Revisiting "Success" and "Failure" of Marine Protected Areas: A Conservation Scientist Perspective

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Marine protected areas (MPAs) form the cornerstone of marine conservation. Identifying which factors contribute to their success or failure is crucial considering the international conservation targets for 2020 and the limited funds generally available for marine conservation. We identified common factors of success and/or failure of MPA effectiveness using peer-reviewed publications and first-hand expert knowledge for 27 case studies around the world. We found that stakeholder engagement was considered to be the most important factor affecting MPA success, and equally, its absence, was the most important factor influencing failure. Conversely, while some factors were identified as critical for success, their absence was not considered a driver of failure, and vice versa. This mismatch provided the impetus for considering these factors more critically. Bearing in mind that most MPAs have multiple objectives, including non-biological, this highlights the need for the development and adoption of standardized effectiveness metrics, besides biological considerations, to measure factors contributing to the success or failure of MPAs to reach their objectives. Considering our conclusions, we suggest the development of specific protocols for the assessment of stakeholder engagement, the role of leadership, the capacity of enforcement and compliance with MPAs objectives. Moreover, factors defining the success and failure of MPAs should be assessed not

only by technical experts and the relevant authorities, but also by other stakeholder groups whose compliance is critical for the successful functioning of an MPA. These factors should be considered along with appropriate ecological, social, and economic data and then incorporated into adaptive management to improve MPA effectiveness.

INTRODUCTION

More than 15,000 marine protected areas (MPAs) cover roughly 7% of the world's marine environment (Lubchenco and Grorud-Colvert, 2015; UNEP-WCMC IUCN, 2017). Scientific evidence shows that MPAs can produce ecological, economic, and social benefits under appropriate design and management conditions (Ban et al., 2012; PISCO UNS, 2016). Comparative studies across marine regions have enabled us to explore common factors contributing to MPA success (e.g., Charles and Wilson, 2009; Edgar et al., 2014). However, assessments of the factors that result in the failure of MPAs to achieve their objectives using information from many regions are far less common (but see Gill et al., 2017). The emphasis on success and achievement may allow us to overlook the importance of failure for learning and development. MPAs are expensive ventures absorbing much of the scarce resources allocated to marine conservation. Thus, identifying practices that ensure MPA effectiveness is a major issue (Pendleton et al., 2018).

Herein, 21 conservation scientists and practitioners (the authors of this paper) used their first-hand knowledge of 27 MPA case studies from around the world (**Figure 1**, Appendix S1, Table S1.1). These case studies were used to critically consider how success and failure are defined and measured when assessing MPA effectiveness. In addition, key factors driving MPA success and failure were identified.

DEFINING MPA SUCCESS AND FAILURE

Given our case-studies span many countries, socio-ecological systems, and biogeographic regions, we needed to establish a common definition by which to benchmark the success or failure of an MPA. The general English language dictionaries define success as "the accomplishment of an aim or purpose." Using that definition, an MPA was considered a success if it accomplished its objectives. Conversely, failure was defined as "not accomplishing an aim or purpose." Thus, an MPA would be a failure if its implementation and/or management were insufficient, inappropriate or neglected. The last would be the case of the so called "paper parks" (Agardy et al., 2011; Scianna et al., 2015). An important challenge is how to assess success or failure when multiple objectives are involved. The aims of MPAs often include ecological, social, economic, cultural, and institutional objectives (Fox et al., 2012). In many cases, planning for multiple objectives concurrently demands trade-offs in achievement across social, economic, and ecological domains (Beger et al., 2015). Thus, in practice, most MPAs have aspects

