

## A New Methodology for Assessing the Effectiveness of Marine Protected Areas

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### ABSTRACT

Management effectiveness is normally accepted as the degree to which a Marine Protected Area (MPA) is used to achieve its goals and objectives. Prior to 1993, an assessment of whether or not the establishment and management of MPA had achieved their goals was lacking. Instead there were only a few papers dealing with MPA objectives and benefits and they concentrated on biological conditions alone, and therefore were not comprehensive in nature. This study produced a new methodology for assessing the management effectiveness of a given MPA and applied it to a real case study. The methodology constitutes an aggregated, interdisciplinary metric of MPA effectiveness that can lead to improvements in the management of MPAs worldwide 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.

*Key words:* management effectiveness, marine protected areas.

### RESUMEN

La efectividad de manejo se entiende como el grado en que los objetivos de manejo de un área protegida han sido cumplidos. Antes del 1993 no existían en la literatura trabajos sobre este tema, y solo se encontraban artículos que trataban sobre los objetivos y beneficios de las áreas protegidas vistos desde una perspectiva biológica solamente. En el presente trabajo se desarrolla una nueva metodología para evaluar la efectividad de manejo de un área marina protegida y la misma se aplica a un estudio de caso real. La metodología propuesta constituye una herramienta interdisciplinaria que pudiera mejorar el manejo de las áreas marinas protegidas. Esta metodología constituye un paso adelante que se nutre de las contribuciones anteriores y provee un nuevo enfoque a aplicar que va más allá de lo que se ha logrado hasta el presente en esta temática.

*Palabras clave:* efectividad de manejo, áreas marinas protegidas.

### INTRODUCTION

Management effectiveness is normally accepted as the degree to which a Marine Protected Area (MPA) is used to achieve its goals and objectives, while assessment of the management effectiveness is the process of documenting how the management of a MPA 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 MPA.

Prior to 1993, an assessment of whether or not the establishment and management of MPA had achieved their goals was lacking. Instead there were only a few 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 MPA 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 MPA 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 metho-

dologies did not allow for assessing MPA success or effectiveness.

More recently, 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 International Union for the Conservation of Nature (IUCN) produced one of the most accepted methodologies to assess management effectiveness in PAs (Hocking *et al.*, 2000). Hocking *et al.* (2000) 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 World Wildlife Fund (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 Protected Areas 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. More recently Pomeroy *et al.* (2004) produced a guidebook that aims at providing MPA managers with a handbook on how to assess management effectiveness. The methodology described by Pomeroy *et al.* (2004) is based on a set of natural and social indicators that resemble those produced by 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). It is this author's opinion, that the major advantages of Alder's methodology in comparison with other methodologies are its flexibility, its ease of application, and its relative low cost. These authors, undertook a pilot study to test the MPAEM using 20 MPA 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 was given a score from which a similarity matrix was constructed, followed by a multidimensional scale analysis (MDS).

Results from Alder *et al.* (2002) 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 Multidimensional Scale Analysis (MDS) 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 previous published work and having into account the need to develop a simple and wider applicable method to assess MPA effectiveness, this paper aims at, first, to develop a methodology, that will provide managers with a practical tool to assess management effectiveness of a single MPA or a group of MPA and, second, to apply the methodology to a real case of MPA in Cuba.

## MATERIALS AND METHODS

### Methodology to assess effectiveness of marine protected areas

This study proposes the use of the typology of benefits developed by Angulo-Valdés and Hatcher (2010) as a guide to set proper indicators to be assessed. According to these authors there are nine main benefit categories: 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 are neither inclusive nor final; many more can be recognized and added to the list according to each MPA's specific conditions and management objectives.

After setting 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 (Figure 1).

The methodology proposed here could provide different possible results, ranging from 0 % to 100 %

