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How is your MPA doing? A methodology for evaluating the management effectiveness of marine protected areas

Robert S. Pomeroy[a,*], Lani M. Watson[b], John E. Parks[c], Gonzalo A. Cid[c]

[a]*Department of Agricultural and Resource Economics/Connecticut Sea Grant, University of Connecticut-Avery Point, 380 Marine Science Building, 1080 Shennecossett Road, Groton, CT 06340, USA*
[b]*NOAA National Ocean Service, Special Projects Office, 1305 East–West Highway, N/MB7, Silver Spring, MD 20910, USA*
[c]*NOAA National Ocean Service, International Program Office, 1315 East–West Highway, SSMC3 N/IP, Silver Spring, MD 20910, USA*

Abstract

Effective management of marine protected areas (MPAs) requires continuous feedback of information to achieve objectives. In 2000, a collaborative initiative was launched to improve the management of MPAs. The initiative focused on working with managers, planners, and other decision-makers to develop a set of indicators for assessing the effectiveness of MPA use. This initiative was aimed at both enhancing the potential and capability for adaptive management of MPAs, as well as improving our understanding of how effective MPAs that are now being used around the world. This paper presents an overview of the MPA management effectiveness methodology and indicators, summary results of the testing phase of the guidebook at 18 MPAs around the world, and considerations for its application and use as an adaptive management tool for MPAs.

*Corresponding author. Tel.: +1 860 405 9215; fax: +1 860 405 9109.
E-mail address: robert.pomeroy@uconn.edu (R.S. Pomeroy).

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1. Introduction

An increasing need exists for the evaluation and understanding of the effectiveness of marine protected areas (MPAs) operating around the world. To meet this need, in 2000 The World Conservation Union (IUCN's) World Commission on Protected Areas—Marine and the World Wide Fund for Nature jointly initiated the *MPA Management Effectiveness Initiative* (MEI), an international collaborative project designed to create a methodology for planning and conducting performance evaluations of MPA management effectiveness. After a two-year participatory design and development process, the initiative identified and described a set of biophysical, socioeconomic, and governance indicators that can be selected and adapted to fulfill different MPAs' evaluation needs while accounting for the different resources they have available. MPAs around the world field-tested a draft version of the methodology and indicators, providing feedback and results that were incorporated into a MPA–MEI guidebook. This paper presents an overview of the MPA–MEI methodology and indicators, results of the testing phase of the guidebook at MPAs around the world, and considerations for its application.

1.1. The rationale for evaluating management effectiveness

During the last few decades, the empirical evaluation of terrestrial and marine protected area performance and impacts has gained increasing attention and notoriety as a conservation priority. The growing interest has been driven in part due to wide interest in using objective evaluation to assess future needs and adapt current practices so as to improve the effectiveness of management efforts and optimize related human and financial resource allocation. As a result, the performance evaluation of protected areas is actively being pursued around the world today.

For the purposes of this paper, the term management effectiveness is defined as the degree to which management actions are achieving the goals and objectives of the protected area [1]. Documented, real-world experience is already demonstrating that the protected area management effectiveness has an important degree of influence over whether or not long-term impacts on natural resources and the people who depend on them can be addressed (see [1]). Management effectiveness evaluations that have been carried out show how they can allow for improvement of protected area management actions through learning, adaptation, and the diagnosis of specific issues influencing whether goals and objectives are being achieved. Management effectiveness evaluations also provide a mechanism to encourage accountability in the management of a protected area. This may be a particularly attractive attribute of management effectiveness evaluations at protected areas that are socially contentious or under frequent public scrutiny.

1.2. Interest in marine protected area management effectiveness

At present, there are broad expectations placed on MPAs as instruments to both:

(1) maintain or restore marine biodiversity and ecosystem function, particularly through marine reserves, also called 'no-take' areas [2,3], and

(2) improve socioeconomic conditions by increasing revenues from fisheries production due to an increase in the size and number of fish migrating out of the MPA [4–6].

Public and management expectations that MPAs can generate such biological and social benefits are being encouraged through the increasing dissemination of successful MPA case studies and scientific review, as well as the rhetoric that comes with increased marine protection advocacy.

However, there is growing concern that over-zealous advocacy or unrealistic expectations of what MPAs can deliver may lead to uninformed design and reckless proliferation of such efforts, inevitably dooming them [7,8]. In addition, MPAs are often challenged in their ability to achieve their objectives due to small management staff size, insufficient financial, logistical, and technical support, lack of scientific information, and insufficient institutional, decision-making, and political support. Such factors are known to inhibit the ability of MPAs to fully achieve their objectives and provide for informed management decision-making [9].

Effective management of MPAs requires continuous feedback of information to achieve objectives. The management process involves planning, design, implementation, monitoring, evaluation, communication and adaptation. Evaluation consists of reviewing the results of actions taken and assessing whether these actions are producing the desired outcomes; in order to complete successful evaluations, management teams must develop consistent records of management actions and data. Evaluation is a routine part of the management process and is something that most managers already do. The evaluation of management effectiveness builds on and documents this existing routine.