of both success and failure (Christie, 2004). Here, we focus on success or failure in achieving ecological outcomes, because evidence is more abundant for assessing ecological rather than other objectives (Gill et al., 2017).
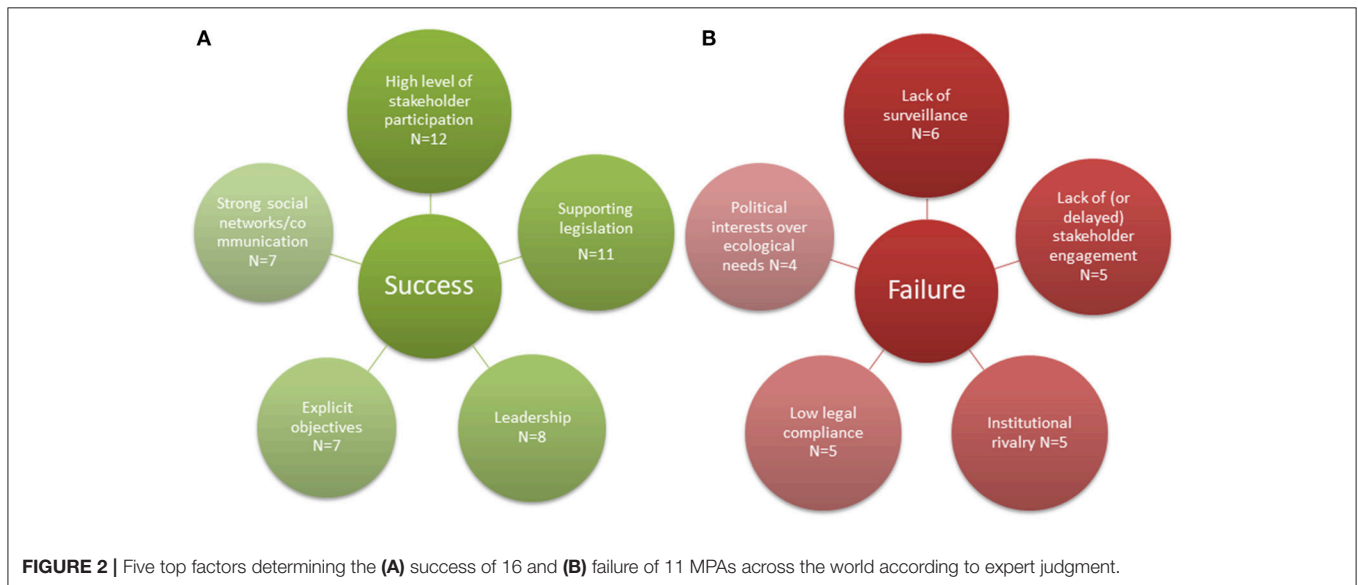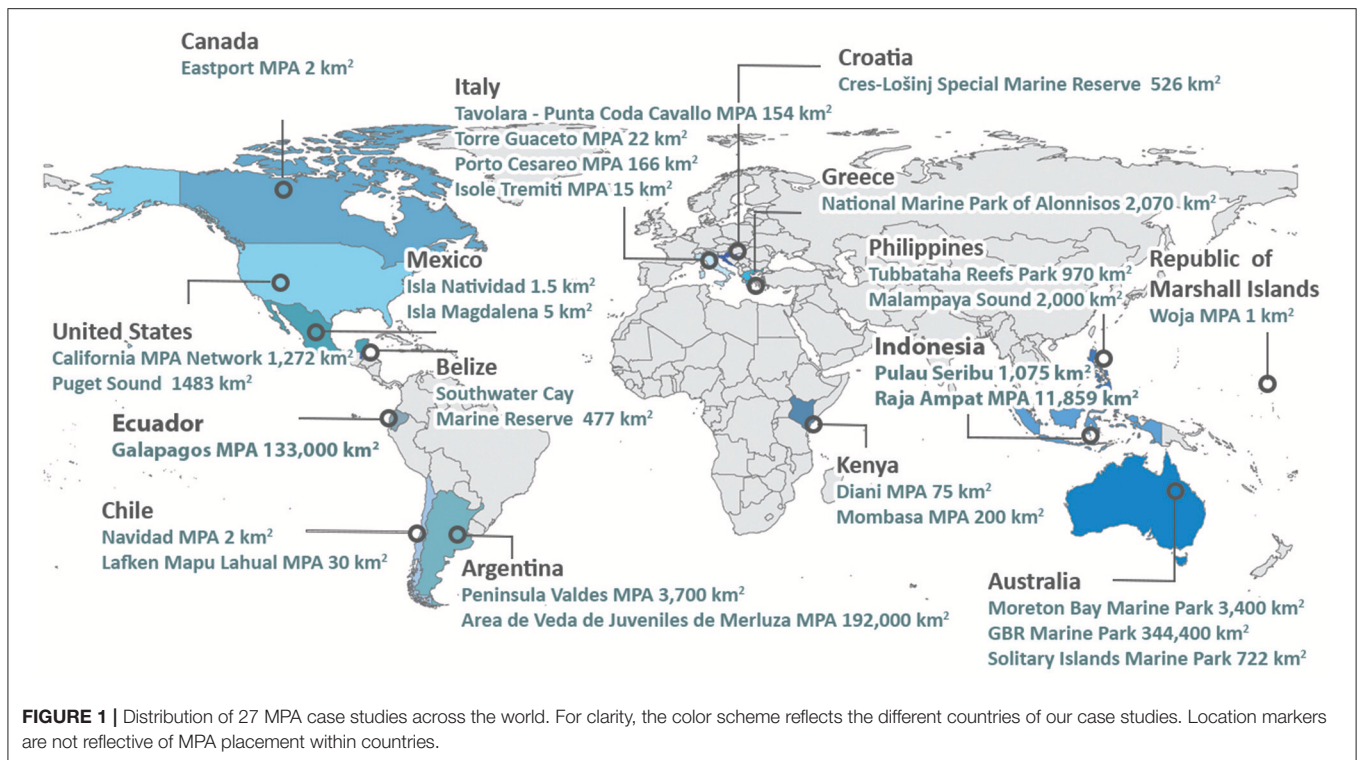
MEASURING MPA SUCCESS AND FAILURE

