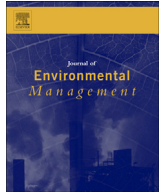




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## Research article

## Evaluating the success of a marine protected area: A systematic review approach

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## ABSTRACT

Marine Protected Areas (MPAs), marine areas in which human activities are restricted, are implemented worldwide to protect the marine environment. However, with a large proportion of these MPAs being no more than paper parks, it is important to be able to evaluate MPA success, determined by improvements to biophysical, socio-economic and governance conditions. In this study a systematic literature review was conducted to determine the most frequently used indicators of MPA success. These were then applied to a case study to demonstrate how success can be evaluated. The fifteen most frequently used indicators included species abundance, level of stakeholder participation and the existence of a decision-making and management body. Using the indicator framework with a traffic light system, we demonstrate how an MPA can be evaluated in terms of how well it performs against the indicators using secondary data from the literature. The framework can be used flexibly. For example, where no MPA data currently exist, the framework can be populated by qualitative data provided by local stakeholder knowledge. This system provides a cost-effective and straightforward method for managers and decision-makers to determine the level of success of any MPA and identify areas of weakness. However, given the variety of motivations for MPA establishment, this success needs to be determined in the context of the original management objectives of the MPA with greater weighting being placed on those objectives where appropriate.

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## 1. Introduction

Marine Protected Areas (MPAs) are areas in which human activity is restricted in order to manage and protect marine and coastal resources against threats such as over exploitation and ecological damage (Eagles et al., 2002; Cleguer et al., 2015). Once these areas are protected, they could have positive ecological effects (Edgar et al., 2014; Selig and Bruno, 2010) such as increasing species abundance and improved habitat quality (Roberts et al., 2001) as well as significant socio-economic effects for coastal communities (Rodríguez-Rodríguez et al., 2015; Santo, 2013). MPAs, are found all over the globe (Salm et al., 2000), and have demonstrated that they protect endangered habitats from decline, restore food webs, and sustain ecosystem services (Pauly et al., 2002). MPAs vary in location; however most occur at intertidal or near-coastal waters (Wood et al., 2008). Recent estimates are that between 2.2% (MPAtlas, 2014) and 3.4% (Juffe-Bignoli et al., 2014) of

the world's oceans are protected by MPAs. However, regulations and enforcement vary at these sites with some being no more than paper parks (Halpern, 2014; Edgar et al., 2014). This impacts the level of protection they provide and so the level of success in meeting management objectives (Hilborn et al., 2004).

Pomeroy et al. (2005) state that at the time of implementation, MPAs must: (1) maintain or restore marine biodiversity and ecosystem function, particularly through marine reserves, also called 'no-take' areas; and (2) also improve the socio-economic conditions by increasing revenues in and around the MPA by increased tourism and improved local commercial fishing outside of the MPA due to an increase in the size and number of fish migrating out of the MPA. Pomeroy and colleagues also suggested that in order to evaluate management effectiveness within a marine ecosystem there is a need to establish specific indicators. These indicators can serve multiple audiences, such as donor agencies, policy makers, management teams, and conservation and development non-governmental organisations. It was concluded that the most frequently cited limitation reported by MPA managers, in measuring the management effectiveness of their efforts, was a lack

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of technical skill and experience in conducting an evaluation. Evaluation techniques should be improved and conducted more regularly, as regular evaluation can strengthen management action, enhance priority setting and ensure accountability (Pomeroy et al., 2005). Lack of evaluation can be complicated when no clearly defined MPA goals or objectives exist or the management plan for the area of the MPA is unclear.

MPA management effectiveness assessment tools have been developed such as MPA MEAT which was created to assess the effectiveness of MPA management in the Philippines (Alino, 2011). This tool provides managers with a clear indication of where management improvement can be made but is not broad enough to incorporate socio-economic and biophysical changes as a result of protection to evaluate the success of the MPA as a whole. The aim of this paper is to provide a framework to assess the biophysical, socio-economic and governance success of any MPA based on criteria found in the most recent literature on MPA indicators of success. The framework should be versatile enough to be used in a variety of ways depending on the level of data and expertise available.

