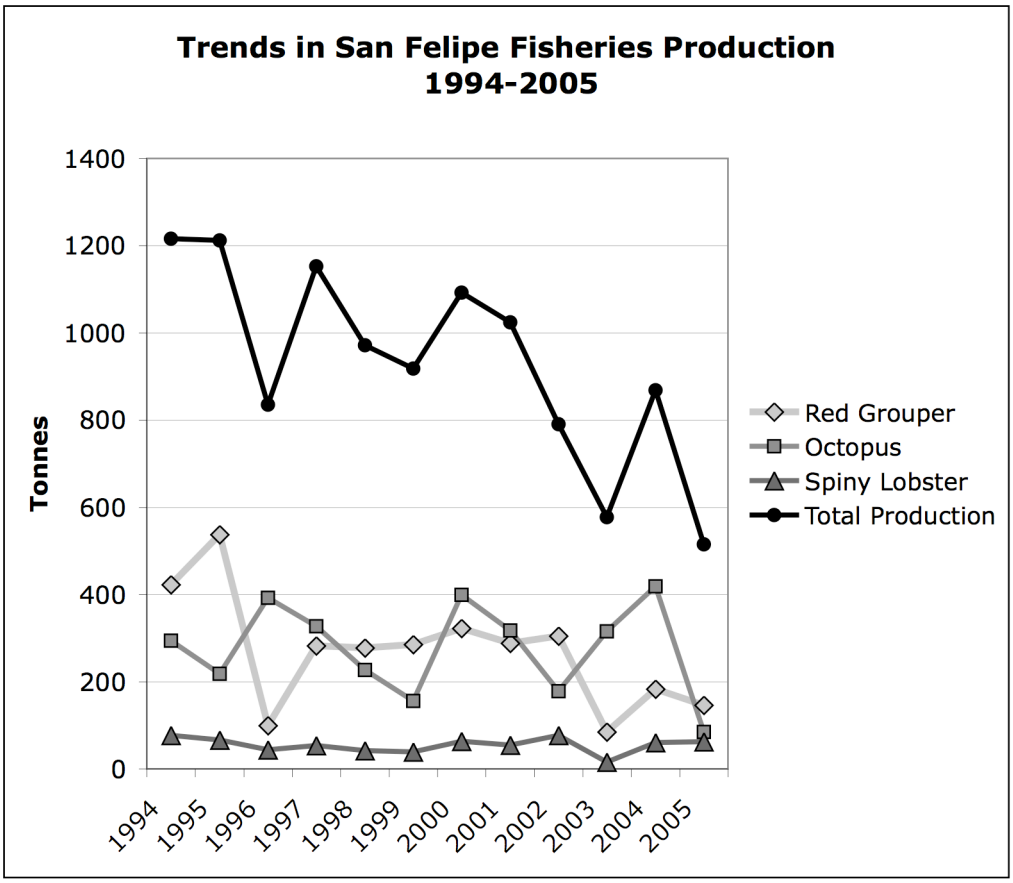
Like in many coastal communities located on the coast of Yucatan, small-scale fishing is San Felipe's main economic activity, being carried out by 55% of its economically active population (15-64 aged population). Followed by service-related activities (30.29%), livestock raising (3.59%) and farming (2.00%) (INEGI 2000). Currently, there is an increasing interest in tourism, particularly ecotourism (e.g., sport fishing, bird watching, snorkelling, scuba diving), as an economic alternative to fishing related activities. The strategy of combining several economic activities is also a common practise.

In San Felipe, small-scale fishing is characterized by a low technological development, employing 7.5 meters long fibreglass fishing boats with outboard motors. Fishermen sell their captures to local fish traders or to one of the two fishing cooperatives, that, in turn, sell it to one or two main intermediaries, who process the product and put it on the national and international markets (Fraga et al 2006b).

The main commercial species, both in terms of value by weight and total landings, are the spiny lobster (*Panulirus argus*), which is harvested by compressed air diving, the octopus (*Octopus maya*) and the red grouper (*Epinephelus morio*). However, similarly to what is happening to the world marine fishery resources, from 1994 to 2005, fisheries production in San Felipe has been reduced to less than the half, from 1216 to 515 tonnes, according to data produced by the Mexican Secretariat for Agriculture, Livestock Farming, Rural development, Fisheries and Nutrition (SAGARPA) (see Figure 3:2). Considering the main commercial species, the production of red grouper decreased from 423 tonnes, in 1994, to 146, in 2005, and

the octopus production decreased from 294 tonnes, in 1994, to 85, in 2005. The production of spiny lobster was the only one that kept more or less stable, varying from 77 tonnes in 1994 to 63 in 2005.

According to these data, it is not possible to identify any "spillover" effect caused by the local Actam Chuleb MPA, which is achieved when larval or adult fish exit the reserve, increasing fish catches in surrounding fishing areas, probably due to the broad extent of the fishing grounds used by the fishermen of San Felipe.



Data source: SAGARPA, Yucatan

Figure 3:2 Trends in San Felipe fisheries production, from 1994 to 2005. Total production includes all the marine species that were captured.

3.2 Actam Chuleb: The Story of a Bottom-Up implement MPA

Actam Chuleb is the name of a shallow coastal MPA located along the coast of the municipality of San Felipe. This MPA has around 4808.502 ha (according to the management plan of the Dzilam State Reserve published in 2006) and it extends approximately along 15 km of coastline, being 3 km wide (see Figure 3:1). The area is very shallow, with water depths ranging from 0 to 3.5 m, the seabed is mainly made up of unconsolidated sediment covered by submerged aquatic vegetation (SAV), but there are also a few rocky-bottom areas and a few submerged freshwater springs (Fraga et al 2006b). According to previous studies (Fraga et al 2006b; Salas et al 1996), seagrass meadows in this area are composed of *Syringodium filiforme*, or manateegrass, *Thalassia testudinum*, or turtlegrass, and *Halodule wrightii*, or shoalgrass. Macroalgae communities include the chlorophytas Avrainvillea sp., Udotea sp., Caulerpa sp., Halimeda sp., Penicillus sp., Acetabularia sp., the rhodophytas Laurencia sp., Gracilaria sp., Eucheuma sp., and the phaeophytas Dictyota sp., Padina sp., among others. Another important feature of the MPA is being contiguous to a coastline bordered by mangrove forests composed of four species: *Rhizophora mangle*; *Avicennia germinans*; *Laguncularia racemosa*; *Conocarpus erectus*. These forests are interrupted by several small fresh water streams (locally known as *ocaes*) that follow they course through the mangroves until reaching the sea (Fraga et al 2006b).

Officially, the Yucatan state government recognizes the Actam Chuleb MPA as a marine subsection of the Dzilam State Reserve (69039.29 ha), decreed in 1989, which encompasses the municipalities of Dzilam de Bravo and San Felipe. This State Reserve, as many others in Mexico, has remained a "paper reserve" (Bezaury-Creel 2005; SEMARNAP 2000) until its management plan (and within it its administrative rules) was finally promulgated on the 26th of September 2006, 17 years after it had been decreed. According to this management plan, the Actam Chuleb MPA is now legally considered an area of restricted use, where the only activities allowed are

conservation, environmental education, ecotourism, and trolling[14]. All fishing methods, except hook-and-line, are prohibited.

In 1995, ignoring the existence of the Dzilam State Reserve, a group of fishermen from the fishing cooperative, supported by the municipality of San Felipe, and by other local authorities[15] and organizations (known as *Fuerzas Vivas*[16]) organized themselves and, on the 26th of April, celebrated a local agreement to protect the "natural spawning and nursery grounds" (*criaderos naturales*) and prohibit the use of fishing nets and diving in a coastal shallow area, located 5 km west from the village of San Felipe, that could be easily identified by its geographical landscape features (see Fraga et al 2006b; 2006d; 2006c; Chuenpagdee et al 2002; 2004). These entities agreed that whoever violated this local agreement established by the community would have to pay a fine of 5000 Mexican Pesos (or 651 US Dollars[17]) to the municipality.

The establishment of a municipal MPA in San Felipe was motivated by a strong dependence on the increasingly overexploited fishery resources (see Figure 3:2), and it aimed to preserve an area that, according to fishermen's local ecological knowledge[18] (LEK), provided spawning and nursery grounds for several commercially valuable species, and was being severely overexploited. Moreover, this was an area close to the village, sheltered from marine currents and waves by its natural topographical features, which provided alternative fishing grounds from which fishermen could subsist during periods when the main fisheries were banned or the weather was bad.

After the celebration of this agreement, the fishing cooperative organized itself, with the support of the municipality, to patrol the MPA on a voluntary basis, but soon

[14] Trolling is a hook-and-line method that tows baited fishing lines behind or alongside a boat.

[15] Municipal Mayor, Harbourmaster, Delegate of the Regional Federation of Fishing Cooperative Societies, and Delegate of the Secretariat of Fisheries.

[16] *Fuerzas Vivas* was a village council comprising the leaders of local organizations, which had the power to take decisions on any community matter

[17] Exchange rate: 1995 – Peso Mex $7.68/USD $1.00.

[18] Local ecological knowledge may be defined as a cumulative and dynamic body of practical knowledge about the relationship of living beings with one another and with their environment, building on experience and adapting to changes by adaptive processes (Berkes et al 2001).

realized that they would need external support to improve patrolling and reduce its costs. In 1997, due to accidental circumstances, the local fishing cooperative ended up collaborating with an environmental NGO from Mérida, named CIRNAC (Centre for the Integrated Management of Natural Resources), who contacted them to provide a natural resources management training course to five of its members, within the ambit of a project[19] involving all the communities encompassed by the Biosphere Reserve of Ría Lagartos.

On the 3rd of December 1997, the leaders of the local organizations and local authorities (know as *Fuerzas Vivas*) gathered once again to re-delimitate the municipal MPA according to precise coordinates[20], to formally name it "Actam Chuleb", and to promote conservation, research, and productive activities in the area. Highlighting, that the municipality of San Felipe was conscious of the need to protect and manage natural resources.

From February 1998 to February 2000, the fishing cooperative along with CIRNAC carried out a two-years project funded by the same donors, the UNDP and the FMCN ($252,769 Mexican Pesos or $26,413 USD[21]), to delimitate and improve the patrolling of the MPA. Within this project, six members of the fishing cooperative received several training courses (e.g., aquaculture, ecotourism, management of coastal resources, etc.), the MPA was delimited for the first time with marker posts of known coordinates, the basic equipment for patrolling the area was acquired (e.g., boat, motor, GPS, RADAR, wood to build a patrolling tower, etc), patrolling shifts of 24 hours were established, the first benthic habitat map of the area was produced, and the first management plan of the Actam Chuleb MPA was written (*Plan Programático del Refugio Marítimo Actam Chuleb*).

[19] This project was financed by the United Nations Development Program (UNDP) and by the Mexican Fund for Nature Conservation (FMCN), and costed $323,400 Mexican Pesos or $44,198 USD (Exchange rate: 1997 – Peso Mex $7.32/USD $1.00).

[20] (SE: 21º33'68''N, 88º16'65''W; NE: 21º34'47''N, 88º16'68''W; NW: 21º34'52''N, 88º22'86''W; SW_1: 21º33'95''N, 88º22'87''W, SW_2: 21º33'03''N, 88º19'34''W; equivalent to 2362 ha).

[21] Exchange rate: 2000 – Peso Mex $9.57/USD $1.00.

In 1999[22], in the sequence of these projects carried out to ultimately improve the management of the MPA, the fishing cooperative contacted the Secretariat of Ecology from the Yucatan State Government (SECOL) to hand in a potential management plan for the municipal MPA, elaborated by a few of its members in cooperation with the above mentioned NGO. They also presented the guidelines for what could have been a potential partnership arrangement between the state and the local government to manage the Dzilam State Reserve and within it the Actam Chuleb MPA. Unfortunately the cooperation attempt fell through.

On the 20th of March 2000, the five most "active" members[23] of the fishing cooperative concerning the MPA officially founded, with the backing of CIRNAC, their own NGO named Actam Chuleb (*Asociación Civil Actam Chuleb*). However, this local NGO would only start its activity five years later, after being restructured, in 2004, to include 11 new members. This restructuring was the consequence of a three-year participatory research[24] project initiated in 2000, funded by the International Development Research Center (IDRC), specifically focusing on the community-based management of the Actam Chuleb MPA, (see chapter 5.2.1 for a detailed description of project results).

The last project focusing the Actam Chuleb MPA that was promoted by the fishing cooperative was carried out in 2003 after the passage of the Hurricane Isidore to restore some of the damages caused by it, and it was funded by the UNDP ($140,000 Mexican Pesos or $12,500 USD[25]). This happened before the division of the fishing cooperative during the 2002-2004 administration, apparently motivated by corruption issues associated to a very strong political bi-partisanship.

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[22] After two years of negotiations with SEMARNAP and SECOL trying that one of these governmental agencies officially recognized the area that was decreed as a municipal marine reserve in 1997.

[23] The ones who were frequently "chosen" to receive training courses since 1997.

[24] Participatory research is characterized by a cyclic, ongoing process of research, reflection and action, which seeks to include local people in designing the research, gathering information, analysing data and taking action. It aims to empower community members through the valorization of local knowledge, and by providing local people with the opportunity to learn new skills, and contribute in the research process (Landon & Langill 1998).

[25] Exchange rate: 2003—Peso Mex $11.20/USD $1.00.

In such a context of political instability, during the beginning of the 2004-2006 administration, a conflict was generated between the fishing cooperative (*Pescadores Unidos de San Felipe*) and the municipality. Apparently, this conflict was caused by partiality issues regarding the MPA patrolling and sanctioning, motivated by close kinship relations, and by the lack of a legal framework enabling the application of fines. Consequently, the *Fuerzas Vivas* council stopped gathering to solve compliance problems.

After this incident, no fishing cooperative in San Felipe was ever again directly involved in the management and enforcement of the Actam Chuleb MPA. Instead, it was the Actam Chuleb NGO that, from 2005 to the present, embraced that role, initiating its activity with a one-year project funded by the UNDP in collaboration with the University of Yucatan (UADY) and with the Secretariat of Ecology (SECOL) ($710,500 Mexican Pesos or $61,622 USD[26]). The aim of this project was to perform the biological characterization of the MPA (including a benthic habitat map), three years after the impact caused by the hurricane Isidore. A timeline summarizing the story of the MPA is presented in Figure 3:3.

[26] Exchange rate: 2005—Peso Mex $11.53/USD $1.00.

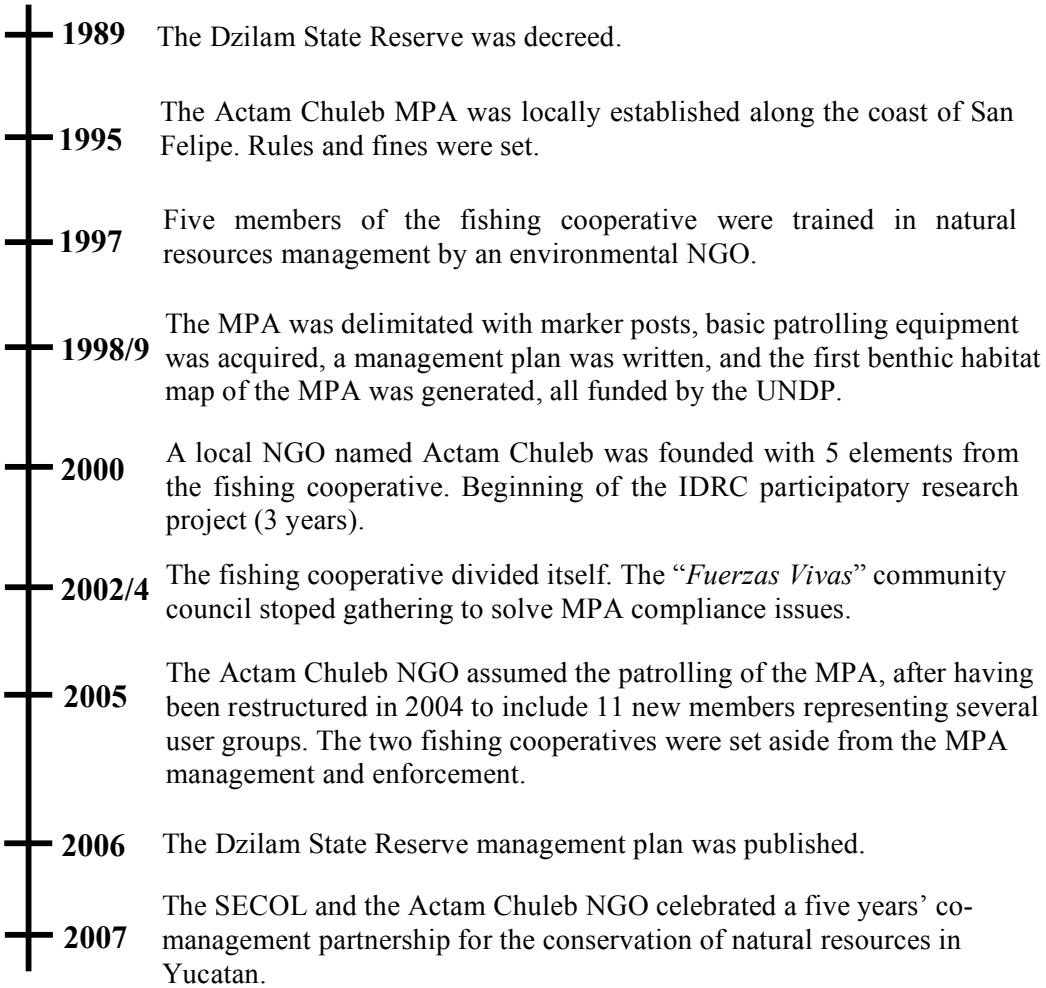


Figure 3:3 Timeline of the story of the Actam Chuleb MPA, validated during the participatory workshop carried out in San Felipe on the 26th of January 2007.

4. Methods

4.1 Benthic Habitat Mapping

Habitat maps generated using remote sensing technologies are extensively and increasingly used to assess the status of coastal natural resources, and as a basis for management planning and monitoring habitat change over time (Green et al 2000). Supervised multispectral classification based on an extensive field survey is considered to be the most effective approach to produce habitat maps, and generally the most accurate alternative (Green et al 2000). Being widely used and recommended by several authors, inclusively to map SAV (Green et al 2000; Gulstrom et al 2005; U.S. NOAA Coastal Services Center 2001).

The aim of this section is to describe the procedures used to generate a submerged aquatic vegetation map from a 2005 image comprising the Actam Chuleb MPA, and the reconstruction of a pre-existing map from the year 2000, in order to enable their comparison in terms of species composition, areal extent, and spatial distribution. For this purpose, Landsat 7 ETM+ (enhance thematic mapper plus), and SPOT (Le Système Pour l'Observation de la Terre) 5 HRG (high resolution geometric) multispectral (XS) imagery from 2000 and 2005 was used, respectively, to perform a supervised classification based on ground-truth data acquired with a towed underwater video camera (see Table 4:1 for sensors' technical specifications). SPOT satellite images were provided by the Secretariat for the Environment and Natural Resources (SEMARNAT) to the Laboratory of Remote Sensing and Geographic Information Systems[27], Centre for Research and Advanced Studies – Mérida Unit (CINVESTAV), where the present study was conducted. Landsat images were acquired by CINVESTAV. The software used for the whole procedure was the TNTmips V7.2 (MicroImages Inc., NE, USA).

[27] In Spanish: Laboratorio de Percepción Remota y Sistemas de Información Geográfica.

Table 4:1 Spectral bandwidths and spatial resolution of the two sensors used.

Satellite: **Landsat 7**			Satellite: **SPOT 5**		
Sensor: **ETM+**			Sensor: **HRG**		
Spectral Bandwidths (nm)		**Spatial Resolution (m)**	**Spectral Bandwidths (nm)**		**Spatial Resolution (m)**
Blue	450-520	25x25	-	-	-
Green	520-600	25x25	Green	500-590	10x10
Red	630-690	25x25	Red	610-680	10x10
Nir[1]	760-900	25x25	Nir[1]	780-890	10x10
SWIR[2]	1550-1750	25x25	SWIR[2]	1580-175	20x20
SWIR[2]	2080-2350	25x25	-	-	-
Image Acquisition	**Date**	21/04/2000	**Image Acquisition**	**Date**	22/01/2005
	Time UTM	16:08:14		**Time UTM**	16:40:59

[1] Near infrared
[2] Short wave infrared

4.1.1 Images Pre-processing

Radiometric dada acquired from distinct sensors has distinct specifications (e.g., orbital altitude, spatial and spectral resolutions, wavelength band limits, relative spectral responses of the sensors, etc.), being sensor-dependent. Therefore, remotely sensed data may not be comparable without pre-standardizing it through radiometric corrections that take into account sensor characteristics, attenuation due absorption and scattering in the atmosphere, the angle of the sun at the time the image was acquired, etc. For underwater habitat mapping, water column correction is also recommended to compensate for the effect of water depth on the signal received by the sensor, due to light attenuation (Green et al 2000; Soudani et al 2006).

In order to compute accurate surface reflectance, ETM+ and SPOT 5 HRG images were geometrically and radiometrically corrected, according to the procedures described by Green et al (2000) and Soudani et al (2006). The geometric correction applied to the SPOT 5 HRG image was based in fifty-seven homologous ground control points (GCPs) that were simultaneously selected on the image and on an

orthophotograph[28] from February 1996, with 2 meters resolution, 1:75000 scale, and Universal Transverse Mercator (UTM) projection, acquired by the Mexican National Institute of Statistics, Geography and Informatics[29] (INEGI). Coastline features, the limits of private properties, and road intersections served as GCPs. The georeferenciation of the image was done with the software TNTmips V7.2 using the affine model. The geolocation error was about half the size of a pixel [X (longitude) = 3.58 m; Y (latitude) = 4.19 m; XY = 5.51 m]. During rectification, the image was radiometrically resampled at its initial spatial resolution using the affine model and the nearest neighbour resampling algorithm, and set to the UTM projection with easting (E), norting (N) (meters) coordinate system. Afterwards, this geometrically corrected SPOT 5 HRG image served as a reference to correct the ETM+ image, according to the same procedure. Seventeen GCPs were used, and the geolocation error was, once more, around half the pixel size [X (longitude) = 6.51 m; Y (latitude) = 9.00 m; XY = 11.11 m]. The first step of the radiometric correction procedure was to convert digital numbers (DN) to at-sensor radiance (W m^{-2} $ster^{-1}$ μm^{-1}) using the gains and offsets given in the image headers. Atmospheric correction was then performed using a dark object subtraction (DOS) approach, as suggested by several authors to be a simple and efficient method (Chavez 1988; Song et al 2001). The final surface reflectance calculation was done with the software TNTmips V7.2, considering several atmospheric parameters, according to the method described by Soudani et al (2006).

Water column correction techniques were not applied in the present study due to the shallowness of the area being considered (depth range: 0.27-2.82 meters), where light attenuation was considered to be minimal, and therefore negligible. Furthermore, according to Green et al (2000), water column correction is likely to be ineffective for multispectral sensors with only two wavebands able to penetrate the water column, like SPOT 5 HRG.

[28] Aerial photograph geometrically corrected with geodesic control points and with a digital elevation model.
[29] In Spanish: Instituto Nacional de Estadística, Geografía e Informática.

4.1.2 Field Survey Design

In order to obtain ground control points for multispectral SPOT 5 HRG image classification (see Figure 4:1), a submerged aquatic vegetation field survey was conducted, on a pilot regime, on the 25th of May, and extensively from the 10th to the 16th of June 2006.

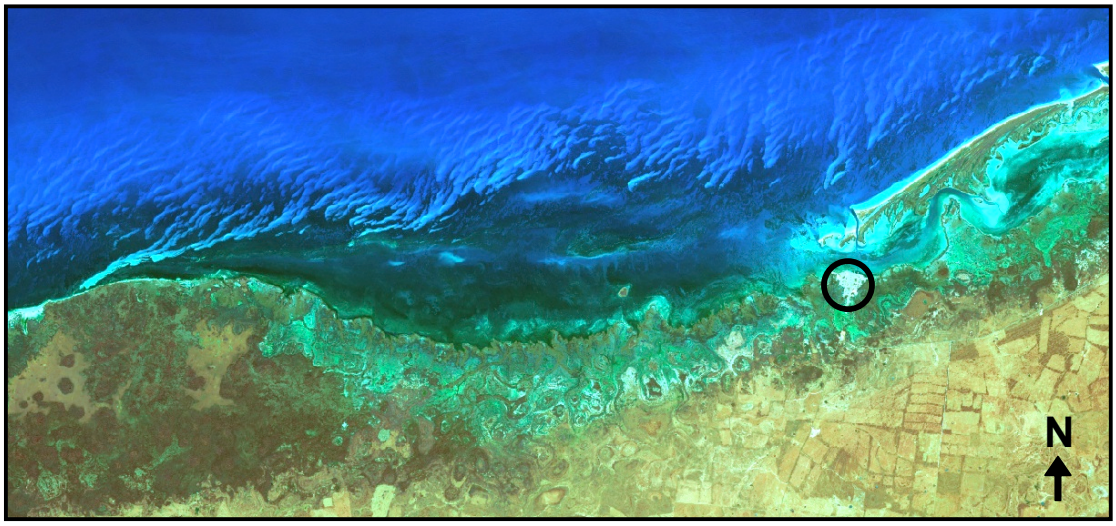


Figure 4:1 Visualization of the study area through a natural colour raster image (RGB - red, green, blue) obtained with the green, red and near infrared 2005 SPOT 5 HRG bands. The black circumference encompasses the village of San Felipe.

Prior to conducting field work, an exploratory unsupervised classification[30] was carried out with the green, red and near infrared SPOT 5 HRG bands, using the ISODATA (Iterative Self-Organizing Data Analysis Technique) clustering algorithm (see Figure 4:2). This procedure was done to explore the location, areal extent and concentration of habitats types, and therefore stratify the sampling effort, as suggested by Green et al (2000). The unsupervised classification resulted in the identification of fifteen cover classes. Subsequently, a minimum of five survey sites per cover class were randomly selected using the unsupervised classification map, avoiding peripheral locations. In total, ninety-three survey sites were assessed, in terms of SAV percentage cover, using underwater videotransects of approximately 5 minutes long, performed with a towed video system (tow speed of ± 0.3 ms^{-1}). Transects' initial and final geographical positions were recorded with a global

[30] Unsupervised classification is the automated statistical clustering of image data.

positioning system device (GPS Garmin 12 XL). Water depth was measured from the surface, at the beginning of every site, with a weighted rope marked every five centimetres to subsequently generate a bathymetric map of the area using geostatistics. Depth measurements were normalized to the mean sea level (MSL) by subtracting tide influence from the data. This was done using a time series of tide measurements obtained with a pressure sensor in a Argonaut XR 3D current meter by Sontek, anchored in Telchac (21°21.310' N, 89°18.414' W), Yucatan, Mexico. Samples of SAV were randomly collected in 21 sites, and subsequently carried out to the laboratory for taxonomic identification, to elementarily describe patches' taxonomic composition. Taxonomic identification was done with the guidance of the identification guide written by Littler and Littler (2000) and with the support of a marine botanic postdoc student.

