EFFECTIVENESS OF A CUBAN MARINE PROTECTED AREA IN MEETING MULTIPLE MANAGEMENT OBJECTIVES

by

Jorge Alberto Angulo-Valdés

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy

at

Dalhousie University
Halifax, Nova Scotia
September 2005

Your file Votre référence
ISBN: 978-0-494-16694-9
Our file Notre référence
ISBN: 978-0-494-16694-9

DALHOUSIE UNIVERSITY

To comply with the Canadian Privacy Act the National Library of Canada has requested that the following pages be removed from this copy of the thesis:

Preliminary Pages
- Examiners Signature Page (pii)
- Dalhousie Library Copyright Agreement (piii)

Appendices
- Copyright Releases (if applicable)

To: Zamara, Melissa and Jorge

Table of contents

List of figures

List of tables

Abstract

In this work the management effectiveness of a Cuban MPA is assessed using an interdisciplinary approach. A series of three hypotheses are tested to determine how effective the Punta Frances Marine Protected Area (PFMPA) has been in meeting the multiple objectives of conserving biological diversity and ecological integrity, while allowing for the development of economic opportunities for tourism, and satisfying the needs of local and distant human populations.

A new typology of benefits derived from MPAs was produced to provide managers with a practical tool that enable them to: 1) identify the benefits at the early stages of MPA creation, 2) state MPA objectives in a clear and measurable way, 3) assess the effectiveness of their MPA in meeting their management objectives.

A new methodology was also developed to assess MPA effectiveness. This methodology constitutes an advancement from previous work, and it is based on qualitative and quantitative measurements of benefits depicted in the proposed typology. It has several advantages over previous methods. One of the main advantages is that it can be applied to assess one single MPA or a group of MPAs in a comparative fashion.

The case study analyzed showed that to date, the PFMPA shows little signs of being negatively affected by the recreational SCUBA diving activities for which it was intended, given that no significant differences were found between intensively used diving areas and unused diving areas in terms of fish abundance, coral cover and macroalgae cover. Despite this, the PFMPA is not currently providing the full set of benefits to humans and the rest of nature, due mainly to administrative issues. If the PFMPA eventually becomes a National Marine Park (i.e. is fully protected from extractive activities), and management is correctly implemented, an annual economic value of almost USD $127,164,116.37 is forecast. At present the PFMPA does not provide any social or economic benefit to the nearby coastal community of Cocodrilo, thereby maintaining a divorce between local people and the users and managers of the MPA. Conversely, foreigners are receiving most of the benefits associated with recreation in a pristine tropical coastal ecosystem situated on the edge of the Caribbean Sea basin.

The interdisciplinary methodologies for assessing effectiveness of MPAs developed in this study provided quantitative and qualitative evidence of a poor level of success in meeting the multiple management objectives of the PFMPA. This situation is apparently the result of several factors, both objective and subjective, especially the restrictive nature of the PFMPA relative to local inhabitants.

List of abbreviations

ASRUP	Areas under Special Regime of Use and Protection
BMP	Bonaire Marine Park
CATIE	Agricultural Center for Tropical Investigations and Teaching
CB	Current Benefits
CBCRM	Community-Based Coastal Resource Management
CCP	Cuban Communist Party
CDR	Committee for the Defense of the Revolution
CITMA	Ministry of Science, Technology and Environment
CM	Council of Ministers
CMEA	Council of Mutual Economic Aid
CMR	Center for Marine Research
CNAP	Centro Nacional de Áreas Protegidas
CPUE	Catch Per Unit of Effort
CS	Council of State
CTO	Caribbean Tourism Organization
CTRDC	Caribbean Tourism Research and Development Center
CYU	Communist Youth Union
CWF	Cuban Women's Federation
DMA	Dirección de Medio Ambiente
EC	Executive Committee
EEZ	Exclusive Economic Zone
EUR	Euro
FRO	Fisheries Regulation Office
GDP	Gross Domestic Product
GEF	Global Environment Facility
GNI	Gross National Income
ICZM	Integrated Coastal Zone Management
IES	International Ecotourism Society
IMO	International Maritime Organization
IRF	Island Resources Foundation
IUCN	International Union for the Conservation of Nature
LOS	Living Ocean Society
MCA	Marine Conservation Areas
MCR	Marine Conservation Regimes
MDS	Multidimensional Scale
MES	Ministry of Higher Education
MINAGRI	Ministry of Agriculture
MINTUR	Ministry of Tourism
MIP	Ministry of Fishing Industry
MITRANS	Ministry of Transportation
MMA	Marine Management Areas

List of abbreviations (continued)

MPA	Marine Protected Area
MPAEM	Marine Protected Area Evaluation Model
MPAs	Marine Protected Areas
MPP-EAS	Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas
MVSP	Multivariate Statistical Package
NAPP	National Assembly of Popular Power
NES	National Environmental Strategy
NSPA	National System of Protected Areas
ONHG	Oficina Nacional de Hidrografía y Geodesia
PA	Protected Area
PAs	Protected Areas
PB	Potential Benefits
PC	Popular Councils
PCA	Principal Components Analysis
PFMPA	Punta Frances Marine Protected Area
PFNMP	Punta Frances National Marine Park
PP	Popular Power
Rapfish	Rapid Appraisal of Fisheries
SCUBA	Self-Contained Underwater Breathing Apparatus
SPAW	Regional Programme for Specially Protected Areas and Wildlife in the Wider Caribbean
TCM	Travel Cost Method
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNDP	United Nations Development Programme
UPGMA	Unweighted Pair Group Average
USD	United States Dollar
USSR	Union of Soviet Socialist Republics
WCED	World Commission on Environment and Development
WCU	World Conservation Union
WTP	Willingness to pay
WTTC	World Travel and Tourism Council
WWF	World Wildlife Fund

Acknowledgements

Firstly I would like to express my sincere gratitude to the Canadian International Development Agency (CIDA) and the International Development Research Center (IDRC) for providing me with the necessary funds to undertake an intensive and extended body of work. I am grateful also for the Tier II Project on Integrated Coastal Zone Education in Cuba, which served as the vehicle to make my joint study in Canada and Cuba possible. Special thanks as well to the Faculty of Graduate Studies, the Marine Affairs Program, and the International Student Office for providing me with the necessary scholarship to cover my tuition expenses.

.

I owe a great deal of thanks to many people for the help they have given me over the course of this work. Most of all to Bruce Hatcher not only for supervising me, but also for the good advice, encouragement, friendship and freedom he has given me from the very beginning. Dr. Aldo Chircop was also of a great help in every moment and I am very grateful for the good advice and words of encouragement. I also thank my supervisory committee for the help provided me along the way.

Special thanks to the people at the Center for Marine Research at the University of Havana for providing me with the time, advice and help needed throughout these years. Here I owe a lot to Dr. María Elena Ibarra Martín, Dr. Gaspar González Sansón, and Dr. Ana María Suárez.

To protect the guilty I will not name the one exception to the otherwise excellent cooperation and luck I have had with many collaborators: Carmen Duranza, Luis Sánchez, Rodney Borrego, Reynaldo Borrego, Ivan Rodríguez, Erick Perera, Orestes Gonzalez, Desiderio, Juan Aramis Vega, and Osmany. Thanks, as well, to my friends at the Colony hotel, the PFMPA, the Cocodrilo community, and the fishermen from La Coloma and the Isle of Youth.

Special thanks to my family who endured all these years of my recurrent and prolonged absences from home.

Chapter I

Introduction

Recurring management failures and the global decline of marine resources have triggered a worldwide demand for change in the way coastal and ocean resources are managed (Bohnsack and Ault, 1996; Field et al., 2002; Sobel and Dahlgren, 2004). Traditionally management measures have tended to be reactive and sectoral, allowing a great margin for malfunction. Conversely, proactive and integrated approaches are becoming more relevant, and as a result a change to ecosystem-based management is taking place (Bohnsack and Ault, 1996; Cicin-Sain and Knecht, 1998; United Nations Environment Program, 2001; Sobel and Dahlgren, 2004).

The ecosystem-based approach to natural resource management combines ecological, social and economic considerations toward achieving the goal of the sustainable use of natural resources. According to Slocombe (1998), this approach relies upon the following principles:

1. Partnerships and citizen participation.
2. Science-based approach.
3. Long-term goals.
4. Comprehensive perspective.

Based upon these principles, ecosystem-based management requires a genuine and meaningful relationship between stakeholders to correctly address issues, identify opportunities and find common solutions that truly support economic prosperity, lasting livelihoods, and ecological health and sustainability. The management process must be based on, and make optimum use, of the best available scientific knowledge (ecological, social, and economic) as a foundation for the decision-making process. This in turn should establish targets and long-term goals to ensure the preservation of ecosystem conditions that sustain public benefits and opportunities into the future. Finally, management has to be a learning process in which decisions are continuously reviewed and revised so that decision making is not paralyzed by uncertainty. It must adapt to changes in social values, environmental conditions, political pressures and available knowledge.

Despite the apparent advantages of ecosystem-based management, its implementation at local or global scales is still far from achieved. To produce good, long-term outcomes implementation of the ecosystem-based management approach should occur in the global context, recognizing the strong connectivity of marine, terrestrial and atmospheric ecosystems. Unfortunately, current political and socioeconomic issues in the international arena do not allow for a worldwide application of ecosystem-based management. For example poverty, war, and discrepancies in levels of social, economic and political development work against the comprehensive and informed human resources required for an ecosystem-based approach. Credit should be given, however, to many national and regional initiatives that look to implement such an approach: for example Australia's

Representative System of Marine Protected Areas (MPAs) (Thackway, 1996); Cuba's Sabana-Camagüey Archipelago (Global Environment Facility (GEF)/United Nations Development Program (UNDP), 1999); and the North Sea basin (Christiansen et al., 2002). There are other significant limitations to ecosystem-based management such as: governmental and institutional inertia to change, inadequate legal frameworks, socioeconomic constraints (e.g., dictatorial decision-making that obstructs open public participation), and significant lack of knowledge and uncertainty about nature's functioning.

On the positive side, there has been increasing international support for this approach. Several international agreements, conventions and laws such as, the Agenda 21, the Convention on Biological Diversity: specifically the Jakarta Mandate and the Law of the Sea, have been enacted to encourage a change in marine management approaches by explicitly recognizing that *"...the marine environment is an integrated whole that is an essential component of global life-support system and a positive asset that presents opportunities for sustainable development"* and calling for *"new approaches to marine and coastal area management and development . . . that are integrated in content..."* (Chapter 17, Agenda 21 of the United Nations Conference on Environment and Development (UNCED), 1992). In the decade since then, the establishment of marine protected areas (MPAs) has emerged as the "new approach" of choice.

Marine protected areas are an important component of the ecosystem-based approach to conserving marine resources (National Academy of Science (NAS), 2001; Charles,

2001). They can be implemented in a great range of economic and social conditions, and exist in a wide array of designs (Kelleher, 1999; Salm et al., 2000). MPAs provide a legal and institutional framework to deal with the complex problems that exist in coastal zones (Agardy, 1997; Bohnsack, 1993; Bohnsack and Ault, 1996; Harriot et al., 1997; Hatcher, 1997; United Nations Environment Programme (UNEP), 1997) fostering achievement of the sustainable development paradigm (Mascia, 1999, 2001; National Academy of Science, 2001; Salm et al., 2000). As such, they have been particularly well embraced in the developing world, where the human, financial and institutional resources are inadequate for a sector-by-sector or species-by-species approaches, and the major sources of funding for marine resource management come from international funding institutions that foster an ecosystem-based approach. Because such nations often take creative, unconventional approaches to Marine Protected Area (MPA) designation and management, I believe that it is useful to study the implementation of MPAs in the developing world.

Despite the worldwide effort in developing MPAs, the question of how truly effective MPAs are at achieving their stated (or assumed) management goals still remains a challenge for managers and scientists (Alder et al., 2002). According to Kelleher and Recchia (1998), Kelleher (1999) and Alder et al. (2002), a MPA must clearly define objectives against which its performance is regularly checked, using a monitoring program to assess management effectiveness. Management should be adaptative, meaning that it is periodically reviewed and revised as guided by the results of monitoring. Evidently, by following this model managers should be able to assess MPA

effectiveness, but the real world situation is different. Many MPAs have been promoted by international and national donor agencies following an agenda that often does not match national or local interests or capabilities. These agencies have been promulgating a universal recipe based on the uncertain assumptions that any MPA is of value and the more the better; a sort of "one size fits all" approach. Many countries have embarked on MPA initiatives without the necessary legal and institutional framework (Alder, 1996; Alder et al., 2002; McClanahan, 1999). A top-down, natural science-based approach to MPA implementation has dominated the international scene (Alder, 1996). Socio-economic issues have had a secondary relevance for many MPA initiatives, which have mainly been based on ecological considerations (Kelleher, 1999), and this bias continues. Consequently, many promising MPA initiatives have failed to achieve the desired outcomes (i.e. the so-called: "paper parks"), and their potential as a management tool has been compromised.

Thus: despite the relative scarcity of documented proof, the MPA appears to be a suitable tool for promoting the sustainable use and conservation of marine and coastal biodiversity, and has been widely embraced as such. MPAs represent a decisive departure from the limited marine management tools of the past towards a more holistic approach to marine resource management. They no longer are considered to be merely exclusive amusement parks set aside for an elite group of users (Dixon and Sherman, 1990; Agardy, 1994, 1997). Instead, new generations of MPAs are being implemented to address a wide range of marine resources and management dilemmas that include the accommodation of multiple users and uses through well-defined zoning scheme. I take it

as given that well-planned and managed MPAs can not only protect critical habitats and general ecosystem functions, but can also meet the needs and even enhance the opportunities of many different stakeholders living in the coastal zone.

Research Question and Hypothesis

Cuba, the largest archipelago in the Caribbean (110,860.6 km^2), has not escaped the depletion of marine resources, and has started to undertake important management measures to protect its marine and terrestrial biota. The National Environmental Strategy (NES), enacted in 1997 by the Ministry of Science, Technology and Environment (CITMA), demonstrates a clear governmental concern for, and commitment to, nature protection. The Cuban NES (CITMA, 1997) is the most important policy document related to the sustainable use, management, conservation and protection of natural resources in the country (Monzón, 2001). The Strategy identifies the full range of Cuban environmental problems, and potential mechanisms to achieve solutions. Related to coastal and marine ecosystems, this document identifies two main problems: marine water pollution and the loss of biological diversity. It proposes Integrated Coastal Zone Management (ICZM) as an important framework in order to prevent future deterioration of coastal areas around the country and clearly states the need for the implementation of a national network of MPAs (Pina, 1999; Monzón, 2001; Centro Nacional de Areas Protegidas, 2002).

Punta Frances at Isla de la Juventud (Cuba) is an example of a MPA established on the basis of economic interests. This area had been used mainly for fishing purposes until 1976, when some international tournaments on underwater photography were organized in the area. Given its remarkable attractiveness above and below water, near-pristine status, and established SCUBA (Self-Contained Underwater Breathing Apparatus) diving facilities (the Colony Hotel and a medical facility for the treatment of SCUBA-dive-related diseases), the place became the most important SCUBA-dive spot in Cuba. The coincidence of these two conflicting activities engendered arguments and legal controversies between the Colony Hotel and the Ministry of Fisheries (main users of the area) that remained some 20 years later.

For over 25 years the Punta Frances Marine Protected Area (PFMPA) was used primarily for SCUBA diving, and 56 diving sites were set and marked with buoys. In 1996 the area become a new tourist attraction with the arrival of large cruise ships that bring more than 400 tourists per week increasing, thus, the number of visitors to the park to an average of 12,194.33 per year (Park Director, personnel communication). Currently, the dive sites are not being used evenly, and there is a significant pressure on those that are considered to be best. Many buoys (more than 40) have been lost and not been replaced, increasing diving pressure on the remaining sites. Furthermore, although the Ministry of Fisheries enacted a regulation in 1996 that bans the fin fishery within the area, some fishing activity takes place right on the borders of the area, using large, non-selective fishing gears that remove large fish species. Also, some illegal spear gun and hook-and-line fishing is conducted within the area limits, due to poor surveillance and enforcement.

Cruise activities are thought to be posing a new threat to the area, given the increasing number of tourists that are being brought every year to the beach, and the possibility of extending tourist activities inland. From 1976 until today the PFMPA has changed in terms of its management objectives, moving from a single purpose MPA to one having multiple management objectives. This change is the result of an evolutionary process in the Cuban system of protected areas management.

Clearly, human use of the PFMPA is changing in type, pattern and magnitude as more interests and stakeholders make use of, or derive value from the natural resources. This situation, combined with an increase in fishing pressure in adjacent areas, and even within the PFMPA, may jeopardize the fulfillment of management objectives for the area. If human use is to be sustainable over the long term, then the marine and coastal ecosystems of Punta Frances must be maintained in a healthy state in the face of these changes.

Given the importance of this issue in the Cuban socio-economic context, the question of **how effective the PFMPA has been in meeting the multiple objectives of conserving biological diversity and ecological stability, allowing for the development of economic opportunities for tourism, and satisfying the needs of local and distant human populations** is of major interest.

The research presented in this thesis responds to the research question by addressing a series of three working hypotheses:

- Fishing and tourism activities negatively affect the function and structure of the coral reef community within the PFMPA, potentially compromising the objective of nature protection.
- Economic benefits derived from exploitation of resources associated with the PFMPA outweigh the direct and indirect costs of nature protection.
- The PFMPA satisfies social needs for employment, cultural diversification, environmental awareness, and recreation for local and non-local human populations.

While these hypotheses may be tested independently using the data collected during the research, they, and the results are truly interdependent, and will be considered both in isolation and in combination.

Outcomes for these hypotheses are expected to be variable due to the intrinsic features of the Cuban socioeconomic and management systems. For instance, it is expected that economic activities currently taking place at the PFMPA have provoked no negative impact on coral reef structure and functioning in the PFMPA. At the same time, economic benefits provided by the PFMPA should outweigh the costs of nature protection, although distributional aspects of these benefits should reflect an unequal allocation due to uneven satisfaction of social needs mostly for nationals, specifically for the nearby coastal community.

This study begins with an introductory chapter stating global issues affecting most coastal countries worldwide It then follows a brief discussion of the ecosystem-based approach to natural resource management as a better alternative to deal with these issues. Later on the topic of MPAs is introduced as a practical way to implement the ecosystem-based management approach. The chapter ends with the description of the research question and a series of three working hypothesis.

Chapter II is devoted to the topic of MPAs, their origins, brief history and most accepted definitions. Chapter III is dedicated to assessing all possible benefits that MPAs can provide to humans and nature. In this chapter a typology of benefits is presented as well as some classical valuation methods that are used to assign monetary values to those benefits.

Chapter IV depicts the Cuban socioeconomic system including its policy and law making process in the context of decision-making about MPAs. Chapter IV ends with an analysis of existing legislation in Cuba regarding MPAs, its current status and future projections. Chapter V constitutes the bulk of the work in this study. In this chapter the PFMPA case is analyzed in detail and three hypotheses are tested independently in separate sections dealing with biology, economic, and social aspects. In Chapter VI a new methodology to assess MPA effectiveness is developed. This methodology uses the classification of benefits provided in Chapter III as reference to calculate an effectiveness value for the PFMPA case. Chapter VII provides the conclusions for the whole work, presents the contributions to knowledge, and proposes future lines of research on this topic.

Chapter II

Marine Protected Areas: Background and Definition

History Reviewed

The need to manage and protect marine environments and their resources by means of spatial closure (i.e. through an MPA) became apparent during the 1950's and 1960's. However, the Fort Jefferson National Monument in Florida, established in 1935, is sometimes considered the first modern MPA (Gubbay, 1995). In 1962 the First World Conference on National Parks called for protection of coastal and marine areas (Adams, 1962; Kelleher and Kenchington, 1992). Following this initial global concern, several meetings were subsequently held regarding MPAs. In 1975, the International Union for the Conservation of Nature (IUCN) (now known as the World Conservation Union (WCU)) held a conference on MPAs in Tokyo, Japan. The concluding report noted increasing pressures on marine environments and called for the establishment of a well-monitored system of MPAs, representative of the world's marine ecosystems (International Union for the Conservation of Nature, 1976; Kelleher and Kenchington, 1992). In 1980, the IUCN, the World Wildlife Fund (WWF), and the UNEP published the World Conservation Strategy, which emphasized the importance of marine environments and ecosystems, with the goal of providing for conservation for sustainable development. The first guide for MPA planners and managers was published in 1984, as a result of a

series of workshops organized by the WCU Commission on National Parks and Protected Areas (Salm and Clarke, 1984; Kelleher and Kenchington, 1992).

In 1983 the United Nations Educational, Scientific and Cultural Organization (UNESCO) organized the First World Biosphere Reserve Congress in Minks, Union of Soviet Socialist Republics (URSS). At that meeting it was recognized that the Biosphere Reserve concept was potentially applicable to the marine environment and that an integrated, multiple use MPA can conform to all of the scientific, administrative, and social principles that define the Biosphere Reserve concept (UNESCO, 1987; Kelleher and Kenchington, 1992). Following the publishing of "From One Earth to One World" report (World Commission on Environment and Development (WCED), 1987), the General Assembly of the United Nations (UN) adopted the "Environment Perspective to the Year 2000 and Beyond" (UN, 1987). Both documents highlighted the current threats faced by the marine environment and proposed alternative ways to address them.

Defining Protected Areas

The IUCN (1994) developed the following definition for PAs that includes the marine environment: *"...an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means..."* The IUCN also stated a series of management objectives for PAs that include scientific research, wilderness protection, preservation of species and genetic diversity, maintenance of environmental services, protection of specific natural and cultural features, tourism and recreation, education,

sustainable use of resources from natural ecosystems, and maintenance of cultural and traditional attributes. At the same time, six management categories were defined to differentiate among the various goals and modes of implementation and operation of PAs, and the degree to which they fulfill their objectives. These management categories constitute a revision and improvement of the ten PA categories previously established in 1978 (Agardy, 1997):

CATEGORY Ia. Strict Nature Reserve: protected area managed mainly for science

Definition: Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

CATEGORY Ib. Wilderness Area: protected area managed mainly for wilderness protection.

Definition: Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

CATEGORY II. National Park: protected area managed mainly for ecosystem protection and recreation.

Definition: Natural area of land and/or sea, designated to:

(a) Protect the ecological integrity of one or more ecosystems for present and future generations;

(b) Exclude exploitation or occupation unfavorable to the purposes of designation of the area; and

(c) Provide a foundation for spiritual, scientific, educational, recreational, and visitor opportunities, all of which must be environmentally and culturally compatible.

CATEGORY III. Natural Monument: protected area managed mainly for conservation of specific natural features

Definition: Area containing one, or more, specific natural or natural/cultural features which are of outstanding or unique value because of their inherent rarity, representativeness or aesthetic qualities or cultural significance.

CATEGORY IV. Habitat/Species Management Area: protected area managed mainly for conservation through management intervention.

Definition: Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

CATEGORY V. Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation.

Definition: Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity.

Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

CATEGORY VI. Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems.

Definition: Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

These categories constitute a worthwhile effort to provide a common, international language for PAs that facilitates communication, information sharing, comparison, and analysis. They also provide a framework for planning and implementing national systems of PAs designed to meet multiple objectives. Although most PAs can be justified for the goals contained in the general definition of the management tool, in practice the precise objectives and management categories for which PAs are created vary among countries. For instance, the Cuban law on PAs tailored the IUCN management categories to the Cuban socioeconomic system. This law calls for a National System of Protected Areas (NSPA) that consists of a network of protected areas (marine and terrestrial). The system is divided according to the relative importance of the PAs (local, regional, national or international importance) and within these divisions, management categories similar to those of the IUCN classification exist. The Cuban NSPA constitutes a governmental

commitment to the Article 8 of the Convention on Biological Diversity, which clearly calls for system plans for PAs in every country.

Defining Marine Protected Areas

Despite the existence of definitions and well-structured management categories for PAs on land, MPAs remain several decades behind their terrestrial counterparts (Agardy, 1994, 1997, Kelleher, 1999). The fluid nature of the marine environment, the variable character of ecological boundaries, highly mobile species and water masses underlie many conceptual and operational difficulties. Therefore, it was necessary for conservation biologists to improve existing management models before applying them to marine ecosystems (Bohnsack, 1998). The 4th World Wilderness Congress developed the current definition for MPA, which was finally adopted by IUCN at its 17th General Assembly in 1988 (IUCN, 1988; Gubbay, 1995). It states: "*...any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment...*" The adoption of this definition represented a worldwide step taken towards the achievement of the three main objectives defined in the World Conservation Strategy in 1982.

This broad definition implies that MPAs must include the marine environment, but may also include coastal land areas and islands. MPAs must have some form of effective protection, usually legal, but not necessarily. The degree of protection need not be the same throughout the area; indeed, most large MPAs have different zones according

biodiversity value, sensitivity to impact and usage levels. MPAs should protect cultural and archeological features (i.e. wrecks, historic sites, and the like) as well as so-called "natural" features. MPAs should cover not only the seabed but also the water column above, including its living organisms.

Although widely accepted and used, the definition has some limitations. First of all, it does not make reference to human beings and how they are expected to fit within MPAs. This apparently small omission has been, in my opinion, a major obstacle in achieving human understanding and compliance with MPAs. For many years MPAs were considered places where people ought to be excluded, and this fostered confrontation and useless conservation efforts. It has now been widely accepted that without people MPAs are not likely to work: every user of the marine environment has to be taken into account. Second, its vague nature has provoked misinterpretation and further erroneous application. For instance, in Canada there are six pieces of legislation that deal with MPAs, and each is based on vague and differing definitions of MPAs (Living Ocean Society, 2000). This has motivated confusion or even antagonism, and sometimes prevented the implementation of MPA initiatives, as in the case of a National Marine Conservation Area in Newfoundland, which failed due to lack of clear definition in the legislation (Living Ocean Society, 2000). In contrast, New Zealand's network of no-take MPAs has proven very successful, in part because of the unambiguous definition and goals of these types of MPAs (Ballantine, 1995). In conclusion, three lessons can be taken from the evolution of the MPA to date:

a) The IUCN definition should not be considered definitive. Instead it should be used as a starting point from which governments and non-governmental organizations (NGOs) can build more precise MPA definitions and goals according to their national and local priorities and socioeconomic necessities.

b) Ensuring human participation and involvement in the selection, planning, management and monitoring of MPAs should always be priority number one: without it failure is almost certain.

c) Practicality should dominate the discussion of MPA definition and establishment. More attention should be paid to what kind of problems need to be solved than to what kind of "name" should be used. This is particularly relevant given the vast amount of literature dealing with definitions and concepts that do not produce obvious, tangible results.

MPAs have been established to fulfill different objectives; the most commonly stated being those related to biodiversity conservation and fishery enhancement (Kelleher, 1999; Salm et al., 2000). For the sake of uniformity the IUCN has defined the general goal of MPAs *to "...provide for the protection, restoration, wise use, understanding, and enjoyment of the marine heritage of the world in perpetuity through the creation of a global, representative system of MPAs and through management in accordance with the principles of the World Conservation Strategy of human activities that use or affect the marine environment..."* (IUCN, 1988). This goal recognizes common issues relevant to any country regardless of its sociopolitical system and this, in my opinion, is what makes it ideal for worldwide acceptance and implementation. For instance, the protection should

apply to both natural and cultural (maritime heritage) elements, including ecosystems, critical habitats, natural processes, production systems, species, genetic stocks, cultural traditions, historical sites, and the like. Similarly, restoration refers to damaged ecosystems, habitats, species, cultural traditions, and the rest. Wise-use implies the sustainable use of natural resources for the well being of present and future generations, especially those directly affected by the creation of the MPA. This term also implies the accommodation of human activities compatible with the objective of protection. Understanding comes with the undertaking of monitoring and research activities that constitute important feedback in education and management processes, especially when adaptative management is intended. Enjoyment involves the enhancement of aesthetic and spiritual values of human beings who are, in turn, ultimately responsible for public support of the MPAs and compliance with its regulations. The concept of perpetuity encompasses the role of MPAs in providing insurance for the continuing use of natural resources by upcoming generations. Finally, the principle of representivity refers to the inclusion in the protection network of every significant marine ecosystem type in a country or region.

The relevance of the underlying principles of MPAs to all coastal states has been highlighted at regional and global levels. At regional level there is the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, commonly known as the Cartagena Convention, was signed in Cartagena, Colombia, in 1983. The objectives of the Convention are to protect the marine environment and to ensure sound environmental management throughout the Wider Caribbean region. To

further detail and elaborate their responsibilities, parties are to conclude regional and sub-regional Protocols. As such the Specially Protected Areas and Wildlife (SPAW) protocol is specifically meant to further Article 10 of the Cartagena Convention. The Protocol encourages:

1. the establishment of protected areas to conserve and maintain ecosystems deemed rare and fragile as well as habitats occupied by vulnerable species;
2. the protection of species deemed endangered and threatened;
3. the promotion of sustainable management (and use) of fauna and flora to prevent their endangerment.

By adopting the SPAW Protocol, it is hoped that the biological diversity and vital ecological function of the Wider Caribbean can be managed for the benefit of future generations. Due to the nature and reach of this protocol it has become the most relevant legal agreement for the Wider Caribbean basin. Also, it has been internationally recognized as the most comprehensive treaty of its kind. This protocol was adopted in Kingston, Jamaica by the member governments of the Caribbean Environment Programme on 18 January 1990, and acts as a vehicle to assist with regional implementation of the broader and more demanding global Convention on Biological Diversity.

At the global scale there are other international agreements, conventions and other instruments such as the Convention on Wetlands of International Importance Especially

as Waterfowl Habitat, commonly known as the Ramsar Convention, was signed in Ramsar, Iran, in 1971, and entered into force on 21 December 1975. The primary objective of the Ramsar Convention is to provide recognition to wetlands of "international importance." Parties are obligated to designate at least one wetland area for inclusion on a List of Wetlands of International Importance, and to ensure its continued protection through the establishment of a nature reserve or other protected area.

The Convention concerning the Protection of the World Cultural and Natural Heritage, commonly known as the World Heritage Convention, was signed in Paris, France, in 1972. This Convention was one of the first international legal instruments to recognize the concept that sites of outstanding natural or cultural significance are part of the heritage of all people, and humankind as a whole has certain rights as well as obligations with respect to conserving these sites. The Convention provides a framework for the protection of unique natural and cultural areas of "outstanding universal value." World Heritage Sites are selected for their special attributes by a World Heritage Committee made up of elected representatives of the Parties to the Convention. Once a site is designated as a "World Heritage Site", the Party with jurisdiction over the site is obligated to do "all it can" to preserve and protect it. Sites that are seriously threatened are identified and included in a List of World Heritage in Danger.

The United Nations Convention on the Law of the Sea (UNCLOS), was signed in Montego Bay, Jamaica, in 1982. UNCLOS provides a framework of principles for

national rights and obligations in relation to ocean use: navigation and fishing, marine minerals development, environmental protection, species conservation and scientific investigation of the oceans. The UNCLOS was designed to encourage States and international organizations to participate in an integrated management system for the oceans. States are encouraged to act through "competent international organizations or diplomatic conferences" to establish global and regional rules, standards, recommended practices and procedures.

More recently the Agenda 21 and the Convention on Biological Diversity constitute remarkable global efforts aiming at promoting the sustainable development goal, calling for global initiatives in natural resources conservation and bringing together worldwide efforts to achieve this goal.

In one way or another, all these previous documents have clearly expressed the need for global establishment of MPAs". As a result, there has been considerable progress in the establishment of MPAs since the first "global call". In 1970 there were 118 MPAs in some 27 nations. In 1995, 430 MPAs had been proclaimed by 69 nations, with another 298 proposals under consideration (De Silva et al., 1986, cited by Kelleher and Kenchington, 1992). Currently, there are over 1400 MPAs around the world (Table 1), (Kelleher et al., 1995; World Wildlife Fund, 1998; Caribbean Environmental Programme United Nations Environment Programme, 2003) ranging from small, highly protected reserves that sustain a particular resource or habitat type to larger, multiple-use areas in which conservation is balanced with various socio-economic activities.

Table 1. Marine Protected Areas around the World.

World region	MPAs	World region	MPAs
Antarctic	24	Central Indian Ocean	15
Arctic	16	Arabian Seas	19
Mediterranean	53	East Africa	50
Northwest Atlantic	89	East Asian Seas	92
Northeast Atlantic	41	South Pacific	65
Baltic	43	Northeast Pacific	167
Wider Caribbean	171	Northwest Pacific	190
West Africa	42	Southeast Pacific	19
South Atlantic	19	Australia and New Zealand	329
		TOTAL	1444

Sources: Kelleher et al. (1995) and Caribbean Environmental Programme United Nations Environment Program (2003).

This significant number is shaded by the fact that 923 (64 %) of MPAs have unknown management status and are rather small (median size is about 16 km^2) with some exceptions, e.g. the Great Barrier Reef Marine Park in Australia (344,000 km^2), the Florida Keys National Marine Sanctuary (47,000 km^2), and the Galapagos Island Marine Resource Reserve (8000 km^2) (McClanahan, 1999). The large majority of the world's MPAs experience some sort of resource extraction (Gubbay, 1995), and enforcement is quite poor (World Wildlife Fund, 1998; McClanahan, 1999). Alder (1996) reported that 65 % of respondents to a global survey of MPAs stated that they have not been successful. Nonetheless, current thinking is that once an MPA initiative overcomes the complicated initial stages it has a much greater chance of success (McClanahan, 1999). Obviously, this will only be true if public support, governmental commitment and funding are available, and if the scientific models underlying assumptions of how MPAs function to achieve their intended goals are sound.

As human uses of the marine environment diversify and intensify, the aims, definitions and management approaches of MPAs are becoming increasingly flexible. Many types of "MPAs" have been created to suit the objectives for which they have been implemented. For example, marine reserves, fishery reserves, harvest refugia, marine sanctuaries, conservation zones, and marine parks are all variations on the MPA theme that imply subtly different expectations of benefits and patterns of human use.

Classifying Marine Protected Areas

Many attempts have been made to standardize the terminology of MPAs (Salm and Clark, 1984; Kelleher et al., 1995, Charles, 2001). Stewart (1993) developed a typology of what she called a Marine Conservation Regime (MCR). According to Stewart, MCR represents a spectrum of institutional schemes, of varying degrees of protection, available to governments seeking to manage their coastal and marine resources in a manner consistent with the guidelines of the World Conservation Strategy. Stewart (1993) also emphasizes the difference between MCR and Marine Conservation Areas (MCA). The latter are specific geographic locations where resources and activities are managed. Consequently, marine parks, for instance, are considered areas with management regimes at the protective end of the spectrum.

This MCR typology is based on the 10 management categories developed by the IUCN in 1978 and later modified by Salm and Clark (1984), to reflect the inclusion of marine conservation systems. The 10 categories are grouped in three clusters that represent a range from low to high human impacts. These groups are compared according to the

following variables: idealized regime type, management philosophy or ethic, management objectives, and primary regulations. Using this typology allows government to coordinate the management of resources and people in the coastal zone (Stewart, 1993). Her main conclusion is that once the objectives to be achieved have been identified, then the type of MCR can be selected based on the depicted typology.

Agardy (1997) provides an interesting typology of MPAs based on the concept of Marine Management Area (MMA). According to this author, a MMA can be defined as: *"...any area of the coastal zone or open ocean conferred some level of protection for the purpose of managing use of resources and ocean space or protecting vulnerable or threatened habitats and species..."* As it can be understood, MPAs represent a subset within this general definition. At least seven major categories can be discerned within the general definition of MMA. These are:

CATEGORY 1: Closed areas

Areas where particular classes of uses are restricted to ensure sustainability of resources. These might include fishery harvest refugia, and moratorium areas. They can be time-limited.

CATEGORY 2: Research and monitoring areas

As its name states, these MMAs are meant for scientific research. They could be reference sites against which to measure impacts of human activities, monitoring sites or

natural laboratories to undertake basic research. Core areas, within biosphere reserves represent this category.

CATEGORY 3: Sensitive sea area

These are defined by the International Maritime Organization (IMO) and encompass those areas that need special protection given their ecological or socioeconomic importance and their susceptibility to damage by maritime activities.

CATEGORY 4: Marine sanctuary and marine parks

Areas set aside to allow for the occurrence of particular uses at the same time as protecting the coastal or marine ecosystems and their processes. Examples of this category include national parks, ecosystem-based multiple use marine parks, sanctuaries and biosphere reserves.

CATEGORY 5: Regional seas and large marine ecosystems

These areas are formally recognized by the UNEP. They represent enclosed or semi-enclosed seas that fall under the jurisdiction of more than one nation and coherent ecological unit, respectively.

CATEGORY 6: Integrated management areas

Include state-administered coastal zone and Exclusive Economic Zone (EEZ).

CATEGORY 7: High Seas under the United Nations Law of the Sea Treaty

Even though the high seas are considered "public goods", international treaties, such as the Law of the Sea, attempt to create a management framework for those countries signing the treaty.

The United States National Academy of Science (NAS) recently analyzed applications of MPAs to marine conservation (National Academy of Science, 2001). According to this private-non-profit society, the six management categories developed by the IUCN in 1994 provide a suitable framework for assessing the status of PAs internationally, but its specificity precludes a practical reference to the more general goals of MPAs. The NAS (2002) defined the following types of MPAs:

Marine Protected Area: a geographical area selected to improve the conservation of marine and coastal resources through the implementation of an integrated management plan.

Marine Reserve: an area where some or all of the resources are protected against harvesting or disturbance.

Fishery Reserve: a zone that prohibits fishing activities for some or all species in order to protect critical habitat, rebuild stocks, enhance catches and avoid overfishing.

Ecological Reserve: an area that protects all living resources from extraction and disturbance. It also prohibits the extraction of non-living resources and only scientific research can be undertaken there.

There exists of significant overlap between these categories. They are neither mutually exclusive nor hierarchical. At best, this classification simplifies; but it provides little insight to the relationship among the many objectives of MPAs.

The Objectives of Marine Protected Areas

Various and numerous have been the stated objectives of MPAs: maintenance of ecological functions, biodiversity conservation, provision of recreational opportunities, conservation of economically important areas and fishery enhancement being the most important ones. Conflicts have occurred, however, given the obvious contradiction between maintaining certain conservation values and fulfilling economic expectations (Davis and Tisdell, 1995a; Hatcher, 1997). Despite the fact that specific objectives for designating a MPA might vary from one country to another, under most national programs, MPAs are designated to meet at least one of the following goals (Salm and Clark, 1984):

- The continued welfare of local people and communities dependent on the sustainable use of productive marine ecosystems, and the economic and social benefits of the coastal and marine environment to the surrounding region.

- Representative examples of coastal and marine ecosystems and habitats of a region, to enhance their long-term viability and to maintain genetic diversity.
- Areas having special importance by reason of their economic, scientific, aesthetic, recreational, cultural, archeological, or educational values or purpose.
- Endangered and threatened species and populations of flora and fauna including habitats considered critical to the survival of such species and populations.

Lemay (1986) proposed that, based on the past experience in several countries such as Australia, and New Zealand and the United States, the planning, implementation and management of MPAs involves the following steps:

1. The formulation and/or confirmation of objectives for the area.
2. Analysis of the regional context (social and economic issues, role of the marine environment and existing management capabilities).
3. Provide public participation early in the process to identify management problems, needs and priorities.
4. Formulation of feasible management options.
5. Development of community-based marine resource management projects.
6. Creation of mechanisms for the implementation of these community-based management projects.

7. Working towards acceptance of preferred options through dialogue and negotiation.
8. Monitoring and assessment of MPA functioning.

However, the institutional arrangements whereby MPAs are planned, implemented and managed vary from one country to another. For instance, the steps chosen for a particular MPA program in one country may depend upon many elements, including the form of government (centralized or decentralized), available finances, boundaries of jurisdiction and the most common decision-making process.

Pina (1999) undertook a comparison of MPA systems in 15 countries, within 5 geographical regions, clustered according to their level of economic development. He concluded that despite similarities among countries in terms of the environmental issues that triggered MPA initiatives, remarkable differences were found in management levels, institutional cooperation, funding availability, community involvement, and research and monitoring capabilities. The pattern of these differences was one of decreasing capacity from economically developed countries to less developed ones. Pina (1999) did not provide quantitative values for these differences nor he did analyze the implications of top-down and bottom-up management approaches in the three development scenarios considered.

Chapter III

Benefits Derived From Marine Protected Areas

Introduction

MPAs provide a large array of benefits to both human and non-human components of marine ecosystems (Cesar, 2000). Nonetheless, as with any human action the establishment and eventual operation of any MPA brings costs associated to it, therefore opposition can be found (Sumaila and Charles, 2002) ranging from governments to general public. Azzoni and Isai (1994), estimated that the costs for environmental protection in Brazil, in terrestrial PAs, represent 0.05 % of the country's GNP. This figure, although significant, was not compared with the benefits accrued from environmental protection. Other studies dealing with costs of MPAs have shown that they are usually a fraction of the net benefits accrued from protecting the marine environment (Dixon et al., 1993; Pendleton, 1995; Spurgeon, 1992, 2002; Spurgeon and Roxburgh, in press). According to Pendleton (1995) the costs of the Bonaire National Marine Park would be approximately USD $1.77 million over 20 years at a real discount rate of 10 %. The net present value of local net benefits for that period of time would be USD $74.21 million. Evidently the difference is enormous; therefore, it has been considered that in the Bonaire National Marine Park the costs of the park are borne by tourists in the form of park permit fees.

This author acknowledges the importance of assessing the costs of protection as well as the costs that are associated with each MPA benefit. I am also aware that Bonaire National Marine Park is a good example but in reality this is not the case for most Caribbean MPAs. Identifying and assessing costs is a difficult task and it would be a function of the particular context where an MPA is located; therefore it becomes complicated to generalize. Although this chapter deals only with benefits, the case study developed in chapter V examines both benefits and costs of the case study developed.

Extensive work has been done to try to quantify benefit's importance or "values" (King and Mazzotta, 2000). Nevertheless, this has been a rather challenging task, given the constraints on valuing benefits that are not marketed, and the subjective nature of some of the methods used to estimate these values. Attempts have been met with different degrees of success, however.

Before focusing on the description and classification of MPA benefits, the interchangeable use of two important terms in the literature must be clarified: "ecosystem goods" and "ecosystem services." Costanza et al. (1997a) defined them as: "...*ecosystem functions refer variously to the habitat, biological, or system properties or processes of ecosystems. Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions...*" More precisely, ecosystem services are the flow of materials, energy, and information from natural capital stocks, which combine with manufactured and human capital services to produce human welfare (benefits). In summary, for these authors, the

term "ecosystem services" encompasses goods and services, and their materialization constitutes benefits for human beings. Note that benefits to non-human components of marine ecosystems are not considered by these authors.

A similar approach was used by de Groot (1994) and de Groot et al. (2002) to define these concepts. As indicated by these authors, ecosystem functions can be understood as: *"...the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly..."* In this regard, they grouped ecosystem functions into four main categories that are responsible for providing all goods and services and direct and indirect benefits to humans, namely regulation, habitat, production, and information functions. De Groot et al. (2002) also developed a framework for assessing and valuating ecosystem functions, goods and services. The main shortcoming of their work is the clearly expressed anthropocentric approach used in their analysis, based on the assumption that the concept of ecosystem goods and services is inherently anthropocentric. Firstly, they did not consider, at all, the inherent natural values, which are completely independent of human interest or use. Therefore, these values are not represented in their framework and are not even mentioned. Secondly, while I agree with the anthropocentric origin of the goods and services terms, I do not view them as the same thing. These two terms clearly represent different outcomes of ecosystem functions, and have different implications for the identification and valuation of MPA benefits.

King and Mazzotta (2000) provided a similar definition for these terms, and also merged into one concept the terms "ecosystem goods" and "ecosystem services." According to them, ecosystem functions are the physical, chemical, and biological processes or attributes that contribute to the self-maintenance of an ecosystem; and ecosystem services are the beneficial outcomes for the natural environment or people that result from ecosystem functions.

Special attention should be given to the work done on the ecological goods and services of coral reefs by Moberg and Folke (1999). To date this is the only published analysis I have found that clearly differentiates ecosystem goods and services. These authors defined coral reef goods as renewable resources (fish, seaweed) and mining of reefs (sand, coral), while services provided by coral reefs were categorized into: physical structure services (i.e., coastal protection), biotic services within and between ecosystems (e.g., biological support through spillover of eggs, larvae or adults), biogeochemical services (e.g., nitrogen fixation), information services (e.g., climate records), and social and cultural services (e.g., aesthetic values, recreation and the like).

With very few exceptions, then, ecosystem goods and services are commonly perceived as being the same thing. This might not be an issue at first sight; but if we take into account the fact that the most recurrent reason for MPA failure worldwide has been the unclear description of management goals and objectives (Alder, 1996; Alder et al., 2002; Kelleher and Recchia, 1998), then it can be understood that a clear recognition of these terms within the MPA context is essential for correct identification of benefits.

A Typology of MPA Benefits

Misunderstanding of management objectives has prevented MPA managers from accurately assessing their effectiveness. This lack of clear evidence for human and non-human benefit maximization within MPA programs has resulted in wastage of money and time, loss of financial support, and more importantly, loss of public confidence. The recognition that benefits should constitute the management objectives for MPAs makes the issue of definition and identification of ecosystem goods and services, as separate items, very important within the MPA domain. Accordingly, I consider ecosystem goods as the direct and often measurable items, such as food, raw materials (minerals, medicinal components), and aesthetic and cultural values that accrued directly to users of the MPA. Ecosystem services are indirect and often hard-to-measure processes (ecosystem functions) that support life on the planet (e.g. climate regulation, shore protection from erosion, nutrient cycle).

Numerous authors have attempted to classify all the possible benefits derived from MPAs (Bohnsack, 1993, 1998; Dixon, 1993; Moberg and Folke, 1999; Sobel, 1996) and from natural ecosystems as a whole (Costanza et al., 1997a; de Groot et al., 2002; Dixon and Sherman, 1990). This has not been an easy task, given the fast growing marine uses that entail new future benefits from MPAs. To the present, most benefit classification studies have only focused on human-related benefits, ignoring many important benefits accrued to nature. These benefits to nature are indeed as important as anthropocentric benefits because human life itself ultimately depends on them. Also, this human-centered approach is based on the fact that current benefit valuation methods only account for

dollar-based values of MPA benefits, rarely taking into account other measurable benefits, for instance the number of species protected or the total area of habitat conserved.

Dixon and Sherman (1990) provided a classification of benefits derived from PAs. According to these authors, benefits are associated with each type of PA, and therefore they "flow" from conservation objectives. They grouped benefits into eight main categories. Within each category a series of specific benefits can be allocated. Rodwell and Roberts (2000) provide a similar classification:

- Recreation/tourism
- Watershed protection
- Ecological processes
- Biodiversity
- Education and research
- Consumptive benefits
- Non-consumptive benefits
- Future values.

There are some shortcomings in this typology. First, MPAs are not only established for conservation objectives; sustainable resource exploitation is also considered an objective for MPAs (e.g. fishery reserves are established to sustain commercially important populations of fish that are exploited). Second, benefits should be treated as management

objectives themselves, not simply as assumed outcomes of an MPA's existence. If erroneous, this assumption may impede appropriate evaluation of MPA effectiveness. Finally, the categories for benefit classification tend to be fuzzy and repetitive. For instance, the first five categories seem correct, but they all fall within the seventh category. The same problem arises with the last category, future use, which can be grouped in both the consumptive or non-consumptive benefit categories. In my opinion, these last two categories should have been the starting point for a hierarchical benefit classification.

Costanza et al. (1997a) provided a list of 17 major ecosystem services, which represent benefits to humans. Contrary to Dixon and Sherman (1990), they did not categorize the benefits. This work constitutes the first attempt to put a monetary value on the world's ecosystems. Although there are several inherent conceptual and empirical problems with their approach, which the authors recognized, this work represents a meaningful effort to provide managers and decision-makers with key information to internalize environmental costs in their management models.

One of the most comprehensive classifications of MPA benefits is provided in the marine reserve benefits statement by Sobel (1996). It identifies a total of 69 MPA benefits organized into four main categories:

- Protect ecosystem structure, function and integrity
- Improve fishery yields

- Expand knowledge and understanding of marine systems
- Enhance non-consumptive opportunities.

This classification is far more useful than the one proposed by Dixon and Sherman (1990). The categories are inclusive and clear. In this case benefits, are arranged within well-defined categories with little repetition or fuzziness. Also, both conservation and exploitation objectives are fully integrated within this classification model.

Following this work, Bohnsack (1998) discussed some fishery and non-fishery benefits that MPAs could provide. Many of the listed benefits were the result of empirical evidence and logical thinking, and the author called for more scientific research. He categorized fishery benefits according to their level of scientific support: well supported, partially supported and unproven or inadequately tested. On the other hand, classification of what he called non-fishery benefits was done following three categories extracted from Sobel (1996):

- Protect ecosystem structure, function, and integrity
- Increase knowledge and understanding of marine ecosystems
- Improve non-consumptive opportunities.

Within these categories, he identified a total of 31 benefits, which have a great deal of resemblance to those provided by Dixon and Sherman (1990), Sobel (1996), and Costanza et al. (1997a). Bohnsack's work could be considered an extension of Sobel's

(1996). The difference here is that Bohnsack paid special attention to fishery-related benefits, which have been claimed as most important for MPA establishment.

The National Academy of Science (2001) provided a benefit classification in which the benefits are expressed in the goals of MPA establishment. Therefore, benefit achievement depends on the fulfillment of the stated goals. According to National Academy of Science (2001), marine systems are able to provide a wide range of direct and indirect benefits to humans, even without exploitation of natural resources. The National Academy of Science classification of benefits has an anthropocentric origin because it accounts for direct and indirect revenues accrued by humans. Direct benefits are mainly based on ecosystem goods and include on-site extractive uses (e.g., fisheries, mining, medical compounds), and on-site non-extractive uses (SCUBA diving, bird and whale watching).

Indirect benefits, on the other hand, are mostly based on ecosystem services and are accrued by individuals who do not use the marine ecosystem directly, but have some interest in its protection (e.g., people who live on shoreline protected from waves by intact coral reefs in MPAs; people who derive spiritual benefits from knowing that a preserved marine environment exists). These indirect benefits are very relevant because they can be essential for human existence. They include the role of marine ecosystems in stabilizing regional and global climates, coastal protection, sequestration of pollutants, biological, and chemical processes that remove atmospheric carbon dioxide, produce oxygen, and moderate global temperatures (Daily, 1997).

In general it can be said that there is a worldwide consensus on the benefits MPAs can provide; the point relies, however, on the classification of those benefits. Most authors have preferred to use classification systems that are anthropocentric, while few have considered more ecocentric models. Even though, that there is nothing wrong with these two models individually, it would be useful to develop a new classification model that merges both approaches. The goal is to build from existing work to produce a comprehensive typology of benefits from MPAs that allows researchers and managers to more easily recognize and value these benefits. The rationale for this goal includes the facts that:

a) Most previous initiatives have had an anthropocentric perspective; therefore, all benefits and values have been described without accounting for benefits to the rest of nature.

b) The current valuation methods only account for dollar-based values of MPA benefits, failing to account for other "measurable" benefits, such as number of species protected or total area of important habitat conserved.

c) The evaluation of the effectiveness of MPA management requires that all possible benefits be clearly identified beforehand, and related to management objectives.

d) The more recognition and appropriation of benefits by individuals, the more likely those individuals will lobby for legislation and comply with rules supporting MPAs.

A total of 99 benefits are identified in this study and divided into two main classes: those accruing to humans and those accruing to the rest of nature (Table 2). This classification includes major past studies and thus it is more comprehensive than previously developed classifications. It is also based on a new classification approach from a less anthropocentric perspective.

Within the human benefits category, a further division is made between direct and indirect benefits. Direct benefits are provided mainly by ecosystem goods, while indirect benefits are generally derived from ecosystem services. This division leads us to identify more specific categories (fishery benefits, non-fishery benefits, management benefits, educational/research benefits, and cultural benefits).

Direct benefits are further subdivided into two main categories: fishery-related benefits and non-fishery-related benefits. These benefits represent extractive and non-extractive uses of marine resources from which human beings obtain direct and indirect economic revenues. As its name indicates, fishery benefits are those related to fishing activities, and it is notable that they account for 16.1 % of all 99 identified benefits. This should not be a surprise since more than the 50 % of the scientific literature devoted to MPAs deals with fishery issues. Alder (1996), Boersma and Parrish (1999), and McClanahan (1999) have stated that the main support for MPA establishment worldwide has been fishery management, although biodiversity conservation also accounts significantly.

Table 2. Classification of Marine Protected Area Benefits. Adapted from Dixon and Sherman (1990), Sobel (1996), Costanza et al. (1997a), Bohnsack (1998), and National Academy of Science (2001).