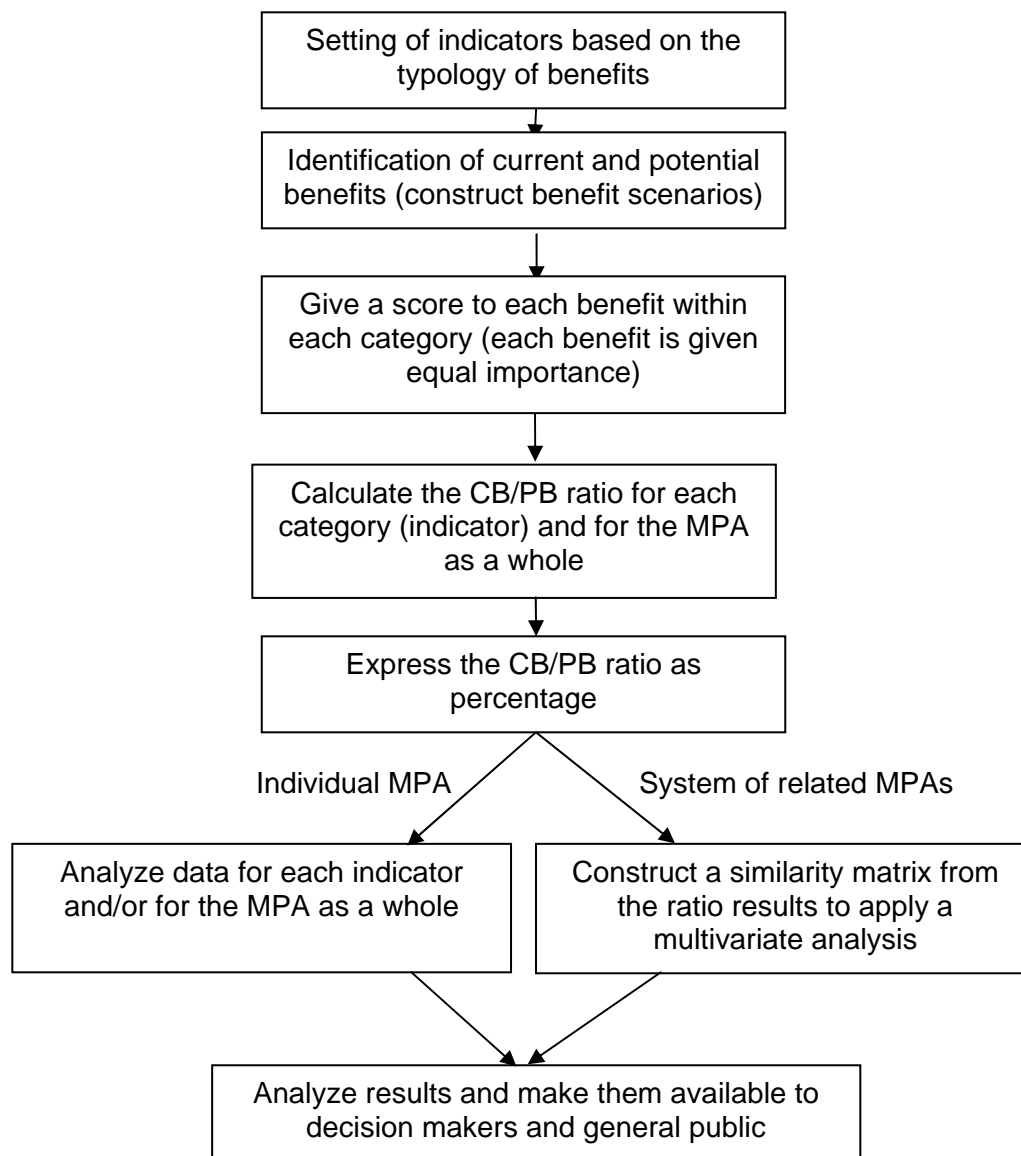


Figure 1. Methodology for assessing effectiveness of marine protected areas.

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 1).

Table 1. 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

#### Case Study: The Punta Francés Marine Protected Area (PFMPA)

The PFMPA is located at the southwest end of the Isle of Youth, Cuba, specifically on the Carapachibey peninsula. It stretches from what is called Punta Pedernales to Cabo Francés (Figure 2). The PFMPA encompasses an area of 4,610 ha, of which 1,596 ha represent land and 3,014 ha are ocean (Centro Nacional de Areas Protegidas, 2002). A more detailed description on the socio-economic and biological features of the selected study area can be found at de la Guardia *et al.* (2004a), de la Guardia *et al.* (2004b), and Angulo-Valdés *et al.* (2007).

### Scenario construction

To construct the scenarios, twelve face-to-face interviews were held with park staff members, representati-

ves from the Colony hotel and the cruise company (former Cubanco S.A.). First, three main groups were identified: park staff, Colony hotel workers, and former Cubanco S.A. company. Then, within each group a snowball technique was used to select interview subjects (Babbie and Benaquisto, 2002). The final number of subjects was 12 (four 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.