The choice of the three broad categories of MPA effectiveness (biophysical, socio-economic and governance) is based on those used in the literature (e.g. CTI NCC (2011)). We use the term governance in the broad sense described by Hufty (2011) and Bevir (2013) where governance refers to “all of processes of governing, whether undertaken by a government, market or network, whether over a family, tribe, formal or informal organisation or territory and whether through the laws, norms, power or language” (Bevir, 2013). It relates to “the processes of interaction and decision-making among the actors involved in a collective problem that lead to the creation, reinforcement, or reproduction of social norms and institutions” (Hufty, 2011). The objectives of the research include: the development of a success criteria matrix using a systematic literature review which detailed the indicators used and the sources of data; identification of specific indicators of success based on the criteria matrix; the ranking of indicators according to their frequently of citation; and then demonstrating how the framework of indicators can be used to evaluate the success of any MPA using a traffic light system, by applying it to a case study. An additional objective was to identify how such a framework might be adapted to data and expertise poor scenarios.

## 2. Materials and methods

In order to begin the process of developing a framework that managers and decision makers can use to evaluate the success of any MPA worldwide, a systematic literature review (based on Pullin and Stewart, 2006) was carried out. By analysing evidence from scientific journal articles that address the question, ‘What makes an MPA successful?’ this study aimed to provide stakeholders, policy makers, and management with key indicators of success which are straightforward to interpret and apply for their own specific use. Since new primary data collection is time consuming and costly, a systematic review approach combined with a traffic light system method of evaluation provides a straightforward system for managers to evaluate the success of marine protected areas and update that evaluation as new data become available. The framework also could be adapted for a variety of scenarios of data availability as will be discussed.

### 2.1. Search engine choice

The Web of Science was chosen as the most appropriate search engine option due to the: high level of reliable cited journal entries; ease of accessibility to third parties; and repeatability of searches.

The search range was from the years 2000–2015 to gather the most current scientific results. Endnote was used as a repository for search engine results as it is highly compatible with Web of Science.

### 2.2. Systematic review and search approach

A systematic review is a scientific approach that is a robust and quantitative way of reviewing literature and is the process of searching, selecting, synthesising and reporting evidence on a particular question or topic. It is currently considered the best, least biased and most rational way to organise, gather and evaluate literature (Ng and Peh, 2010). This method allowed for indicators of MPA success to be determined and ranked in order of most commonly used.

The steps of this systematic review are described below:

- Step 1: In order to capture all recent papers concerning the evaluation of MPA success a Web of Science search was carried out with 10 primary terms covering the terminology for marine protection commonly found in the literature (Table 1). In addition, 5 secondary terms were added to the search to specify the focus of the search on MPA success or effectiveness. Despite this narrow focus, this process generated a list of 6941 journal articles.
- Step 2: The large number of papers generated by Step 1 required further refining in terms of the relevance of the paper. The abstract and title of each of the 6941 articles were read. Based on the identification of relevant articles and common terms used in Step 1, only articles which mentioned one or more of the following tertiary terms were included in the final list of articles: biological, biophysical, environmental, ecological, economic, social, socioeconomic, conflict, governance and stakeholders. These terms were chosen to cover the broad areas under which MPA success would be deemed successful by decision makers and other stakeholders. This process narrowed down the results to 966 papers by removing many papers which did not address the criteria of assessing an MPA's success or effectiveness.
- Step 3: Upon reading the full-text of 966 papers from Step 2's results there were still papers, that although they included some of the search terms, did not address the topic of interest. These papers appeared to fit into two broad categories: journals with the search words in text but on an unrelated topic (e.g. Allan et al., 2008; Foster-Smith and Evans, 2003; Ye et al., 2011); or those that were related to MPAs but only covered the theory behind the closure, design or implications for specific species (e.g. Alexander and Armitage, 2014; Alfonso et al., 2008; Ban et al., 2012). Therefore based on the title and abstracts of the articles, further criteria for inclusion and exclusion were then applied (Table 2). In order to ensure consistency of the

**Table 1**  
Primary and secondary search terms for systematic review.

Primary terms (n = 10)		Secondary terms (n = 5)
Marine protected areas	and	Success
Marine reserve		Effectiveness
Marine refugia		Failure
Marine refuge		Benefits
MPA		Indicator
Marine Parks		
Partial closure		
No-take zone		
No trawling		
Marine conservation zone		

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