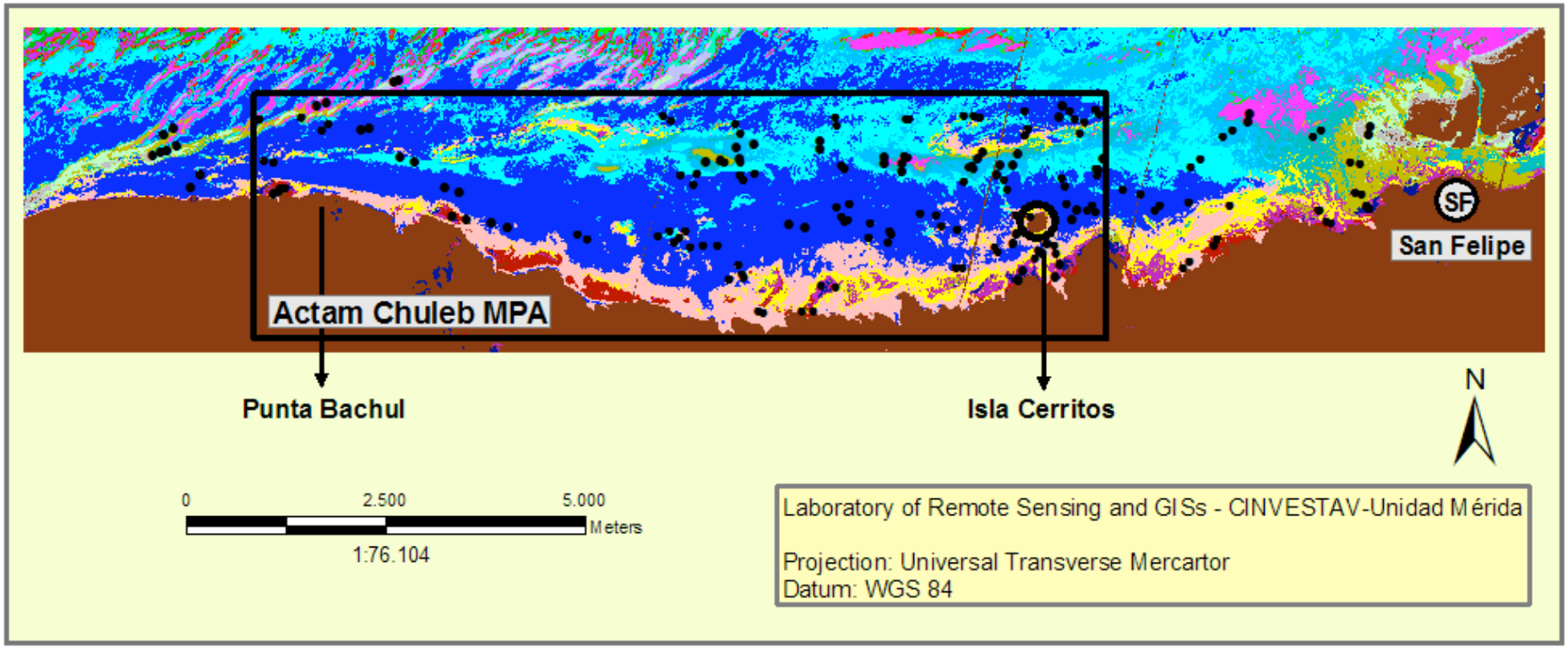


Figure 4:2 Unsupervised classification based on the green, red and near infrared SPOT 5 HRG bands, using ISODATA. Black dots represent survey sites, and the different colours represent the 15 cover classes identified.

4.1.3 Video Analysis

Underwater videography is considered by many experts to be a very powerful tool for characterizing benthic habitats (NOAA Coastal Services Center 2001), being widely used in studies of distribution and abundance of seagrass (McDonald et al 2006), and coral reef monitoring (Aronson et al 1994; Carleton & Done 1994). In the present study underwater videography was the non-destructive sampling methodology chosen to acquire ground-truth data, once it allows quick gathering of data, and provides a permanent record of organisms *in situ* that can be analysed at a later date or by several researchers. Its major limitation is the reduced taxonomic resolution of benthos compared to *in situ* techniques.

To ensure the consistency of the resulting data, detailed interpretation methods for visually categorizing habitats on video images were employed. Therefore, the first methodological step was to homogenise the analysis of video transects in terms of length. In this sense, only eighty video frames of every underwater video transect were considered in the analyses, corresponding, approximately, to the first 80 meters of each transect (considering that the distance between the camera and the sea bottom was kept constant, maintaining a field of vision of about $1m^2$). Afterwards, the minimum sampling effort (number of video frame "quadrats") was determined, considering 6 of the 10 transects with highly variable SAV cover. SAV percentage cover was first estimated by analysing all the first 80 video frames (scenario considered to illustrate percentage cover *in situ*), then 40 in 80, 27 in 80, and 20 in 80. The cover (%) estimation error per habitat type ('x-habitat' cover% – 'x-habitat' cover% estimate), averaged across the six analysed transects, was calculated for each sampling effort scenario (40 in 80, 27 in 80, and 20 in 80). According to the results (see Figure 4:3), a sampling effort of 27 in 80 frames, where every 2 other frames were analysed, was the most appropriate, since it generated an error equivalent to the one generated by the sampling effort '40 in 80' and inferior to the '20 in 80', for every class.

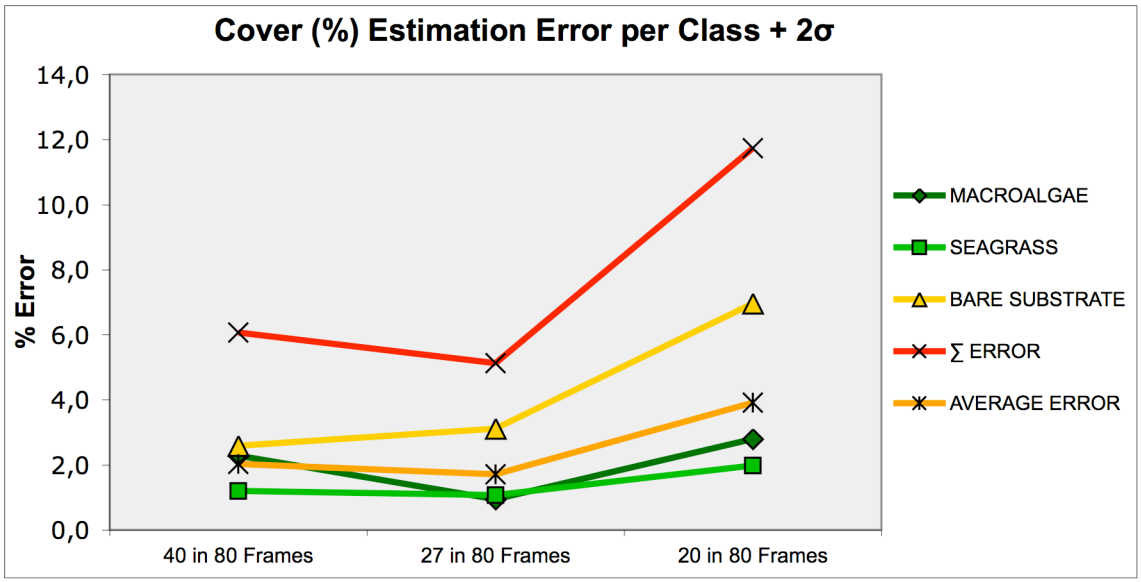


Figure 4:3 Variation of the cover (%) estimation error per class (averaged across six of the 10 transects with highly variable SAV cover) when analysing 40 in 80, 27 in 80, and 20 in 80 video frames. (The '∑error' was calculated for each sampling scenario by summing the obtained cover (%) errors per class; the 'average error' represents the mean cover (%) error for each sampling scenario, averaged across classes).

SAV average percentage cover per species (or taxonomic group) were determined for each video transect with a thirteen-fixed dots template displayed on the screen, by pausing the video (playing in the computer) on every selected video frame, and recording the presence or absence of SAV species underlying each dot (see Figure 4:4). To estimate SAV percentage cover per species, the following formula (Osborne & Oxley 1997) was employed:

$$\text{Cover (\%)} = \frac{\text{Total number of dots per species}}{\text{Total number of dots per video transect}} \times 100$$

In this study, a regular linear sampling approach, where both frame selection and dots position on the screen were systematic, was preferred to guarantee that the measurements were evenly spread over each video transect and video frame "quadrat" (sampling area). Each 351dot data set (13dots × 27 frames) generated an estimate of SAV percentage cover per species for each survey site.

The adopted sampling protocol was chosen considering monitoring studies testing point-count sampling strategies performed by other authors for coral reefs and

seagrass habitats. In terms of dots density, Aronson et al (1994) found appropriate the use of 10 random-dots per video frame, when monitoring coral reefs, a much more complex habitat than SAV. In terms of the number of video frame "quadrats", McDonald et al (2006), who used underwater video to detect changes in seagrass cover, suggested the analysis of 10 video frame "quadrats" per 50 m transect. To monitor coral reefs, on the one hand, Aronson et al (1994) suggested the analysis of 50 video frame "quadrats" per 25 m transect, generating 500 dots per 25 m. On the other hand, Carleton and Done (1995) considered optimum a sampling design using 550 points per 200 m transect. Carleton and Done (1995) also found out that random (both frame selection and dots position on the screen are random), random linear (only frame selection is random), and regular linear (both frame selection and dots position on the screen are systematic) data extraction techniques performed equivalently in their study. That being said, the adopted sampling protocol with 27 video frame "quadrats" per transect and 13 fixed dots per video frame was considered to be in accordance with the revised literature and adequate to achieve the desired methodological objectives.

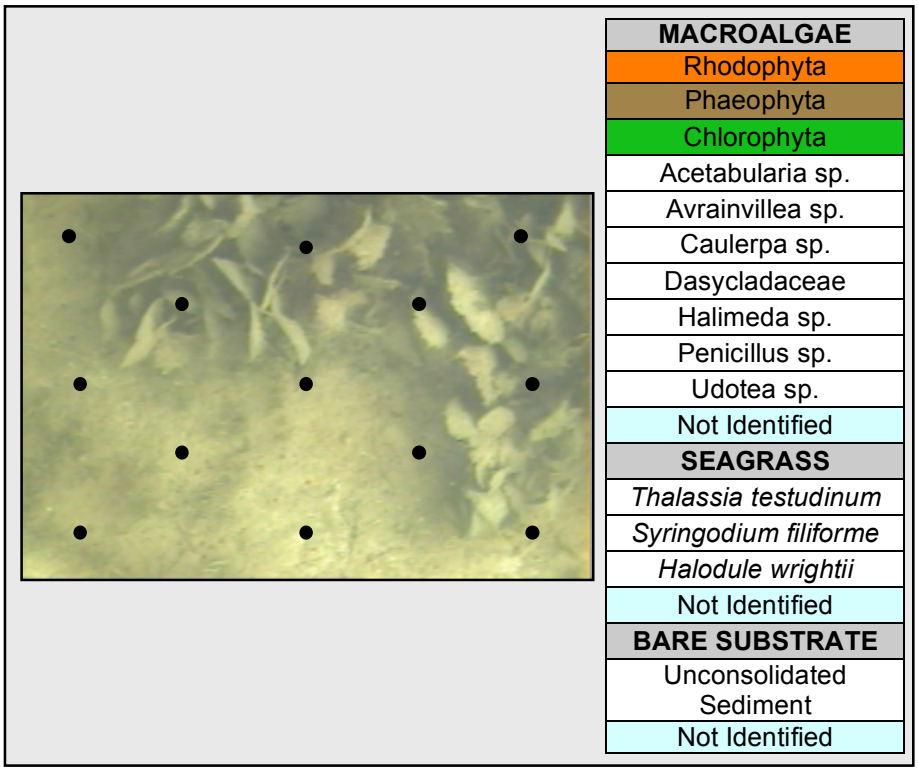


Figure 4:4 Video point-count sampling method, based on thirteen-fixed dots, used to estimate percentage cover per species on every survey site. The list of considered species was divided in three major groups: macroalgae, seagrass and bare substrate.

4.1.4 Training Stage and Habitat Classification Scheme

An ecologically-based habitat classification scheme was developed for the Actam Chuleb MPA by initially applying a cluster analysis to the data obtained by the video point-count sampling method. The cluster analysis was carried out with the Bray-Curtis similarity coefficient to group survey sites in habitat classes, according to their similarity in terms of SAV species composition and percentage cover. The Bray-Curtis similarity coefficient was computed with the software PRIMER (Plymouth Routines in Multivariate Ecological Research). Thirty-one clusters (three one-site clusters were discarded), which separated at a Bray-Curtis similarity level of 85% (see Figure 4:5), were initially considered as potential habitat classes, as recommended by Green et al (2000).

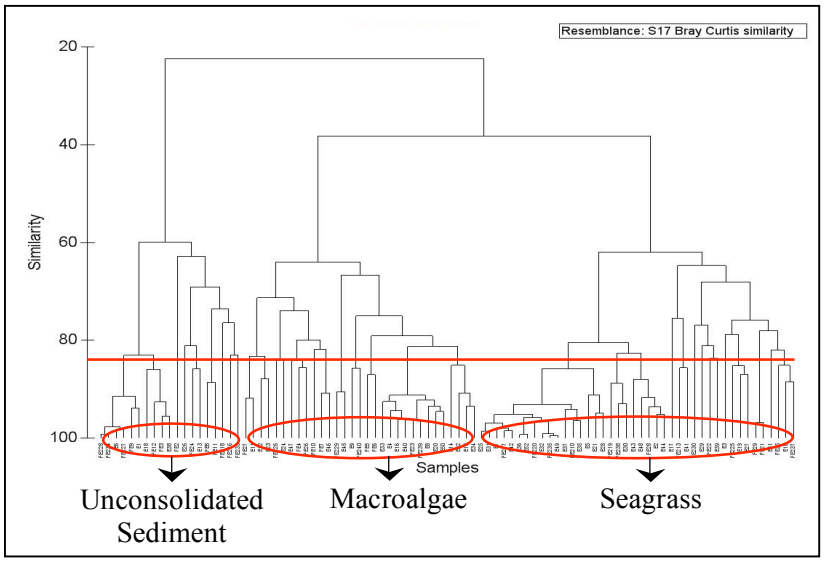


Figure 4:5 Dendrogram for SAV percentage cover per species in 93 sites using Bray-Curtis similarity coefficient.

The selection of training samples[31] per class (necessary to perform the supervised classification of any image) was done by seeding on a RGB (Red, Green, Blue) raster of the SPOT 5 HRG image a line of pixels of about 80 meters over each video transect and growing a training area around it by aggregating 2 to 3 contiguous pixels, when accepted by the analyst to be spectrally similar. Considering that variation within each group of training samples inevitably occurs, due to spectral variation within the considered habitat, errors in the geometric correction applied to the image

[31] A training sample is a group of pixels representing a known habitat on the image.

and in GPS positioning, variation in water turbidity, etc., atypical training samples within the training set were identified, some were deleted, others merged and/or renamed. To do so, the spectral signatures of the thirty-one classes initially considered were continuously evaluated in terms of spectral homogeneity, to obtain a final training set ideally composed by non overlapping spectral signatures. This spectral evaluation was based on the analysis of dendrograms, illustrating Euclidean "spectral distances" among signatures defined for each class; on the direct visual analysis of the spectral variation within each group of training samples; and on preliminary classification tests to check if the defined signatures accurately classified known training samples (according to contingency matrixes), and to check the spectral overlapping between signatures (according to spectral signature graphs and matrixes). Desirably, there should be high separability between signatures corresponding to different habitats and low separability amongst signatures from the training samples of a particular habitat.

Taking into account the separability amongst signatures and the model suggested by NOAA (Kendall et al 2001), the ecologically-based habitat classification scheme was assembled with seven classes defined in terms of SAV species composition and average percentage cover (see Table 4:2): (1) dense seagrass meadows (90-100%) composed by a mixture of *Syringodium filiforme*, *Thalassia testudinum*, and *Halodule wrightii*, with a percentage cover per species under 50%; (2) dense *Syringodium filiforme* dominated meadows (90-100%); (3) medium to dense *Syringodium filiforme* dominated meadows (50-90%); (4) medium to dense macroalgae dominated meadows (50-90%), mainly composed by the Chlorophytas Avrainvillea sp., Caulerpa sp., Acetabularia sp., Halimeda sp., Penicillus sp., and by the Rhodophytas Gracilaria sp., Laurencia sp.; (5) medium to dense Avrainvillea spp. dominated meadows (50-90%); (6) sparse to medium mixed submerged aquatic vegetation meadows composed by seagrasses and macroalgae (10-50%); and (7) bare unconsolidated sediment with less than 10% of sparse SAV.

At the end, 112 training pixels (1.12 ha) were used to define the spectral signature for the class 'Seagrass 90-100%', 246 (2.46 ha) for the class '*Syringodium filiforme* 90-100%', 125 (1.25 ha) for the class '*Syringodium filiforme* 50-90%', 100 (1.00 ha) for the class 'macroalgae 50-90%', 305 (3.05 ha) for the class 'Avrainvillea spp. 50-

90%', 161 (1.61 ha) for the class 'SAV 10-50%', and, finally, 196 training pixels (1.96 ha) were used for the class unconsolidated sediment <10% SAV (see Table 4:2).

Table 4:2 Habitat classification scheme (2005).

Habitat Categories		% Cover	Meadows Composition	No. Training Pixels	Total Training Area (ha)
Seagrass habitats	Seagrass (mixture)	Dense 90-100%	Seagrass dominated meadows, composed by *Syringodium filiforme, Thalassia testudinum, Halodule wrightii* (percentage cover per species under 50%).	112	1.12
	Syringodium filiforme	Dense 90-100%	Seagrass meadows dominated by *Syringodium filiforme.*	246	2.46
		Medium to Dense 50-90%	Seagrass meadows dominated by *Syringodium filiforme.*	125	1.25
Macroalgae habitats	Macroalgae (mixture)	Medium to Dense 50-90%	Macroalgae dominated meadows, mainly composed by Chlorophytas (Avrainvillea sp., Caulerpa sp., Acetabularia sp., Halimeda sp., Penicillus sp.) and Rhodophytas (Gracilaria sp., Laurencia sp.).	100	1.00
	Avrainvillea spp.	Medium to Dense 50-90%	Macroalgae meadows dominated by Avrainvillea spp..	305	3.05
Submerged Aquatic Vegetation		Sparse to Medium 10-50%	Mixed SAV meadows composed by seagrasses and macroalgae.	161	1.61
Bare substrate	Unconsolidated Sediment	Sparse SAV <10%	Bare unconsolidated sediment with less than 10% of sparse submerged aquatic vegetation.	196	1.96

4.1.5 Supervised Classification

Classification is the procedure of identifying image pixels with similar characteristics, organising then into groups and assigning them labels (e.g., habitat names). Classification is based on the principle that different types of habitats reflect electromagnetic radiation in distinctive ways across the wavelengths being measured, creating their own spectral signatures. The end product is a map of habitats or other features of interest (Green et al 2000).

To conclude the supervised classification process and generate a thematic map, the software uses the evaluated signatures to assign every pixel within the image to a particular class according to a specific decision rule, which sets certain criteria to assign a candidate pixel to a certain class. In this study it was used a maximum likelihood classifier, or decision rule, considered by Green et al (2000, p. 148) to be "the most sophisticated of the common parametric decision rules", as it takes into account both the variability of classes and the probability of a pixel belonging to each class when calculating the distance between a candidate pixel and the mean of all classes. The classification was carried out with the green, red, and near infrared SPOT 5 HRG bands, using a binary mask to attribute zero values to every pixel on the image corresponding to terrestrial areas, and therefore exclude these areas from the classification process.

Classification accuracy was estimated by comparing the classification output with the initially obtained ground truth data through an error matrix, from which the "overall accuracy", "user's accuracy", "producer's accuracy", and Kappa statistic (KHAT) were computed. The overall classification accuracy was computed as the total number of correct class predictions (the sum of the diagonal cells) divided by the total number of cells. The Kappa statistic, which tells us how much better is our classification compared to one where we randomly assigned class values to each pixel (Verbyla 1995), was computed as:

$$\text{Kappa Statistic} = \frac{\text{Overall Classification Accuracy} - \text{Expected Classification Accuracy}}{1 - \text{Expected Classification Accuracy}}$$

The expected classification accuracy is the accuracy based on chance, or the expected accuracy if we randomly assigned class values to each pixel. It was calculated by first using the error matrix to produce a matrix of products of row and column totals. The expected classification accuracy was then calculated as the sum of the diagonal cell values divided by the sum of all cell values.

The classification accuracy of each cover site was evaluated through the "user's accuracy" and "producer's accuracy". The "user's accuracy" is the percentage of pixels that were predicted to be a cover type that actually were that cover type, and reflects commission errors, since from the pixels committed to a class some will be incorrect. "Producer's accuracy" reflects omission errors, since considering the pixels that actually belong to a class, some will be incorrectly classified (Verbyla 1995).

The accuracy of a classification refers to the correspondence between the class label and the "true" class, which is generally defined as what is observed on the ground during field surveys. That is how much of the class labelled x on a classified image is actually x *in situ*. Ideally, the accuracy of one habitat map should be estimated by comparing the classification output with additional field data. Unfortunately, due to financial restrictions, it was not possible to accomplish such procedure.

4.1.6 Reconstruction of the 2000 Pre-existing SAV Map

The first benthic habitat map of the Actam Chuleb MPA to be performed using remote sensing technologies was done in 2000, within the ambit of an international multidisciplinary research project entitled "Community-based management of a Marine Reserve in San Felipe, Mexico". The sampling methodologies used to acquire ground-truth data (visual estimates of SAV percentage cover) were underwater video, snorkelling, and shipboard surveys using glass-bottom buckets. Data was collected from 76 survey sites located along 9 transects, perpendicular to the coastline. Samples of SAV were collected in 21 sites. The data generated by this project was used in the present study to train the supervised classification of a 2000 ETM+ image of the area, using the blue, green, red, and near infrared bands.

The ecologically-based habitat classification scheme was assembled taking not only into account the separability amongst signatures, but also the viability of comparing both 2000 and 2005 SAV maps. The resulting habitat classification scheme was comprised of four classes (see Table 4:3) defined in terms of taxonomic group and percentage cover: (1) medium to dense seagrass dominated meadows (>50%), essentially composed by one species or by a mixture of several seagrass species (*Syringodium filiforme*, *Thalassia testudinum*, and *Halodule wrightii*); (2) medium to dense macroalgae dominated meadows (50-90%), mainly composed by the Chlorophyta Avrainvillea sp. plus a mixture of other species (e.g., Caulerpa sp., Halimeda sp., Penicillus sp.); (3) sparse to medium mixed submerged aquatic vegetation meadows composed by seagrasses and macroalgae (10-50%); and (4) bare unconsolidated sediment with less than 10% of sparse SAV. 4501 training pixels (45.01 ha) were used to define the spectral signature for the class 'seagrass >50%', 1101 (11.01 ha) for the class 'macroalgae >50%', 1061 (10.61 ha) for the class 'SAV 10-50%', and, finally, 459 training pixels (4.59 ha) were used for the class 'unconsolidated substrate <10% SAV' (see Table 4:3).

Table 4:3 Habitat classification scheme (2000).

Habitat Categories	% Cover	Meadows Composition	No. Training Pixels	Total Training Area (ha)
Seagrass	Medium to Dense >50%	Seagrass dominated meadows, essentially composed by one or by a mixture of several species (*Syringodium filiforme*, *Thalassia testudinum*, and *Halodule wrightii*).	4501	45.01
Macroalgae	Medium to Dense >50%	Macroalgae dominated meadows, mainly composed by Avrainvillea sp. plus a mixture of other species (e.g., Caulerpa sp., Halimeda sp., Penicillus sp).	1101	11.01
SAV	Sparse to Medium 10-50%	Mixed SAV meadows composed by seagrasses and macroalgae.	1061	10.61
Unconsolidated substrate	Sparse SAV <10%	Bare unconsolidated sediment with less than 10% of sparse submerged aquatic vegetation.	459	4.59

4.1.7 Change Detection

Change detection is a technique used to determine the change between two or more time periods for a particular land cover, by providing quantitative information on spatial and temporal distribution (Lillesand & Kiefer 1987). It offers an important tool for monitoring and managing natural resources. Four aspects of change detection are important when monitoring naturally occurring or human-induced phenomena: (1) detecting the changes that have occurred; (2) identifying the nature of the change; (3) measuring the areal extent of the change; and (4) assessing the spatial pattern of the change (Macleod & Congalton 1998).

A change detection using a post-classification comparison procedure, based on supervised classification results, was carried out between the 2000 and 2005 SAV maps. However, to perform it, it was necessary to apply the same habitat classification scheme to both maps. Since the 2000 SAV map had a simpler classification scheme with only four habitat classes, this classification was adopted to perform the change detection (see Table 4:3). The first step was to readjust the 2005 SAV map, which had seven habitat classes, to generate a similar habitat map with four classes. This was done by merging the two seagrass classes and the two macroalgae classes of the 2005 classification scheme. The second step was to resample the ETM+ image having the SPOT 5 HRG as reference. Considering that the images had different spatial resolutions this procedure was obligatory to enable their comparison. The post-classification change detection was carried out with the TNTmips V7.2, by generating a "from-to" matrix, based on the comparison of the two SAV maps, indicating the number of pixels that had been gained or lost per habitat class. Additionally, four maps, one per habitat class, visually illustrating the occurred changes (unchanged, lost, and gained cover) were generated.

4.1.8 Landscape Ecological Indices

According to Turner (1989), patterns seen on the ground strongly influence ecological processes, and it is becoming widely accepted that to understand patterns (e.g.,

abundance, diversity) and processes (e.g., recruitment, predation) at a specific site, broad-scale variables and landscape attributes need to be included (Boström et al 2006). This conviction reveals the importance of computing landscape ecological indices.

In this study, landscape metrics and patch characteristics were calculated using the software FRAGSTAT v3.3 (McGarigal et al 2002). Patch characteristics at the class level were generated based on land cover, number and density of patches. Landscape metrics included patch shape (fractal dimension), dispersion (or aggregation) as a measure of fragmentation, and cohesion as a measure of patches' connection. Fractal dimension approaches 1 for shapes with very simple perimeters and approaches 2 for shapes with highly convoluted, plane-filling perimeters. Aggregation index equals -1 when the focal patch type is maximally disaggregated (one pixel patch), 0 when the focal patch type is distributed randomly, and approaches 1 when the patch type is maximally aggregated into a single compact patch. Cohesion index approaches zero as the proportion of the landscape covered by a class decreases, becoming increasingly subdivided and less physical connected, and equals 100 when it is maximally clumped in its distribution and more physical connected. Landscape ecological metrics were computed for the same 2000 and 2005 four-class habitat maps used for change detection.

4.2 Stakeholder Perceptions regarding the MPA

Understanding stakeholder interests and perceptions regarding the design, establishment and functioning of a co-management agreement is fundamental to evaluate its performance, since they influence stakeholder behaviour, compliance and support towards it, and explain some of the variance in short- and long-term project success (Berkes et al 2001; Pollnac & Crawford 2000; Pomeroy & Rivera-Guieb 2006; Webb et al 2004).