MPA BENEFITS								
To humans					To nature			
DIRECT			INDIRECT/OFFSITE					
Fishery benefits	Non-fishery benefits	Management benefits	Education/Scientific benefits	Cultural benefits	Process benefits	Ecosystem benefits	Population benefits	Species benefits
• Protect spawning stocks • Increase population fecundity • Foster reproductive capacity • Provide undisturbed spawning sites • Ensure viable spawning conditions • Improve spawning habitats • Enhance eggs and larvae production • Provide export of egg and larvae • Build up fishery recruitment • Support sport trophy fisheries • Allow for spillover of adults and juveniles • Increase abundance of overfished stocks (inside and outside the reserve) • Reduce overfishing • Increase spawning stock biomass • Enhance spawning density • Diminish fishery-related genetic impacts	• Allow harvesting of renewable and non-renewable resources • Expand non-consumptive recreation opportunities (SCUBA, ecotourism) • Enhance and diversify economic activities • Increase wilderness opportunities • Promote alternative employment opportunities • Strengthen property and liability rights • Broaden and strengthen economy • Enhance other forms of income generation • Protect attractive habitats for tourism.	• Reduce use and user conflicts. • Reduce incidental and bycatch mortality. • Reduce variance in yields. • Maintain diversity of fishing opportunities. • Allow opportunities for mariculture. • Facilitate and simplify enforcement and compliance. • Improve management and efficiency. • Insure against management failures. • Facilitate stakeholder involvement. • Reduce possibility of irresponsible development. • Promote holistic approach to management. • Promote bases for ecosystem management.	• Improve understanding of natural systems • Provide educational opportunities • Allow knowledge permanence of undisturbed sites • Provide cumulative understanding from multiple studies at one site over time • Allow research, monitoring and data collection from untouched sites • Provide control areas for assessing human-induced impacts • Reduce risks to long-term experiments • Enhance synergy from cumulative studies • Provide long-term monitoring areas • Maintain memory of natural ecosystems • Provide sites for enhanced primary and adult education • Provide sites for high-level graduate education • Provide undisturbed areas for particular experiments • Preserve archeological sites • Provide biological information from unfished populations	• Improve peace-of-mind • Enhance aesthetic experiences and opportunities • Foster constructive social activities • Promote spiritual relations and development • Enhance conservation appreciation • Promote international relations and cooperation • Provide foundation to increase public awareness and compliance • Promote concern for future generations. • Improve aesthetic values • Preserve and expand historical knowledge • Facilitate cultural resource management	• Allow for suitable nutrient cycles • Protect from coastal erosion • Provide physical refugia • Maintain global climate regulation • Avoid physical damage to habitats • Sustain evolutionary processes • Protect critical habitats • Maintain biological diversity • Allow for the transformation, detoxification and sequestration of pollutants	• Eliminate second order impacts • Maximize ecosystem resilience • Preserve natural communities composition and functioning • Ensure biodiversity protection • Prevent cascading ecosystem effects • Maintain trophic structure and food web • Maintain key areas (reproductive, nursery, feeding) • Allow for ecosystem recovery	• Protect natural population structure and functioning. • Protect genetic resources and diversity • Restore population size and age structure • Protect spawning populations (commercial and non-commercial) • Increase survival rate for juveniles and adults • Increase natural recruitment • Allow recovery of depleted populations • Increase reproductive outputs	• Protect keystone and dominant species • Prevent loss of vulnerable species • Sustain species presence and abundance • Prevent loss of rare species • Protect long-lived species (sea turtles) • Protect slow-growth species • Protect low-reproductive species • Allow for complete species interaction • Protect migratory species • Restore species abundance and biomass • Restore species diversity

Other authors have claimed that the role of MPAs in fishery protection and enhancement is the issue of foremost interest worldwide (Boersma and Parrish, 1999; DeMartini, 1993; McClanahan and Mangi, 2000; Polacek, 1990; Rakitin and Kramer, 1996; Roberts et al., 2001; Rowley, 1994; Russ, 1985; Russ et al., 1992). Despite the fact that true fishery benefits from MPAs have very rarely been unequivocally demonstrated (Hatcher, 1997), MPAs have been extensively promoted as alternative fishery management tools that enhance fishery yields (Boersma and Parrish, 1999; Hatcher, 1999; Kelleher et al., 1995; Lauck et al., 1998; Nowlis and Roberts, 1999; Roberts et al., 2001; Russ and Alcala, 1994; Suman, et al., 1999).

Under the non-fishery benefits category fall all other existing marine uses. They include extractive uses such as: mineral and sand mining, seaweed harvesting, coral collection for construction, and the non-extractive uses such as SCUBA diving, whale and bird watching, site-seeing of natural areas, and the like. My intention in designating this very broad category is to identify the main benefits expected beyond the fisheries. Many other non-fishery benefits will be identified as MPA uses broaden (National Academy of Science, 2001).

Tourism development constitutes a key set of benefits in the non-fishery category that deserve some attention. In the last decade there has been a rapid escalation of tourism-based activities undertaken within MPAs (Green and Donnelly, 2003), reflecting the common necessity for multiple uses beyond strict resource conservation, towards

sustainable resource use. Thoroughly protected MPAs offer pristine habitats that are in high demand by tourists.

Symmetrically, tourism provides a crucial means of financing MPAs, and may keep more damaging forms of development away from sensitive marine environments. Of course, too much tourism development can produce very negative change in marine ecosystems in MPAs. Several examples of SCUBA diving impacts on coral reefs have partially demonstrated this (Davis and Tisdell, 1995b, Harriot et al., 1997). Still lacking, however, are comprehensive studies that measure the degree of compatibility between tourism activities and the long-term existence of MPA benefits. Such studies should shed light on the modes and magnitudes of tourism activity that should be allowed within MPAs as well as the actual and potential impacts that these activities have on the biological, economic and social components of MPAs.

The indirect benefit category encompasses those that accrue to individuals who do not use the protected marine ecosystem directly. Two specific sub-categories are identified here: educational-research and cultural benefits. The combination of research and educational benefits in one category should not be interpreted to mean they are the same thing, despite obvious linkages. Research results can extend beyond the education ambit to encompass knowledge acquisition and adaptative management. Nonetheless, for the sake of simplicity in the model these two are considered together, and account for 15.1 % of the total number of benefits identified. Educational-research benefits play a key role in MPAs management. Among other things, they provide the major source of information

upon which to adapt management and shape people's understanding and awareness that ultimately enhance cultural benefits. Improved comprehension of nature's functioning, in turn allows for the better implementation of an ecosystem-based approach in the management process.

The relevance of cultural benefits derived from MPAs is expressed in the role they play in the development of biocentric values among human populations. The degree to which nature is valued for its own sake is a function of people's beliefs about their relationship with nature. These beliefs are critical for explaining the adaptations of human cultures to their local, regional, and global environments, and also to explain the development of a conservation ethic towards natural resources. A clear example of this is given by Dunlap et al.'s (1993) finding in a 24-nation poll that 50% of people chose environmental protection over economic benefits. It has been demonstrated that people fully committed to nature conservation can play a significant role in supporting MPAs because of their influence on regulatory policies for nature conservation enacted by governments. It follows that cultural benefits are ultimately responsible for the acceptance of MPAs by society.

Management benefits of MPAs have thus far been left out of the analysis of direct and indirect benefit categories. This is because management benefits are generally both direct and indirect in nature (graphically represented by a shade of gray in the management cell of Table 2). For instance, the reduction of incidental fishing mortality (bycatch) may have a positive effect on the Catch per Unit of Effort index (CPUE), resulting in an increase in

revenues that constitute a direct benefit to humans. On the other hand, the management benefit of promoting foundation for ecosystem management clearly forms part of the indirect benefits that helps in the enhancement of people's understanding and compliance with MPAs and in the development of the management process itself. Similar analysis can be done with the rest of the benefits identified within this category. It should be clear to the reader that benefits identified here are neither inclusive nor final; many more can be recognized and added to the list.

Four main categories of benefits to nature are identified: process benefits, ecosystem benefits, population benefits and species benefits. These categories attempt to cover all possible benefit recipients in the non-human "world", including biotic and abiotic elements. Despite the undisputed links between the population and species categories, these two are separated by the different ecological footprints and economic relevance that each one has.

Most of the benefits included within these categories present indirect but vital links to humans. For instance, many of them represent indirect benefits essential for the survival of human beings (i.e. global climate regulation, shore protection, recovery of depleted populations on which humans live). Although the shade of gray is the same as the one used for indirect-benefit categories, it does not imply that all benefits to nature should automatically be considered indirect benefits to humans.

Natural benefits are ultimately responsible for an MPA's existence and have extensively been used to promote MPA initiatives. Unfortunately, the fact that most of them have not been successfully demonstrated and have not been included in valuation studies, due to their non-market character, has provoked poor social compliance with MPAs. It is obvious that more research is needed to determine the real magnitude of these benefits, and how to assign them a monetary value for inclusion in economic models.

Two more general comments should not escape readers' attention. First, all benefits identified in Table 2 have not been completely demonstrated. Indeed, most of them are the result of logical thinking and theoretical analysis rather than empirical evidence. Only 33 % of the identified benefits actually enjoy well-supported evidence in the scientific literature, while the remaining 67 % have only partial support or no support at all (Bohnsack, 1998 and NAS 2001). Needless to say the "lucky" 33 % encompass most of the direct benefits. Second, as a result of biased human analysis models, a mere 30 % of the benefits are actually taken into consideration in valuation studies, leaving out an impressive 70 % of them. This huge disproportion is the result of:

a) An anthropocentric approach to the assessment of MPA benefits.
b) Imperfections of the current human economic valuation system that do not internalize environmental issues.
c) Current methods of analysis that only account for market-based benefits.

Due to these limitations a great deal of information has been left out of past analysis and this has, in turn, left scientists and managers with few options to accurately assess MPA effectiveness. A clear need for integrative research is obvious, and a thorough revision of current valuation methods and models is also necessary, if MPAs are to be legitimately claimed as the best tool for the sustainable development paradigm in the marine realm.

In this regard the last part of this chapter is devoted to succinctly describing existing benefit valuation methods, assessing their relationships to already identified benefits, and to provide a benefit valuation framework that allows MPAs managers to assess their effectiveness.

Valuation Methods

Perhaps one reason why the marine environment has been so degraded by human activities is because we have not been able to fully understand its true value. This "human mistake" has its roots, in part, in the fact that we take what we have for granted; and in part because our economic valuation system does not account for values not directly related to the market. This fact has also been called "market failure" (Dixon and Sherman, 1990; Goodstein, 1999). Many other factors are also responsible for market failures but those will not be analyzed in this paper (for a comprehensive review of these factors, refer to Dixon and Sherman, 1990). Marine conservation has traditionally been based on ecological concerns and goals. However, as human pressures on marine and coastal ecosystems have intensified, so economic approaches have started to play a key role in the establishment and operation of MPAs. Particularly, it has been recognized that

issues such as financial viability and economic sustainability are of central importance to the success of MPAs (Salm et al., 2000).

Valuation is the process of putting a monetary value on goods and services (Farber et al., 2002). This process has been an essential part in human life, and has been considered a rather straightforward task when goods and services are sold in the market.

There are three major factors that make valuation of MPA benefits a complex task. Firstly, ethical concerns probably create the biggest problem when valuing the environment. Many people simply believe that it is immoral to put a price tag on nature, thus making it more difficult to do value estimation (Cesar, 2000; Costanza et al. 1997a; King and Mazzotta, 2000; National Academy of Science, 2001, Spash, 2000; Spurgeon, 1992). Secondly, market failure or market imperfection is responsible for distorted market prices that do not reflect the true value of these benefits (Dixon and Sherman, 1990; Salm et al., 2000; Spurgeon, 1992). Thirdly, current valuation methods are based on market prices only, making it impossible to account for benefits that are not quantifiable in monetary forms (e.g., number of endangered species protected, total area of critical habitat protected, environmental knowledge acquire by MPA visitors and the general public). Despite these shortcomings, there is an increasing demand to counter development schemes (e.g., coastal tourism, mariculture, fisheries) that promise large financial returns, with solid arguments based on valuations of the social and economic benefits provided by MPAs. These arguments should help in demonstrating that various

benefits can make MPAs self-financing entities, especially in developing countries, and a truly excellent tool to achieve sustainable development.

It does not matter whether the good or service (benefit) is market or non-market based, the underlying principle of valuation is to try to obtain a sense of people's preferences for the good or service. Economists argue that individuals, not the government, are the best judges of what they want (King and Mazzotta, 2000); thus, the theory of economic valuation relies on individual preferences and choices. Following this line of argument, the economic value of a particular non-market benefit is measured by the maximum amount of other "things" (usually money) that a person is willing to give up to obtain the mentioned benefit (good or service). This is what has been called "willingness to pay" (WTP) (Costanza et al., 1997b; Dixon and Sherman, 1990; Goodstein, 1999; King and Mazzotta, 2000). An alternative way to assess these preferences or choices is by estimating the "willingness to accept" (WTA), which refers to how much a person is willing to be compensated for a lost benefit (Goodstein, 1999, King and Mazzotta, 2000).

In general there are three major accepted approaches to the valuation of benefits in monetary terms: (1) market prices or revealed WTP, (2) circumstantial evidence or imputed WTP, and (3) surveys or expressed WTP. The market price or revealed WTP approach measures the value of those market-related benefits. In other words, the methods grouped within this category are good to estimate direct use values (extractive or non-extractive); therefore, value estimation is easy. For example, with this approach, to estimate the value of fishery and non-fishery benefits we just need to obtain the current

value of, for example, fish in the market or the price paid by a tourist to SCUBA dive within a MPA. Dixon et al. (2000) estimated that revenues from SCUBA diving (a direct non-fishery benefit to humans) in the Bonaire Marine Park were about 4.8 million USD per year. Hodgson and Dixon (2000) estimated gross revenue to fisheries, as a result of MPA implementation, of USD $28 million in El Nido, Philippines. Gonzalez et al. (2002) anticipated that non-fishery benefits (SCUBA dive and cruise activities) represent around USD $200,000.00 y^{-1} to the Punta Frances Marine Protected Area, in Cuba.

The circumstantial evidence or imputed WTP approach values benefits by estimating what people are willing to pay, or the cost of actions they are willing to undertake, for an equivalent benefit obtained in a different setting (if the foregoing is correct, then omit: with the intention of avoiding the adverse effects of a benefit lost). For example, coral reefs provide effective coastal protection from erosion and bad weather. The amount that people pay to avoid coastal erosion in areas similar to those protected by the coral reefs can be used to estimate WTP for the coastal protection services of the coral reefs. This approach uses observable market prices for one good or service (surrogate market goods), that is closely associated with the market-unrelated good or service, to estimate the value of an environmental good that does not have its own price (Dixon and Sherman, 1990). One of the main shortcomings of this approach is that in the majority of the cases no surrogate market goods can be found, therefore many benefits are not valued accordingly or are completely neglected.

Finally, the survey or expressed WTP approach is meant for those goods and services that are not traded in markets, and are not closely related to any marketed good from which a surrogate value can be estimated. This impedes attempts to reveal people's WTP through their market purchases or actions. In these cases, surveys are used to ask people directly what they would pay for a good or service, based on a hypothetical scenario, from which their WTP can be projected. One of the best examples of the application of this approach to value benefits from coral reef biodiversity (ecosystem benefits) is given by Spash (2000). This author undertook a contingency valuation method in two Caribbean countries (Curaçao and Jamaica) and he found that in both countries the total WTP averaged USD $25.00 per person. He also analyzed the motives behind respondent's monetary valuations and found out that lexicographic preferences can be very common and create problems for interpretation of contingency valuation method results. In simple terms, lexicographic preferences exist where respondents are unwilling to accept any trade-offs for the loss of a benefit. In the case of coral reefs it means that survey participants considered that there was no possible compensation for the loss of coral reef biodiversity (for a more complete analysis refers to Spash (2000)).

Table 3 summarizes the three approaches including their particular methods. It also presents an overview of each method and their advantages and limitations. This table graphically expresses what methods are appropriate to value MPA benefits identified in Table 2. As can be seen, valuation methods using the market price or revealed WTP approach can be used to assess the economic value of fishery, non-fishery and some management benefits. On the other hand, valuation methods using circumstantial

evidence or imputed WTP and expressed WTP approaches could be used to value the remainder of benefits identified in Table 2. It is remarkable that the vast majority of MPA benefits appear not to be market-related. According to Tables 2 and 3 only 30% of the benefits can be valued directly based on market prices, while the remaining 70% require the use of surrogate and expressed values. This fact should lead scientists and managers to develop alternative valuation methods that are not based on the dollar-value of benefits and more importantly to conclude that benefit valuation based on market prices only is not a realistic approach to decision support for MPA management.

Given that MPAs are a clear product of a decision-making process, benefit valuation is a very important issue. At the same time the ultimate decision of whether or not to establish a MPA will depend on a variety of factors, the quantified and non-quantified benefits expected from protection, the costs of protection, the potential net benefits for alternative uses of the site, social issues, and so on. Consequently, the need to justify MPAs in social, economic and developmental terms has become almost universal, especially in developing countries, where resource scarcity and poverty make them prone to overexploit marine resources. Therefore, to fully assess the success of MPAs, national governments or any other entities responsible for MPA implementation have to be able to clearly identify all possible benefits that may accrue from the MPA, and from that point clearly state their objectives. It is evident that designating significant areas of coastal regions as MPAs will alter both the kind of benefits (or ecosystem goods and services) provided by the marine environment and the distribution of these benefits among different groups of individuals.

Table 3. Summary of dollar-based valuation methods. Adapted from King and Mazzotta (2000).

Approaches	Methods	Overview	Advantages	Limitations
Market prices (Revealed WTP)	Market price	Estimates economic values for ecosystem goods or services that are market related.	People's values well defined. Price, quantity and cost data are easy to obtain. Uses actual observed data. Uses standard accepted economic techniques.	Market data may not be available for all products. Market imperfections do not reflect true values. Has no account of external effects that affect prices (i.e., seasonal variation). Cannot easily measure large-scale changes that affect supply and demand.
	Productivity	Estimates economic values for ecosystem goods or services that contribute to the production of commercially marketed goods.	Straightforward methodology. Relatively inexpensive. Data readily available.	Only valued resources that can be used as inputs in production of marketed goods. Requires considerable scientific information. May become difficult to apply in certain settings.
	Hedonic pricing	Estimates economic values for ecosystem or environmental services that directly affect market prices of some other good.	Estimates values based on actual choices. Property markets are good value indicators. Property records are reliable. Versatile method. Data easy to obtain.	Only benefits related to housing prices can be measured. Requires people's knowledge regarding environmental attributes. Outside effects influence people choices (e.g., taxes). Relatively difficult to implement.
	Travel cost	Assumes that the value of a site is reflected in how much people are willing to pay to travel to visit the site.	Based on actual people behavior. Inexpensive to apply. Results easy to interpret. Allows for large sample size.	Assumes people travel for just one purpose. Issues such as availability of substitute choices, and opportunity costs limit the analysis. Limited scope and application.
Circumstantial evidence (imputed WTP)	Damage cost avoided	Estimates economic values based on costs of avoided damages resulting from lost ecosystem services.	Provide a rough indicator of economic value (subject to data constrains). Less data and resource intensive. Provide surrogate measures of value for services difficult to measure. Data or resource limitation affects the methods.	Assumes that expenditures fairly reflect value of benefits. Does not consider social preferences. Considers environmental actions and regulations based only on benefit/cost comparisons. The replacement cost considers fully substitution between the market good and the natural resource. To be used only after project implementation and proper assessment of people's WTP.
	Replacement cost	Estimates economic values based on costs of replacing ecosystem services.		
	Substitute cost	Estimates economic values based on costs of providing substitute ecosystem services.		
Surveys (expressed WTP	Contingence valuation	Estimates economic values for virtually any ecosystem or environmental service by asking people WTP directly.	High flexibility. Most accepted to assess Total Economic Value. Results easy to analyze and describe. Widely used, therefore, methodologically proven.	Controversial results. People lack of knowledge of environmental valuation. Survey and questionnaire design problems. Lexicographic preferences. Personal preferences. People behavior.
	Contingence choice	Estimates economic values for virtually any ecosystem or environmental service by asking people to make trade-offs among sets of ecosystem or environmental services.	Allows respondents to think in terms of trade-offs. It is better to estimate relative values than absolute ones. Minimizes biases from open-ended questionnaires. Reduces risk of getting protest bids and symbolic values.	Some trade-off may be difficult to evaluate. Respondent behavior not well understood. Requires more sophisticated statistical techniques. Untested validity and reliability. Expressing answers in dollar values may lead to greater uncertainty.

Chapter IV

Cuban Political and Legal Context

Cuba is the largest island state located in the Caribbean basin, at the entrance of the Gulf of Mexico, south of Florida and east of the Yucatan Peninsula. With a total land area of 110,860.6 km^2 and a population of 11,139,875, Cuba has 5,746 km of irregular coastline with 200 bays, over 200 keys, and nearly 300 natural beaches influenced by the warm waters of the Caribbean Sea and the Florida Strait (*Oficina Nacional de Hidrografía y Geodesia* (ONHG), 2000). Its geographic location and physical shape gives Cuba very distinct features such as remarkable terrestrial and marine resources that need wise management and use.

As in the case of other Caribbean countries, Cuba shares most of the common environmental problems that prevail in this region. For instance, Cuba's coastal zone is subject to population increase as a result of enhanced urban and tourism development. Other coastal uses also jeopardize the integrity of Cuba's natural resources, such as agriculture, industrial development, transportation, and fishing (Monzón, 2001). According to CITMA (1997) and *Dirección de Medio Ambiente* (DMA) (2003), the major environmental problems that affect the Cuban archipelago are: soil degradation through erosion, insufficient draining and salinization, deterioration of human settlements, inland and sea water pollution, deforestation and loss of biological diversity. All of these have prompted governmental concern for the conservation of Cuba's natural

resources and a series of measurements have been implemented, one of them being the establishment of a National System of Protected Areas (NSPA).

Cuba is a republic with a centralized socialist system of government closely identified with the workers (Constitution of the Republic of Cuba, 1976). Administratively and politically, a territorial division created in 1974 divided the country into 14 provinces (Figure 1): *Camagüey, Ciego de Avila, Cienfuegos, Ciudad de la Habana, Granma, Guantánamo, Holguín, La Habana, Las Tunas, Matanzas, Pinar del Rio, Sancti Spiritus, Santiago de Cuba,* and *Villa Clara*), 169 municipalities and one special municipality, *Isla de la Juventud* (Isle of Youth). The capital of the country is *Ciudad de la Habana* (ONHG, 2000).

Figure 1: Map of Cuba.

In Cuba, the government facilitates coherent and effective policies, provides performance of public duties, monitors results and fosters transparency of its work. To do well, it must constantly enhance its own capacity for planning and implementation. It also serves as a facilitator to improve interaction among all the economic and social sectors of the country. Finally, government pushes social reforms and undertakes actions so that society, as a whole, can progress and the well-being of all Cuban citizens is ensured. This is, essentially, the paradigm of a socialist system.

This chapter describes the government structure in Cuba as well as the decision-making system in relation to MPAs, and also provides some insights into the current status of the NSPA in Cuba.

The Organizational Structure of the Government

The unicameral National Assembly of Popular Power (NAPP) and the Council of State (CS) form the legislative branch of the government. The NAPP is the supreme body of the state. It represents and expresses the sovereign will of all the Cuban people. The NAPP is the only body with constituent and legislative power in the Republic. The NAPP is made up of deputies chosen by the free, direct and secret vote of the voters, in proportions and procedures that the law determines. The NAPP chooses, among its deputies, the members of the CS, which is integrated by a President, a First Vice-President, five Vice-Presidents, a Secretary and twenty three additional members. The President of the CS is Chief of State and Head of Government. The CS has to account for all its decisions and activities to the NAPP. The CS is the organ of the NAPP that

represents it between both periods of sessions, executes agreements made, and fulfills other functions as stated in the Constitution.

The Council of Ministers (CM) is the highest executive and administrative organ. The law determines the number and functions of the ministries and central organisms that comprise the CM. The CM consists of the Chief of State and Head of the Government (which acts as President of the CM), the First Vice-President of the CS, the Vice-Presidents, the ministers, the Secretary and other members determined by law. The Executive Committee (EC) of the CM consists of the President of the CM, the First Vice-President, the Vice-Presidents, and other members of the CM as proposed by the President of the CM. This EC can decide on issues pertaining to the CM during the periods between one and another of its meetings. The CM is accountable of its actions and decisions to the NAPP.

At the provincial and municipality levels, the Assemblies of the Popular Power (PP) constitute the superior government bodies in each territory. They exercise state functions in their respective territories and for it, within its competence, and conforming to the law, they govern. Municipal assemblies report of their actions and decisions to provincial assemblies and these last ones do the same to the NAPP.

Municipal Assemblies of the PP direct local economic organizations in order to satisfy the economic, health, educational, cultural, sport and recreational needs of the jurisdiction to which each one extends. For the exercise of their functions, the Municipal

Assemblies of the PP rely on the Popular Councils (PC), the initiative and participation of the population, and act in coordination with various mass and political organizations (e.g., the Cuban Communist Party (CCP), the Communist Youth Union (CYU), the Cuban Women's Federation (CWF), the Committee for the Defense of the Revolution (CDR), and the like).

The People's Supreme Court of Justice and the Popular Tribunals that are established at each territorial level and compose the judicial branches. These are the organs responsible for the administration of justice and law enforcement. The law establishes the main objectives of judicial activity, and regulates the organization of the Courts; their jurisdiction and competence; their powers and the way to exert them; the requirements to select judges, their appointment, and the causes and procedures for their removal.

It is important to consider the role that political and mass organizations play in Cuba. These organizations function as the political vanguard of the population. The political subsystem is comprised of the Cuban Communist Party (CCP) and its youth organization, the Communist Youth Union (CYU). The most important characteristics of the political sub-system are the single political party and the sanctioned powers of the CCP in the Constitution.

The associations and mass organizations are strongly linked to the political system. They consist of organizations representing specific sectors of the population (i.e., students, women, children, and the like). Their principal functions are: to socialize political

decisions and proposals defined by the system, to create mass mobilization, and to act as a vehicle to built consensus among Cubans. These organizations were formed by pre-existent organizations at the beginning of the Revolution in 1959, and adapted to the objectives and conditions of the new political system.

The Policy and Law-Making Processes

Two branches of the Cuban Government contribute to the formulation of national policies: the Executive Branch (President and CM), and the Legislative Branch (NAPP headed by the CS). Cubans are governed at three levels - their national government, their provincial government and their local government, but considering the centralized and mainly vertical subordination of the provincial and municipal government to the national government, almost all policy making processes at each level depend on top level decisions.

The 27 Ministries and 5 National Institutes are responsible for the formulation, direction, implementation and monitoring of national policies in their respective sectors. The NAPP approves national-level policies. Ministries have provincial delegations which are responsible for the policy making process at the provincial level. These policies have to be appropriate to the economic, social and geographic characteristics of each region but, not surprisingly, they are often replicates of the national policy. Provincial Assemblies approve the provincial policies, and Municipal Assemblies do the same at their level.

The policy making process in Cuba begins with recognition of the problem, and is based on analysis of the policy matter and its alternative solutions. It involves consultation with those who have an interest in the matter, including all parts of the administration that may be affected by any proposed solution. It analyzes the impact of the proposed solution, and further assesses the resources that the proposed solution would require, including those needed to implement and/or enforce it.

Policy-makers must be prepared to explain why action is necessary, and why one issue is more important than another competing issue. Policy action also requires public inputs and support or, at a minimum, a working majority of the legislative body. Finally, influence on policy making at each level requires insight into the rapidly changing power relations among principal actors, knowledge of procedures to be followed by decision makers, and information management to reach opinion makers and their audiences.

Cuba's legal system is based on a combination of the long-established Roman civil law and socialist law or Soviet legal system. As part of the civil law system, the use of the law as the primary source of the legal framework is the most important characteristic. The laws are the primary determinant of legal rights and duties. Also, due to the socialist legal system's influences on the Cuban system, the focus is on the dynamics of the legal and regulatory process. This system tends to make the law a guide for governments and regulators.

In Cuba, as in the rest of the world, the making of law is arguably the most important activity of government, and the process is a matter that depends on political will and legal process. Law-making authorities in Cuba are limited by the constitutional distribution of powers. Law-making initiatives are the responsibility of:

- The deputies of the National Assembly of the Popular Power;
- The Council of State;
- The Council of Ministries;
- The commissions of the National Assembly of the Popular Power;
- The National Committee of the Centre of Workers of Cuba, and the National Directions of mass organizations;
- The Popular Supreme Court, in matters related to administration of justice;
- The Attorney General of the Republic in the matters of its competence;
- The citizens. In this case ten thousand citizens with an electoral vote are required to exercise the initiative.

Some underlying principles guide the preparation of the legislation. The main objectives in this process are:

- To ensure that the responsible organs and organisms have the information they need to make sound decisions about proposed laws.
- To outline the relationship among laws and other types of regulations and ensure that they are viewed as products of a continuous process of law making.

- To ensure that proposed laws are properly drafted.
- To make it clear that law-making initiatives can be very complex, and must be properly planned and managed.
- To ensure that Government agents who are involved in law-making activities understand their roles, and have the knowledge and skills to perform their roles effectively.

Cuba's law-making process is based on the rule of law. This means that laws must be made in conformity with the Constitution. The law-making process in Cuba takes place through several legal instruments, in accordance with the Cuban legislative and administrative process. At the top level, laws are presented to and approved by the NAPP, and their implementation offers the highest degree of authority for the measures adopted. A second instrument is the Decree-Law, which may be proposed by individual ministers but, is presented to and approved by the CS. Third in order of authority is the Decree, which is proposed by a single Ministry, but approved by the CM. Last in order is the Resolution, adopted by a Ministry or agency on its own initiative, limited to the ministry or agency itself or to issues within its legislated jurisdiction.

The decision to address a matter through a Law, Decree-Law, or Decree is made by the NAPP on the basis of information developed by the CM and the Minister's departmental directions. The information must be accurate, timely and complete. Usually, Decree-Laws address issues directly connected to a formal Law and the Decrees address issues related to both instruments previously mentioned; their main function is regulatory.

Once a Law has been drafted, read carefully and introduced to the National Assembly by the Legislative Commission of the National Assembly, the Assembly will arrange for its printing and for copies to be sent to the Organs of the Central Administration of the State. This process is known as internal passage. Once the opinions of these organs are given, the Law is reviewed to make sure its wording and content are correct. After that, the process of external circulation starts. This process involves public consultation, depending on the type of legislation that will be introduced. The National Assembly decides the level of public consultation. After that, the new law is ready to be approved by the National Assembly, but its enactment depends on the date of its publication in the Official Gazette of the Republic of Cuba. The process described above is similar to the process for the enactment of Decree-Law and Decrees, but it is important to consider the difference among the competent authorities in each case.

Public participation is an important aspect due to its implication for MPAs selection and establishment. According to the Cuban legal system, MPA proposals go to the CM for final approval, at this level public participation is almost none. It is essential, therefore, to ensure ample and thoroughly public participation during the early stages of the MPA proposal. This task is then responsibility of the agency or state organism which is making the proposal.

Recent Transformations

As can be appreciated from previous sections, Cuba has a centralized government system where decisions, in almost every case, are made at high levels of the government in

response, mainly, to national economic strategies decided by the government on behalf of the people. For many years, Cuban socialism was shaped by a peculiar international context that provided crucial support to Cuba's form of state socialism. The USSR and the Council of Mutual Economic Aid (CMEA) allowed Cuba's socialism to develop in relative isolation from the difficult market forces that drove much of Latin America into a structural crisis in the 1980s, followed by a major era of reform in the 1990s (Font, 1997). However, after the abrupt collapse of socialism in Europe in 1989, the challenge for Cuba in the nineties was perceived as finding ways of re-linking to the world. Several transformations took place that represented fundamental changes, especially in the Cuban economic system. It has been argued that the relative step back in economic openness for the country during the early nineties constituted an historical accident, rather than a deliberate decision (Monreal, 2002). This viewpoint is open to debate, because during the process of Cuba's reinsertion into the world economy the CCP considered the process to be part of a larger effort to implement necessary transformations to sustain the Revolution's socialist essence in conditions imposed by the international context.

One of the first steps in this change was the amendment of the Constitution introduced by the Law on Constitutional Reform, approved by NAPP in 1992. For the purposes of this thesis, the most important amendments are related to the introduction of the sustainability concept into development strategies and the constitutional recognition of the importance of the protection and rational use of Cuban natural resources. Other important changes included opening the economy to foreign capital investment, including expanding the tourist sector in partnership with foreign private capital, legalization of dollar holdings,

and the beginning of the process of limited liberalization of some food and crafts production by private entrepreneurs. Major reforms have been successful in enhancing economic growth, but at the same time have posed new threats to the country's natural resources (Centro Nacional de Areas Protegidas, 2002).

In this context, and after the Rio Earth Conference in 1992, Cuba became a strong supporter and promoter of international legislation for the protection of natural resources. The country has already become a party on the UNCLOS that stipulates rights and duties to protect and preserve the marine environment from pollution and to fisheries conservation and management. It has adopted the principles of the Rio Declaration on Environment and Development and the Agenda 21, particularly the one identified in Chapter 17 of the Agenda 21, which states: *"New approaches to marine and coastal area management and development are needed, approaches that are integrated in content and precautionary and anticipatory in ambit"* (United Nations Conference on Environment and Development, 1992). These legal instruments emphasize the development of a comprehensive legal and management regime for the oceans, respect for environmental standards and provide enforcement provisions to deal with the appropriate use and management of the marine and coastal environment.

There are several examples of Cuban government's will to contribute to international effort in achieving for sustainability. In this regard, the Constitution of the Republic (as amended in 1992) states that:

> ***Article 27**: The State protects the nation's environment and natural resources and recognizes their close relationship with sustainable economic and social development to make human life more rational and to ensure the survival, well being and security of present and future generations. It is the responsibility of proper governmental agencies to apply this policy. It is the duty of the citizens to contribute to the protection of the water, atmosphere, and the conservation of the soil, wild flora and fauna and all the rich potential of nature.*

Cuba has become a state party of the Cartagena Convention, and consequently of the SPAW protocol. It is also a state party of the Ramsar Convention (there exist five officially recognized Ramsar sites in Cuba), the World Heritage Convention, and the UNCLOS. More recently Cuba has taken important tangible steps towards the implementation of the principles of sustainable development as set forth in the Rio Declaration on Environment and Development and the Agenda 21 in 1992. For instance, implementation of a USD $10 million Global Environmental Facility (GEF) project aimed at biodiversity conservation and sustainable development of the Sabana-Camagüey Archipelago. The enactment of CITMA Resolution 111/1996, which regulates the use of biological diversity resources and guarantees the fulfillment of the guidelines, set in the Convention on Biological Diversity.

In 1994 the Cuban government created the Ministry of Science, Technology and Environment (CITMA), with the clear mandate of implementing the sustainable development concept, and developing an appropriate environmental policy based on the new Cuban context. As a result, several environmentally related regulations were adopted. Among the most important ones are regulations for the protection of the coastal zone and the conservation of marine resources (CITMA, 1997).

Policy and Legal Framework

Formally adopted in 1997, the Cuban National Environmental Strategy (NES) is the most important policy document related to the sustainable use, management, conservation and protection of natural resources in the country. Sustainable development, from the point of view of the NES, is development that satisfies the needs of the present, and ensures intra-generational equity without compromising the capacity of future generations to satisfy their own needs (CITMA, 1997).

The NES is a document that identifies the full range of Cuban environmental problems, potential solutions, potential mechanisms to achieve these solutions, and the main actors responsible in the implementation of these solutions. In relation with coastal and marine ecosystems, the NES identifies two main problems: marine water pollution and the loss of biological diversity. It proposes ICZM as the best approach to prevent future deterioration of coastal areas around the country, and implement restoration plans in degraded coastal areas (CITMA, 1997; *Centro Nacional de Areas Protegidas* (CNAP), 2002).

Despite the recognition of only two main problems for the Cuban coastal and marine resources, the NES additionally points out several other important issues concerning the coastal zone. In this regard the NES states:

- The coastal zone is rich in a variety of natural, commercial, recreational, ecological, industrial, and aesthetic resources of immediate and potential value to the present and future well being of the nation.
- Important ecological, cultural, historic, and aesthetic values in the coastal zone, which are essential to the well being of all citizens, are being irretrievably damaged or lost.
- Special natural and scenic characteristics are being damaged by improperly planned development.
- Because of their proximity to and reliance upon the ocean and its resources, the state has substantial and significant interests in the protection, management, and development of the resources of the EEZ. These can only be achieved with the active participation of all stakeholders in all national programs concerning such resources and, wherever appropriate, by the development of the ICZM approach.
- There is a national interest in the effective management, beneficial use, protection, and development of the coastal zone.

The Strategy launched a process of implementing secondary strategies that is expected to continue for years. Following the adoption of the national program, CITMA officials met with other ministries to draft, approve and begin the execution of new strategies for all government agencies with specific environmental objectives.

The NES, both in general terms, and in regard to coastal and ocean issues specifically, shows some weaknesses. It presents environmental issues with very strong sectoral

perspective. Coastal zone concerns are only addressed in one paragraph, following the previous sectoral point of view, without any specific reference to the importance of integration among land, water and atmosphere environments. This could be paradoxical, if we take into consideration that the NES is the most important Cuban policy document that calls for ICZM approach to manage coastal resources in the country. The absence of higher management capacity, and of a comprehensive rationale for the need of an integrative approach to coastal zone management are the most relevant shortcomings. Also, considering the generic treatment of coastal and ocean issues, the NES is a general document that in reality does not say much. Mistakes and shortcomings are due mainly to insufficient environmental awareness, knowledge and education (Monzon, 2001).

Cuban coastal areas remained largely without management legislation until 1981, when Law 33/1981 Environmental Protection and the Rational Use of Natural Resources was enacted. The Law 33/1981 represented an early and important normative expression of the principles of Cuban environmental policy, which established the basis for the development of a national legal framework in this area. Despite being inclusive in its objectives, this law was short on implementation, due to the fact that the complementary legislation necessary for the enforcement of Law 33/1981 (Decree-Law 118/1990) was passed in 1990, nearly ten years after the enactment of Law 33/1981. However, due to this early initiative, some advances in the coordination of agencies with disparate environmental responsibilities in Cuba occurred during the 1980s. Nonetheless, the absence of a proper legal and policy framework for ICZM impeded the achievement of earlier results.

Internally, Cuba was experiencing obvious coastal problems and development pressures from investment in tourism and mining (Cruz, 1998). At the same time, Cuba was participating in international agreements calling for increased coastal management efforts and coastal development regulations (Dirección de Medio Ambiente, 2003). In this context, the conditions of economic and social development demanded a legal framework more in line with the current situation. Cuba now faces an economic crisis with gradual introduction of market oriented reforms, the development of careful decentralized initiatives in several sectors, and the desire to pursue sustainable development. Therefore, Law 33/1981 needed to be replaced by a legal instrument that adequately reflected requirements for environmental protection and the attainment of sustainable development. The response was development of Law No. 81/1997, and also known as the Environmental Law.

CITMA officials, together with other ministries, interested agencies and local government, worked for more than two years to produce Law 81/1997. This law updated the legal principles, objectives and basic concepts of Cuba's environmental policy; institutional frameworks and the tools for their implementation; the powers, functions and duties of the state agencies and bodies; and, in general, the rights and obligations of natural and legal persons. Law 81/1997 is very ambitious in its goals and its details. Its 163 articles cover issues related to air, water, waste, noise, toxic substances, historic sites preservation, biological diversity, national parks, forests and wildlife refuges, coastal zone protection, education, research and technology, and environmental impact assessment and planning among others. Law 81/1997 recognizes the importance of

rational and sustainable use, and adequate protection of natural resources in Cuba and makes clear reference to the necessity of establishing a NSPA.

Having set the strategy and enacted general guidelines for the sustainable use of Cuba's natural resources in Law 81/97, more specific pieces of legislation were needed to address marine and coastal issues. In this regard, two legal instruments are considered most important. Firstly, Decree-Law 201/1999 established the NSPA, specified regulations regarding its administration and control, defined the PA categories for Cuba, and regulated the level and type of uses allowed within a PA's limits. Secondly, Decree-Law 212/2000, on the management of the coastal zone sets provisions for the appropriate management of the coastal zone, and demonstrates Cuba's commitment to ICZM (CNAP, 2002).

Decree-Law 212/2000 addresses the difficult issue of what the coastal zone is. This regulation uses a substantive definition coupled with references to mobile boundaries, depending on the type of coast. The term "coastal zone" means, under article 2 of Decree-Law 212/2000, the maritime-terrestrial line of variable extension, in which the atmosphere, water and land converge through natural processes. Land-sea-air integration is seen as a dimension, which is of special importance, thus, a flexible delineation of the extent of the coastal zone is provided, depending on each type of coast.

Decree-Law 212/2000 established free, public use of the coastal zone, but also imposes limitations on the rights to use it. These limitations are imposed on uses that require

infrastructure which imply alteration of the coastal ecosystem. This Decree-Law identifies and defines the components of the coastal zone, e.g., coastal wetland, beach, dune, barrier island, reef, estuary, and the like. It also describes what constitutes permissible land and water uses within the coastal zone, identifies those who have a direct and significant impact on coastal waters, and inventories and designates areas of particular concern within the coastal zone. It also sets use priorities in particular areas, and describes the management instruments necessary to carry out any project in those areas.

A key aspect of Decree-Law 212/00 is that it also deals with conflict resolution occurring in the coastal zone. The Decree-Law clearly recognizes the fact that a crucial function of ICZM legislation is to create institutional arrangements and establish procedures which, firstly, reduce the potential for conflict and, secondly, facilitate the resolution of conflicts which do arise (Sorensen, et al., 1990; Cicin-Sain and Knecht, 1998). Under this Decree-Law, the use of CITMA as a conciliation institution makes it possible to avoid the use of courts to resolve conflicts among coastal zone uses and users (Monzón, 2001).

In this author's opinion, the main shortcoming of this Decree-Law 212/2000 is that it establishes the ICZM approach, but it does not provide any definition of ICZM for the Cuban context. The overall aim of ICZM is to ensure that development in the coastal zones, a common heritage of the nation, is regulated in such a way as to benefit the Cuban people, while safeguarding the intrinsic environmental features and ecological processes of the coast. But, even when the NES deals with this issue, or refers to this

approach, it does not mention this definition, which in practice is not easy to understand or interpret. Therefore, in the absence of a definition of ICZM for the Cuban context, this integrative approach may be interpreted differently by stakeholders setting the stage for conflicts to come about.

Despite any shortcomings Decree-Law 212/2000 constitutes a fruitful governmental step toward sustainable development. It includes important principles such as: integrated management, sustainable development, the precautionary approach and public involvement. It also looks at coastal ecosystems as a whole, not just as single species or organisms or single areas or types of coastal resources. More importantly, this Decree-Law brought order to the dispersed and overlapping jurisdictions in Cuban's coastal zone. For the first time, responsible institutions are identified and specific tasks assigned to them.

A large variety of legislative instruments directed toward particular sectors, as well as some specific coastal zone management issues are in force in Cuba. They include regulations regarding property rights, environmental offences, specific resources protection, and the like. Due to the nature of this thesis these legal instruments will not be further analyzed, except for Decree-Law 201/1999, which will be considered in the next section.

Management and Decision-Making Process in Regard to Marine and Terrestrial Protected Areas in Cuba

The establishment of PAs in Cuba dates to 1930. At that time the terrestrial National Park "*Sierra del Cristal*" was established in the former province of Oriente under Presidential Decree 487/1930 (CNAP, 2002). Later, under Presidential Decree 803/1933, the government created the *Ciénaga de Zapata* National Refuge of Fishing and Hunting in the province of Matanzas. This legal instrument banned all fishing and hunting activities in this productive area. A few years later, in Presidential Decree 1370/1936 instituted a National Reserve for Flamingos in the province of Camagüey that also included adjacent keys and islets (CNAP, 2002). Of these three areas, two included some marine components. These are the Ciénaga *de Zapata* National Refuge of Fishing and Hunting and the National Reserve for Flamingos. The former is the biggest swamp system in the insular Caribbean, one which was recently (2001) declared as a Ramsar site. The second is the most important nesting area for Flamingos in the Caribbean, and is also a Ramsar site. In general terms, it can be said that these initiatives lack an integrative approach, the management objectives were very narrow and single purpose oriented.

In 1959, after the triumph of the revolution, the new Cuban government enacted Law 239/1959, giving to the Department of Forest Protection the responsibility to protect, conserve and enhance our forest resources. In article 20 of Law 239/1959, nine terrestrial national parks were created across the country, banning the destruction of flora and fauna. Later on, under Resolution 412/1963, the newly-created National Institute of Agriculture Reform created five Natural Reserves: El Veral and Cabo Corrientes in Pinar

del Río province, Jiguaní and Cupeyal del Norte in the former province of Oriente, and Cayo Caguanes in the North of Sancti Spiritus province (CNAP, 2002). These five natural reserves are considered pioneers in the Cuban efforts to protect and conserve natural resources through the use of PAs. According to CNAP (2002), they constitute the first official Cuban PAs.

During the 1970s and 1980s the Cuban economy experienced accelerated development, and the basis for better management of its natural resources began to mature. In this regard Mr. Kenton Miller's visit to Cuba in 1973 was very important. His advice helped to increase interest in implementing PAs as management options for our developing economy (CNAP, 2002). In 1975 a total of one hundred natural areas were proposed as terrestrial PAs.

During the 1980s, the Cuban PA initiative gained momentum thanks to the work done by different agencies and organisms of the state administration. Among these should be mentioned the National Commission for the Protection and Wise Use of Natural Resources, the Institute of Planning, the Institute of Ecology and Systematic, and the Institute of Geography. In 1989, a series of participatory workshops started to take place, aiming at designing and implementing a NSPA in Cuba. These workshops were organized by the CNAP and included all parties interested in establishing, operating and controlling marine and terrestrial PAs (CNAP, 2002). The NSPA constitutes an interconnected system, methodologically directed and controlled by CNAP. The system was design to truly represent all natural values of the country. The NSPA has been

integrated, and complemented with national planning strategies, and its financial sustainability has been ensured through national government funding and external (international) sources of funds.

The implementation of the NSPA is through programs that look at fulfilling the objectives of the NSPA. These programs have been organized in a systemic fashion aiming at complementing tasks with other management programs that are in effect (e.g., Biological Diversity National Program). The programs that compose the NSPA are:

- Coordination Program.
- Legislation Program.
- Planning Program.
- Institutional Control Program.
- Protected Areas Administration Program.
- Protection Program.
- Human Resources Development Program.
- Resource Management Program.
- Invasive Species Program.
- Promotion and Environmental Education Program.
- Public Use Program.
- Research and Monitoring Program.
- Sustainable Use and Local Communities Program.
- Financial Sustainability Program.

Each of these programs has specific objectives and tasks, and many of these tasks are horizontal and trans-sectoral in nature. This implies that in order for the system to work, efficient coordination between all interested parties should exist, to avoid duplication and overlapping of functions. It is notable that in the NSPA there is no clear reference to an evaluation program that provides assessment, in general terms, of how well the system is working. This author considers this as the main weakness of the system. The research and monitoring program mentioned before does not cover this aspect.

The NSPA is implemented by the coordinated functioning of many internal and external actors. Among the internal actors are: CNAP, National Enterprise for the Protection of Flora and Fauna, Local Popular Power, Forestry protection, Fisheries Regulation Office, CITMA Delegations in each territory, local communities, and the like. The external actors are several ministries, research centers, museums, universities, non-governmental organizations, and the like. The NSPA is affected by many factors that may play a key role in its functioning and development. Most of these concern the NSPA mandate and jurisdiction, therefore the system can do nothing to change them. These factors are:

- Country's socio-economic model.
- Country's international relations.
- Tourism development policy
- Agricultural and forestry development policy.
- Mining and Energy development policy.
- Fishing development policy.

- Environmental policy and legislation.
- International legislation.
- Environmental education policy.
- Public influence.

In this author's opinion this is a major drawback for the system, because a significant change in any of these factors my render the system useless. This author found no reference to alternative measures that could overcome such a change in the document that describes the NSPA (CNAP, 2002).

The 1990s have been a real departure for the National System of Protected Areas in Cuba. With the creation of CITMA in 1994 and CNAP a year later, the country finally attained the administrative infrastructure needed to design, implement and control the NSPA in Cuba. Together with these two institutions, a very important piece of legislation came at the end of the decade. It was Decree-Law 201/1999.

Decree-Law 201/1999 sets the legal regime for the NSPA (terrestrial and marine) in Cuba. This includes all regulations for use, control, management, funding, and administration. The decree also establishes the Cuban PAs categories, and regulates the granting of authorization to develop economic activities within PAs (Decree-Law 201/1999). According to Decree-Law 201/1999, a PA is a portion of the national territory that has been declared according to existing legislation, and incorporated in the national planning system. The area should have ecological, social, cultural or historical relevance

to the nation, and might also have international importance. The area should be managed efficiently to ensure the protection of biodiversity and the sustainable use of natural, cultural and historic resources for the well-being of the Cuban people.

Cuban PAs have been grouped into eight categories that resemble those of the WCU (Table 4). These categories are set out consistently with the Cuban socio-economic context using scientific criteria and ensuring agreement among all stakeholders. There is a gradient of use and human intervention in the Cuban categories. For instance, no human intervention, except for undertaking scientific research, is allowed in a Nature Reserve, whereas more use and management occur in the subsequent categories.

Table 4. Cuban categories of Protected Areas and their World Conservation Union (WCU) counterparts.

Cuban categories	WCU categories
Natural Reserve	Ia
National Park	II
Ecological Reserve	II
Outstanding Natural Element	III
Managed Floral Reserve	IV
Fauna Refuge	IV
Protected Natural Landscape/Seascape	V
Protected Area of Managed Resources	VI

Figure 2 depicts the Cuban governance structure as well as the three possible pathways by which a MPA proposal can be submitted for governmental approval. As it can be seen, there is a bottom-up approach that starts at the municipal level and goes all the way up passing through the provincial and national levels until it reaches the CM, which is by law the state entity responsible of approving or not the designation of a Cuban area as a MPA. This bottom-up path, although possible to occur, is not very common. Another

possible way could be from the provincial administration up to the CM. This is more likely to occur because at the provincial level there are representations of ministries that hold stakes in nature protection and sustainable resource use, therefore most of the proposals come from these representations. A third, and fastest, way could occur exclusively at the national level. Regardless of the paths, all proposals should go to CITMA for further elaboration aimed at reaching compatibility among all interested parties. The amount of time needed to have a proposal approved is variable and will depend on national development priorities, economical and political issues.

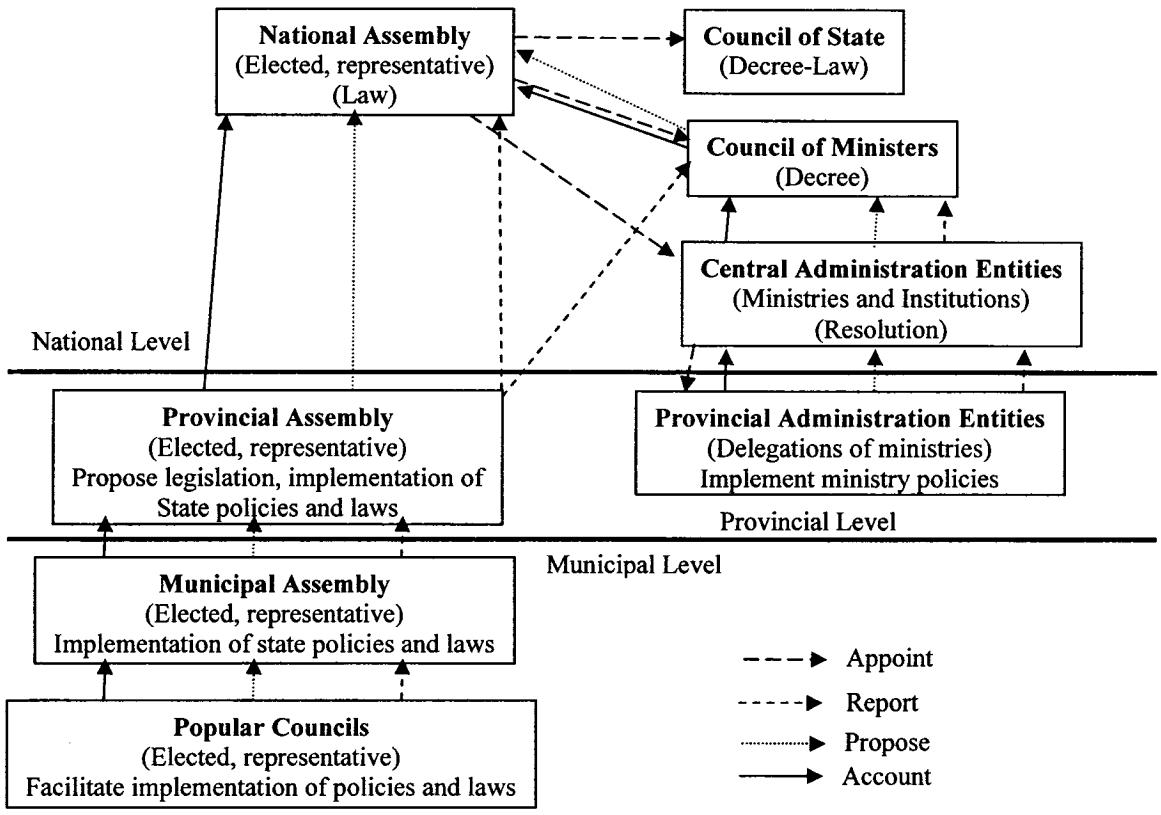

Figure 2. Cuban governance structure

Cuban MPAs still remain behind their terrestrial counterparts in terms of governmental recognition, public acceptance, scientific knowledge, implementation and management. According to Estrada et al. (2003), it was not until 1995 that the marine component of the NSPA gained recognition as a vital part of the system. The Instituto de Oceanología (1995) proposed 18 marine areas as fishing reserves. Out of this number, 15 are currently included within the NSPA. Parallel to this, the Ministry of Fishing Industry (MIP), through its Fisheries Regulation Office (FRO), started to declare Areas under Special Regime of Use and Protection (ASRUP), also called Fishing Reserves. Essentially, these areas act as MPAs because fishing is not allowed within their limits or only takes place under particular conditions.

The marine environment was finally included as a sub-program within the NSPA during the Third National Protected Areas Workshop in 1998. After this meeting, MPAs in Cuba gained momentum and several proposals were sent for approval to the CM. The first official group of Cuban PAs was formally declared by the CM in its Agreement 4262/2001. This agreement included a total of 32 PAs out of which 18 were MPAs. Three other MPAs have been declared under different bodies of legislation. A second group of 23 PAs, where the marine component prevails, is under consideration for approval. Currently there are 21 official MPAs in Cuba, with 13 more to come in the near future. These 21 MPAs cover 3.51 % of the insular shelf. When the 13 new areas come into operation, some 10.73 % of the insular shelf will be protected. The NSPA includes a total of 108 MPAs, covering 25 % of the insular shelf (CNAP, 2002; Estrada, et al., 2003).