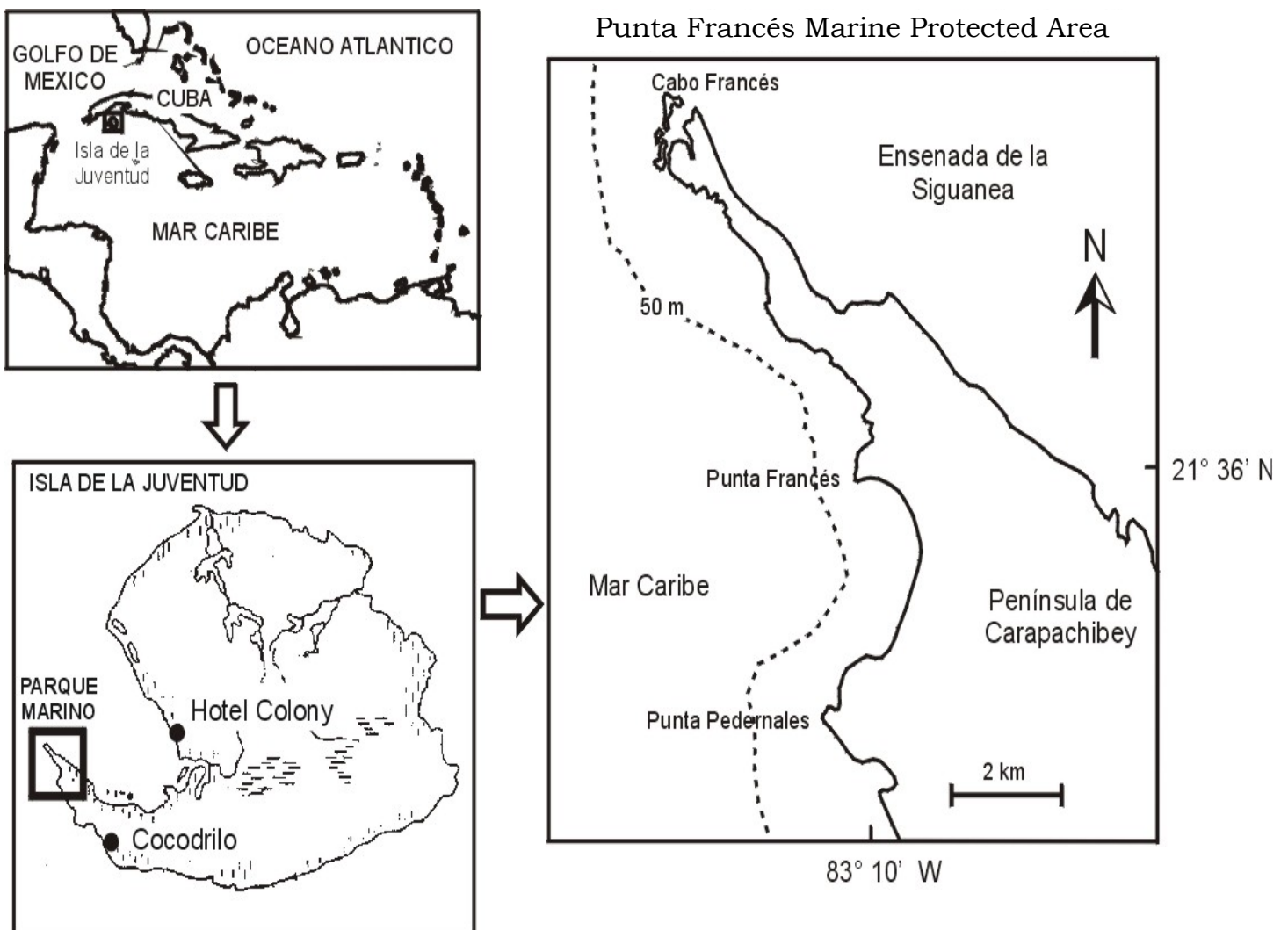


Figure 2. Map showing study site.



## RESULTS AND DISCUSSION

### **Methodology to assess management effectiveness**

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 by 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 World Conservation Union (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.

The rationale for using Angulo-Valdés and Hatcher's benefit typology was three fold. First, 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 MPA in social, economic and developmental terms becomes crucial, especially in undeveloped countries where resource scarcity and poverty make them prone to overexploit marine resources. Therefore, to fully assess the success of MPA, 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 MPA (Alder *et al.*, 2002). Because public acceptability will depend on whether the perception of benefits is greater with or without MPA, this assessment will, in turn, influence the political support for MPA programs (National Academy of

Science, 2001). Second, the typology proposed will allow to overcome the issue of selecting appropriate indicators and to provide margins for comparison with other MPA (Angulo-Valdés, 2005). Finally, it 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.