The aim of this section is to describe the procedures used to investigate the perceptions and attitudes of the stakeholders of the Actam Chuleb MPA considering the benefits and obstacles associated with its implementation and co-management, and to identify the key issues that influence their support, indifference or opposition towards the MPA. The methodological procedures used to acquire data on this topic have their roots on social sciences, and comprised the review of information from secondary data sources, ethnological fieldwork (field notes taking, participant observation, semi-structured and informal interviews), a small e-mail survey, an in-depth stakeholder survey based on structured interviews, and a participatory workshop.

4.2.1 Secondary data analysis

Relevant secondary data was gathered and analysed (e.g., statistical reports, official and unofficial documents, research articles, academic thesis, reports of previous and ongoing projects, decrees, former and current management plans) before and during field data collection to help in its preparation, verification, and to document and refine the whole research process.

Additionally, to better understand such a complex and dynamic process as the bottom-up implementation of an MPA in San Felipe, the main findings of a three-year multidisciplinary project performed by Fraga et al (2006b; 2006d), focusing on

stakeholder perceptions regarding the Actam Chuleb MPA and its management, were summarized and analysed (see Section 5.2.1).

4.2.2 Community Entry and Involvement

Establishing a relationship of trust with the community and understanding the local setting was the aim of the first month spent actively living daily life in the fishing community of San Felipe. An approach regularly adopted by ethnographic researchers, who highly advocate the involvement and participation of the researcher in the topic being studied as well as the methodical attention paid to the social context in which data is collected (Marvasti 2004). At this stage, the primary means of data collection relied on ethnological methodologies, particularly on participant observation (complemented by field notes) and informal interviews with key informants[32].

Two strategies of participant observation were conducted throughout the fieldwork period. One focusing on daily activities carried out by the MPA user groups, such as fishing trips inside and outside the MPA, observing fish traders and the functioning of fishing cooperatives, and tours inside the MPA (bird-watching, snorkelling, fly-fishing). The other one focusing on the MPA management activities carried out by the Actam Chuleb NGO, including patrolling and monitoring trips, and attending to the NGO meetings at their headquarters. These observations provided valuable insight into the technicalities of the activities carried out by the MPA user groups and into their daily life concerns, and provided insight into the MPA management process, into the NGO activities, internal organization and group dynamics. According to DeWalt and DeWalt (2002) and to Berkes et al (2001), participant observation improves the quality of the acquired field data and the quality of its interpretation, allowing for a closer communication and trust between the researcher and the community members,

[32] Key informants are community members, who are able to provide reliable information on a particular topic based on their knowledge, skills or experience with that subject (Pomeroy & Rivera-Guieb 2006).

and for a greater understanding of the social practices, organization and informal rules.

4.2.3 Stakeholder Analysis

The process of stakeholder identification is of paramount importance to get the whole picture in terms of needs and interests playing the co-management process (Pomeroy & Rivera-Guieb 2006). In this study, the identification of the main stakeholder groups regarding the Actam Chuleb MPA was made with the guidance of 3 key questions proposed by Borrini-Feyerabend (2000): (1) Which community organizations or groups have access or use the MPA?; (2) Who are the community organizations or groups actually or potentially affected by the MPA management decisions?; and (3) Who are the main local authorities and government agencies officially responsible for the management of the area?. Therefore, stakeholder groups considered for the purpose of this study were divided into three main categories: (1) direct MPA users, including fishermen (cooperative and independent), fisherwoman, tour operators, and members of the Actam Chuleb NGO; (2) indirect stakeholders, comprising fish traders, hotel administrators, local business owners, and school teachers; and (3) government officials, comprising both local authorities (mayor and harbour master) and state government officials from the Secretariat of Ecology (see Table 4:4).

A snowball sampling method[33] was used to choose individual stakeholders (from each one of the identified stakeholder groups) to take part in the survey. According to this method, key informants where asked the following five questions: (a) Who are the leaders or the most active members within each organization?; (b) Who is or has been directly involved in the process of establishing and managing the MPA?; (c) Which individuals are the most dependent (economically or socially) on the MPA resources?; (d) Who is or might be interested in the MPA conservation and management?; (e) Who does not agree with the existence of the MPA or does not comply with its rules?.

[33] In snowball sampling you ask key informants or interviewees to recommend other individuals who they might know that meet the criteria defined by you (Trochim 2006).

Table 4:4 Numbers of interviewees per MPA stakeholder group or organization considered in the in-depth stakeholder survey.

	Considered Stakeholder Groups and Organizations				
	Stakeholder Categories		**Community Groups and Organizations**	**No. Interviewees**	
MPA direct users	Fishermen	Cooperative	*Pescadores Unidos de San Felipe*	4	39
			Pescadores Legítimos de San Felipe	5	
		Independent		5	
	Fisherwomen		*Mujeres Trabajadoras del Mar*	3	
	Tour operators		*Sociedad de Lancheros Punta Bachul*	4	
			Hubel Chac-Ha	3	
			Rede Ambiental Isla Cerritos	2	
			Servicios Turísticos del Puerto de San Felipe	3	
			Hotel fly-fishing guides	2	
	Local NGO		*Actam Chuleb A.C.*	8	
Indirect stakeholders	Fish traders			2	7
	Hotel administrators		*Hotel San Felipe de Jesús*	1	
			Hotel Hacienda	1	
	Local business owners		Restaurants	2	
	School teachers		Primary school teacher	1	
Government officials	Local authorities		Mayor	1	2
			Harbour Master	1	
	State government		Officials from the Secretariat of Ecology	*	

* State government officials were interviewed using semi-structured and informal interviews (see section 4.2.4 for a more detailed explanation).

4.2.4 In-Depth Stakeholder Survey Design

An in-depth stakeholder survey was carried out, between August and November 2006, with a sample of forty-eight individuals representing the main stakeholder groups identified (see Table 4:4). This survey aimed to identify the interests, sources of motivation and the arguments of both the MPA supporters and those not willing to comply, in order to understand the present and predict the future strengths and weaknesses of the MPA co-management process.

The first five interviews were carried out in a pilot regime to enable its adjustment in terms of content and layout (a copy of the final interview is provided at the Appendix I). The interview was composed by thirty questions (dichotomous (yes/no), multi-

response, ordinal (ranking), and open-ended questions) organized in five different sections: (1) aims; (2) benefits and beneficiaries; (3) obstacles and potential solutions; (4) management and participation; and (5) future perspectives. The first section (1) was designed to understand the aims of the MPA establishment according to the interviewees and set a baseline to understand the following answers. The second section (2) was meant to explore the benefits generated by the MPA and to identify its beneficiaries. Section three (3) investigated the obstacles related with the MPA functioning and how to overcome them. The fourth section (4) addressed stakeholder perceptions about the MPA management and participation issues. Finally, the fifth section (5) consisted of only one question regarding the future of the MPA. To conclude the interview, seventeen short-answer questions were made to acquire personal data to characterize the interviewee. The whole interview usually took about one hour and a half to two hours to complete. The survey data was analysed using the Statistical Package for the Social Sciences (SPSS) software.

Since this survey was not meant to address state government officials, only local authorities, an exploratory semi-structured interview and several informal interviews, focusing on the technicalities of the MPA management, were carried out in parallel in Mérida with officials from the Secretariat of Ecology (SECOL). According to Berkes et al (2001), semi-structured interviews provide an informal, flexible listening technique, where new interesting topics and questions may arise as the interview develops.

A very important group of stakeholders that has not been mentioned so far comprises *external agents*. Generally, this group includes NGOs, academic and research institutions, and development agencies, which facilitate the co-management process and provide technical expertise and training to empower and enhance the capabilities of the community to manage their lives and resources (Pomeroy & Rivera-Guieb 2006). In August 2007, based on these characteristics, 9 key external stakeholders were identified and invited, via e-mail, to collaborate by answering to a questionnaire consisting of 9 open-ended questions (see Appendix II to consult a copy of the questionnaire). Four out of nine persons collaborated: the Director of the Ría Lagartos Biosphere Reserve; the SAGARPA Fisheries Delegate; and two researchers, one from CINVESTAV, and the other from the University of Quintana Roo.

4.2.5 Participatory Workshop Design

In an attempt to share the results of the current study, cross validate the obtained data, and particularly to encourage communication and cooperation between community groups towards the conservation of natural resources, the MPA stakeholders were invited to attend a participatory workshop[34] in San Felipe, from 19h to 22h on the 26th of January 2006, in a neutral place, the restaurant *El Popular Vaselina*. Although an invitation letter was delivered personally to 63 persons (mainly survey interviewees) on the weekend before the event, the workshop was opened to everyone. The workshop was carried out with 26 persons, representing 14 different organizations or stakeholder groups (see Table 4:5). Regarding the attendance of the invited authorities, it is important to highlight the absence of the SECOL representatives, the state government agency responsible for the management of the Dzilam State Reserve and consequently for the management of the Actam Chuleb MPA.

Table 4:5 Number of participants per organization or stakeholder group present in the workshop.

Organization or stakeholder group	No. Participants	
Official representative of the Ría Lagartos Biosphere Reserve	1	26
Municipal Secretary (representing the Mayor)	1	
Actam Chuleb NGO	4	
Local warden of the Dzilam State Reserve	1	
Fishing cooperative *Pescadores Unidos de San Felipe*	4	
Fishing cooperative *Pescadores Legítimos de San Felipe*	2	
Tourism cooperative society *Servicios Turísticos del Puerto de San Felipe*	2	
Tourism cooperative society *Hubel Chac-Ha*	4	
Tourism cooperative society *Punta Bachul*	1	
Representative of the Hotel San Felipe	1	
Local restaurant owners	2	
Primary school teacher	1	
Housewife	1	
Not identified	1	

[34] The workshop was designed by the author with the supervision of Dr. Julia Fraga, an anthropologist with large years of fieldwork experience in the community of San Felipe, and Dr. Jorge Euán, an expert in coastal resources management.

The specific objectives of the workshop were to: (1) outline the events that influenced the course of the MPA co-management process; (2) communicate and discuss, based on participants' local ecological knowledge, the results of the benthic habitat mapping; (3) cross validate the results of the in-depth stakeholder survey; and (4) make the participants reflect about their role, responsibility, and personal challenges as local agents who may have a stake in the future management of the MPA.

The workshop started with a short preamble emphasizing the importance of giving back the information generated by a research project and making the data available to be used by the community according to their interests. Then, since not all the stakeholders were familiar with the events that influenced the course of the MPA co-management process throughout time (identified as a main source of conflict between users), a series of timelines containing the relevant events were shown and discussed. After this activity, participants were invited to brainstorm[35] on the future of the MPA, and on the role that community groups should play in the MPA management. All the ideas and opinions were recorded on a flip chart for posterior analysis. Subsequently, the study results were presented and discussed, starting with the benthic habitat mapping results. After the presentation, participants were asked to divide themselves into four discussion groups to debate and register their findings, based on their experience and local ecological knowledge, of the ecological changes that occurred on the local flora and fauna after the hurricane Isidore hit the area in 2002. The benefits of the MPA were discussed, as well as the main obstacles affecting its management and potential solutions. To conclude the workshop, participants were asked to brainstorm on what would come next and invited to individually write down the compromises they were willing to assume regarding the MPA management. At the end, a short evaluation questionnaire was distributed to all the participants to assess their opinions and suggestions for future workshops. The whole workshop was video- and audiotaped, photographs were taken (see Appendix III), and there was one person responsible to report everything that was happening and being said.

[35] Brainstorming is a group activity based on a continuous flow of ideas started by an open-ended question put forward by the facilitator. Brainstorming can bring out multiple creative ideas on a given issue, and the following group discussion can help group members to explore and compare a variety of possible solutions (Borrini-Feyerabend 2000).

5. Results

5.1 Benthic Habitats

5.1.1 Benthic Habitat Characterization (2005)

According to the analysis of the underwater video transects and to the results of the supervised classification, the submerged aquatic vegetation (SAV) was the main benthic habitat found in the study area, being essentially composed by seagrass and macroalgae species, which assumed different percentage covers along the area. The substrate was mostly unconsolidated sediment, particularly sand or mud. There were also a few, relatively small, rocky bottom areas that were not documented by the videos nor detected by the satellite images.

As the results of the exploratory taxonomic identification of SAV species illustrated, by the time the survey was conducted, 19 different genera were registered in the area, from which 16 were macroalgae. As it usually occurs in tropical and subtropical waters, seagrass meadows in the Actam Chuleb MPA were generally mixed-species meadows containing two or three seagrass species: *Syringodium filiforme*, *Thalassia testudinum*, and *Halodule wrightii*. As expected, macroalgae presented a greater specific diversity. Among the 16 genera reported, 13 were identified at the species level. The Chlorophyta was the best represented macroalgae Division, presenting species from 9 genera: Acetabularia sp. Avrainvillea sp., Batophora sp., *Caulerpa ashmeadii*, *C. cupressoides*, *C. mexicana*, *C. paspaloides*, *C. prolifera*, *C. racemosa*, Dasycladus sp., Enteromorpha sp., *Halimeda monile*, Halimeda sp., Penicillus sp, and Udotea sp.. The Division Rhodophyta was represented by species belonging to 5 different genera: Acanthophora sp., *Bryothamnion triquetrum*, *Laurencia intricata*, Laurencia sp., *Heterosiphonia gibbesii*, and *Gracilaria cervicornis*. The Division with less representation was the Phaeophyta, with species only from 2 genera: *Dictyota cervicornis*, *D. ciliolate* and Sargassum sp.. The complete list of the identified SAV species per survey site can be consulted in Table 5:1.

Table 5:1 Submerged aquatic vegetation species found per survey site. Sites are organized according to the dominant cover, starting by seagrass dominated sites, followed by macroalgae and bare substrate dominated sites.

			Survey sites and corresponding water depth																						
			Seagrass > Macroalgae > Substrate																						
Division		Species	2.82 m	1.81 m	0.27 m	2.35 m	0.86 m	0.46 m	1.89 m	0.75 m	2.36 m	0.55 m	0.84 m	1.65 m	1.34 m	1.29 m	1.84 m	1.35 m	1.96 m	1.76 m	1.82 m	2.11 m	1.32 m
			FE210	E49	E51	FE29	FE25	FE230	FE22	FE26	FE10	FE226	E11	E46	E24	E50	E8	E33	FE216	FE229	E17	E38	E18
SEAGRASS	Magnoliophyta	*Thalassia testudinum* *(Banks ex König 1805)*	×	×	×		×	×	×			×		×	×	×	×	×		×	×		×
		Halodule wrightii (Ascherson 1868)		×	×	×		×		×			×	×					×				
		Syringodium filiforme (Kützing in Hohenacker 1852-1962)	×			×	×				×			×		×		×	×	×	×	×		
MACROALGAE	Chlorophyta	Acetabularia sp.		×	×	×	×	×		×			×	×			×	×			×	×	
		Avrainvillea sp.							×	×		×	×	×		×	×	×		×	×		×
		Batophora sp.			×			×															
		Caulerpa ashmeadii (Harvey 1858)	×	×		×	×								×				×	×			
		Caulerpa cupressoides ((Vahl 1802) C. Agardh 1817)								×					×								
		Caulerpa mexicana (Sonder ex Kützing 1849)																	×				
		Caulerpa paspaloides ((Bory de Saint-Vicent 1828) Greville 1830)					×				×			×	×		×		×		×		
		Caulerpa prolifera ((Forsskal 1775) J.V. Lamouroux 1809a)		×			×		×	×		×	×	×	×	×	×	×		×	×	×	×
		Caulerpa racemosa ((Forsskal 1775) J. Agardh 1873)									×				×				×				×
		Dasycladus sp.			×			×															
		Enteromorpha sp.																				×	
		Halimeda monile ((J. Ellis & Solander 1786) J. V. Lanouroux 1816)		×						×		×	×		×							×	
		Halimeda sp.				×			×		×			×		×	×	×	×	×	×		
		Penicillus sp.					×		×	×	×		×	×		×	×		×	×	×		
		Udotea sp.									×			×					×				
	Phaeophyta	*Dictyota cervicornis* (Kützing 1859)									×			×		×		×				×	
		Dictyota ciliolate (Kützing 1859)		×																			
		Sargassum sp.		×																			
	Rhodophyta	Acanthophora sp.									×								×				
		Bryothamnion triquetrum ((S.G. Gmelin 1768) M. Howe 1915)									×									×			
		Laurencia intricate (J.V. Lamouroux 1813)		×								×		×		×				×			×
		Laurencia sp.	×	×			×			×		×	×		×	×				×		×	
		Heterosiphonia gibbesii ((Harvey 1853) Falkenberg 1901)									×												×
		Gracilaria cervicornis ((Turner 1808-1809) J. Agardh 1852 (1851-1853)		×		×			×		×	×		×	×	×		×			×	×	×

The areal extent and spatial distribution of SAV meadows were assessed through the analysis of the benthic habitat map[36] of the study area (see Figure 5:1), the output of the supervised classification of a 2005 SPOT 5 HRG image. In terms of spatial distribution, macroalgae dominated meadows, represented by the classes 'Macroalgae 50-90%' and 'Avrainvillea spp. 50-90%', predominated in the shallow coastal areas along the coastline of mangrove forests (not represented in the map), with the class 'Avrainvillea spp. 50-90%' presenting the greatest areal extent.

On the other hand, seagrass-dominated meadows, represented by the classes 'Seagrass 90-100%', '*Syringodium filiforme* 90-100%' and '*Syringodium filiforme* 50-90%', occurred preferentially in the central and seaward zones of the study area, with the class '*Syringodium filiforme* 50-90%' presenting the greatest areal extent, making *Syringodium filiforme* the most abundant seagrass species at that time. Dense mixed seagrass meadows (90-100%) occurred mainly in the central zone along with Avrainvillea sp. dominated meadows. According to the video transect analysis, the highest percentage cover of *Thalassia testudinum* occurred in the area classified as 'seagrass 90-100%', generally not reaching the 50%. From the 93 surveyed sites only 3 (3.2%) corresponded to *Thalassia testudinum* dominated meadows (percentage cover over 50%). The species *Halodule wrightii* was the less representative in terms of areal extent.

The class mixed 'SAV 10-50%' frequently occurred surrounding areas of bare 'unconsolidated sediment <10% SAV', and it was understood as a transitional stage between the bare substrate and the vegetated areas. The bare 'unconsolidated sediment <10% SAV' mainly occurred as sand bars on the west and central part of the area, as well as on the east part near the village of San Felipe.

[36] The habitat map was assembled following a classification scheme with seven classes, already discussed and presented in Table 4:2.

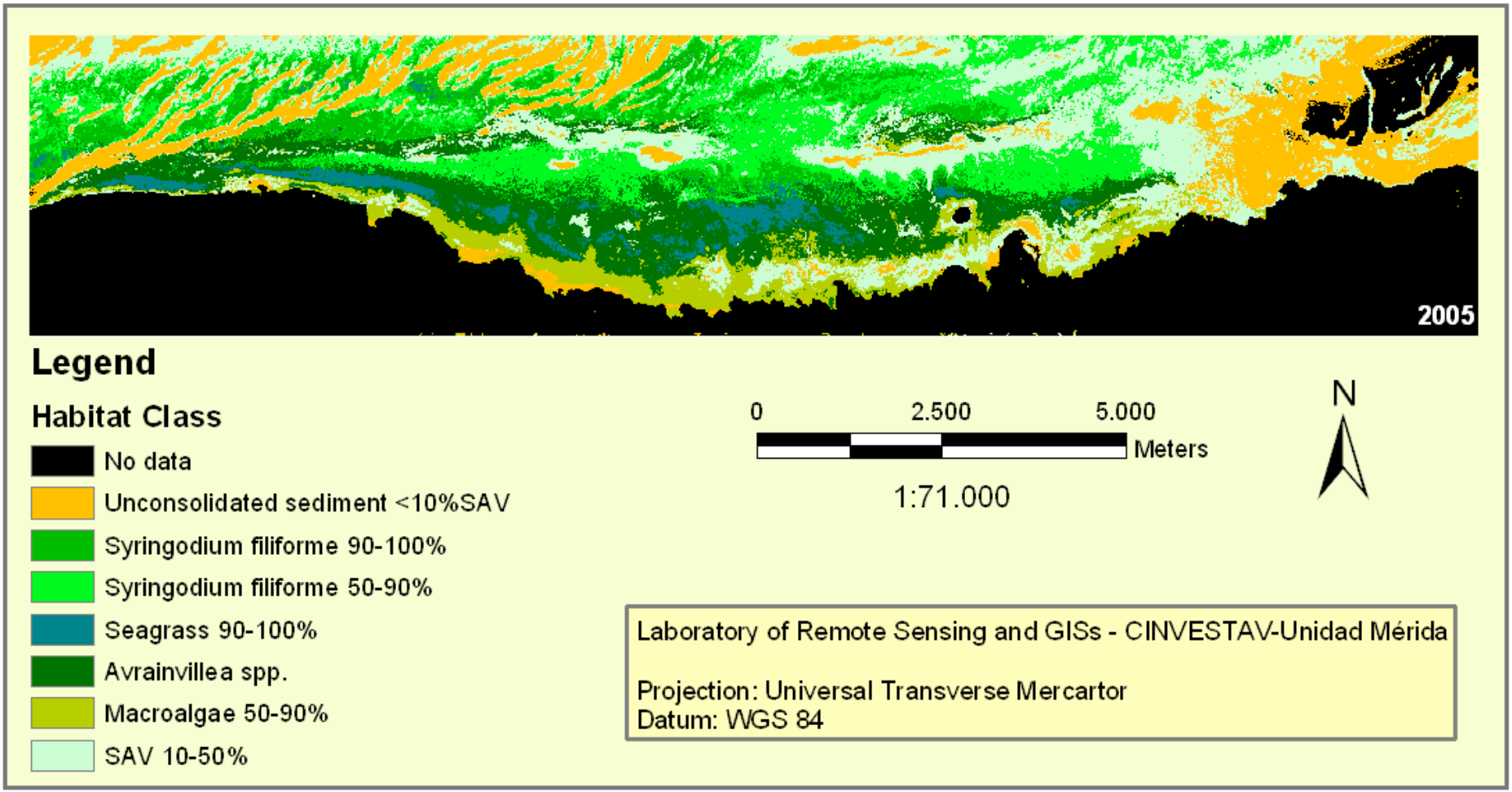


Figure 5:1 2005 submerged aquatic vegetation map.

The supervised classification of the 2005 SPOT 5 HRG image was performed with a overall accuracy of 89.24% and Kappa statistic of 87.20%, meaning that this particular classification was 87.20% better in terms of accuracy than that expected if a cover type class had been randomly assigned to each image pixel (see Table 5:2). In the error matrix the reference data columns represent the ground truth data classes observed in the sample sites and the rows represent the predicted cover classes for the same sites. The classification accuracy of each cover type was evaluated through the "user's accuracy" and "producer's accuracy" results, adjacent to the matrix. The lower "user's accuracy" value (62.22%) was obtained for the class 'Seagrass 90-100%', which means that from the 180 pixels classified as belonging to the class 'Seagrass 90-100%', only 112 were actually 'Seagrass 90-100%' in the field (112/180 × 100 = 62.22%). In terms of "producer's accuracy", the lower value was obtained for the class 'Macroalgae 50-90%', which means that from the 100 pixels found in the field belonging to the 'Macroalgae 50-90%', only 65 were accurately classified as 'Macroalgae 50-90%' (65/100 × 100 = 65%).

Table 5:2 Error matrix computed to assess the overall accuracy and kappa statistic of the supervised classification of the 2005 SPOT 5 HRG image.

	Reference Data ("ground truth")								
Predicted Cover Type	Seagrass 90-100%	*Syringodium filiforme* 90-100%	*Syringodium filiforme* 50-90%	Macroalgae 50-90%	Avrainvillea spp. 50-90%	SAV 10-50%	Unconsolidated sediment <10% SAV	TOTAL	**User's Accuracy**
Seagrass 90-100%	112	9	0	0	59	0	0	180	62.22%
Syringodium filiforme 90-100%	0	230	3	0	0	0	0	233	98.71%
Syringodium filiforme 50-90%	0	7	119	1	7	0	0	134	88.81%
Macroalgae 50-90%	0	0	0	65	11	0	0	76	85.53%
Avrainvillea spp. 50-90%	0	0	1	34	228	0	0	263	86.69%
SAV 10-50%	0	0	2	0	0	161	0	163	98.77%
Unconsolidated sediment <10% SAV	0	0	0	0	0	0	196	196	100%
TOTAL	112	246	125	100	305	161	196	1245	
Producer's Accuracy	100%	93.5%	95.2%	65%	74.75%	100%	100%		
Overall accuracy = 89.24%; Kappa statistic = 87.20%									

5.1.2 Bathymetry (2005)

The Actam Chuleb MPA is located in a coastal shallow area with water depths ranging from 0 to 2.50 m, as illustrated by its bathymetric map (see Figure 5:2). The 10 m depth contour is usually more than 10 km away from the shoreline and the 20 m depth contour more than 20 km away. The deepest areas (in blue and purple) can be seen in between the coastline and the seaward limit. As shown by the map, the area resembles a small bay sheltered from wave's action and other oceanographic perturbations by its natural topography. Two main channels connect the area with the "deeper" ocean, one of them is located right in the central portion of the area and the other one is located in the eastern portion of the area.

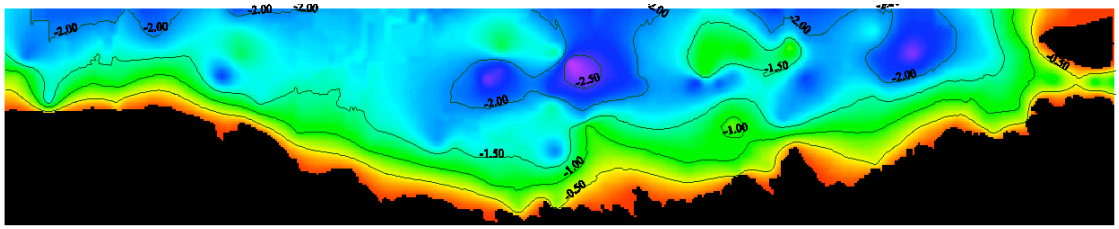


Figure 5:2 Actam Chuleb MPA bathymetric map. The red colour corresponds to the sallower areas and the purple to the deepest.

5.1.3 Change Detection

A post-classification change detection procedure was conducted by comparing every image pixels, in terms of habitat class, on both 2000 and 2005 SAV maps. To do so, it was necessary to generate two SAV maps based on a four-class habitat classification scheme (see Figure 5:3). The four-class 2000 SAV map was obtained with an overall classification accuracy of 77.97%, and Kappa statistic of 72.45%. Since the four-class 2005 SAV map was adapted from the seven-class map, its accuracy parameters were precisely the same obtained in the seven-class map (see Table 5:2).