The link between actions and outcomes is often not so obvious. Faced with the daily demands of their jobs, many managers are not able to regularly and formally step back and reflect on the cumulative results of their efforts. In the absence of such reflection, resources may be wasted and objectives may not be achieved. The evaluation of management effectiveness provides a formal way to learn from successes and failures and help people understand how and why management practices are being adapted.

In the early 1990s, 383 out of 1306 MPAs were rapidly assessed for management effectiveness. Roughly one-third were judged to have met their management objectives, one-third partially met their objectives, and the remaining had inadequate information, suggesting that perhaps as much as one-third may not have successfully met their objectives [9]. More recently in Southeast Asia, of 332 MPAs whose management effectiveness could be assessed, only 14% were found to be effectively managed, 48% partially effective, and 38% inadequately managed [10]. In Belize, an evaluation of management effectiveness of the country's marine protected area system concluded that overall the system is evaluated as being ''moderately satisfactory'', indicating that there are minimal elements necessary for management, but there are also deficiencies that prevent effective management and reduce the probability that conservation objectives will be achieved [11]. The mixed success of current MPA performance demonstrates an important and immediate need to build

capacity for MPA management teams to evaluate the effectiveness of their strategies and actions so that they may be able to manage their efforts adaptively and improve the impact and scope of their protective strategies over time.

One of the factors that restrict effective decision-making in adaptively managing MPAs is a lack of information about the status and nature of conditions (including threats) operating within or around MPAs. Obtaining such information requires a periodic and comprehensive assessment of the natural and social processes occurring within and outside the boundaries of MPAs. As such, there is an increasing interest in the development and use of an adequately comprehensive set of indicators that measure the socio-economic, biophysical, and institutional (governance) outputs and outcomes from the process associated with MPA management. Several organizations including the IUCN, the World Bank, the Intergovernmental Oceanographic Commission, and the US National Oceanic and Atmospheric Administration (NOAA), have recently developed efforts to identify indicators for the performance evaluation of coastal resources management. This demonstrates the importance that these and other marine resource management and conservation organizations are placing on the use of instruments to monitor changes in coastal and marine resources, identifying and assessing socio-economic activities, and evaluating the institutional and legal aspects of the coastal resources governance.

2. Developing the evaluation methodology

The application of specific indicators to evaluate management effectiveness in marine ecosystems and coastal communities can serve multiple audiences, including donor agencies, policy makers, management teams, and conservation and development non-governmental organizations. Evaluation results also can be used for a number of purposes, such as highlighting the progress of MPA management, assisting in identifying and setting new priorities for future management actions, and ensuring accountability and promote better management policies and practices by the agencies and organizations that are responsible for implementing national or local MPAs. Managers might not only use evaluation results to improve future performance and document achievements, but also to report and seek assistance in addressing barriers to stated management goals and objectives or formulating new ones. Different stakeholder groups and coastal communities might additionally use completed evaluation results to see how far their interests have been taken into account and addressed in the management of an MPA.

In 2000, IUCN's Marine Section of the World Commission on Protected Areas (WCPA-Marine) and the World Wide Fund for Nature (WWF) launched a collaborative initiative, coordinated by NOAA's National Ocean Service, to improve the management of MPAs. The initiative focused on working with managers, planners, and other decision-makers to develop a set of indicators for assessing the effectiveness of MPA use. This initiative is aimed at both enhancing the potential

and capability for adaptive management of MPAs, as well as improving our understanding of how effective MPAs are now being used around the world. The initiative builds on other work done on measuring effectiveness in protected areas, including the IUCN Management Effectiveness Framework [1].

A primary product of the MPA Management Effectiveness Initiative (MEI) is a guidebook designed to provide step-by-step guidance to managers and other practitioners in: (a) selecting the relevant biophysical, socioeconomic, and governance indicators for the evaluation of a particular MPA, (b) developing a process for planning for and implementing this evaluation, and (c) using the results generated to inform and adaptively manage the MPA [12]. Over the four-year period of the initiative, the following activities were carried out: (1) development of a set of indicators, (2) development of the guidebook methodology with the assistance of expert peer reviewers, and (3) field-testing and refining the methodology and indicators at 18 diverse MPA sites from around the world.

2.1. An overview of the evaluation methodology

The cornerstone of the guidebook methodology is the selection and measurement of indicators of MPA management effectiveness. The guidebook outlines a four-part process to do this (see Fig. 1): (1) select the appropriate indicators, (2) plan and prepare for the evaluation, (3) collect and analyze data for the selected indicators, and (4) communicate and use evaluation results to adapt the MPA's management. In the guidebook, the reader is walked through the various steps needed to complete each of the four parts.

Identifying and developing indicators to assess the performance of MPAs is fundamental to evaluating whether their goals and objectives are achieved. There is a wide range of types of indicators that need to be considered when evaluating the overall management effectiveness of a protected area. These include context (where are we now?), planning (where do we want to be?), inputs (what do we need?), processes (how do we go about it?), outputs (what were the results?) and outcomes (what did we achieve?) [1]. The MPA MEI effort deliberately focused on output and outcome indicators. Outcome evaluation is the true test of management effectiveness.