Chapter V

Punta Frances Marine Protected Area. Case Study

Study Area

Out of the 13 MPAs still seeking governmental approval, one will be the subject of analysis in this chapter. It will be called Punta Frances Marine Protected Area (PFMPA), although officially it is considered an Area under Special Regime of Use and Protection (ASRUP) (Resolution 560, MIP, 1996). After its eventual approval by the CS, it will become the Punta Frances National Marine Park (PFNMP).

The PFMPA is located at the southwest end of the Isle of Youth, specifically on the Carapachibey peninsula. It stretches from what is called Punta Pedernales to Cabo Frances (Figure 3). The PFMPA encompasses an area of 4,610 ha, of which 1,596 ha represent land and 3,014 ha are ocean (CNAP, 2002).

Physical Features

The terrestrial portion forms a long and narrow piece of land whose north coast is surrounded by the rich and shallow waters of the Siguanea Gulf, it constitutes a well-developed mangrove system dominated by red mangle (*Rhizophora mangle*). The submerged part of this bay is characterized by muddy and sand-muddy bottoms covered by sea-grass beds, mostly seaturtle grass (*Thalassia testudinum*) and manatee grass (*Syringodium filiforme*). Several high salinity coastal lagoons exist, and provide

important wetland habitats for birds and other species, particularly in association with adjoining mangrove systems.

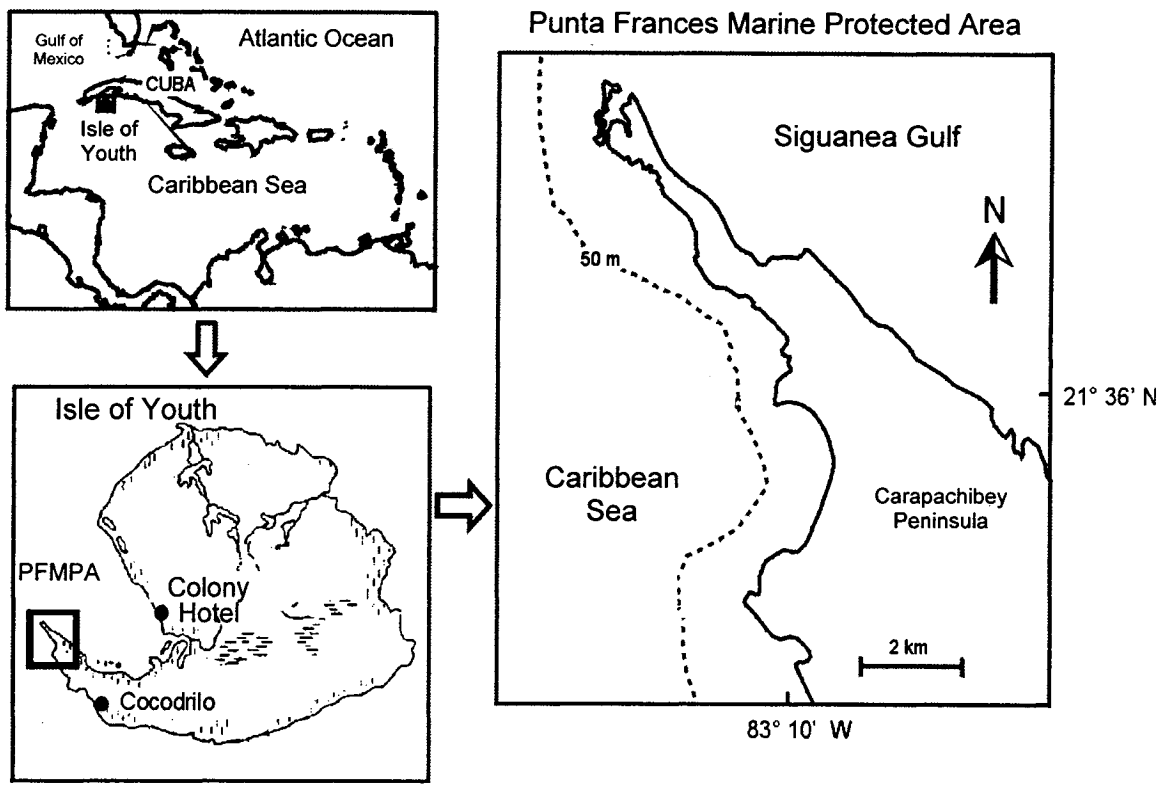

Figure 3. Map showing study site.

The West shore is bordered by the Caribbean Sea, and is dominated by limestone formations of variable height, alternating with sandy beaches. The main part of the subtidal area is represented by coral reef formations that reach their maximum development at 15 m depth, close to the end of the insular shelf (drop off). Between the shore and the drop off there also are extensive areas of sea-grass beds, dominated by sea turtle grass (*Thalassia testudinum*), as well as sandy areas punctuated with patch reefs

and coral heads. There is also a small but well-developed fringing reef that runs parallel and close to shore (de la Guardia et al., 2004a).

Bathymetry

Much of the western side of the study area is characterized by its distinct near-shore continental shelf break with water depths rising rapidly from 400 m in depth to 30 m before emerging onto the narrow fringing barrier reef and reef lagoons, where water depth is generally less than 10 m.

Tides

Tidal range at Punta Frances is minimal, ranging from 40 to 60 cm, and it is semi-diurnal.

Water Quality

Water quality is good due to a general lack of pollutants and turbidity; transparency is high at 70 % to 80 %. Salinity changes throughout the year from 37 p.p.t. in August to 38 p.p.t., coinciding with the wet and dry seasons (Vrba and Drovak, 1967).

Oceanic Currents

Tidal currents are very weak because of the minimal tidal range. Dominant ocean currents flow from north to south at an average speed of 25 cm/s. Spring southerly winds bring an increase in turbidity to the Punta Frances area.

Fresh Water Input

The only known sources of underground fresh water occur very close to the shore at Caleta Lugo and at Punta Pedernales, before diverting to the east in Puerto Frances. There are no perennial or permanent fresh water courses in the Punta Frances area.

Geology

The geologic origins of the area date back to the Quaternary period of 60 to 65 million years ago. The area is characterized by underlying rocks of limestone, dolomite and sandstone, which contribute to variations in marine and terrestrial habitats.

Climate

Temperature

Punta Frances enjoys a climate highly conducive to recreation and tourism pursuits. Temperatures vary from an average of 22.4°C in winter to an average of 28.7°C in summer. Water temperatures are high, with a mean of 29°C in the summer and 25°C in winter.

Precipitation

Annual precipitation ranges between 590 mm and 1056 mm per annum, with the rainy season stretching from June to September. Humidity is high at an average of 80 %.

Winds

Winds are generally mild, and originate from the east throughout the year at an average speed of 9.4 km/hr. In spring, strong winds from the south provoke increasing water turbidity. During the hurricane season (June-November) strong cyclonic winds may affect the area.

History Reviewed

Punta Frances at Isle of Youth (Cuba) is an example of a MPA established on the basis of economic interests. Given its remarkable attractiveness above and below water, near-pristine status, and established SCUBA diving facilities (the Colony Hotel and a Center for the treatment of SCUBA-dive-related diseases), the place became the most important SCUBA-dive spot in Cuba. According to Kennedy and Williams (2004) the PFMPA ranks among the sixty top dive locations in the world and one of the best in the Caribbean.

This area had been used mainly for fishing purposes until 1976, when some international tournaments on underwater photography took place. Since then, the PFMPA has been primarily used for SCUBA diving, and 56 diving sites were set and marked with buoys. Later in 1996, the area became a new tourist attraction with the arrival of large cruise ships that bring more than 400 tourists per week. Also, some industrial and subsistence fishing takes place right on the boundaries, or even within the area. Fishermen use spear

gun, hook-and-line and large, non-selective fishing gears that remove large quantities of fish. Fishing is believed to be inflicting environmental damage.

The coincidence of these conflicting activities engendered arguments and legal controversies between the Ministry of Tourism (MINTUR) and MIP (the main users of the area), ones which remain some 20 years later. The lack of a proper regulatory body was, in this author's opinion, the main reason why this problem was not solved in a legal manner (note that the Protected Areas Decree-Law and the Coastal Zone Decree-Law were enacted much later, in 1999 and 2000 respectively). Nonetheless, some efforts were made to control this situation, and in 1985 the MIP enacted Resolution 273/1985, which banned fin fisheries within the area, but did nothing to control the use of large-non selective fishing gears nearby. The controversy remained until 1996, when CITMA appointed a multidisciplinary team to reach a final solution to the problem. The team consisted of specialists from CNAP, the tourist agency Puerto Sol (former agency in charge of the Colony Hotel), the Fisheries Regulation Office at the MIP, the Ministry of Agriculture (MINAGRI), and the Provincial Delegation of CITMA on the Isle of Youth. The team recommended the following actions:

- To officially declare Punta Frances a National Marine Park and to formulate its management plan.
- To review the current fisheries regulations for the area, seeking to ban all fin fisheries within it.

- To produce a diving code to be used by tourist and tourist operators aiming at reducing SCUBA-dive impacts on coral reefs.

Most of the previous actions have already been accomplished and Resolution 560/1996 is an example of governmental will to solve the problem. The first recommendation has not been implemented yet, because it has been waiting for governmental approval for more than 8 years. This situation has led to a situation where the main stakeholders (CITMA and MINTUR) still do not trust each other and responsibilities for park use, maintenance and protection still remain unassigned. This puts the PFMPA's natural resources conservation in potential danger. Nevertheless, there is full time representation from the CITMA Delegation in the PFMPA on the Isle of Youth, and it has an operative management plan.

An important aspect of this MPA is that there is no human settlement within its boundaries and no coastal infrastructure, with the exception of some tourist facilities. This fact, together with the remote location of the PFMPA, might constitute advantages for management and control purposes, because it is easier to implement a management measure and control it if humans are not included. The area can only be visited by boat or by car with former being the most common transportation of MPA users. Either way an entry permit must be obtained from the Coastguard. In addition, if you take into account that in Cuba there is a strict control on who goes aboard, then human access to the MPA is difficult. As a result, the area is mostly enjoyed by foreigners (SCUBA and cruise ship tourists), while nationals remain excluded. Unfortunately this has been the procedure

since 1976, and has resulted in separation between nationals and the MPA. The best example of this can be found at the Cocodrilo community. This community is located approximately 20 km from the PFMPA. More information about this community will be provided later in this chapter.

Stakeholders

Human uses in the PFMPA range from non-extractive (tourism, scientific research) to extractive (fisheries); therefore, several stakeholders accrue benefits from this area. Main governmental stakeholders are: MINTUR, MIP, Ministry of Transportation (MITRANS), CITMA, Ministry of Interior (MININT), Ministry of Higher Education (MES), and MINAGRI. Other stakeholders are local inhabitants of the Cocodrilo community and the tourists who visit the area. Stakeholders show different interests, levels of activity and jurisdiction over the area. For instance, MINTUR and MITRANS undertake the bulk of activities, and also obtain the largest portion of economic benefits. Local inhabitants (from Cocodrilo) have been almost completely excluded from accruing direct economic benefits from the MPA. A brief description of each of these users is given below, as well as their level of participation in the PFMPA activities.

Ministry of Tourism (MINTUR)

Through Decree-Law 147/1994 on the modification of the bodies of the Central State Administration, MINTUR was created to be responsible for the guiding functions of

political direction, regulation and control of the tourism sector as well as enterprise activities within it.

MINTUR is the state organization ruling the tourism system, while other entities in the country participate. MINTUR creates policy, and monitors its implementation in entities which directly manage the properties of the sector. Its current strategic objectives are the following:

- Design and develop more efficient marketing of the tourist product
- Increase and diversify a competitive tourist industry
- Recover and expand room capacity
- Increase the level of economic efficiency in the tourism system
- Develop and advance computer science and communication systems
- Incorporate more foreign capital into the development of the sector
- Forecast tourism development up to the year 2010, and adjust organizational structures to meet the forecast

In order to develop tourism in Cuba, a system of entities formed by hotel and extra-hotel entities has been structured. As well, autonneomous entities are in charge of supporting functions for the other tourist organizations. Among them is the tourist group called Cubanacan. This group is responsible for the development and marketing of nautical business in its different specialties, such as diving, cruising, yachting, and others. This group operates the International Scuba Diving Centre "El Colony", and could be

considered the main user of the park, in terms of the number of tourists brought to the area and revenues generated from park usage.

Ministry of Fishing Industry (MIP)

The MIP is responsible for directing, implementing and monitoring state and government policy related to the exploration, conservation, extraction, cultivation, processing and marketing of fishing resources and the merchant fleet. Fisheries in Cuba are completely state owned and controlled. This allows for better control and management of our fishery resources. All fishermen in Cuba are organized in fishing cooperatives spread throughout the archipelago. Each of these cooperatives is responsible for the exploitation of a portion of the island shelf. These organizations ensure fishermen with secure employment and a salary throughout the year, regardless of whether the fishing season for a particular species is open or closed.

Three fishing cooperatives accrue benefits from the PFMPA. They are the "Cristobal Labra" Fishing Cooperative in Cocodrilo, "Epicol" in Coloma, and "Pescaisla" in the Isle of Youth. Among these three, Cocodrilo is the one with fewest resources and fishing capacity, therefore their fishing effort exerted near the PFMPA is considered insignificant, in comparison with Epicol and Pescaisla. Also fishermen from Cocodrilo target sea turtles as their main source of income. This situation is considered an exception in Cuba, because this type of fishery is banned in the whole country. There is no commercial finfish fishing within the PFMPA, only lobster is allowed to be harvested

using few traps. The main impact that the fishing industry is thought to be having on the PFMPA is extraction of large quantities of adult fish that wander out of MPA or swim by it.

Ministry of Transportation (MITRANS)

MITRANS is a body from the State Central Administration, under the CM. Its functions are to manage, perform and control the State and Government policy as to land, maritime, and river transport, their auxiliary and connected services, as well as civil maritime navigation. MITRANS is responsible for offering a safe and environment-friendly transport system, one that meets demands, and be one that is most efficient for the domestic economy, the society and international trade.

MITRANS is represented at the PFMPA through an important tourist company, is the Italian-Cuban enterprise known as Cubanco S.A., that has increased its stakes in the PFMPA. This enterprise specializes in operating cruise ships. Since 1998, large cruise ships arrive in the area twice a week. Each ship brings more than 400 tourists who use the area for leisure and recreation (beach activities, terrestrial excursions, SCUBA diving, snorkelling, and the like).

Ministry of Science, Technology and Environment (CITMA)

CITMA was created by the same Decree-Law that created MINTUR in 1994. It is responsible for directing, implementing and monitoring state and government policy

related to science and technology, environmental policy and the peaceful use of nuclear energy, promoting its systematic integration into the country's development, as well as regulating biological security and monitoring chemical substances controlled by the convention on chemical weapons.

Some of its most important functions are related to the elaboration and presentation of strategies and policies to be considered and approved by the Council of Ministers in matters pertaining to science, technology and other matters concerning protection of the environment and rational use of national resources, integrating them with national sustainable development. These policies are prepared with the participation of the scientific community, and other agencies for technology development, and are the foundations of the approved National Plan of Science and Technology. The plan includes objectives, priorities, research themes and programs to be carried out.

At the national level, CITMA is composed of several agencies or offices that undertake the main tasks. They are: Nuclear Energy, Science and Technology, Environment, and Information. Within the Environment agency there is the National Centre for Protected Areas. This centre is responsible for the organization, designation and implementation of a national system of protected areas. It guarantees the proper direction, management and control of protected areas. Obviously this centre hold stakes in the PFMPA and together with the Provincial Delegation of CITMA on the Isle of Youth, represent this ministry's interests in the PFMPA.

Currently there is an ecological station at the PFMPA. This facility is operated by the CITMA Delegation, although the real owner is Cubanco S.A. CITMA workers use the facility for living, and as a base for controlling the area and undertaking some monitoring activities.

Ministry of Agriculture (MINAGRI)

MINAGRI is responsible for directing and controlling agricultural and forest production in Cuba, with the objectives of satisfying the population's needs, and meeting demands from other industries, such as tourism, substitute imports and enhance exports with maximum efficiency, promote rational use of the earth, water and technical means available, preserve soils, and genetic funds of the species of domestic and wild fauna.

The main stake of this ministry in the PFMPA is represented by the enterprise "Flora and Fauna". This enterprise is responsible for conserving all natural resources on the land side, and for enforcing the law regarding use and exploitation of forest resources.

Ministry of Interior (MININT)

The Ministry of the Interior is the body of the state central administration responsible for directing, implementing and monitoring the application of state and government policy related to the organization, maintenance and defense of the country's security and internal

order. This ministry is responsible for controlling and granting access to the PFMPA, and for the protection of the national integrity in the area.

Ministry of Higher Education (MES)

The Ministry of Higher Education is the body responsible for directing, implementing, and monitoring state and government policy related to the third and fourth levels of education. The MES directs, controls and executes policies regarding university teaching, at undergraduate and graduate levels. The Cuban system of higher education guarantees free university studies to all students who finish grade twelve or equivalent level and pass the admittance exams.

The Center for Marine Research at the University of Havana is one of the institutions that undertake scientific research at the PFMPA. This center is devoted to teaching and research; and for more than 6 years, it has been working in the PFMPA.

Human Uses of the Punta Frances Marine Protected Area

Human uses of the PFMPA are variable and although they do not appear to be contradictory, current changes in patterns and magnitudes are putting pressure on the area. Human impacts on the PFMPA's natural resources could negatively affect its sustainability in the long-term.

A total of twenty-three human uses were identified and classified according to the Taxonomy of Ocean Uses developed by Chircop (1996). Several authors have made similar efforts to create a typology of coastal and ocean uses. One of the first attempts was made by Couper (1983) with his Marine Interaction Model. In his work, Couper described eight main categories that encompass ocean and coastal uses. Vallega (1992) made a similar effort, but extended the number of categories to sixteen. Both authors put more emphasis on the marine side, leaving the coastal uses not well described. On the other hand, Sorensen and McCreary (1990) and Pido and Chua (1992) emphasized the land, describing eleven and ten categories respectively. Cicin-Sain and Knecht (1998) produced a more comprehensive classification of coastal and ocean uses, describing ten categories and fifty-three activities or human uses.

Despite a few limitations in Chircop's taxonomy of ocean uses, I consider it most appropriate for classifing human uses at the PFMPA. The hierarchical classification proposed by Chircop allows for a more suitable accommodation of the different human uses identified at the PFMPA (Figure 4), including some non-consumptive uses which were added to Chircop's taxonomy.

Four uses were identified under the resource use category. Two of them pertain to extractive use of living resources (subsistence and industrial fisheries) and the remaining two fall under non-extractive use of living and cultural resources (conservation and archeology, respectively). A more precise description of these uses follows.

Subsistence fisheries: Carried out by local inhabitants and other people who visit the area. Despite the complete ban of this type of fishery in the area, its control is difficult to enforce. The area staff lacks the necessary infrastructure and resources to undertake this labor. Nonetheless, levels of this type of illegal behavior are considered low.

Industrial fisheries: Performed by the fishing cooperatives that belongs to the MIP. Within the area, only spiny lobster (*Panulirus argus*) is licit to catch, although some bait fish (mostly engraulids) is also caught to support skipjack tuna (*Katsuwonus pelamis*) fisheries in nearby oceanic areas. It should be mentioned that extensive industrial fisheries take place very close, or even within the area limits. This situation has been subject of analysis between the PFMPA staff and fishermen, and there has been no final solution.

The main issues here are twofold. First there are problems with area delimitation. The PFMPA limits depicted by MIP Resolution 560/1996 do not coincide with limits stated by CITMA officials (Figure 5). Therefore, it becomes difficult for fishermen to distinguish when they are operating inside or outside the PFMPA. This issue was demonstrated when fishermen were asked about limits location. They had different opinions and references points.

It was a general belief, though, that the PFMPA did not include any portion of the Siguanea Gulf. This in reality is not correct, because both sets of limits consider part of the Siguanea Gulf to be inside the PFMPA. It should be mentioned that the most

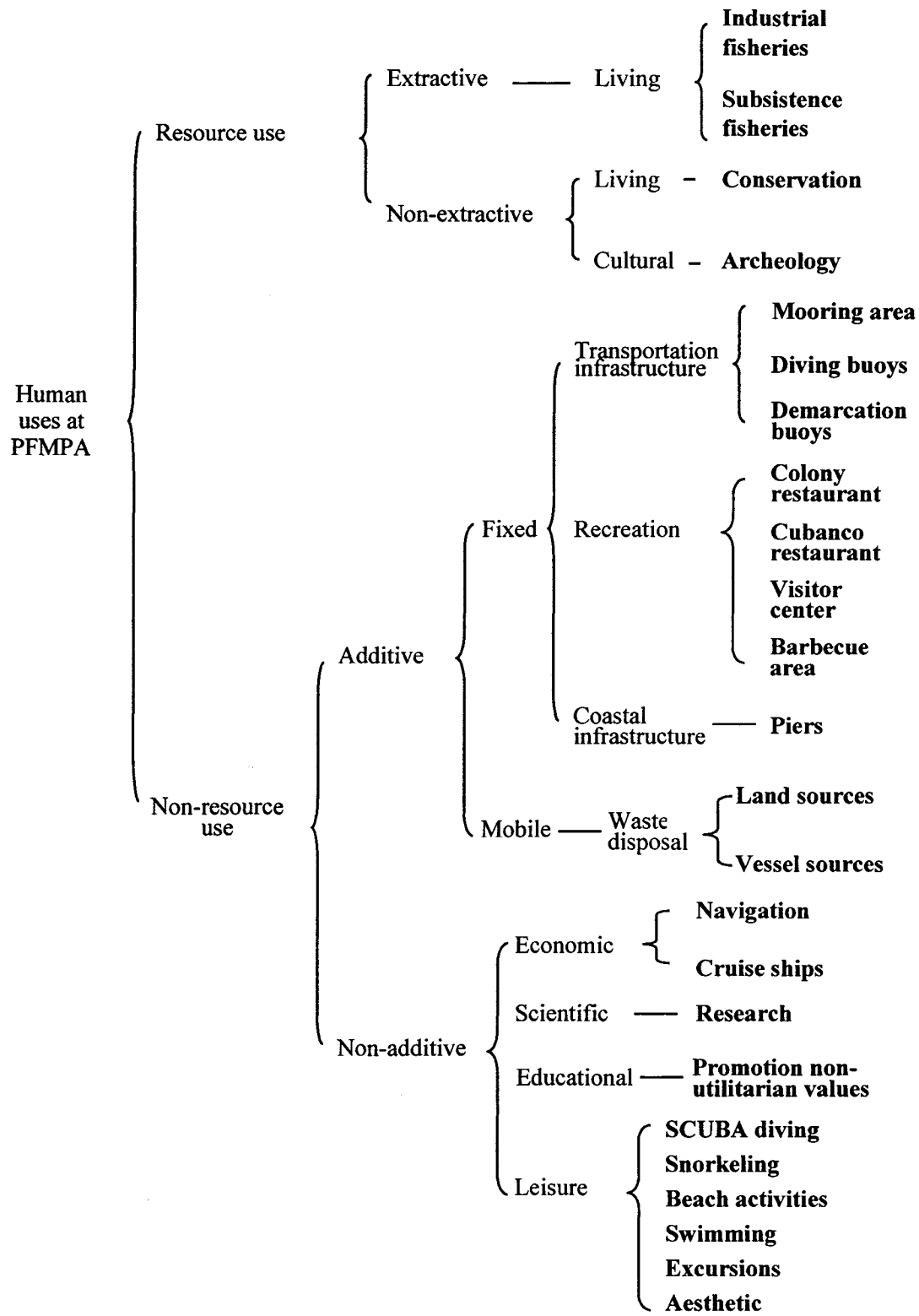

Figure 4. Taxonomy of human uses at Punta Frances Marine Protected Area. Adapted from Chircop (1996).

productive area of this MPA in fishery terms is essentially the Siguanea Gulf. The second issue is lack of infrastructure to patrol and enforce existing regulations on fishing matters. In reality, CITMA staff at the MPA does not have any means to control fishing activities within or near the PFMPA.

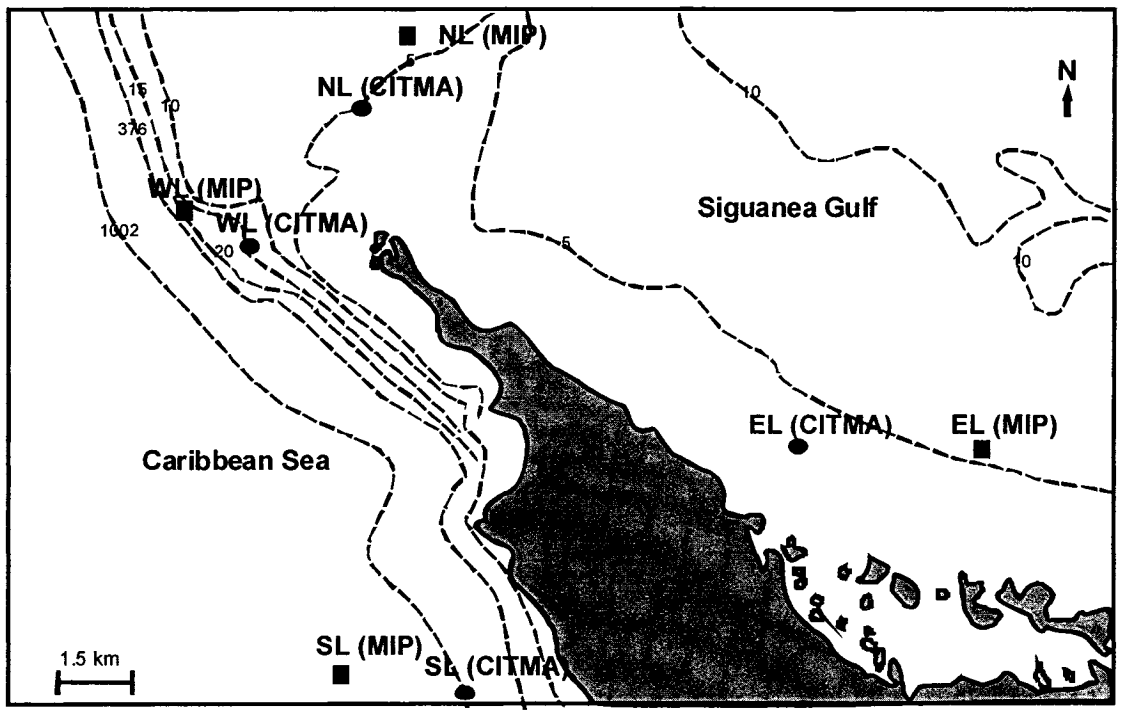

Figure 5. Punta Frances Marine Protected Area limits. NL: North Limit, SL: South Limit, EL: East Limit, WL: West Limits. • Limits set by CITMA (Ministry of Science, Technology and Environment), P Limits set by MIP (Ministry of Fishing Industry).

Conservation: According to the proposal sent to the CS for approval the PFMPA is meant to become a National Park. This management category clearly states that conservation and preservation of natural resources is one of the most important objectives to fulfill (Decree Law 201/2000, CITMA). If the proposal is finally approved, then conservation will officially be a prime use at the PFMPA.

Archeology: In the PFMPA some of the caves located along the shore show pictorial evidence of aboriginal settlements in the area. This, together with more recent evidence which indicated that the PFMPA was used as an operation base for pirates and buccaneers in the eighteenth century, makes the area an interesting archeological site.

The PFMPA is, in the first instance, a tourist attraction, and most of the activities tend to be related to non-consumptive uses of natural resources. Consequently, the majority of human uses were clustered in the non-resource uses category. For instance, mooring area, diving buoys and demarcation buoys were classified as additive-fixed transportation infrastructure. Additionally, piers, Colony and Cubanco restaurants, visitor center, barbecue area, are additive-fixed coastal infrastructure. Waste disposal from land and vessel sources was identified as additive-mobile. Navigation and cruise ships were recognized as non-additive economic uses. In addition, scientific research was classified as non-additive scientific use. Promotion of non-utilitarian values was categorized as non-additive educational activity. Finally, SCUBA diving, snorkelling, beach-related activities, swimming, excursions and aesthetic were identified as the most common uses in the PFMPA, and categorized as non-additive leisure activity. A more precise description of the identified uses follows.

Mooring area: In the PFMPA it is common to see small foreign boats that use the area as a mooring site. This activity is not subject to regulation, with the exception of reporting their presence in the area to the Coastguard. Boat owners drop anchors in

sheltered sandy portions of the PFMPA that provide protection and a quiet environment to overnight. Also, some fishing boats use the PFMPA as a temporary mooring site.

SCUBA diving buoys: A total of 56 dive sites were established and marked with buoys. Skippers of diving boats are supposed to use these buoys to avoid dropping anchor on coral reefs. None of these buoys actually exist because they have been swept away by ocean currents due to lack of maintenance.

Demarcation buoys: Are used to indicate safe paths to navigate as well as reference points for cruise ship activity.

Piers: Two of them exist. One is 300 m long and connects to Colony restaurant with the beach. The other is 150 m long, and is used to disembark tourists coming from the cruise ship.

Colony restaurant: This facility is used to provide food and beverages for tourists and Colony staff who work with divers. It was built on poles right over the seagrass beds, creating exceptional scenic views for tourists. It operates on a daily basis to provide lunch and a space for divers to rest during the day. At night this facility is not used. (At the time of writing, this facility was severely damage by Hurricane Ivan. It was consequently dismantled. The incidence of this human use was not considered in the analysis)

Cubanco restaurant: It was built by Cubanco S.A. to handle large numbers of tourists who come on cruise ships. The objective was to provide them with a buffet where they can eat and drink all what they want. The facility is fully equipped for this activity. The restaurant is located over the dune and behind the coastal vegetation, it is impossible to spot from the sea.

Visitor center: This is a wooden house built on poles over the dune that functions as a visitor center and ranger house. It gives shelter to the PFMPA staff and provides some services to tourists coming on cruise ships. This facility was built by Cubanco S.A. to use as an operational base to control cruise ship visits.

Barbecue area: This is a small place over the dune that is used to prepare fast food for cruise ship tourists.

Waste disposal: Liquid wastes from both restaurants' operations are dumped into septic tanks, although some residuals end up on the beach due to poor maintenance. Solid wastes are gathered and taken away by road or by boat. Some fishing boats dump their ballast waters in the area.

Navigation: Many small boats use the area as navigation routes. As such, some navigational aids are in place to facilitate this activity.

Cruise ships: Initially, large cruise ships arrive twice a week to the area, bringing tourists to enjoy the place and use the facilities built there. This project had a good beginning, but later momentum was lost, even came to a halt for two years. It has started to recover recently. Cruise ships do not drop anchors in the PFMPA; rather they remain loose controlling their dynamic position system. Tourists are brought to the beach in small boats.

Scientific research: Several institutions have carried out scientific research in the PFMPA. Among them are the CITMA Delegation on the Isle of Youth, CNAP, and the Center for Marine Research at UH.

Promotion of non-utilitarian values: As part of their activities, the PFMPA staff organizes and directs informal meetings and seminars with workers and tourists to instill environmental and conservation values among them. These encounters have proven very useful because they have helped in educating the PFMPA users and stakeholders to respect natural resources and promote non-utilitarian values of the marine environment.

SCUBA diving: This is by far the most important human use that takes place in the PFMPA. For more than 26 years the area has been used for this purpose. An average of 8,450 divers visit the area annually to enjoy a wonderful diving experience in the PFMPA.

Snorkelling: This activity is undertaken by cruise ship tourists organized in groups, and occasional dive tourists from the Colony hotel.

Beach-related activities: These are represented by wind surfing, kayaking, and sailing. Also, sun bathing and relaxation take place along the 3.079 km of the sandy beach occurring in the PFMPA.

Swimming: A large number of tourists opt for this activity at the beach.
Excursions: Occasional adventurers take walks into the forest in the PFMPA. A hiking trail has been created to facilitate this activity.

Aesthetic: This use is represented in the PFMPA by the human enjoyment and spiritual renewal that proximity to pristine environments can provide.

In order to assess how these uses interact with each other, and the impact they have on natural resources, interaction of uses and impact matrices were constructed. These matrices have proven useful to simplify the complex scenario represented in the coastal zone. They allow us to identify actual or potential interactions between uses, define responsible institutions, facilitate inter and intra agency coordination, forecast conflicts, plan their solutions, and the like (Cicin-Sain and Knecht, 1998). The main shortcomings are that they are oversimplifications of real life; they only allow for considering interaction between two uses, while real coastal interactions may include more than two uses, these matrices depend on information gathered at a particular moment, meaning that

they do not consider change over time. Despite these shortcomings their use has been reported in the literature (Couper, 1983; Vallega, 1990; Cicin-Sain and Knecth, 1998; Chircop, 2000).

In general terms, human uses in the PFMPA tend to interact with each other. Figure 6 shows that there are 131 cases of interaction among uses, representing a 52 % of the total number of possible interactions. A more detailed analysis indicates that only 34 % of these cases are actually conflicting interactions, while 67 % represent beneficial relations among uses. From a management perspective, this is a very positive result because fewer resources need to be allocated to find solutions for these conflicts. The most conflicting uses were those related to extractive resource use (industrial and subsistence fisheries) and waste disposal (land and vessel sources). This came as no surprise, given the detrimental effect that such activities have on the environment in general (Sobel and Dahlgren, 2004). Of these two, waste disposal is far easier to solve by creating facilities on land to receive and process solid and liquid waste, and through strict control of the vessel traffic in the area. The remaining fishery-related conflicts need careful review and analysis to allocate fishermen to other areas. Given the centralized and state planned-fishery system in Cuba, this possible solution should not be problematic.

The two main human uses in the PFMPA (SCUBA diving and cruise ships) neither conflicted with each other nor with other uses. This result indicates that these activities seem to be properly accommodated in the MPA. Building from the Cuban example, one could present an option to maximize economic benefits from MPAs.

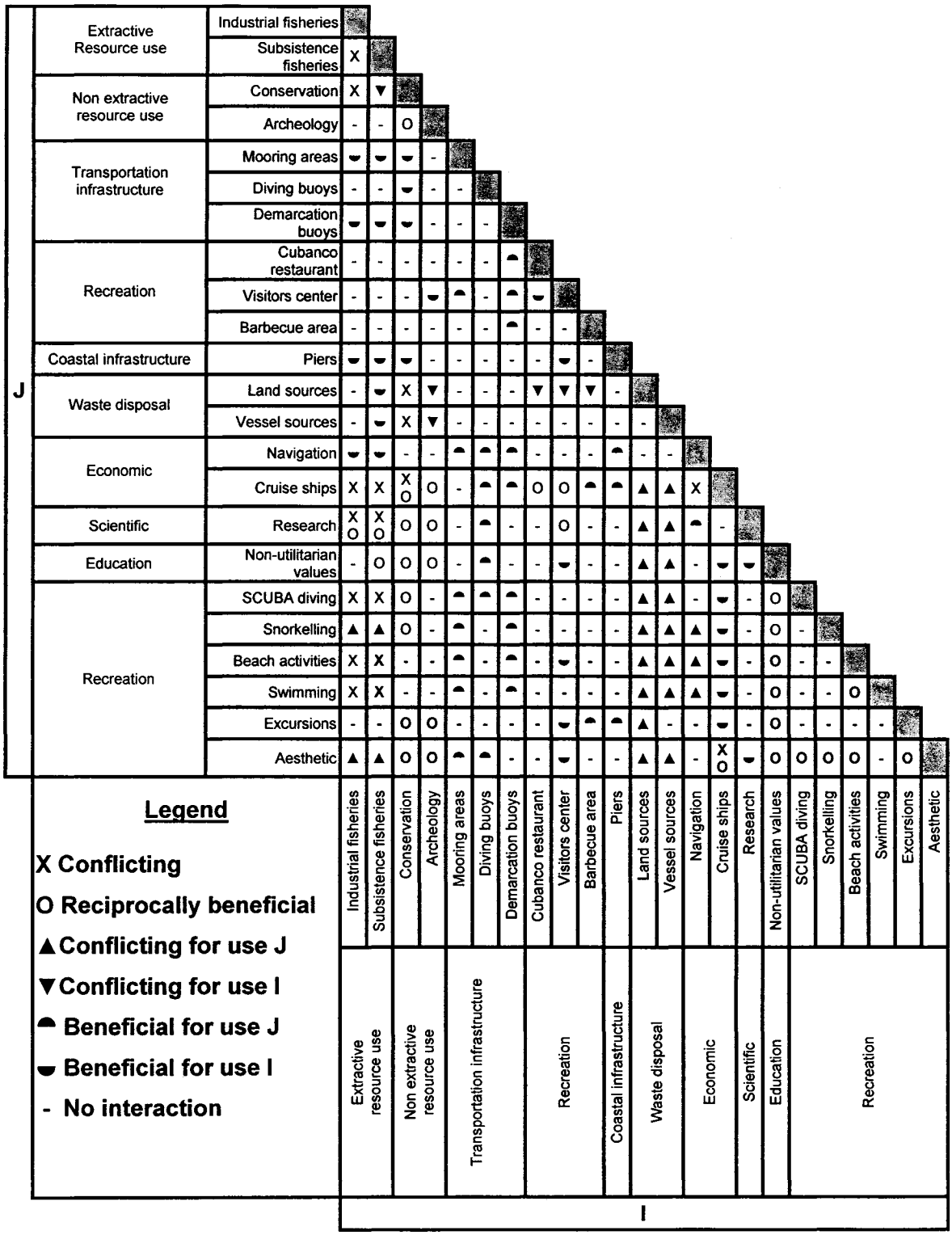

Figure 6. Interaction of human uses at Punta Frances Marine Protected Area.

Ritter and Schaefer (1998) argued that the ecological impacts of cruises are low, spending by individual tourists high, and cultural processes minimal. Therefore, cruise ships compare favorably with other types of tourism.

Other authors claim that this relationship is not positive at all, Marsh and Staple (1995) warned about the great potential for irreversible damage that cruise ships represent in visiting environmentally fragile destinations such as the Canadian Arctic. Wood (2000) pointed out that the cruise ship industry is producing significant cultural and sociological impacts through what he called "globalization at sea".

Despite the debate, it is my opinion that well-planned and controlled visits of cruise ships to MPAs may multiply revenues and promote environmentally sound activities and attitudes among tourists. One most also recognize the economic opportunities that the cruise ship industry represents. For instance, the Caribbean Tourism Organization (CTO) (2000) reported that the cruise industry in the Caribbean grew in a 10 % rate in comparison with 1999 and this trend is predicted to continue with an average growth per year of 6.5 % until 2010 (Sobers, 2002). It should be added that for some uses (e.g., cruise ships and research) the occurrence of conflicting and/or beneficial interactions depends on how human intervention takes place. For instance, if cruise ship activities are well planned and zoned, then conservation uses should not be jeopardized. However, if this activity is conducted without care, then consequences might be very negative.

Another important aspect is that no interaction at all was found for the 48 % of the cases. This could be interpreted in two ways. First, current uses in the PFMPA are taking place in an orderly manner and, second, the PFMPA can accommodate more human uses, providing opportunities to maximize benefits to human and nature.

Table 5 shows impacts that human uses have on the PFMPA natural resources. According to this matrix, the majority of impacts are positive (27 %) and in 49 % of the cases, there are no impacts whatsoever. A 24 % of the impacts were negative, and although this figure is rather small it needs attention because it may disguise real and potential problems creating a false perception of sustainability. For instance, the bulk of positive impacts are related to non-consumptive uses such as conservation, research, non-utilitarian values, aesthetic, and the like; while negative ones are mostly related to consumptive uses, which in fact take place in the area more frequently.

Additionally, According to Table 5, the most vulnerable natural resource to the impact of human activities is the sand dunes (39.1 % negative impacts). This is because most of human uses in the PFMPA take place in the beach. Although coral reefs showed a high number of negative impacts (34.7 %) they also showed a remarkable amount of positive impacts. This appears to be an indication of: a) SCUBA diving is not producing negative changes in these communities, and b) other human activities in the PFMPA facilitate conservation of coral reefs. The least impacted natural resources in the PFMPA are evergreen forest, mangrove system, and fishery resources (65.2 %). The first two could be explained by the fact that almost no human activity takes place within them. The last

one may be interpreted as an indication thin the PFMPA has been effective in protecting natural resources.

From the management standpoint, these results provide evidence that there is a very variable scenario in the PFMPA. Therefore, actions need to be taken to precisely plan the type and extent of current consumptive activities within this MPA.

Table 5. Impacts of human uses on natural resources at Punta Frances Marine Protected Area.

	Natural resources						
	Terrestrial		**Marine**				
Uses	Evergreen forest	Sand dunes	Mangrove system	Beach	Seagrass beds	Coral reefs	Fishery resources
Industrial fisheries	-	-	-	-	-	N	N
Subsistence fisheries	-	-	-	-	-	N/P	N/P
Conservation	P	P	P	P	P	P	P
Archeology	-	-	-	-	-	-	-
Mooring areas	-	-	-	-	P	P	-
Diving buoys	-	-	-	-	P	P	-
Demarcation buoys	-	-	-	-	P	P	-
Cubanco restaurant	N	N	-	-	-	-	-
Visitors center	N	N	-	P	P/-	P/-	P/-
Barbecue area	-	N	-	N	-	-	-
Piers	-	N	-	N	N	-	-
Land sources	N	N	N	N	N	N	N
Vessel sources	-	N	N	N	N	N	N
Navigation	-	-	-	-	-	N/-	-
Cruise ships	N/-	N/-	-	N	-	N/-	-
Research	P	P	P	P	P	P	P
Non-utilitarian values	P	P	P	P	P	P	P
SCUBA diving	-	-	-	-	-	P/N	-
Snorkelling	-	-	P/N	-	P/N	P/N	-
Beach activities	-	N/-	-	P/N	N/-	-	-
Swimming	-	-	-	-	-	-	-
Excursions	P/N	P/N	P/N	P/N	-	-	-
Aesthetic	P	P	P	P	P	P	P
Legend P Positive Impact N Negative Impact - No impact	% (*) P. 21.7 N. 21.7 - 65.2	% (*) P. 21.7 N. 39.1 - 52.1	% (*) P. 26.0 N. 17.3 - 65.2	% (*) P. 30.0 N. 30.0 - 47.8	% (*) P. 34.7 N. 21.7 - 52.1	% (*) P. 47.8 N. 34.7 - 43.4	% (*) P. 26.0 N. 17.3 - 65.2

(*): Figures may not add up to 100 %.

Section I

Effects of Tourism Activities on the Structure and Functioning of Coral Reef Communities in the Punta Frances Marine Protected Area

Introduction

The PFMPA constitutes one of the most pristine marine environments in the Cuban archipelago. Its clear, warm waters, sandy beaches, diverse marine flora and fauna, and impressive underwater geography make the area an unforgettable experience for those that visit it. These natural features have been the main reasons for the tourist usage the area has experienced for more than twenty years.

The majority of uses found in the PFMPA are directly or indirectly related to tourism, making this tourism the most important economic activity. This situation represents a worldwide trend in using MPAs as tourism attractions. This trend is so significant that in many areas around the world, economic and social values associated with tourism are beginning to compete with, or even outweigh, the value of, for example, coastal fisheries. For instance, coral reef-based tourism is attracting millions of divers per year, and these tourists will often select their location and pay more to observe undamaged reefs (Walters and Samways, 2001; Green and Donnelly, 2003). The value of tourism has been critical for some sites in providing direct income for management and enforcement activities. For example, user fees in the marine parks of Saba and Bonaire in the Netherlands Antilles covered 60 % to 70 % of the annual park's operating costs in 1999 (Dixon et al., 2000; Spalding, et al., 2001; Green and Donnelly, 2003), with much of the remainder being

provided by sales of souvenirs and yacht fees. Even where such direct benefits cannot be calculated, however, the income provided to individual hotels, dive companies and national economies from dive tourism is clearly enhanced in many countries by the presence of MPAs (Green and Donnelly, 2003).

The use of MPAs as tourism attractions should be carefully monitored due to the detrimental effects tourism can produce on natural and social resources. Tourism has been identified as a potent force capable of transforming, not only physically but also socio-economically, the region where it is developed. In this regard, Holder (1988), the Caribbean Tourism Research and Development Center (CTRDC) (1988), Burke et al. (2001), and Hall (2001) pointed out the following as the major negative impacts from tourism: land erosion due to housing and road construction, filling in of wetlands and mangrove areas for resort properties (Holder (1988) reported 51 % to 97 % growth on accommodation availability for many Caribbean islands); beach loss and lagoon pollution from sand mining, dredging, sewage dumping (three quarters of water treatment plants in the Caribbean do not comply with basic effluent criteria (Island Resources Foundation, 1996) releasing 80 % to 90 % of the sewage generated across the region without adequate treatment (UNEP, 1997)); damaging of coral reefs from anchoring (Hall and Braithwaite, (1990) sedimentation and marina development. Sobers (2002) predicted that by the year 2005 cruise arrivals will surpass stopover arrivals in the Caribbean; more recent statistics show higher increase rates for cruise arrivals over stopover arrivals in the last decade (Silva, 2002)) and SCUBA diving (many of the diving destinations in the Caribbean are

close to their maximum carrying capacity levels (Dixon et al., 1993, 2000; Tratalos and Austin, 2001; Gallo et al., 2002)).

Additionally, an increase in social problems is also a direct result of tourism development, especially in developing countries. Mass tourism brings invasion by culturally insensitive and economically disruptive foreigners, drug use, prostitution, and delinquency.

Despite this large list of adverse effects, tourism also provides a large array of positive inputs that could easily outweigh any possible pitfalls. The figures provided by the World Travel and Tourism Council (WTTC) suggest this. Tourism provides the bulk of economic revenue for many countries; for instance, in some Caribbean islands tourism contributes more than the 43 % of their Gross Domestic Product (GDP) and the largest proportion of people employed (25 %) (CTO, 2000; Miller and Auyong, 1991;).

Tourism in the PFMPA manifests itself through recreational SCUBA diving and cruise arrivals. The last round started back in 1996 and has been an intermittent activity because there have been market failures mainly provoked by the negative influence of the United States of America's blockade on the Cuban economy. Also, effects from September 11, 2001 have influenced tourist activities.

Recreational SCUBA diving has long been the most important activity in the PFMPA. Since 1976, this area has been visited by thousands of divers from all over the world.

Recreational SCUBA diving ranks as the most important tourism activity in tropical marine environments, including coral reefs. According to Dignam (1990) and Tabata (1992), SCUBA diving is one of the fastest growing sports in the world, and it is undertaken, preferably, in pristine areas. As a result, the impact of SCUBA diving tourism on coral reefs is a growing research topic, and several studies in MPAs have been designed to determine the level of SCUBA diving activity that will not compromise reef resources.

This level has often been termed as "capacity" (Davis and Tisdell, 1995(a); Hawkins and Roberts, 1997; Gallo et al., 2002). As pioneers of this work, Hawkins and Roberts (1992, 1993, 1994, and 1997) undertook SCUBA diving impact studies at a popular dive resort in Egypt called "*Sharm-el-Sheikh*". Results from these studies suggested that coral reefs might endure high levels of SCUBA-dive use, but this might not last long. Nonetheless, some aesthetic damage is expected to occur mainly to the most fragile coral species (branching). Hawkins and Roberts also suggested that the response of this ecosystem to the number of tourists (divers) follows an exponential model, suggesting the figure of 5,000 to 6,000 dives per year as a maximum limit beyond which reef degradation might appear.

Dixon et al. (1993) and Scura and van't Hof (1993) produced one of the most important contributions to the understanding of ecological impacts of SCUBA diving. They reported a critical value, above which impacts on coral communities from SCUBA-dive activities would become visible and compromise the sustainability of the industry.

According to these authors, a usage rate of more than 5,000 dives per year per site in the Bonaire Marine Park (BMP) would significantly degrade coral reef quality, thus compromising the sustainability of the SCUBA tourism industry. From this figure they suggested a park carrying capacity of approximately 200,000 dives per year. Although these results are limited in their prediction capacity because of the lack of long-term monitoring, they provide a good starting point for estimation of carrying capacity. Zakai and Chadwick (2000) reported high frequencies of SCUBA-dive activities (>200,000 dives/year) at Eilat, northern Red Sea. According to them, this figure is significantly above carrying capacity, and has inflicted severe damage to massive and branching stonney corals at heavily-used sites. This finding suggests that the use of indices of coral damage to assess SCUBA-dive impacts might be advisable.

Other initiatives in the use of ecological indexes to evaluate SCUBA-dive impacts have been reported. A particular case is the Coral Damage Index (CDI) proposed by Jameson et al. (1999). These authors described a simple way to assess SCUBA dive impacts on coral reefs by estimating the percentage of broken coral colonies at a certain site. They applied this methodology in the Red Sea, and the results showed that this method can be applied globally to measure the severity and extent of the damage, focus managers on which areas need mooring buoys, and provide a starting point from which to focus more detailed research and monitoring.

Other ideas have also been proposed. Edinger and Risk (2000) defined a reef classification method using coral morphology to predict coral reef's conservation values.

Their main result was that definitions of reef status based solely on percentage of live coral cover should be supplemented with other indices, such as conservation class, that more accurately predict biodiversity value and fisheries potential.

From these studies, it can be concluded that a shift in the scale and complexity of analysis is emerging in coral reef studies. No longer are species-specific indexes being used exclusively to answer questions related to management issues in coral reefs. Instead, more general approaches are being taken such as coral morphology and presence/absence indexes. An example of this comes from a study done by Rouphael and Inglis (1997) who explored SCUBA dive impacts on coral reefs using a reef topography index. They found that reef topography was not a useful predictor of the amount of damage done by divers; the morphological composition of benthic assemblages at the site was more important.

Harriott et al. (1997) studied SCUBA dive impacts on four major dive sites in Australian MPAs and found that, at that time, SCUBA diving was not producing any significant impacts on coral reefs. Davis and Tisdell (1995b) did one of the most extensive literature reviews of SCUBA-dive impacts. They concluded that before any signs of biological deterioration appear, due to high levels of SCUBA-diving, amenity values are first affected. They proposed that divers' perceptions should be assessed to determine when amenity values begin to decline. As possible variables to measure in this regard, they mentioned "wilderness experience, overcrowding, and acceptable level of degradation".

Williams and Polunin (2000) undertook a study in the Caribbean looking for differences between protected and unprotected areas in attributes preferred by dive tourists. Results from this work show that tourists were more interested in seeing fish and other large animals (i.e., big fishes, other large animals, variety of fishes, abundance of fishes and unusual fishes) than those relating to reef structure and benthos (drop-offs, variety of corals, large corals, coral cover, unusual corals, sponges, unusual algae, lobsters, crabs, and the like). This finding might be helpful in choosing which variables to measure to estimate lost of amenity values.

This part of chapter 4 is intended to measure the impacts, if any, of recreational SCUBA diving on the coral reefs of the PFMPA, and also to provide an estimation of the SCUBA divers' carrying capacity in the MPA.

Materials and Methods

Eighteen field trips were undertaken from January 2001 to June 2003 using the research vessel Felipe Poey from the University of Havana. These trips lasted for about 10 days each and more than 150 SCUBA immersions were made in depths ranging from 3 to 20 meters.

During the first trip, informal interviews were held with three dive instructors and two tourist boat skippers to differentiate among dives sites on the basis of their intensity of use (heavy, moderate, light). According to them it was possible to distinguish among heavily dived and non-dived areas; moderate dived sites were not present. Subsequently,

two main biotopes were identified within the defined usage zones: spur-and-groove and reef wall. Spur-and-groove is a common reef biotope present in the deep "forereef" area. It consists of alternate channels of sand and rock lines running perpendicular to shore. Depths of this biotope oscillate around 13 m to 17 m. Reef-wall biotope represents an ancient shore line which is underwater now, and appears as an escarpment that generally drops from 5 m to 12 m. Differences in fish and coral abundance, species composition, and diversity indexes have been reported for these two biotopes in Cuba (González et al., 1997; de la Guardia, et al., 2004b).

A total of four combinations of usage level-biotope areas were thus identified, and within them three replicate sites were allocated (Table 6, Figure 7). These replicates sites were actual diving buoys, when it was possible, or sites selected within the non-use areas.

Relative abundance of selected fish species was estimated using a modification of the Stationary Visual Census Technique (Bohnsack and Bannerot, 1986). The difference between the published method and the one used in this work is that our cylinder census volume had 5 m radius rather than 7.5 m, and not all fish species were counted and measured. Instead, only commercially important species (i.e. those interesting to divers and fishermen), all herbivores, and all territorial species were considered. There were two reasons for doing this. Firstly, counting and measuring all fish species would have meant more time in terms of doing the fish censuses, and this would have counted against the time needed to do other censuses (coral cover, rugosity). Secondly, given the fact that we were looking for SCUBA-dive impacts, it was this author's opinion that these impacts

should have first been observed on charismatic fish species such as the commercially important, the herbivores and the territorial species.

Table 6. Combinations of usage level-biotope strata identified for this work. (B: Buoy, Ped: Pedernales, B-RC: buoy RC; B-M and B-P are random names; numbered buoys refer to actual dive sites).