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 weighing among them, therefore benefits to ecosystem or populations have the same importance than cultural benefits, for instance. This author acknowledges that this might not be the case in some 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 final result would be different.

### **Case Study: The Punta Francés Marine Protected Area (PFMPA)**

Punta Francés is an example of a MPA established on the basis of economic interests (Angulo-Valdés *et al.*, 2007). Given its remarkable attractiveness above and below water, near-pristine status, and established Self Contained Underwater Breathing Apparatus (SCUBA) diving facilities (the Colony Hotel), the place became the most important SCUBA-dive spot in Cuba (Angulo-Valdés *et al.*, 2007). 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 significant environmental damage.

The coincidence of these conflicting activities engendered arguments and legal controversies between the Ministry of Tourism (MINTUR) and the former Ministry of Fisheries (MIP) (the main users of the area at that time), ones which remain some 25 years later. The lack of a proper regulatory body was considered to be the main reason why this problem was not solved in a legal manner. 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. This situation remained like that until 1996 when the MIP enacted Resolution 560/1996, which narrowed the scope of fishing protection in the area, but its enforcement remained neglected. Just recently, April 2012, the Ministry Council enacted the Agreement 7233, which declared Punta Francés a National Park. This Agreement does not go further on what activities are allowed within the National Park, it just pronounced the Ministry of Agriculture (MINAGRI) as the area administrator and commanded it to elaborate an operational management plan within two years.

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 small tourist facilities. This fact, together with the remote location of the PFMPA, might constitute advantages for management and control purposes,

because it should be 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 being the former 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 a boat, 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 almost 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 22 km south from the MPA and their inhabitants have always been remained excluded from the PFMPA.

### Scenarios construction

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 finally functions as a National Marine Park and management is fully efficient.

### Scenario I

Table 2 depicts benefits provided by the PFMPA at its current management status (Scenario I). A total of twelve benefits were identified and an explanation of each benefit is presented below.

Table 2. Scenario I. Current benefits provided by the Punta Francés Marine Protected Area to humans and nature.

CURRENT PFMPA BENEFITS					
To humans				To nature	
DIRECT		INDIRECT/OFF SITE		Process benefits	Ecosystem benefits
Non-fishery benefits	Management benefits	Education/Research benefits	Cultural 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.

### 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.

**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 on board yacht charters, private excursions and others.

### Management benefits

#### Maintain diversity of fishing opportunities:

Currently only fishing for lobster is allowed within the PFMPA. Approximately 10 tons are caught per year in the area.

### 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.

#### Allow research, monitoring and data collection from untouched sites:

Several research projects have been carried out in the PFMPA by the CMR and lately by the Faculty of Biology at the University of Havana.

### 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.

### 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.

**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.

**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.

**Maintain global climate regulation:** It has been estimated that coral reefs act as a sink of 111 million tons of carbon per year (Spurgeon, 1992; Costanza *et al.*, 1997). This is the equivalent of 2 % of the present output of anthropogenic CO<sub>2</sub>. Healthy coral reefs at PFMPA are providing this benefit.

### 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 good health, 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.

**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) and Faber *et al.* (2002) 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.

## Scenario II

Table 3 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 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*). It has been widely accepted that this kind of economic activity can be very profitable.

**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. It has to be taken into account though that for this benefit to become evident certain conditions need to occur, such as: effective protection from fishing, increase of fish biomass within the PFMPA, account for over 10 years of real protection for this to occur.

### 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 (Angulo-Valdés, 2007). 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.

**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 MPA 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 (Caribbean Films and Video Productions, 1996).

**Promote alternative employment opportunities:** In addition to current SCUBA diving instructors and the PFMPA staff, other forms of employment can be provided in the MPA: for instance, nature trails guide maintenance workers, cooks, and the like.

**Enhance other forms of income generation:** It is now widely acceptable to charge an entry fee to visitors (mostly divers) in MPA (Arin and Kramer, 2002). Despite this only 25 % of the more than 200 MPA 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<sup>-1</sup>. That accounted for an income of more than USD \$170,000.00 y<sup>-1</sup> 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 (Centro Nacional de Áreas Protegidas, 2002). The downside of this is that the USD \$10.00 figure has been arbitrary set with no consideration of, for instance, visitor's Willingness to pay (WTP).