As an initial step in the development of the guidebook, a survey of goals and objectives from MPAs around the world was conducted. The goals and objectives fell into three primary categories: governance, biophysical, and socioeconomic. Next, a survey was done of existing indicators used to measure various aspects of the marine environment and coastal communities. Over 130 indicators used to measure various aspects of the marine environment and coastal communities were identified. The indicators were then linked to the relevant MPA goals and objectives that they could measure and peer reviewed.

The initial draft set of MPA goals, objectives, and indicators was reviewed, evaluated, and prioritized by a group of experts at workshop in Chichiriviche, Venezuela, in October 2001. Thirty seven experts from 17 different countries with diverse backgrounds in MPAs and expertise in governance, biophysical, and

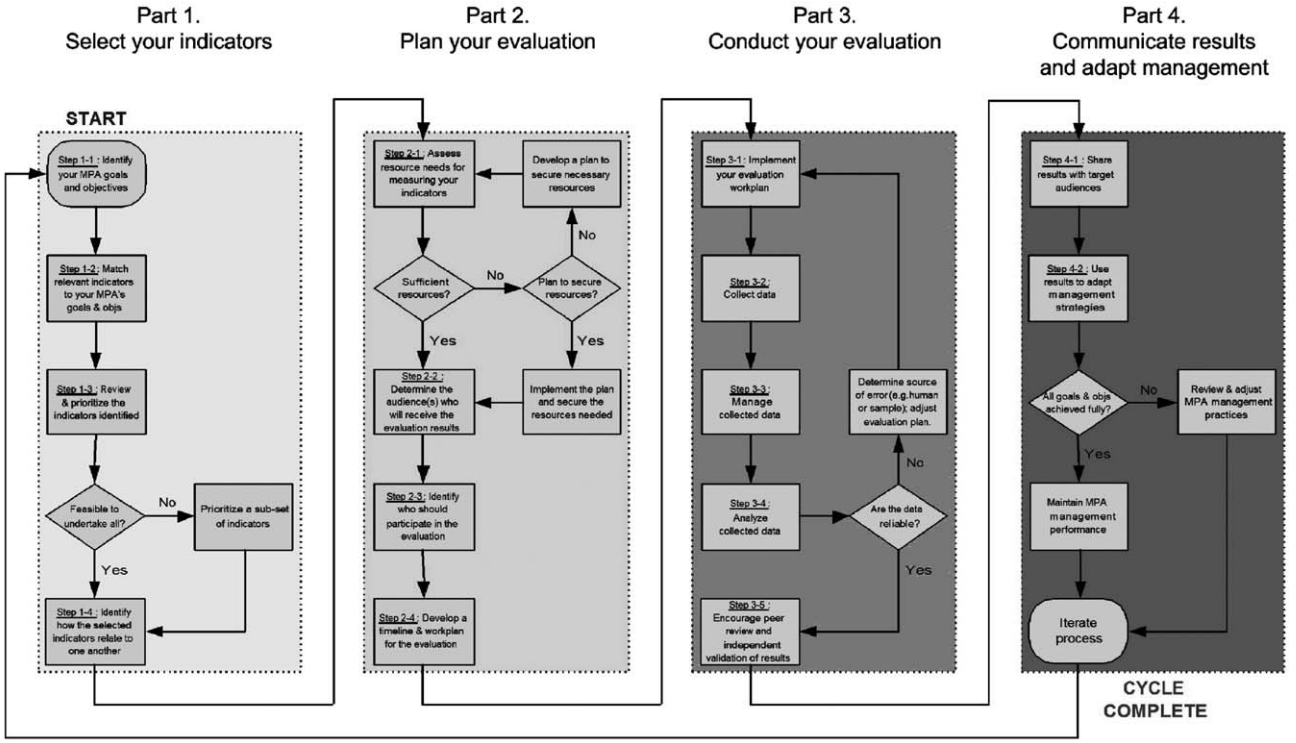


Fig. 1. Four-part process and respective steps described in the guidebook for conducting a marine protected area management effectiveness evaluation.

socioeconomic fields of study participated. The result of the workshop was a revised set of 52 priority indictors and information on each indicator. Through two additional rounds of peer review, the 52 indictors were later reduced to 42 and made operational by describing definitions, methods of measurement, and brief guidance on analysis of results.

2.2. Introducing the indicators

Around the world, MPAs are expected to operate under many different biophysical, socioeconomic, and institutional (governance) conditions. The causal relationships between such conditions operating in a given location and country, and the direct or indirect influence each has on the health of the area under protection, can be numerous and convoluted. Fig. 2 presents a highly simplified representation of such complex relationships and how they inevitably influence whether or not a MPA is capable of achieving its goals and objectives. For example, the rules and regulations governing national fisheries often directly influence the amount of fishing effort that is allowable within a country's coastal waters. Likewise, the legal orientation of private and communal ownership arrangements over the land—and in some cases, the sea—by institutions or individuals may strongly influence the