		USAGE LEVEL	
		Heavily used (**H**)	Non used (**N**)
BIOTOPE	Spur and groove (**S**)	**B-7** (21°35.2539'N, 83°10.2396'W) **B-14** (21°35.5049'N, 83°10.4284'W) **B-50** (21°35.1540'N, 83°10.2320'W)	**B-21** (21°35.9676'N, 83°10.7525'W) **B-25** (21°36.0020'N, 83°10.8740'W) **Ped.** (21°34.7574'N, 83°10.4888'W)
	Reef Wall (**W**)	**B-36** (21°37.3980'N, 83°12.5330'W) **B-40** (21°36.8360'N, 83°11.7960'W) **B-34** (21°37.1582'N, 83°12.2263'W)	**B-RC** (21°36.4259'N, 83°10.9851'W) **B-M** (21°36.8928'N, 83°11.4845'W) **B-P** (21°36.6343'N, 83°11.1902'W)

Benthic community structure was assessed in terms of proportional cover using the line intersect method (Rogers et al., 1994; English et al., 1997). Percent cover of live coral, recently dead coral, old dead coral, macro algae, gorgonian, sponges, and rock-sand substrate were estimated. As a separate variable, bottom complexity, also known as rugosity, was measured using the chain transect method (Rogers et al., 1994; English et al., 1997).

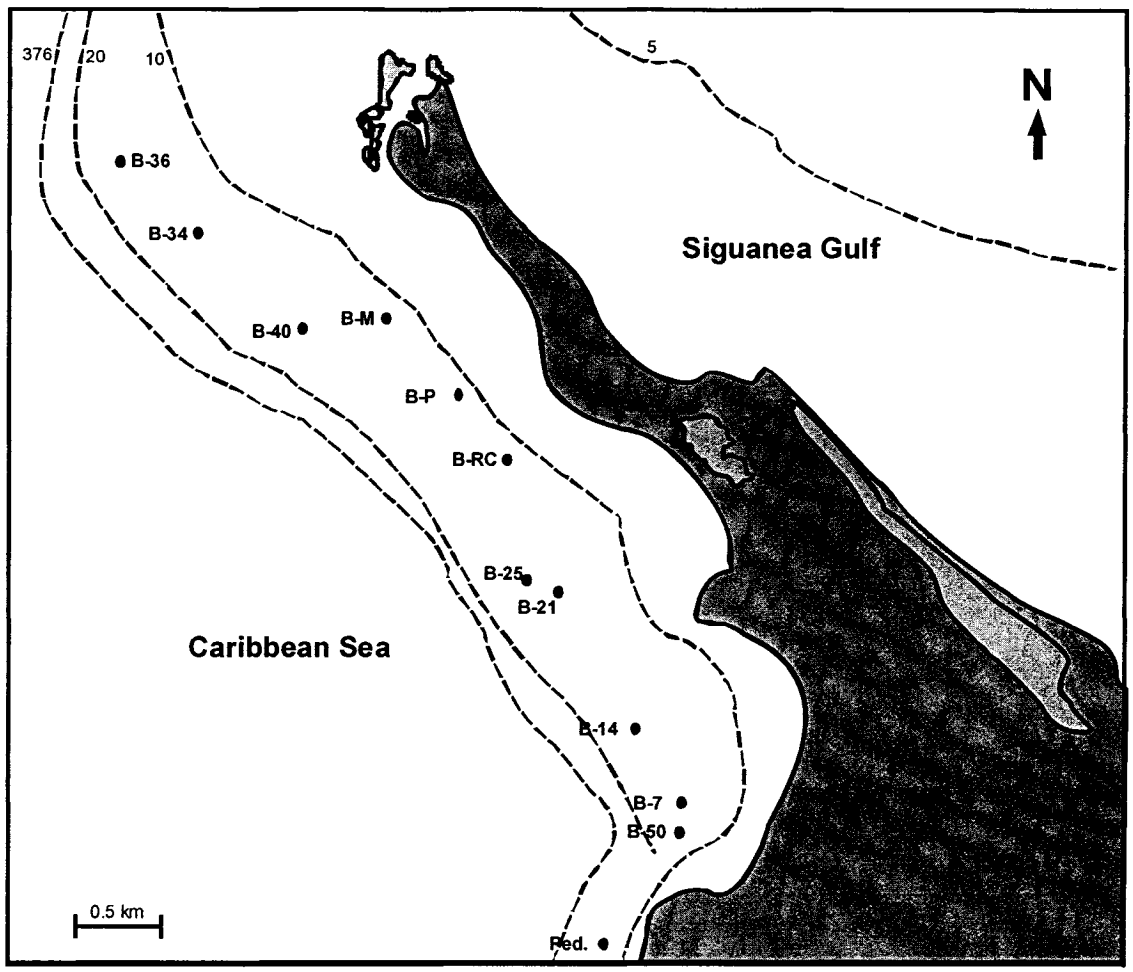

Figure 7. Map showing sampling sites at Punta Frances Marine Protected Area. B: Buoy

Data Analysis

All biological data were tested for normality and (log +1) transformed as required. To determine whether sampling was representative, the cumulative numbers of species vs. counts curves were prepared for each combination of factors (HS, HW, NS, NW as in Table 5). Analysis of normality and scale transformation were done using SPSS 12.0 for Windows. Microsoft Excel 2002 for Windows was used for the construction of the accumulated number of species vs. counts curves.

Determination of the power of the test was done using Gpower 2.0 software (Faul and Erdfelder, 1992). The log of total abundance of fish was used in an *a priori* power analysis to estimate the number of replicates necessary to achieve 90 % and 70 % power. Additionally, a *post hoc* power analysis was also performed for the same variable (log (fish abundance)) to actually estimate the power of this experiment. In both cases, the tests were done on the outputs of ANOVA.

A balanced, two-way ANOVA (fixed effects) was performed to estimate differences between levels of use and biotopes regarding fish abundance, fish biomass, coral cover (live, dead), algal cover, and rugosity. SPSS 12.0 for Windows software was used to conduct the analysis. Estimates of fish biomass were obtained using previously published length-weight relationships for marine fishes of Cuba (Claro and Garcia-Arteaga, 2001).

Multivariate analysis was also performed to explore patterns of distribution between usage-level and biotopes regarding fish abundance (all fish combined and commercially important species), and percent cover. A hierarchical classification was performed using the Percent Similarity Coefficient as a similarity index and the clustering method employed was the Unweighted Pair Group Average (UPGMA). A Principal Component Analysis (PCA) was also applied to explore for patterns of significance in the distribution of data found in the cluster analysis. The Multivariate Statistical Package (MVSP) 3.13m for Windows was used to undertake these multidimensional analyses.

Results and Discussion

Although not all areas were sampled with the same intensity, around 16 counts seemed enough to obtain a representative sample (Figure 8). This finding is particularly relevant given the importance of ensuring an appropriate sampling effort to guarantee precision and accuracy in the experiment (Underwood, 1997; Babbie and Benaquisto, 2002).

The issue of the power of a test has been under debate for many years. Scientists have always been worried about controlling type I error. Therefore, α=0.05 has been used as a magical number (Underwood, 1997). The acceptance of this "almost mandatory" number, however, means that type II error becomes larger; that is accepting Ho when it is not valid. This fact could be very serious in experiments that seek to explore for human induced-impacts on natural resources because by accepting this outcome, we are predicting that there are no impacts when in reality they are occurring (Underwood, 1997). In a real life situation this could be catastrophic, because management measures are taken based on incorrect prediction. Factors such as sample size, sample variability and effect size determine the power of a test (Underwood, 1997).

In the experiment to test for the effect of SCUBA diving use at reef sites at PFNMP, it was found that in order to obtain a power of 90 %, 72 replicate measures per site-intensity combination would have been necessary. This number of replicates is not logistically possible for this experiment. Firstly, the area is not big enough to allow for the establishment of 72 truly independent replicates, and secondly the time required to undertake such a massive task would have been excessive.

When analyzing for a power of 70 %, results showed that 48 replicates would have been necessary. Although this number seems more plausible, the issue of enough physical space within the PFMPA and replicate independence remains a constrain. In ecological studies, independence of samples constitutes the most important assumption that should be respected when using the F distribution to explore for significant differences (Underwood, 1997). Other assumptions such as homogeneity and normality are important as well, but not as crucial as independence of samples (Underwood, 1997).

The *post hoc* analysis showed that this experiment had a power of 30.87 %. Although it is not high, it should be considered that large variability is a reality that affects all ecological experiments. Thus, the key issue here is not to struggle for a higher power in the experiment. It is rather, to acknowledge the limitations of the experiment, and make the implications clear to everybody, so the conclusions drawn from it can be effectively implemented and not misunderstood (Hatcher, personnel communication).

Generally fish are abundant and diverse within the PFMPA. The most common species are those typical of coral reefs that have not been significantly impacted by human activities. However, the low abundance of large fish, especially predators, belonging to the families Lutjanidae (*Lutjanus spp.*, snappers) and Serranidae (two species of the genus *Epinephelus*, locally known as nassau grouper and jewfish, and several species of the genus *Mycteroperca*, locally known as black grouper and tiger grouper), are noticeable. This fact could be the result of the illegal fishing that takes place within the area, as well as the commercial fisheries that take place outside the area (near the boundaries of the MPA).

Bohnsack (1993) described this as "fishing the line", it is considered one of the benefits that MPAs could provide to commercial fisheries.

On the other hand, the lack of these fish in the PFMPA contrasts to the finding of Eklund, et al. (2000) who discovered large black grouper aggregations within certain MPAs in the Florida Keys National Marine Sanctuary. It is this author's opinion that this the pattern identified should not be considered a benefit for the fisheries. Since the PFMPA area is very small (only 3,014 ha), in comparison with the surrounding area. Significant exports in biomass and larvae should not be expected from it. Furthermore, larval dispersion and adult migration patterns have not been studied in the PFMPA, so it is difficult to predict whether the area constitutes a source of fish larvae and biomass.

Specimens of the Acanthuridae (*Acanthurus spp.*) and Scaridae (*Scarus spp.* and *Sparisoma spp.*) families are specialized herbivores that constitute a key element in the structure and composition of coral reef fish communities, given the control they exert over the algal growth on the reef (Aronson and Precht, 2000; Hughes, 1994; Williams and Polunin, 2001). These two families are very well represented in the PFMPA, although high algal cover (between 40 % and 60 %) has also been reported (Centro de Gestión y Servicios Ambientales y Tecnológicos, 2001; De la Guardia et al., 2004b). This fact suggests that there might be some kind of nutrient input to the PFMPA that is offsetting grazing losses to these herbivore fish (Lapointe et al., 1997; Lapointe, 1999). Williams and Polunin (2000) have found that despite a strong negative correlation between herbivore biomass and algal cover, the latter has remained high in some parts of

the Caribbean.These researchers found, that the macro algal-grazer interaction does not follow a simplistic linear model. Instead it might be influenced by other factors, such as the development of defense mechanisms by macro algae against the grazing activity of herbivores. Hence, factors such as algal palatability should also be considered.

Contrary to what was expected, high-use sites showed significant higher means of total fish abundance ($F=11.136$; $p<0.05$), commercial fish abundance ($F=5.249$; $p<0.05$), and fish biomass ($F=7.704$; $p<0.05$) in comparison with non-used sites. This could be interpreted as meaning that SCUBA diving may not be affecting fish communities' structure in the PFMPA, and that SCUBA diving concentrates along these sites because they are more attractive to divers. Questionnaires support this latter interpretation, firstly, because fish abundance was one of the most preferred reef attributes divers would like to see, and secondly because 86.1 % of the tourists ranked the PFMPA in good quality condition regarding this variable.

Biotopes also significantly differed in total fish abundance ($F=5.658$; $p<0.05$) and fish biomass ($F=6.266$; $p<0.05$), which appears to be a consequence of significant differences found in the structural complexity (rugosity) between the two biotopes ($F=8.191$; $p<0.05$). Higher structural complexity means more habitats and shelter opportunities available for fish; therefore an increase in fish abundance should be expected in those areas with higher structural complexity. Kaufman (1983) postulated that the loss of spatial heterogeneity could reduce the carrying capacity of the reef. At the same time,

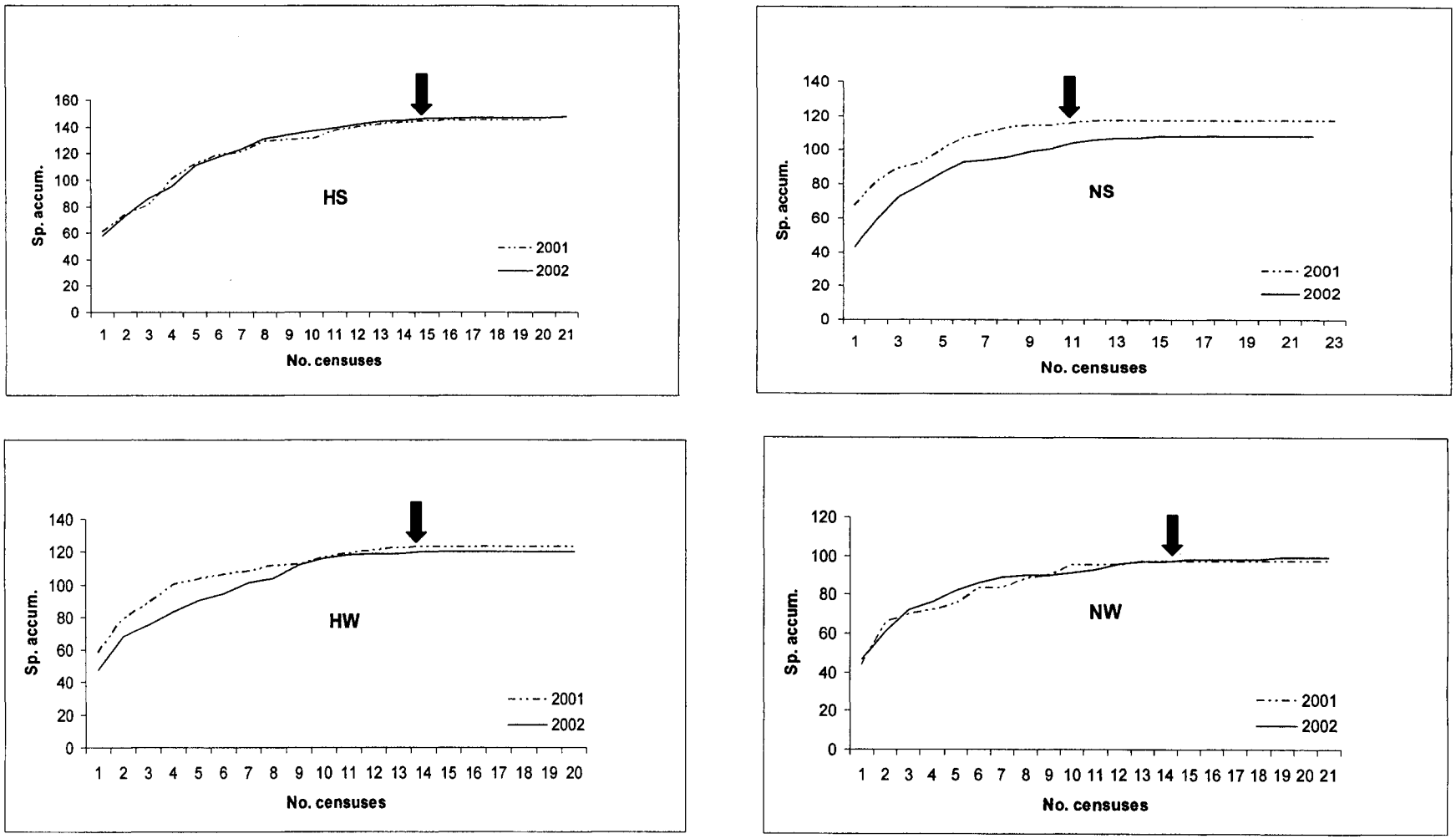

Figure 8. Accumulated number of species vs. counts for the four factor combinations (HS: heavily used-spur and groove; HW: heavily used-wall; NS: non used-spur and groove; NW: non used-wall). Black arrows show the number of counts where the curve becomes asymptotic. Total number of counts made in each site-intensity combination can be obtained from the count axis.

higher structural complexity could explain the higher fish biomass also found in this biotope. Large fish occur mostly at greater depths because food tends to be more abundant there. Rudd and Tupper (2002) reported higher abundance of Nassau Grouper (*Epinephelus striatus*) in deep and structurally complex reef formations such as spur and groove, in the Turks and Caicos Islands. Also, Gonzalez-Sanson et al., (1997) reported significant differences between spur and groove and wall biotopes in relation to fish community structure and abundance for Cuban reefs.

Abundance of herbivore fish did not show significant differences between usage levels ($F=4.266$; $p>0.05$), although it did between biotopes ($F=11.149$; $p<0.05$). In this case higher means of herbivore fish were found in the spur and groove biotope than in the wall biotope. A more detailed analysis of this aspect showed that no significant differences were found between biotopes regarding macroalgae cover ($F=1.900$; $p>0.05$), which may lead us to think that instead of macroalgae abundance as the reason for herbivore fish distribution in this area, the structural complexity (rugosity) once again may be responsible for these findings. A regression analysis was conducted between these two last variables (abundance of herbivore fish and rugosity) and it did not show any relation between these two variables ($F=0.223$, $p>0.05$, $r^2=0.022$). In fact the regression coefficient was lower than expected.

To further explore this issue a multiple regression analysis (stepwise method) was applied among herbivore abundance, as dependent variables, and percent cover of live coral, recent dead coral, old dead coral, macroalgae, gorgonians, sponges, rock-sand substrate,

number of divers, and number of visits as independent variables. Result shows that percent cover of sponges explains 69.2 % of the error ($F=22.466$, $p<0.05$, $r^2=0.692$). This was completely unexpected and no biological explanation was found. However, neither of the two SCUBA-related variables showed relations with herbivore abundance, supporting the notion that SCUBA diving is not affecting natural communities.

Sessile invertebrates (sponges, gorgonians, and corals) are very well represented in the PFMPA, although signs of deterioration were seen. High numbers of dead coral colonies, algal and cyanophyte cover was observed. A relatively high incidence of bleaching and black band disease was also present. These events had previously been reported by de la Guardia et al. (2004b), who found that 20 % of the coral colonies at the spur and groove biotope had signs of deterioration due to diseases and bleaching. These authors did not find any correlation between these events and SCUBA dive intensity in the area.

Coral cover was rather low and varied from 10 to 25 % throughout the MPA. Alcolado et al., (1998) found even lower coral cover percentages at similar biotopes in Cayo Coco, on the north shore of Cuba and de la Guardia et al. (2004b) also found low coral cover (less than 20 %) for the PFMPA in 2001. Lower percentage of coral cover was found at sites located in the north of the PFMPA; while sites located in the south had higher coral cover. This could be explained by the fact that sites located in the south have more oceanic influence than sites located at the North of the PFMPA. Oceanic waters, although not rich in nutrients, are clean and have more stable salinity and temperature than waters coming from the Siguanea Gulf. It was observed that sites located in the north side of the

PFMPA are receiving higher levels of terrestrial inputs (sediments and fresh water). Significant differences were found only between biotopes with a higher mean of coral cover in the spur and groove area ($F=11.066$; $p<0.05$) (Figure 9). This result matches that of de la Guardia et al. (2004b) who also found significant differences between biotopes regarding coral cover and the spur and groove biotope.

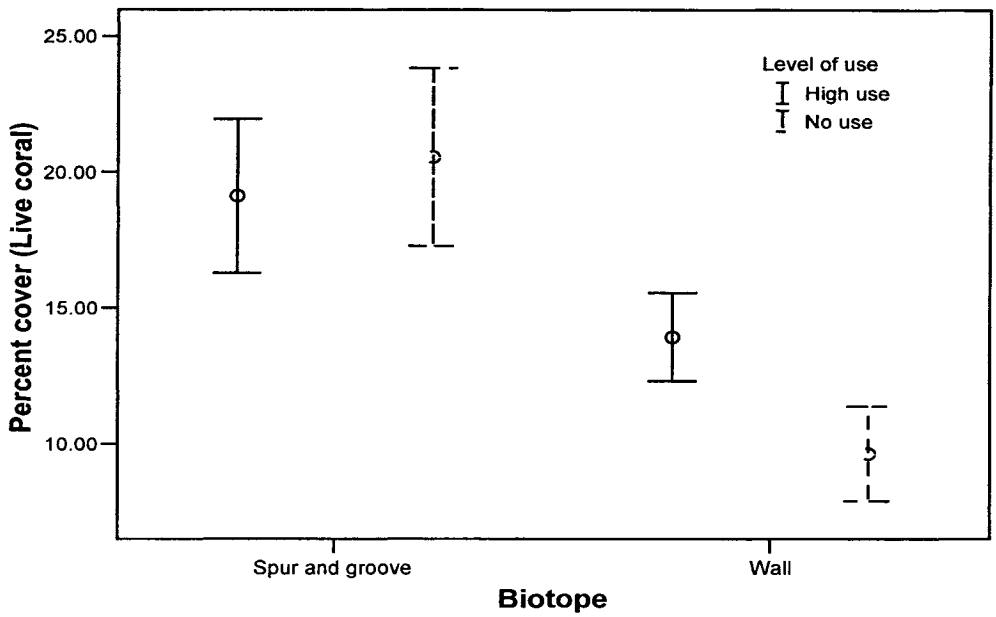

Figure 9. Percent cover of live coral. Circles represent means; bars represent Standard Error of the means.

The ratio of recent and old mortality varied evenly along the park, since no significant differences were found for biotopes and usage levels ($F=2.272$; $p>0.05$ and $F=0.214$; $p>0.05$ respectively). Old mortality probably reflects past alterations suffered by the coral, although it is hard to estimate when they occurred. Recent mortality seems to have been inflicted by coral-related diseases, and not by SCUBA diving.

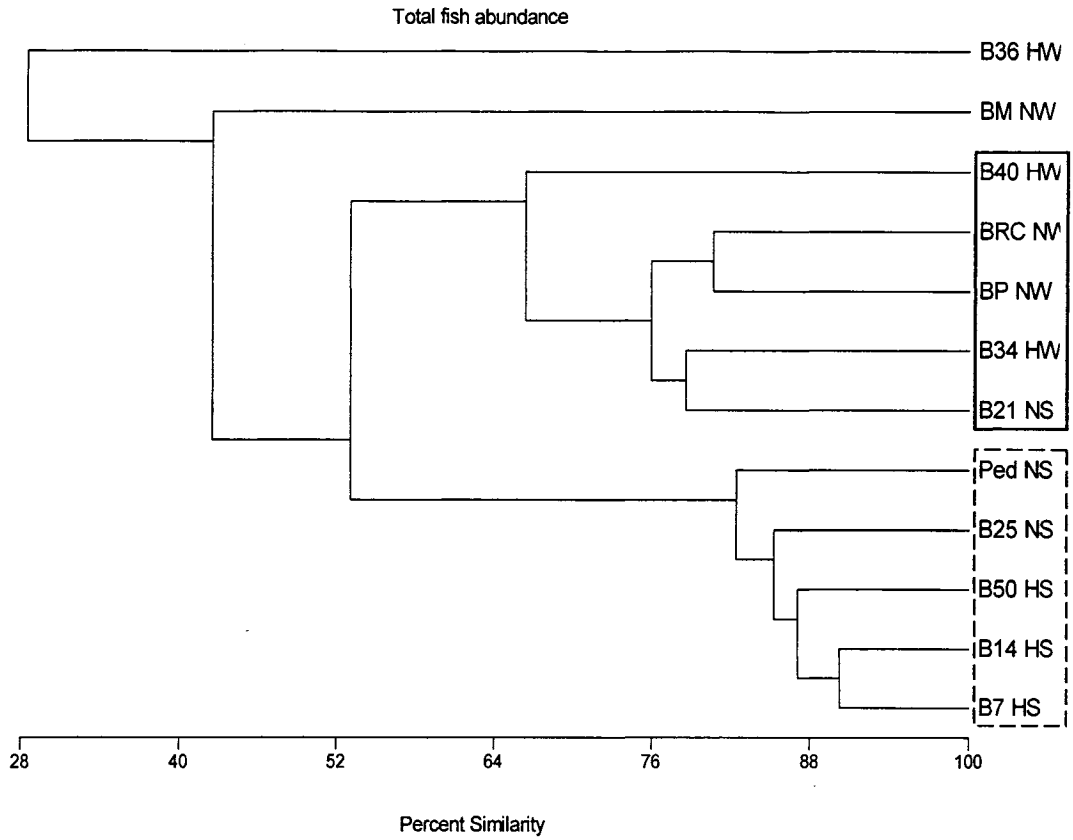

Figure 10. Dendrogram showing similarity between sites for total fish abundance. (HS heavily use-spur and groove; HW: heavily used-wall; NS: non used-spur and groove; NW: non used-wall; B7: buoy 7; B14: buoy 14; B21: buoy 21; B25: buoy 25; B34: buoy 34; B36: buoy 36; B40: buoy 40; B50: buoy 50; BM: buoy M; BRC: buoy RC; Ped: Caleta de Pedernales; BP: buoy P).

Multivariate analysis has been reported as a useful tool to explore relationships between large set of variables, especially when statistical tests do not allow differentiating between groups of samples (Gonzalez et al., 1997b). Figure 10 shows the cluster for the multivariate analyses done with total fish abundance. In general terms, groups are not well formed. Nonetheless, it appears that usage level does not seem to be a grouping factor. Instead groups are primary distinguished according to biotopes.

Figure 11 shows a similar cluster analysis done for abundance of commercial fish. In this particular case, no clear groups were formed. Therefore, it was not possible to identify any possible pattern of distribution of sites according to this variable. Figure 12, on the other hand clearly shows a pattern of distribution similar to figure 10, where groups were formed by biotope and not by level of use. This last cluster was done using data on percent cover.

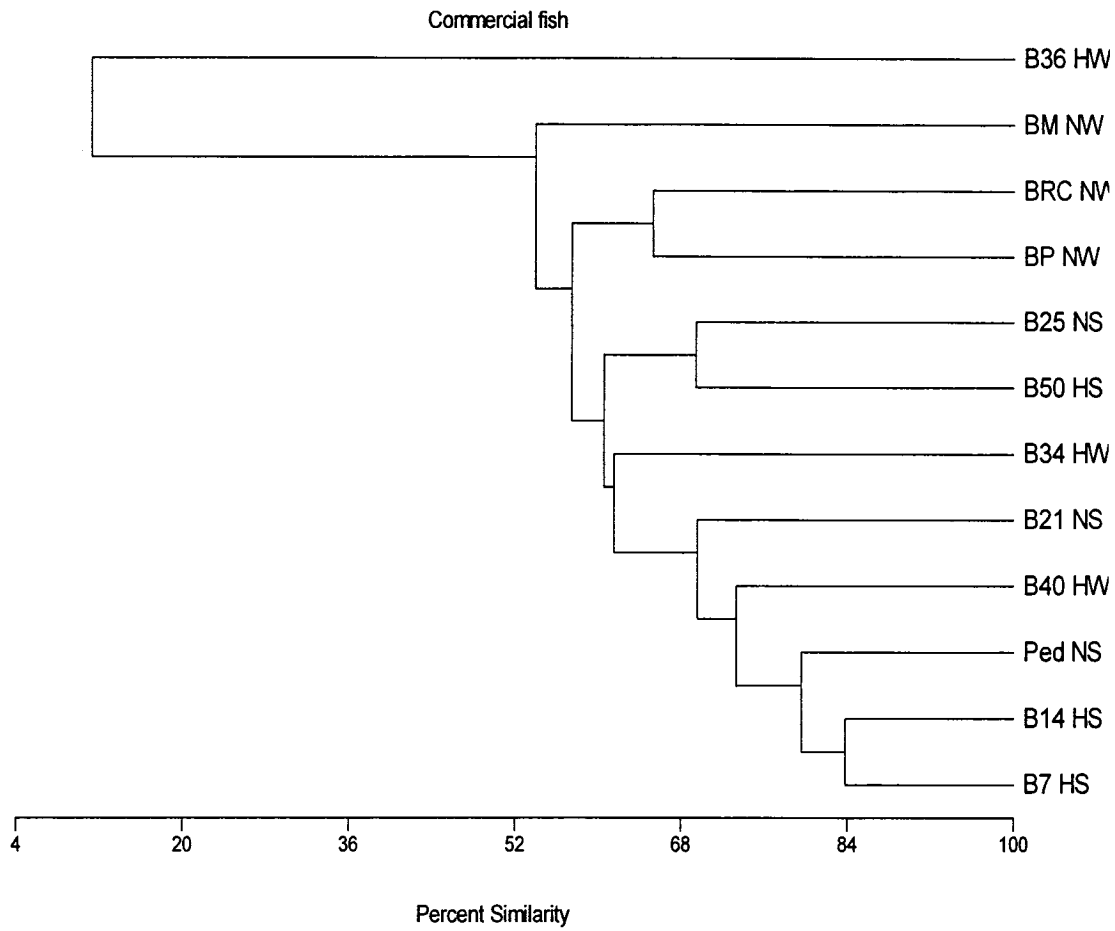

Figure 11. Dendrogram showing similarity between sites for commercial fish abundance. (HS heavily use-spur and groove; HW: heavily used-wall; NS: non used-spur and groove; NW: non used-wall; B7: buoy 7; B14: buoy 14; B21: buoy 21; B25: buoy 25; B34: buoy 34; B36: buoy 36; B40: buoy 40; B50: buoy 50; BM: buoy M; BRC: buoy RC; Ped: Caleta de Pedernales; BP: buoy P).

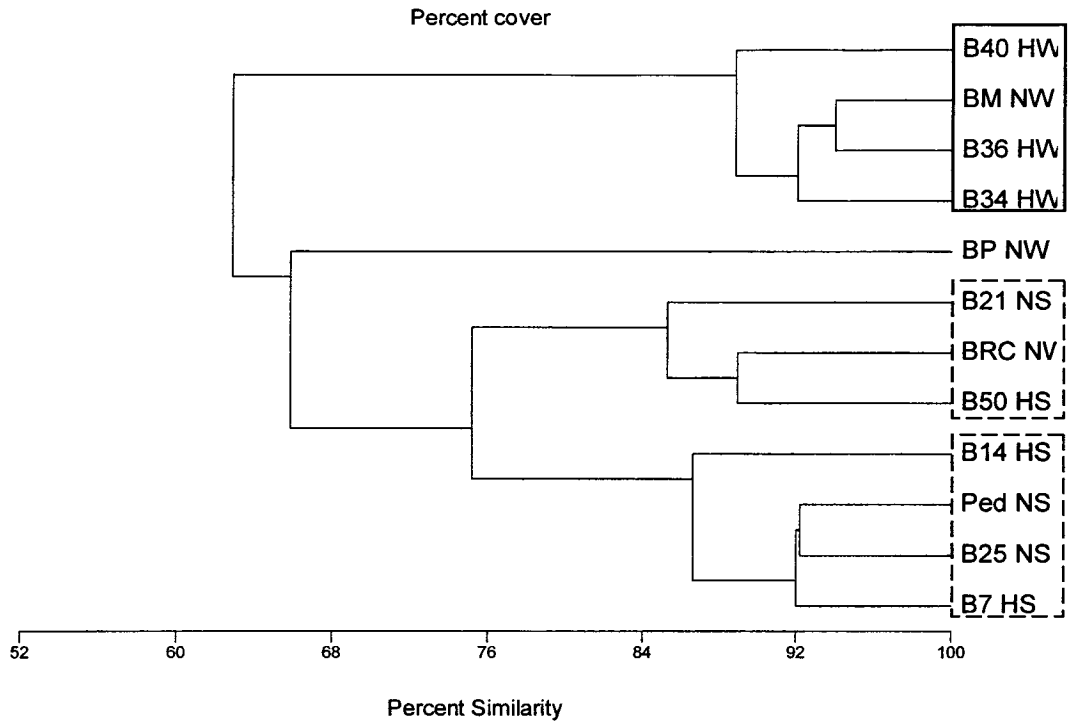

Figure 12. Dendrogram showing similarity between sites for percent cover of live coral. (HS heavily use-spur and groove; HW: heavily used-wall; NS: non used-spur and groove; NW: non used-wall; B7: buoy 7; B14: buoy 14; B21: buoy 21; B25: buoy 25; B34: buoy 34; B36: buoy 36; B40: buoy 40; B50: buoy 50; BM: buoy M; BRC: buoy RC; Ped: Caleta de Pedernales; BP: buoy P).

These results match findings by Gonzalez et al., (1997b) and de la Guardia et al. (2004b) and could be explained in two ways. Firstly, SCUBA dive use has not had any effect on coral reefs in the PFMPA, so there is no differentiation in terms of usage level. Secondly, the scale (in terms of working at the group level of: live coral, macro algae, sponges,) used in this study did not allow for differentiating between use levels. The first option seems more plausible according to results obtained in interviews. The second option, on the other hand, might show that at the current stage of MPA exploitation, a more detailed level of analysis should be applied. In this case, it may be better to work at the species level instead of the percent cover of coral forms and other sessile organisms.

This finding contradicts Edinger and Risk (2000), who concluded that definitions of reef status based solely on percentage of live coral cover should be supplemented with other indices, such as conservation class, that more accurately predict biodiversity value and fisheries potential.

This fact leads to the conclusion that a shift in the scale and complexity of analysis is needed. No longer are species-specific indexes being used exclusively to answer questions related to management issues in coral reefs. Instead, more general approaches are being taken, such as coral morphology and presence/absence indexes. It seems possible from this study, however, that when you are dealing with impacts below significant levels, detection might be possible if the work is done at the species level.

To further explore the distribution of groups found in the cluster analysis a PCA was applied for fish abundance data. Clark and Warwick (1994) reported PCA as the longest-established method, and although the relative inflexibility of its definition limits its practical usefulness, it makes it more suitable to multivariate analysis of environmental data than species abundance or biomass. Nonetheless, it is still widely used, and is of fundamental importance. Also, ter Braak and Prentice (1988) advised the use of linear ordination methods, such as PCA, over non-linear ordination methods, such as Detrended Correspondence Analysis and Canonical Correspondence Analysis when the community variation (gradient) is within a narrow range.

Results of the analysis showed a clear separation along axis 1 between B36 and the rest of the sites (Figure 13A). This is the consequence of the fact that B36 showed a higher abundance of fish in comparison with other sites. This difference introduces a great variance in the data which is reflected in PCA, which separates B36 from the rest of the sites along axis 1. There is also some distribution along axis 2, which appeared to be related to biotopes. To explore this, B36 was removed from the analysis, and results showed the formation of two clear groups along axis 1 with biotopes as the main criteria for separation (Figure 13B). No explanation was found for B21, which despite being representative of the spur and groove biotope, appeared related to the wall biotope group. PCA results strongly support what has been previously found through ANOVA and cluster analysis: SCUBA diving may not be a determining factor that explains coral reef community structure and distribution in the area.

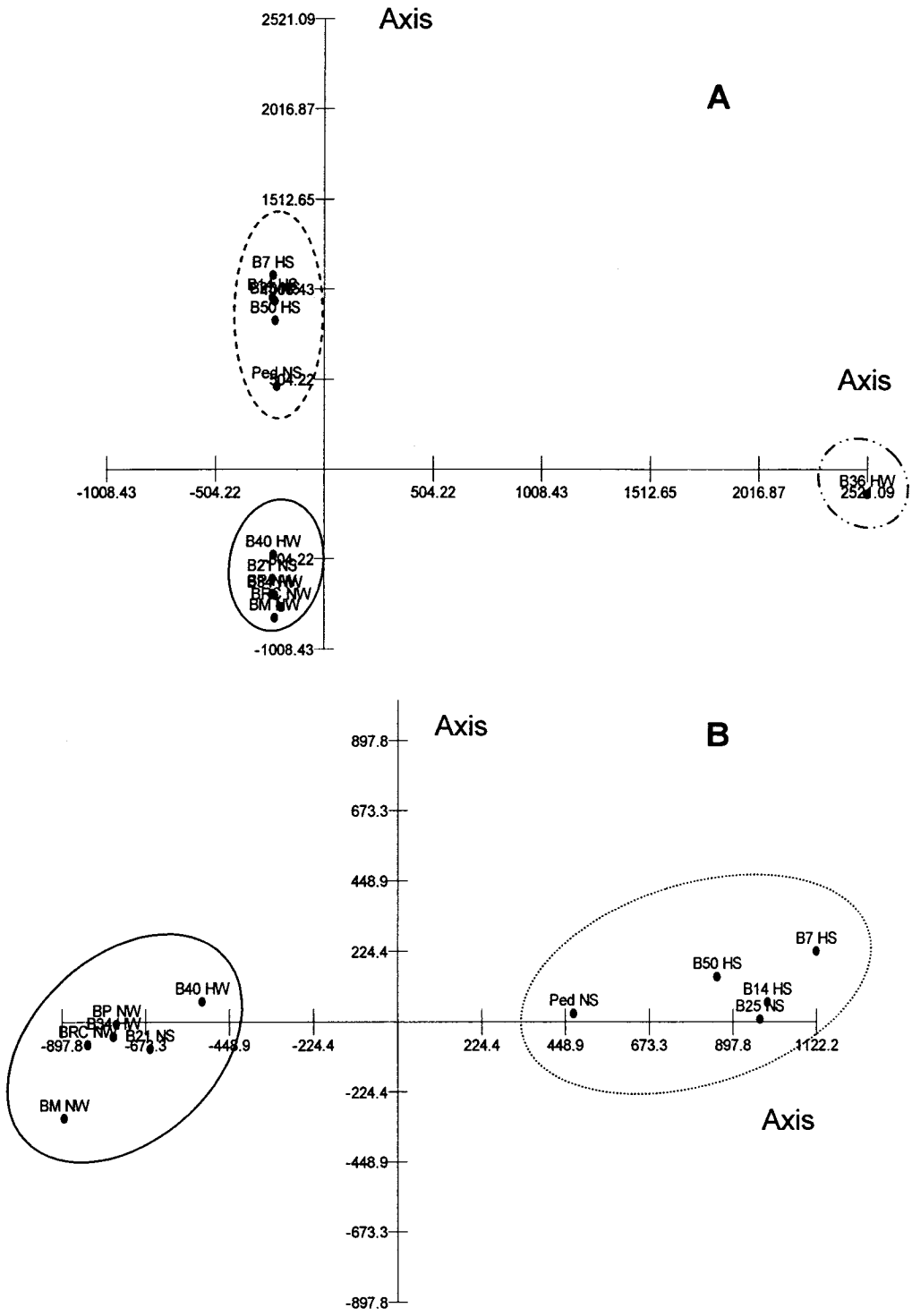

Figure 13. Scatter plot showing PCA results. A: for all sites, B: with B36 HW excluded. (HS heavily use-spur and groove; HW: heavily used-wall; NS: non used-spur and groove; NW: non used-wall; B7: buoy 7; B14: buoy 14; B21: buoy 21; B25: buoy 25; B34: buoy 34; B36: buoy 36; B40: buoy 40; B50: buoy 50; BM: buoy M; BRC: buoy RC; Ped: Caleta de Pedernales; BP: buoy P).

Carrying Capacity of the Punta Frances Marine Protected Area

Figure 14 shows gross incomes to Colony Hotel from tourist activities in the PFMPA. Incomes, although lower than earnings from cruise visits, are significant, and have been the Colony Hotel's *raison d'être* throughout its existence.

It is notable that since 1998 there has been a steady decline in incomes from SCUBA diving, and in the number of tourists (Figure 14). When asked about this, hotel officials expressed that there is no obvious reason for the decrease in the number of dive tourists.

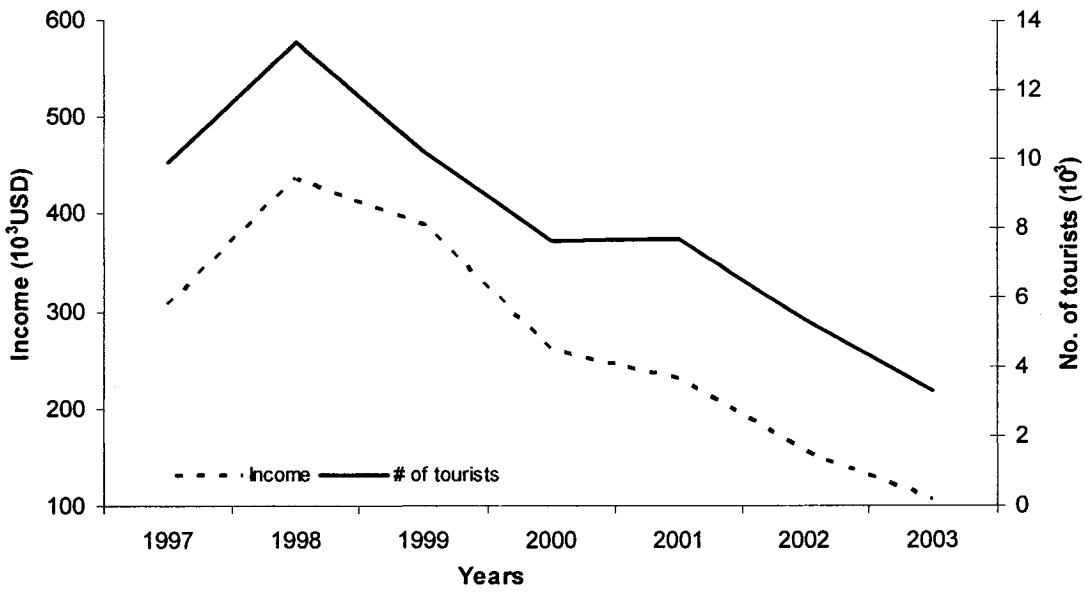

Figure 14. Annual gross incomes of the Colony Hotel from tourist activities at Punta Frances Marine Protected Area. (Source: Colony Hotel)

It is this author's opinion, however, that deterioration of hotel facilities, a decline of service, SCUBA diving safety issues, cruise company competition, and loss of

competitiveness with other Cuban SCUBA-related companies might be the prime reasons behind this reduction in visitors. It should be noted that external factors such as the United States' blockade against Cuba, market/diver fatigue, loss of novelty of the area, global recession effects on tourism, and the September 11th terrorist event might have also influenced this situation.

An important question that arises here is whether or not perception of deterioration of the PFMPA could have provoked this steady reduction of incomes to the Colony Hotel. To explore this question, a survey of tourist divers, dive instructors, and boat skippers that operate in the area was conducted (details on survey construction and objectives are explained in the next section).

In general, tourist divers were pleased with the quality of the PFMPA as a dive destination. There were no negative comments about the PFMPA, instead, the majority of complains were related to hotel conditions and organizational issues. When asked about their opinion regarding the conservation status of the PFMPA, 45.7 % and 40 % considered the PFMPA in excellent and in very good condition, respectively. Also 85.6 % of the respondents considered dive sites at the PFMPA as excellent, and 55.5 % found no evidence of damage in the area. Tourists considered human-related causes as the culprit for some environmental deterioration signs in the PFMPA (Figure 15). According to them, pollution, SCUBA diver impacts, high sedimentation, anchoring on the reef, and fishing were the main reasons for the current status of the PFMPA. Tourist divers in the PFMPA considered themselves as dedicated divers (57.8 %), with more that 100 dives in

their lives (55.1 %). Also, 68.1 % of them considered the quality of diving as the determining factor when choosing their vacation destiny. These results provide evidence thin the PFMPA still holds a natural appeal that made it the prime dive destination in Cuba some 25 years ago. Also given their diving experience, tourist opinions should be considered credible.

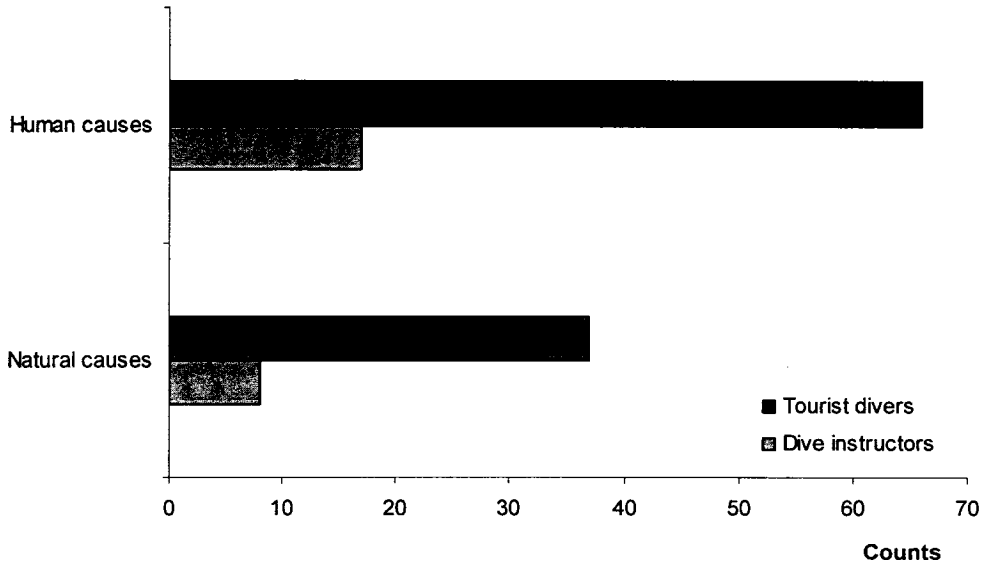

Figure 15. Main causes of Punta Frances Marine Protected Area deterioration according to dive instructors and boat skippers.

Opinions from dive instructors and boat skippers, on the other hand, were more distributed among response options provided in the questionnaire. Their work experiences in the area ranked from 9 to 25 years, and 64.3 % of the respondents have made more than 500 dives in the PFMPA. When asked about rating the current conservation status of the PFMPA, 21.4 % of dive instructors and boat skippers responded as "regular", 42.9 % "good", and 28.6 % as "very good". One might conclude that the PFMPA has not suffered significant deterioration due to exploitation; nonetheless, some damage has occurred. Overall, 85.7 % of the respondents stated that

there is evidence of damage in the PFMPA, and mentioned "human-related causes", such as intense fishing, poor surveillance, boat traffic, and diver impacts (Figure 15). Also, when asked to compare the PFMPA today with the PFMPA a few years ago, the majority of responses (57.1 %) concentrated around "regular" to "good" options. Among the main causes, they mentioned fishing, poor surveillance and enforcement, SCUBA diver impacts, and boat traffic in the area.

There are some points of divergence between tourist divers and dive instructors regarding the main causes of the PFMPA deterioration. It was noticeable that tourists mentioned anchoring as a cause, while instructors did not. Some years ago, anchoring was strictly prohibited in the PFMPA, and mooring buoys were available. As time passed, mooring buoys were lost due to the effect of surge and waves coupled with lack of maintenance. There are no mooring buoys in the PFMPA now, and diving boats drop anchor at certain sites to undertake diving activities. It would not be fair to say that this always happens, because boat skippers and dive instructors are very concerned with the PFMPA conservation. When the weather conditions allow, they do not drop anchors and undertake what they call a drift dive operation. This issue should be of foremost importance for CITMA staff in the PFMPA and for the Colony Hotel. Many authors have identified anchoring as having one of the most important on long lasting negative impacts on the health of coral reefs (Davis, 1977; Rogers et al., 1988; Jameson et al., 1999).

Another important aspect mentioned either by tourists and dive instructors was impacts from divers. A large amount of scientific material has been produced dealing with this

problem and some authors have called it carrying capacity. Colony officials kindly provided us with information from the boat's log books. According to them, the PFMPA receives an average of 7,149.3 tourist divers per year. Assuming an even distribution of divers and that each diver does two dives per site, then yearly average dives per site would be 255.33 (Figure 16). This number is remarkably low compared with others diving destinations in the Caribbean, such as the Bonaire Marine Park, which receives around 17,000 divers per year (Dixon et al., 1993). Hawkins and Roberts (1997) found a first order polynomial relationship between percentage of damaged coral colonies and number of dives (r^2= 0.88). These authors set figures of 5,000 to 6,000 dives per site per year as a threshold level above which SCUBA diving may cause detrimental effects on coral reef. This finding coincided with Dixon et al. (1993) findings for Bonaire Marine Park. Using the figures provided by Hawkins and Roberts (5,000 to 6,000), and assuming an even used of the existing 56 diving sites in the PFMPA, the area can hold up to 336,000 dives per year. Undoubtedly, the PFMPA is still far from reaching its carrying capacity levels in terms of SCUBA diving use.

Nonetheless, this estimation should be seen with caution. Figures provided by Hawkins and Roberts (1997) and Dixon et al. (1993) only took into account the number of dives and percentage of damaged coral colonies, and assumed that damage to corals was only caused by divers. In reality, carrying capacity is a function of many other factors such as: number of people entering the water, means of accessing the water (anchoring, shoreline, boardwalks), activity (diving, snorkelling, with gloves), diver experience (training and education), existing management tools (fines, visitor facilities, restricting access), natural

physical conditions (depth, topography, currents, waves), type of corals (form and fragility), extent of other stresses (natural and human induced), and the level of acceptable change (Gallo et al., 2002; Spurgeon, (in prep.)).

The PFMPA dive sites have not been evenly used for many years (Figure 16), which mean that diving pressure is concentrated on a few sites, making then more susceptible to damage. Also, although anchoring is not allowed it does occur, introducing another uncontrolled variable to the system. The PFMPA is also the site of other economic activities, such as cruise tourism and illegal fishing, as well as natural events, such as hurricanes, that also affect the area very frequently. Therefore, a precautionary approach should be taken when planning for SCUBA dives because the carrying capacity level in the PFMPA might be lower than that reported by Dixon et al. (1993) and Hawkins and Roberts (1997).

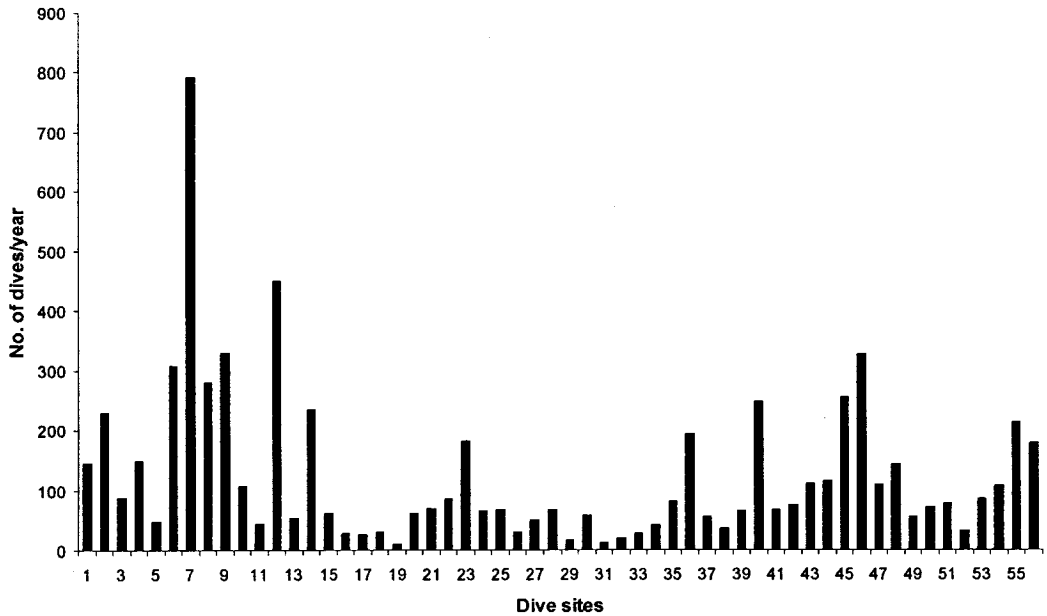

Figure 16. Dive intensity at Punta Frances Marine Protected Area. Source: Boat's log books.

Conclusions

Even though strong evidence exists about damage caused by SCUBA diving to coral reefs in other locations (Hawkins and Roberts, 1992, 1993, 1994, 1997; Davis and Tisdell, 1995b) this does not appear to be the case in the PFMPA. SCUBA diving is considered as an activity with residual and sub-lethal effects in the longer term. This, together with the fact that site selection for SCUBA diving is a function of their quality, makes any impact detection very difficult (Hawkins and Roberts, 1992, 1993; Chadwick-Furman, 1997).

Other factors that also might be affecting coral reefs in the PFMPA, which were not taken into consideration in this study, could include snorkel diving by cruise ship tourists on near shore reefs, illegal fishing that takes place within the area, and commercial fisheries that removes emigrants from the park. The catches from these later two activities is not known, so it is not possible to say how many fish are actually removed from the MPA. Also, according to interviews, cruise ships appear to be inflicting a greater impact on the PFNMP coral reefs, although this assertion needs to be tested. Cruise ships are increasingly visiting the park, and this appears likely to continue into the future. The actual effects of these large ships hovering over the reef are unknown. Issues such as underwater noise pollution and sewage discharge from ships should also be examined.

From this study it can be concluded that SCUBA diving has no apparent impact on the coral reefs in the PFNMP at present. Nonetheless, this should not be taken as a final statement, given that a more precise sampling design is needed to overcome the problems

with the power of the test. Furthermore, it appears that the analysis should be conducted at the species level for some sessile organisms, especially coral colonies, when looking for human-induced impacts at a low level.

It is also important to stress the importance of time scale in this type of study. In this particular case two years were considered sufficient to detect human-induced changes in coral reef communities. Nonetheless, this author considers that a longer period of time may have produced superior results, especially for long[lived species that have turnover times much longer than two years.

It can be concluded that evidences found in this study indicates that deterioration of the PFMPA has not been a reason for the declining trend in income experienced by the Colony Hotel. The PFMPA still holds sufficient natural attractiveness to draw attention from the diving industry. To support this it can be said that no loss of amenity values related to diving was perceived. Davis and Tisdell (1995b) stated that before any signs of physical deterioration appear due to high levels of SCUBA-diving, amenity values are first affected, and proposed assessing diver's perceptions to determine this.

Questionnaires used in this study aimed to measure divers perceptions, and results presented did not provide any indication of declining amenity values. Additionally, no significant impacts from diving over the coral reefs were proved through the biological assessment to the PFMPA dive sites. Finally, 95.3 % of the diving tourists did not consider the place to be overcrowded, and 57.2 % of the dive instructors and boat

skippers shared the same opinion. Nonetheless, a precautionary approach is recommended to be used when planning and managing SCUBA diving in the PFMPA. Carrying capacity results showed that, apparently, this area is still far from reaching an internationally accepted number of divers above which coral reef damage becomes evident. However, other aspects such as anchoring and uneven use of dive site may be interacting, decreasing carrying capacity levels in the PFMPA.