MPA effectiveness, in ecological terms, is commonly measured by comparing values of ecological or biological measures (e.g., sizes of organisms, density and biomass of fish assemblages, species richness, live cover of benthic organisms) in MPAs and adjacent unprotected areas and/or before and after an MPA is established. However, the appropriate rigor of the empirical design for such evaluations of the ecological effectiveness is often lacking (Ferraro and Hanauer, 2014). Thus, our assessments of ecological success, while considering available published evidence, reflect our perspectives based on first-hand experience and expert knowledge (Table S1.2). Acknowledging the fact that MPA effectiveness is not static, this assessment corresponds to a specific time period for which we had data and/or personal experience. This period does not necessarily correspond to the initial stage of the MPA establishment but also to later post-establishment stages which vary across our case studies depending on the age of each MPA.

For each case study, we considered 23 factors that were identified through group discussions and a literature review, as those commonly attributed to MPA "success" and "failure" (Table S1.1). For each case study, five factors were ranked based on their importance for the success or failure of the case study (for more information see Appendix S1).

ASSESSING MPA SUCCESS AND FAILURE

On aggregating the individual rankings, most factors indicating success were found to also point to failure; i.e., when the presence of a factor was considered to lead to success, its absence led to failure (**Figure 2**, Table S1.3). Overall, the factors viewed as principal drivers of success and failure of MPA effectiveness were related to contextual factors, such as governance and socio-economic characteristics, rather than the design attributes, such as the MPA size.

Stakeholder engagement was consistently selected as the most important factor affecting MPA success; its absence was most often linked to failure. Other factors that were reported as crucial for success, and their absence as drivers of failure, included: surveillance, leadership, political will, and the existence of sanctioning and conflict resolution mechanisms. Interestingly,

FIGURE 1 | Distribution of 27 MPA case studies across the world. For clarity, the color scheme reflects the different countries of our case studies. Location markers are not reflective of MPA placement within countries.

FIGURE 2 | Five top factors determining the **(A)** success of 16 and **(B)** failure of 11 MPAs across the world according to expert judgment.

whereas some factors were identified as critical for success, their absence was not identified as a driver of failure (Table S1.3). Those factors include setting clear objectives, strong scientific engagement throughout the planning and implementation stages, and the existence of clearly delineated MPA boundaries. The existence of explicit objectives (i.e., well-defined overarching qualitative objectives such as protection of endangered species or habitats, fisheries enhancement, or food security) was selected as one of the most important factors defining success. Yet, its absence was never identified amongst the most important factors

contributing to MPA failure. This mismatch may originate from disparities between the scientific principles of MPA design, on the one hand, and practical realities of MPAs, on the other. Scientific literature often recommends that MPA goals and objectives should be clearly defined, compatible with one another, and account for inherent uncertainty (Rossiter and Levine, 2014). In practice, however, the absence of explicit objectives may not lead to failure, but may facilitate broader acceptance by a range of stakeholders, each of which may have a different set of objectives with respect to their interests.

Conversely, certain factors contributed to failure, but their presence was never selected as crucial for success (Table S1.3). Those factors include: legal compliance, effective MPA size, and the correct identification of key stakeholder groups during the planning process. A lack of compliance, and consequently illegal activities within the area, were commonly noted as causing the failure of MPAs to achieve ecological objectives. Logically, compliance should have been identified as an indispensable driver of success, but in our activity, it seems to have been taken for granted and was not highlighted as a factor in driving success. This could potentially be attributed to the implicit assumption that it is inconceivable to have a successful MPA without compliance when assessing drivers.