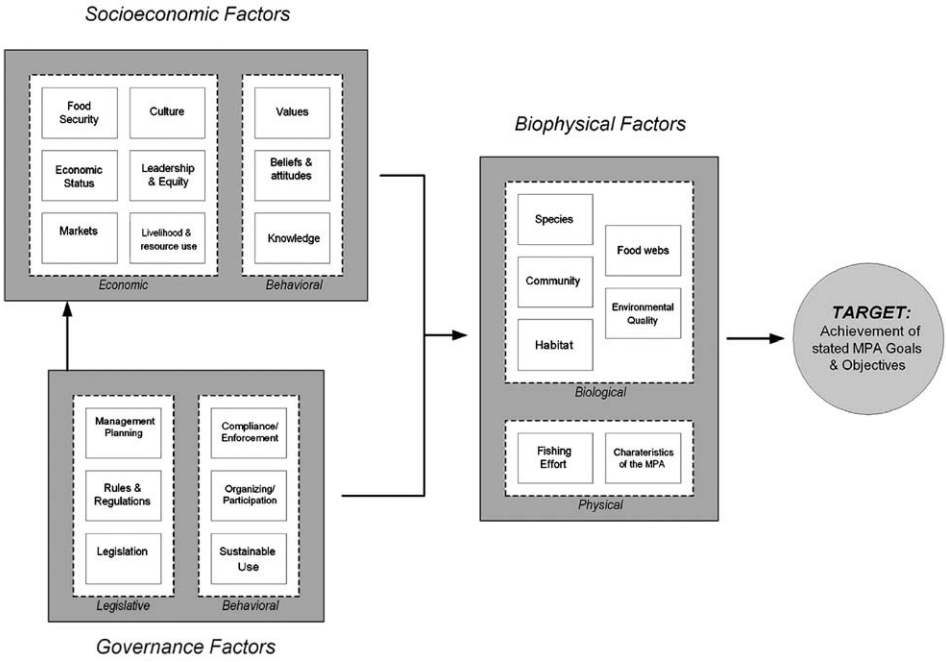


Fig. 2. A conceptual framework of the potential operating conditions within and around marine protected areas.

socioeconomics of a country, such as the distribution of wealth and resulting economic status across society or even poverty rates and food security. In other cases, the existing social conditions may directly influence the natural setting in which a MPA operates. For example, the cultural practices of the dominant ethnic group or values, attitudes, and beliefs held by a specific set of coastal residents may directly determine which species or habitat types within near shore waters are most heavily fished. The biophysical conditions affected by operating institutional and socioeconomic conditions in turn influence the ecological integrity of the area being managed and the ability of the MPA to achieve its intended management aims (goals and objectives).

A common assumption that may be held by the public and decision-makers involved in the approval, implementation, and maintenance of a MPA is that despite whatever conditions are operating in the country and/or at the location, the MPA will inevitably achieve its stated goals and objectives with sustained time and effort. However, the reality is that even if designed appropriately given the operating conditions, no amount of time or effort will allow a MPA that is not managed effectively to succeed at achieving its intended aims.

In recognition of this need, the guidebook identifies a set of 42 indicators: ten biophysical (Table 1), sixteen socioeconomic (Table 2), and sixteen governance indicators (Table 3). Each set of indicators is associated with general goals and objectives that may be part of a MPA.

The biophysical indicators address various factors relating to the natural environment:

- Six focus on the biotic context (indicators B1, B2, B3, B4, B5, and B6), including two at the species level (B1 and B2), one on habitat (B3), and three on community ecology (B4, B5, and B6).
- One measures the 'goods' generated (B7).
- One is an abiotic measure (B8).
- Two are 'aerial' indicators of observed change (B9 and B10).

Table 1
Five common MPA biophysical goals and the 10 associated indicators used to evaluate progress being made against them

Goals (no. of associated objectives)	Indicators
1. Marine resources sustained or protected (6)	B1—Focal species abundance
2. Biological diversity protected (7)	B2—Focal species population structure
3. Individual species protected (4)	B3—Habitat distribution and complexity
4. Habitat protected (4)	B4—Composition and structure of the community
5. Degraded areas restored (5)	B5—Recruitment success within the community
	B6—Food web integrity
	B7—Type, level, and return on fishing effort
	B8—Water quality
	B9—Area showing signs of recovery
	B10—Area under no or reduced human impact

Table 2
Six common MPA socioeconomic goals and the 16 associated indicators used to evaluate progress being made against them

Goals (no. of associated objectives)	Indicators
1. Food security enhanced or maintained (2)	S1—Local marine resource use patterns
	S2—Local values and beliefs regarding the marine resources
2. Livelihoods enhanced or maintained (4)	S3—Level of understanding of human impacts on resources
	S4—Perceptions of seafood availability
3. Non-monetary benefits to society enhanced or maintained (6)	S5—Perceptions of local resource harvest
	S6—Perceptions of non-market and non-use value
	S7—Material style of life
4. Benefits from the MPA equitably distributed (3)	S8—Quality of human health
	S9—Household income distribution by source
5. Compatibility between management and local culture maximized (2)	S10—Household occupational structure
	S11—Community infrastructure and business
	S12—Number and nature of markets
6. Environmental awareness and knowledge enhanced (4)	S13—Stakeholder knowledge of natural history
	S14—Distribution of formal knowledge to community
	S15—% of stakeholder group in leadership positions
	S16—Changes in conditions of ancestral and historical sites, features, and/or monuments

The socioeconomic indicators address various factors regarding the social context of stakeholders and neighboring communities:

- Three focus on people's perceptions (S4, S5, and S6).
- Seven focus on households or users (S1, S2, S3, S7, S9, S10, and S13).
- Four look at people's understanding (S2, S3, S13, and S14).
- Seven focus on economics (S1, S6, S7, S9, S10, S11, and S12).