Section II

Economic Benefits from Resource Use vs. Nature Protection: An Analysis of the Punta Frances Marine Protected Area

Introduction

Marine protected areas contain some of the world's most beautiful scenery and outstanding natural and cultural seascapes. The natural or near-natural environment features of MPAs constitute attractions that in many countries have become the keystone of tourism and recreation. This implies an economic relevance of MPAs, although promoting tourism for the economy has not been the primary role for most MPAs, and conservationist objectives have prevailed over economic interests as major functions of MPAs (Task Force on Economic Benefits of Protected Areas of IUCN in collaboration with the Economic Service Unit of IUCN, 1998).

The debate over using MPAs as environmental protection tools versus using them for developing economic opportunities is often about balancing benefits and costs associated with leaving areas in their natural, or near-natural, state with those obtained by exploiting them. For most developing countries this question becomes crucial. On one side, there is the vital need to produce goods and services to increase economic welfare, and on the other side there is the necessity of preserving natural resources either for the sake of protecting them or for their future use. Of course there is no one-size-fits-all answer for this. Developing countries differ in many aspects, i.e. culturally, sociologically, economically, so their necessities and priorities will vary across a very broad spectrum.

The Caribbean, also known as the Wider Caribbean or the American Mediterranean, is a diverse region that includes 14 continental countries and 23 island nations (Beekhuis, 1981). This diversity of cultures, languages, and socio-economic development makes generalization a rather difficult task. Nonetheless, every Caribbean country shares a common commodity, i.e. excellent conditions for coastal tourism. This is especially true for the island nations that coexist in the Caribbean basin. Also, the tourism product in the Wider Caribbean is largely dependent on the natural resource base; that is, on the physical and biotic environment. This has provoked an increasing concentration of tourist facilities in the coastal areas (UNEP, 1997).

The Caribbean region is still marketed as a "3s" (sun, sand, and surf) tourism destination, despite the existence of unspoiled natural environments (Silva, 2002; Weaver, 1994). This may seem ambiguous, given the myriad natural and cultural attractions that the region enjoys. The contradiction is the result of many years of old-fashioned marketing, and the negative environmental and social impact that has occurred, particularly in the less-economically developed Caribbean nations (Weaver, 1994).

Current trends in Caribbean tourism development are pointing towards reassessing the way in which their current "3s" products are being delivered. This strategy is based on the fact that most Caribbean tourists come from industrialized countries and are demanding nature-based vacations (Gössling, 1999). Silva (2001) pointed out that over 46 % of respondents in a motivation survey were interested in natural marine attractions as the main reason for their visit to Belize. Similar results were found by Boers and Bosch

(1994) and WTTC et al. (1997), as cited by Burke et al. (2001), for surveys done in Spain and Japan, respectively. In both cases, appreciation and enjoyment of nature-related attributes was the main reason to undertake tourism activities. Essentially the Caribbean strategy should aim to introduce the application of ecotourism principles into the usual "3s" type of tourism to reduce the social and environmental impacts of tourism activities. Two main advantages can be recognized in this strategy. First, there is no need to find new tourist products to advertise and sell. Second, there is a well established market that can be accommodated; it will both maximize economic profits and protect the environment.

Although this strategy might be correct in some points, there is a downside, which is that it might allow for an incorrect interpretation, and consequently an incorrect implementation, of ecotourism. If tourism operators incorrectly label all their "3s" products as ecotourism, it is obvious then that the very same environmental and social impacts will remain, thereby jeopardizing the resources on which the activity is based, and the credibility of "ecotourism" as a sustainable approach to tourism development. For these reasons more drastic approaches need to be taken. This means working towards changing current perceptions regarding ecotourism, which is being marketed and sold in disregard of the set of principles elaborated by Hetzer (1965) and the International Ecotourism Society (IES).

The bi-directional nature of the relationship between tourism and natural resource conservation must be fully understood and employed. It provides good incentives for

protection and offers a common ground for merging tourism development and nature protection. Coastal tourism is sometimes used as an economic justification to create MPAs and, at other times, the existence of a MPA justifies the development of tourism activities. An example of this is that overall, 50 % of dives in the Caribbean take place within MPAs (Green and Donnelly, 2003). Ceballos-Lascurain (1996) pointed out that nature-oriented tourism is able to make tourists active supporters of environmental conservation.

Two practical examples of the use of this bi-directional relationship in the insular Caribbean can be found at Bonaire National Marine Park and Saba Marine Park. Bonaire National Marine Park, founded in the early 1980s, receives approximately 26,000 to 28,000 divers and an unknown number of snorkellers, sport fishermen, windsurfers and local people every year. The magnitude of the tourism industry in this small island is such that half of its GDP comes from tourism revenues (Pendletonne, 1995). In 1991, the tourism industry depended entirely on the park reported net revenues of around US $22 million (Dixon, 1993). The operational costs of the park is self-financed through the collection of diver admission fees (Silva, 2001; Green and Donnelly, 2003). This park has been recognized as a good example of what can be achieved in meeting economic goals, while keeping the marine environment protected (Dixon et al., 1993, 2000; Silva, 2001). According to Dixon et al. (1993), this park is in position to increase its economic revenues from SCUBA diving by implementing environmental education programs to tourists.

Saba Marine Park (Netherlands Antilles), established in 1987, constitutes another successful example in maximizing the tourism-nature relationship. Since its beginning a fund-raising effort was implemented that helped to cover 70% of its operational costs (Agardy, 1993; Spalding, et al., 2001; Green and Donnelly, 2003) making the park self-sufficient in economic terms, and a source of economic benefits for local people. In 1988, one year after its creation, revenues from the park fluctuated around US $1.5 million (Dixon, 1993). These economic benefits have increased proportionally since then, with the use of the park for tourism and at the same time have produced a strong economic incentive to protect the marine environment.

These examples demonstrate that it is possible to extract economic and social benefits from the tourism-nature bi-directional relationship. Several authors, therefore, have called for the use of MPAs as a way to make operational the concept of ecotourism (Agardy, 1993; Stewart, 1993; Ceballos-Lascurain, 1996; Hodgson and Dixon, 2000; Dixon et al., 1993, 2000; Silva, 2001; Green and Donnelly, 2003, Sobel and Dahlgren, 2004). Further, international agencies such as the World Bank have argued that although MPAs are usually established for nature protection objectives, some trade-offs should exist between protection and wise use of marine resources, and ways should be found to produce economic benefits from marine areas while protecting species or ecosystems. In this regard, it has been found that proper management can yield both protection and development benefits, although issues such as carrying capacity and retention of economic benefits within the local economy are important for the long term sustainability of the marine-based tourism.

This worldwide trend in using MPAs as tourism attractions is justified because the economic and social values associated with tourist arrivals are beginning to compete with, or even outweigh, the value of, for example coastal fisheries. Coral reef-based tourism is attracting millions of divers per year, and these tourists will often select their location and pay more to observe undamaged reefs (Green and Donnelly, 2003; Rudd and Tupper, 2002; Walters and Samways, 2001). The value of tourism has been critical for some sites in providing direct income for management and enforcement activities. For example, user fees in the marine parks on Saba and Bonaire in the Netherlands Antilles covered 60 % to 70 % of the park's annual running cost in 1999 (Dixon et al., 2000; Spalding, et al., 2001; Green and Donnelly, 2003) with much of the remainder being provided by the sales of souvenirs and yacht fees. Even where such direct benefits cannot be calculated, however, the income provided to individual hotels, dive companies and national economies from dive tourism is clearly enhanced in many countries by the presence of MPAs (Green and Donnelly, 2003).

The arguments presented above may suggest that converting MPAs into tourist attractions and making them ecotourism tools is a straightforward task. Nothing is farther from truth. Many important issues must be resolved, such as the availability of suitable legal frameworks, clear definition of MPA objectives, identification of which ecosystem components should be protected and the extent of that protection, modeling or predictions to demonstrate that benefits will outweigh the opportunity costs and direct costs of protection, and provision of true benefits and alternative solutions to local inhabitants who will bear most of the costs if various human uses are excluded from an MPA.

This section of chapter 4 aims at looking into economic benefits provided by the PFMPA, and whether or not they outweigh the costs associated with nature protection.

Materials and Methods

A classification of benefits provided by the PFMPA was made using the typology presented in Chapter 2. A monetary value was assigned to each benefit in order to assess two possible scenarios, and to compare these figures with costs related to nature protection. It should be made clear that estimation of monetary value for each benefit was done in a preliminary way. The rationale is that it was impossible to collect all the relevant data needed given the wide spectrum of possible benefits. In some cases classical valuation methods were used depending on the data available, in others instances figures extracted from the literature and estimates provided by tourism officials were used to calculate monetary value of benefits. The underlying principle throughout the analysis was that it is better to have at least a rough estimate than a blank space. Two possible scenarios are presented. Scenario I shows current benefits provided by the PFMPA to humans and nature, while Scenario II illustrates potential benefits that the PFMPA could provide if the area is finally approved as a National Marine Park and management is fully efficient. The exchange rate of 24/1 between USD and Cuban pesos was always used in the valuation of benefits.

Twelve face-to-face interviews were held with park staff members, representatives from the Colony hotel and the cruise company (Cubanco S.A.). First, three main groups were identified: park staff, Colony hotel workers, and Cubanco S.A. company. Then, within

each group a snowball technique was used to select interview subjects. The final number of subjects was 12 (4 from each main group). A larger number of subjects could have been selected, but it was not necessary, given the nature of the socioeconomic information needed and the small number of people that work directly in the area. Each subject was given an explanation of the nature and objectives of the research, verbal consent was obtained from each of them. Anonymity was assured to each participant and all written and tape recording was destroyed after analysis to avoid subject identification.

Economic information was obtained from Colony hotel officials as well as the PFMPA staff. Most of the information consisted of time series data, which is depicted below.

- Number of visitors at the Colony Hotel (1997-2003)
- Income from tourism activities at the Colony Hotel (1997-2003)
- Dive distribution per site (Dive boat's logbook) (1996-2001)
- Income to the park from cruise visits (1996-2001)
- Number of cruise visitors (1996-2001)

Results and Discussion

Scenario I

Table 7 depicts benefits provided by the PFMPA at its current management status (Scenario I). A total of twelve benefits were identified and a detailed explanation of each benefit as well as the method followed to estimate its economic value, when it was possible, is presented below.

Non-fishery benefits

Expand non-consumptive recreation opportunities: SCUBA diving is the most important non-consumptive tourism activity currently undertaken in the PFMPA. However, other activities related to cruise ship arrivals are gaining in importance lately. Economic value of this type of benefit was estimated based on the price tourists pay to dive in the PFMPA today. The figure presented in Table 7 (**USD $ 230,967.49 y^{-1}**) corresponds to the annual mean of gross income from SCUBA diving in the PFMPA according to Colony Hotel officials.

Enhance other forms of income generation: There are other activities that produce significant revenues and are closely related to the PFMPA i.e., marina services, live a board yacht charters, private excursions and others. The economic valuation of this benefit includes two main components. On one side the annual mean of gross income from gear rentals, diver training, safaris at sea (Seafari), live a board, marina services from Colony Hotel (USD $38,344.14 y^{-1}). On the other side, the Colony hotel provides

several services to tourists coming in cruise ships. Among them are snorkelling, SCUBA diving, discovery diving (shallow dives for people without any diving experience), and renting of nautical equipment. According to Colony officials income from these services varies from USD $2,500.00 to USD $4,100.00 per cruise visit. Assuming a mean income of USD $3,300.00 per cruise visit from these services and that cruise ships arrive once a week for 40 weeks per year, it is possible to forecast an annual income of around USD $132,000.00 y^{-1}. This figure added to USD $38,344.14 (see above) makes an annual estimate of **USD $170,344.14 y^{-1}**.

Management benefits

Maintain diversity of fishing opportunities: Currently only fishing for lobster is allowed within the PFMPA. Approximately 10 tonnes are caught per year in the area. The economic value of this benefit was calculated taking into account what the area produces per year and the price paid for lobster to fishermen, which is 700.00 Cuban pesos/tonne plus a bonus in USD that constitutes the 20% of the total value of the catch, after boat expenses have been covered.. Projecting an annual catch of 10 tonnes, out of which fishermen use 1 tonne to pay for running costs, income to fishermen would be of 6,300.00 Cuban pesos plus USD $1,260.00 per year. Converting the Cuban pesos into USD would make USD $262.50, which added to the bonus price represents a total annual income of **USD $1,522.50 y^{-1}**.

Education/research benefits

Provide educational opportunities: The PFMPA has served as a field laboratory for the implementation of graduate courses for international students. The Center for Marine Research (CMR) at the University of Havana has been responsible for this. In order to provide a figure of monetary value of this type of benefit the cost of a course to an international student was used as a proxy. In this case six international students have attended courses so far at a cost of USD $1,000.00 per person. This makes a total of **USD $6,000.00 y^{-1}**.

Allow research, monitoring and data collection from untouched sites: Two research projects have been carried out in the PFMPA by the CMR. Monetary value of this benefit reflects funds allocated to undertake these activities (i.e. costs). The first of such initiatives totaled USD $31,186.25 while the second accounted for USD $16,295.00. These two figures added up for a total of **USD $47,481.25**. This total figure should be higher given that other institutions may have developed research projects in the PFMPA. Unfortunately, this information was not available at the moment of this study.

Cultural benefits

Enhance aesthetic experiences and opportunities: Foreigners receive virtually 100 % of this benefit. Nationals do not benefit because, with the exception of the handful that work there, they have been excluded from the PFMPA by rules and by problems with transportation and access. The monetary value presented in Table 7 was calculated by

adding the average yearly price the cruise company pays to CITMA for using the PFMPA as a tourism destination and the average yearly income for accommodation and diving at the Colony hotel). This is (USD \$6,831.00 y^{-1} + USD \$1,514,052.14 y^{-1}) = **USD \$1,520,883.14 y^{-1}**.

Process benefits

Protect from coastal erosion: Coral reefs at the PFMPA protect the beach and mangrove areas from erosion. It has been recognized that beaches and mangrove areas provide many important ecological goods and services, i.e. nesting and nursery habitats for commercially important species, they also serve many socio-economic functions such as recreational and tourism destination sites (Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas (MPP-EAS), 1999). To estimate an economic value for this benefit the replacement cost method was used. This cost-based method has been reported successful in many instances. For example the MPP-EAS (1999) employed the method for estimating the economic value of shoreline protection in Malaysia, the method was also used by Costanza et al. (1997) in estimating the value of world ecosystems. It has, however, some intrinsic limitations, such as not considering individual or social preferences for ecosystem services, and assuming that expenditures to repair damage or to replace ecosystem services are valid measures of the benefits provided.

Table 7. Scenario I. Current benefits and economic value provided by the Punta Frances Marine Protected Area to humans and nature.

CURRENT PFMPA BENEFITS					
To humans				**To nature**	
DIRECT		**INDIRECT/OFF SITE**			
Non-fishery benefits	**Management benefits**	**Education/Research benefits**	**Other benefits**	**Protection benefits**	**Ecosystem benefits**
I. Expand non-consumptive recreation opportunities (SCUBA, ecotourism). II. Enhance other forms of income generation.	I. Maintain diversity of fishing opportunities.	I. Provide educational opportunities. II.. Allow research, monitoring and data collection from untouched sites.	I. Enhance aesthetic experiences and opportunities.	I. Protect from coastal erosion. II. Provide physical refugia. III. Avoid physical damage to habitats. IV. Maintain global climate regulation.	I. Preserve natural communities composition and functioning. II. Maintain biological diversity.
Estimated value/year (USD)	**Estimated value/year (USD)**	**Estimated value/year (USD)**	**Estimated value/year (USD**	**Estimated value/year (USD)**	**Estimated value/year (USD)**
I. 230,967.00 II. 170,344.00 **Total: 401,311.00**	I. 1,523.00 **Total: 1,523.00**	I. 6,000.00 II. 47,481.00 **Total: 53,481.00**	Foreigners: 1,520,883.00 Nationals: 0.00 **Total: 1,520,883.00**	I. 6,004,050.00 II 389,011.00 III. 1,919,500.00 IV. 508,094.00 **Total: 8,820,655.00**	I. 237,798.00 II. 1,759,373.00 **Total: 1,997,171.00**
Total to humans/year (USD) 1,977,198.00				**Total to nature/year (USD) 10,817,826.00**	
			Total/year (USD): 12,795,025.00		

Note: Economic value figures were rounded.

In the case of the PFMPA, calculations were made using costs of recovering Varadero beach, the most important tourist area in Cuba, which was USD $39 million in total at USD $1,950,000.00 per km of coast. Although the PFMPA does not enjoy the international reputation that Varadero does, it was reasonable to use this figure because, in first instance the PFMPA could be considered to have similar or even better quality beach than Varadero in terms of its natural appeal and sand quality. Secondly, the remote location and difficult access thin the PFMPA enjoys clearly add value to it, and may compensate somehow for its less well-known status in comparison with Varadero. There are 3.079 km of sandy beach in the PFMPA. Multiplying this figure by the cost of recovering 1 km of beach using Varadero's estimate, the total economic value of this benefit would be of **USD $6,004,050.00 y^{-1}**.

Provide physical refugia: The mangrove and coral reef systems in the PFMPA constitute important habitats that provide shelter to different life stages of many commercially important and migratory species, such as birds. The habitat/refugia function of mangroves is very important, both with regard to their value as nursery areas for commercially important species (fish and crustaceans) and as resting and feeding areas for many migratory (and sedentary) species. Costanza et al. (1997) estimated the economic value of these services at an average of USD $439.00 ha^{-1} y^{-1}. Additionally, de Groot (1992) calculated the value of these functions for coral reefs at USD $7.00 ha^{-1} y^{-1}. Using these figures as references and knowing that in the PFMPA there are 875 ha of mangrove system and 698 ha of coral reef system; then the economic value of this benefit

was calculated as (875 ha * USD \$439.00 ha^{-1} y^{-1}) + (698 ha * USD \$7.00 ha^{-1} y^{-1}) = **USD \$389,011.00 y^{-1}**.

Avoid physical damage to habitats: This benefit is well-related to the protection from coastal erosion benefit because a healthy coral reef will ensure that important coastal habitats, such as mangrove and seagrass beds, would not be physically altered by ocean energy. Modification of these habitats causes other ecological functions to be severely altered, producing, therefore, an unpredictable response of unknown magnitude and cost. Costanza et al. (1997) calculated an economic value for this type of benefit of USD \$2,750 ha^{-1} y^{-1}. Taking into consideration that in the PFMPA there are 698 ha of coral reef it is possible then to estimate an economic value for this benefit of (698 ha * \$2,750.00 ha^{-1} y^{-1}) = **USD \$1,919,500.00 y^{-1}**.

Maintain global climate regulation: It has been estimated that coral reefs act as a sink of 111 million tonnes of carbon per year (Spurgeon, 1992). This is the equivalent of 2% of the present output of anthropogenic CO_2. Costanza, et al. (1997) estimated an average value for this ecosystem service of USD \$38.3 ha^{-1} y^{-1} for oceanic systems. These authors also reported that carbon sequestration by wetlands represents an economic value of USD \$265.00 ha^{-1} y^{-1}, and tropical forest represents an economic value of USD \$223 ha^{-1} y^{-1}. Calculations for the PFMPA were made using these figures and taking into account that the marine area in the PFMPA is 3014 ha, and the terrestrial area encompasses 1596 ha, out of which 721 ha are tropical forest and 875 ha are mangrove. Hence, the economic

value for this benefit was calculated as: (3014 ha* USD \$38.30 ha^{-1} y^{-1}) + (721 ha * USD \$223.00 ha^{-1} y^{-1}) + (875 ha * USD \$265.00 ha^{-1} y^{-1}) = **USD \$508,094.20 y^{-1}**.

Ecosystem benefits

Preserve natural communities' composition and functioning: Healthy natural communities contribute to the sustainability of economic activities that rely on them. In the PFMPA natural communities are in goodhealth, according to evidences found in the biological study reported here. This means that SCUBA diving and cruise ship activities can be maintained with the consequent revenue generation. At the same time healthy communities preserve vital ecological goods and services. The economic value of this benefit was calculated based on yearly average income from economic activities undertaken in the PFMPA. This is from SCUBA diving and cruise ship visits. (USD \$ 230,967.49 y^{-1} + USD \$6,831.00 y^{-1}) = **USD \$237,798.49 y^{-1}**. This figure should be considered to be rather conservative because it only takes into account values from economic activities, leaving out vital goods and services provided by healthy communities.

Maintain biological diversity: Turner et al. (2003) stated that economic valuation becomes most difficult when assessing biodiversity, per se. If biodiversity is considered as the "glue" that holds all of nature's structure and processes together, it is indispensable and therefore invaluable. There are also issues with the complexity of the concept and its different levels of expression. Nunes & van den Bergh (2001) concluded that monetary valuation of changes in biodiversity requires, *inter alia*, that a clear diversity level (i.e.

genetic diversity, species diversity, population diversity, ecosystem diversity) is chosen, that a concrete biodiversity change scenario is formulated, that a multidisciplinary approach seeking the identification of direct and indirect effects of the biodiversity change on human welfare is used, and, very importantly, that the change is well defined and not too large. On the other hand, Faber et al. (1996) pointed out that biodiversity is an abstract notion, linked to the integrity, stability and resilience of complex systems, and thus difficult to disentangle and measure. For this study the biodiversity value was estimated as the arithmetic sum of all those benefits that directly depend on the existence of that biodiversity: These include expanding non-consumptive recreation opportunities (USD $ 230,967.49 y^{-1}) + maintaining diversity of fishing opportunities (USD $1,522.50 y^{-1}) + providing educational opportunities (USD $6,000.00 y^{-1}) + enhance aesthetic experiences and opportunities (USD $1,520,883.14 y^{-1}) = **USD $1,759,373.13 y^{-1}**.

Scenario II

Table 8 shows Scenario II, which projects the potential benefits that the PFMPA could provide if well implemented and managed. As in the previous scenario, a detailed description of each benefit and the calculation of its economic value is presented below.

Fishery benefits

Support sport trophy fisheries: Sport fisheries can be developed in the area due to the occurrence of species such as: Great barracuda (*Sphyraena barracuda*), Tarpon (*Megalops atlanticus*), Permit (*Trachinotus falcatus*), Cero (*Scomberomorus regalis*),

Common snook (*Centropomus undecimalis*). At Jardines de la Reina, another MPA in the Cuban archipelago, the price for this activity fluctuates between USD $70.00 and USD $180.00 per day (Pina, personnel communication). The price included boat, fishing gear, crew, and guide service. Given the PFMPA's natural features and opportunities, an average price of USD $100.00 per day could be charged. (Borrego, personnel communication). The calculation was made assuming that this activity will be taken by a maximum of 10 people per day throughout the year. Rationale for this assumption is based on considerations from Colony Hotel officials that considered real and potential possibilities of the Colony Hotel in terms of number of boats available and existing facilities to undertake this activity. The economic value of this benefits was calculated as (USD $100.00 day $^{-1}$ * 10 people * 300 days) = **USD 300,000.00 y^{-1}**.

Allow for spillover of adults and juveniles: If protection from fisheries is truly effective within the PFMPA there are chances for spillover of adults to adjacent fished areas. The small size of the MPA, together with the fact that much of its boundary does not coincide with ecosystem boundaries is conducive to the movement of fish outside the MPA (Appeldoorn et al., 2003), thereby improving the quality of yields and increasing economic revenues for fishermen.

In the Cuban fishery system, there are four weight groups that determine the value of the catch. Especial Group includes all fish over 950 g and it is paid at 1,500.00 Cuban pesos per tonne (typical species of this group include: Muttonne snapper *Lutjanus analis*, Cubera snapper *Lutjanus cyanopterus*, and the like). All other fish below 950 g fall

within groups A, B or C, which are paid as follow: Group A at 800.00 Cuban pesos per tonne, Group B at 400.00 Cuban pesos per tonne, Group C at 200.00 Cuban pesos per tonne. In all cases there is a bonus price which is paid in USD and constitutes 20% of the value of the whole catch after costs of running the boat have been covered. Tuna and demersal fishermen have reported that 1 tonne of catch per fishing trip (typically 10 days) is usually enough to cover fishing costs.

Around two or three fishing boats operate on a daily basis near the PFMPA (sometimes even illegally inside). Usually they deploy trawl nets (three to four times a day) that are hauled by hand. Average catch per haul is approximately 560 kg, with about 70 kg (12.5 %) of the catch in the especial group (fishermen, personnel communication).

The yearly economic value for this benefit was calculated as follows: Fishing boats usually carry out ten fishing trips per year that last for 10 days each. On each fishing trip they catch approximately 2 tonnes (Fishery official, personnel communication). Out of this 2 tonnes, 250 kg (12.5 %) are of Especial Group. Assuming that bigger fish (over 950 g) are the most likely to move outside the PFMPA, spillover is projected to increase catches within the especial group at 20 % (112 kg), then the 2 tonnes catch will produce 400 kg of fish within the Especial Group, and 1600 kg of fish within Groups A, B and C.

Putting this in monetary terms implies that fishermen will earn around 600.00 Cuban pesos ((1,500.00 Cuban pesos * 400 kg)/ 1000 kg) = 600.00 Cuban pesos) for this increment in the Especial Group. Considering that the remaining 1600 kg of the catch is paid at an average price of 467.00 Cuban pesos per tonne (average price of fishing

Groups A, B, and C together), then one average fishing trip will yield: Especial Group (400 kg) + Groups A, B and C (1600 kg): (600.00 Cuban pesos + 467.00 Cuban pesos (1000 kg) + 280.20 Cuban pesos (600 kg)) = 1,347.20 Cuban pesos. Bonus price in USD would then be: for the Especial Group: the 20 % of 400 kg = 80 kg at a price of USD $1,500 per tonne = USD $120.00. For Groups A, B and C, the 20 % of 600 kg is 120 kg at a price of USD $467.00 per tonne = USD $280.20. This totals USD $400.20. Consequently, in one year fishermen will earn (1,347.20 Cuban pesos * 10 trips = 13,472.00 Cuban pesos and as bonus price (USD $400.20 * 10 trips) = USD $4002.00. Converting everything into USD the grand total would be (13,472.00 Cuban pesos = USD $561.33) + (USD $4002.00)) = **USD 4,563.33 y^{-1}**.

Non-fishery benefits

Expand non-consumptive recreation opportunities: If properly managed and planned SCUBA diving opportunities should multiply in the future. The PFMPA has sufficient natural appeal to attract more divers and also to implement new recreational options on the terrestrial side. For instance, hiking trails, bird watching and other activities can be accommodated within the PFMPA to allow for a diversification of recreation opportunities, taking into account the large number of tourists that come on the cruise ships.

The calculation was made based on the average number of tourists that visit the area (Colony Hotel and Cruise ships) and prices charged to tourists for similar services in other protected areas in Cuba (CNAP, 2002). Projections were made of 10,000 tourist

divers per year from Colony Hotel and 15,000 tourists per year from cruise ships. Divers at the Colony Hotel normally buy 10-dive packages which cost USD $309.00 (Colony Hotel officials, personnel communication), so revenues are (10,000 tourists * USD $309.00) = USD $3,090,000.00 y^{-1}. Additionally projecting that 50 % of cruise tourists take hiking trails or bird watching options in the PFMPA at a price of USD $10.00 each, this revenue will total (7500 tourists * USD $10.00) = USD $750.000.00 y^{-1}. Adding these two figures (USD $3,090,000.00 y^{-1} + USD $750.000.00 y^{-1}) = **USD $3,840,000.00 y^{-1}**.

Enhance and diversify economic activities: Other economic activities can be accommodated in the area. Many foreigners visit the MPA by boat (i.e. private yachts). They come from everywhere and use the area for overnight stays. This activity can be organized, and charges applied for overnight mooring and marina services. There are examples in other Caribbean MPAs such as the Soufriere Marine Management Area of Saint Lucia. Mooring sites can be created, and a charge based on the length of the boat and the duration of the stay can be applied. For instance, following the example of Soufriere Marine Management Area (Caribbean Films and Video Productions, 1996) and taking into consideration educated opinions from Marina officials at the Colony Hotel, boats less than 40ft long might pay USD $10.00 for staying up to two days in the PFMPA and USD $15.00 for staying from two days to one week. Vessels between 40 ft and 70 ft long might pay USD $20.00 for staying up to two days and USD $27.00 for staying from two days to one week. Vessels above 70 ft might pay USD $35.00 for staying up to two days and $45.00 for staying from two days to one week. Projecting thin the PFMPA will

be visited by 100 vessels in one year (between 40 ft and 70 ft long) and the average duration of the stay is 4 days, then income would be (100 vessels * USD $27.00) = **USD $2,700.00 y^{-1}**. Evidently this is a rough approximation of the economic value of this benefit; therefore, conclusions drawn from this should be taken with caution.

Promote alternative employment opportunities: In addition to current SCUBA diving instructors and the PFMPA staff (Director, Biologist), other forms of employment can be provided in the MPA: for instance, nature trails guide maintenance workers, cooks, and the like. Assuming an average income of 3,600.00 Cuban pesos per year and assuming new employment of three people, the economic value of this benefit can be estimated as (3,600.00 Cuban pesos * 3 people) = 10,800.00 Cuban pesos per year, which converted into USD will be **USD $450.00 y^{-1}** at the official exchange rate.

Enhance other forms of income generation: It is now widely acceptable to charge an entry fee to visitors (mostly divers) in MPAs (Arin and Kramer, 2002). Despite this only 25 % of the more than 200 MPAs in the Caribbean region charge tourist divers an entry fee (Green and Donnelly, 2003). Dixon et al. (1993) reported that in the Bonaire Marine Park there applies a visitor fee of USD $10.00 y^{-1}. That accounted for an income of more than USD $170,000.00 y^{-1} in 1993, which was enough to cover salaries, operating costs and capital depreciation of MPA infrastructure. Additionally, Arin and Kramer (2002) highlighted the significant potential revenue source from such charges to finance coral reef conservation in the Philippines.

At the PFMPA no entry fee has ever been established, meaning that a significant income has been forgone. In other Cuban PAs an entry fee of USD $10.00 is charged to foreign visitors (CNAP, 2002). The downside of this is that the USD $10.00 figure has been arbitrary set with no consideration of visitor's WTP. For the sake of simplicity, and taking into account the limitations on the analysis that this represents, an entry fee of USD $10.00 could be charged to divers and cruise ship tourists that visit the PFMPA. Using the same projection of 10,000 tourist divers per year from Colony Hotel and 15,000 tourists per year from cruise ships, the establishment of an entry fee will produce an economic income of: ((10,000 divers + 15,000 cruise ship tourists) * USD $10.00) = **USD $250,000.00 y^{-1}**. Other ways to enhance incomes could be through the sale of hand craft articles, souvenirs and local food and beverages.

Broaden and strengthen the economy: All these options have the potential to enhance the national and local economy in the future. Cuba as a country has a large stake in tourism as a path to economic development. At the local level, sustainable tourism could bring many benefits to local communities. A figure for this benefit is difficult to estimate because it will depend on the type and extent of the activity that would be enhanced through the correct functioning of the PFMPA. A possible order of magnitude of the economic value of this benefit could be considered of around hundred thousand USD per year. Given the inaccuracy of this estimate it will not be considered in the analysis.

Table 8. Scenario II. Potential benefits and economic value provided by the Punta Frances Marine Protected Area to humans and nature.

POTENTIAL PFMPA BENEFITS								
To humans					**To nature**			
DIRECT			**INDIRECT**					
Fishery benefits	**Non-fishery benefits**	**Management benefits**	**Educational benefits**	**Cultural benefits**	**Ecosystem benefits**	**Ecosystem benefits**	**Population benefits**	**Species benefits**
I. Support sport fisheries (catch and release). II. Allow for spillover of adults and juveniles.	I. Expand non-consumptive recreation opportunities (SCUBA, ecotourism). II. Enhance and diversify economic activities. III. Promote alternative employment opportunities. IV. Enhance other forms of income generation. V. Broaden and strengthen economy.	I. Reduce use and user conflicts. II. Maintain diversity of fishing opportunities. III. Facilitate stakeholder involvement. IV. Promote holistic approach to management. V. Promote bases for ecosystem management.	I. Improve understanding of natural systems. II. Allow long term research, monitoring and data collection. III. Provide sites for education at all levels. IV. Provide undisturbed areas for particular experiments. V. Preserve archeological sites.	I. Improve peace-of-mind. II. Enhance aesthetic experiences and opportunities. III. Promote spiritual relations and development. IV. Enhance conservation appreciation. V. Provide foundation to increase public awareness and compliance. VI. Promote concern for future generations. VII. Foster constructive social activities. VIII. Promote international relation and cooperation.	I. Allow for suitable nutrient cycles. II. Protect from coastal erosion. III. Provide physical refugia. IV. Maintain global climate regulation. V. Avoid physical damage to habitats. VI. Allow for the transformation, detoxification and sequestration of pollutants.	I. Preserve natural communities composition and functioning. II. Maintain biological diversity. III. Maintain trophic structure and food web. IV. Maintain key habitats (reproductive, nursery, feeding).	I. Protect natural population structure and functioning. II. Protect genetic resources and diversity. III. Increase survival rate for juveniles and adults.	I. Protect keystone and dominant species. II. Prevent lost of vulnerable species. III. Sustain species presence and abundance. IV. Allow for complete species interaction.
Estimated value/year (USD)	**Estimated value/year (USD)**	**Estimated value/year (USD)**	**Estimated value/year (USD)**	**Estimated value/year (USD)**	**Estimated value/year (USD)**	**Estimated value/year (USD)**	**Estimated value/year (USD)**	**Estimated value/year (USD)**
I. 300,000.00 II. 4,563.00 **Total: 304,563.00**	I. 3,840,000.00 II. 2,700.00 III. 450.00 IV. 250,000.00 **Total: 4,093,150.00**	I. 17,000.00 II. 32,460.00 **Total I+II: 49,460.00** III-IV-V: 4,447,173.00*	II. 100,000.00 III. 10,000.00 IV. 70,000.00 V. 75,000.00 **Total: 255,000.00** I. 4,144,563.00 *	I-VII. 4,788,400.00 VIII. 10,000.00 **Total: 4,798,400.00**	I. 105,664,466.00 II. 6,004,050.00 III. 389,011.00 IV. 1,919,500.00 V. 508,094.00 VI. 1,181.250.00 **Total: 115,666,371.00**	I. 237,798.00 II. 1,759,373.00 **Total: 1,997,171.00**	Value included in ecosystem and process benefits	Value included in ecosystem and process benefits
Total to humans/year (USD) 9,500,573.00					**Total to nature/year (USD) 117,663,542.00**			
				Total/year (USD) 127,164,116.00				

* These figures were not considered when calculating the total value per benefit category to avoid over estimation of economic value.

Management benefits

Reduce use and user conflicts: Current controversies among users and responsible authorities in the PFMPA can be resolved with proper definition of responsibilities, correct zoning and by building trust among interested parties. This will allow for peaceful coexistence and maximization of economic benefits by giving everyone an opportunity to take part in the "business". For instance, SCUBA diving activities should be organized and controlled by the Colony Hotel, which has the experience and the infrastructure in place. Other activities such as MPA maintenance and enforcement should rest with the CITMA staff. The Cubanco S.A. cruise company may look after providing other services, such as food and beverage sales to tourists. The economic value of this benefit was estimated using the average costs of a legal process to determine jurisdiction over a resource. This figure fluctuates around **USD $17,000.00 y^{-1}** (Villalobos, personnel communication).

Maintain diversity of fishing opportunities: Lobster catches in the PFMPA should be maintained and entirely devoted to supply demand from tourists that visit the MPA. In doing this, fishermen may receive higher prices for their catch. For instance, an agreement was reached between the Colony Hotel and the MIP dealing with lobster supply to Colony restaurant. Fishermen will catch lobster and sell them to the Colony Hotel at USD $9.00 per lobster. This agreement did not last long because the restaurant was destroyed by Hurricane Charlie in August 2004. Assuming that fishermen can

provide around 100 lobsters per week, they would make USD $900.00 a week (USD $3,600.00 a month). A yearly total would be **USD $32,400.00**.

Additionally, according to interviews held with fishermen from Cocodrilo, Punta Frances was always recognized as a good fishing ground for deep slope demersal species, such as Silk snapper (*Lutjanus vivanus*) and Blackfin snapper (*Lutjanus bucanella*). For many years, they have been asking for permission to exploit stocks that remain untouched, and are not the subject to any legislation in Cuban fishery law because these resources are not part of the island shelf. It is this author's opinion that, with some entrance limitation (only fishermen from Cocodrilo); and strict control on the fishing intensity and gear to be used; this type of fishery should be allowed within the PFMPA. This will enhance the benefits that the MPA can provide to the nearby community by improving, firstly, their fishing options, secondly their economic income, and thirdly their awareness and compliance with the MPA.

Baisre (2004) reported yields from this type of fishery of around 1000 t/year for the whole country (the deep slope fishing area is 4500 km^2). In the PFMPA, the area devoted to this activity would be 10.6 km^2, which represents an annual yield of 2.2 t. Although this figure may seem very small, it should be taken into account that Cocodrilo has only twenty-three people involved in fishing activities. Despite precarious conditions in terms of their fishing boats and gear, fishermen have managed to maintain acceptable catches for other species. The proximity of the shelf break on this coast means that fishing can take place in deep waters without going far from shore. Therefore, it should be expected that fishermen from Cocodrilo will be able to extract an important benefit from this

activity. To put a value on this it was assumed that an average price of 725.00 Cuban pesos is paid per tonne (considering all fishing groups). Projecting an annual yield of 2 tonnes will makes 1,450.00 Cuban pesos a year. Converting this figure into USD it would be **USD $60.41 y^{-1}**. No bonus price was calculated here; therefore the real figure should be higher.

The total economic value of diversify fishery benefit is thus (USD $32,400.00 y^{-1} + USD $60.41 y^{-1}) = **USD $32,460.42 y^{-1}**.

Facilitate stakeholder involvement: This is similar to the first and second benefits (Reduce use and user conflicts, and maintain diversity of fishing opportunities). A value for this benefit was estimated by adding up the first two benefits.

Promote holistic approaches to management: The small size of the area, relatively few stakeholders, and generally non-conflicting economic uses (Table 5) make it relatively easy for implementing a holistic approach to management. In other words the PFMPA constitutes a good starting point for implementing ICZM at a manageable scale.

Promote bases for ecosystem management: The remoteness, small size and low human use of the area makes it manageable for the establishment of ecosystem-based management. The PFMPA can be used as a model to try this management approach, aiming at its future generalization to other areas.

Putting a monetary value on these last two management benefits is rather difficult. Both benefits encompass, one way to another, all direct benefits, so their economic value was estimated as the sum of all other direct benefit values.

Education/research benefits

Improve understanding of natural systems: By effectively protecting and monitoring the area, our current understanding of how nature works might be improved. This should have a significant influence on how we interact with adjacent natural resources subject to exploitation. For instance, understanding how fish move in the area should enhance the quality of catches and consequently the economic benefits to fishermen. Similar analysis can be applied to other resources. For instance, knowing the distribution of coral reef and fish species within the PFMPA should allow for a better zonation and a consequent maximization of benefits from SCUBA diving. Therefore the economic value of this benefit was approximately calculated using economic values of the two Fishery benefits and the number one non-fishery benefit (expand non-consumptive recreation opportunities) (Table 8). This is: (USD \$304,563.33 y^{-1} + USD \$3,840,000.00 y^{-1}) = **USD \$4,144,563.33 y^{-1}**.

Allow research, monitoring and data collection from untouched sites: If well protected, the PFMPA can be used as a field base for seagrass, coral reef and mangrove research. Implementation of long term monitoring projects is also a possibility, and data gathered from it might compared with other sites. The value of this benefit was estimated using the potential research project proposals that are planned to be implemented in the

area for next year. According to CITMA officials there are five research proposals waiting for funds to commence. The figure presented here **USD $100,000.00 y^{-1}** constitutes the sum of the five operating budgets of the research proposals.

Provide sites for education at all levels: Educational activities can be enhanced at the PFMPA. The area provides an undisturbed environment suitable for instilling conservation values in the population, increasing public knowledge of natural systems, and enhancing awareness of the values of conservation and compliance with regulations. Also, the PFMPA can function as a natural laboratory for university students. In valuing this benefit it was taken into account that education is free in Cuba for all levels; therefore the figure presented only represents the economic value accrued from summer courses offered to international students at the CMR. Usually around 10 to 15 international students per year attend summer courses at the CMR. Assuming that 10 students will participate in summer courses that use the PFMPA as a field station and taking into account that a summer course of this nature costs USD $1,000.00 per student, then it is possible to estimate that the approximate economic value of this benefit would be **USD $10,000.00 y^{-1}** (10 students * USD $1,000.00).

Provide undisturbed areas for particular experiments: This benefit is closely related to the research and monitoring benefit. It was estimated separately because there are specific examples of experiments that will take place at the PFMPA in the near future. One of them is a collaborative research work that will look at recruitment patterns of Spiny lobster (*Panulirus argus*) in this region. For this research project, a budget of **USD**

$70,000.00 y^{-1} has been allocated and this figure was used as a rough calculation of the potential economic value of this benefit. There are other research initiatives that still need substantial work, therefore they were not considered.

Preserve archeological sites: At the PFMPA there is evidence of aboriginal presence, as well as of pirates and buccaneers. This could be exploited in the future by aiming at improving historical and cultural knowledge and, at the same time, economic benefits to the area. The figure presented in the table 8 was calculated based on the possible number of visitors from cruise ships (50 % of expected visitors from cruise ships take the excursion) and an interpretative excursion price of USD $10.00 per visitor (7500 tourists * USD $10.00) = **USD $75,000.00 y^{-1}**.

Cultural benefits

Improve peace-of-mind: The existence of natural areas provides human beings with places to relax and meditate. This with no doubt contributes to the well being of people and is one of the most important values that are first affected when significant levels of SCUBA diving is exerted over certain reef areas (Davis and Tisdell, 1995b).

Enhance aesthetic experiences and opportunities: Foreigners receive almost 100 % of this benefit. Nationals, with the exception of those who work on the dive boat and the ranger station, do not enjoy because they are excluded from the MPA; there are also problems with transportation and access. A change of this condition should be expected in the near future.

Promote spiritual relations and development: Related to the first and second cultural benefits.

Enhance conservation appreciation: Related to the previous cultural benefits.

Provide a foundation to increase public awareness and compliance: This is very important to nationals, as they do not see the MPA as belonging to them. Cocodrilo inhabitants are divorced from the PFMPA, as they have been excluded from entering it.

Foster constructive social activities: Allow the nearby community to directly benefit through elevation of their social values

Promote concern for future generations: Bequest values can be enhanced through different activities related to the PFMPA.

All seven of these cultural benefits are closely related to each other, and, as a whole, they fall within the realm of non-use values such as: quasi-option values, bequest values and existence values. The key issue here is that currently, mainly foreigners accrue these benefits from the PFMPA. Nationals have remained excluded from the MPA for several reasons, which include remoteness of the area, problems with transportation, and forbidden access. This situation must change in the future if the PFMPA is to provide local people with real opportunities derived from non-consumptive uses of natural resources.

The economic value calculated here (Table 8) encompasses all seven benefits and was obtained by applying the Travel Cost Method (TCM) to information gathered from surveying tourists in the Colony hotel. The TCM is one of the four market price approaches described in the literature (Goodstein, 1999). This method is normally used to estimate economic use values associated with ecosystems or sites that are used for recreation and on which people expressed some interest in visiting them. The basic premise of the TCM is that the time and travel cost expenses that people incur to visit a site represents the "value" of access to the site (King and Mazzotta, 2000). More practically, Spurgeon (1992) stated that the main assumption of the TCM is that the number of people visiting a site is inversely related to the distance they come from. Therefore, if the number of people visiting the site and their travel costs are known, then regression analysis estimates the value of that site to visitors. Basically, people's WTP to visit the site can be estimated based on the number of trips that they make at different travel costs, which is analogous to estimating people's WTP for a marketed good based on the quantity demanded at different prices (King and Mazzotta, 2000).

The TCM has been widely applied in many scenarios. Lampietti and Dixon (1995) used this method to estimated economic values of recreation in tropical forest in Costa Rica and Kenya. According to these authors the economic value of recreation in tropical forest was estimated at USD \$52.00 ha^{-1} y^{-1}. Additionally, Kramer et al. (1992) estimated a yearly economic value of forests in Madagascar of USD \$174,720.00. On the other hand, Saunders et al. (unpublished, cited by Arin and Kramer (2002)) applied the TCM to assess the value of recreation services in the Bunaken National Marine Park in Indonesia.

They found that non-local tourists derived a recreational value of about USD $328.00 per person per year from visiting the park. When aggregated across all non-local tourists, a total recreation value of USD $4.2 million per year was estimated for this remote park.

According to King and Mazzotta (2000) there are different ways to approach a particular problem to which the TCM can be applied. These authors described three alternatives of the TCM. They are:

- A simple zonal travel cost approach, which mostly uses secondary data and some simple data collected from visitors.
- An individual travel cost approach, using more detailed survey data from visitors.
- A random utility approach using survey and other data, and more complicated statistical procedures.

In this study the simple zonal approach was used due to the nature of the data collected and its availability at the time of the analysis. The zonal travel cost method is the simplest and least costly approach. This method is applied by collecting information on the number of visits to the site from different distances. Because the travel and time costs will increase with distance, this information allows the researcher to calculate the number of visits "purchased" at different "prices". This information is then used to construct the demand function for the site, and estimate the consumer surplus, or economic benefits, for the site.

The first step was to define a set of zones surrounding the PFMPA. In this case the country of origin of tourists was the criteria used to define zones.

The second step was to collect information on the number of visits from each country made in the last year. This data was obtained from questionnaires applied to tourist divers.

The third step was to calculate the average round-trip travel distance and travel time to the PFMPA for each country. Two assumptions were made to calculate these. For the average round-trip travel distance it was considered that tourists departed and returned from their country capital and for the travel time a plane cruise speed of 900 km/h was considered. Next, using average cost/km and cost/hour of travel time it is possible to calculate the travel cost/trip. In this case the cost/km was estimated using ticket prices of airlines flying to Cuba. The ticket price was then divided by the travel distance to obtain the cost/km.

The cost of time is more complicated. King and Mazzotta (2000) reported that the simplest approach is to use an average hourly wage, which according to them is USD \$9.00 h^{-1}, or USD \$0.15 min^{-1}. This approach was not considered appropriate in this case due to the ample differences existing among countries of origin in the working sample. Instead data on Gross National Income (GNI) per capita (World Bank, 2004) were used. To estimate the cost/hour the GNI per capita for each country was divided by 1800 hours,

which was considered the approximately working time of a person in one year. Table 9 shows calculations made up to this point. Travel cost averaged USD $1,043.84.

The fourth step was to estimate, using regression analysis, the equation that relates number of visits to travel costs. To maintain the simplest possible model the equation was calculated only using travel cost as dependent variable and number of visits as independent variable. The regression analysis yielded the following non-significant results: ($n = 19$, $r^2 = 0.11$, $F = 0.2308$, $p > 0.05$). According to the model used in the analysis, the equation that relates visits per capita to travel costs was: $V=24.78-0.014C$, being V: number of visits and C: travel costs.

Table 9. Partial calculations of the Travel Cost Method. TD: Travel Distance; TT: Travel Time; D: Distance; TC: Travel Cost; USD: United States Dollar; km: kilometer; h: hour.

Country	No. of visits	TD (km)	TT (h)	Cost/km (USD)	D * cost/km (USD)	Cost/h (USD)	TT * cost/h (USD)	TC/trip (USD)
Mexico	31	3571.67	3.97	0.1470	525.00	3.29	13.05	495.12
USA	4	3638.54	4.04	0.1924	700.00	19.67	79.51	541.34
Venezuela	1	4349.80	4.83	0.1108	482.00	2.27	10.96	799.18
Canada	13	5103.53	5.67	0.2077	1,060.00	12.44	70.54	837.20
Brazil	44	11422.75	12.69	0.1138	1,300.00	1.57	19.95	842.16
Ireland	4	14261.25	15.85	0.1001	1,428.00	12.79	202.74	842.83
Scotland	3	14480.58	16.09	0.0411	595.00	14.17	228.02	934.68
Spain	7	14895.80	16.55	0.0470	700.00	8.10	134.06	1,004.62
UK	12	15024.83	16.69	0.0544	818.00	14.17	236.59	1,006.65
France	12	15466.43	17.18	0.0459	710.00	12.36	212.33	1,048.35
Belgium	3	15649.71	17.39	0.0520	814.00	12.74	221.61	1,057.56
Netherlands	2	15654.57	17.39	0.0648	1,014.00	12.99	226.02	1,068.77
Switzerland	8	16305.37	18.12	0.0827	1,349.00	20.09	364.05	1,084.28
Germany	37	16755.33	18.62	0.0355	595.00	12.63	235.20	1,142.97
Sweden	1	16792.10	18.66	0.0429	721.00	14.43	269.19	1,175.95
Finland	2	17405.41	19.34	0.0521	906.00	13.27	256.68	1,253.02
Austria	6	17450.72	19.39	0.0466	814.00	13.26	257.02	1,321.53
Italy	1	17494.77	19.44	0.0452	790.00	10.60	206.05	1,643.53
Poland	2	17732.47	19.70	0.0567	1,005.00	2.54	50.02	1,733.15
	193						**Average TC**	**1,043.84**

The fifth step was to construct the demand function for visits to the PFMPA (Figure 17), using the equation obtained through the regression analysis. The first point in the demand curve is the total visitors to the site at current access costs (this is at USD $0.00 entry fee). The other points were found by estimating the number of visitors with different hypothetical entrance fees that spanned from USD $0.00 to USD $60.00.

The final step was to calculate the consumer surplus for visiting the PFMPA, which is represented by the area under the demand curve. The consumer surplus was estimated at USD $478.84 per visit. Therefore using the forecasted figure of 10,000 tourist divers per year from Colony hotel, the economic value of these benefits would be around **USD $ 4,788,400.00 y^{-1}**.

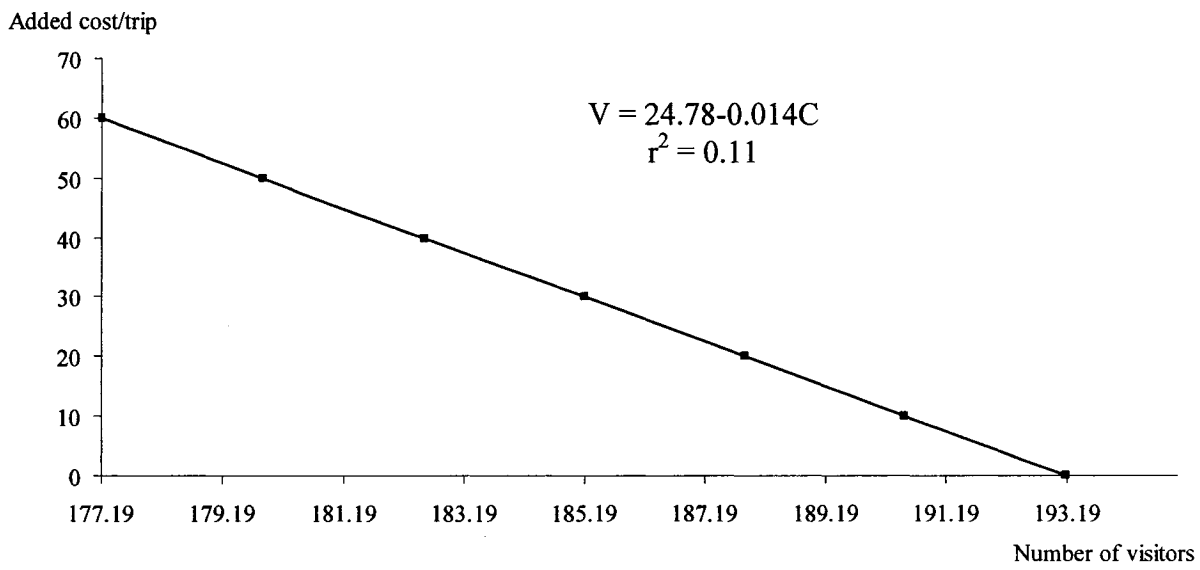

Figure 17. Demand function for visits to Punta Frances Marine Protected Area.

This figure, although apparently high, should be seen with caution for several reasons. First, this author is aware that the nature of the seven analyzed benefits is much broader than the real possibilities of the TCM, because the method was applied taking into account only information from the Colony Hotel, and using the zonal-TCM approach. This fact, somehow, reflects the exclusive character of the area for Cuban nationals, and evidently leaves out of the analysis a significant amount of relevant information. Certainly, the use of random utility approach would have yielded more comprehensive results. Second, the sample size was rather small ($n = 19$), which might explain why regression analysis did not show a significant relationship between ($p > 0.05$), and why the regression coefficient was rather low ($r^2 = 0.11$). A larger sample size may have provided better results in the regression analysis.

Promote international relations and cooperation: If well managed and advertised, international interest will increase and possible funding donors may appear. Good examples of this are the Bonaire Marine Park, the British Virgin Islands System of MPAs, Saba Marine Park, and Pigeon Island National Park, Saint Lucia (Geoghegan, 1994). The economic value of this would be a function of advertising efforts, management effectiveness and quality of services provided. In the near future staff at the PFMPA could apply for international funding agencies. According to Geoghegan (1994) this constitutes a significant funding mechanism that has proved successful in other instances, such as the Bonaire National Marine Park. In the case of the PFMPA, CITMA officials at the Isle of Youth considered that approximately **USD $10,000.00 y^{-1}** could be

obtained from international cooperation. This figure is based on previous experiences with donor agencies such as the UNEP.