**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.

### 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 MINAGRI staff. The cruise ship company may look after providing other services, such as food and beverage sales to tourists.



Table 3. Scenario II. Potential benefits and economic value provided by the Punta Francés Marine Protected Area to humans and nature.

POTENTIAL PFMPA BENEFITS								
To humans					To nature			
DIRECT		INDIRECT/OFF SITE			Process benefits	Ecosystem benefits	Population benefits	Species benefits
Fishery benefits	Non-fishery benefits	Management benefits	Education/Research benefits	Cultural 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.

**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.

Additionally, according to interviews held with fishermen from Cocodrilo, Punta Francés 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 effort; this type of fishery should be allowed within the PFMPA. This will enhance the benefits that the PFMPA 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.

**Facilitate stakeholder involvement:** This is similar to the first and second benefits (Reduce use and user conflicts, and maintain diversity of fishing opportunities).

**Promote holistic approaches to management:** The small size of the area, relatively few stakeholders, and generally non-conflicting economic uses 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.

**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 zoning and a

consequent maximization of benefits from SCUBA diving.

**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 could be compared with other sites.

**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.

**Provide undisturbed areas for particular experiments:** This benefit is closely related to the research and monitoring benefit.

**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.

**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, 1995).

**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.

**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 MPA, Saba Marine Park, and Pigeon Island National Park, Saint Lucia (Geoghegan, 1994).

#### 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.

**Protect from coastal erosion:** The same as Scenario I.

**Provide physical refugia:** The same as Scenario I.

**Maintain global climate regulation:** The same as Scenario I.

**Avoid physical damage to habitats:** The same 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 (Costanza *et al.*, 1997).

#### Ecosystem benefits

**Preserve natural community composition and functioning:** The same as Scenario I

**Ensure biodiversity protection:** The same as Scenario I

**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.

### Quantitative analysis

Table 4 shows the quantitative results from the application of the methodology in this study. The PFMPA has an overall CB/PB ratio of 28.5 %, which means that its effectiveness is, at the moment, poor (Table 1). Therefore, immediate management measures need to be taken to improve this situation.

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 by Angulo-Valdés *et al.* (2007) who reported that despite 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 of this as well. Small MPA tend to be not 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 tourism exploitation objectives and not conservational ones. Fishery benefits scored zero because out of the sixteen fishery-related benefits identified in Table 2, 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 over 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 ensure some effective protection (Angulo-Valdés *et al.*, 2007). 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. This is the commercial fisheries near and within the MPA.

Table 4. Quantitative assessment of the effectiveness of the PFMPA<sup>a</sup>.

PFMPA	PFMPA Benefits									
	To humans					To nature				
	Direct			Indirect/off site		ProB	EB	PopB	SB	Total
FB	NFB	MB	E/RB	CB						
Sc. I	0	2	1	2	1	4	2	0	0	<b>12</b>
Sc. II	2	5	5	5	8	6	4	3	4	<b>42</b>
CB/PB	0	0.4	0.2	0.4	0.13	0.6	0.5	0	0	<b>0.29</b>
%	<b>0</b>	<b>40</b>	<b>20</b>	<b>40</b>	<b>12.5</b>	<b>66.6</b>	<b>50</b>	<b>0</b>	<b>0</b>	<b>28.5</b>
<b>MPA assessment</b>	<b>Very poor</b>	<b>Poor</b>	<b>Very poor</b>	<b>Poor</b>	<b>Very poor</b>	<b>Very good</b>	<b>Good</b>	<b>Very poor</b>	<b>Very poor</b>	<b>Poor</b>

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



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 non-fishery-benefit and in the 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 benefits is very important for what it represents. For MPA to be socially accepted, issues related to conservation ethics, spiritual fulfillment, aesthetic opportunities, and awareness need to be instilled in the human population; otherwise MPA success is put at risk. As was shown earlier, the PFMPA is not providing any 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 just recently 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 extreme limited capacities to enforce such a designation. Management improvement is urgently needed to make Punta Francés a successful an effective MPA.

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 worldwide 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 MPA 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).

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

The main advantages of the methodology presented here are:

- relative 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 MPA.
- produce results suitable for comparison.
- avoid data transformation (when multivariate analysis is performed).

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 MPA 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 MPA. This advantage differs with 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 Angulo-Valdés and Hatcher (2010). 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 case study of a small, 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 just been legally designated as a National Park. Most of this study was done when the area was not designated like such. Nonetheless, 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 MINAL 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 the Centro Nacional de Areas Protegidas (2002) 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.

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