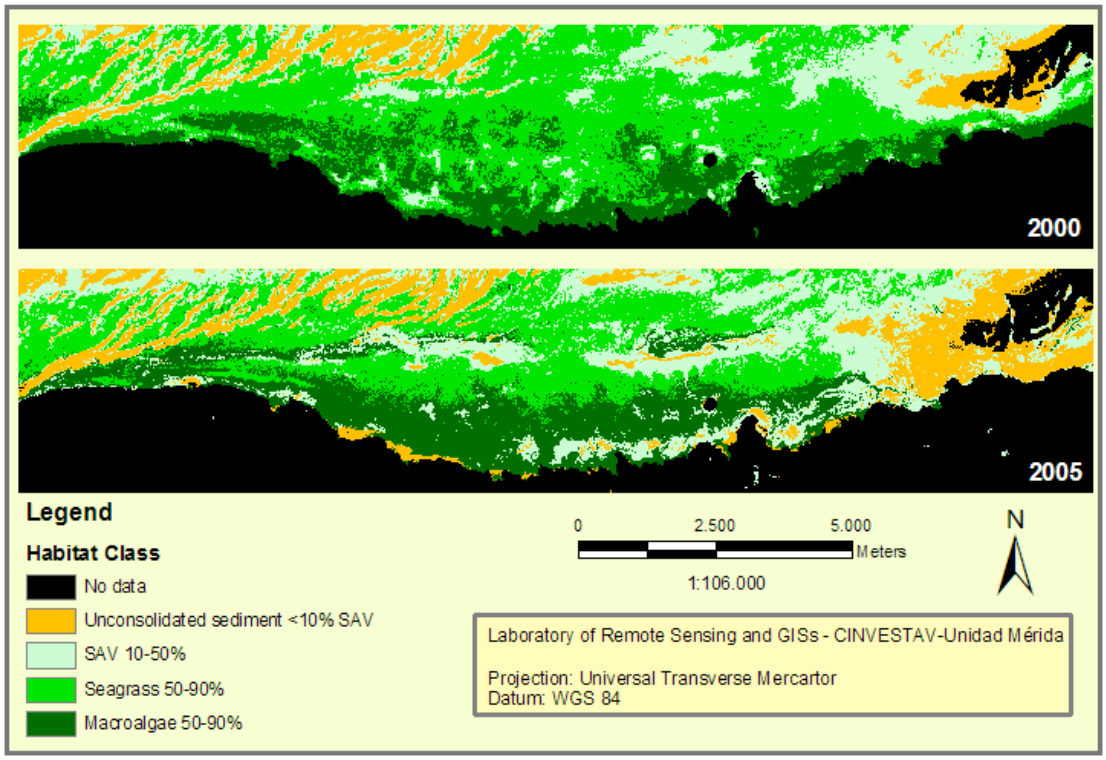


Figure 5:3 MPA submerged aquatic vegetation maps from 2000 and 2005, used in the change detection analysis.

A "From-To" matrix was computed to quantify the changes occurred in each habitat class in terms of pixels (see Table 5:3). In other words, how many pixels per habitat class in the 2000 SAV map remained in the same class in the 2005 SAV map, how many were lost to other classes, and how many were gained from other classes. To facilitate the visualization of these data four maps were assembled, one per class, illustrating the gained, lost and unchanged cover (see Figure 5:4). Although all four classes lost and gained pixels, according to the results the only one showing a negative net gain equivalent to 92985 pixels or 929.9 ha[37] was 'Seagrass >50%'. On the other hand, the class 'unconsolidated sediment <10% SAV' presented the greatest net gain – 43830 pixels, corresponding to 438.3 ha, especially on the eastern part of the study area, near the village. Apparently, to some extent, this gain was accompanied by an increment in the class 'SAV 10-50%' of 34630 pixels or 346.3 ha. It is interesting to verify that after five years, which comprised the impact of a hurricane like Isidore (category 3 in the Saffir-Simpson scale) with winds reaching the 220 km/h in 2002, the characteristic pattern of sand bars located in the western

[37] In both SPOT 5 HRG and ETM+ resampled images one pixel corresponds to one hundred square meters.

part of the area remained basically the same. Finally, the class 'macroalgae >50%' also increased its cover in 14525 pixels or 145.3 ha, showing a clear seaward expansion in 2005, basically to the detriment of the 'seagrass >50%' class.

Table 5:3 "From-To" matrix, showing the nº of pixels that were lost (rows), gained (columns) or remained in the same habitat class (diagonal) from 2000 to 2005. Net gains were calculated subtracting the total losses from the total gains.

	2005					
2000	Seagrass >50%	Macroalgae >50%	SAV 10-50%	Unconsolidated sediment <10% SAV	**TOTAL LOSSES**	**NET GAINS (Gains – Losses) (Hectares)**
Seagrass >50%	116792	56953	71196	14727	259668	**-929.85**
Macroalgae >50%	19874	51723	19697	12465	103759	**145.25**
SAV 10-50%	27738	9502	57268	29252	123760	**346.30**
Unconsolidated sediment <10% SAV	2279	106	10229	43876	56490	**438.30**
TOTAL GAINS	166683	118284	158390	100320	543677	

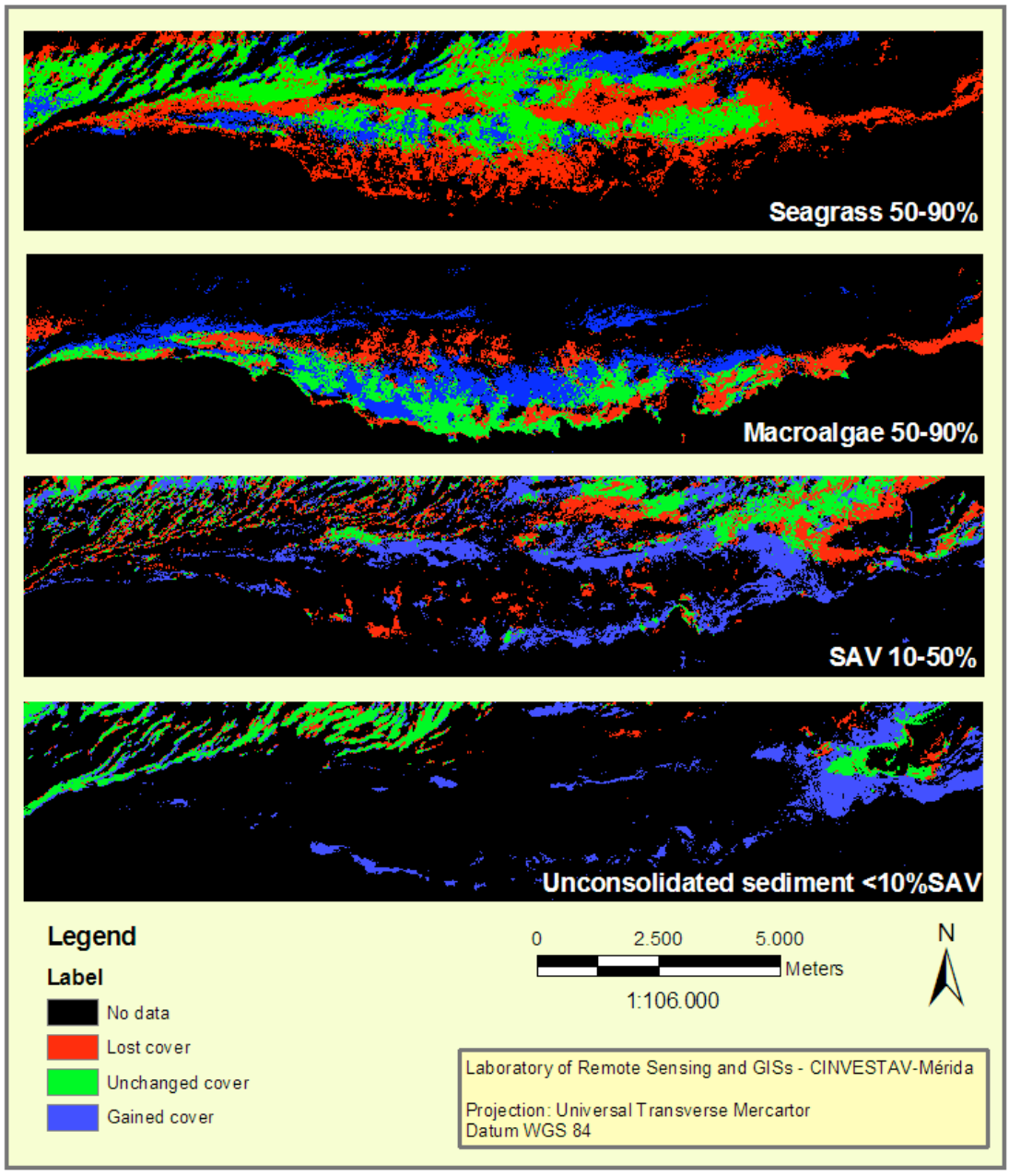


Figure 5:4 Change detection maps illustrating, per habitat class, the areal extent and spatial distribution of the unchanged, lost, and gained cover.

5.1.3.1 Local Ecological Knowledge

At the participatory workshop held in San Felipe, on the 26th of January 2006, with the main MPA stakeholder groups, the 26 participants, from which 17 were fishermen, were asked to divided themselves into four groups and discuss the ecological changes caused by the hurricane Isidore, which hit the area in 2002. In

terms of flora, three of the four groups mentioned a perceived decrease in the areal extent of the dominant macroalgae species Avrainvillea sp., locally known as *orejona*. According to the participants, this genus used to occupy and dominate the sallower areas along the coastline and, as shown by the 2005 SAV map (Figure 5:1), apparently moved seaward, being replaced by a mixture of other macroalgae, without an evident dominant species. Two of the four discussion groups referred that there was a reduction in the areal extent of the seagrass meadows, and two other groups mentioned an increase in the amount of bare sandy areas, which in some cases caused the disappearance of some rocky areas by burying. Despite being beyond the scope of this study, the four discussion groups mentioned the great lost of mangrove forest caused by the hurricane.

In terms of ictiofauna, all the four groups mentioned a notorious increase in the population of sea trout (Cynoscion sp.); three of them noticed a decrease in the population of great barracuda (*Sphyraena barracuda*); two referred that by then it was frequent to see nurse sharks in the area, especially from January to April (according to one of the groups), probably to reproduce themselves; and, to conclude, one of the groups noticed a decrease in the populations of red grouper, white grunt, spiny lobster, and tarpon. As pointed out by two of the groups, several populations of seabirds (e.g., cormorant, pelican, bare-throated tiger-heron, and frigatebird) had managed to recover from the impact caused by the hurricane and were nesting in the area again.

5.1.4 Landscape Ecological Indices

Landscape ecological metrics at the class level illustrated, once more, the expansion occurred in terms of cover in every habitat class from 2000 to 2005, except in ‘seagrass 50-90%’, which saw its total land cover being reduced in almost 20% (see Table 5:4). The class ‘SAV 10-50’, besides having increased its cover in 4.4%, almost doubled its number of patches (741 to 1406), and thus patch density (11.0 to 20.9 patches per 100ha). Contrarily to all the other classes, ‘macroalgae 50-90%’, besides having increased its cover in 6.7%, suffered a decrease in the number of patches (695

to 419), and patch density (10.3 to 6.2 patches per 100ha). Potentially explaining why both the aggregation and cohesion indices increased from 2000 to 2005, towards a greater aggregation and cohesion of the class patches, respectively. Finally, the mean fractal index assumed values very close to 1 for all the habitat classes, illustrating the generalized simplicity of patches' perimeters.

Table 5:4 Landscape ecological indices per habitat class considering both 2000 and 2005 SAV maps.

	Landscape Ecological Indices													
	2000	2005	2000	2005	2000	2005	2000		2005		2000	2005	2000	2005
Habitat Class	Land cover (%)		Number of Patches (#)		Patch Density (#/100ha)		Fractal Index 1 to 2				Aggregation -1 to 1		Cohesion 0 to 100	
SAV 10-50%	21,3	25,7	741	1406	11,0	20,9	1,08	±0,07	1,07	±0,07	0,86	0,85	98,2	99,0
Unc. Sed. <10%SAV	14,0	22,4	266	466	3,9	6,9	1,08	±0,06	1,07	±0,06	0,91	0,92	98,9	99,0
Seagrass 50-90%	53,1	33,5	511	576	7,6	8,6	1,06	±0,06	1,06	±0,06	0,89	0,92	99,8	99,6
Macroalgae 50-90%	11,6	18,3	695	419	10,3	6,2	1,07	±0,07	1,06	±0,06	0,85	0,92	98,4	99,7
Total	100	100	2213	2867										

5.2 Co-management of the Actam Chuleb MPA: Seven Years of Research

5.2.1 2000-2003: Results Overview

From 2000 to 2003, a multidisciplinary project, with two phases, was carried out in San Felipe (1st and 2nd phases) and in Dzilam Bravo (2nd phase)[38]. The first phase was entitled "Community-based management of a Marine Reserve in San Felipe, Mexico", and the second one "Community-based management of a Natural Reserve in Yucatan, Mexico". This project was part of the Caribbean Coastal Resources Community Management Program, funded by the IDRC in collaboration with the CARICOM Fisheries Unit, based in Belize, the Laval University of Canada, and the International Ocean Institute of Costa Rica. It was developed by a multidisciplinary team of researchers from CINVESTAV-Mérida, Mexico; University of British Columbia, Canada; Virginia Institute of Marine Science (VIMS), USA; and from the Yucalpetén Regional Center of Fisheries Research (CRIPY), Mexico.

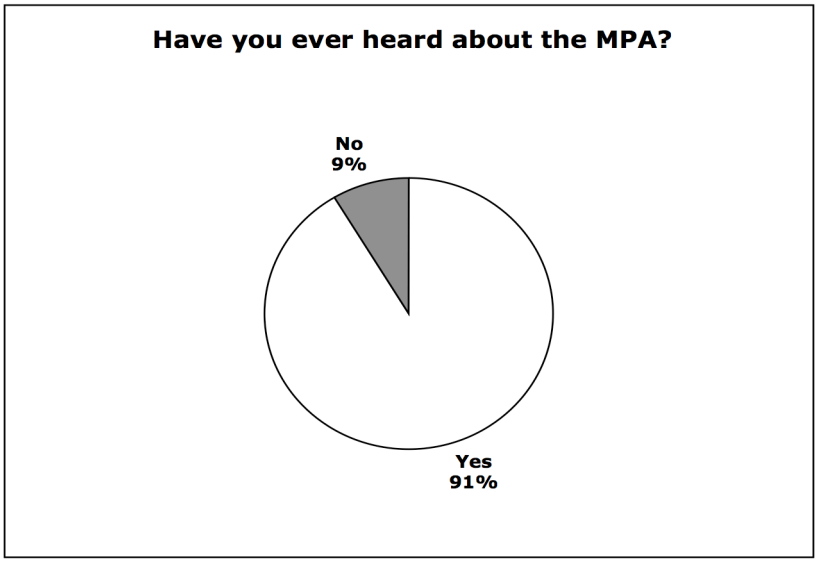
The main objectives of this project were to work in collaboration with the community to: (1) understand the perceptions, interests, and attitudes of the men and women of San Felipe, government, and researchers concerning the MPA; (2) generate baseline bio-physical information about the marine ecosystem; (3) analyse the governance system and institutional arrangements necessary for the implementation and management of the MPA; (4) identify the obstacles and the key factors leading to the success of the MPA; (5) develop an organizational model towards the co-management of the MPA; (6) provide basic training to local personnel to manage the MPA, and build capacities for the implementation of productive projects in the area; and (7) develop a "Multipurpose Community Centre" to integrate the knowledge and management capacities of local users, managers, researchers, and NGOs towards the sustainable management of marine resources. The methodologies adopted included

[38] The first phase of the project was conducted from March 2000 to August 2001, and the second phase from June 2002 to November 2003.

the analysis of secondary data sources, informal and semi-structured interviews with key informants, natural resources valorization, socioeconomic surveys focusing on the main stakeholder groups (including women and teenagers), benthic habitat mapping techniques, and a series of participatory workshops (Fraga et al 2006b; 2006d).

5.2.1.1 Stakeholder Survey (2000)

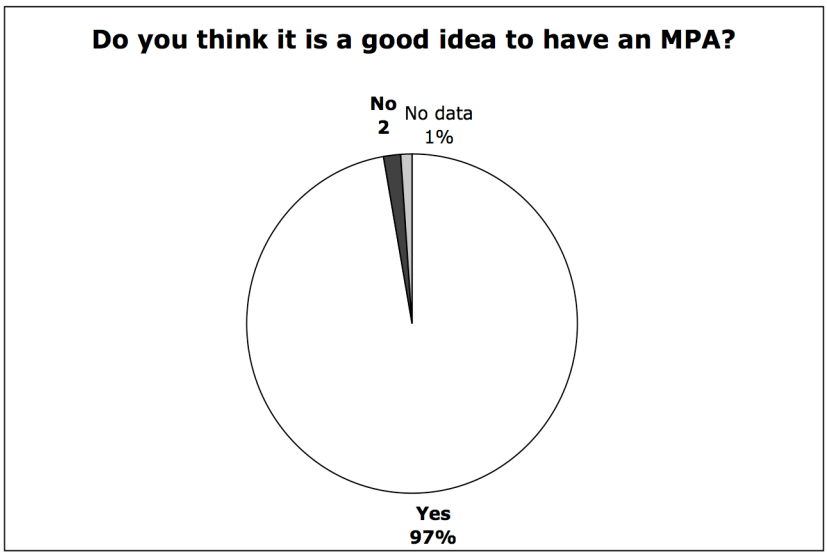
In June 2000, five years after the establishment of the Actam Chuleb MPA in San Felipe, a survey focusing on people's opinion about the MPA and its management was conducted with a sample of 175 people (76% male), considering five main stakeholder groups: (1) cooperative fishers, (2) independent fishers, (3) people having tourism-related occupations, (4) residents (e.g., ranchers, teachers, housewives, etc.), and (5) experts (e.g., researchers, government officials, NGO representatives) involved with coastal resources management in San Felipe (Fraga et al 2006b). According to the results, 91% of the respondents had heard about the MPA (see Figure 5:5) locally know as *la reserva*, showing that it was widely known among the people from the village and by experts in general.



Source: Adapted from Fraga et al 2006b, p. 53.

Figure 5:5 Percentage of respondents that had or had not heard about the Actam Chuleb MPA.

Similar results were obtained when respondents were asked if they considered a good idea to have an MPA in the community, since 97% considered it to be a good idea, illustrating its generalized acceptance (see Figure 5:6).

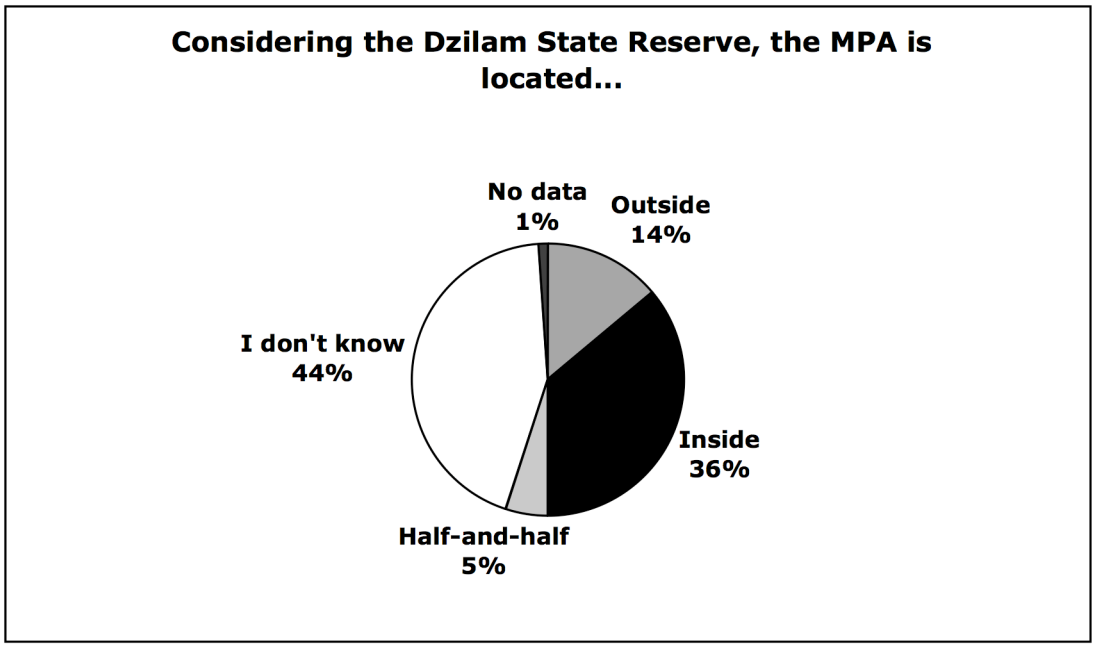


Source: Adapted from Fraga et al 2006b, p. 55.

Figure 5:6 Percentage of respondents that considered or not a good idea to have an MPA in the community.

When inquired about the location of the MPA in relation to the Dzilam State Reserve, 44% of the respondents confessed that they did not know, 36% stated that it was located inside the State Reserve, 14% affirmed that is was located outside, and 5% considered that it was located half inside and half outside the State Reserve (see Figure 5:7). These results reveal that the majority of the respondents were not aware of the geographic limits of the Dzilam State Reserve, and contribute to explain why the municipality of San Felipe along with the fishing cooperative and other local authorities decided to decree an municipal MPA in an area already encompassed by a State Reserve, action which is not allowed according to the Mexican environmental legislation[39].

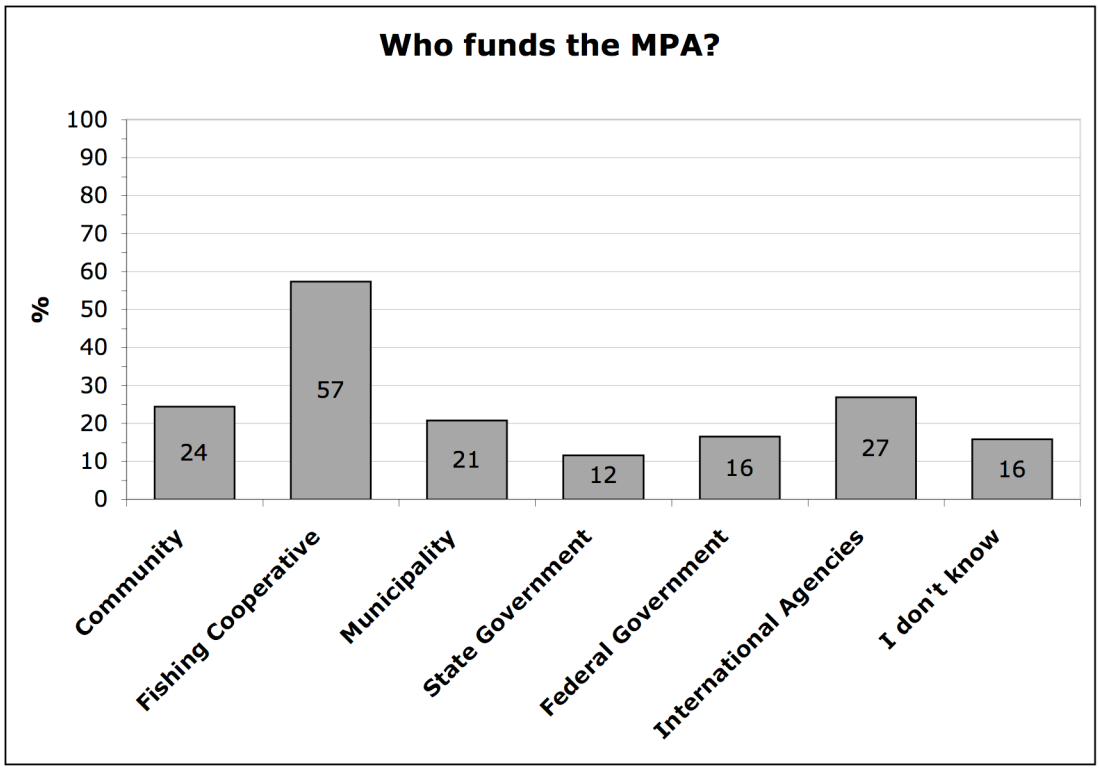
[39] For further details consult the General Law for Ecological Balance and Environmental Protection (LGEEPA) and the Law for the Environmental Protection of the Yucatan State (LPAEY).



Source: Adapted from Fraga et al 2006b, p. 56.

Figure 5:7 Respondents' opinion concerning the spatial location of the MPA in relation to the Dzilam State Reserve.

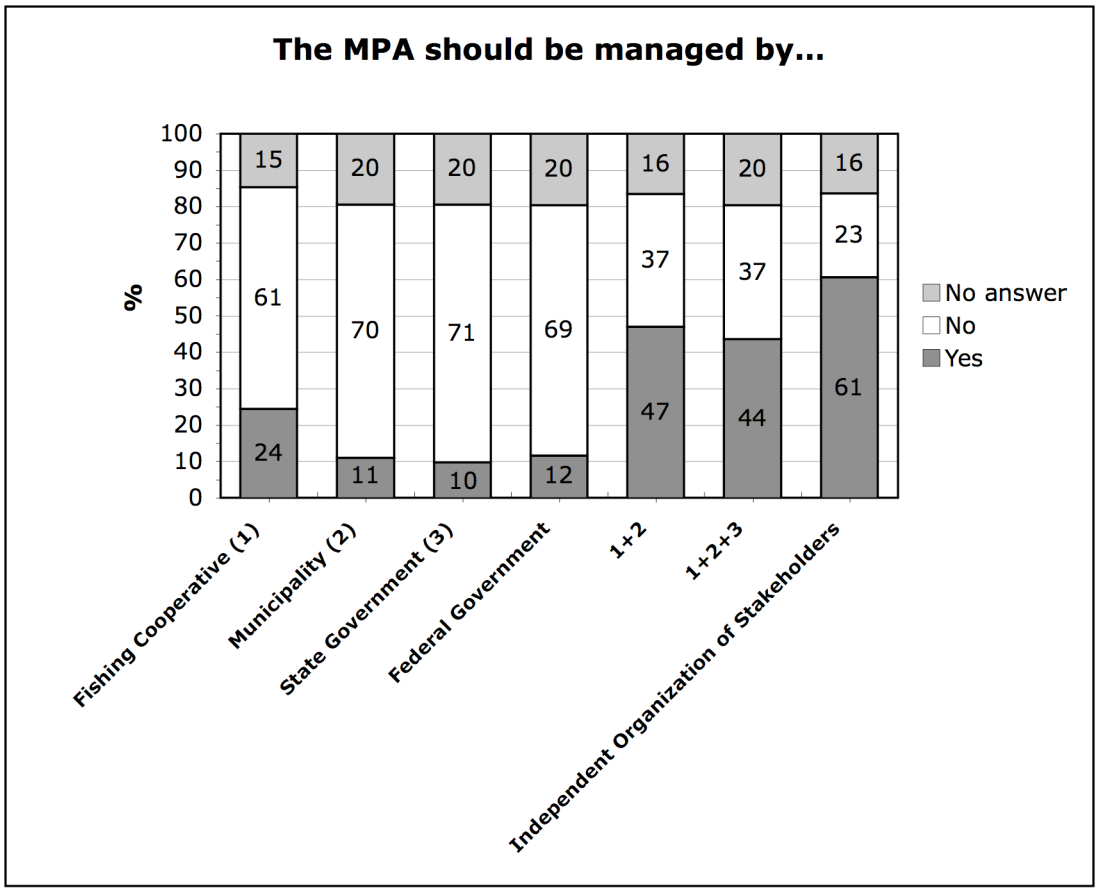
When respondents were asked if they knew you funded the MPA functioning, the majority (57%) answered the fishing cooperative, 27% claimed that it was funded by international agencies, and 24% stated the community. Less than 20% of the respondents mentioned the municipality, the state government or the federal government (see Figure 5:8). In fact, between 1995 and 2000, it was essentially the fishing cooperative with the economic support of the Mexican Fund for Nature Conservation (FMCN) and the United Nations Development Program (UNDP) who funded the MPA functioning.