Process benefits

Allow for suitable nutrient cycles: Coastal ecosystems play a key role in nutrient cycles. This service has gained attention recently, and its economic value has been recognized. To calculate the economic value of this benefit the PFMPA was divided into areas representing existing coastal ecosystems: mangrove, coral reefs, seagrass beds, and open ocean. The area of each zone was then estimated from a digital nautical chart, and the economic value of this benefit was assessed by multiplying each zone's area by economic estimates provided by Costanza, et al. (1997). According to these authors the average economic value of nutrient cycling is as follow: open ocean, USD \$118.00 ha^{-1} y^{-1}; mangrove, USD \$1,350.00 ha^{-1} y^{-1}; seagrass beds, USD \$19,000.00 ha^{-1} y^{-1}. Within the PFMPA there are 2,112 ha of open ocean (2,112 ha * USD \$118.00 ha^{-1} y^{-1} = USD \$249,216.00 y^{-1}), 875 ha of mangrove (875 ha * USD \$1,350.00 ha^{-1} y^{-1} = USD \$1,181.250.00 y^{-1}), and 5,486 ha of seagrass beds (5486 ha * USD \$19,000.00 ha^{-1} y^{-1} = USD \$104,234,000.00 y^{-1}). Adding up the results from each ecosystem the total economic value of this benefit would be **USD \$105,664,466.00 y^{-1}**.

Protect from coastal erosion: The same calculation as scenario I.

Provide physical refugia: The same calculation as scenario I.

Maintain global climate regulation: The same calculation as scenario I.

Avoid physical damage to habitats: The same calculation as scenario I.

Allow for the transformation, detoxification and sequestration of pollutants: Mangrove areas play a key role in waste treatment. They can absorb and recycle large amounts of chemical substances without negative-side effects to the overall functioning of the ecosystem. This waste treatment function has a considerable economic value which is increasingly being recognized. The value calculation is based on Costanza, et al. (1997) who reported that mangroves provide an economic value of USD \$1,350.00 ha^{-1} y^{-1}. Multiplying this figure by the area of mangrove within the PFMPA (875 ha * USD \$1,350.00 ha^{-1} y^{-1}) yields a result of **USD \$1,181.250.00 y^{-1}**.

Ecosystem benefits

Preserve natural community composition and functioning: The same calculation as Scenario I (**USD \$237,798.49 y^{-1}**).

Ensure biodiversity protection: The same calculation as Scenario I (**USD \$1,759,373.13 y^{-1}**).

Maintain trophic structure and food web: Ecosystems protected from extractive uses are able to maintain their natural trophic structure. This, in turn, will make them more stable and suitable for non-consumptive tourism activities, such as SCUBA diving. Also, a well-conserved trophic structure will allow living organisms to develop to their full potential, and this might contribute to the preservation of communities in the broader region. The maintenance of trophic structure in the PFMPA is vital to sustain future development.

Maintain key habitats (reproductive, nursery, feeding): Maintenance of key habitats is critical to ensure the occurrence of most nature-based benefits, as well as human-based benefits.

Population benefits

Protect natural population structure and functioning: In the PFMPA, fish populations occur that are subject to fishing in nearby areas. Having a portion of these populations protected functions as an insurance against irreversible losses due to fishing activities or other human-induced actions.

Increase survival rate for juveniles and adults: Effective protection of important habitats, in concert with fishing bans and other conservation measures, should enhance the probability of juvenile recruitment and adult survival in the PFMPA.

Species benefits

Protect keystone and dominant species: Herbivorous organisms such as fish (*Acanthuridae* and *Scaridae*) and sea urchins (*Diadema antillarum*) occur in the PFMPA. These organisms play a key role in maintaining coral reef health, thus promoting sustainability of non-consumptive activities like SCUBA diving. Protection of these species (and others as well) constitutes an important benefit for nature and humans.

Prevent loss of vulnerable species: In the PFMPA are found some vulnerable species, such as the Hawksbill turtle (*Erectmochelys imbricata*), which uses the area as a feeding

ground. By ensuring protection of this portion of the island shelf, this species will have more chance to survive.

Sustain species presence and abundance/Allow for complete species interaction: This and the previous benefit are very much related. Successful protection of the PFMPA will allow for an increased species presence and abundance, as well as maximization of their natural interaction.

Given the interconnection of most benefits accrued by nature, it is this author's opinion that the economic value of the last seven benefits (two belonging to **Ecosystem benefits**, two to **Population benefits** and three to **Species benefits**) have already been included in previous estimates related to **Process benefits** and **Ecosystem benefits**.

Costs of Nature Protection

Sumaila and Charles (2002) stated that despite the myriad of benefits that a MPA could provide there exist significant opposition to its creation due to the costs involved in its establishment and operation. These authors also called for a need to develop appropriate methodologies to assess the balance among benefits and costs, taking into account the crucial necessity to undertake such an analysis from an interdisciplinary perspective, given the diverse nature of issues involved in this subject.

It has been generally accepted that the cost of nature protection includes direct costs, indirect costs and opportunity costs (Dixon et al., 1993; Pendletlon, 1995). Direct costs are those associated with the establishment, subsequent rehabilitation and operation of the MPA. Indirect costs are those costs imposed on others as the result of the establishment of a MPA, and that are not included in its budget. Opportunity costs are those benefits forgone by the decision to protect the area instead of using it for a different purpose.

Costs of protection in the PFMPA were estimated based on the Operative Management Plan (OMP) (Delegación Territorial CITMA Isla de la Juventud, 2004a) currently approved for the area, and a document titled Policies, Regulations and Strategies of Management on the South Portion of the Isle of Youth (Delegación Territorial CITMA Isla de la Juventud, 2004b).

Table 10 depicts current costs of nature protection in the PFMPA. Items within the direct cost category represent different management programs identified in the Operative Management Plan for the PFMPA.

Indirect costs of nature protection in the PFMPA could be considered low because most of the uses and users that occur there do not present conflicting interactions among them (Figure 6). None-the-less, some indirect costs could be identified, such as that of Skipjack tuna fishermen who are bearing the cost of losing part of their bait fishing area due to development of tourism activities. This implies that they have to go further away to find the bait, increasing thus the consumption of fuel and time.

Table 10. Costs of nature protection at the Punta Frances Marine Protected Area. Source: For Direct costs (Delegación Territorial CITMA Isla de la Juventud, 2004a).

Costs	Cuban Pesos/year	USD/year
Direct		
Natural resources management.	4,566.12	724.00
Natural resources protection.	6,178.45	364.00
Recreation.	3,769.04	3.130.00
Environmental education.	1,787.76	--
Scientific research.	10,524.02	50.00
Administration.	5,334.82	2,260.00
Construction and maintenance.	18,500.00	7,658.00
Cooperation and collaboration.	2,697.07	--
Human resources.	8,494.93	--
Indirect (to fishermen)	9,800.00	1,904.00
Opportunity (to fishermen)	1,760.00	352.00
Total	**73,412.21**	**16,442.00**
Grand total (adjusted to USD at 24/1 exchange rate)	**19,500.84**	

Approximately 1.5 tonnes of the catch is used to cover expenses for running a tuna boat (fuel, oil, food) per fishing trip. This means that around 700.00 to 800.00 Cuban pesos are invested every time they go fishing. Assuming a twofold increase in the travel distance to find the bait, then costs of running the boat should, at least, double (1,400.00 Cuban pesos), implying a decrease in earnings either in Cuban pesos as in USD (because the bonus price of 20 % in USD is paid to them after running costs have been covered).

Given its characteristics, the PFMPA has no possibilities for developing urban infrastructure that could accommodate human communities, nor for implementing new uses on the terrestrial side. This makes opportunity costs rather insignificant. Nonetheless, there is one example of opportunity cost borne by fishermen from Cocodrilo that needs attention. This is the cost of not being able to extract the estimated 2.2 t per year of deep sea fish that exist in the PFMPA. Although the opportunity cost figure seems

low (Table 10) it has an important meaning for Cocodrilo fishermen because they have been excluded from since the PFMPA was established. This issue might be crucial for MPA success in the future, because it could be used as a building point to strengthen relationships between people from Cocodrilo and the PFMPA staff.

Analysis of Benefit Scenarios

Before proceeding to analyze the two benefit scenarios it is important to make clear that no estimation of the consumer surplus was possible, except for the estimation of the economic values of cultural benefits in Scenario II. This introduces biases in the economic figures provided in the sense that they will only reflect market values, leaving out the value represented by the consumer surplus. King & Mazzotta (2000) argued that it is incorrect to assume that market prices measure the true economic values of goods and services. Consumer surplus is considered as the difference between what people would be willing to pay for a good or service and what they actually pay for it (Dixon et al., 1993; Costanza et al., 1997; King & Mazzotta, 2000).

Given the fact that it was not possible to undertake a contingency analysis to get an estimation of the consumer surplus, the economic figures provided in both scenarios should be read with caution. The key point here is to understand that these figures might be underestimating the true economic value of the benefits presented; therefore, benefits provided by the PFMPA might be even more important.

This fact becomes especially crucial when trying to set an entry fee for MPA users. In Scenario II, an entry fee of USD $10.00 per tourist was considered. This figure is rather conservative if we take into account results obtained in other places. For instance, Dixon et al. (1993) found that for the Bonaire Marine Park, the average WTP expressed by tourists was USD $27.40, while the annual entry fee was USD $10.00. Similar results were found by Sloan (1987) for a top dive destination in Australia (as cited by Dixon et al., 1993). Arin & Kramer (2002) also found that divers have a positive willingness to pay to enter areas that are under some kind of protection from fishing. In summary it is crucial to understand and to assess consumer's WTP before setting any price to maximize economic benefits.

Currently, the PFMPA provides a total of twelve benefits representing a year value of USD $12,795,025.00 y^{-1} (Table 7). Benefits to humans comprise 50 % of the total number, and the remaining 50 % goes to nature. Benefits accrued to humans account for USD $1,977,198.00 y^{-1} (15.5 % of the total value of benefits), while benefits accrued to nature represent 84.5 % of the total value of benefits (USD $10,817,826.00 y^{-1}). This clearly illustrates two key points: firstly, the vital importance of ecosystem goods and services for the well being of human populations; and secondly, its irreplaceable nature. As pointed out by Costanza, et al. (1997) the artificial biosphere experience, Biosphere II proved exceedingly complex and expensive, while Biosphere I (the Earth) is a very efficient, least-cost provider of human life-support services.

The majority of the benefits (75 %) are the indirect, off site type valued at USD \$12,392,191.00 y^{-1}. Out of this total 66.7 % accrue entirely to nature. Direct benefits encompass 16.7 % of the total number of benefits and are worth USD \$401,311.00 y^{-1}. This may be an indication that economic opportunities have not been exploited to their maximum in the PFMPA. This is reinforced by the fact that no estimation of the consumer surplus was made;.

Scenario II, on the other hand, presents more than a threefold increment in the total number of benefits (42), with 31 of them as new additions (Table 8). The increase in the number and value of benefits accrued to humans is remarkable; 25 benefits (59.2 % of the total) accounting for USD \$9,500,573.00 y^{-1}. This indicates an increment of USD \$7,523,375.00 y^{-1} in value in comparison with Scenario I. This finding clearly suggests that with proper management, direct economic benefits to humans could be increased and their full value be used for improving human life as well as investing in conservation. Further, benefits accrued to nature also increased in number and value with 17 benefits (11 new benefits), and a value of USD \$117,663,542.00 y^{-1}. In this case, the increment in value was also remarkably high, totaling USD \$106,845,715.00 y^{-1}. As in Scenario I indirect/off site benefits comprise the greater part of the total number of benefits (71.4 %), while direct benefits encompass 28.6 % of the total number (Table 8). In both cases there was an increment in comparison with Scenario I, either in number of benefits and value. Indirect benefits account for a value of USD \$122,217,516.00 y^{-1}, representing an increment of USD \$109,825,325.00 y^{-1} while direct benefits account for USD \$4,397,713.00 y^{-1} incrementing USD \$3,996,401.00 y^{-1} in comparison with Scenario I.

This clearly indicates thin the PFMPA could become an important source of revenues to the country as well as a model to apply in similar areas of the Cuban archipelago.

For Scenario II to be possible, there are two main hurdles to overcome. First there is a need to legalize the status of the PFMPA, and solve problems about who is responsible for the area. Currently the main stakeholders are claiming jurisdiction over the MPA, thus increasing conflicts among them. There are considerable controversies involving CITMA, Colony Hotel and Cubanco S.A.

According to Colony Hotel staff, cruise ships are significantly diminishing the quality of the PFMPA. It is their feeling that coral reefs in the park have started to suffer degradation due to cruise ship activities. Although cruise ships do not drop anchors on the reef and they usually stay outside the island shelf, dive instructors think that noise from running engines is causing reef deterioration, and is also affecting diving activities (due to the inconvenience of underwater sound). They have also reported negative effects from propellers running over the reef.

Cubanco S.A. officials maintain that cruise ships never go inside the MPA shelf. Some Colony workers think, on the other hand, that fish abundance increases during cruise ship operations. This needs further study. From a management perspective, these opinions should be weighed carefully because of the arguments between the cruise company and the Colony Hotel. It is this author's opinion that what really lay beneath this conflict is fear on the part of the Colony hotel that they will lose business in the area. When

Cubanco S.A. arrived in the PFMPA, they made an agreement with CITMA by which Cubanco S.A. will build some facilities, such as a small visitor center, a pier, a barbeque area, and the like. These facilities were to be used during cruise-ship operations and by CITMA as well. This arrangement allows CITMA to have an operations base for their staff in the PFMPA, as well as to enjoy other facilities such as radio and telephone communication, electricity from solar panel, and the like.

At the same time Cubanco S.A. hired CITMA workers to undertake maintenance work and beach cleaning before and after cruise-ship operations. As part of that agreement, Cubanco S.A. had to pay CITMA for the use of the PFMPA to bring tourists from cruise ships. Initially, they agreed on a fixed figure of USD $500.00 a month, regardless of the number of tourists they could bring. This changed in 1999 with a new fee of USD $0.50 per tourist who actually lands in the PFMPA. Figure 18A shows annual trends from 1996 to 2001 in income generated by the latter procedure, and the number of cruise tourists who visit the area. As can be seem, incomes to CITMA remained constant for three years, and then started to fluctuate in accordance with the number of visitors. Figures for 2001 show a decrement because data was only available until May of that year. In a general sense, the activity was going well, and provided a source of extra funds to CITMA. The downside was that none of these funds were directly invested back in the MPA.

By the end of 2001, cruise operations came to a halt due to several indirect reasons. These included organizational problems, bad weather conditions and one key external

factor. According to MITRANS officials, the most important issue that affects cruise operations is the USA blockade against Cuba, specifically the Torricelli Law.

This clearly extraterritorial US law states that any foreign vessel that enters any Cuban port will be forbidden to enter any US port for at least six months, or the vessel will be seized and large fines charged against vessel owner. This constitutes a big constraint for any cruise company planning to come to Cuba. Other factors included the September eleventh terrorist attack on the US, and the fact that most cruise companies are US owned. Given this situation, Cuba decided to start business with European cruise companies that do not include the US in their destinations. In November 2004 cruise operations started again. Since then, cruise ships have been coming on a weekly basis (Figure 18B).

According to anonymous sources, difference in earnings between CITMA and MITRANS are very noticeable (Figure 18B). MITRANS, and other agencies, earn incomes on the order of thousands, and even hundred of thousands of USD per cruise visit, while CITMA only earns hundreds of USD per cruise visit. If this is indeed the case, it then may appear that there is an unequal distribution of economic benefits because the cruise company, and other agencies, appears to be making a lot of profit from it, while CITMA is being disadvantaged. For instance, the cruise company advertises the

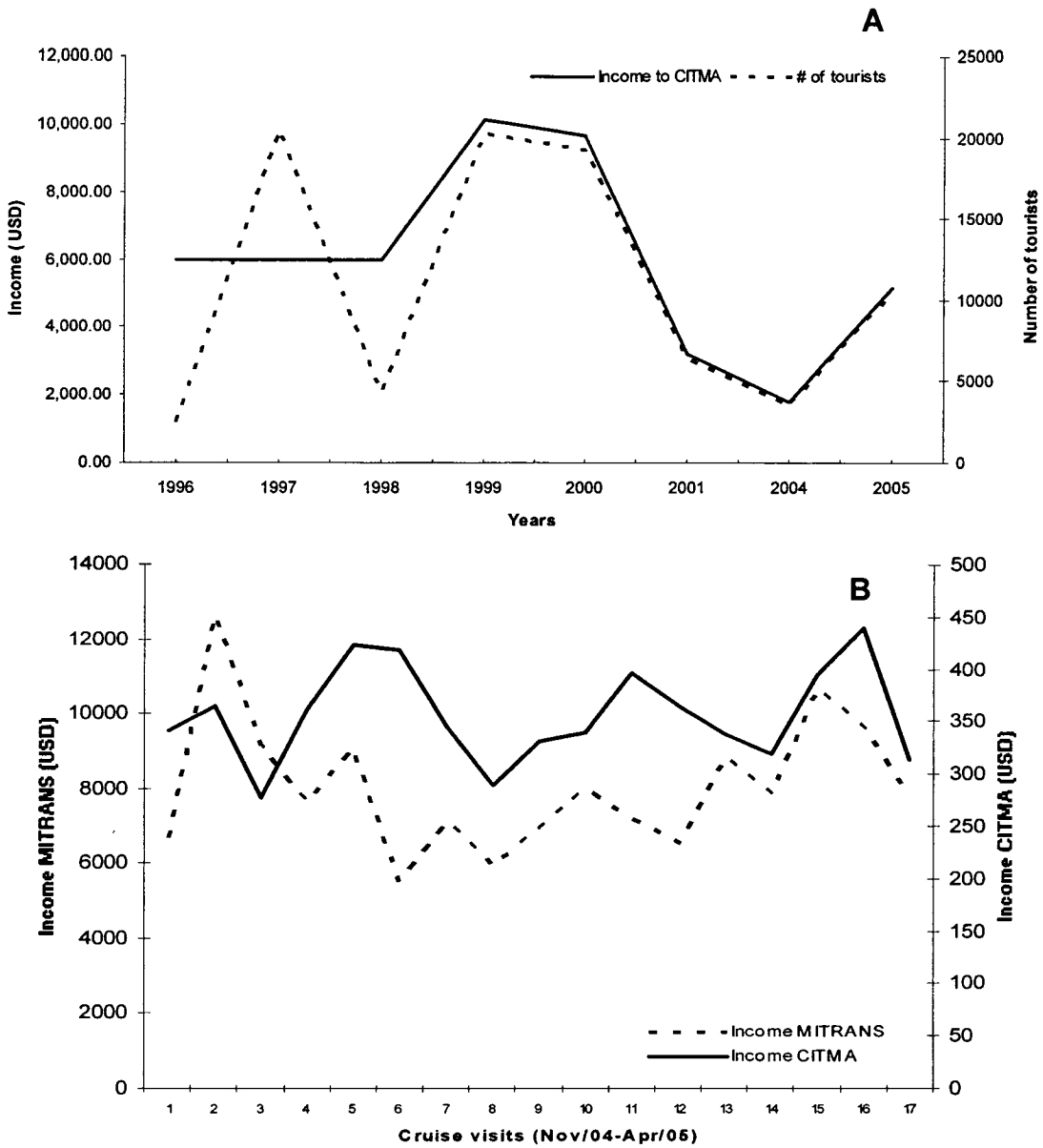

Figure 18. Trends from cruise ship operation in the PFMPA. A: Income to CITMA and number of tourists from 1996 to 2001. B: Income to CITMA and MITRANS from November 2004 to April 2005. Source: A: CITMA officials in the PFMPA, B: Cruise Terminal at Havana.

PFMPA as "the exclusive island of the cruise" and uses the name of "Paradise Island" to attract interest. They offer several services to tourists including snorkeling and diving. For a single dive they charge €55.00, while only paying to the Colony Hotel USD $35.00 per tourist per dive (personnel communication). At the current exchange rate between

Euro (EUR) and USD (1/1.29597 as of April 27, 2005), and with 50 out of the nearly 400 tourists who land in the PFMPA, going diving, the cruise company can pay the USD $0.50 per tourist fee to CITMA, and still make considerable profits from diving. It then becomes vital for CITMA to change this situation to be able to maximize economic benefits from the PFMPA. At the same time, part of those funds should be invested back in the PFMPA to ensure the fulfillment of conservation objectives and foster sustainability in the economic activities that rely on natural resources of the PFMPA.

Cruise companies have a bad reputation for several reasons. These include detrimental ecological effects in fragile environments (Marsh & Staple, 1995); and the globalization effects with significant cultural and sociological impacts (Wood, 2000). In 2002, more than 8.6 million passengers boarded cruise ships, and traveled through fragile marine ecosystems generating, on a daily basis, as much as 37,000 gallons of oily bilge water, 30,000 gallons of sewage, and 255,000 gallons of gray water from showers, laundries and kitchens (Hertz and Davis, 2002; McCann, 2005). This latter situation is currently changing because current regulations on waste management and treatment (adopted by the International Council of Cruise Lines) have started to move from voluntary to mandatory compliance for all active members. Additionally, the International Maritime Organization (IMO) has set very stringent rules in relation to maritime traffic and anchoring in what has been termed Particularly Sensitive Sea Areas, such as the Florida Keys. Finally, the fact that cruise ships are like floating cities with all facilities on board leave no room for business development on land. Most cruise destinations in the Caribbean are losing business opportunities because their inability to compete with cruise

ships in tourism infrastructure. In addition, only 20 % to 40 % of the retail tourist price remains within the economy of the Caribbean destination countries (Dixon et al., 1993; Gössling, 1999; Hall, 2001). Others authors, such as Ritter and Schaefer (1998), argue that the ecological impacts of cruises is low, spending by individual tourists high, and cultural processes minimal; therefore, cruise ships compare favorably with other types of tourism.

In a recent public appearance the Cuban President, Sr. Fidel Castro Ruz discussed the problems that cruise ships impose to most Caribbean countries. Among the main issues mentioned were environmental impacts and socioeconomic difficulties as cruise ships hinder the capacity of local economies to develop. According to President Castro, Cuba will not become a cruise ship destination in the Caribbean; instead the tourism industry in this country will opt for other types of activities. His statement clearly constitutes a governmental position on this issue that will certainly influence the future of cruise arrivals in the PFMPA.

It is this author's opinion that a more careful review of this issue should be done. It is true that the cruise ship industry can have adverse impacts on local economies, but in the Cuban context this could be overcome. A centralized system of government allows for a better control of all economic activities and for a faster decision making process and policy implementation. These arrangements, combined with the fact that in Cuba, economic resources are allocated where they are most needed confers an advantage, in comparison with other countries in the Caribbean and worldwide. In Cuba, cruise

activities can be arranged in a way that could produce, firstly, the necessary economic inputs in terms of foreign currency, and secondly, ensures that the money stays in the country and will be used efficiently.

For example, according to a personnel communication, in the last twenty cruise visits (five months), a total of USD $4,897,768.37 went into the Cuban economy. The main hurdles to overcome here are twofold: first, getting government priorities to establish the need for investing in natural capital. This is to protect the natural resources upon which most of the Cuban tourism industry relies. And second, to deal with some bureaucratic problems that slow down the process of getting the funds back in use. This opportunity should not be forgone giving the current development trends in the cruise ship industry. In particular, as mentioned above, CTO (2000) reported that the cruise industry in the Caribbean grew 10 % since 1999, and this trend is predicted to continue at an average growth per year of 6.5 % until 2010 (Sobers, 2002).

Another issue that came up during the interviews was that relationships between Cubanco S.A. and the PFMPA staff (CITMA) have improved, while relationships between the Colony hotel and the PFMPA staff (CITMA) have deteriorated. The keystone here is thought to be the fee that Cubanco S.A. currently pays to CITMA for using the PFMPA. Through this arrangement, Cubanco S.A. has acquired a status that makes it the most important stakeholder in the PFMPA, although they have been exploiting the MPA for only 9 years. In simple terms Cubanco S.A. feels like it is the owner of the PFMPA. The Colony hotel, on the other hand, which has been making use of the PFMPA for more than

25 years, is not enjoying this situation because they feel unwelcome in the MPA. In these circumstances, it becomes extremely hard to negotiate any arrangement among stakeholders because interpersonal problem may become an issue. From interviews it was known that Colony Hotel at some point ban CITMA staff in the PFMPA the use of their nautical resources to fulfill their needs (transportation, monitoring, surveillance, and the like).

In contrast to Cubanco S.A., the Colony hotel is not willing to pay CITMA any fee for using the park, although its incomes from using it are considerable (yearly average of USD $269,311.63). According to hotel officials, the main reason is that they are not willing to pay for something that they both use and take care of. It is Colony Hotel official's opinion that if CITMA wants to charge them for using the PFMPA, then CITMA has to carry the expenses of maintaining it, especially in installing and fixing mooring buoys. Although the point here is a little complicated the argument is quite fair. On one hand, CITMA is, by law, the state entity in charge of controlling and administering MPAs in Cuba but, on the other hand, CITMA lacks the necessary funds to do so.

The best way to solve this problem would be to try to bring all stakeholders together, and build common points of view. The PFMPA is a small place where users can be accommodated, and there is evidence suggesting different economic activities can coexist without serious conflict. CITMA should function as a collaborative entity, building trust among stakeholders, and looking after the fulfillment of multiple objectives. Finally,

there is the moderate problem of finding financial mechanisms that allow a direct flow of money from different sources into the PFMPA. Currently, CITMA staff in the PFMPA has very limited prospects of making their work more efficient. It is almost impossible to effectively patrol the area, and control illegal activities.

Cost-benefit Analysis

A traditional cost-benefit analysis would require information on the revenues and expenditures over time for each of the activities that take place in the PFMPA. These data were not completely available. Therefore, the author used the data available, and compared the two possible benefit scenarios with the costs of nature protection. Benefits to nature were excluded from the analysis because they occur at no cost whatsoever.

The PFMPA provides an array of benefits that exceed, by far, costs of protection. Figures provided here (Table 7) clearly indicate that current incomes from activities in the PFMPA far outweigh present costs of nature protection (Table 10). This finding is consistent with Pendletonne (1995) who stated that costs of protection (even in those cases where they are high) are outweighed by the economic benefits of marine protection.

It should be mentioned that costs of protection, based on information provided by CITMA, are rather incomplete. For instance, higher costs should be expected in items such as: natural resources management and protection, environmental education,

scientific research, maintenance, and the like. This fact needs urgent attention because it clearly limits further analysis.

Considering only the benefits to humans in Scenario I (Table 7), the figure of USD \$1,977,198.00 y^{-1} exceeds costs (USD \$19,500.84 y^{-1}) by more than one hundred times. Even in the case of a two or threefold increment in costs, benefits will surpass costs by a significant amount.

In Scenario II, this difference becomes even greater. Assuming that costs may increase in this circumstance by a factor of 20, the benefits figure of USD \$9,500,573.00 (Table 8) is still much higher, leaving a significant profit available. According to Alder (1996), costs of protection for tropical MPAs averaged \$433,363.00 USD y^{-1}.

The PFMPA has a myriad of opportunities, both for development of economic activities and for the conservation of natural resources. The key questions here are how to make these prospects operational, and how to ensure that a portion of the economic benefits are reinvested in the MPA. This study illustrates how a fairly simple analytical approach can yield useful policy insights, and provide managers with a more integrated vision of the existing issues. Also, it became evident that to estimate the full range of economic benefits and costs associated with the use of any coastal resource, it is necessary to effectively combine natural and social sciences. This combination allows exploration of planned resource use with respect to links among ecosystems, and their effects on people depending on the area for a living.

Section III

Realization of Social Needs in the Punta Frances Marine Protected Area

Introduction

One of the most debated issues in the creation of MPAs is the question of whether the MPA should unequivocally benefit coastal communities (Russ and Alcala, 1994; Kelleher et al., 1995; Lauck et al., 1998; Boersma and Parrish, 1999; Hatcher, 1999; Nowlis and Roberts, 1999; Roberts et al., 2001). Unfortunately, there are very few examples of MPAs meeting this goal, even on a worldwide basis. Without doubt, MPAs have social impacts on local communities, which can support or undermine the MPA idea; in any case, an evaluation of social needs should be included in the planning and realization of MPA initiatives (Badalamenti et al., 2000). This becomes vital, given the myriad of viewpoints held by different stakeholders in the process of MPA establishment and management (Suman et al., 1999).

Marine Protected Areas are generally regarded as areas designated for the conservation of wildlife and improvement of exploitable resources, especially fishery-related ones. A paper published by Boersma and Parrish (1999) stated that the main reasons for MPA creation include the maintenance of biodiversity, fisheries management, promotion of tourism development, and protection of marine environments. Although these reasons have an implicit aim of improving the quality of human life, none of them directly address the issue of directly benefiting human populations living within or very close to

preserved areas. Debates over the objectives of MPAs and the benefits that they should provide have become increasingly confused and complex (MacKinnon, 2001). In addition to the natural resource management duties MPA managers have, there is an increasing need to address social issues pertaining to their MPAs. In this regard it is becoming mandatory that MPAs become effective tools in dealing with poverty alleviation, property rights, resource allocation, social and economic injustice and market failure. Some authors claim that poverty is the principal threat to biodiversity worldwide (MacKinnon, 2001); I would add that the increasing need for profit making by industrialized countries is another important cause of biodiversity deterioration.

An alternative way to deal with the issues just discussed above is Community-Based Coastal Resource Management (CBCRM), a procedure for which there is a great deal of consensus. Many papers have been published regarding this topic, and several successful case studies have been presented. For instance, many initiatives of CBCRM in the Philippines are considered as worldwide models for the application of this approach (White et al., 1994; Russ and Alcala, 1994, 1996; Alcala, 1998; Christie, et al., 2002; White et al., 2002). Nonetheless, it has been reported that approximately 80 percent of such initiatives have not succeeded and their implementation is quite challenging in the current socio-political and environmental context (Pollnac et al., 2000, 2001).

For community-based management to be truly effective and sustainable, several essential factors need to be taken into consideration. The literature provides some discussion regarding which dimensions are really important and which ones can be neglected. For

instance, Newkirk and Rivera (1996) listed eight essential features for CBCRM. They are: genuine community participation, integration, partnership with government, institutionalization, capacity building, education, impact demonstration, livelihood improvement, a conducive policy environment, and power against poverty. In addition, Alcala (1998) set other criteria for successful CBCRMs. Among them are: a viable organization or organizations within the community, a working marine reserve protected by the community, sources of livelihood based on coastal fishery resources, networking arrangements with government and international agencies and NGOs, and a capacity building program. As it may be observed, there is a lot of overlap in these proposals, and they cannot be considered as independent of one another. While a CBCRM approach may not initially be considered, practical circumstances dictate that it is mandatory. In the first place, one must convince the community of the need to protect and manage their own resources. Secondly, one must demonstrate the role of healthy environments in ensuring sustainable economic gains. Thirdly, one has to ensure broad participation in the process.

Regardless of the advantages of CBCRM as a management strategy, its applicability in every MPA should be carefully analyzed. For instance, given the origin of the PFMPA, its geographic location, and the nature of the economic activities that occur there, the social context is rather different, and cannot be incorporated in a simple coastal community analysis. The confluence of different interests and stakeholders makes the area unsuitable for implementing CBCRM directly. Here we have a natural area, with no human settlement inside its geographic limits, and with controlled human access to the MPA. Additionally, the MPA has no potential for developing an urban setting, due to its

lowland setting, and frequency flooding. At the same time, many stakeholders make use of the MPA; there is a mobile, diverse human population composed mainly of foreign tourists, as well as a minor number of Cubans who work in the area. These features make it necessary to look for alternative ways of management that ensure the fulfillment of conservation and economic development objectives in the MPA, and to maximize benefits accruing to all stakeholders.

Thus, the human component in the PFMPA cannot be ignored. The success of any MPA project is closely related to how well user groups and stakeholders are identified and brought into the planning and management processes (Agardy, 2000). MPAs should not be seen as exclusive places for those lucky enough to obtain access to their use and exploitation. Instead, the PFMPA should provide wide-ranging rights of access and use, paying special attention to those coastal communities that bear the major costs in being excluded from space they have customarily used. The remainder of this chapter is devoted to analyzing whether or not the PFMPA actually satisfies social needs for employment, cultural diversification, environmental awareness, and recreation among both local and non-local human populations.

Materials and Methods

As pointed out above, the human population in the PFMPA is diverse and mobile. It is composed of tourists who visit the area to undertake SCUBA diving, as well as tourists arriving on cruise ships. There are also Cuban nationals who work for different stakeholders in the MPA. On any given day, except during cruise ship visits, there may

be around fifty people at the PFMPA. During cruise visits, this number increases significantly, typically into the four to six hundreds.

A total of 256 questionnaires were distributed to tourist divers that visit the area. Questionnaires were utilized to get a sense of what reef attributes tourists would like to see in a dive, to assess the conservation status of the PFMPA with regard to those reef attributes preferred by divers. This permitted me to compare the PFMPA with other MPAs, and to evaluate tourist satisfaction with the dive and the place.

No questionnaire was distributed to cruise tourists. First, there was a lot of uncertainty about the cruise visit day; indeed, during the study period, the cruise operation stopped due to economic and political causes. Second, I knew that cruise tourists come to the PFMPA just because it was part of the package they bought, and not because SCUBA diving was a first option in their vacation needs. This is not true for tourists at the Colony Hotel; they come to the PFMPA just for the sake of diving. Third, cruise tourists only stay at the PFMPA for a few hours, and this amount of time was not sufficient for them to become acquainted with the PFMPA. By contrast, tourists at the Colony Hotel stay there for approximately 10 days.

At the same time, a total of 14 questionnaires were administered to SCUBA dive instructors and boat skippers who work for the Colony Hotel (9 dive instructors and five boat skippers). In these cases, questionnaires were designed to get a sense of the conservation status of the PFMPA, assess the MPA in relation to the attributes preferred

by tourists in a dive, and get an estimation of the current level of exploitation in terms of the number of divers. In all cases, tourists as well as dive instructors and boat skippers, anonymity and confidentiality were assured. Results from both sets of questionnaires were codified and data entered for analysis in SPSS 12.0 for Windows.

Although they do not live on the PFMPA, and in fact are excluded from it, people living in the nearby community were also incorporated in this study. Twenty face-to-face interviews were held with local inhabitants of the community, following an interview guide that took into account the following question areas:

- General demographic information (gender, age, education, occupation).
- Knowledge about the PFMPA, and its meaning to them.
- Relationship to, and participation in the PFMPA, or tourist activities within the PFMPA.
- Possible involvement with the PFMPA (alternative jobs, fishing, services, and the like).
- Perspectives on community development through the PFMPA development.
- Opinions about visits by tourists to the community.
- Negative and positive impacts on the community from the PFMPA activities.
- Opinions regarding the conservation status of the PFMPA.
- Attitudes towards the real or potential benefits to the community from the PFMPA.

The snowball technique, a non-probability sampling method (Barbie and Benaquisto, 2002), was chosen to select interview subjects from Cocodrilo population. The rationale behind this decision was based on the homogeneity of the Cocodrilo population, its geographical isolation (with almost no inputs from outside), and the small number of people who live there. Care was taken, however, to cover gender and job distribution in the sample. Verbal consent was obtained from each subject prior to the interview, and anonymity was guaranteed to every participant.

Results and Discussion

Surveys of the Tourists and the Colony Hotel Staff

Response and completion rates of questionnaires were significantly high at 77 % and 56 % respectively. This is very positive because high response rate is an index of sample representativeness and its accomplishment reduces chances of response bias (Babbie and Benaquisto, 2002). According to Miller and Auyong (1991) and Babbie and Benaquisto (2002), a 50 % response rate is adequate for analysis and reporting, 60 % is good, and 70 % is very good. Nonetheless, these authors point out that there is no fixed rate for an "adequate" response rate. The most important concern is to ensure low response bias, independent of population size.

A total of 198 tourist divers from 18 different countries responded to the questionnaire (Table 11). Of there 33.7 % were women, and 66.3 % were men. Year of birth ranged from 1929 to 1985, with most of the cases concentrated in the 1960s and 1970s (Figure

19). The average age was 41.64 years. Brazil was the best represented country among the tourists, followed by Germany and Mexico. The large representation of European countries (13) is notable, although the number of tourists was similar to those from North and South America. This confirms the fact that the Americas are becoming an important tourist market for Cuba despite of many years of unilateral and illegal blockade imposed by USA. If this blockade is lifted, a shift in the tourism market would be expected, with the arrival of USA citizens who are currently not allowed to visit Cuba.

Table 11. Country of origin, gender distribution, and number of tourists that visited the Punta Frances Marine Protected Area.

Country of origin	Gender		Total of tourists
	Female	Male	
Austria	2	4	6
Brazil	19	25	44
Belgium	1	2	3
Canada	3	10	13
Finland	1	1	2
France	6	6	12
Germany	12	25	37
Ireland	0	4	4
Italy	0	1	1
Mexico	6	25	31
Netherlands	1	1	2
Poland	0	2	2
Spain	3	4	7
Sweden	0	1	1
Switzerland	2	6	8
United Kingdom	8	7	15
USA	0	4	4
Venezuela	1	0	1
Total	**65**	**128**	**193**
No answer			5

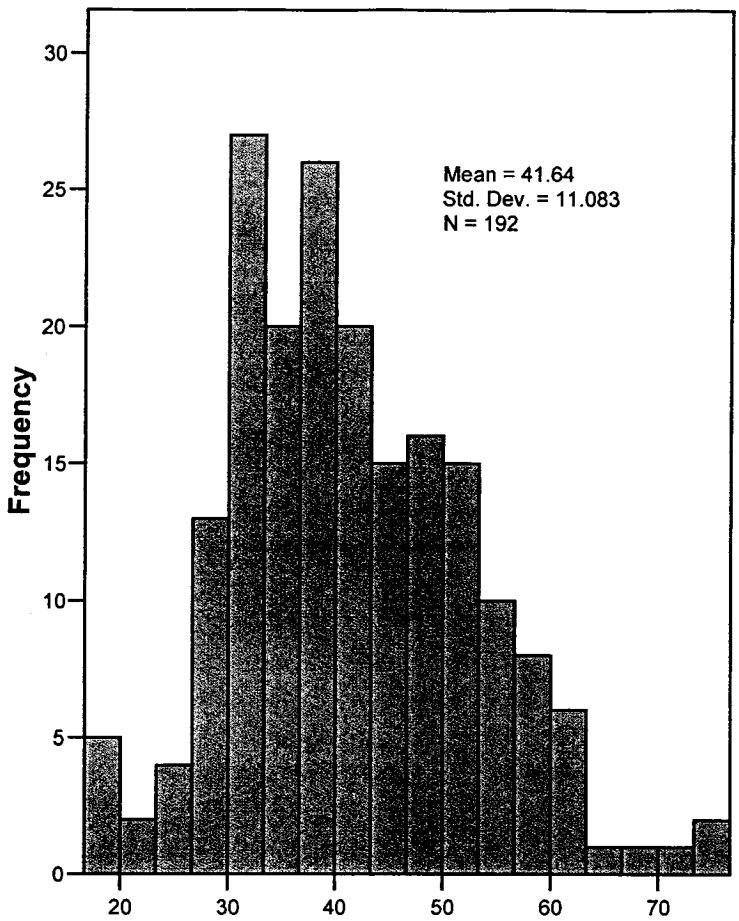

Figure 19. Age distribution of tourists who visited the Punta Frances Marine Protected Area.

As main reasons to come to the PFMPA, tourists reported their interest in seeing Cuban reefs (65.2 %), and 48.6 % liked a previous visit to Cuba (Figure 20). These results are supported by the fact that for 68.1 % of the tourists, quality of diving was the determining factor in coming to the PFMPA.

A majority of the tourists rated the status of the PFMPA as "excellent" (45.7 %) or "very good" (40.0 %), but it should be noted that for 81.8 % of the respondents, this was their first visit to the PFMPA. It is normal to find approval of something the first time it is

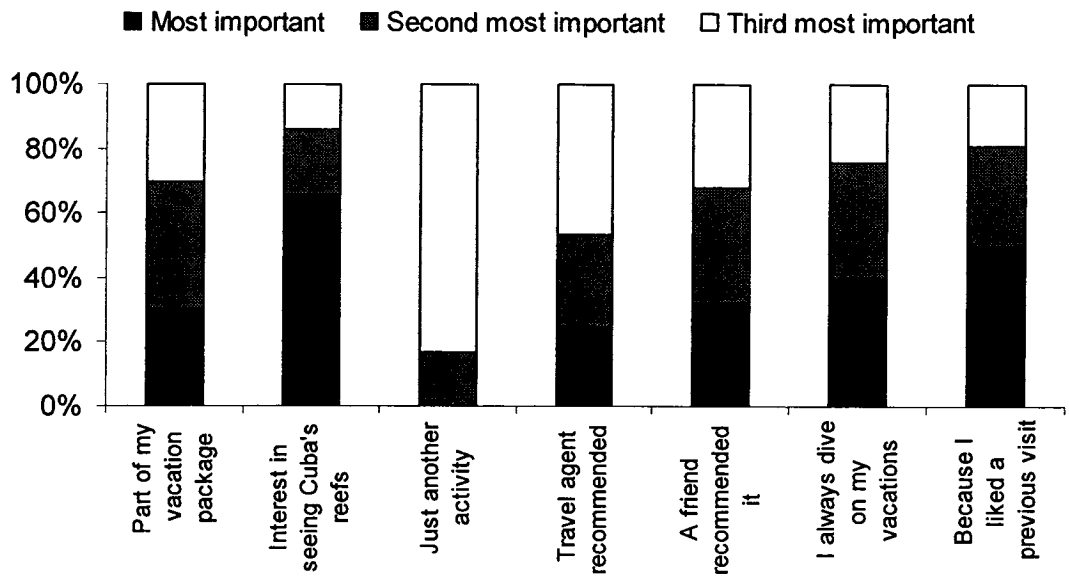

Figure 20. Main reasons for tourists choosing the Punta Frances Marine Protected Area as their diving destination.

experienced. It is also relevant that 18.2 % of the respondents are returning tourists, which is considered very significant in Cuba (Borrego, personnel communication). However, this proportion looks insignificant when compared with Biscayne National Park in Florida, which has 70 % of its tourists as returnees (Stynes and Yen-Sun, 2003). The majority of divers classified themselves as a "dedicated diver" (57.8%), with more than 100 dives in their lives.

When asked what reef attributes were important to them in choosing a diving location, responses were quite homogeneous (Figure 21). Out of the 18 choices, two were ranked as "extremely important" by over 60 % of the divers. These choices were "clear water" (67.5 %) and "variety of fish" (65.8 %). There were other choices considered as "extremely important", with over 50 % ranking "reef structure, caves, pinnacles" (52.7 %), "abundance of fish" (51.7 %), and "variety of corals" (54.6 %). There were also other

options suggested by tourists that were not initially included in the questionnaire. They included "wreck dive", "water temperature", "mollusks", "mammals", and "preserved ecosystems". Knowing this kind of information is very relevant for management objectives, because it allows decision makers to apply measures aimed at enhancing those reef attributes divers prefer. In the particular case of the PFMPA, these findings complement the conservation objectives of this MPA, suggesting the possibility that one may maximize economic benefits while protecting natural resources.

These results are similar to those identified by Williams and Polunin (2000). They employed a similar questionnaire with tourist divers in Jamaica, and obtained similar responses regarding reef attributes. The difference in their case was that fish related attributes prevailed over others, such as "good weather" and "good visibility".

Additionally, tourist divers were asked to rate the PFMPA according to those reef attributes they observed in their diving. Responses were similar in pattern to previously analyzed results but percentages were slightly lower (Figure 22). For instance, there were no responses over 60 %. Nonetheless, responses were generally positive, rating the PFMPA as good (24.4 %), very good (30.4 %) and excellent (28.0 %) in terms of reef attributes they would like to see in a dive.

From a management perspective this result could be very useful. A case by case comparison of what tourists want to see (Figure 21) with what they actually saw

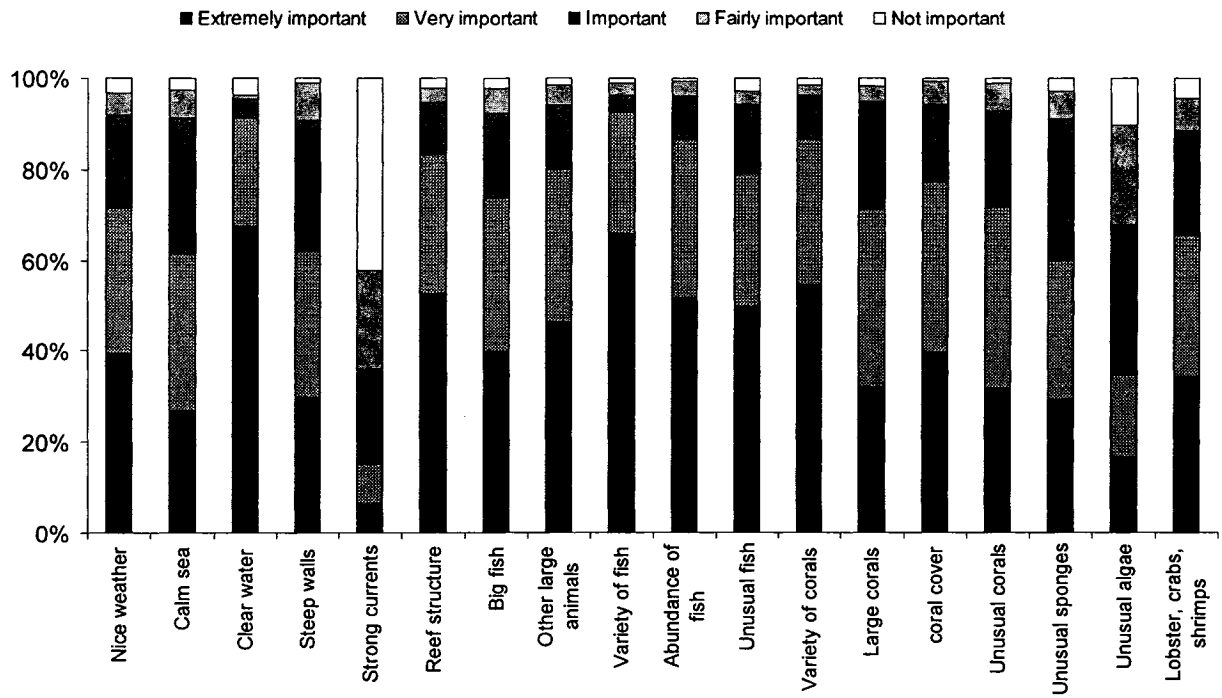

Figure 21. Preferred reef attributes among tourist divers at Punta Frances Marine Protected Area.

in a dive (Figure 22) should allow managers to identify and implement proper management decisions. For instance, reef attributes that need urgent attention were related mostly to living organisms. Among them "Big fish", "Other large animals", "Variety of fish", "Abundance of fish", "Unusual fish", and "Variety of corals" were the ones that obtained the lower scores. This probably indicates that fishing is having a significant impact on the PFMPA fish communities. Management measures should focus on controlling illegal fishing within the PFMPA, as well as discouraging heavy commercial fishing along the PFMPA limits. Figure 21 also supports the earlier findings in the biological section, where we found that large predatory fish were rather scarce (less than 10% of tourists rate the PFMPA as excellent in this attribute).

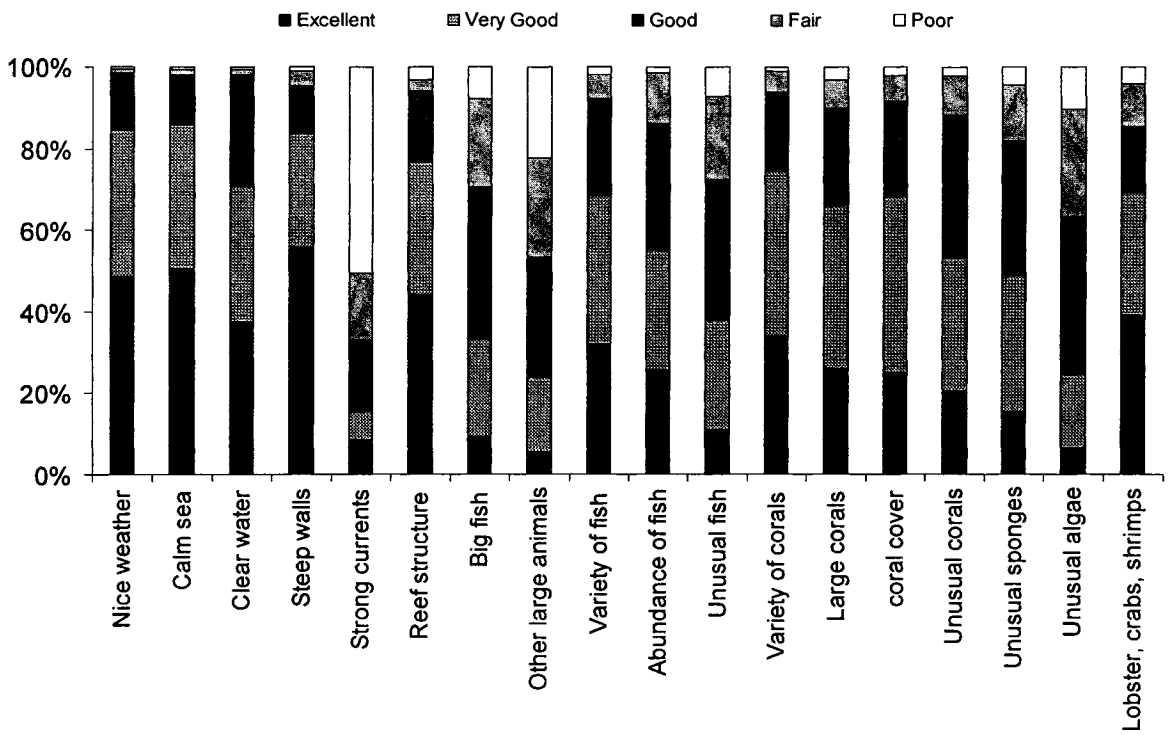

Figure 22. Tourist divers' rating of the Punta Frances Marine Protected Area according to preferred reef attributes.

These results provide evidence that the PFMPA is in good conservation status. This can be demonstrated by estimating a reality-expectation ratio (R/E). Assuming that reef attributes expressed by tourists (Figure 21) are the expectation of what they would like to see in a dive, and that the ratings of the PFMPA according to those attributes (Figure 22) are the reality they perceived, then three options are possible. First, R/E >1- this means that reality has exceed the expectations, the experience has been enjoyable and the site is in fine conservation status. Second, R/E=1- in this case reality matches expectations, and the site may be considered as in good condition. Third, R/E<1- this indicates that expectations were not fulfilled, and the site needs attention. In the case of the PFMPA, R/E=1.01, which could be interpreted as meaning the area has not been negatively affected by human activities, and still contains natural attributes worthy of conservation

and use. Nonetheless, to err in the side of caution, management intervention should not be delayed to enhance those reef attributes that were identified as needing attention.

Skippers and dive instructors were asked similar questions regarding reef attributes they like to see in a dive (Figure 23). Response patterns was similar to those for tourist divers, with similar percentages of "excellent" conditions for physical characteristics such as "Nice weather", "Calm sea", "Steep wall", and the like. Skippers and dive instructors are decidedly more critical of type, number and abundance of fish. With little doubt, this problem should be tackled by the PFMPA staff, and also by Colony Hotel staff. Fish assets cannot be neglected if maximization of economic benefits is to be achieved.

In general terms, tourist divers perceived the PFMPA more positively than skippers and dive instructors. This is reflected in the (excellent-very good-good-fair)/poor answer ratios calculated for tourist divers (0.07) and skippers and dive instructors (0.2). These ratios probably reflect the fact that skippers and dive instructors have more experience in the PFMPA (and know what was once possible), but they lack the comparative perspective that tourist divers, who have been able to dive elsewhere in the world, enjoy.

For most of the tourist divers, the PFMPA was favorable compared with other dive destinations. Table 12 provides a geographical comparison of the PFMPA with other diving destinations in the Caribbean, the Indo-Pacific region and the rest of the world.

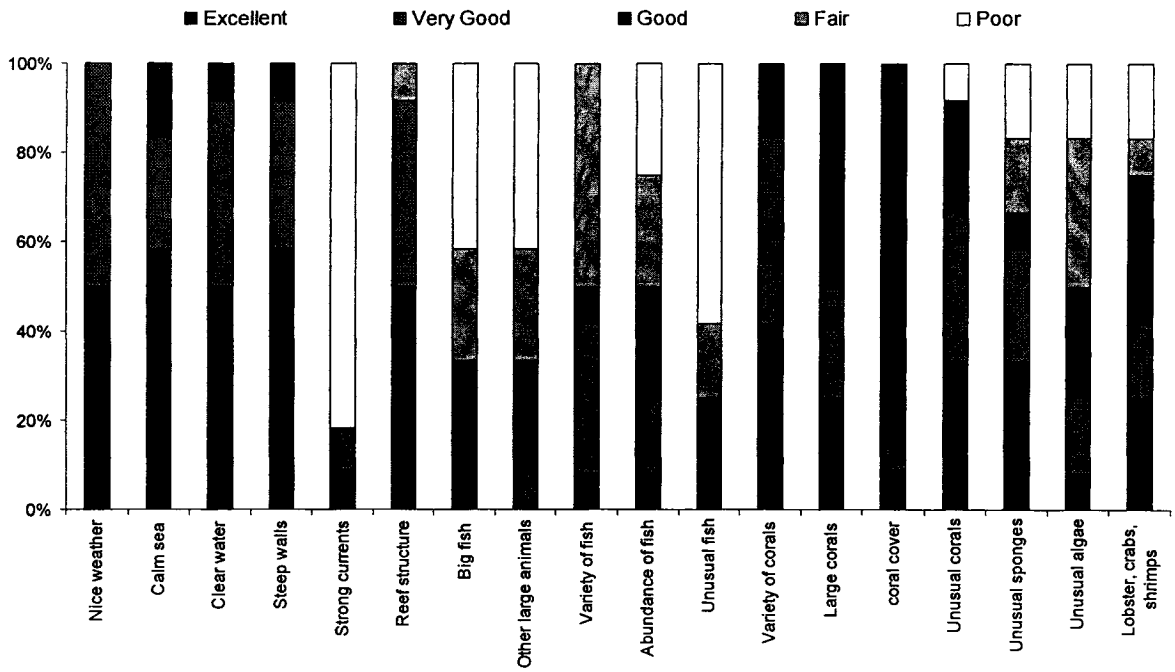

Figure 23. Skippers and dive instructors rating of the Punta Frances Marine Protected Area according to preferred reef attributes.