RECOMMENDATIONS FOR FUTURE RESEARCH

Looking to the future, we have two major recommendations. First, we need to develop standardized measures to link the range of factors influencing success and failure to MPA effectiveness. Monitoring and evaluation of MPA effectiveness are most often limited to assessments of biological and ecological metrics, such as fish biomass (e.g., Sala and Giakoumi, 2018). Meanwhile, crucial social factors identified herein (**Figure 2**), such as stakeholder engagement, are rarely measured in a systematic way. Currently, there are very few studies demonstrating the direct relationships between participatory governance and improved ecological metrics (Stafford, 2018, but see Di Franco et al., 2016). Thus, the adoption of standardized metrics for social factors is a prerequisite for identifying how these factors truly affect MPA effectiveness and for developing guidance to decision-makers on how to improve MPA planning. More specifically, based on our collective experience, we suggest the development of protocols for the assessment of the following factors:

Stakeholder Engagement

Stakeholder engagement is a dynamic process that needs to be dialogue-based and include feedback mechanisms that allow stakeholders to assess their engagement. Social auditing, defined as a process that enables an organization to assess its performance in relation to society's requirements and expectations (Gao and Zhang, 2006), could be a valuable approach to engage stakeholders in marine conservation and promote co-operation. Ideally, all stakeholder groups should be involved in the process; in practice, however, this is rarely possible. Therefore, specific groups, whose compliance is crucial for MPA effectiveness, e.g., small-scale fishing co-operatives and local government (Beger et al., 2004; Di Franco et al., 2016), should be targeted.

Leadership

Conservation success stories are often related to a key individual, a "leader," who made things happen. Recently, there has been a shift from the individual leader at the top, to the process of leadership, which can occur throughout an organization and is not restricted to one person or group with a formal role (Schultz

and Fazey, 2009). The design of processes that promote and evaluate leadership in MPAs within the framework of adaptive management is crucial for evaluating the MPA performance.

Enforcement and Compliance

Effectiveness also depends on how the MPA authority influences the behavior of marine users through enforcement and/or compliance. Enforcement and compliance are linked and need to be monitored. Indices to monitor enforcement (e.g., hours of surveillance) are straightforward. The assessment of compliance is more complex and could be based on modeling and game-theoretic approaches, then validated by available empirical data (see Keane et al., 2008). Such approaches could assist MPA managers to optimize enforcement strategies and encourage compliance.

In our exercise, we defined success and failure in terms of achieving ecological outcomes, but we recognize that there are a range of possible objectives that can be assessed (e.g., improvements in wellbeing). Empirical studies around the factors that lead to the success and failure of particular objectives of MPAs (e.g., biodiversity conservation or fisheries enhancement) are needed. These studies should be based on clear experimental designs and be sufficiently replicated to obtain statistically reliable results. Rigorous empirical studies would then allow the provision of more specific recommendations around the design and management of MPAs planned for different objectives. Furthermore, we recognize that the results presented herein reflect the opinion of a restricted number of conservation scientists. Exploring whether our findings apply to the wider conservation community is a necessary next step.

Secondly, within a given context and for a specific objective, assessments of the drivers leading to MPA success and failure should be conducted by multiple stakeholders (e.g., different groups of commercial and recreational fishers, tourism operators, conservation scientists) and compared across groups. The importance of factors defining success and failure may differ significantly among stakeholder groups as each group has an inherent bias toward particular MPA objectives. The factors defining success and/or failure that are shared widely across the various stakeholder groups should be a priority for scientific research and investment of conservation efforts in the specific context. Although various sources of bias and uncertainty are associated with expert knowledge elicitation, the benefits of incorporating such knowledge into decision-making can be substantial (Martin et al., 2012). Furthermore, this process should be repeated through time to avoid a static view of success and failure, as these likely change over time. Iterative stakeholder assessments accompanied with updated ecological, social, and economic assessments of MPA performance based on empirical data should be incorporated into adaptive management. More effective MPA design, implementation, and management can then be achieved by building on success and learning from failure. Some of these lessons may be transferable between MPAs; however, some others may not as the importance of the factors determining MPA effectiveness depends on the spatial scale of the MPA (Ban et al., 2017; Giakoumi et al., 2017) as well as the

socio-cultural, political, and legislative context in which the MPA is established (Gill et al., 2017).

AUTHOR CONTRIBUTIONS

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2018.00223/full#supplementary-material

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