Source: Adapted from Fraga et al 2006b, p. 57.

Figure 5:8 Respondents' knowledge about who funded the MPA.

When invited to express their views about who should manage the MPA, the majority of the respondents (61%) answered that the management of the MPA should be shared by several organizations, defending the creation of an autonomous stakeholder organization composed of community representatives, government officials, and researchers; 47% believed that the MPA should be managed by the fishing cooperative along with the municipality; and 44% agreed that it should be managed by the fishing cooperative along with the municipality and the state government (see Figure 5:9).



Source: Adapted from Fraga et al 2006b, p. 57.

Figure 5:9 Respondents' opinion about who should manage the MPA.

5.2.1.2 I Participatory Workshop (2000)

In November 2000, the first of three participatory workshops was held in San Felipe for two days, with 22 and 33 participants, respectively. The aim was to communicate the so far obtained results, and identify, according to the participants, potential uses and conservation actions to be carried out in the MPA that could guide the establishment of a future management plan.

Several discussions took place, and among the priority actions regarding the MPA, besides conservation, research and education, participants mentioned the need to reinforce patrolling, which was not being performed in a permanent basis due to insufficient funds, lack of infrastructures (like a patrolling tower, which they could

not get the official permit to build), and specially due to the lack of a legal framework. In fact, the MPA legal status was considered by the participants to be one of its main issues, followed by the lack of economic support. Collaboration among community members and between the community and the government was also considered to be essential to progress (Fraga et al 2006b).

According to Fraga et al (2006b) and Chuenpagdee et al (2004), the existence of a local fishing cooperative (a relevant organization that could act as key co-management partner), the high dependence on coastal resources, the profound local ecological knowledge possessed by the locals, and the interest shown by the main local stakeholder groups in managing the MPA in collaboration with the government and research institutes were circumstances that could potentiate the effective development and implementation of a collaborative coastal resources management agreement in San Felipe. Nevertheless, a key element to succeed was still lacking, the legal support provided by the government.

5.2.1.3 II Participatory Workshop (2002)

The second participatory workshop to be held in San Felipe occurred on November 2002 (Phase II) with about 60 participants from the main local stakeholder groups and government agencies (present only on the second day). Among the different group activities conducted on the first day, one focused on participants' interests regarding the management of the MPA by asking them how would they like the MPA to be managed, what did they have to accomplish it, and what was lacking. In this activity, participants mentioned, once more, that they would like the MPA to be patrolled in a regular basis by trained guards, and within a legal framework allowing for the application of fines. They also expressed that the MPA management should count with greater support from the government, from the community itself, who should be kept informed, and from research institutes and funding agencies. Regarding what was already available to accomplish what was being proposed, the groups mentioned that there was a boat to patrol the area, a radar, wood to build a guard tower (that could also serve tourism purposes), motivation, local agreements, the support of local

authorities, and local people to constitute a management committee. Concerning what was lacking, participants referred fuel for the boat, the official permit to build the guard tower, enough trained people with full-time availability to patrol the area, impartiality in patrolling, new marker posts delimitating the MPA, the support of the State government, a legal framework, regulations, economic resources, projects to obtain funds, technical support, natural resources management capacities, coordination, organization, improved communication, efficient ways of spreading information, and consciousness (Fraga et al 2006d).

On the second day, a group exercise, focusing on the management and administrative technicalities of the Dzilam State Reserve revealed that the majority of the participants still considered the Actam Chuleb MPA and the Dzilam State Reserve (from which they affirmed not knowing much about) two distinct reserves (Vidal 2006). In terms of personal compromises towards its protection and management, the majority stated that they could offer themselves as volunteers to patrol the MPA and to help to reforest the area. According to the participants, inclusive meetings like those could be an important instrument to improve the management capacity of the Dzilam State Reserve, by enabling local users and government officials to share information and discuss their interests. Moreover, the need to train new generations for the conservation of natural resources, the creation of a local committee to address the needs and incorporate the opinion of local people into the MPA management, and the need to collaborate, in a coordinate manner, with the government agencies responsible for the management of the Dzilam State Reserve were also underlined by the participants (Vidal 2006).

According to the authorities attending to the workshop, co-management between government agencies and local resource users could be a good alternative approach to overcome the lack of public financial resources to manage and patrol reserve areas as big as the Dzilam State Reserve, and improve their effectiveness. Therefore, management agreements between the government and local resource users should be established, communities should be involved in the design of management plans, and if possible in patrolling. However, a technical committee should only include those institutions or organizations most directly involved or affected by the use of natural resources to avoid big inoperative groups. According to the authorities, the major

challenge regarding the Actam Chuleb MPA was the official recognition of its regulations (Vidal 2006).

According to Vidal (2006), this exercise revealed that there was still a long way to go towards the effective participation of local communities in the development and implementation of a management plan for the Dzilam State Reserve[40]. A great effort was needed to explain to people how the Reserve's administrative structure and management plan could be organized, which were the advantages and disadvantages of each single possibility, and, obviously, what strategies could be used to effectively enable people to participate. Nevertheless, Vidal (2006) believes that it is the responsibility of local resource users to put pressure on government agencies to accelerate intergovernmental coordination processes, and implement effective civic participatory mechanisms, since the legal instruments do exist.

5.2.1.4 III Participatory Workshop (2003)

The third participatory workshop was carried out in San Felipe, in June 2003, and one of its purposes was to answer to the question: "Is the co-management of the Dzilam State Reserve possible?" The workshop counted with the participation of about 50 persons representing the main stakeholder groups of San Felipe and one of Dzilam Bravo (2 persons), government officials, researchers, including the leaders of similar projects being carried out in other Caribbean countries, and a few foreign fishermen (Fraga et al 2006d).

When invited to think about what would come next concerning the MPA, participants' main suggestion was the legal creation of a local management committee to represent the interests of the main stakeholder groups (women included) in the management of natural resources, to make projects to support the MPA economically, and always keep the population informed. Committee members should be honest, participative, experienced, knowledgeable, and committed.

[40] Officially, the Dzilam State Reserve did not have a management plan until September 2006

The need to constitute an inclusive management committee for the MPA was also recognized by the mayor of San Felipe, particularly as a means to decentralize management responsibilities being carried out exclusively by a few elements of the fishing cooperative. The local mayor also underlined the need to establish a legal framework for the Actam Chuleb MPA.

According to the representative of the Secretariat of Ecology (SECOL), the state government recognized the need to collaborate with the community, and, therefore, was going to assume the compromise of assisting the legal establishment of such a committee and subsequent search for funding. According to the same representative, the management plan of the Dzilam State Reserve was already being formulated and it was going to consider the local uses and informal rules conceived by the community of San Felipe regarding the marine area known as Actam Chuleb.

5.2.1.5 Overall Achievements

This project helped to understand the different interests and perspectives coexisting in the community of San Felipe regarding the conservation and management of the Actam Chuleb MPA, and to strengthen the community's social network and participation. It culminated in the reorganization of a local NGO named Actam Chuleb[41], in 2004, through the integration of eleven new members, as a means to guarantee the representation of diverse stakeholder groups and broaden the scope of interests managed by a local organization aspiring to have a stake in the MPA management. Moreover, it promoted the establishment of communication channels among stakeholder groups involved in the use and management of the MPA, particularly between local users and researchers, local users and government officials, and among the different levels of government (Fraga et al 2006b; 2006d).

[41] This NGO had been founded in 2000 by five fishermen from the fishing cooperative, actively involved in the management of the MPA.

5.2.2 2006-2007: Stakeholder Perceptions regarding the MPA

The following results were obtained between April 2006 and March 2007 using an in-depth stakeholder survey, a participatory workshop, field notes taking, participant observation, informal interviews, and questionnaires sent via e-mail (see chapter 4.2). The results focus on stakeholder perceptions regarding the MPA aims, benefits and beneficiaries, obstacles and potential solutions, management and participation, and future perspectives. In this context, it is important to underline that interviewees should be considered as persons who make decisions concerning what information to share, what image to present to outsiders, and what factors they consider relevant to the problems they face (Fraga 2006).

5.2.2.1 Perceived MPA Aims

The structured interview used in the in-depth stakeholder survey started by an open-ended question asking what were the aims of creating an MPA in San Felipe. According to 95% of the 57 total responses (A+B+C), the Actam Chuleb MPA was established in 1995 to protect what was considered by the local people to be a natural spawning and nursery area (*criadero natural*) for many economically important marine species (see Figure 5:10). From these, 65% of the responses (given by 77% of the interviewees) focused on the spillover effect of the MPA on the nearby fishing grounds, 21% (given by 25% of the interviewees) highlighted the importance of protecting an area that could be used to subsistence fishing (trolling) during fishing ban and bad weather periods, and 9% mentioned the possibility of fishing inside the area in case of a hurricane[42]. Finally, 5% of the responses indicate that one of the MPA aims was to promote employment alternatives to fishing such as tourism activities. When the decision of establishing an MPA in San Felipe was made tourism was not one of its purposes, but lately, due to the increasing exploitation of fishery resources, developing alternative economic activities besides fishing has become one

[42] In 2002, a few days after the hurricane Isidore hit San Felipe, in order to reduce the social crisis menacing the village, the municipality allowed for a few boats to use fishing nets inside the MPA. The fish caught was freely distributed to every family.

of the preoccupations shared by the fishermen of San Felipe, illustrated by the constitution of three tourism oriented cooperative societies in 2006.

When invited to give their opinion about the accomplishment of the MPA aims, the majority of the participants (57%) stated that the aims were being acceptably accomplished despite of all the problems associated with the MPA management, 29% considered that the aims were being poorly fulfilled, and just 10% believed that the MPA aims were being fairly achieved (see Figure 5:11).

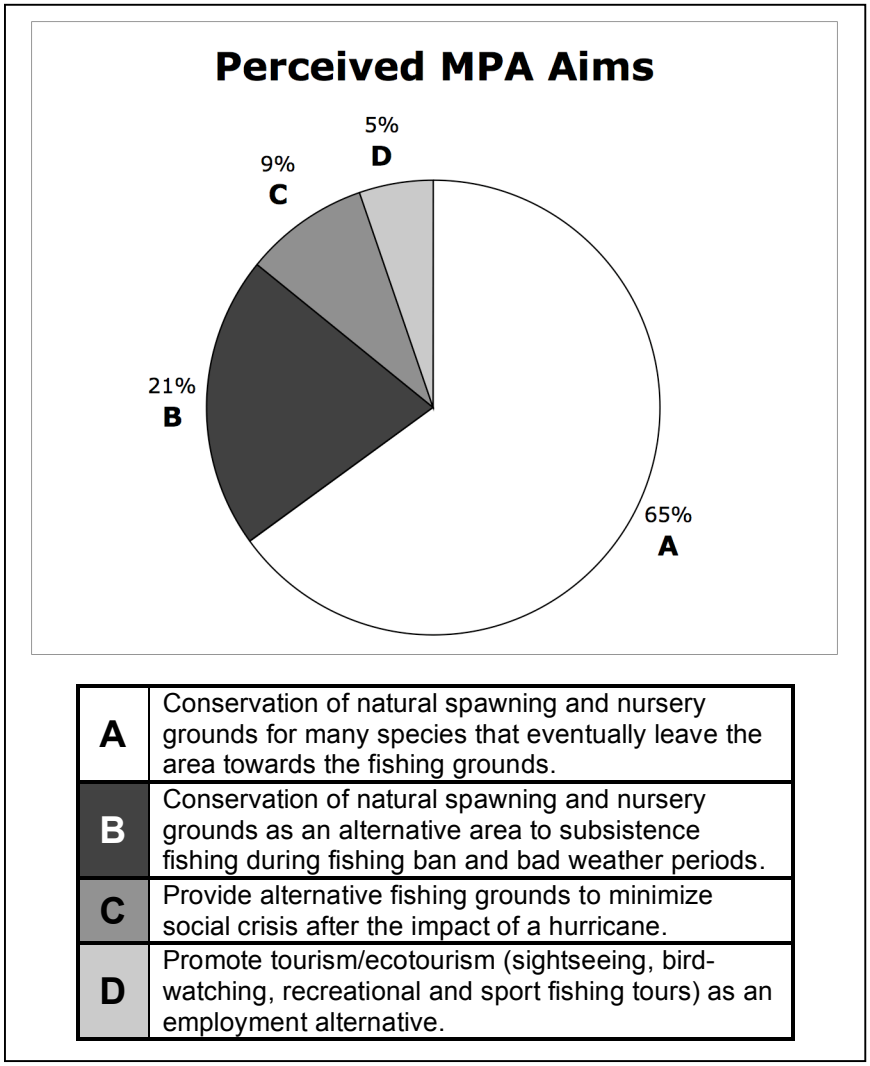


Figure 5:10 Aims of the MPA according to the interviewees.

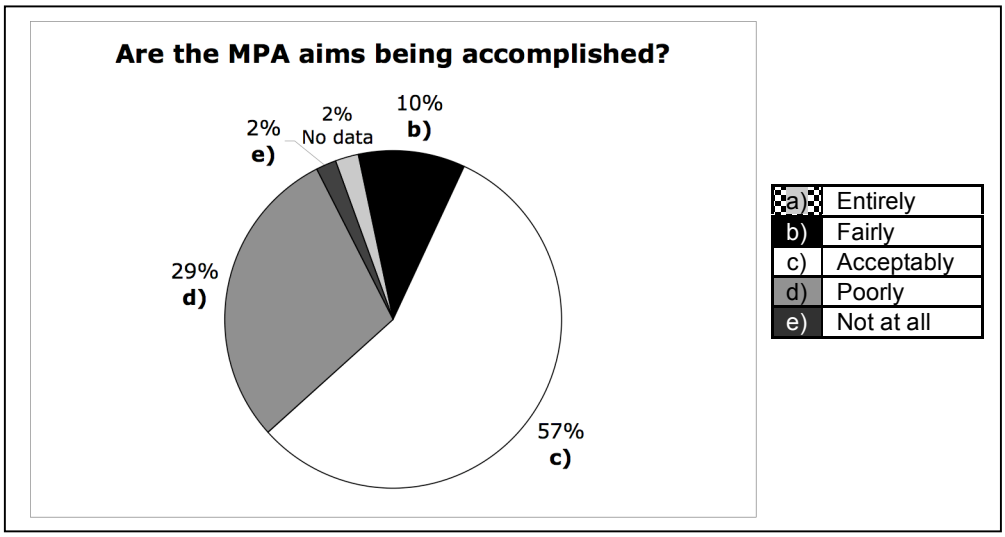


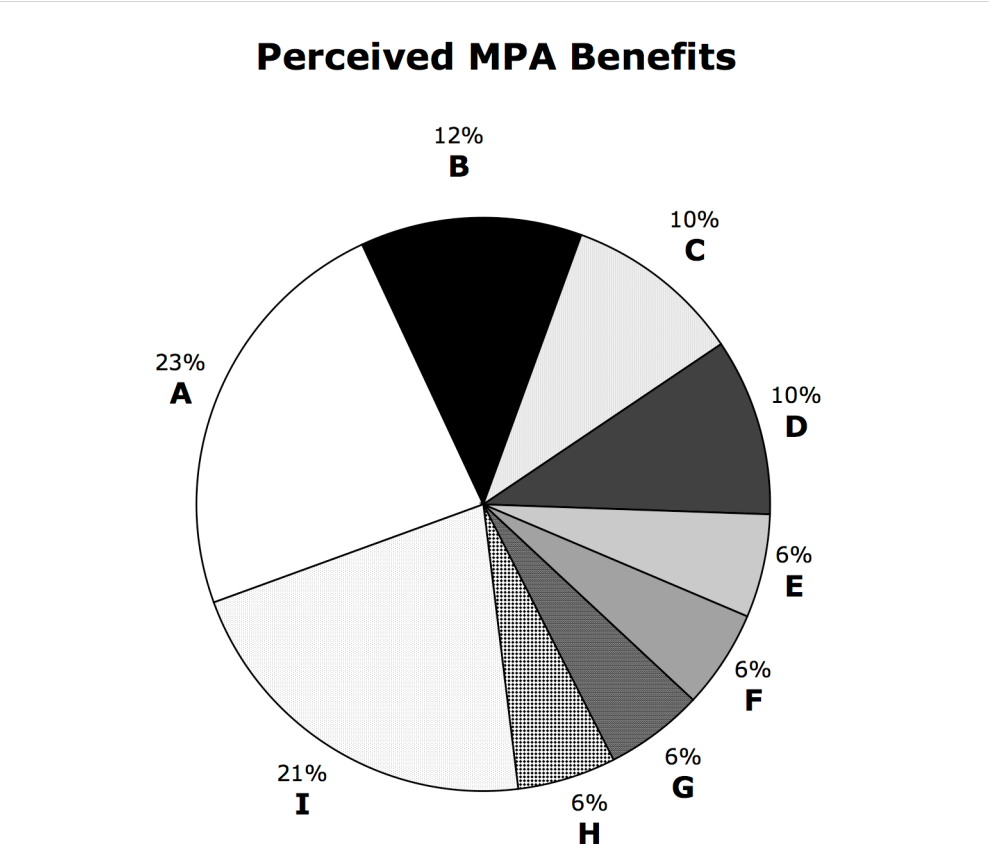
Figure 5:11 Interviewees' opinion about the MPA aims' accomplishment.

5.2.2.2 Perceived MPA Benefits

Comprehending what were the MPA benefits according to the perceptions of the interviewees was one of aims of the interview. To avoid influencing interviewees' answers, the topic was introduced using an open-ended question. According to the results, 45% of the 90 total responses (A+B+C) referred benefits related with the fishing activity (see Figure 5:12). From these, 23% of the responses (given by 44% of the interviewees) stated that one of the main benefits generated by the MPA was to provide alternative subsistence fishing grounds during fishing ban and bad weather periods; 12% of the responses (given by 23% of the interviewees) mentioned that fishing with nets around the MPA boundaries was very profitable, especially during the cold fronts' season, when weather conditions do not always allow fishermen to go somewhere else; and 10% of the responses (given by 19% of the interviewees) referred the spillover effect caused by the MPA as one of its benefits. Tourism related benefits comprised 16% of the total responses (D+E), 10% (given by 19% of the interviewees) mentioning the economic benefits obtained by tour operators, who used the MPA to carry out their tours, and 6% (given by 10% of the interviewees) referring tourists' satisfaction regarding what the MPA had to offer, generally making them wish to visit the area again. Benefits related with the conservation of natural resources

were mentioned in 12% of the responses (F+H), 6% of them referring the conservation as a benefit for the present and future generations, and 6% mentioned the high biological diversity and abundance found in the MPA due to fishing restrictions. Finally, 6% of the responses stated that the MPA benefited the whole population of San Felipe through fisheries and tourism related activities, since the majority of its inhabitants are fishermen or shop owners. The responses corresponding to less than 5% of the total were not considered.

To corroborate the results obtained with the in-depth stakeholder survey, participants of the participatory workshop carried out in San Felipe, in January 2007, were asked to brainstorm on the benefits of the MPA. The results were identical to the ones obtained with the survey, since the same sorts of benefits related with the fishing activity, with tourism, and natural resources conservation were mentioned (see Figure 5:13), indicating that the MPA benefits were widely recognized by the community in general.



A	Alternative subsistence fishing (trolling) area during fishing ban and bad weather periods.
B	Profitable fisheries around the MPA boundaries especially during the cold fronts' season.
C	Conservation of natural breeding and nursery grounds for species that eventually leave the area towards the fishing grounds.
D	Benefits tour operators.
E	Pleased tourists.
F	Resources' conservation for the benefit of present and future generations.
G	Benefits the whole population through fisheries and tourism.
H	High abundance of fish (adults and juveniles) inside the area due to the prohibition of fishing with nets.
I	Other (<5%).

Figure 5:12 MPA benefits according to the interviewees.

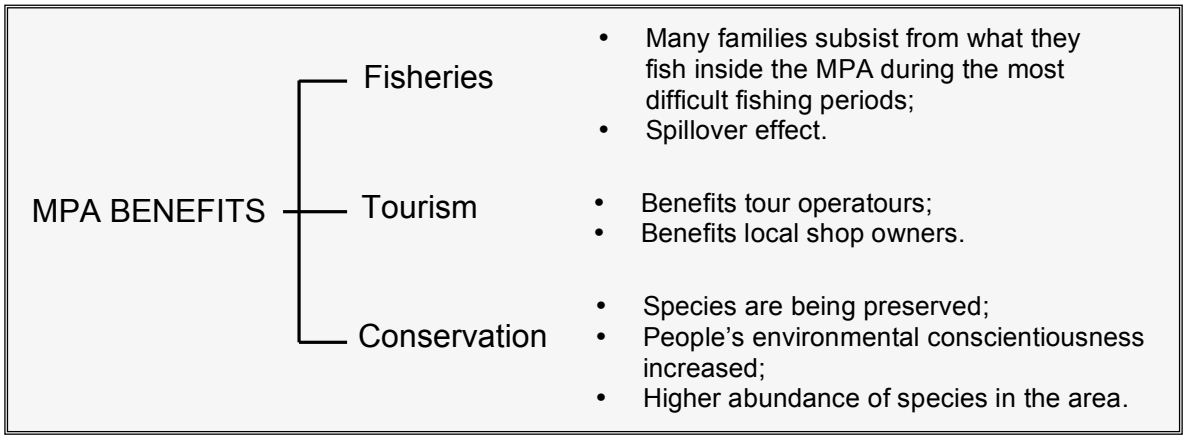


Figure 5:13 MPA benefits mentioned by the participants during the participatory workshop carried out in San Felipe in January 2007.

When asked who, in San Felipe, benefited from the MPA, 63% of the interviewees mentioned 'everyone' (27%) or 'almost everyone' (36%), mainly through fishing and tourism related activities, while 33% of the interviewees stated that only 'some' were being beneficiated, and 4% just 'a few' (see Figure 5:14).

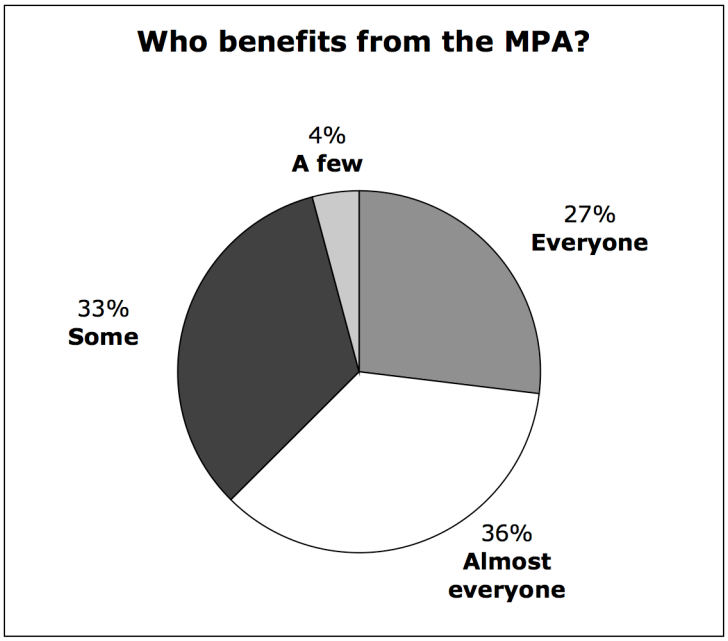


Figure 5:14 Interviewees' opinion about whom, in San Felipe, benefited from the MPA.

After having identified the main benefits provided by the MPA, an ordinal question was posed to understand how the interviewees would rank, by order of relative

importance, a set of four pre-determined categories of benefits potentially related with the MPA: (1) social, (2) ecological, (3) economic, and (4) educational. According to the results, the 'social' and the 'ecological' categories were the most highly rated, picked by 38% and 33% of the interviewees, respectively (see Figure 5:15). The majority of the interviewees interpreted 'social' benefits as those related with subsistence fishing activities carried out inside and around the boundaries of the MPA, which obviously have an implicit economic dimension as well. 'Ecological' benefits were associated with the conservation of the area's biodiversity and with the higher abundance of bird and marine species (including a few endangered ones) within the MPA and in its surrounding areas or fishing grounds.

The 'economic' and 'educational' categories of benefits were third and fourth in the ranking, respectively, being considered by the interviewees the less representative ones. Perhaps because participants associated the economic benefits provided by the MPA with those generated by tourism that was still a sporadic activity carried out only by a few people. On the other hand, the educational dimension of the MPA, although acknowledged by the interviewees to be very important for the future of natural resources conservation in San Felipe, is still nonexistent.

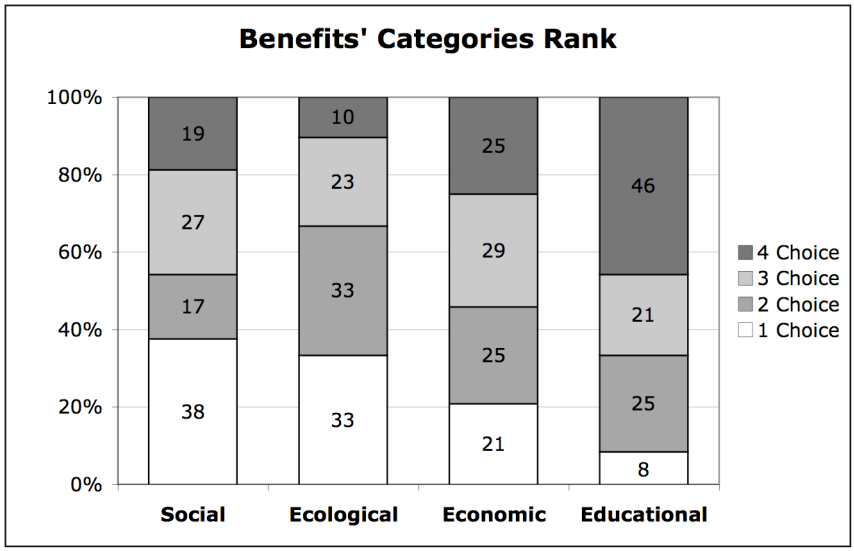


Figure 5:15 Ranking of the most relevant categories of benefits provided by the MPA, according to the interviewees.