As can be seen in Table 12, 39.2 % of diving destinations in the Caribbean were rated as worse than the PFMPA, 37.2 % had the same status, and only 23.6 % of Caribbean dive areas are viewed as better. This is impressive, and marks the PFMPA as one of the better dive destinations in the Caribbean. When compared with the rest of the world, these figures are even higher, with a remarkably low 8 % of dive areas ranked as better than the PFMPA. The situation is reversed when compared with dive areas in the Indo-Pacific region where 58.1 % of dive sites were rated as better than the PFMPA. This was expected because the Indo-Pacific area is more diverse in terms of fish and invertebrates, which makes it ideal for SCUBA diving, and a good number of the most famous dive sites are known to occur there (e.g. Great Barrier Reef in Australia, and "*Sharm-el-Sheikh*" in Egypt). Nonetheless, Kennedy and Williams (2004) classified the PFMPA among the top 60 dive destinations in the world.

Table 12. Rating of other dive areas around the world in comparison with the Punta Frances Marine Protected Area.

Rating	Caribbean region (%)	Indo Pacific region (%)	Rest of the world (%)
Better	23.6	58.1	8
Same	37.2	29.5	24
Worst	39.2	12.4	68

The majority of tourist divers demonstrated high levels of satisfaction with the diving in the PFMPA, as 80.7 % of them expressed a desire to return, and 91.4 % would recommend the place to others. It should be noted, however, that most of the tourists were not happy with the hotel. Although this issue was not a direct subject of inquiry in the survey, many tourists clearly expressed their negative opinions regarding hotel facilities. For instance, comments such as: "too many mosquitoes", "too expensive", "few recreational options", and "problems with room maintenance" repeatedly appeared in questionnaires. An interesting finding here was that most of these negative opinions came from European tourists. They may represent the higher expectations Europeans have, by comparison with Latin Americans.

Cocodrilo Coastal Community

There is a coastal community, Cocodrilo, approximately 22 km south of the PFMPA and 100 km south of Nueva Gerona (the capital city of the Isle of Youth) (Figure 3). This human settlement was established at the beginning of the twentieth century by immigrants from Grand Cayman. Atkins Jackson was the first settler who ever set foot in the area; he brought his family along, and formed a community initially known as Jacksonville. Later on, the name was changed to Cocodrilo, and has remained that The

first settlers were mostly fishermen, lured by an abundance of fishing resources, The settlers also did some agriculture, but the clear majority of their living was based on fishing. These people brought their culture and lifestyles with them, and it is still possible to find evidence of older cultural influences. For instance, some houses in the community still provide examples of Caymanese architecture. Atkins Jackson's house is still there, with his descendents living there.

Currently Cocodrilo is the only human settlement on the southern part of the Isle of Youth. A total of 308 people live there, out of which 135 are female and 173 male. Nearly one third of the populations (93) are children and young people (teenagers) (Table 13). A further 174 (90 men and 84 women) are of working age (16 years old) and 106 or 61%, have full-time jobs. However, only 34 of the 84 women are working at fulltime paid jobs (Tenenbaum et al., 1998; CNAP, 2001). Given a relatively high overall unemployment rate there is strong governmental concern to create more employment, especially for women. As in other parts of Cuba, every citizen enjoys free access to health and education, and the government invests considerable resources to ensure basic living conditions for everybody, regardless of their economic status. This fact constitutes a key aspect that differentiates this coastal community from many others worldwide, and without doubt, helps create real socio-economic development in the community.

The government system in the community is represented by the Popular Council (PC). This PC is led by a Delegate who is democratically elected by the Cocodrilo residents.

Table 13. Distribution of children and young people in Cocodrilo. Source: CNAP, 2001; Tenenbaum et al., 1998.

Category	Number of people
Neither working nor studying	1
Apprenticeship program	5
Non-formal education	27
Daycare	5
Primary school	46
Secondary school	9
Total	93

Among his duties are to effectively represent the interests of his people at higher levels of government and to facilitate, coordinate and control all actions within the community, aiming at improving the socio-economic well-being of their comrades. The Delegate has to publicly provide explanations of his job fulfillment to the community. At a public meeting, residents state their main problems and propose ways of solving them. This form of government is very well accepted by the majority of people. It is worth mentioning that this Delegate does not receive any salary or economic gain for doing this job. Their labor as a Delegate is entirely voluntary.

There are also several political and mass organizations that help the PC Delegate to fulfill their tasks. These community organizations allow for the effective involvement of all inhabitants in the socio-economic development of the community, as well as ensure the proper use of the material and financial resources that are received from the national and provincial government. Some examples of these organizations are: the Cuban Women's Federation (that joins all Cuban women), the Committee for the Defense of the Revolution (that joins people in the neighborhood), the Young Communist Union (that

unites young people), the Pioneers Organization (that brings together all the children), as well as others.

Fishing and agriculture are the main economic activities in the community. There are other sources of income such as production of vegetal coal, and forestry (Table 14). Agricultural activities were improved with the creation of a Farming Cooperative, which allowed an enhancement of the food supply for the community. There is also a Fishing Cooperative that constitutes the main source of employment in the community. Despite precarious conditions of most fishing boats and problems with the cooperative infrastructure (lack of electricity and fresh water), annual yields have remained steady (Figure 24).

Fishermen leave for fishing grounds in pairs in the morning and return in the afternoon. The critical technical status of fishing boats (poor maintenance and care, problems with engine and spare parts, too small) does not allow them to go to better fishing grounds, which are located at greater distance. Main fishing gears are hook and line, trawl net, fishing pots and long lines; in the case of sea turtles they use special nets. The whole catch is bought directly from fishermen by the Fishing Cooperative at nationally established prices (Table 15) that remain the same throughout the year. There is a bonus paid in USD, and constitutes 20% of the value of one tonne. This constitutes an incentive mechanism implemented by the government to improve living conditions of fishermen, as well as catches.

Table 14. Job distribution in Cocodrilo. Source: CNAP, 2001; Tenenbaum *et al.*, 1998.

	Employees		
Employer	Females	Males	Total
Education	11	3	14
Public health	4	3	7
Commerce	4	2	6
Fishing	4	19	23
Farm cooperative	2	5	7
Culture	3	-	3
Water and waste management	-	1	1
Electricity	-	2	2
Communal services	1	1	2
Flora and fauna	1	9	10
Local services	-	1	1
Coast guard	1	2	3
Local industries	1	-	1
CITMA	-	1	1
Forestry	1	20	21
GEOCUBA	-	3	3
Church	1	-	1
Total	**34**	**72**	**106**

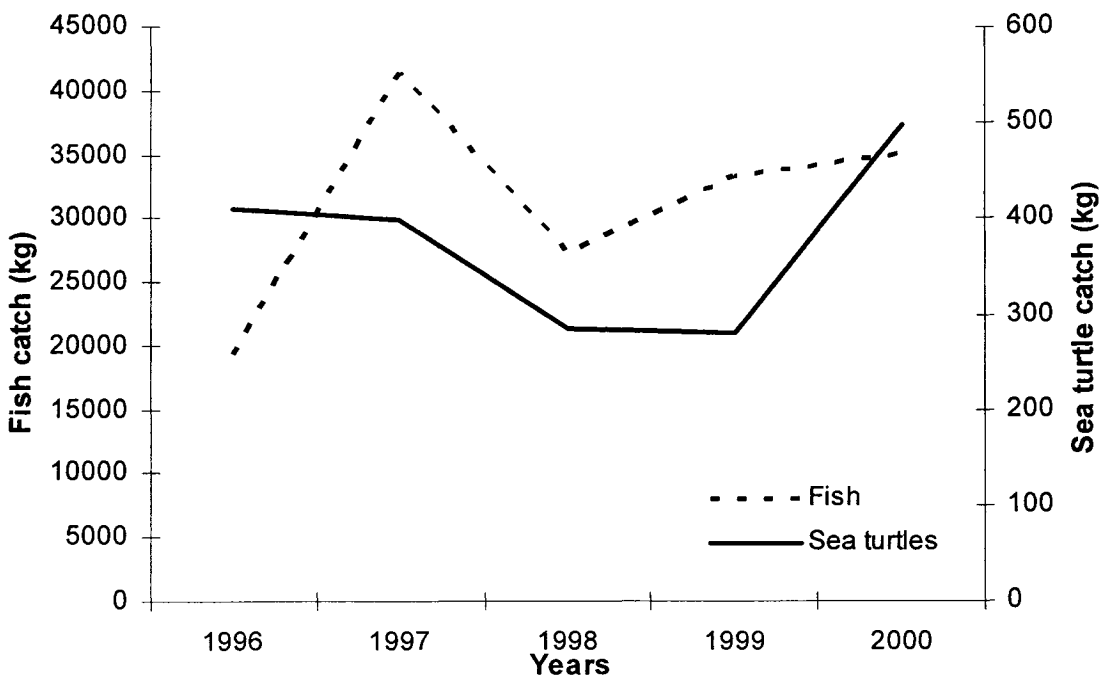

Figure 24. Annual fin fish and sea turtle catches at Cocodrilo. Source: "Cristobal Labra" Fishing Cooperative.

Table 15. Prices paid to fishermen for their catch. Source: "Cristóbal Labra" Fishing Cooperative.

Fishing group	Weight (g)	Price (Cuban pesos/tonne)
Special group	> 950	1,500.00
Group A	631 - 950	800.00
Group B	316 - 630	400.00
Group C	< 315	200.00

This financial mechanism could be of greater benefit to Cocodrilo fishermen. The fact that Cocodrilo is the only human settlement on the southern part of the Isle of Youth makes this community different in many ways. In particular, there is a high level of subsidies from the government in terms of basic products and services, such as food, clothing, health education, and the like. Because of these subsidies, most products that are sold elsewhere in USD can be acquired in Cuban pesos in Cocodrilo. If fishing conditions are improved (i.e. better fishing boats and storage capacity for catches), then fishermen's earnings would be higher, with a resulting improvement in living conditions.

One key element in this community that makes it different from the rest of Cuban coastal communities (and probably from most Caribbean coastal communities) is the fact that sea turtles are among their exploited fishing resources. There are international regulations that ban fishing and trading sea turtle species, due to their endangered status. Cocodrilo is one of the two places in Cuba, and probably in the Caribbean, where sea turtle fishing is allowed. They have traditionally exploited this resource for local consumption, and catches have remained fairly constant through the years (Figure 25). In the case of the Hawksbill turtle (*Eretmochelys imbricata*), residents use the meat. However, the shell is

carefully classified and packed and sent to Havana for storage. They will be commercialized in the future, if an agreement can be reached with the Convention on International Trade of Endangered Species (CITES).

Earnings from sea turtle fishing vary according to the species caught. The MIP pays 110.00 Cuban pesos per tonne of Loggerhead turtle (*Caretta caretta*), 200.00 Cuban pesos per tonne of Green turtle (*Chelonia mydas*), and 590.00 Cuban pesos per tonne of Hawksbill turtle (*Eretmochelys imbricata*). No financial incentive in USD is paid to fishermen in these cases. It should also be mentioned that fishermen do not receive any revenue from the Hawksbill shell. This is by far the most valuable potential asset in the sea turtle fishing industry in Cuba. Initially, Cuba primarily sold this resource to Japanese buyers. This trade was later banned by CITES, and since then all shells have been classified, codified and stored in Havana, waiting for the trade restriction to be lifted.

At Cocodrilo there is a sea turtle farm. This facility was built and administered by the MIP, and is the only one in the country. Its main objective is to contribute to the preservation of these species through a reduction of natural mortality in early life stages. New-born turtles are collected from nearby nesting beaches, and brought to the farm, where they are kept in tanks. During their first three years of life, these turtles receive special care until they are released back to the wild. This facility provides employment to the community, and could be used as an attraction to draw the attention of tourists, as well as funding for the community.

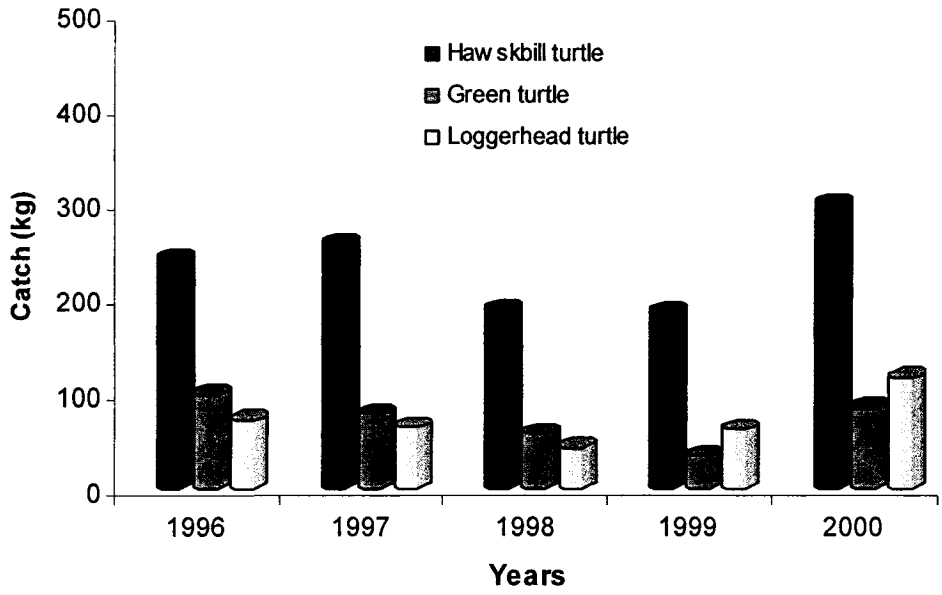

Figure 25. Annual sea turtle catches in Cocodrilo. Source: "Cristóbal Labra" Fishing Cooperative.

Electricity is provided to the community by mean of generators that used to run 9 hours a day during weekdays, and 12 hours on the weekends. Since November, 2004, the service was extended to 24 hours a day. Alternative sources of energy are also used, such as the solar panels installed in the school and in the medical center. These panels guarantee health services and educational activities to children.

Public transportation is one of the most crucial problems in the community. Currently, there is only one bus that travels to Nueva Gerona in the early morning, and returns to Cocodrilo in the evening. No other means of public transportation is available, save for an ambulance that is used only in emergency cases. Communications are ensured through four public telephones that are available to every person in Cocodrilo. The community

receives mail and newspapers on a daily basis. There is a local radio station in the community that functions two hours a day providing local information as well as environmental education programs.

Prior to 1976, the Punta Frances area was openly and freely visited by Cocodrilo inhabitants interested in recreation or leisure. The natural beauty of the area attracted people from the community, and beyond, for camping, In addition, fishing resources were abundant on the entire south coast of the Isle of Youth. Fishing was an important use within the Punta Frances area, particularly for its excellent deep sea fishing grounds.

After 1976, access to Punta Frances began to be restricted for tourism development and conservation. This decision was based on the excellent natural conditions for diving that the area offers. Controversy among stakeholders began to increase, and actions were taken to minimize them. As part of those actions there were a series of recommendations that aimed at solving the problems of conflicting uses and users in the PFMPA. Despite good intentions, the multidisciplinary team created by CITMA to address issues in the PFMPA, there was no direct representation from Cocodrilo. The community's interests were not taken into consideration, and it comes as no surprise that Cocodrilo inhabitants are indifferent towards the PFMPA.

From interviews, it was possible to identify a very poor level of interaction between the PFMPA and the Cocodrilo community. Contrary to what was expected, local inhabitants refer to the PFMPA as a forbidding place, where access to or benefits from it were denied

to them. Expressions such as: "I did not know that Punta Frances was a MPA", "I have no interest in visiting it", "I do not want to go there", and "I do not see how it could benefit us", were very common, and clearly indicate a rupture between Cocodrilo and the nearby MPA.

It was interesting to see that people from Cocodrilo recognize their limitations regarding employment qualifications for work at the PFMPA. Many residents do not have the possibility for employment in the PFMPA. Currently, there are only three people at Cocodrilo with a higher education degree, and only one person actually works as an Environmental Specialist in the PFMPA. However, it is also recognized that lack of skill is not the only barrier to employment for Cocodrilo inhabitants, as many of the jobs at the PFMPA do not require high education or skill levels. Indeed, much of the work is simply hard physical work, such as rustic construction and maintenance of existing facilities. There have been cases when foreign construction workers were hired with no thought for the available workers in Cocodrilo.

Another issue that emerged from the interviews was discontent with CITMA officials. Most of the interviewees maintained that CITMA has not been truthful about including them in management actions regarding the PFMPA. In fact, CITMA has excluded Cocodrilo residents from the PFMPA management. At one point there was a great deal of collaboration and joint work, thanks to a project in which CITMA acquired a truck which it promised to Cocodrilo when the project ended. Unfortunately, the truck was taken

away, and relationships have deteriorated considerably. CITMA faces a major task in re-building trust with Cocodrilo.

Despite the separation between Cocodrilo and the PFMPA, many inhabitants see potential benefits for the community from the use of the PFMPA. These benefits may be classified as economic and non-economic. Economic benefits include those relating to employment in the PFMPA, selling goods and services to tourists who visit the park, and fishery benefits within the park. Among non-economic benefits, the enhancement of human relations through cultural exchange with MPA visitors is important. For many people in Cocodrilo, their remoteness, and access restrictions to their community, hinder their capacity to develop as a society. Comments like, "we need to know other cultures and exchange ideas with people from outside", "before, there was no restriction to access the community, and that was good", and "it is important to instill proper human relations in our children" were frequent. The comments clearly suggest there is a general concern for their future in the community.

Other non-economic benefit includes improved cultural contacts and resources, and a sense of attachment to the natural resources present at the PFMPA. Despite problems with isolation, people in Cocodrilo feel very proud of their community. For them, it is a source of great pride to have no social problems, such as drugs, prostitution, and other criminal activities. They feel very fortunate that they can live with their house doors open.

On the other hand there was a strong consensus among Cocodrilo inhabitants that the current government system is the best option they have to solve their problems. The vast majority of interviewees prefer to make effective use of existing government tools, i.e. the Delegate, political and mass organizations, and the like, to overcome current problems with the PFMPA. An alternative that emerged during this research was the possible creation of a nature-oriented group to facilitate obtaining external funds. A group named Pro-Naturaleza was created, with the support of a Cuban NGO which bears the same name. This group will look at improving relations between the community and the PFMPA in terms of increasing understanding of natural processes and conservation awareness among local inhabitants. At the same time the group will act as a mediator between CITMA and the community to build trust between the two.

Conclusions

From this analysis, it may be concluded that the PFMPA has primarily been effective in providing fulfillment of social needs for its foreign visitors. Results the survey of tourist divers clearly suggest that the area contains enough natural beauty to satisfy the most demanding tourists. Similar opinions were expressed by boat skippers and dive instructors at the Colony Hotel, although the skippers and dive instructors perceive the PFMPA in a more critical way than they used to. These results complement findings in the biological and economic sections, where no negative impacts from SCUBA diving was identified, and current benefits derived from MPA use clearly outweigh the costs of nature protection.

Despite these positive trends, there is a major limitation in the PFMPA effectiveness that requires immediate attention. The fact that people from Cocodrilo are not receiving any direct benefit from the PFMPA is a major weakness in the fulfillment of the PFMPA objectives. Local inhabitants showed little interest in the PFMPA; in general terms, they feel excluded from it. The genesis of this problem dates back to the creation of the MPA in 1976, and was reinforced in the 1996 review of the MPA's mandate. The community should have been consulted, and existing mechanisms for community participation should have been used. Instead, matters were handled by governmental stakeholders, leaving the community with no real possibilities for involvement.

Nonetheless, there is still room to resolve this situation; local inhabitants expressed their intention to cooperate with local authorities to create better integration with the PFMPA. This possibility is clearly a result of the Cuban socioeconomic system, in which coastal communities have their basic living needs ensured. People in Cocodrilo trust their governmental authorities, and are willing to work with them. This window of opportunity should not be disregarded. One possible way to start is by giving people from Cocodrilo free access to the PFMPA for recreational purposes, as well as to give Cocodrilo fishermen exclusive rights to exploit deep sea fish resources in the PFMPA. This relatively simple and inexpensive measure would clearly improve current community attitudes towards the PFMPA. By giving them these privileges the community as a whole will fill more involve with the MPA and will accrue part of the direct and indirect benefits derived from the PFMPA.

Chapter VI

Methodology for Assessing the Effectiveness of Marine Protected Areas

Introduction

Management effectiveness is normally accepted as the degree to which a PA is used to achieve its goals and objectives, while assessment of the management effectiveness is the process of documenting how the management of a PA ultimately influences its success (Hocking et al., 2000). It is crucial to understand management effectiveness as a comprehensive process that involves different disciplines relevant to MPAs.

Prior to 1993, an assessment of whether or not the establishment and management of MPAs had achieved their goals was lacking. Instead there were only papers dealing with MPA objectives and benefits (Kenchington, 1990; Kelleher and Kenchington, 1992; van't Hof, 1992), and they concentrated on biological conditions alone, and therefore were not comprehensive in nature (Hocking et al., 2000). After that, management effectiveness of MPAs started to receive increased attention worldwide.

Alder (1996) produced one of the pioneer works on this subject. She undertook a mail survey to 290 individual MPA participants in 110 countries located in the tropical belt of the planet. The survey aimed at collecting information regarding crucial MPA aspects, such as: MPA establishment, MPA planning, implementation of management plans, and

stakeholder's involvement and education. Among other important aspects, Alder found that only 45 % of the respondents (the response rate for this survey was only 30 %) believed that their MPAs were successful, 35 % believed the contrary, and 20 % could not decide. This could be interpreted in two ways: first, at that moment, MPA success was actually very low; and second, lack of knowledge and methodologies did not allow for assessing MPA success or effectiveness.

Currently, several methodologies have been proposed with different degrees of complexity. These methodologies have mostly come from international institutions that have tried to solve particular issues in different regions worldwide. For instance, the IUCN produced one of the most accepted methodologies to assess management effectiveness in PAs (Hocking et al., 2000). Hocking et al.carried out a detailed analysis of every aspect involved, and provide a comprehensive rationale for undertaking such an effort. According to them, proper assessment of management effectiveness allows for the promotion and implementation of adaptative management, improves planning, and promotes accountability.

The WWF and the Agricultural Center for Tropical Investigations and Teaching (CATIE) developed the WWF/CATIE methodology to assess management of PAs in Costa Rica. Also, WWF Brazil did something similar to assess a large number of PAs in a short period of time (Hocking et al., 2000). Both methodologies have their own specific features, but fit very well within the framework provided by IUCN.

Regardless of the methodology used, there are common elements in all of them. First is the promotion of adaptative management. This management approach is based on a circular, rather than a linear, management approach. Its key attribute is that information concerning the past is fed back into the process and use to improve the way management is conducted in the future (Agrawal, 2000). Second, project planning is improved by reviewing previous actions and applying lessons learnt from them, which will allow decision-makers to allocate resources more efficiently. Finally, accountability is promoted by having managers report their success in conserving natural resources, builds greater support and trust. Accountability has changed from focusing on issues of financing and managerial probity to include concerns for management effectiveness (Hocking et al., 2000).

Alder et al. (2002) developed one of the simplest, yet workable, methodologies to assess MPA effectiveness. They proposed a Marine Protected Area Evaluation Model (MPAEM) based on a multidisciplinary approach used to assess the sustainability of fisheries, called Rapid Appraisal of Fisheries (Rapfish). In my opinion, the major advantages of Alder's methodology in comparison with other methodologies are its flexibility, its ease of application, and its relative low cost.

Alder et al. (2002), undertook a pilot study to test the MPAEM using 20 MPAs distributed all over the world. The evaluation fields (indicators) considered were: living (renewable) resources, nonliving (nonrenewable) resources, economic (market values),

social, ecosystem functions, and management. According to them these evaluation fields categorize the attributes that best reflect effective management.

Each evaluation field is then given a score from which a similarity matrix is constructed, followed by a multidimensional scale analysis (MDS). Results from their study were very positive in providing managers with pragmatic indicators to assess whether their MPA was performing acceptably. The main shortcoming of the MPAEM, however, is that it does not allow for assessing the management effectiveness of a single MPA. The multivariate nature of the MDS analysis requires data from more than one MPA to function properly. If the analysis is applied to just one MPA (this means working with a vector instead than with a matrix), the MDS will provide fault results that are not reliable.

Based on Alder et al's (2002) findings and taking into account the need to develop a simple and widely applicable method to assess MPA effectiveness, this chapter is dedicated to develop a methodology that will provide managers with a practical tool to assess management effectiveness of a single MPA or a group of MPAs.

Methodology to Assess Effectiveness of Marine Protected Areas

Any methodology for assessing management effectiveness selects a set of indicators that best reflect management effectiveness. These indicators may vary in time and space scales, and must be related to the stated objectives for which the MPA was created. Selection of indicators is not a simple process; it requires deep knowledge of the area, as

well as the existing issues. The WCU provides general criteria to select indicators (Hocking et al., 2000). According to WCU an indicator should be:

- unambiguous, predictable and verifiable
- integrate environment effects over time and space
- reflect changes (in space and time) and processes of significance to management
- cost-effective
- simple to measure
- able to be collected, analyzed and reported in a timely fashion

It is important, also, that the outcome of the assessment is easily comprehended, and accepted by decision makers who ultimately will decide what to do next. Otherwise time and resources will be wasted. In this regard, Hocking et al. (2000) provided excellent advice on how to present and publish the results produced with WCU methodology for assessment of management effectiveness.

Figure 26 depicts the proposed methodology for assessing MPA effectiveness. First, to overcome the issue of selecting indicators that will allow proper representation of the MPA under consideration, and to provide margins for comparison with other MPAs, this study proposes the use of the benefit categories as indicators to be assessed. This will help in obtaining a standardized set of data ready to be processed, and avoid possible future transformation of the data if multivariate techniques are to be used. Clark and

Warwick (1994) stressed the negative effect that data transformation could have on multivariate analysis, thus limiting subsequent interpretation.

In Chapter 2, a typology of benefits derived from MPAs was presented (Table 2, page 42). In such a table, nine main benefit categories were identified: Fishery benefits, Non-fishery benefits, Management benefits, Education/research benefits, Cultural benefits, Process benefits, Ecosystem benefits, Population benefits, and Species benefits. These categories encompass several specific benefits that, as pointed out earlier, are neither inclusive nor final; many more can be recognized and added to the list according to each MPA's specific conditions.

The rationale for using these benefit categories is based on the notion that, ultimately, the decision to establish a MPA will depend on a variety of factors: the quantified and non-quantified benefits expected from protection, the costs of protection, the potential net benefits for alternative uses of the site, social issues, and so on. Consequently, the need to justify MPAs in social, economic and developmental terms is crucial, especially in undeveloped countries where resource scarcity and poverty make them prone to overexploit marine resources. Therefore, to fully assess the success of MPAs, national governments or any other entity responsible for MPA implementation, have to be able to clearly identify all possible benefits that may accrue from the MPA, and from that point state their objectives. A correct early identification and assessment of MPA benefits will ensure public acceptability of MPAs (Alder et al., 2002). Because public acceptability

will depend on whether the perception of benefits is greater with or without MPAs, this assessment will, in turn, influence the political support for MPA programs (NAS, 2001).

After having set the nine indicators (benefit categories), then identification of current and potential benefits provided by the MPA in question should be done. Current benefits (CB) are the existing benefits provided by the MPA. Potential benefits (PB), on the other hand, are the possible benefits that the MPA could provide in a hypothetical better management status.

Once the two possible benefit scenarios are constructed, then each benefit within each category (indicator) is given a score (in this case, a one). Next scores, within each indicator are added, and a CB/PB ratio is then calculated for each benefit category independently. A total CB/CP ratio for the whole MPA is estimated by adding scores along the nine benefit categories. Finally, ratios can be expressed as percentage to allow for better understanding. This will provide a quantitative measure of how effective the MPA has been both by separate indicators, and as a whole.

The methodology can also be used to compare effectiveness within a system of related MPAs. Essentially the steps are the same, with the additional step of constructing a similarity matrix that may be used to conduct a multivariate analysis (e.g., cluster analysis, MDS).

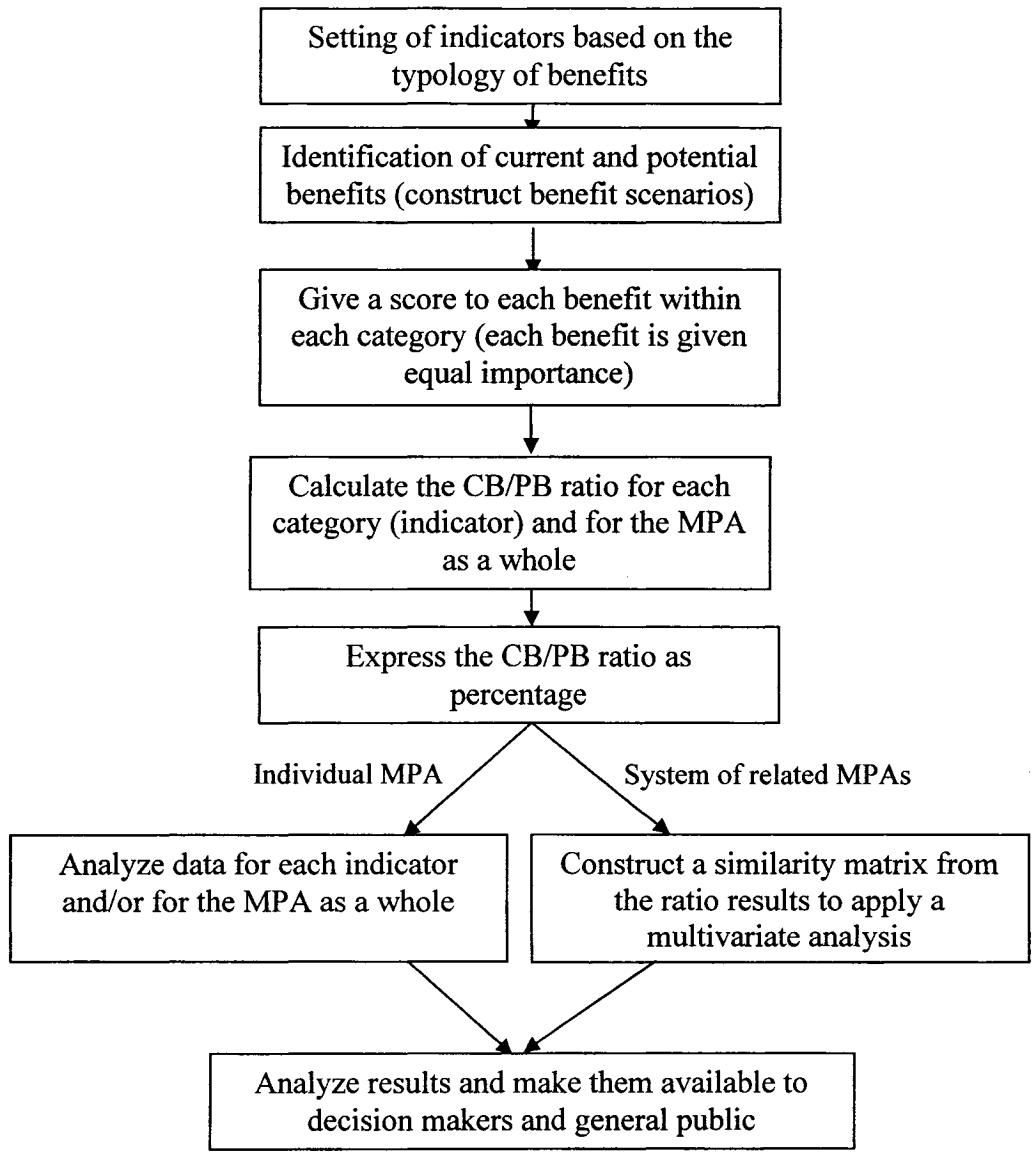

Figure 26. Methodology for assessing effectiveness of MPAs.

The main advantages of the methodology presented here are:

- relatively simple approach
- easy to undertake
- no need for high qualification to undertake the assessment

- low cost
- allow for analysis of one particular MPA or system of related MPAs
- produce results suitable for comparison
- avoid data transformation (when multivariate analysis is performed)

The methodology presented in this work follows a relatively simple approach because it only relies on estimating current and potential benefits provided by the MPA in question. Other methodologies, on the other hand, follow a more complicated path and require data that most of the times are not easy to gather. For instance, the setting of evaluation fields, or indicators, is not a simple task and it is prone to failure due to the large number and diversity of issues occurring in a MPA. This simple approach, at the same time, does not require highly qualified personnel to conduct it, which is essential for most MPAs located in under-developed countries that lack necessary human resources. Its simplicity also implies a low cost and makes it easy to implement because existing staff at a MPA can conduct the analysis saving, hence, financial resources that will need to be used to hire external specialists.

The proposed methodology is also suitable for analyzing one particular MPA or a system of related MPAs. This advantage differs from every other methodology reported in the literature. As pointed out earlier, most of the existing methodologies were developed to solve particular problems at particular times; therefore they do not provide room for comparison with other cases. The main reason is that the set of indicators differ for each particular case. Using the proposed methodology ensures that for every MPA in analysis

the set of indicators will be the same. These are the benefit categories presented in this study. The methodology provides results that are readily available to apply multivariate analysis such as cluster analysis and MDS. These methods often require transforming and standardizing the data, with the new proposed methodology the results can be processed directly without any transformation.

The most difficult step of the methodology, due to the level of information and knowledge that is needed, is the construction of the benefit scenarios. This construction needs to be done using a truly interdisciplinary approach, and ensuring full collaboration among participants. It is very important, as well, to ensure ample participation of all stakeholders and especially local communities. This strategy will ensure that the best information will be available to forecast potential benefits as well as to identify current MPA benefits. Additionally, it is important to mention that all benefits are treated equally. This means that there is no differential weighting among them, therefore benefits to ecosystem or populations have the same importance as cultural benefits, for instance. This author acknowledges that this might not be the case in any particular MPA. For instance, there might be a MPA for which managers consider that benefits to nature are more important than benefits to humans. In this case; the scores associated with those benefits could be weighted accordingly and the final result would be different. The problem with weighting is that it throws the analysis opens to subjective bias and compromises comparisons. If weighted is to be used in calculating the effectiveness index, it should be done in a rigorous process, such as multi-criteria analysis (Bunce at al., 2002).

The methodology proposed here could provide different possible results, ranging from 0 % to 100 % effectiveness. The ratio will depend on how well existing management is at extracting all possible benefits from the MPA. There might be cases where some benefit category is not present in the current benefit scenario; in this case, the score would be zero. One hundred percent effectiveness, on the other hand, will be obtained if the number of current benefits equals the number of potential benefits. In this case, it can be concluded that the MPA is doing an excellent job. What should normally be expected, however, is a higher number of potential benefits in comparison with the number of current benefits. It is then up to researchers undertaking the assessment to determine what percentage is considered acceptable under the prevailing working circumstances. Nonetheless, for the sake of simplicity the following criteria can be used.

Table 16. Criteria for classifying MPA effectiveness.

Percentage	Criteria
0 - 20	very poor effectiveness
21 - 40	poor effectiveness
41 - 60	good effectiveness
61 - 80	very good effectiveness
81 - 100	excellent effectiveness

Applying the Methodology to Punta Frances Marine Protected Area

Tables 7 and 8 illustrate the two benefit scenarios for the PFMPA. As may be seen, there obvious differences exist between the two, either in the number of benefits, and in the economic value of those benefits. Table 17 shows the application of the methodology proposed in this study.

According to Table 17, the PFMPA has an overall CB/PB ratio of 28.5 %, which means that its effectiveness is poor at present (Table 16). Therefore, immediate management measures need to be taken to improve this situation.

Table 17. Quantitative assessment of the effectiveness of the Punta Frances Marine Protected Area. FB: Fishery Benefits, NFB: Non-Fishery Benefits, MB: Management Benefits, E/RB: Education/Research Benefits, CB: Cultural Benefits, ProB: Process Benefits, EB: Ecosystem Benefits, PopB: Population Benefits, SB: Species Benefits, Sc: Scenario, CB: Current Benefits, PB: Potential Benefits

	PFMPA Benefits									
	To humans					To nature				
	Direct			Indirect/off site						
PFMPA	FB	NFB	MB	E/RB	CB	ProB	EB	PopB	SB	**Total**
Sc. I	0	2	1	2	1	4	2	0	0	**12**
Sc. II	2	5	5	5	8	6	4	3	4	**42**
CB/PB	0	0.4	0.2	0.4	0.125	0.666	0.5	0	0	**0.285**
%	**0**	**40**	**20**	**40**	**12.5**	**66.6**	**50**	**0**	**0**	**28.5**
MPA assessment	**Very poor**	**Poor**	**Very poor**	**Poor**	**Very poor**	**Very good**	**Good**	**Very poor**	**Very poor**	**Poor**

An individual analysis per benefit category shows that in each case there are possibilities for a significant improvement on the effectiveness of the PFMPA. Remarkable is the case of cultural benefits, which show a potential increase of seven benefits in a possible scenario II, also management and species benefits could increase by four their number of potential benefits.

The three benefit categories that scored zero (very poor) in the analysis are very notable. They clearly illustrate that the PFMPA is not being exploited at its maximum capacity, and that current management measures are insufficient for the MPA to succeed. Some practical evidence of this was found in the biological section of chapter 5. It was noticed that although fish were abundant and diverse, the area lacked large fish specimens,

mainly predators belonging to the families Lutjanidae (*Lutjanus spp.*, snappers) and Serranidae (two species of the genus *Epinephelus*, locally known as nassau grouper and jewfish, and several species of the genus *Mycteroperca*, locally known as black grouper and tiger grouper). This situation may explain why the PFMPA is not doing well in the population and species benefit categories. Also the size of the MPA may have some influence on this as well. Small MPAs tend not to be efficient in protecting wild populations, unless they are located in places where spawning aggregations occur. This seems to be the case for the PFMPA, remember that its creation back in 1976 aimed at fulfilling objectives of tourism exploitation and not conservation. Fishery benefits scored zero because out of the sixteen fishery-related benefits identified in Table 2 (pag. 42), the PFMPA is considered to be able to provide at least two. Others still need experimental evidence. Currently the PFMPA is not providing any fishery-related benefit because of administrative and management problems.

Benefits to nature were the best represented, with percentages exceeding 50 % for two categories, (although the remaining two categories scored zero). Although, the PFMPA is not providing the full range of possible benefits to nature, its management status apparently ensures some effective protection. This result is supported by findings in the biological section of chapter 5. There is no evidence of negative impact on natural communities by SCUBA diving activities at the present time. This finding should be viewed with caution, because there is an important external effect that needs attention: the industrial fisheries near and within the MPA.

On the other hand, direct type benefits had lower scores, which indicate that economic opportunities are not being fully exploited in the PFMPA, and that there is some room to work in order to achieve maximum economic benefits. For example, the PFMPA is not providing any fishery-related benefits, when there are real possibilities (e.g., the excellent deep fishing grounds). In addition, the low number of benefits found in the non-fishery-benefit and management categories is noteworthy. These two categories are very important because they encompass the bulk of direct economic inputs to the MPA. All those benefits that have direct influence on the conservation and appropriate use of the natural resources as well as the satisfaction of most social needs either for local and non-local people, fall within their domain.

Additionally, cultural benefits scored low in the analysis. This type of benefit is very important for what it represents. For MPAs to be socially accepted, issues related to conservation ethics, spiritual fulfillment, aesthetic opportunities, and awareness need to be instilled in the population; otherwise MPA success is put at risk. As was shown earlier, the PFMPA is not providing very few such benefits to local human populations. This situation must be changed in the near future. Management type benefits also score very low on the effectiveness scale. Twenty percent effectiveness is a questionable result for any MPA. The fact that the area has not been approved as a National Marine Park yet makes it difficult for MPA staff to take actions to improve this situation. The PFMPA is essentially a no fishing zone with limited capacities to enforce such a designation. Management improvement is urgently needed to make Punta Frances a successful MPA.

Chapter VII

Conclusions

In the body of research reported in this thesis I have used a case study of an established Cuban MPA to explore the broader mechanisms and implications of management effectiveness for what is becoming the tool of choice for achieving integrated management goals in coastal marine ecosystems. The contributions to new knowledge come from multidisciplinary research, interdisciplinary analysis, methodological innovation and socio-political argument. Here I attempt to summarize and extend my findings towards future research endeavor.

Analysis of a Cuban Marine Protected Area

The PFMPA constitutes an interesting example of a MPA within the Cuban system of protected areas. As a matter of fact, this area was one of the pioneers of its type in the whole country. Keep in mind that limitations on certain economic activities (i.e., fisheries) and other conservation measures were implemented in the area some 25 years ago. The initial rationale for implementing such measures was economic in nature because the area had proven popular for recreational SCUBA diving in the first instance. Later, tourist activities within the area increased in diversity and magnitude due to the arrival of cruise ships, prompting a change in the existing approach to include broader conservation objectives and leading to an initiative of creating a national marine park in 1998. Currently, this initiative is still waiting for approval at the higher level of

government. According to CITMA specialists the reason for this delay in the declaration of the PFMPA is because other areas in the country have been assigned higher priority as a result of strategic planning at the national level.

Interdisciplinary Approach to Evaluating Management Effectiveness

To address the changes in the types, patterns and magnitudes of human uses that the PFMPA has experienced, and to assess how these uses coexist with an increase in extractive activities (i.e., fishing) in adjacent areas that may jeopardize the fulfillment of management objectives, a research question was posed: "how effective has the PFMPA been in meeting the multiple objectives of conserving biological diversity and ecological stability, allowing for the development of economic opportunities for tourism, and satisfying the needs of local and distant human populations?". Clearly the interdisciplinary nature of this research question requires an interdisciplinary approach. I started by framing a series of three, interconnected hypotheses, each couched within one or more of the relevant disciplines of the natural and social sciences that form the basis for evaluating MPA effectiveness.

- Fishing and tourism activities negatively affect the function and structure of the coral reef community within the PFMPA, potentially compromising the objective of nature protection.
- Economic benefits derived from exploitation of resources associated with the PFMPA outweigh the direct and indirect costs of nature protection.

- The PFMPA satisfies social needs for employment, cultural diversification, environmental awareness, and recreation of local and non-local human populations.

To rigorously address the research hypotheses it was necessary initially to investigate all possible benefits that a MPA could provide. The rationale for this was that MPAs are a clear product of a decision-making process; therefore benefit identification and valuation are important issues in both decision support and evaluation of consequences (i.e., outcomes). Additionally, the ultimate decision whether or not to establish a MPA will depend on a variety of factors: the quantified and non-quantified benefits expected from protection, the costs of protection, the potential net benefits for alternative uses of the site, social issues, and so on. Consequently, the need to assess management effectiveness of MPAs in social, economic and developmental as well as ecological terms has become almost universal, especially in developing countries where resource scarcity and poverty make them prone to overexploit marine resources. Therefore, to fully assess the success of MPAs it becomes vital to clearly identify all possible benefits that may accrue from the MPA and from that point clearly state those that are the objectives of management in a given instance. Alder et al. (2002) also reported that correct, early identification and assessment of MPA benefits will foster public acceptability of MPAs. Because public acceptability of an MPA will depend on the perception that benefits will be greater with an MPA than without it. Therefore, identification of MPA benefits will influence the political support for MPA programs (NAS, 2001).

In recognition of these realities, I created, a typology of benefits derived from MPAs that goes well beyond what had been done previously. A total of 99 benefits were identified using a comprehensive classification model based in the integration of two themes: anthropocentric and biocentric. This classification draws on the work of others to form a new synthesis of MPA benefits. Its value lies in a framework that simplifies the identification benefits, facilitates their valuation, and allows for comparison among MPAs. Besides the novelty of the classification approach it also constitutes a work in progress, remaining open for the inclusion of newly recognized benefits. There is room for improvement of this typology. For instance it would be interesting to find a way to include costs in the typology, which will allow managers to have a more comprehensive tool for prioritizing the objectives of MPAs.

Only 33 % of the 99 benefits identified have been scientifically proven to accrue in at least some MPAs. The rest are the result of logic and theoretical analysis of several authors (Bohnsack, 1998 and NAS, 2001), which have partial support or not support at all in research results. Additionally, a mere 30 % of the benefits are in fact used in most valuation studies, leaving out the remaining 70 % of the identified benefits. Causes for this situation were identified as:

- Anthropocentric approaches that influences the assessment of MPA benefits.
- Economic valuation systems that do not internalize environmental issues.
- Analytical methods that account mostly for market-based benefits.

These shortcomings have provoked insufficient analysis that, consequently, has left scientists and managers with few options to accurately assess MPA effectiveness. Therefore, a clear need for integrative research becomes evident if MPAs are to be legitimately claimed as the best method for achieving the sustainable development paradigm in the marine realm.

Measuring the Effects of Human Activity on Marine Protected Area Function

One of the most commonly studied aspects of MPA function analyzed in this study was the possible negative effect that fishing and tourism activities may have on the structure of coral reef communities within the PFMPA. The first part of the question was addressed with an experimental design aimed at determining whether there were significant differences in well-established indices of coral community health between sites with high levels of use (SCUBA diving) and sites with no use at all. The potential effects were evaluated in the two main biotopes in which recreational SCUBA diving takes place: the spur and groove zone and the reef wall. Multivariate analysis was used to explore for relationships among the variables measure.

The results of these analyses were consistent in demonstrating that SCUBA diving, up to its present magnitude and manifestation at least, is apparently not exerting any significant impact on the coral reef communities in the PFMPA. This result should be interpreted with some caution because the power of the statistical test was low (30 %), indicating the limitations of the sampling design. This figure warns managers of the likelihood of Type-

II error, making the risks and implications of management decisions clear; thereby enhancing implementation.

Results obtained from the economic and social analyses supported the ecological findings here, providing evidence that amenity and recreational values appear not to have been affected by current human activities at the PFMPA. Quantitative evidence of this can be found in the results of the carrying capacity assessment. To date, the PFMPA has not reached commonly acceptable intensities of recreational dives, which means that despite more than 20 years of exploitation the area still holds a high level of attraction for divers. It is important to mention, though, that uneven distribution of diving in the PFMPA may actually be an issue at certain sites because the estimate of carrying capacity used in this study was made on the assumption of equal use of the existing 56 diving sites.

The question of whether or not economic benefits derived from the exploitation of resources associated to the PFMPA outweigh the costs of nature protection was another subject of analysis in this study. Two hypothetical scenarios were created using the typology of benefits and a monetary value assigned to each benefit using a combination of "educated guesses" of local experts, published valuation results, and established valuation methods. Scenario I depicted twelve current benefits provided by the PFMPA to humans and nature. Under this scenario the PFMPA provides a yearly value of USD $12,795,025.00, most of which is attributable to benefits provided by nature. Scenario II, on the other hand, represents the potential benefits and their economic value that the

PFMPA could provide if fully implemented as a National Marine Park and effectively managed.

According to Scenario II the PFMPA could provide up to forty-two benefits accounting for USD \$127,164,116.37 y^{-1}. Undoubtedly, scenario II represents a much better option for the Cuban economy, but also for the non-human component of this ecosystem, as a whole because if it is achieved the PFMPA could be used as a model to apply in other areas in Cuba. Nonetheless, for Scenario II to be possible there are two main hurdles to overcome. First, there is a compulsory need to finally legalize the status of the PFMPA. To declare it as a National Marine Park would go a long way towards solving certain administrative problems, such as establishing unequivocally who is responsible for the area and setting appropriate jurisdictions. Secondly, the improvement of relationships among stakeholders in the PFMPA is absolutely necessary for a governance environment that promotes efficient coordination and cooperation towards a maximization of benefits.

A preliminary cost-benefit analysis showed that despite all the management problems with the PFMPA, economic benefits clearly outweigh costs of protection. It should be said, however, that cost estimation is not accurate because it was done based on information gathered from the operative management plan for the PFMPA. It is this author's opinion that the information on direct costs presented in table 10 is rather incomplete. Nonetheless, the significant amount of economic benefit still outweighs costs of protection in both scenarios, even assuming a two or threefold increase in costs. This

finding supports the notion that costs of protection on MPAs are generally a fraction of the net benefits provided by them.

It is evident that for the PFMPA there exists a wide range of opportunities for both the development of economic activities and for the conservation of natural resources. The key questions here are how to make these operational and how to ensure that a portion of the economic benefits derived are invested back in the PFMPA. A simple, partial solution is declaring the PFMPA as a National Marine Park. The issue of ensuring a direct financial feedback to the PFMPA management from the economic benefits it generates is a more complicated part of the solution due to the centralized nature of the Cuban socioeconomic system. For this to happen it is necessary to review the existing financial mechanisms that have national influence. Undoubtedly, this is a more time consuming process but it is not unachievable, although it does not seem realistic in the current Cuban situation.

The economic section of the study has illustrated how a fairly simple analytical approach can yield useful policy insights, and provides managers with a more integrated vision of the existing issues to deal with. Also, it became evident that to estimate the full range of economic benefits and costs associated with the use of any coastal resource, it is necessary to effectively combine natural and social sciences. This combination allows exploring potential effects of a planned resource use with respect to links among ecosystems, and their effects on people depending on the area for their existence.

Benefits-Based Assessment of Marine Protected Area Effectiveness

The first section of the thesis has shed light on a fairly poorly developed field of research in Cuba: ecological economics. Given the features of the socioeconomic system in Cuba, market-oriented methodologies have not been used. Nonetheless, with the increasing involvement of the Cuban economy in the global economy, mostly through tourism, is it evident that a change in government perceptions and attitudes should be expected; therefore, the methodology for assessing MPA management effectiveness, presented in this thesis could be used as a benchmark for future analyses of MPA effectivness in the Cuban context.

Since MPAs essentially work by controlling human activities within their limits (Sumaila and Charles, 2002) the exploration of social aspects related to MPAs becomes essential. One key aspect is the fulfillment of social needs such as employment, cultural diversification, environmental awareness, and recreation. This topic was also a subject of investigation in this study. The PFMPA has the potential to serve the interests of both local and non-local human populations. The former one is represented mainly by a nearby coastal community (Cocodrilo), while the second corresponds primarily to foreigners that visit as tourists, but also the greater population of Cuba.

The survey study undertaken among tourist divers concluded that the PFMPA has primarily been effective in providing for fulfillment of social needs of its foreign visitors, largely by maintaining a very high quality of marine environmental experience based on existing natural capital. Results clearly indicated that the area contains enough natural

beauty to satisfy the most demanding tourists. Similar opinions were expressed by boat skippers and dive instructors at the Colony Hotel, although the skippers and dive instructors perceived the PFMPA in a more critical way than they used to, recognizing perhaps through their consistent familiarity with the locale the early signs of environmental degradation. These results complemented what was learned from the biological and economical studies, where no negative impacts from SCUBA diving were identified, and current benefits derived from MPA use clearly outweighed the costs of nature protection. Survey results also support the idea that to date amenity and recreational values have not been lost in this Cuban MPA. These, findings clearly support the concept of sustainability in the recreational SCUBA diving industry of Cuba.

It is unfortunate that it was not possible to conduct a similar analysis of the more recent cruise ship tourism industry in the PFMPA to determine whether the results corroborate those of the well-established diving industry. In one sense, the cruise tourist is a less discerning user of the PFMPA's resources because she spends relatively little time in the ecosystem, and sees only the littoral strip. On the other hand, the intensity during cruise visits of use is far higher than SCUBA diving per units of time and area, and the shallow, near-shore sub-tidal environment where visitor's snorkel contains some of the most fragile components of the coral reefs community (i.e. the branching corals). The recent, sharp increase in cruise ship visits obviously demonstrates that the amenity value of the PFMPA remains high as perceived by this industry. It will be useful to track development in this sector over the next few years, and analyze its impacts using the interdisciplinary methodology developed in this study.

This study has also proved that a remote and lightly used MPA can be economically beneficial in a socialist economy. There exist expectations in relation to recreational SCUBA diving, and MPAs can be used to fulfill these expectations, maximizing, therefore, economic benefits. Empirical work showed that divers are interested in the state of the MPA, and their decision to visit the MPA or not depends in part on the status of the MPA; and thus on the effectiveness of its management. This reasoning can be extended to Cubans who, as pointed out before, remain excluded although they have high expectations of benefit from the MPA. The finding that even the informal establishment of an undeclared MPA gives rise to community expectations to participate in their benefits goes along with the sustainability concept I have developed here, and constitutes, in my opinion, a contribution to new understanding of MPA function.

A major factor limiting the effectiveness of the PFMPA is the fact that people from the local community (Cocodrilo) were not receiving any direct or indirect benefit from the PFMPA. This constitutes a major weakness in the fulfillment of the PFMPA objectives. Results from face-to-face interviews with local inhabitants confirmed that there was little interest in the PFMPA; in general they felt excluded from it. The origin of this problem was dated back to the establishment of the MPA in 1976, and was reinforced in the 1996 review of the MPA's mandate. The community should have been consulted, and existing mechanisms for community participation should have been used. Instead, matters were handled only by governmental stakeholders, leaving the community with no real possibilities for involvement at any level.