The governance indicators address various factors relating to the process used to manage, patrol, and enforce the MPA:

- Four focus on stakeholder participation (G9, G11, G12, and G13).
- Four provide measurements on 'input' and 'process' aspects of management (G10, G11, G15, and G15).
- Four are 'output' indicators focused on what has been achieved (G2, G3, G8, and G12).

A profile was developed for each indicator that provides a description, methods for collecting data on each indicator, and guidance on analysis of the data (Table 4). In order to help the users of the guidebook in selecting an appropriate set of

Table 3
Five common MPA governance goals and the 16 associated indicators used to evaluate progress being made against them

Goals (no. of associated objectives)	Indicators
1. Effective management structures and strategies maintained (6)	G1—Level of resource conflict
	G2—Existence of a decision-making and management body
	G3—Existence and adoption of a management plan
2. Effective legal structures and strategies for management maintained (5)	G4—Local understanding of MPA rules and regulations
	G5—Existence and adequacy of enabling legislation
3. Effective stakeholder participation and representation ensured (3)	G6—Availability and allocation of MPA administrative resources
	G7—Existence and application of scientific research/input
4. Management plan compliance by resource users enhanced (6)	G8—Existence and activity level of community organization(s)
	G9—Degree of interaction between managers and stakeholders
5. Resource use conflicts managed and reduced (1)	G10—Proportion of stakeholders trained in sustainable use
	G11—Level of training provided to stakeholders in participation
	G12—Level of stakeholders participation and satisfaction in management process and activities
	G13—Level of stakeholder involvement in surveillance, monitoring, and enforcement
	G14—Clearly defined enforcement procedures
	G15—Enforcement coverage
	G16—Degree of information dissemination to encourage stakeholder compliance

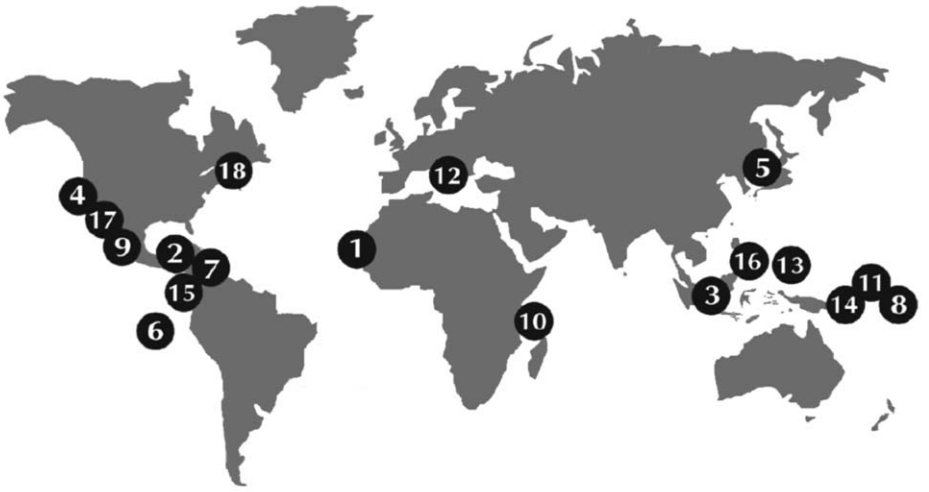
indicators and understanding how easily or difficult they can be to measure, each indicator has a difficulty rating based on the time, technical skills, finances, and other resources necessary to measure the indicator. The indicator profiles were peer-reviewed twice and revised into a final draft set. The indicators were developed with a wide range of MPAs in mind, so that they could be flexible and adaptable to the specific conditions and situation of a particular MPA.

2.3. Field-testing the evaluation methodology

Field-testing was necessary to test and improve the use of the guidebook and indicator measurement methods. Eighteen MPAs around the world (Fig. 3), representing a range of characteristics and purposes (Table 5), volunteered to pilot the methods and steps outlined in the Guidebook. In a process initiated during a

Table 4
The information provided within each of the 42 indicator profiles included in the guidebook

- The name of the indicator
- The goals and objectives related to the indicator (*listed*)
- Difficulty in measuring the indicator (*on a scale of 1–5, from easy to hard*)
- What is [indicator name]? (*definition*)
- Why measure it? (*purpose and rationale*)
- What is required to measure it? (*a list of resources and equipment needed*)
- How are data collected? (*methods*)
- How are results interpreted/shared? (*analysis and communicating results*)
- Outputs (*suggested list*)
- Strengths and limitations in using the indicator
- Example from the field (*a story, data set, and/or results from one of the MPA pilot sites*)
- References and other useful information (*listed*)