5.2.2.3 Perceived MPA Obstacles

Understanding what were the obstacles shaping the MPA development according to the perceptions of the interviewees was another chief element in the in-depth stakeholder survey. The topic was introduced using an open-ended question about the problems or obstacles faced by the MPA, to avoid conditioning interviewees' answers. According to the results, 40% of the 85 total responses (B+D+E+G) had to do with patrolling problems (see Figure 5:16). Among these, 24% (given by 42% of the interviewees) referred the lack of patrolling, which was not being performed in a regular basis during the day- and the nighttime; 6% (given by 10% of the interviewees) mentioned partiality issues related with the conduct of the patrollers and with the application of fines, due to close kinship relations between community members; 5% (given by 8% of the interviewees) pointed out the lack of people available to patrol the MPA, particularly during the high fishing season, once patrollers were also fishermen; and another 5% of the responses stated that one of the problems was the lack of funds to maintain the permanent patrolling of the area. This problem was mentioned only by a small percentage of the interviewees, since the majority believed that the MPA was being funded by international agencies. Problems regarding fishermen's lack of compliance and environmental conscientiousness were mentioned in 38% (A+C) of the total responses, 29% (given by 52% of the interviewees) and 9% (given by 17% of the interviewees), respectively. The lack of compliance was mainly associated with the illegal fishing carried out within the MPA by a few fishermen (10 to 15, according to the interviewees), who insisted in disrespecting the rules established by the "community". The lack of environmental consciousness was associated to environmentally unfriendly behaviours, such as throwing garbage out to the sea, etc. Finally, the incomplete marking of the MPA geographical limits, due to deliberated damage or natural fall of the marker posts, was considered to be a problem in 5% of the responses. The responses corresponding to less than 5% of the total were not taken into consideration for the purpose of the analysis.

The results obtained with the in-depth stakeholder survey were cross-validated during the participatory workshop carried out in San Felipe in January 2007, by asking the

participants to brainstorm on the problems faced by the MPA. Once again, the survey results turned out to be confirmed, since, according to the participants, the main obstacles regarding the MPA had to do with the inefficient patrolling of the area, due to the lack of funds, the lack of a legal framework and the absence of fines, and with the lack of compliance and environmental consciousness of some fishermen (see Figure 5:17).

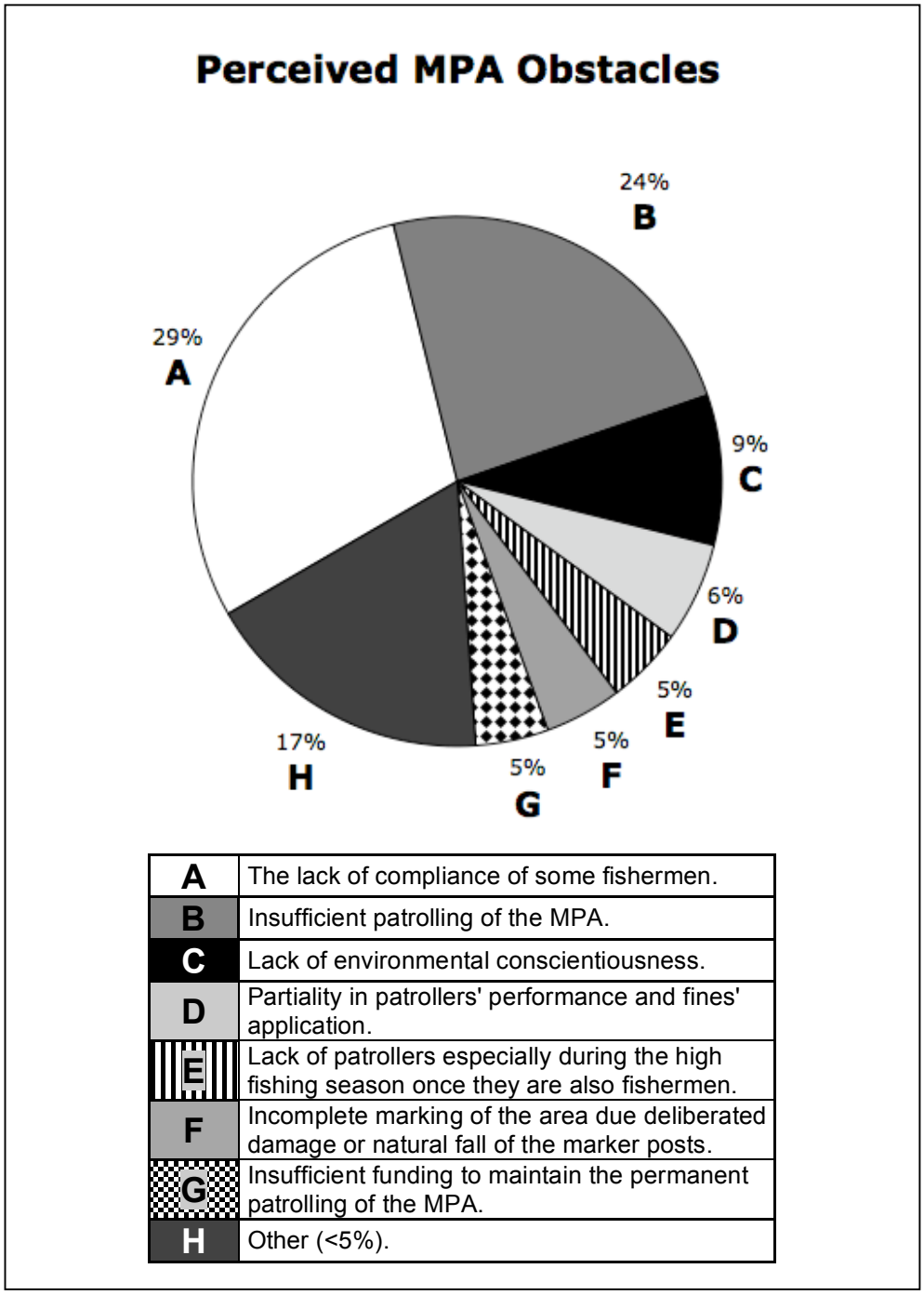


Figure 5:16 MPA obstacles according to the interviewees.

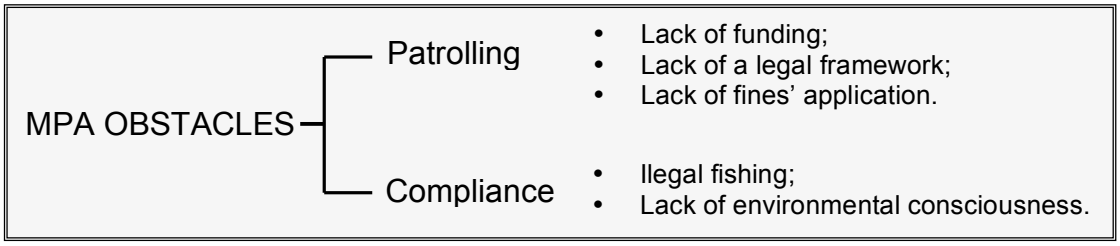


Figure 5:17 Main MPA obstacles referred by the participants during the participatory workshop carried out in San Felipe in January 2007.

After having identified the main obstacles affecting the MPA, an ordinal question was posed to understand how the interviewees would rank, by order of relative importance, a set of six pre-determined categories of obstacles potentially affecting the MPA: (1) legal, (2) administrative, (3) communication, (4) funding, (5) patrolling, and (6) compliance. According to the results, the 'legal', 'patrolling' and 'compliance' categories were the most highly rated ones, with 48%, 46% and 42% of the interviewees considering these obstacles to be the first or second most important ones, respectively (see Figure 5:18). 'Funding', 'administrative', and 'communication' categories were the less rated ones on the first and second choices, with only 16%, 21% and 23%, respectively. Since a considerable percentage of the participants were not even aware of these issues or did not consider them to be a problem at all.

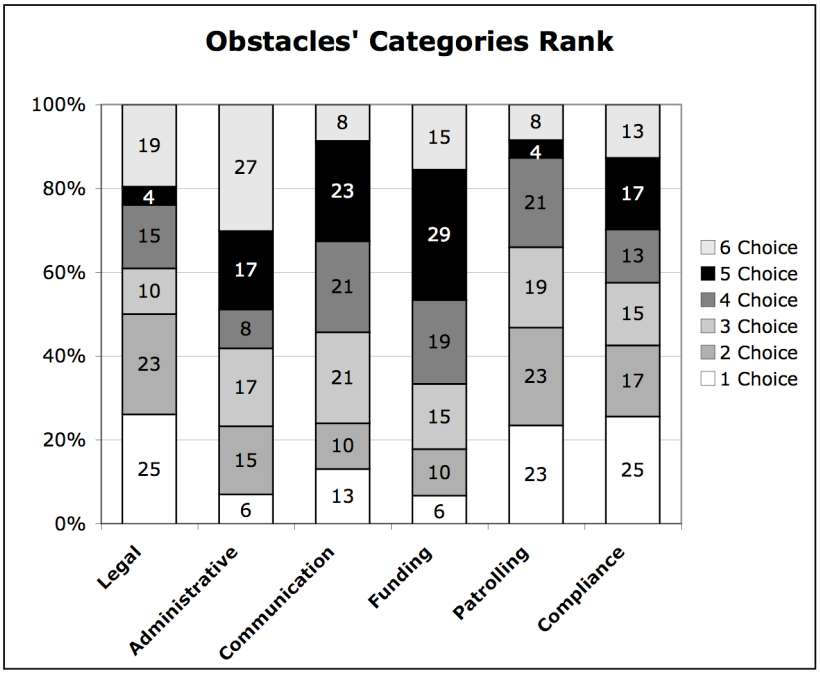


Figure 5:18 Ranking of the most relevant categories of obstacles affecting the MPA, according to the interviewees.

Subsequently, interviewees were invited to present examples of real-live situations illustrating the referred obstacles and to suggest potential solutions to overcome them. The list of the main obstacles and potential solutions pointed out by the interviewees, can be consulted in Table 5:5.

In terms of legal obstacles, 44% of 48 total responses referred the impossibility to apply penalties, once the MPA did not have a legal framework, being based merely in a local agreement, whereas 15% simply mentioned that no fines were being given, making no allusion to the lack of a legal background. Finally, 25% of the responses were given by interviewees who confessed that they were not really into the topic (10%) or did not consider it to be a problem at all (15%). The most popular suggestion to overcome the legal issues (55% of the 33 total responses) was to regulate the MPA through the establishment of a legal framework. Nevertheless, 15% of the responses simply mentioned the need to apply efficient and adequate legal penalties (e.g., confiscation of fishing gear and equipment) (see Table 5:5).

Patrolling issues were mainly related with the insufficient patrolling of the MPA, especially during the nighttime and during the fishing season, and with the lack of funding to maintain it, according to 48% and 13% of the 54 total responses, respectively. To solve patrolling issues, 21% of 54 total responses suggested that patrolling should be permanent (24 hours per day); 19% highlighted the need to use the appropriate equipment (e.g., a guard tower, radar, infrared binoculars, etc); 15% mentioned that patrollers should earn a fair salary and should not be fishermen at the same time; 7% considered that the municipality, the fishing cooperatives, fish traders and local organizations interested or benefiting from the MPA should contribute with human and/or financial resources to generate a patrol fund; another 7% mentioned the need to find sponsors (national and international); and, finally, 6% suggested bringing patrollers from other places with the legal authority to impose penalties (see Table 5:5).

Compliance issues pointed out by the interviewees had to do with illegal fishing practices carried out by a few fishermen, who apparently kept using fishing nets inside the MPA seduced by the activity's high profit, according to 61% of the 49 total responses. In terms of potential solutions for this problem, 41% of 46 total responses

advocated the application of efficient and adequate legal penalties (e.g., confiscation of fishing equipment); 15% mentioned the need to reinforce patrolling; another 15% considered that it would be important to work to raise people's consciousness and increase compliance; and 11% mentioned the establishment of a legal framework enabling the application of penalties (see Table 5:5). According to 14% of 49 total responses, the MPA was not affected by compliance problems.

Although communication was not one of the main MPA problems in the opinion of the interviewees, only 16% of 51 total responses mentioned that there were no significant communication problems. According to 57% of the responses, communication problems were linked with the lack of communication between the MPA management body and the local organizations. The ultimate solution for this problem, according to 66% of the 41 total responses, would be to organize regular informative/advisory meetings between the MPA management body and the local organizations, to increase people's interest, compliance and participation towards a better future for the MPA (see Table 5:5).

According to the results, funding was not considered by the interviewees to be a major problem (see Figure 5:18). Since some did not even considered it to be a problem at all (18% of 51 total responses), others affirmed not to be well enough informed about it (20% of 51 total responses), and some believed that the MPA was being funded by international agencies (e.g., UN). Nevertheless, some interviewees manifested their opinion about funding issues, with 25% of the responses referring that the available funds were insufficient to assure the permanent patrol of the MPA; and 18% suggesting lack of transparency in the way the Actam Chuleb NGO administrated the financial resources (e.g., project funds) related with the MPA. The generation of a patrol fund, through the collaboration of the municipality, fishing cooperatives, fish traders and local organizations interested or benefiting from the MPA, was pointed out by 24% of 34 total responses; 12% suggested restructuring the administrative body of the Actam Chuleb NGO; 12% proposed searching for (national and international) sponsors to finance the patrol of the MPA; and another 12% suggested trying to get funds from government agencies (see Table 5:5).

Administrative problems were definitely not considered to be an important issue. Therefore, a considerably high percentage of the responses given by the interviewees confessed that they were not aware of how the MPA was being administrated (35% of 48 total responses) or did not consider it to be a problem at all (10%). However, some people (31%) ended up mentioning that the administration of the MPA's financial resources was very poor. As potential solutions to this problem, 41% of 22 total responses suggested restructuring the administrative body of the Actam Chuleb NGO; 23% proposed organizing regular informative/advisory meetings between the MPA management body and the community organizations to increase people's interest, compliance and participation; and 18% simply recommended improving the administration of the MPA's financial resources (see Table 5:5).

Table 5:5 Main MPA obstacles and potential solutions according to the interviewees.

Obstacles' Categories	Stated Obstacles	Proposed Solutions
Legal	Impossibility to apply penalties since the MPA does not have a legal framework, being based merely in a local agreement.	Regulate the MPA through the establishment of a legal framework recognized by the State government. **(A)**
	No fines being applied to the illegal fishermen.	Application of efficient and adequate legal penalties. **(B)**
Administrative	Bad administration/lack of transparency in the way the Actam Chuleb NGO manages project funds/financial resources. **(1)**	Restructure the administrative body of the Actam Chuleb NGO (and replace the president). **(C)**
		Organize regular informative/advisory meetings between the MPA management body and the community organizations in order to increase people's interest, compliance and participation towards a better future for the MPA. **(D)**
		Improve the administration of financial resources.
Communication	Lack of communication between the NGO members and the local organizations, resulting in their poor involvement and interest.	**(D)**
Funding	Insufficient funding to maintain the permanent patrol of the MPA. **(2)**	The municipality, fishing cooperatives, fish traders and local organizations that are interested or benefit from the MPA should contribute with human and/or financial resources to generate a patrol fund. **(E)**
	(1)	**(C)**
		Find sponsors (national and international) for the MPA's patrolling. **(F)**
		Try to obtain funding from government agencies.
Patrolling	Insufficient patrolling of the MPA, especially during the night and during the fishing season.	Reinforce patrolling making it permanent (24h per day). **(G)**
		Patrolling should be done using the appropriate equipment (e.g., a guard tower, radar, infrared binoculars, etc.).
		The patrollers should earn a fair salary to patrol and should not be at the same time fishermen.
		Bring patrollers from other places with the legal authority to apply penalties.
	(2)	**(E)**
		(F)
Compliance	Illegal fishing performed by a few fishermen who keep using fishing nets inside the MPA seduced by profit.	**(A)**
		(B)
		(G)
		Work to increase people's consciousness and compliance.

During the 2007 workshop, participants were confronted with a series of problems regarding the MPA that were being mentioned by the community since 2000 and apparently had not been solved. Participants, divided into four discussion groups, were invited to reflect on those problems to understand why the community has not been able to resolve them, and what would be their ultimate solution.

The first problem to be discussed was the inadequate patrolling of the MPA, which, in the opinion of the four groups of participants, has not been resolved due the lack of funding. One of the groups composed of young fishermen (around 30 years old), who had recently constituted a tourism cooperative society, referred that the poor communication between the local NGO members, who patrolled the MPA, and the rest of the population might have helped as well, since no effort was ever made to establish a collaboration agreement to patrol the area and overcome the lack of funding.

Until this point, the lack of funding had not been one of the main arguments used to explain the poor patrolling of the MPA, as the results of the in-depth stakeholder survey illustrate (see Figure 5:16 and Figure 5:18). However, during the 2007 workshop, some of the members of the Actam Chuleb NGO had the opportunity to communicate and explain that their organization did not have enough funds to patrol de area in a regular basis, since it would cost about $600,000 Mexican Pesos (or $54,610 USD[43]) per year.

In terms of solutions for this problem, which turned out to be a financial problem rather than anything else, 3 of the 4 groups claimed that the solution would be looking for alternative funding institutions willing to support the MPA. Nevertheless, the same group, which considered the lack of communication as one of the causes for the problem, suggested improving communication between the NGO and the population to motivate people to voluntarily collaborate to preserve an area that was a source of benefits for all. Interestingly, this group was the only one that apparently understood the question "Why is the MPA patrolled only when there is money available", claiming that such thing happened because not all the groups in the community were

[43] Exchange rate: 2007—Peso Mex $10.99/USD $1.00.

involved in the MPA patrolling, and because an agreement among them was never made. As this group pointed out, all the community groups, including fishermen and the rest of the citizens, should be conscious about the MPA situation, and be willing to give a little bit of their own time to patrol without being paid.

When the lack of funding was finally discussed, the young fishermen's group stated once again that funding was only a problem because an agreement had never been made between the local organizations interested in the MPA maintenance. In the opinion of the three other groups, the lack of funding had to do with the improper administration of the MPA and with the lack of approved projects to finance it. As a means to overcome it, the groups suggested the search for organizations or companies willing to sponsor the MPA, the submission of projects to funding agencies, the training of the MPA administrative body, and the establishment of adequate user fees (which should not affect the community) to help generating a patrol fund.

5.2.2.4 Perceptions Regarding the Current and Future MPA Management

Understanding stakeholder perceptions about the MPA management, by addressing participation issues, was an essential element in the in-depth stakeholder survey and in the 2007 participatory workshop. Stakeholders' perceptions about who was managing the MPA were assessed through a multi-response question, where several options could be chosen. According to the most frequent response, given by 40% of the interviewees, the MPA was exclusively managed by a local group. Although not all the interviewees who gave this answer knew that this group was an NGO called Actam Chuleb, everyone was able to identify at least some elements of the group, particularly the president. According to 13% of the interviewees, the MPA was managed by the municipality along with the, previously mentioned, local group; and 10% believed that it was the municipality along with the fishing cooperatives who managed the MPA. Considering the total responses given per option, 71% of the interviewees mentioned a local group, 42% mentioned the municipality, and less that

20% mentioned the fishing cooperatives, the state government (SECOL), and the federal government as entities engaged in the MPA management (see Figure 5:19).

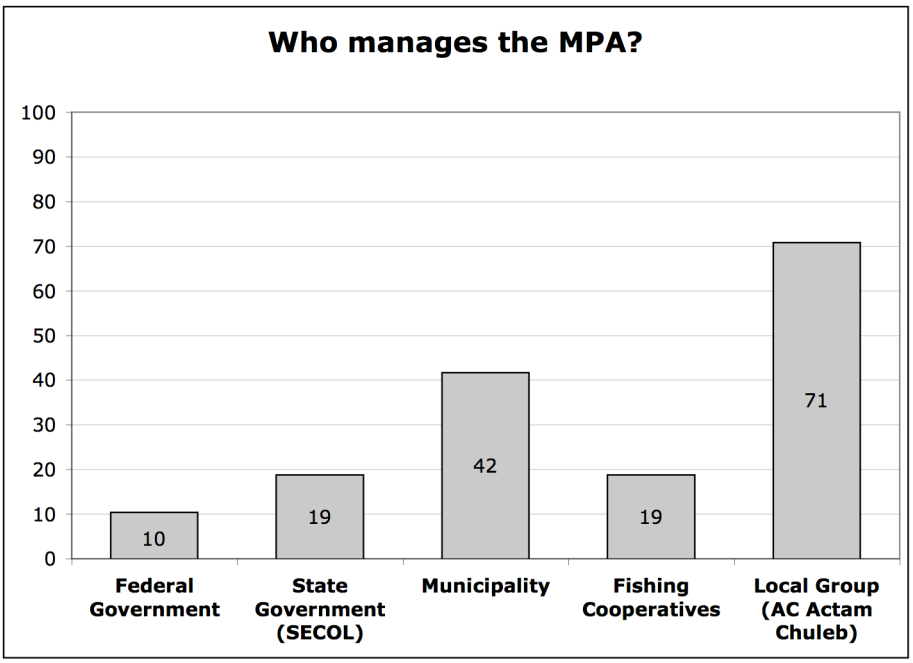


Figure 5:19 Interviewees' perceptions regarding the entities engaged in the MPA management.

When asked if they knew how the MPA was actually being management, 64% of 40 participants[44] confessed that they did not know, whereas 28% considered being aware of it (see Figure 5:20). Even so, when asked to classify the MPA management in terms of suitability (now considering the 48 interviewees), the majority (46%) considered that it was 'not very appropriate'; 29% considered it to be 'acceptably appropriate'; and 17% considered it to be 'inappropriate' (see Figure 5:21).

[44] The 8 members of the Actam Chuleb NGO were not considered in this particular question.

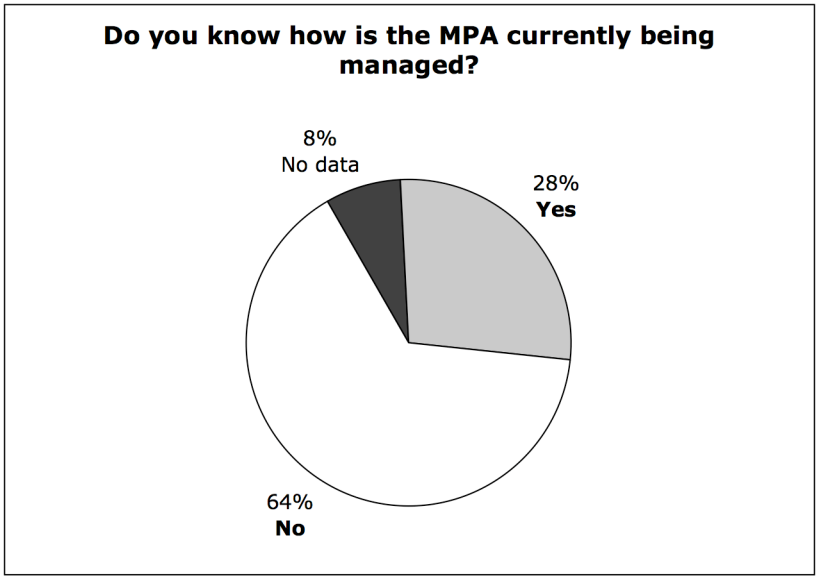


Figure 5:20 Interviewees' knowledge about the MPA management technicalities (the members of the Actam Chuleb NGO were not considered in the analysis).

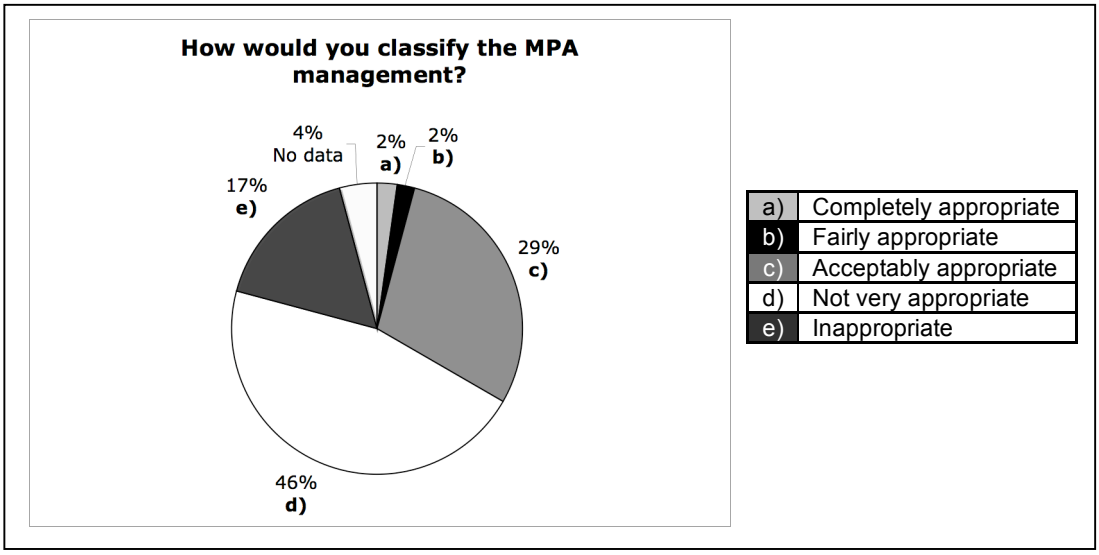


Figure 5:21 Interviewees' opinion about the suitability of the MPA management.

To understand how participation issues were interpreted, interviewees were asked if they considered that the necessary background to enable public participation in the MPA management actually existed (see Figure 5:22). This particular question has drawn interesting results, since 69% of the interviewees answered 'yes', and only 31% answered 'no'. However, the majority of those who answered 'yes' simply meant that everyone in San Felipe knew what was best for the MPA, and if anyone had anything to say could always speak with the mayor or with the president of the

Actam Chuleb NGO. On the contrary, the opinion expressed by the president of the Actam Chuleb NGO was that this structure did not really exist:

> "We do not have enough resources to keep our headquarters opened. Those of us who are deeply committed open it about two times a week, but only from 7 to 8 p.m. There is not an established schedule. (…) Anyway until now no one ever came by saying that she or he would be interested in participating in the MPA patrolling. No one wants to get into trouble, like getting involved in patrolling or in managing the resources. Besides, people would have to quit their job to do it, something that not even the current members do…" (president of the *Actam Chuleb* NGO, 33 years old)

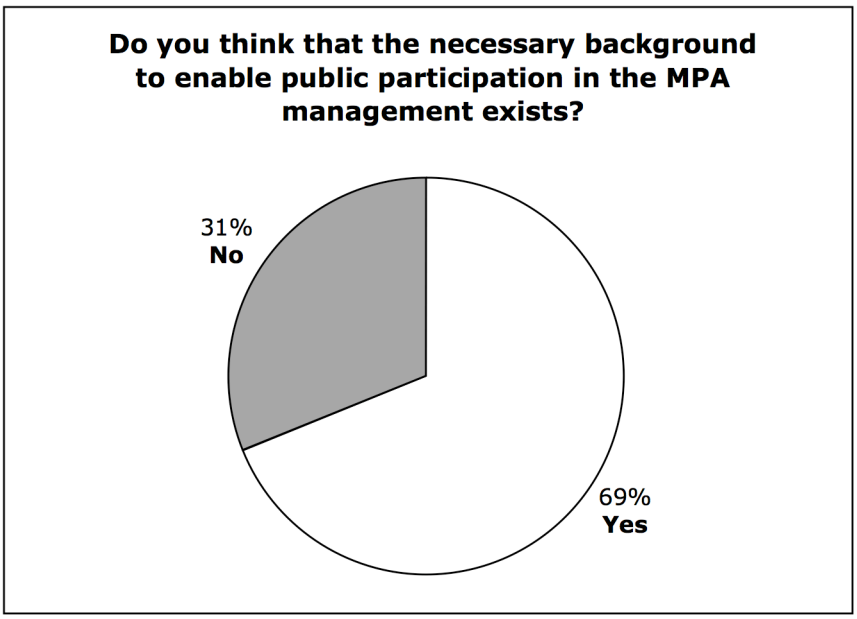


Figure 5:22 Interviewees' opinion about the existence of the necessary background to enable stakeholders' participation in the MPA management.