It is this author's opinion, however, that there remains a possibility to overcome this problem, because the local inhabitants expressed their intention to cooperate with local authorities to create better integration of their activities with the operation of the PFMPA. Undoubtedly, this is a result of the Cuban socioeconomic system, in which coastal communities have their basic needs for economic, health and job security ensured. This situation does not occur in most Caribbean countries, where the bulk of MPA research has been conducted. People in Cocodrilo generally trust their governmental authorities, and are willing to work with them. It then becomes crucial not to disregard this window of opportunity. A possible start is to grant free access to the PFMPA for recreational purposes to people from Cocodrilo and the surrounding hinterland. Additionally Cocodrilo fishermen could be granted exclusive rights to exploit deep sea fish resources in the PFMPA. This relatively simple and inexpensive measure would certainly improve current community attitudes towards the PFMPA. By giving these privileges, the community as a whole will feel more involved with the MPA, will be more highly disposed to contribute to and comply with its management, and will thus start to accrue part of the direct and indirect benefits derived from the PFMPA.

Evolving Methodology

Returning to the basic research question of just how effective the PFMPA has been, this study has produced a new methodology for assessing the management effectiveness of a given MPA. It constitutes an aggregated, interdisciplinary metric of MPA effectiveness that can lead to improvements in the management of MPAs in Cuba or elsewhere by

providing quantitative feedback on the ability any one or combination of management interventions to achieve multiple objectives. The methodology constitutes an advancement that draws on other contributions to produce a new approach that goes beyond what has been done previously in evaluating MPA effectiveness.

The methodology takes a relatively simple approach, based on a complete typology of all possible MPA benefits developed previously. It is then a matter of identifying which of these describe the current and potential benefits provided by the MPA in question, and then calculating a current-benefit/potential-benefit ratio, which is expressed as a percentage to allow for an easier interpretation. The percentage expresses the proportion of the total possible benefits of a given MPA that are actually being realized under the current management regime, and is thus sensitive to the absolute potential of an area. An MAP with little potential and very good management practice would receive a very high score, while an MPA with a similar management regime but great potential for benefit could receive a much lower score. Note that the method does not acknowledge stated management objectives, but rather evaluates against potential benefits (some of which may not even be recognized by management, much less managed for).

Other methodologies, on the other hand, follow a more complicated path and require data that are rarely easy to gather. For instance, the setting of evaluation fields, or indicators, is not a simple task, and is prone to ambiguity due to the large number and diversity of issues occurring in a MPA. This benefit ratio method does not require highly qualified personnel to conduct it, which is essential for most MPAs located in under-developed

countries short of trained human resources. Its simplicity also implies a low cost and makes it easy to implement because existing staff at a MPA can conduct the analysis saving, hence, financial resources that will need to be used to hire external specialists.

The proposed methodology is also suitable for analyzing a system of related MPAs, not just one particular MPA, because of the standardized benefit typology. This advantage differs from every other methodology reported in the literature because most of them were developed to solve particular problems at particular times; therefore they do not provide a rigorous basis model for comparison with other cases. The methodology also provides results that are amenable to multivariate statistical tools such as cluster analysis and MDS. Most methods often require transforming and standardizing the data for analyses, while the new methodology allows the results to be processed directly without transformation.

The most difficult step of the methodology is the construction of the benefit scenarios, due to the level of information and knowledge that is needed. This requires a truly interdisciplinary approach that ensures full collaboration among participants. It is very important, as well, to ensure ample participation of all stakeholders and especially local communities in the process so that potential benefits important to some stakeholders will not be omitted.

The methodology proposed here to assess MPA effectiveness is completely new in the Cuban context. Indeed, to date there is no methodology described for evaluating the

success of Cuban PAs, including MPAs. CNAP (2002), states that evaluation of MPAs should follow a set of measurable indicators, but does not provide any information on the kind of indicators to be used nor the methods of their application.

Lessons From and For the Punta Frances Marine Protected Area

The case study of a small, established, but yet to be legally declared MPA in the far southwest of Cuba that was analyzed in this research clearly demonstrates that there is still much to do to achieve high levels of management effectiveness within a socialist system of governance. Results showed a rather poor performance in this respect, as the figure of 28.5 % overall management effectiveness for the PFMPA reflects.

Despite the existence in Cuba of a strong governmental will to solve environmental problems, there exist issues that impede the effective functioning of the PFMPA. Causes of this are various and range from those generic to ones specific to the particular setting of the MPA. Among the broad-spectrum issues can be included the economic crisis that Cuba is facing today, which delays development in many areas that are not crucial for the nation's basic survival, such as the implementation of a National System of Protected Areas. Another compelling cause, that has been affecting Cuba for more than 40 years, is the US blockade against Cuba. This extraterritorial law has provoked significant economic losses in the order of millions of USD, as well as has denied access to important funding agencies such as the World Bank.

Among the particular causes there is one that stands up as the prime reason for the PFMPA ineffectiveness. This is that the area has not been legally designated as a National Park yet under Cuban law. Currently there is a great deal of uncertainty among users about the geographical limits (i.e., boundaries) of the PFMPA, and among users and managers about who is fully responsible and accountable for the PFMPA. At present, none of the stakeholders feel responsible for the area, although all considered themselves as the owners of it. There is still too much overlapping in functions and jurisdiction among the main stakeholders of the PFMPA. For instance the MINAGRI is responsible for all aspects associated with the adjacent land, while the MIP is responsible for aspects related to the sea. CITMA, on the other hand, claims responsibilities for land and marine issues. This situation provokes competition amongst empowered agencies, overlapping of jurisdictions, and eventually duplication of management functions that impede proper management of the area. Cost-effectiveness is but one, albeit important casualty of such a confused management structure.

Additionally, there exist a number of limitations, ranging from financial to administrative to subjective that hinder the proper functioning of the PFMPA. In the first instance, most of the revenues obtained from exploiting the area do not stay there. The majority goes to central accounts at the different ministries that hold responsibility for specific uses of the MPA, and there is almost no return of funds to the PFMPA for management expenses. This situation is characteristic of centralized government systems, both capitalist and socialist., but the rationale is best formulated in an economy that is fully centralized and planned by the government as it is in Cuba. On the positive side this strategy allows for

appropriate allocation and immediate use of financial resources when and where they are most needed, regardless of the locale capacity to produce income; and it limits the occurrences of improper use of the scarce resources by imposing non-local oversight and audit. On the negative side, centralized management delays the direct and timely use of monies at the target site when required due to the complexity of the bureaucracy involved in obtaining it. A possible solution is to place MPAs among the first priorities for the country, such that more financial resources could be expected. Given Cuba's many economic and social challenges, this is a remote possibility. Another way is to look for alternatives that facilitate the process of obtaining and using external financial resources. Currently this is a very stressful and time consuming process that certainly affects proper functioning of PAs and MPAs in Cuba.

Besides the issue of non-declaration, administrative problems with the PFMPA include insufficient implementation of the operational management plan for the area, poor coordination and collaboration with other national and local agencies and institutions, low qualification of human resources on management staff, and lack of necessary staff overall. The last issue is of particular relevance to the inability of the PFMPA staff to effectively control access and patrol the area so as to enforce existing regulations, much less potential future restrictions of human activities therein.

Subjective problems include those of human relations that could have a significant impact on the management of the PFMPA. For instance, there have been conflicts among stakeholders for unimportant reasons such as differences of opinion about certain aspects.

Most of these conflicts have, fortunately, been solved to date but some still remain, influencing negatively in the operation of the PFMPA.

Another important cause of ineffective management of the PFMPA is, in this author's opinion, its restricted nature. When this area was set aside for specified uses in 1976, the approach that prevailed was to exclude nationals from its use, which prevented a major stakeholder from accruing important benefits from the PFMPA. This was profoundly reflected in the perceptions, attitudes, and expectations of Cocodrilo inhabitants regarding the PFMPA. For this sector of the Cuban population the PFMPA meant nothing but prohibition and exclusion from an area they had previously used. In this regard CNAP (2004) has identified, among other aspects, the lack of involvement of local communities in the processes of design, implementation and management of PAs as a key issue that must be effectively addressed to ensure sustainability of PAs at the national and local scales.

Social Systems as Determinants of Marine Protected Area Effectiveness

At this stage an important question arises that has had little direct analysis in the thesis, but has been referred to often throughout. Is a centralized economy, within a socialist system, a superior option for making MPAs more effective in meeting their management objectives? Is an MPA in Cuba, for example, more likely to succeed than one of similar size and environmental, social and cultural resources in a capitalist nation of the Caribbean?

The question is extremely difficult to answer, in first the instance because there is little basis for comparitive analysis due to the scarcity of socialist regimes relative to the large number of capitalist countries. Secondly, because the concept and practice of MPAs is still relatively new, at least in the Cuban context. The specific question was not a guiding theme for the design of the research undertaken here: it arose during the analysis of results, and lead to the generic question stated above. The discussion that follows does not intend to answer the questions posed above, instead this section constitutes an exploration that aims to raise some relevant issues that are, in this author's opinion, of crucial importance for future research on the effectiveness of MPAs and the design of their management systems in the context of global sustainability.

One key problem that needs urgent attention is the current rate of consumption of natural resources by human beings. The most accepted socio-economic model worldwide is capitalism, based on production as a vehicle for exploitation. In this system, money is invested in workers (wages) and in materials and instruments of production, in order to produce commodities which recover the original investment plus profits. This relation was first described by Marx in his major work (Marx, 1973). For Marx, the capitalist system is based on constant reinvestment, and productive transformation. If this process fails, then recession, depression and crises arise. Accordingly, lowering societal consumption rates is incompatible with capitalism as a social system (Nelson, 2001).

Sarkar (1999) maintains that capitalism is not the appropriate option for future human development in a limited global ecosystem because of the values capitalism represents:

competition, profit making, and exploitation. According to Sarkar, our future should be an eco-socialist society based on social justice, equal opportunities, moral growth, ethical behavior and cooperation.

Other authors, however, have called for "Natural Capitalism" as an emergent approach that seeks to solve current environmental resource problems produced by constant economic growth and industrial development. Its main objective is not only to protect the biosphere, but also to improve business conditions (Hawken et al., 1999; Lovins and Lovins, 2001). They correctly identified the unsustainable character of contemporary industrial capitalism, and regard it as an illogical model, based on the evidence of rapid decline that this system has precipitated in natural resources (i.e., natural capital). As an alternative option, they envisioned a new form of capitalism (Natural Capitalism) based on four main principles that should redirect the way we conduct business today. These principles are:

- radical increase in resource productivity;
- elimination of the concept of waste;
- change in the structure of the economy from one of goods and purchases to one of services and flow; and
- investment in natural capital

Hawken et al. (1999) and Lovins and Lovins (2001) failed to recognize that economic development cannot occur without a subsequent production of wastes that can not be

fully utilizable (Costanza et al., 1997; Goodstein, 1999; Llanes, 1999). The entropy law (i.e., third law of thermodynamics) succinctly informs us of the ultimate irreversibility of our actions in terms of matter and energy. Energy available on the planet can only be used in one direction, from usable to non usable form, and this process is not reversible (Rifkin, 1990). It is possible to maintain local points of high order (low entropy), but at the expense of creating a disorder (high entropy) somewhere else (Rifkin, 1990). Extending this model to geo-political systems of order, we might ask where the big disorder will be created to allow for the high entropy system that Hawken et al (1999) and Lovins & Lovins (2001) envisioned? Would it be in the over-developed countries of the first world, or in the under-developed countries of the third world? Regardless of the validity of the thermodynamic laws to social systems, there is no doubt that energy and global marine resource use in the first world comes at the cost of development options for the third world. Thus, it appears most likely that such a contrast of order and disorder will serve to increase the existing big gap between developed and undeveloped countries.

Hawken et al. (1999) and Lovins and Lovins (2001) also overlooked several key global aspects that must also be changed in order to achieve a sustainable society. They did not provide for a mechanism to alleviate global poverty, or address issues such as population growth, unsustainable resource consumption rates and, perhaps most importantly, how to close the economic gap between rich and poor countries. Natural capitalism might be an option for first world countries, which have enough financial and human resources to produce the necessary technological development on which natural capitalism is based; but not for many developing countries. Nonetheless, current problems of sustainability

have a global character that requires global solutions. Although the appealing nature of the model proposed by these authors is its correct valuation of natural resources while maintaining a capitalist character, the narrowness of its profit-making nature represents a fatal contradiction of the model.

A socialist system, although considered extinct by many after the collapse of the Soviet communist block in Eastern Europe, still operates in several countries (including Cuba) and provides a viable alternative for experimenting with the achievement of a sustainable balance between humans and the rest of the natural world. Socialism's intrinsic commitment to social justice, true sharing of resources, and formalized expressions of altruist behavior have the potential to lead to real freedom; that is, freedom from the negative forces of the capitalist markets, freedom from alienation, and freedom to directly control and plan human life. Nonetheless, socialist systems still need to resolve many contradictions that face them if they are to reach their potential for human management. This is not an easy task in the current worldwide situation, which appears to be dominated by imperialist and capitalist forces hindering real possibilities. One of the contradictions most relevant to the discussion here is that of the role of money in the socialist society. According to Marx (1977), money represents a special type of commodity upon which the capitalist system is based. Accumulating money becomes the prime objective for human beings, who may resultantly disregard other important aspects of their life. As a result, monetary considerations have priority over ecological values in decision making (Nelson, 2001). To date, socialism has not been able to resolve this issue either.

A socialist society has the potential to provide a sound framework for an effective and complete set of relations between humans and nature. As Marx (1977) pointed out *"Man lives on nature - means that nature is his body, with which he must remain in continuous interchange if he is not to die. That man's physical and spiritual life is linked to nature means simply that nature is linked to itself, for man is a part of nature"*. This thought clearly supports the idea that human beings are not the owners of the earth; they are simply one of its many beneficiaries, and have to share it with other organisms and bequeath it to succeeding generations.

A socialist system is, by definition if not in practice, a more egalitarian type of society that provides more nearly equal opportunities to everybody regardless of origin, faith, color of the skin or gender. At its best, socialism represents a better organized society that instills in its members sentiments of respect for each other as well as for nature. It follows that any type of management that requires widespread compliance of a set of regulations for a commonly-shared good (e.g., respect of MPA rules in anticipation of sustained marine ecosystem goods and services) would flourish under socialism. Some may argue, however, that there has not yet been a successful socialist society, and this is partially true. However, socialism, contrary to capitalism, has had to develop under strenuous circumstances. From its very beginning, it has faced its main opponent under difficult, even subversive conditions, economic, social, and military. The cold war is a good example. In the Cuban case, this fact is very obvious: the unilateral and illegal blockade that the United States government holds against Cuba has not allowed the Cuban socialist system to succeed in many aspects. Under these circumstances it is extremely difficult to

work towards improving the socialist system in its environmental management aspects. The fact that significant social advantages are enjoyed by all Cubans has come at the cost of other programs accorded lower priority.

In summary, I argue that Cuban society is organized so as to provide an ideal framework to implement integrated management approaches, including those in the coastal zone. The existence of political and mass organizations that include all sectors of the population, and a state organization representing all levels (national, regional, local) facilitates the management process. A broad concensus amongst citizens concerning the nation's priorities and government means that voluntary compliance with public good regulations is the norm. These attributes apply to many aspects of Cuban society, but unfortunately not in all cases. For instance, there is still much to do regarding the establishment and operation of MPAs. It is necessary to set the issue of PAs as a national priority for implementation of integrated marine resource management, and to work towards finding, in first instance, motivational mechanisms that actually grasp people's interest in the issue. More efficient administrative and financial mechanisms are also urgently needed.

Going back to the general question of the appropriateness of the socialist system for delivering effective MPA management, I judge it to be a theoretically superior option. Nonetheless, much needs to be done to put this into practice. One possible way of making this operational could be by promoting the idea of the MPA as a practical tool for investing in natural capital. This essentially means:

- Framing MPAs in economic language, which ultimately will make them part of existing economic models (but not necessarily capitalist ones),
- Making MPA benefits fully accountable regardless of their origin or type,
- Giving MPAs a business side that will attract more investors and money, and
- Increasing public understanding of MPAs and compliance with their protection regulations.

Regardless of the debates, there is a worldwide agreement that MPAs constitute tools with high potential to deal with the increasing deterioration of natural capital. Their holistic nature allows for the implementation of ecosystem-based management actions. Therefore, the goal of sustainable development will have higher odds of being achieved through the use of this rather proactive management tool than by remaining attached to ineffective management measures based soley on maximizing production and prohibition of certain human activities or technologies. MPAs stand as a crude, but potentially effective way to achieve sustainability in marine resource exploitation, and to maintain the large array of vital ecological goods and services provided to man and to the rest of nature by the coastal ocean.

Bibliography

Adams A (1962) First World Conference on National Parks. Proceedings of a Conference. Seattle, Washington. National Park Service, U.S. Dept. of the Interior.

Agrawal A (2000) Adaptative management in transboundary protected areas: The Bialowiesa National Park and Biosphere Reserve as a case study. Environmental Conservation 27(4): 326-333.

Alcolado P, Menendez G, Garcia-Parrado P, Zúñiga D, Martinez-Darana B, Sosa M, Gomez R (1998) Cayo Coco, Sabana-Camaguey Archipiélago, Cuba. In UNESCO 1998. CARICOMP- Caribbean coral reef, seagrass and mangrove sites. Coastal regions and small island papers 3. UNESCO, Paris, pp. 132-151.

Alder J (1996) Have tropical marine protected areas worked? An initial analysis of their success. Coastal Management 24: 97-114.

Alder J, Zeller D, Pitcher T, Sumaila R (2002) A method for evaluating marine protected area management. Coastal Management 30: 121-131.

Agardy T (1993) Accommodating ecotourism in multiple use planning of coastal and marine protected areas. Ocean and Coastal Management 20: 219-239.

Agardy T (1994) Advances in marine conservation: the role of marine protected areas. Trends Ecol. Evol. 9(7): 267-270.

Agardy T (1997) Marine Protected Areas and Ocean Conservation. R. G. Landes and Academic Press.

Agardy T (2000) Information needs for marine protected areas: scientific and societal. Bulletin of Marine Science 66(3): 875-888.

Appeldoorn R, Friedlander A, Sladek-Nowlis J, Usseglio P, Mitchell-Chui A (2003) Caribbean marine protected areas: practical approaches to achieve economic and conservation goals. Gulf and Caribbean Research 14(2): 61-78.

Arin T, Kramer R (2002) Divers' willingness to pay to visit marine sanctuaries: an exploratory study. Ocean and Coastal Management 45: 171-183.

Aronson RB, Precht WF (2000) Herbivory and algal dynamics on the coral reef at Discovery Bay, Jamaica. Limnol. Oceanogr. 45(1): 251-255.

Azzoni CR, Isai JY (1994) Estimating the cost of environmental protection in Brazil. Ecological Economics 11: 127-133.

Babbie E, Benaquisto L (2002) The basics of social research. Thomson Canada Limited. Canadian Edition.

Badalamenti F, Ramos A, Voultsiadou E, Sanchez-Lizaso J, D'Anna G, Pipitone C, Mas J, Ruiz-Fernandez J, Whitmarsh D, Rigió S (2000) Cultural and socio-economic impacts of Mediterranean marine protected areas. Environmental Conservation 27(2): 110-125.

Baisre J (2004) La pesca marítima en Cuba. Editorial Científico Técnica, La Habana, Cuba.

Ballantine WJ (1995) Networks of "No-take" marine reserves are practical and necessary. In Shackell NL and Willison JHM. Marine Protected Areas and Sustainable Fisheries. SAMPAA, Wolfwille, Canada, pp. 13-20.

Beekhuis JV (1981) Tourism in the Caribbean: impacts on the economic, social and natural environments. AMBIO 10, 325-331.

Boersma PD, Parrish JK (1999) Limiting abuse: marine protected areas, a limited solution. Ecological Economics 31: 287-304.

Bohnsack JA (1993) Marine Reserves: they enhance fisheries, reduce conflicts, and protect resources. Oceanus 36: 63-71.

Bohnsack JA (1998) Application of marine reserves to reef fisheries management. Australian Journal of Ecology 23: 298-304.

Bohnsack JA, Ault JS (1996) Management strategies to conserve marine biodiversity. Oceanography 9(1): 73-82.

Bohnsack JA, Bannerot SP (1986) A stationary visual census technique for quantitatively assessing community structure of coral reef fishes, NOAA tech. Rep. NMFS-41: 15.

Bunce L, Gustavson K, Williams J and Miller M (1999) The human side of reef management: a case study analysis of the socioeconomic framework of Montego Bay Marine Park. *Coral Reefs* 18: 369-380.

Burke L, Kura Y, Kassem K, Revenga C, Spalding M, McAllister D (2001) Pilot analysis of global ecosystems: Coastal ecosystems. World Resources Institute, Washington D.C.

Caribbean Environmental Programme United Nations Environment Program (CEPNET) (2003) Caribbean Marine Protected Areas Database. Available on line at: http://www.cep.unep.org/pubs/databases/databases2.html. Data accessed: January, 2003.

Caribbean Films and Video Productions (1996) The Soufriere Marine Management Area: Rescue the Reef Share the Bounty. Produced by Caribbean Films and Video Productions. Sta. Lucia.

Caribbean Tourism Organization (CTO) (2000) Caribbean tourism statistical report. Caribbean Tourism Organization, Barbados.

Caribbean Tourism Research and Development Center (1988) Caribbean tourism-economic development. Tourism Management. June 1988, 155-161.

Ceballos-Lascurain H (1996) Tourism, ecotourism and protected areas: The state of nature-based tourism around the world and guidelines for its development. IUCN, Gland, Switzerland, and Cambridge, UK.

Centro de Gestion y Servicios Ambientales y Tecnologicos (2001) Informe de monitoreo, Estacion Ecologica del PNMPF. CITMA Isla de la Juventud. Cuba.

Centro Nacional de Areas Protegidas (CNAP) (2001) Desarrollo sostenible y autosostenimiento económico de la comunidad Cocodrilo en el área protegida Sur de la Isla de la Juventud, Cuba. La Habana, Cuba.

Centro Nacional de Areas Protegidas (CNAP) (2002) Sistema Nacional de Areas Protegidas. Cuba. Plan del 2003-2008. Escandon Impresores Sevilla. España.

Cesar HSJ (2000) Coral reefs; their functions, threats and economic value. In Cesar HSJ Collected Essays on the economics of coral reefs. CORDIO, Kalamar, Sweden, pp. 14-39.

Chadwick-Furman NE (1997) Effects of SCUBA diving on coral reef invertebrates in the US Virgin Island: Implications for management of diving tourism. Proc. 6th Int. Conf. Coelent. Biol. 1995: 91-100.

Charles AT (2001) Sustainable Fishery Systems. Blackwell Science, Oxford UK.

Chircop A (1997)Taxonomy of Ocean Uses. As delivered in Contemporary Issues in Ocean Management and Development Course (1997).

Chircop A (2000) Human uses at the coastal zone. Training course in Integrated Coastal Zone Management. Santiago de Cuba, February-March 2000. Cuba.

Christiansen S, Andersson A, Luther S (2002) Making space for North Sea wildlife. Available at: http://www.ngo.grida.no/wwfneap/Publication/briefings/MPASpatialPlanning.pdf Data accessed on January, 2003.

Christie P, White A, Deguit E (2002) Starting point or solution? Community-based marine protected areas in the Philippines. Journal of Environmental Management 66: 441-454.

Cicin-Sain B, Knecht RW (1998) Integrated coastal and ocean management: concepts and practices. Island Press: Washington, D.C. and Covelo, California. USA.

CITMA (1997) National Environmental Strategy. Ediciones Geo. Habana, Cuba.

Clark KR, Warwick RM (1994) Change in marine communities: an approach to statistical analysis and interpretation. Natural Environment Research Council. UK.

Claro R, Garcia-Arteaga J (2001) Growth patterns of fishes of the Cuban shelf. In Claro R, Lindeman K, Prenti, L. (Eds). Ecology of the Marine Fishes of Cuba. Smithsonian Institution Press. Washington and London, pp. 149-178.

Costanza R, Cumberland J, Daly H, Goodland R, Norgaard R (1997b) An Introduction to Ecological Economics. International Society for Ecological Economics. St. Lucie Press. Florida. USA.

Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill R, Paruelo J, Raskin RG, Sutton P, van den Belt M (1997a). The value of the world's ecosystem services and natural capital. Nature 387: 253-260.

Couper AD (1983) Atlas of the Oceans. Times Books. London.

Cruz T (1998) Esferas Específicas de Protección del Medio Ambiente y Uso Racional de los Recursos Naturales. Habana: CITMA. (Unpublished paper).

Daily GC (1997) Nature's services: societal dependence on natural ecosystems. Island Press, Washington DC.

Daily GC, Söderqvist T, Aniyar S, Arrow K, Dasgupta P, Ehrlich PR, Folke C, Jansson A, Jansson B, Kautsky N, Levin S, Lubchenco J, Mäler K, Simpson D, Starret D, Tilman D, Walker B (2000) The value of nature and the nature of value. Science 289: 395-396.

Davis GE (1977) Anchor damage to a coral reef on the coast of Florida. Biological Conservation. 11: 29-34.

Davis D, Tisdell C (1995a) Economic management of recreational SCUBA diving and the environment. Journal of Environmental Management 48: 229-248.

Davis D, Tisdell C (1995b) Recreational SCUBA-diving carrying capacity in marine protected areas. Ocean and Coastal Management 26(1): 19-40.

de Groot RS (1992) Functions of nature: Evaluation of nature in environmental planning, management, and decision making. Wolters-Noordhoff, Groningen.

de Groot RS (1994) Functions and values of protected areas: a comprehensive framework for assessing the benefits of protected areas to human society. In: Munasinghe M, McNeely J (Eds). Protected areas economics and policy: linking conservation and sustainable development. World Conservation Union and the World Bank, Washington, DC, pp. 159-169.

de Groot R, Wilson M, Boumans R (2002) A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41: 393-408.

de la Guardia E, Angulo J, González-Sansón G, Aguilar C, González-Díaz P (2004[a]) Biodiversidad en la zona de buceo del Parque Nacional de Punta Francés, Isla de la Juventud, Cuba. Revista de Investigaciones Marinas 25(2):91-102.

de la Guardia E, González-Díaz P, Castellanos S (2004b) Estructura de la comunidad de grupos bentónicos sésiles en la zona de buceo de Punta Francés, Cuba. Revista de Investigaciones Marinas 25(2): 81-90.

Delegación Territorial CITMA Isla de la Juventud (2004[a]) Plan Operativo de Manejo Parque Nacional Marino Punta Francés. Delegación Territorial Isla de la Juventud. Ministerio de Ciencia, Tecnología y Medio Ambiente, Cuba.

Delegación Territorial CITMA Isla de la Juventud (2004b) Políticas, Directrices y Regulaciones para el manejo del Área Protegida de Recursos Manejados "El Sur" en la Isla de la Juventud. Delegación Territorial Isla de la Juventud. Ministerio de Ciencia, Tecnología y Medio Ambiente, Cuba.

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

de Silva ME, Gately EM, Desilvestre I (1986) A bibliographic listing of coastal and marine protected areas: a global survey. Woods Hole Oceanog. Inst. Tech. Rept. WHOI-86-11. (cited by Kelleher and Kenchington, 1991).

Dignam D (1990) SCUBA gaining among mainstream travelers. Tour and Travel News 26: 44-45.

Dirección de Medio Ambiente (2003) Las Costas Cubanas: Información para una Gestión Integrada. Reporte Preliminar. Dirección de Medio Ambiente, CITMA, La Habana, Cuba.

Dixon JA (1993) Economic benefits of marine protected areas. Oceanus 36: 35-40.

Dixon JA, Scura LF, Vant-Hof T (1993) Meeting ecological and economic goals: marine parks in the Caribbean. AMBIO 22(2-3): 117-125.

Dixon JA, Scura LF, Vant-Hof T (2000) An economic and ecological analysis of the Bonaire Marine Park. In Cesar HSJ Collected Essays on the economics of coral reefs. CORDIO, Kalamar, Sweden, pp. 158-165.

Dixon JA, Sherman PB (1990) Economics of protected areas: a new look at benefits and costs. Earthscan Publications Ltd, London.

Dunlap RE, Gallup Jr GH, Gallup AM (1993) Of global concern: Results of the health of the planet survey. Environment 35(9): 7-15.

Edinger EN, Risk MJ (2000) Reef classification by coral morphology predicts coral reef conservation value. Biological Conservation 92: 1-13.

Eklund AM, McClellan DB, Harper DE (2000) Black grouper aggregations in relation to protected areas within the Florida Keys National Marine Sanctuary. Bulletin of Marine Science 66(3): 721-728.

English S, Wilkinson C, Baker V (1997) Survey manual for tropical marine resources. Australian Institute of Marine Science, Australia.

Estrada R, Hernández A, Gerhartz J, Martínez A, Melero M, Bliemsrieder M, Lindeman K (2003) El Sistema Nacional de Áreas Marinas Protegidas de Cuba. WWF, Environmental Defense and Centro Nacional de Áreas Protegidas, Cuba.

Faber M, Manstetten R, Proops J (1996) Ecological Economics. Concepts and Methods, Edward Elgar, Cheltenham, Brookfield.

Farber SC, Costanza R, Wilson MA (2002) Economic and ecological concepts for valuing ecosystem services. Ecological Economics 41: 375-392.

Faul F, Erdfelder E (1992) GPOWER: a priori, post-hoc, and compromise power analysis for MS-DOS (Computer Program). Bonn, FRG: Bonn University, Dep. of Psychology.

Field JG, Hempel G, Summerhayes CP (2002) Oceans 2020: science, trends, and the challenge of sustainability. Island Press, Washington, DC, USA.

Font M (1997) Advancing Democracy in Cuba: The International Context." Paper presented at Symposium *Economic Integration and Democracy: Latin America and Cuba*, Instituto de Estudios Internacionales, Santiago de Chile, May 26-27.

Gallo F, Martínez A, Ríos J (2002) Carrying capacity for dive sites in San Andres Island, Colombia. Universidad Tecnologica de Pereira. Available on line at: www.utp.edu.co/areasmarinas. Data accessed July, 2003.

Geoghegan T (1994) Financing strategies for protected areas in the insular Caribbean. Parks 4(2): 28-38.

Global Environmental Facility/United Nations Development Program (GEF/UNDP). (1999) Protecting biodiversity and establishing sustainable development in the Sabana-Camaguey ecosystem. Ed. Alcolado P, Garcia E, Espinosa N. GEF/UNDP Project Sabana-Camaguey CUB/92/G31. CESYTA S.L. Madrid.

González-Sansón G, Aguilar C, Angulo J, González C (1997) Variacion espacial y estacional de la ictiofauna en un arrecife de coral costero de la region noroccidental de Cuba. II: Diversidad. Revista de Invesigaciones Marinas 18(3): 233-240.

González-Sansón G, Angulo J, Borrego R, Yero G, Izquierdo J, de la Guardia E, Aguilar C, Borrego R (2002) Investigación orientada al establecimiento de un plan de manejo en el Parque Nacional Marino de Punta Francés, Cuba. En: Balance entre población y recursos: investigación interdisciplinaria y manejo de áreas costeras en el gran caribe. Ed. IDRC/CFU-LAVAL. 1ra ed. Heredia-EFUNA. Costa Rica, pp. 252-269.

Gössling S (1999) Ecotourism: a means to safeguard biodiversity and ecosystem functions?. Ecological Economics 29: 303-320.

Goodstein ES (1999) Economics and the environment. Prentice Hall, New Jersey.

Green E, Donnelly R (2003) Recreational SCUBA diving in Caribbean marine protected areas: do the users pay? AMBIO 32(2): 140-144.

Gubbay JA (1995) Marine protected areas: past, present and future. In: Marine Protected Areas: Principles and techniques for management. S. Gubbay. Chapman & Hall. London. U.K, pp. 1-14.

Hall MC (2001) Trends in ocean and coastal tourism: the end of the last frontier. Ocean and Coastal Management 44: 601-618.

Hall JA, Braithwaite R (1990) Caribbean cruise tourism: a business of transnational partnership. Tourism Management December 1990. 339-347.

Harriot VJ, Derrin D, Banks S (1997) Recreational diving and its impact in marine protected areas in eastern Australia. AMBIO 26(3):173-179.

Hatcher BG (1997) Can marine protected areas optimize fishery production and biodiversity preservation in the same ecosystem?. Proceeding of the 50th Annual Gulf and Caribbean Fisheries Institute, Merida, Mexico.

Hatcher BG (1999) Varieties of science for coral reef management. Coral Reefs 18: 305.

Hawken P, Lovins AB, Lovins LH (1999) Natural Capitalism: Creating the Next Industrial Revolution. Little, Brown and Company. USA.

Hawkins J, Roberts C (1992) Effects of recreational SCUBA diving on fore-reef slope communities of coral reefs. Biological Conservation: 171-178.

Hawkins J, Roberts C (1993) Effects of recreational SCUBA diving on coral reefs: trampling on reef-flat communities. Journal of Applied Ecology 30: 25-30.

Hawkins J, Roberts C (1994) The growth of coastal tourism in the Red Sea: present and future effects on coral reefs. AMBIO 23(8): 503-508.

Hawkins J, Roberts C (1997) Estimating the carrying capacity of coral reefs for SCUBA diving. Proc. 8th Int. Coral Reef Sym. 2: 1923-1926.

Hertz M, Davis J (2002) Cruise control, a report on how cruise affect the marine environment. Ocean Conservancy, USA.

Hetzer ND (1965) Environment, tourism, culture. Links (now Ecosphere) 1:3.

Hocking M, Stolton S, Dudley N (2000) Evaluating effectiveness: A framework for assessing the management of Protected Areas. IUCN, Gland, Switzerland and Cambridge, UK.

Hodgson G, Dixon JA (2000) El Nido revisited: ecotourism, logging and fisheries. In Cesar HSJ Collected Essays on the economics of coral reefs. CORDIO, Kalamar, Sweden, pp. 55-68.

Holder JS (1988) Pattern and impact of tourism on the environment of the Caribbean. Tourism Management. June 1888. 119-127.

Hughes TP (1994) Catastrophes, Phase Shifts, and Large-Scale Degradation of a Caribbean Coral Reef. Science 265: 1547-1551.

Indab JD, Suarez-Aspilla PB (2004) Community-based marine protected areas in the Bohol (Mindanao) Sea, Philippines. NAGA 27(1-2): 4-8.

International Union for the Conservation of Nature (1976) An International Conference on Marine Parks and Reserves: papers and proceedings of an international conference held in Tokyo, Japan, 12-14 May, 1975. IUCN, Gland, Switzerland.

Instituto de Oceanología (1995) Propuesta de áreas vedadas de pesca, para el manejo sostenible de los recursos de la plataforma cubana. Ministerio de Ciencia, Tecnología y Medio Ambiente. Cuba.

Island Resources Foundation (IRF) (1996) Tourism and Coastal Resources Degradation in the Wider Caribbean. St. Thomas, Virgin Islands. Available on line at: http://www.irf.org/irtourdg.html#Tab1_Overview. Data accessed: January 2004.

IUCN (1988) Resolutions 17.38 and 19.46 of the IUCN General Assembly. 17th Session in San Jose, Costa Rica, 1-10 February 1988.

IUCN (1994) Guidelines for protected areas management categories. IUCN, Cambridge, UK and Gland, Switzerland.

Jameson SC, Ammar MSA, Saadalla E, Mostafa HM, Riegl B (1999) A coral damage index and its application to diving sites in the Egyptian Red Sea. Coral Reefs 18: 333-339.

Kaufman LS (1983) Effects of Hurricane Allen on reef fish assemblages near Discovery Bay, Jamaica. Coral Reefs 2:43-47.

Kelleher G (1999) Guidelines for Marine Protected Areas. International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland and Cambridge, U.K.

Kelleher G, Kenchington R (1992) Guidelines for establishing marine protected areas. A Marine Conservation and Development Report. IUCN, Gland, Switzerland.

Kelleher G, Bleakley C, Wells S (1995) A Global representative system of marine protected areas. Canberra, ACT, Australia: Washington, D.C.: Gland, Switzerland: Great Barrier Reef Marine Park Authority; World Bank; World Conservation Union.

Kelleher G, Recchia C (1998) Editorial- Lessons from marine protected areas around the world. Parks 8: 1-4.

Kenchington RA (1990) Managing Marine Environments. Taylor & Francis. New York.

Kennedy S, Williams T (2004) Dive. The ultimate guide 60 of the world's top dive locations. Ultimate Sports Publications. London, UK.

King DM (1994) Can we justify sustainability? New challenges facing ecological economics. In Jansson A, Hammer M, Folke C, Costanza R (Eds). Investing in Natural Capital: The Ecological Economic Approach to Sustainability. Island Press, Washsington D.C, pp. 323-342.

King DM, Mazzotta M (2000) Ecosystem Valuation. Available at http://www.ecosystemvaluation.org. Data accessed on August, 2001.

Kramer RA, Healy R, Mendelsohn R (1992) Forest valuation. In Sharma NP Managing the World's Forest: Looking for Balance Between Conservation and Development. Kendall/Hunt Publishing Company, Iowa, US, pp. 237-267.

Kunzmann A (2004) Corals, fishermen and tourists. NAGA 27(1-2): 15-19.

Lampietti JA, Dixon JA (1995) To see the forest for the trees: a guide to non-timber forest benefits. The World Bank. Environmental Economic Series 013, Washington, D.C.

Lapointe BE, Littler MM, Littler DS (1997) Macro algal overgrowth of fringing coral reefs at Discovery Bay, Jamaica: bottom-up versus top-down control, p. 927-932. In: Lessios HA, MacIntyre IG (eds.). Proceedings of the Eighth International Coral Reefs Symposium, Panama, 24-29 June 1996. Smithsonian Tropical Research Institute, Panama City, Panamá.

Lapointe BE (1999) Simultaneous top-down and bottom-up forces control macro algal blooms on coral reefs (Reply to the comment by Hughes et al.). Limnol. Oceanogr. 44(6): 1586-1592.

Lauck T, Clark C, Mangel M, Munro G (1998) Implementing the precautionary principle in fisheries management through marine reserves. Ecological Applications 8(1): S72-S78.

Lemay MH (1986) Planning for marine protected areas. Paper presented at the International Marine Protected Area Seminar, June 1-12.

Living Ocean Society (LOS) (2000) What is a marine protected area?. Available at: http://www.livingoceans.org. Data accessed on January, 2003.

Llanes J (1999) Políticas Económicas Ambientales: El Caso Contaminación. Editorial de Ciencias Sociales, La Habana. Cuba.

Lovins LH, Lovins AB (2001) Natural capitalism: path to sustainability? Corporate Environmental Strategy 8(2): 99-108.

MacKinnon K (2001) Editorial. Parks 11(2): 1-5.

Marsh J, Staple S (1995) Cruise tourism in the Canadian Artic and its implications. In: Hall CM, Johnston ME (Eds.). Polar tourism: tourism in the Artic and Antarctic regions. Chichester: Wiley. 63-72.

Marx C (1973) El Capital. Tomo I. Editorial Ciencias Sociales. La Habana, Cuba.

Marx K (1977) Economic and Philosophic Manuscripts of 1844. Progress Publishers. Moscow.

Mascia MA (1999) Governance of Marine Protected Areas in the Wider Caribbean: Preliminary Results of an International Mail Survey. Coastal Management 27:391-402.

Mascia MA (2001) Designing effective coral reef marine protected areas. Special Report to IUCN World Commission on Protected Areas-Marine.

McCann T (2005) Clean Cruise Ship Act of 2005 Promotes Responsible Ocean Stewardship. Available at: http://www.oceanconservancy.org/site/News2?abbr=press_&page=NewsArticle&id=7105. Data accessed on April, 2005.

McClanahan TR (1999) Is there a future for coral reef parks in poor tropical countries? Coral Reefs 18: 321-325.

McClanahan TR, Mangi S (2000) Spillover of exploitable fishes from a marine park and its effect on the adjacent fishery. Ecological Applications 10(6): 1792-1805.

Miller LM, Auyong J (1991) Coastal zone tourism: a potent force affecting environment and society. Marine policy. March 1991. 75-99.

Moberg F, Folke C (1999) Ecological goods and services of coral reef ecosystems. Ecological Economics 29: 215-233.

Monreal P (2000) Cuba's Reinsertion into the World Economy. Available at: http://www.igc.org/datacenter/conexiones/monreal.html. Data Accessed on July, 2001.

Monzón Y (2001) Integrated coastal zone management governance process in Cuba: the case of Cienfuegos bay. Submitted in partial fulfillment for the requirements for the degree of Master of Marine Management. Dalhousie University, Halifax, Nova Scotia, Canada.

National Academy of Science (NAS) (2001) Marine protected areas: tools for sustaining ocean ecosystems. National Academy Press: Washington, D.C.

Nelson A (2001) The proverty of money: Marxian insights for ecological economists. Ecological Economics 36: 499-511.

Newkirk GF, Rivera RA (1996) Synthesis. In Ferrer EM, de la Cruz LP, Domingo MA (Eds.). Seeds of Hope. Collage of Social Work and Community Development, University of the Philippines, Diriman, Quezon City. 195-202.

Nowlis JS, Roberts CM (1999) Fisheries benefits and optimal design of marine reserves. Fisheries Buletin. 97: 604-616.

Nunes P, van den Bergh J (2001) Economic valuation of biodiversity: sense or nonsense? Ecological Economics 39(2): 203-222.

Oficina Nacional de Hidrografía y Geodesia (2000) Cuba, síntesis geográfica, económica y cultural. Ediciones GEO, La Habana, Cuba.

Pendleton LH (1995) Valuing coral reef protection. Ocean and Coastal Management 26(2): 119-131.

Pido MD, Chua TE (1992) A framework for rapid appraisal of coastal environments. In Chua TE, Scura LF (Ed). Integrative Framework and Methods for Coastal Area Management. . ICLARM: Conference {Proceedings No. 37. Manila: International Center for Living Aquatic Resources Management, pp. 144-147.

Pina F (1999) What do global experiences with MPAs offer Cuban in planning its sytem of MPAs?. Submitted in partial fulfillment for the requirements for the degree of Master in Marine Management. Dalhousie University, Nova Scotia, Canada.

Polacek T (1990) Year round closed areas as a management tool. Natural Resources Modeling 4: 327-354.

Pollnac RB, Crawford BR, Gorospe MLG (2000) Discovering factors that influence the success of community-based marine protected areas in the Visayas, Philippines. Ocean and Coastal Management 44: 683-710.

Pollnac RB, Pomeroy RS, Harkes I (2001) Fishery policy and job satisfaction in three southeast Asian fisheries. Ocean and Coastal Management 44: 531-544.

Programa de las Naciones Unidas para el Medio Ambiente (PNUMA) (1996) Directrices para una planificación y un manejo integrados de las áreas costeras y marinas en la región del Gran Caribe. Programa Ambiental del Caribe del PNUMA, Kingston, Jamaica.

Rakitin A, Kramer DL (1996) Effect of a marine reserve on the distribution of coral reef fishes in Barbados. Marine Ecology Progress Series 131: 97-113.

Resolución No. 560 del Ministerio de la Industria Pesquera. Declaración de zona bajo régimen especial de uso y protección del área de Punta Francés, Isla de la Juventud, del 24 de diciembre del 1996.

Ritter W, Schafer C (1998). Cruise-tourism: a chance to sustainability. Tourism Recreation Research 23(1): 65-71.

Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas (1999) Total economic valuation: Coastal and marine resources in the strait of Malacca. MPP-EAS Technical Report No. 24/PEMSEA Technical Report No.2. Global Environment Facility/United Nations Development Programme/International Maritime Organization Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas (MPP-EAS)/Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines.

Roberts C, Bohnsack J, Gell F, Hawkins J, Goodridge R (2001) Effects of marine reserves on adjacent fisheries. Science 294: 1920-1923.

Rodwell LD, Roberts C (2000) Economic implications of fully-protected marine reserves for coral reef fisheries. In Cesar HSJ Collected Essays on the economics of coral reefs. CORDIO, Kalamar, Sweden, pp. 107-124.

Rogers CS, Garrison G, Grober R, Hillis Z, Franke MA (1994) Coral reef monitoring manual for the Caribbean and Western Atlantic. The Nature Conservancy and the World Wildlife Fund, Virgin Islands.

Rogers CS, McLain L, Zullo E (1988) Damage to coral reefs in Virgin Island National Park and Biosfere Reserve from recreational activities. In: Choat UH (Eds), Proceedings of the VI International Coral Reef Symposium. Townsville, International Coral Reef Symposium Executive Committee, Townsville, 405-441.

Rouphael A, Inglis G (1997) Impacts of recreational SCUBA diving at sites with different reef topographies. Biological Conservation :329-336.

Rowley RJ (1994) Case studies and reviews, marine reserves in fisheries management. Marine and Freshwater Ecosystems 4: 233-254.

Rudd M, Tupper M (2002) The impact of Nassau grouper size and abundance on SCUBA diver site selection and MPA economics. Coastal Management 30: 133-151.

Russ G (1985) Effects of protective management on coral reef fishes in the Central Philippines. In: Proceedings of the 5th International Coral Reef Congress, 27 May – 1 June 1985, Tahiti. Vol. 4. 219-224.

Russ G, Alcala A (1994) Sumillon Island Reserve: 20 years of hopes and frustrations. *NAGA* (quarterly report) 8-12.

Russ G, Alcala A (1996) Do marine reserves export adult fish biomass? Evidence from Apo Island central Philippines. Marine Ecology Progress Series 132: 1-9.

Russ G, Alcala A, Cabanban A (1992) Marine reserves and fisheries management on coral reefs with preliminary modeling of the effects on yield per recruit. Proc. 7th Int. Symp. Coral Reefs 2: 988-995.

Salm RV, Clark JR (1984) Marine and coastal protected areas: a guide for planners and managers. State Printing Co. Columbia, South Carolina. USA.

Salm RV, Clark JR, Siirila E (2000) Marine and coastal protected areas: a guide for planners and managers. IUCN, Gland, Switzerland.

Sarkar S (1999) Eco-socialism or Eco-capitalism? A Critical Analysis of Humanity's Fundamental Choices. Zed Books, London and New York.

Scura LF, van't Hof T (1993) The ecology and economics of Bonaire Marine Park. Divisional Paper No. 1993-44. Washington D.C.: Environment Department, The World Bank, Washington D.C.

Silva M (2001) Ecotourism in the Caribbean: seizing the opportunity. Industry and Development 24(3-4).

Silva M (2002) Perspectivas del turismo en el Caribe. Caribbean Tourism Organization. Avialable at: http://www.onecaribbean.org/information/documentview.php?rowid=478 Data accessed December, 2003.

Sloan K (1987) Valuing Heron Island: Preliminary results. Paper presented to the 16th Conference of Economists. Surfer's Paradise, Queensland, Australia. (cited by Dixon et al., 1993).

Slocombe DS (1998) Defining goals and criteria for ecosystem-based management. Environmental Management 22: 483-493.

Sobel J (1996) Marine reserves: necessary tools for biodiversity conservation? Global Biodiversity 6(1): 8-18.

Sobel J, Dahlgren C (2004) Marine Reserves. A guide to science, design and use. Island Press. Washington DC. USA.

Sobers A (2002) Tourism trends in the Caribbean. Caribbean Tourism Organization. Available on line at: http://www.onecaribbean.org/information/categorybrowse.php?categoryid=45 Data accessed January 2003.

Sorensen JC, Mc Creary ST (1990) Institutional Arrangements for Managing Coastal Resources and Environments. Renewable Resources information Series No. 2. US Department of Interior, National Park Service, Washington, D.C.

Sorensen JC, Mc Creary ST, Hershman MJ (1990) Institutional Arrangements for Management of Coastal Resources. 2nd Ed. Coastal Renewable Resource Information Series, Research Planning Inc., Columbia, South Carolina.

Spalding MD, Ravilious C, Green EP (2001) World atlas of coral reefs. Prepared at the UNEP World Conservation Monitoring Centre. University of California Press, Berkeley, USA.

Spash CL (2000) Assessing the benefits of improving coral reef biodiversity: the contingency valuation method. In Cesar HSJ Collected Essays on the economics of coral reefs. CORDIO, Kalamar, Sweden, pp. 40-54.

Spurgeon JPG (1992) The economic valuation of coral reefs. Marine Pollution Bulletin 24(11): 529-536.

Spurgeon JPG (In press) Maximizing benefits and revenues from coral reef management.

Spurgeon JPG, Roxburgh T (In press) A blueprint for maximizing sustainable coastal benefits: the American Samoa case study.

Stewart CM (1993) Sustainable tourism development and marine conservation regimes. Ocean and Coastal Management 20: 201-217.

Stynes D, Yen-Sun Y (2003) Impacts of visitors expending on local economy: Biscayne National Park, 2001. Department of Parks, Recreation and Tourism Resources. Michigan State University. January 2003.

Sumaila UR, Charles AT (2002) Economic Models of Marine Protected Areas: An Introduction. Natural Resource Modeling 15(3):261-272.

Suman D, Shivlani M, Milon W (1999) Perceptions and attitudes regarding marine reserves: a comparison of stakeholder groups in the Florida Keys National Marine Sanctuary. Coastal and Ocean Management 42: 1019-1040.

Tabata RS (1992) SCUBA diving holydays. In Special Interest Tourism, Weiler B, Hall CM (Eds.). New York, Bellhaven. 171-184.

Task Force on Economic Benefits of Protected Areas (WCPA) of IUCN in collaboration with the Economic Service Unit of IUCN (1998) Economic Values of Protected Areas: Guidelines for Protected Area Managers. IUCN, Gland, Switzerland and Cambridge, UK.

Tenenbaum A, Jeréz M, Pilar A, Portilla M, Cruz L (1998) Estrategia de desarrollo sostenible, comunidad de Cocodrilo. Delegación Territorial del Ministerio de Ciencias, Tecnologías y Medio Ambiente, Isla de la Juventud, Cuba.

Ter Braak CJF, Prentice IC (1988) A theory of gradient analysis. Advances in Ecological Research 18: 271-313.

Thackway R (1996) Developing consistent national criteria for the identification and selection of a national representative system of marine protected areas. A discussion paper. In R. Thackway (ed). Developing Australia's representative system of marine protected areas. Proceedings of a technical meeting held at the South Australian Aquatic Sciences Centre, West Beach, Adelaide, 22-23 April 1996. Australian Nature Conservation Agency: Canberra.

Tratalos JA, Austin TJ (2001) Impacts of recreational SCUBA diving on coral communities of the Caribbean island of Grand Cayman. Biological Conservation 102: 67-75.

Turner K, Paavola J, Cooper P, Farber S, Jessamy V, Georgiou S (2003) Valuing nature: lessons learn and future research directions. Ecological Economics 46(3): 493-510.

Underwood AJ (1997) Experiments in Ecology: their logical design and interpretation using analysis of variance. Cambridge University Press: UK.

United Nations (1987) Environment Perspective to the Year 2000 and Beyond. 42th Session of the United Nations General Assembly. December 11, 1987.

United Nations Conference on Environment and Development (UNCED) (1992) Rio de Janeiro, Brazil, "Chapter 17: Protection of the oceans, all kinds of seas, including semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources", p. 147-165.

United Nations Educational, Scientific and Cultural Organization (UNESCO) (1987) A practical guide to MAB. UNESCO. Division Ecological Science, Paris.

United Nations Environment Programme (UNEP) (1997) Coastal Tourism in the Wider Caribbean Region: Impacts and Best Management Practices CEP Technical Report No. 38. UNEP Caribbean Environment Programme, Kingston.

United Nations Environment Programme (UNEP) (2001) Ecosystem-based management of fisheries: opportunities and challenges for coordination between marine regional fishery bodies and regional seas conventions. Regional Seas.UNEP Regional Seas Reports and Studies, No. 175. Nairobi.

Vallega A (1992) Sea Management: A Theoretical Approach. Elsevier Applied Science. New York.

Van't Hof T (1992) Coastal and marine protected areas in the Caribbean: How can we make them work? Parks 3:32-35.

Vrba J, Drovak L (1967) Informe preliminar sobre investigaciones hidrogeológicas e hidroquímicas de algunas regiones de Isla de Pinos. Serie Isla de Pinos Editorial Academia de Ciencias de Cuba. La Habana, Cuba.

Walters RDM, Samways MJ (2001) Sustainable dive ecotourism on a South African coral reef. Biodiversity and Conservation 10: 2167-2179.

Weaver D (1994) Ecotourism in the Caribbean. In Cater and Lowman (eds.) Ecotourism: a sustainable option? Wiley & Sons, England. 159-176.

White AT, Courtney CA, Salamanca A (2002) Experience with marine protected area planning and management in the Philippines. Coastal Management 30: 1-26.

White AT, Hale LZ, Renard Y, Cortesi L (1994) Collaborative and Community-Based Management of Coral Reefs. Lessons From Experience. West Hartford: Kumarian Press.

Williams ID, Polunin NVC (2000) Differences between protected and unprotected reefs of the western Caribbean in attributes preferred by dive tourists. Environmental Conservation 27(4): 382-391.

Williams ID, Polunin NVC (2001) Large-scale associations between macro algal cover and grazer biomass on mid-depth reefs in the Caribbean. Coral Reefs 19: 358-366.

Wood RE (2000) Caribbean cruise tourism. Globalization at sea. Annals of Tourism Research 27(2): 345-370.

World Bank (2004) World Development Indicators. Available on line at: http://www.finfacts.com/biz10/globalworldincomepercapita.htm. Data accessed July 2005.

World Commission on Environment and Development (WCED) (1987) From One Earth to One World, Our Common Future. Oxford University Press. London.

World Wildlife Fund (WWF) (1998) Marine protected areas: WWF's role in their future development. Edited by Sue Wells. World Wide Fund for Nature, Gland, Switzerland.

Zakai D, Chadwick-Furman NE (2000) Impacts of intensive recreational SCUBA diving on reef corals at Eilat, northern Red Sea. Proceedings of the 9th International Coral Reefs Symposium, Bali, Indonesia, 23-27 October 2000.