1) Banc D'Arguin National Park (Mauritania)
2) Banco Chinchorro Biosphere Reserve (Mexico)
3) Bunaken National Park and Pulau Sebesi Marine Reserve (Indonesia)
4) Channel Islands National Marine Sanctuary (US)
5) Far Eastern Marine Preserve (Russia)
6) Galapagos Islands Marine Reserve (Ecuador)
7) Hol Chan Marine Reserve (Belize)
8) Lenger Island Marine Protected Area (Federated States of Micronesia)
9) Loreto Bay National Park (Mexico)
10) Mafia Island Marine Park (Tanzania)
11) Managaha Conservation Area and Sasanhaya Fish Reserve (Commonwealth of the Northern Marianna Islands)
12) Miramare Marine Protected Area (Italy)
13) Ngemai Conservation Area and Ulong Channel Grouper Spawning Area (Republic of Palau)
14) Piti Bomb Holes Preserve and Achang Reef Flat Preserve (Guam)
15) Sian Ka'an Coastal Biosphere Reserve (Mexico)
16) Tubbataha Reef National Marine Park (Philippines)
17) Upper Gulf of California and Colorado River Delta Biosphere Reserve (Mexico)
18) Saguenay-St. Lawrence Marine Park (Canada)

Fig. 3. Geographic location of the 18 pilot site marine protected areas that volunteered to test a draft version of the evaluation methodology and indicators.

Table 5
Summary characteristics of the 18 pilot site marine protected areas

	Name of MPA	Host country	Country income status[a]	Marine Ecoregion[b]	Size (km^2)	Latitude	Type of management
1	Banc D'Arguin National Park	Mauritania	Low	West African	12,000	15–30N	Conventional
2	Banco Chinchorro Biosphere Reserve	Mexico	Upper middle	Mesoamerican Caribbean Reef	1443	0–15N	Conventional
3	Bunaken National Park and Pulau Sebesi Marine Reserve	Indonesia	Lower middle	Sulu-Sulawesi	790	0–15N	Co-Management and Community-Based
4	Channel Islands National Marine Sanctuary	USA	High	California Current	4349	30–45N	Co-Management
5	Far Eastern Marine Reserve	Russian Federation	Lower middle	Sea of Japan	643	30–45N	Conventional
6	Galapagos Islands Marine Reserve	Ecuador	Lower middle	Galapagos Marine	135,000	0	Co-Management
7	Hol Chan Marine Reserve	Belize	Upper middle	Mesoamerican Caribbean Reef	18	0–15N	Co-Management
8	Lenger Island Marine Protected Area	Federated States of Micronesia	Lower middle	Central Pacific	2	0–15N	Community-Based
9	Loreto Bay National Park	Mexico	Upper middle	Gulf of California	2065	15–30N	Conventional

10	Mafia Island Marine Park	Tanzania	Low	East African	822	0–15S	Co-Management
11	Managaha Conservation Area and Sasanhaya Fish Reserve	Commonwealth of Northern Mariana Island	Upper middle	Central Pacific	1; 2	0–15N	Conventional
12	Miramare Marine Protected Area	Italy	High	Mediterranean	1	45–60N	Co-Management
13	Ngemai Conservation Area and Ulong Channel Grouper Spawning Area	Republic of Palau	Upper middle	Palau	30; 15	0–15N	Conventional and Community-Based
14	Piti Bomb Holes Preserve and Achang Reef Flat Preserve	Guam	High	Central Pacific	5; 4	0–15N	Conventional
15	Sian Ka'an Biosphere Reserve	Mexico	Upper middle	Mesoamerican Caribbean Reef	6000	0–15N	Conventional
16	Tubbataha Reef National Marine Park	Philippines	Lower middle	Sulu-Sulawesi	332	0–15N	Co-Management
17	Upper Gulf of California and Colorado River Delta Biosphere Reserve	Mexico	Upper middle	Gulf of California	9340	30–45N	Conventional
18	Saguenay—St. Lawrence Marine Park	Canada	High	Northeast Atlantic	1138	45–60N	Conventional

[a] *Source*: The World Bank (2004), *Income Groupings of Global Economies*. Country income status ('low', 'lower middle', 'upper middle', or 'high') is accepted as a more precise classification to differentiate between 'developing' and 'developed' economies.

[b] *Sources*: Olson and Dinerstein (1998) The Global 200: a representation approach to conserving the Earth's most biologically valuable ecoregions. Conservation Biology 12: 502; and NOAA (2003) Large Marine Ecosystems of the World.

workshop held in Hawaii during September 2002, the 18 MPA pilot sites selected a set of biophysical, socioeconomic, and governance indicators that were the most appropriate to be tested at their site, based on their aims, interests, capacity, and resources.