Understanding the level of interest and commitment expressed by the MPA stakeholders towards their participation in the MPA management was a major concern addressed by the participatory workshop carried out in San Felipe in 2007. Nevertheless, when confronted with the question "What roles will local stakeholder groups play in the MPA management?" participants did not present concrete proposals. Instead, they made clear that, first of all, it was very important to re-invite

all the groups to participate in the MPA management to re-conquer people's trust and motivate them to care about the MPA. The regularization of the MPA legal status, due to the promulgation of the Dzilam State Reserve management plan, on the 26th of September 2006[45], was also stressed, as it finally enabled the application of fines. Moreover, participants mentioned the need to increase the number of fishermen patrolling the area in the near future.

Subsequently, when asked to brainstorm on "What would be next?" participants answered obtaining funds to patrol; organizing a rotative patrolling scheme with the help of the local organizations; delimiting the MPA with marker posts; involving fishing cooperatives in the MPA management and keeping them informed; establishing user fees to economically support the MPA; promoting periodical meetings, which should start by an informative session promoted by the Actam Chuleb NGO to present the results of their last project carried out in the area; integrating new members in the Actam Chuleb NGO; and creating an official state committee composed of (at least) one representative of each local organization.

According to the president of the Actam Chuleb NGO, now that the Dzilam State Reserve management plan had finally been promulgated, the MPA was going to be managed by the Secretariat of Ecology (SECOL) together with the municipality of San Felipe and the Actam Chuleb NGO, according to an organizational chart that was still being formulated, but would probably include an advisory committee similar to the one presented by the Ría Lagartos Biosphere Reserve. Additionally, he announced that the NGO would soon be able to give tax-deductible receipts to potential donors, to facilitate the obtention of funds.

To conclude, participants were invited to individually write down their personal commitments towards the improvement of the MPA management. This exercise was undertaken only by 16 of the 26 participants, from which 6 of them simply highlighted the need to improve communication and public participation.

[45] After the promulgation of the Dzilam State Reserve management plan, the Actam Chuleb MPA officially became an area of restricted use, where the only activities allowed are conservation, environmental education, ecotourism, and trolling. All fishing methods, except hook-and-line, are prohibited.

Regarding the impossibility to commit themselves with the MPA, two interesting comments were made:

> "…we need to be informed, only then we will be able to make our personal compromises." (fisherman from the fishing cooperative *Pescadores Unidos de San Felipe*, 38 years old)

> "I cannot compromise myself because the MPA is being managed by a specific group[46] (...)" (fisherman and former president of the tourism cooperative society *Sociedad de Lancheros Punta Bachul*, 59 years old)

Considering the 10 participants who actually wrote down their personal compromises, the majority (8 persons) offered themselves to voluntarily collaborate with the MPA patrolling, 4 offered to contribute economically through the payment of user fees, 2 affirmed that they were willing to comply with the MPA rules, and 1 committed himself to put pressure on the members of the Actam Chuleb NGO to inform the community. Curiously, only 1 of the 4 Actam Chuleb members attending the workshop completed the exercise, mentioning that he was willing to take training courses and act as a multiplier by training other people, and was ready to accuse any illegal fisherman that he saw inside the MPA.

5.2.2.5 External Agents' Point of View

Understanding the opinion of key external agents or stakeholders regarding the Actam Chuleb MPA co-management process was considered an essential element to enrich its overall analysis, and it was accomplished by sending via e-mail a questionnaire based on open-ended questions to 9 key external stakeholders (NGOs representatives, researchers, decision-makers, natural resources managers, and donors). As Table 5:6 summarizes, in terms of strengths and/or opportunities, the interviewees emphasised the bottom-up nature of the MPA, and underlined some of the contextual

[46] The word 'group' refers to the Actam Chuleb NGO.

characteristics of San Felipe (e.g., small population, limited external influences). To potentiate these strengths and/or opportunities they pointed out the importance of having a local leader picked up by the community; of providing training courses and promoting education; and the need to count with economic support and operative plans.

In terms of weaknesses and/or limitations (see Table 5:7), it was mentioned the lack of economic resources to operate the MPA; the lack of legal mechanisms to allow municipalities to manage marine resources, once marine jurisdiction was strictly Federal; the devastating effects caused by natural hazards (e.g., hurricanes); a strong bi-partisanship; low levels of education; lack of specific co-management agreements regarding the MPA; lack of community participation in decision-making; apathy; conflict of interests; lack of information, communication and transparency in the MPA management; and poor communication with the inhabitants of Dzilam de Bravo, with whom the community of San Felipe shares the Dzilam State Reserve. To overcome these weaknesses and/or limitations the interviewees suggested that it would be important to provide technical support, education and training to every community group; identify common interests and an adequate local leader; carry out biological studies to characterize the ecosystem and understand its dynamics; promote voluntarism and cooperation values; develop social cohesion and conflict resolution mechanisms; and suggested that the MPA management model should be consensually adopted by the community.

Considering what would be necessary to develop an equitable co-management partnership of the natural resources encompassed by the Actam Chuleb MPA (see Table 5:8), stakeholders highlighted that the authorities representing the 3 levels of government must have political will and be proactive in order to make the MPA initiative work juridically, administratively, economically and operationally; pointed out the importance of choosing a local leader who does not see the whole process as a way of satisfying personal interests, nor getting economic benefits; emphasised the role of “local initiative” in the reinforcement of internal cohesion mechanisms; and suggested the development of a legal instrument conceding the management of the MPA to the municipality.

Table 5:6 Summary of the main strengths and/or opportunities regarding the Actam Chuleb MPA co-management process, and how to potentiate them according to the four key external stakeholders questioned.

Stakeholder Occupation	Strengths/Opportunities	How can strengths/opportunities be potentiated?
Director Ría Lagartos Biosphere Reserve	• Consolidated initiative supported by the majority of the inhabitants of San Felipe.	• Identify an adequate local leader; • Provide training for the population in general.
Fisheries Delegate SAGARPA	• Being a bottom-up initiative, motivated by a profound knowledge and dependence of the natural resources; • Contrarily to top-down scenarios there is no need to impose conservation; • Potential to develop sustainable productive projects (e.g., aquaculture).	• Establish operative programmes that should promote the conservation and the sustainable use of the area; • With economic support from government agencies and NGOs.
Researcher UQRoo*	• Small population; • Limited external cultural influences; • Trust relationship between the community and the researchers; • The uniqueness of the initiative facilitates international support.	• Promote participatory research programs; • Promote educative workshops; • Facilitate the emergence of truly local leaders among the youngsters and the adults.
Researcher CINVESTAV	• Identify those actors that are negatively affecting the process.	• Involve the community at every level; • Understanding the complexity of interests regarding the MPA; • Community members need to choose their leaders by themselves.

* University of Quintana Roo

Table 5:7 Summary of the main weaknesses and/or limitations regarding the Actam Chuleb MPA co-management process, and how to overcome them according to the four key external stakeholders questioned.

Stakeholder Occupation	Weaknesses/ Limitations	How can weaknesses/ limitations be overcome?
Director Ría Lagartos Biosphere Reserve	• Lack of economic resources to operate the MPA; • Marine jurisdiction is strictly Federal; • Lack of specific co-management agreements regarding the MPA.	• Identifying an adequate local leader; • With continuous technical support from external agents (e.g., NGOs, research institutes, etc.); • Policy development to support the initiative with an adequate legal framework.
Fisheries Delegate SAGARPA	• Lack of economic resources to operate the MPA; • Hurricanes and other natural hazards; • The potential disinterest of the community in the long-term.	• Establishing collaboration agreements with research institutes, and government agencies; • Elaborating annual operative plans; • Carry out biological studies to characterize the ecosystem and understand its dynamics and recover capacity.
Researcher UQRoo	• Strong bi-partisanship; • Low levels of education; • Lack of legal mechanisms to allow the municipality to manage the marine resources once marine jurisdiction is strictly Federal; • Poor communication and eventual disagreements with the inhabitants of Dzilam de Bravo with whom the community of San Felipe shares the Dzilam State Reserve; • Governmental pressure towards neoliberal forms of economic development; • Population growth due to immigration; • Poor understanding of what should be the role played by a local leader; • Opportunistic behaviour of some people.	• Promote education and training among every community groups; • Identify common interests; • Develop social cohesion mechanisms; • Develop conflict resolution mechanisms; • Reinforce the sense of belonging regarding the MPA; • Promote voluntarism and cooperation values.
Researcher CINVESTAV	• Lack of community participation in decision-making; • Apathy; • Conflict of interests; • Lack of information, communication and transparency; • Misunderstandings;	• Reinforce the collective compromise to preserve the MPA; • The community must consensually adopt a management model for the MPA.

Table 5:8 What would be necessary to develop an equitable co-management partnership to manage the natural resources encompassed by the Actam Chuleb according to the four key external stakeholders questioned.

Stakeholder Occupation	What would be necessary to develop an equitable co-management partnership?
Director Ría Lagartos Biosphere Reserve	• To find a truly local leader (group or person) who does not see the whole process as a way of satisfying personal interests, getting economic benefits, nor should he or they be the only one(s) to beneficiate from training courses or other experiences; • External agents should be disinterested and focused on providing technical support and training; • The authorities representing the 3 levels of government must have political will to make this initiative work juridically, administratively, economically and operationally.
Fisheries Delegate SAGARPA	• A solid basis.
Researcher UQRoo	• Internal cohesion mechanisms need to be reinforced on the community's own initiative; • Proactive participation of the three levels of government; • Develop a legal instrument conceding the management of the MPA to the municipality; • More external pressure from NGOs to accelerate the consolidation process.
Researcher CINVESTAV	• The community (e.g., local resource users, indirect stakeholders, external agents) must commit itself.

6. Discussion

6.1 Ecological Importance of the Actam Chuleb MPA and Landscape Changes

Seagrass meadows are considered to be an economically and ecologically extremely valuable component of coastal ecosystems. They support numerous detritus- and herbivore-based food webs, stabilize and enrich the sediments, reduce the energy of the water flow inside the canopy, increase habitat complexity, provide critical habitat (e.g., feeding, spawning and nursery grounds), and work as a refuge from predation for a wide diversity of organisms, including the juvenile stages of ecologically and commercially important species. Therefore, the abundance and diversity of the fauna and flora living in seagrass meadows are generally higher than those of adjacent unvegetated areas (Hemminga & Duarte 2000; Terrados & Borum 2004; Turner & Schwarz 2006).

The local fishermen of San Felipe perfectly acknowledging the environmental role played by seagrass in coastal ecosystems decided to protect a coastal marine area rich in submerged aquatic vegetation, 5 km west from the village, known to provide spawning and nursery grounds for several commercially important species on which they highly depended. Particularly, in a local context of increasing overexploitation of fishery resources, as Figure 3:2 illustrates. After the implementation of the Actam Chuleb MPA, the local fishing cooperative, recognizing its importance and influence on fisheries production, had the preoccupation of mapping the area's benthic habitats[47] as a means to better understand the MPA ecosystem dynamics.

As noticed by the fishermen of San Felipe, seagrass meadows are not static landscapes. Instead, seagrass populations are continuously subject to loss and

[47] The first benthic habitat map of the Actam Chuleb MPA was done between 1998 and 2000 by a group of five fishermen from the fishing cooperative, funded by the UNDP and by the FMCN. In 2005/2006, the second local attempt to map the MPA's benthic habitats was carried out by the Actam Chuleb NGO in cooperation with the University of Yucatan (UADY), funded by the UNDP, UADY and SECOL.

replacement of shoots motivated by anthropogenic, environmental, or internal growth related processes. Therefore, the development of seagrass landscapes depends on the frequency and magnitude of the disturbance regarding the species' capacity to resist and to recover (Hemminga & Duarte 2000).

As demonstrated by the results, from 2000 to 2005, a series of changes occurred in the areal extent and spatial distribution of the submerged aquatic vegetation meadows, which dominated the benthic marine communities of the Actam Chuleb MPA. These changes might be partly explained by the impact of Isidore, a hurricane category 3 in the Saffir-Simpson scale, which hit the area in September 2002 with winds reaching the 220 km h^{-1}, accompanied by high wave action, and causing the redistribution of sediments. The specific damages inflicted by a hurricane on the submerged vegetation are determined by the nature and magnitude of the mechanisms causing these damages (e.g., mechanical thinning, sediment deposition, erosion, drastic decreases in salinity, etc.) (Cruz-Palacios & Van Tussenbroek 2005; Fourqurean & Rutten 2004). Nevertheless, it is important to underline that in mixed-species seagrass meadows, species composition largely influences the outcomes of such an impact. Although different studies (carried out with congeners of the species documented for the Actam Chuleb MPA) might draw different conclusions regarding the most sensitive species to disturbance (Fourqurean & Rutten 2004; Duarte et al 1997), the hypothesis suggested by Duarte et al (1997) that climax species are often sensitive to disturbance might be suitable for the present study. Considering that one of the main changes was precisely the lost of 20% of 'seagrass 50-90%' cover (as recognized by the MPA stakeholders during the 2007 workshop), accompanied by a decline in the population of *Thalassia testudinum*, which in 2005 dominated (cover over 50%) only 3 of the 93 surveyed sites (3.2%), against 24 of 76 in 2000 (32%). In areas where significant lost occurred, seagrass dominated meadows were essentially substituted by a macroalgae dominated cover ('macroalgae 50-90%') and by a sparse to medium SAV cover composed of macroalgae and seagrass species ('SAV 10-50%'). Both substitute covers were interpreted as primary ecological stages following disturbance. Since, compared to seagrasses, macroalgae have a very high investment in sexual reproduction and higher dispersal ability, exhibiting the characteristics of early colonizers in a successional sequence (Fourqurean & Rutten 2004). In terms of seagrasses, the species *Halodule wrightii* is considered to play an important role as a

pioneer species, followed by *Syringodium filiforme*, colonising unvegetated sediments following perturbations, and preceding the climax community of *Thalassia testudinum* in the successional sequence of Caribbean seagrasses (Fourqurean & Rutten 2004; Gallegos et al 1994; Hemminga & Duarte 2000).

In 2005, new areas of bare sand could be seen in the study area, illustrating the cover increase of 8.4% (see Table 5:4) that occurred in the class 'unconsolidated sediment <10% SAV' from 2000 to 2005 (as highlighted by the participants of the 2007 workshop). In 2005, it was also frequent to find areas of 'SAV 10-50%', which increased its cover in 4.4% and almost duplicated its number of patches and patch density from 2000 to 2005 (see Table 5:4), surrounding new areas of bare 'unconsolidated sediment <10% SAV', and making the transition between areas that suffered from sediment deposition or burial and adjacent vegetated areas. Interestingly, in terms of sediments' redistribution, it was possible to demonstrate the maintenance of the characteristic sand bar patterns in the western part of the study area from 2000 to 2005, suggesting that steady environmental and oceanographic factors, like the influence of northeast predominant winds (wind drifts) and ocean currents, continuously act in the area maintaining a dynamic equilibrium concerning the transport of sediments.

Landscape ecological metrics at the class level corroborated the results obtained using a post-classification change detection procedure, highlighting once more the changes that occurred in every habitat class from 2000 to 2005 in terms of land cover (see Table 5:4), and definitely gave new insights into SAV dynamics. One interesting aspect to emphasise considering the class 'macroalgae 50-90%' is that besides having increased its cover in 6.7% from 2000 to 2005, its number of patches and patch density diminished as the class became more physically connected in 2005, as illustrated by its cohesion index (see Table 5:4), reinforcing its reputation of "early colonizers" in this particular context. As it would be expected, precisely the opposite occurred with the class 'seagrass 50-90%', which lost 19.6% of its cover, but increased its number of patches and patch density, being in 2005 more subdivided and less physically connected than it was before Isidore, in 2000. Corroborating the hypothesis suggested by Duarte et al (1997) that climax species are often vulnerable to disturbance. Considering the present scale of analysis, no major changes were

detected in terms of patches fractal index, neither between classes nor through time, indicating that in general patches presented simple perimeters.

Finally, hurricanes have been observed to cause widespread damage to submerged vegetation, but when perceived at a plant community level, the effects of hurricanes and major storms in the Gulf of Mexico and Caribbean region may be considered part of the natural processes and dynamics of seagrass beds (Fourqurean & Rutten 2004; Hemminga & Duarte 2000; Marbà et al 1994). In fact, some researchers have even suggested the positive impact of mechanical storm damage on seagrass beds on the long-term, since it might help to maintain species diversity in ecosystems, by creating disturbed patches within the landscape (Fourqurean & Rutten 2004). Four years after the impact of the hurricane Isidore, and according to the perceptions of 67% of the stakeholders interviewed (Figure 5:11), the spawning and nursery functions provided by the benthic habitats encompassed by the Actam Chuleb MPA are being acceptably or fairly accomplished.

Another important aspect to underline is that both local- (<1 to 10s of m) and landscape-scale (100s to 1000s of m) variations in seagrass habitat structure, as well as variations in the hydrodynamic activity, may influence processes (e.g., predation, survival) that shape faunal abundance and structure communities in seagrass habitats (Hovel et al 2002). As the participants of the 2007 workshop underlined, there have been visible changes (increase and decrease) in the abundance of several marine species that they suspect to be related with the impact of Isidore (see chapter 5.1.4). However, these relationships are far too complicated, and integrated long-term monitoring studies are needed to explore them in detail.

6.2 Co-Management of the Actam Chuleb MPA

6.2.1 Strengths

Underlying the emergence and functioning (successful or not) of a bottom-up initiative, like the establishment of a municipal MPA in San Felipe, are a set of conditions that, according to Agrawal (2003), have to do with the nature of the natural resources being considered, with the characteristics of the community groups that depend on these resources, with the particulars of the institutional arrangement itself, and with the nature of the relationship between community groups and external forces and authorities such as markets, states, and technology.

The following analysis of the factors underlying the emergence and conditioning the institutional sustainability of the collaborative management agreement of the Actam Chuleb MPA was centred on the list of factors presented by Agrawal (2003), based on his own findings and on three "landmark works" by Robert Wade (1994), Elinor Ostrom (1990), and Jean-Marie Baland and Jean-Philippe Platteau (1996). Therefore, in the particular context of San Felipe, the most significant factors were believed to be the high dependence on coastal resources; the small geographic area occupied by the village; its relatively small population; shared norms imposed by religious homogeneity; close kinship relations among community members; its high social capital[48], illustrated by the high organizational capacity of local user groups which started to develop in the early 70's with the creation of the fishing cooperative; the apparently low levels of poverty; the MPA proximity from the village; its easy access and safeness even during bad weather periods; the fact that it was established as an area of restricted use (only trolling is allowed), which gives fishermen the possibility to use it in a sustainable way and directly benefit from its conservation; and, finally, the fact that the rules of the MPA are simple and easy to understand, having been locally devised.

[48] Social capital can be defined as the features of social organization that facilitate collaboration and cooperation for mutual benefit, such as networks, norms, and social trust (Putnam 1995).

Interestingly, the contextual factors listed above were corroborated by the findings of Pollnac and Crawford (2000), who made an attempt to explore what influenced the success of community-based MPA (CB-MPA) projects in the Visayas region of the Philippines. Finding out that community compliance with the rules of MPAs and consensus building were easier in smaller geographic areas, and in communities with smaller populations, who apparently tended to see the benefits in terms of increased fish abundance more readily. According to the same authors, communities that perceive a crisis in fisheries may be more willing to take action to reverse such trends, which was precisely what motivated the local implementation of an MPA in San Felipe; the more important the occupation of fishing is to the community, the more interested and committed stakeholders may be in attaining fish production benefits from a CB-MPA, what explains the importance given by stakeholders to the fishery benefits provided by the MPA (see Figure 5:12 and Figure 5:13); and, finally, found out that communities with participatory and democratic decision making traditions were more predisposed to developing broad-based consensus and complying with decisions reached through a participatory process. Hence, according to the findings presented by Pollnac and Crawford (2000), the community of San Felipe fulfils all the contextual criteria that are likely to increase the probability of success of a community-based MPA project in the area. However, it is very important to have in mind that the weight of some of these factors in promoting the sustainability of local institutions for the management of local resources might vary according with a series of evolving internal and external circumstances (Agrawal 2003; Pascual-Fernández et al 2005).

Nowadays, the Actam Chuleb MPA is a considerably well-consolidated bottom-up initiative, widely supported and recognized for its benefits among the community of San Felipe, as the current director of the Ría Lagartos Biosphere Reserve, and the SAGARPA Fisheries Delegate pointed out (see Table 5:6). As the results of the IDRC project illustrate, in 2000, the majority of the interviewees knew about the existence of the MPA and considered it to be a good idea (see Figure 5:5 and Figure 5:6). In 2006, the in-depth stakeholder survey revealed that the MPA aims were fully known and understood (Figure 5:10). Similarly, its main benefits were largely recognized and emphasized both by the interviewees and by the 2007 workshop participants (Figure 5:12, Figure 5:13 and Figure 5:15). Benefits, mainly related with fisheries (the major

economic activity in the village) and with the expansion of tourism in the area, which definitely the community would like to preserve and share with future generations (especially considering all their previous efforts concerning the MPA). Therefore, the local fishermen who organized themselves into four distinct cooperative societies offering tourism related services, in an attempt to diversify their sources of income, were considered a determinant stakeholder group with great potential to push forward the MPA management in the nearest future, once they hold a very concrete economic interest in the conservation of the MPA.

6.2.2 Weaknesses

One of the main issues standing in the way of the collaborative management of the Actam Chuleb MPA functioning in an effective manner is the lack of communication. The exchange of information is poor between the MPA management body, which comprises the Actam Chuleb NGO, the municipality of San Felipe and the SECOL, and the rest of the stakeholder groups. Moreover, it is also unsatisfactory among the members of the local NGO that was restructured in 2004 with the support of the SECOL to guarantee the representation of the main stakeholder groups and broaden the scope of interests managed by the former MPA committee, essentially comprised of members from the fishing cooperative.

Although communication was not on the top three of the ranking when interviewees were requested to rank a series of obstacles affecting the MPA (Figure 5:18), communication issues are clearly reflected in stakeholders' perceptions about the management, patrolling, funding, and legal aspects of the MPA. In terms of management, 71% of the interviewees knew that the Actam Chuleb NGO was engaged in the MPA management and patrolling (Figure 5:19), but only 28% believed to be aware of its technicalities (see Figure 5:20), revealing a generalized lack of knowledge among the MPA stakeholder groups concerning the subject. This lack of information and transparency inevitably led to a widespread misunderstanding and mistrust among stakeholders (Figure 5:21), particularly regarding the administration of the MPA's financial resources (Table 5:5). According to Adams et al (2003),

conflicts over the management of common pool resources are not merely material, but greatly depend on the perceptions of social actors. Therefore, the accountability of monitors and other officials to users is a very important factor for the success of an institutional arrangement (Agrawal 2003). Interestingly, one of the solutions proposed to overcome administrative issues was the implementation of regular informative/advisory meetings between the MPA management body and the local organizations, to increase people's interest, involvement, and compliance (see Table 5:5).

Another example of generalized misunderstanding caused by the lack of communication had to do with stakeholders' perceptions of the MPA patrolling. Maintaining an adequate patrolling has always been one of the main concerns of the Actam Chuleb MPA stakeholders (see the results of the IDRC project, Figure 5:16, Figure 5:17, Figure 5:18). Excluding the legal side of it, which will be discussed further on this chapter, some of the aspects constraining its efficiency, according to the MPA stakeholders, are its irregularity; the lack of adequate equipment; the lack of patrollers, especially during the fishing season; and, the greatest problem of all, the lack of funding.

Funding, however, was not seen as a major problem (Figure 5:16, Figure 5:18) until the 2007 participatory workshop, since the majority of the stakeholders believed that the MPA was being funded by international donor agencies (e.g., UNDP) via the Actam Chuleb NGO, and, thus, thought that the inadequacy of the MPA patrolling was motivated by the misuse of funds and not by lack of it. This perception explains why 37% of the interviewees believed that only 'some' or a 'few' people (economically) benefit from the MPA (see Figure 5:14). However, as pointed out by one group during the 2007 workshop, the greatest problem concerning the MPA patrolling is beyond the lack of funding, as it is the lack of communication between groups which prevents the community to organize itself towards the establishment of a collaboration agreement to patrol the area, like it happened on the first years after the establishment of the MPA. According to the same group, a patrolling fund and a pool of volunteer patrollers should be created with the support of local user groups, to overcome the lack of funding (see Table 5:5).

As Fraga et al (2006c) suggested, it is likely that a shift of focus from community to monetary interests occurred, since the United Nations (through its Development Programme - UNDP), and the Mexican Fund for Nature Conservation (FMCN) started to donate huge amounts of money to support the conservation and the enforcement of the Actam Chuleb MPA, in 1997. Therefore, the insignificant importance that has been given lately to collaborative solutions to overcome not only the lack of funding affecting the quality of the MPA patrolling but also others issues affecting the MPA might be a consequence of the "monetarisation" of the MPA initiated in 1997.

The need to increase and improve communication among the MPA stakeholders was a quite highlighted topic during the 2007 workshop. As some participants pointed out, this lack of communication gave rise to a widespread disinterest among stakeholders, a trend that needs to be reversed if participatory decision-making mechanisms are to be set up to manage the MPA. This disinterest was made clear by the generalized lack of initiative showed by the MPA stakeholders, who never attempted to contact the MPA management committee to express their opinion, even though they believed that this was possible (see Figure 5:22). Nevertheless, according to the president of the Actam Chuleb NGO, the necessary conditions to enable people to express their opinion and/or participate in the MPA management did not exist. According to the MPA stakeholders, to revert this situation it would be necessary to organize a first informative meeting between the MPA management body and the rest of the MPA stakeholders, to afterwards decide on which participatory mechanisms could be implemented. A plan that, apparently, the president of the Actam Chuleb NGO did not have the intention to follow, since, as he announced, "they" (the Actam Chuleb NGO and the SECOL) were already setting up the MPA organizational chart based on the example given by the neighbouring Río Lagartos Biosphere Reserve, not mentioning any previous consultative process with the community. According to Pascual-Fernández et al (2005), whenever possible the state should support the pre-existing institutional framework instead of imposing a new one imported from another country or institutional context. An opinion shared by one of the interviewed experts (from CINVESTAV), who believed that "the community must consensually adopt a management model for the MPA" (see Table 5:7). To conclude, it is essential to underline that to actually allow for public participation in the MPA management and

move forward towards the establishment of a community-based management agreement in San Felipe, stakeholders will have to unite and make pressure on the MPA management body to guarantee that their interests are heard and to defend their legitimate right to participate. As the researcher from the University of Quintana Roo pointed out "internal cohesion mechanisms will need to be reinforced on the community's own initiative" (see Table 5:8). Nevertheless, a few circumstances might limit stakeholders' capacity for co-operative and collective action, such as the strong political bi-partisanship among the inhabitants of San Felipe, which ended up dividing the fishing cooperative and with it entire families; stakeholders' short-term vision of the benefits generated by the MPA, very well disguised under their conservationist type of speech; conflict of interests; and misunderstandings.