The official testing period for the pilot sites lasted eight months (September 2002 through April 2003). Most sites created a multidisciplinary evaluation team to conduct the testing. At the end of the testing period, pilot sites submitted an evaluative report of testing results from using the draft guidebook and measuring the indicators that they chose. The results from the pilot sites allowed the MEI team to appropriately revise and improve the guidebook and its methods in order to ensure that it is applicable and useful across a range of conditions. The pilot site feedback helped to validate the indicators and demonstrated that they could be used flexibly and adapted across varied conditions, scales and contexts in global MPA application. Some pilot site experiences were also documented as case studies in conducting MPA management effectiveness assessments for documentation purposes (see: http://effectivempa.noaa.gov/cases.html). The incentive for MPA participation as a pilot site was based on their ability to use indicators to build their capacity to adaptively manage their conservation efforts.

3. Results and lessons in using the methodology

3.1. Summary results

All of the pilot sites completed their testing of the draft indicators and evaluation methodology outlined within the guidebook. Two-thirds ($n = 13$) of these sites submitted their testing results within the originally specified evaluation time period of eight months, with the remainder ($n = 5$) submitting during the following four to six months. There was no correlation between the size or complexity of the test site and whether or not an evaluation was completed within the originally specified eight-month timeframe. These results suggest that the evaluation methodology outlined within the guidebook is feasible for completion by a MPA within an eight to twelve month timeframe.

Most of the pilot sites reported that using the step-by-step process outlined in the guidebook, they were able to effectively match the goals and objectives of their site against those presented in the guidebook, thereby allowing for them to logically select a set of indicators to measure. Nearly all of the pilot sites (80% of those reporting) indicated that they believe that this process allowed them to successfully select the necessary and most appropriate number of indicators to evaluate the management effectiveness of their MPA. Because pilot sites reported a high degree of relevance between the indicators they selected and measured and the specific management aims of their MPA, all (100%) pilot sites reported finding the methodology useful for evaluating the performance of their MPA.

Pilot sites selected a wide range of the number and type of indicator. On average, each site selected three biophysical, four socioeconomic, and five governance indicators. There was no correlation between the number and type of selected indicators and the various characteristics of the pilot MPAs.

The most common constraints placed on the evaluation team during the evaluation period were time restrictions within which to perform indicator measurements, interference of seasonal activities and weather, lack of experience to perform evaluation, and unfamiliarity with certain indicators and measurement methods.

Biophysical and socioeconomic indicators were found to be the most expensive and time consuming to measure, due to the high cost of materials, time required for field trips and survey preparation, and the cost and time required to mobilize necessary technical support. Pilot sites reported that generally the costs of measuring selected governance indicators were four to five times less than what was required with biophysical and socioeconomic indicators. Biophysical indicators were the most time consuming and costly of the three sets tested.

All pilot MPAs reported that they found the guidebook and the process outlined "useful" or "very useful", particularly as a learning experience for adaptive management of their MPAs and its relative effectiveness. This was particularly true with MPAs that had no prior experience in in-depth performance review and evaluation, or with no defined evaluation mandate at the local or national level. This finding contradicted the frequently voiced concern that the guidebook would be too technical and dense for most MPAs to undertake. Each site reported having gained insights into ways to more effectively manage their sites.

3.2. Lessons learned

Based on the submission of results and review feedback from the pilot sites, a number of lessons have emerged with regard to the use of the evaluation methodology and the indicators.

First, in working through the indicator selection process, many pilot sites found that they did not have adequately and/or clearly defined goals and objectives in their management plans or declarative language. Some sites used the goals and objectives presented in the guidebook (which were derived through a comprehensive literature and peer review) as surrogates not only to conduct their selection of indicators, but to also think more critically and carefully about their own management aims and language. Sites with no previous evaluation experience or established monitoring programs emphasized the need for clearly understanding and articulating site goals and objectives before selecting indicators.

Next, the outlined measurement techniques for some indicators needed to be adapted by some pilot site evaluation teams in order for them to most appropriately address specific issues relating to their MPA. These included survey site accessibility, various levels of participation of local communities, and the size and remoteness of the MPA. An important lesson that was learned through this experience was that the indicators outlined in the guidebook are flexible enough to be adapted to local site conditions.

Also, the methods used by pilot sites to measure the indicators were generally followed as suggested in the guidebook. A few sites did offer additional and enhanced measurement methods and alternative data collection techniques for a few indicators, depending on the capacity and resources of the implementing team. In some cases, methods suggested in the guidebook were part of already established monitoring systems at pilot sites, particularly in the case of biophysical indicators. Few alternative methods and techniques were proposed by pilot sites with established monitoring programs and/or qualified working teams. Two sites proposed the addition of two new socioeconomic and one governance indicator to be added to the final version of the guidebook, which were subsequently peer reviewed and adopted.

Finally, a number of challenges and needs were identified as a result of the pilot site testing. First, sites identified the need to have access to socioeconomic and governance specialists. Many pilot site evaluation teams were largely composed of natural scientists, and very few had social science expertise on staff. In spite of the need for professional assistance in this discipline, the sites did report that they were able to measure the social indicators by following the guidebook instructions.

Another challenge that was learned was that for several of the pilot sites, specific limitations in doing evaluations existed. These included restricted access to some areas of the MPA due to poor weather or distance, and reluctance of local populations to respond to interviews or participate in group evaluation activities as a result of distrust, unfamiliarity, or time requirements.