Another equally important facet of the communication problem affecting the collaborative management of the MPA has to do with the internal group dynamics of the Actam Chuleb NGO. When this organization was restructured in 2004, by including 11 new members, its aims were to represent community interests regarding the management of the natural resources, to make projects to support the MPA economically, and to keep the population informed (see chapter 5.2.1.4 for the 2003 workshop results). However, no public meetings were ever held, nor the new members have ever established effective links between the NGO and their own organizations, as it was supposed to happen. In fact, the group of people involved in the Actam Chuleb NGO has never functioned as a consolidated group. On the contrary, the "group" started to disintegrate itself very precociously. In April 2006, only seven of the sixteen members were attending to the meetings in a regular basis. Unfortunately, this situation was not to last due to the opening of the high fishing season[49], on the 1st of July. Which reconverted the NGO members back to fishermen and fisherwomen with limited availability (and interest) imposed by livelihood patterns shaped by seasonal fishing cycles, as illustrated by the following quotation:

> "Why should I care about the group? It does not feed me, does it? I am now going out to fish everyday and I do not have time for it. Fishing is

[49] Lobster season opened on the 1st of July 2006 and closed on the 28th of February 2007; the octopus season opened on the 1st of August 2006 and closed on the 15th of December as set by the National Commission for Aquaculture and Fisheries (CONAPESCA).

more important." (female member of the Actam Chuleb NGO, 35 years old)

Interestingly, the two members who continued to attend to the MPA meetings during the high fishing season, besides having other sources of income, had concrete interests in the MPA. One was the president of the NGO, and the other was one of the main fly-fishing guides in the village, who worked for the San Felipe Hotel:

"My main source of income comes from the MPA, therefore I am really interested in its conservation." (fly-fishing guide and member of the Actam Chuleb NGO, 31 years old)

Both quotations clearly highlight the weight of personal interests in the level of motivation and commitment shown by each single member of the organization. However, according to the NGO members, there were other factors undermining the internal cohesion of the organization, such as the poor communication between the president and the majority of the NGO members; the low level of information hold by the members concerning the activities developed by their own organization; the lack of financial transparency (which motivated the former accountant to abandon the organization); and the limited delegation of responsibilities and trust, which culminated in mistrust, misconceptions, and in the profound disinterest and poor participation of the NGO members. In November 2006, confronted with the lack of participation and interest revealed by the majority of the members, the president of the Actam Chuleb NGO manifested the need to restructure the organization, and suggested the potential benefits of having as members people who economically depend on the MPA all year-round, like tour operators. In his opinion, the majority of the current members (men and women) were only interested in the MPA during fishing ban periods as a means to earn some money through the sporadic monitoring activities carried out by the organization.

Besides the lack of communication, the legal side of the Actam Chuleb MPA had long been a thorny issue and only with the publication of the Dzilam State Reserve management plan on 26th of September 2006 did it finally acquire an official legal status and a regulatory instrument. Up to that point, the MPA was merely a marine

component of the Dzilam State Reserve, a "paper park" decreed on the 25th of January 1989, without specific regulations, which meant that all the fines that were levied by the municipality of San Felipe were illegal, since the municipality had no legal authority to collect fines in a State reserve, and the area was not yet officially regulated. All the enforcement mechanisms of this period were merely based on a local agreement between the fishing cooperative and the municipality.

As the survey results reveal, the legal dilemma of the MPA was generally well known and the majority of the stakeholders saw it as a major issue (Figure 5:17, Figure 5:18). Particularly because in the absence of a legal and regulatory framework it would be impossible to fine "illegal" fishermen (see Table 5:5), an enforcement mechanism essential to check non-compliance. When, during the workshop, the participants were informed that the MPA had finally been decreed in September 2006, they expressed the hope that fines could be legally imposed 12 years after the reserve had been established. However, a key question emerged: how will the law be enforced? In the past, when an illegal fisherman was caught in the MPA by a local patroller, he was taken to the municipality, which immediately decided what penalty he should pay in terms of the pre-established agreement. The process was quick and very effective. As pointed out by Agrawal (2003), the ease of monitoring, having effective enforcement mechanisms, and available low-cost adjudication, are central elements to the success of community-based resource management institutions. Moreover, although the existence of supportive external sanctioning institutes will probably enhance the sustainability of the enforcement mechanisms, central governments should not undermine local authority (Agrawal 2003).

According to a SECOL representative, the current patrollers from the Actam Chuleb NGO will need to be trained by the Federal Department of Environmental Law Enforcement (PROFEPA)[50] to become official "community patrollers" and be able to present formal accusations directly to the SECOL. Subsequently, the SECOL will have to forward these accusations to the PROFEPA or to the CONAPESCA[51],

[50] PROFEPA is as a government department from the Secretariat for the Environment and Natural Resources (SEMARNAT).
[51] CONAPESCA is a government department from the Secretariat for Agriculture, Livestock Farming, Rural development, Fisheries and Nutrition (SAGARPA), responsible for managing fish stocks.

depending on the nature of the accusation. The same official pointed out that the biggest problems menacing the effectiveness of this process are poor articulation and coordination (vertical and horizontal) among the different levels of government and government agencies, which will considerably delay the process of imposing fines.

As referred by the Organization for Economic Co-operation and Development (OECD 2006), a key policy challenge in the Mesoamerican Region is to design arrangements that enable the effective co-operation across and within levels of government, and a greater participation of the civil society into policy design and implementation. In Mexico, one of the major problems affecting the legislative framework dealing with coastal and marine issues is its fragmented nature, which is aggravated by a dispersed and overlapping body of government institutions with jurisdiction over coastal and marine issues, and the lack of enforcement capacity (Bezaury-Creel 2004; 2005). In an ultimate analysis of the present situation, a serious feeling of scepticism about the effectiveness of this potentially long and bureaucratic sanctioning process emerges, which hopefully will not culminate in the disappointment and profound frustration of the local stakeholders of the Actam Chuleb MPA.

6.2.3 Opportunities and Limitations

The first consummated attempt to formalize a co-management partnership between the state government and a local stakeholder organization from San Felipe took place in June 2007, twelve years after the bottom-up implementation of the Actam Chuleb MPA, with the celebration of a five-year general agreement for the administration and management of the protected areas in the state of Yucatan[52] between the Actam Chuleb NGO and the SECOL.

That being said, the excessively long period of time that the state government took to officially recognize this bottom-up initiative, prepare a management plan for the

[52] Originally in Spanish: "Acuerdo de concertación de acciones para la conservación y el manejo sustentable de los recursos naturales en el estado de Yucatán".

Dzilam State Reserve, and formalize a general co-management partnership to manage the Actam Chuleb MPA (among other protected areas) has to be noted, especially when the major legal instruments were already available, both at the state and the federal level.

Whether or not this is the "desirable" co-management partnership in the case of the Actam Chuleb MPA, only time will tell. Either way, it will take some time for this co-management agreement to become operational, especially the process of concluding specific agreements, more so because the new (six-year) presidential administration replaced all the SECOL administrative personnel in July 2007.

Although this was an important governmental initiative to officially decentralize natural resource management in Yucatan, it is imperative to stress that effective management partnerships should consider the interests and concerns of all affected partners, and incorporate them into the development of the collective will, providing as much as possible for equity (Borrini-Feyerabend & Tarnowski 2005; Salm et al 2000).

As a means to operationalize and promote the institutional sustainability of this particular co-management partnership there are certain key aspects that must be considered, some of them already pointed out by the interviewed experts (see Table 5:6, Table 5:7, and Table 5:8), such as the establishment of efficient communication channels among the MPA stakeholders; the reinforcement of internal cohesion mechanisms and the promotion of voluntarism and cooperation; providing continuous capacity building for the population in general, where those already "educated" must be involved in "educating" others so as to achieve a multiplier effect, as suggested by Uychiaoco et al (2000); assuring the long-term technical support from external agents; guaranteeing the continuous institutional support from the three levels of government, which must be proactive and have political will to make this initiative work juridically, administratively and economically; the implementation of effective participatory decision-making and conflict-resolution mechanisms; the development of efficient enforcement mechanisms; and the promotion of the economic self-sufficiency of the Actam Chuleb MPA.

To conclude this analysis, it seems important to underline that although some of these suggestions might require a considerable effort to implement, particularly in terms of time and money, in the long-term it is likely that a co-management partnership that encourages the equitable participation of all stakeholders turns out to be quite an effective and sustainable approach to manage the natural resources.

6.2.4 Lessons Learnt

The Actam Chuleb case study illustrates the complexity of the process of consolidating a sustainable co-management agreement to manage a protected area, even when it has been initiated by a bottom-up initiative. It highlights the long time needed and the factors that might encourage or discourage cooperation for natural resources management while a variety of interests are negotiated. This study underlines the importance of having the government's recognition and legal, technical and economic support from it, as well as the support from the academic community and civil society (like NGOs).

One of the main lessons learned from this case study is that a great deal of importance must be given to the adoption of effective decentralization strategies, both at the community and at the governmental level, which must enable the establishment of truly inclusive participatory decision-making mechanisms if collaborative management strategies are to succeed and be advocated as a means of promoting civic participation and responsibility sharing for the sustainable management of common pool resources. Otherwise a feeling of mistrust might fully undermine the compliance of the "excluded" stakeholder groups. Besides, when a local management committee is dominated by a restrict group of people, and therefore by a limited scope of interests, these interests will not be legitimate, nor truly representative of those of the "community", and might eventually affect management sustainability in the long-term.

In the particular case of the Actam Chuleb, the strategy used to decentralize the MPA management and broaden its scope of interests by promoting the active participation

of the main stakeholder groups in management through a local NGO failed completely. The restructured Actam Chuleb NGO was in fact reduced to a few members at the beginning of 2007. Furthermore, from its founding in 2004 to the beginning of 2007, the NGO never organized an informative and/or consultative meeting on the MPA with the other stakeholder groups in the community. So no effective participatory decision-making mechanisms were developed to involve the community in the MPAs management process. In part, this happened because a private organization, instead of a public platform, was chosen to celebrate a partnership agreement for the co-management of natural resources. Regarding the nature and the obligations of this organization, according to a representative of the SECOL:

> "The Actam Chuleb is a private organization and does not have to make public declarations to the community regarding its activities nor accounts." (representative of the SECOL, March 2007)

Not even if it the organization frequently uses the label "community-based MPA" to successfully obtain funding from international donor agencies, as admitted by the representative of the SECOL. In situations like this, maybe some of the responsibility lays on international development agencies, which promote ideals such as equity, community empowerment, democratization of resources management and so forth (UNDP Energy and Environment Group 2006), but do not pay enough attention to the efficiency of the mechanisms used to evaluate the level of success achieved by those kind of projects. The same applies to the state government, which should make sure that the co-management mechanisms that they support are truly inclusive and democratic.

7. Final Considerations

The complex and dynamic nature of ecological and social systems requires the continuous monitoring, evaluation, and adaptation of management strategies and partnerships to assure their institutional sustainability. Consequently, one of the main challenges of this study was to generate useful socio-ecological baseline data to inform the Actam Chuleb MPA management process and nourish community participation. This data was produced using an interdisciplinary approach that combined methodologies from the social and natural sciences to obtain a more holistic and, therefore, accurate perspective of the research setting. The generated baseline data can now be used directly by the Actam Chuleb MPA stakeholders in the formulation of management plans, to inform decision-making, and to document the process of establishing an MPA to restrain the overexploitation of fishery resources in San Felipe.

Considering the broad application range of the adopted interdisciplinary approach and the availability of socio-ecological baseline information it would be interesting to develop further work to better understand the intertwined dynamic nature of socio-ecological systems and explore new ways of effectively develop cooperation, communication, leadership, and capacity-building mechanisms to enhance the sustainability of natural resources co-management institutions in the long-term, and obtain further insight into institutional dynamics. Meanwhile the findings presented by this study are expected to be useful for decision-makers and other coastal management practitioners worldwide.

To conclude, it is important to highlight that rethinking conservation is definitely one of the great challenges of the present time, as mentioned by Berkes (2004), considering that we have assisted to a historical shift in ecology towards a systems view of the environment, where humans are now considered part of the ecosystem, an integrated complex socio-ecological system that cannot be divided along disciplinary lines.

8. References

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Appendix I

In-depth stakeholder interview:

1. ¿Para usted cuáles fueron los objetivos principales de la creación de la reserva marina? *(¿Con qué finalidad fue criada la reserva?)*
2. ¿Para usted cuáles son actualmente los objetivos de la reserva marina? *(¿Qué finalidad tiene la reserva ahora?)*
3. ¿En su opinión en que medida se están logrando eses objetivos *(finalidades)*?
   a) Completamente
   b) Mucho
   c) Aceptablemente
   d) Poco
   e) Nada
4. ¿Considera que los objetivos actuales de la reserva son adecuados? *(¿Está de acuerdo con la finalidad actual de la reserva?)*
   a) Si
   b) No
5. ¿En su opinión cuáles deberían de ser los objetivos de la reserva (acrecentaría algo)? *(¿Qué finalidades debería tener la reserva o que otras finalidades podría tener?)*
6. ¿En su opinión cuáles son los principales beneficios *(ventajas)* de la creación de la reserva marina?
7. Considerando las categorías de beneficios presentadas, ordénelas por orden de importancia (de 1 al 5, donde el 1 es el más importante y el 5 el menos importante).
   a) Sociales (mejores condiciones/calidad de vida; mayor disponibilidad de alimento fuera de la temporada de la langosta y pulpo; recreación) _____
   b) Ecológicos (recuperación de especies sobreexplotadas dentro y fuera de la reserva; mayor abundancia de especies en la área de pesca) _____
   c) Económicos (creación de empleos temporales; fuente de ingresos indirectos: fomento del turismo y directos: pesca deportiva) _____

d) Educativos (mayor conocimiento y valorización de los recursos naturales del pueblo y su importancia; mayor conciencia ambiental) ____

e) Otros ____

8. Para cada una de las categorías de beneficios presentadas mencione ejemplos de beneficios concretos.

a) Sociales (mejores condiciones de vida; mayor disponibilidad de alimento fuera de la temporada de la langosta y pulpo; recreación)

b) Ecológicos (recuperación de especies sobreexplotadas dentro y fuera de la reserva; mayor abundancia de especies en la área de pesca)

c) Económicos (creación de empleos temporales; fuente de ingresos indirectos: fomento del turismo y directos: pesca deportiva)

d) Educativos (mayor conocimiento y valorización de los recursos naturales del pueblo y su importancia; mayor conciencia ambiental)

e) Otros

9. ¿Qué grupos sociales se han beneficiado con la creación de la reserva marina?

a) Todos

b) Casi todos

c) Algunos

d) Muy pocos

e) Ninguno

10. De los grupos indicados señale cuáles son los que se benefician y diga por qué.

a) Las Cooperativas de pescadores

b) Los permisionarios que comercializan el pescado

c) Los pescadores libres

d) Las mujeres que pescan

e) Hoteles

f) Los grupos de lancheros

g) Los grupos que hacen ecoturismo

h) El Puerto en general

i) Otros

11. ¿En su opinión cuáles son los principales obstáculos en el logro de los objetivos actuales de la reserva marina? *(¿Cuáles son los principales problemas en el funcionamiento de la reserva marina?)*

12. Considerando las categorías de obstáculos presentadas ordénelas por orden de importancia (de 1 al 7, donde el 1 es el más importante y el 7 el menos importante).
    a) Legales (inexistencia de suporte legal) _____
    b) Administrativos (estructura administrativa y su funcionamiento, quienes participan y que rol tienen, preactivos vs. reactivos; división de la cooperativa, prestación da la A.C. Actam Chuleb, eficiencia del comité municipal, desempeño del gobierno) _____
    c) Comunicación entre stakeholders (pobre interacción entre grupos locales de usuarios, gobierno municipal, estatal (SECOL) y federal, grupos de investigación, ONGs) _____
    d) Financiamiento (facilidad en obtener financiamientos y forma como son utilizados) _____
    e) Vigilancia (disponibilidad de vigilantes, lanchas, gasolina, fondos, eficiencia, frecuencia) _____
    f) Aceptación social (no cumplimento de las reglas por los habitantes; aceptación/relevancia de los objetivos; difusión, envolvimiento) _____
    g) Otros _____
13. Para cada una de las categorías de obstáculos presentadas mencione ejemplos concretos y diga como los podría minimizar o eliminar no sentido de un mejor funcionamiento da reserva marina.
    a) Legales (inexistencia de suporte legal)

Obstáculo concreto:

Propuesta de solución:

    b) Administrativos (estructura administrativa y su funcionamiento, quienes participan y que rol tienen, preactivos vs. reactivos; división de la cooperativa, prestación da la A.C. Actam Chuleb, eficiencia del comité municipal, desempeño del gobierno)

Obstáculo concreto:

Propuesta de solución:

    c) Comunicación entre stakeholders (pobre interacción entre grupos locales de usuarios, gobierno municipal, estatal (SECOL) y federal, grupos de investigación, ONGs)

Obstáculo concreto:

Propuesta de solución:

    d) Financiamiento (facilidad en obtener financiamientos y forma como son utilizados)

Obstáculo concreto:

Propuesta de solución:

e) Vigilancia (disponibilidad de vigilantes, lanchas, gasolina, fondos, eficiencia, frecuencia)

Obstáculo concreto:

Propuesta de solución:

f) Aceptación social (no cumplimento de las reglas por los habitantes; aceptación/relevancia de los objetivos; difusión, envolvimiento)

Obstáculo concreto:

Propuesta de solución:

g) Otros

Obstáculo concreto:

Propuesta de solución:

14. ¿ Está Usted enterado de cómo se administra o maneja la reserva actualmente?
    a) Si
    b) No
15. A su juicio, el manejo/administración de la área le parece: (en términos de tener objetivos adecuados; da forma como se intenta alcanzar eses objetivos y de los resultados)
    a) Perfectamente adecuado
    b) Muy adecuado
    c) Adecuado
    d) Poco adecuado
    e) No adecuado
16. ¿Quien o quienes se hacen cargo de la reserva (puede señalar más que una opción)?
    a) Gobierno Federal
    b) SECOL (Gobierno del Estado)
    c) Municipio
    d) Cooperativas de pescadores
    e) Grupo (s) Local (es) ¿Cuáles?
    f) Otro
    g) Ninguno
17. ¿En su opinión están reunidas las condiciones para que la gente de San Felipe participe y opine en las consultas publicas sobre el manejo de la reserva marina?

a) Si
b) No

18. ¿Por qué?
19. ¿Se siente Usted motivado para asistir y participar en las consultas publicas sobre el manejo de la reserva marina?
    a) Si
    b) No
20. ¿Por qué?
21. ¿Tiene Usted interese en recibir capacitaciones relevantes para el manejo de la reserva marina?
    a) Si
    b) No
22. ¿Por qué?
23. ¿Que tenga memoria, cuantas veces ha sido consultado o informado relativamente a asuntos relacionados con el manejo de la reserva en los últimos 5 años?
    a) 0
    b) 1 – 3
    c) 4 - 6
    d) 7 - 9
    e) +10
24. ¿Por parte de quien ha sido consultado o informado?
25. ¿Tiene conocimiento que actualmente el limite oriental de la poligonal de la reserva de Dzilam Bravo se ha extendido hasta el limite occidental de la reserva de la biosfera Ría Lagartos, desde su publicación en el "Diario Oficial del Gobierno del Estado de Yucatán" en el 28 de Diciembre de 2005? *(¿Sabe hasta dónde llega el limite de la Reserva Estatal de Dzilam?)*
    a) Si
    b) No
26. Cree Usted que va beneficiar con esa medida…
    a) Nada
    b) Poco
    c) Aceptablemente
    d) Mucho

e) Otro

27. ¿Por qué?
28. ¿Personalmente se siente motivado/interesado por el tema de la reserva marina independientemente de sus obstáculos?
    a) Si
    b) No
29. ¿Por qué?
30. ¿Qué perspectivas tiene a respecto del futuro que tendrá la reserva en 10 años?
    (¿Cómo imagina que estará la reserva en 10 años?)

Appendix II

External agents' questionnaire:

1. ¿En su opinión, cómo surgió la iniciativa local de creación de una área marina municipal en San Felipe y que etapas identifica en su desarrollo?
2. ¿En su opinión, cuáles son las principales (a) limitaciones y las principales (b) amenazas para el desarrollo de una iniciativa de manejo de base comunitaria en San Felipe, como es el caso de la reserva marina Actam Chuleb?
3. ¿Como se podrán superar tales (a) limitaciones y evitar tales (b) amenazas?
4. ¿En su opinión, cuáles son las principales condiciones o potencialidades existentes para lograr el desarrollo de una iniciativa de manejo de base comunitaria en San Felipe?
5. ¿Cómo se podrán maximizar y tornar efectivas estas potencialidades?
6. ¿En su opinión, qué es lo que motiva a la gente (los diferentes usuarios) de San Felipe a: i) involucrarse en el proceso de co-manejo de la reserva marina, ii) a ser indiferente, o iii) a estar en contra el mismo?
7. ¿En su opinión, cuál fue el papel de las intervenciones externas: a) ONGs; b) instituciones académicas y de investigación; c) agencias internacionales de desarrollo en el proceso de implementación y desarrollo de la iniciativa local de manejo de la reserva marina Actam Chuleb en San Felipe?
8. ¿Será posible desarrollar un verdadero manejo de base comunitaria de los recursos en San Felipe?
9. ¿Cuál es el papel del gobierno en esta iniciativa?

Appendix III

Pictures from the participatory workshop carried out in San Felipe in 2007:

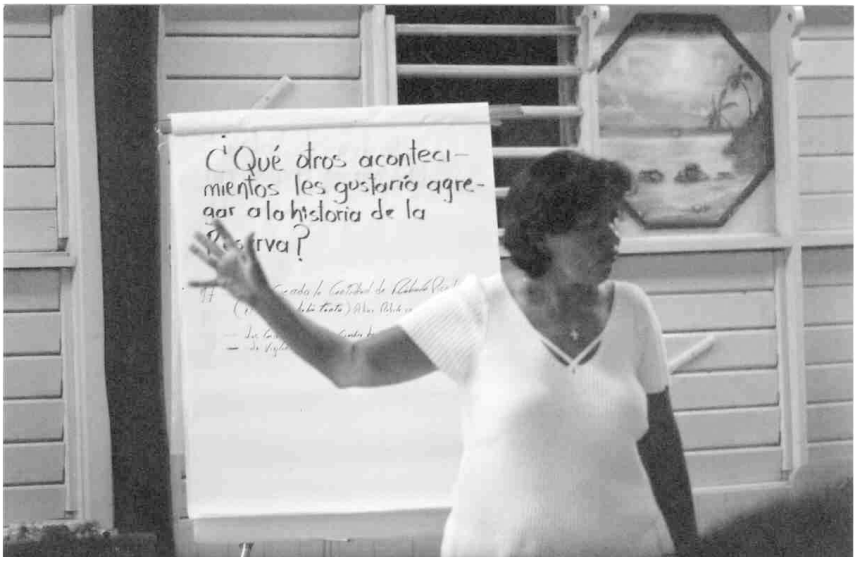

Photo by Guylene Solon.

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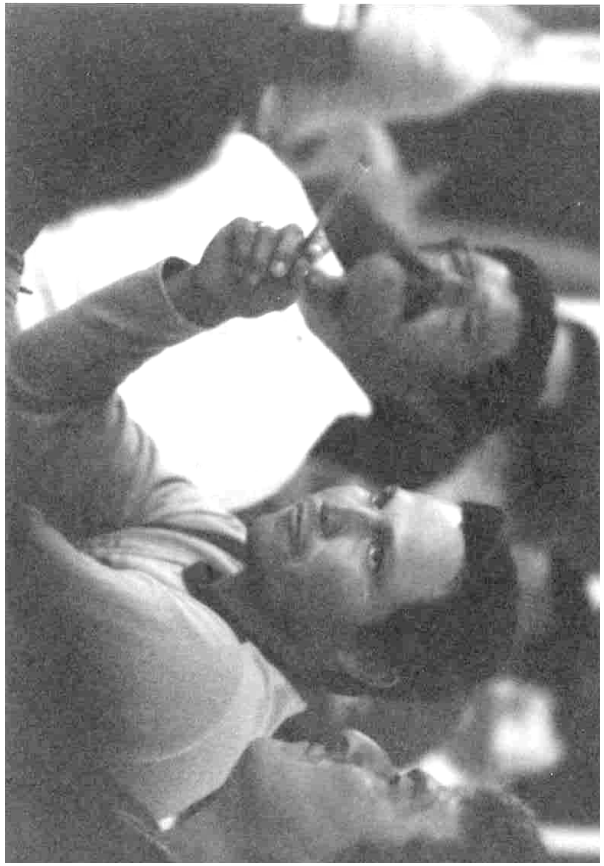

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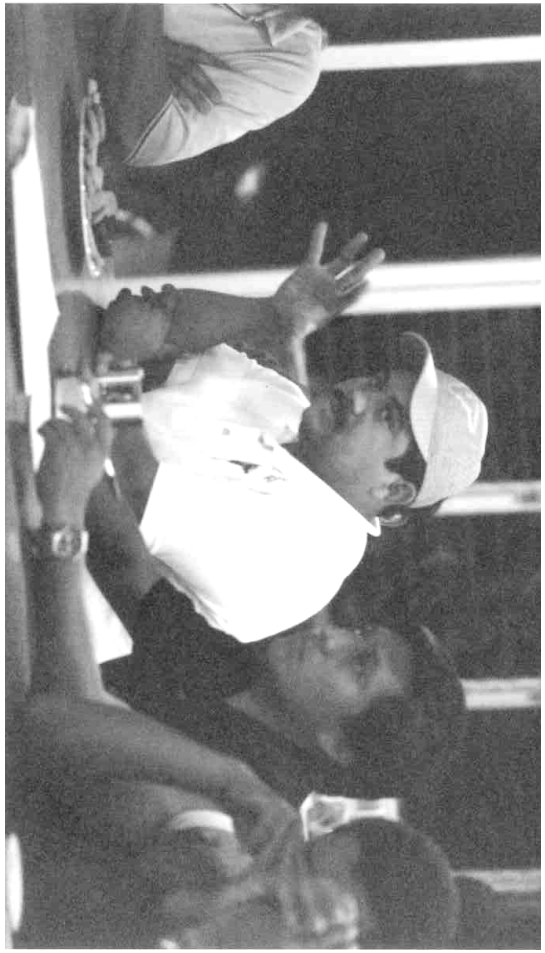

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Appendix IV

Pictures from the village of San Felipe:

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