The most commonly identified evaluation problems by pilot sites were the need for additional financial resources, time, and technical capacity and infrastructure to measure certain indicators. Several sites reported that this was a key finding and based on their evaluation results, demonstrated a need to increase or shift attention and resources to regularly evaluating management effectiveness at their MPA in the future.

3.3. Conclusion

One of the most frequently cited limitations reported by MPA managers in measuring the management effectiveness of their efforts is a lack of technical skill and experience in conducting an evaluation. With the 2004 publication of the final, tested methodology, it is hoped that the guidebook can provide some pragmatic and useful guidance in addressing this need [12].

The lack of evaluation experience with many managers is further complicated when there are either poorly defined MPA goals and objectives or an unclear management plan and work plan for the area. Pilot site testing confirmed that the methodology outlined within the guidebook clearly illustrates the need and relevance of having appropriate and well-defined goals and objectives, particularly prior to conducting an evaluation of an MPA. Several pilot site evaluation teams indicated that merely the act of clarifying and specifying their MPA's goals and objectives, as well as the assumptions underlying them, was one of the most practical outputs in their use of the guidebook. This consideration is particularly relevant to recently

implemented MPAs, which may assume that commencing a management effectiveness evaluation process early on will not necessarily provide immediate utility.

When pilot sites were asked why the guidebook was found to be a useful instrument in measuring their MPA's management effectiveness, they reported that they saw the guidebook as being flexible enough to adapt the process and indicators provided to the particular situation at each of the pilot site MPAs. This was reported even in the case of MPAs that were community managed and at sites with low to modest financial and technical support. The demonstrated ability for the guidebook to be adaptable to MPAs operating at a variety of scales, capacities, and budgets was of key importance to the development team. This shows how the need to provide management tools that can be used by MPA practitioners across a wide, disparate set of natural and social conditions operating across the world can be met (see [7]).

The evaluation methodology outlined within the guidebook must be viewed as an initial effort. Undoubtedly, it can and should be improved upon in the coming years, based both on the application of newly emerging MPA science and on the experiences and feedback from MPAs actively engaged in management effectiveness. It is hoped that the use of this initial effort will lead to the development of additional indicators and refinement of existing ones that are useful to MPA teams conducting management effectiveness evaluations.

Based on the experiences reported to date, evaluating the effectiveness of MPA management has the potential to assist managers and their supporting partner groups, decision-makers, donors, and other interested parties to undertake adaptive management, thereby strengthening management action, enhancing priority setting, and ensuring accountability.

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References

[1] Hockings M, Stolton S, Dudley N. Evaluating effectiveness: a framework for assessing the management of protected areas. IUCN, WCPA Best Practice Protected Area Guidelines Series #6. IUCN, Gland, Switzerland and Cambridge, UK, 2000.
[2] Lubchenco J, Palumbi SR, et al. Plugging a hole in the ocean: the emerging science of marine reserves. Ecological Applications 2003.
[3] Scientific consensus statement on marine reserves and marine protected areas. 2001. Available at: http://compassonline.org/files/inline/NCEAS%20Scientific%20Consensus.pdf
[4] Russ GR, Alcala AC, Maypa AP, et al. Marine reserves benefits local fisheries. Ecological Applications 2004(2):597–606.
[5] Halpern BS. The impact of marine reserves: do reserves work and does reserve size matter? Ecological Applications 2003;13:S117–37.
[6] Pauly D, Christensen V, Guenette S, Pitcher TJ, Sumaila UR, Walters CJ, Watson R, Zeller D. Towards sustainability in world fisheries. Nature 2002;418:689–95.
[7] Agardy T, Bridgewater P, Crosby MP, Day J, Dayton PK, Kenchington R, Laffoley D, McConney P, Murray PA, Parks JE, Peau L. Dangerous targets? unresolved issues and ideological clashes around marine protected areas. Aquatic Conservation-Marine and Freshwater Ecosystem 2003;13(4):353–67.
[8] Jameson SC, Tupper MH, Ridley JM. The three screen doors: can marine protected areas be effective? Marine Pollution Bulletin 2002;44(11):1177–83.
[9] Kelleher G, Bleakley C, Wells S. A global representative system of marine protected areas, vol. I–IV. Gland, Switzerland and Cambridge, UK: The Great Barrier Reef Authority, The World Bank and The World Conservation Union, IUCN; 1995.
[10] Burke L, Selig L, Spalding M. Reefs at risk in Southeast Asia. Washington, DC, USA: The World Resources Institute; 2002.
[11] McField M. Evaluation of management effectiveness: Belize marine protected areas system. Belize City: Coastal Zone Management Authority and Institute and World Wildlife Fund; 2000.
[12] Pomeroy R, Parks J, Watson L. How is your MPA doing? A guidebook of natural and social indicators for evaluating marine protected area management effectiveness. IUCN, Gland, Switzerland and Cambridge, UK, 2004. Available at: http://www.effectivempa.noaa.gov/guidebook/guidebook/html