



# From measuring outcomes to providing inputs: Governance, management, and local development for more effective marine protected areas

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## ABSTRACT

Marine protected areas (MPAs) have the potential to conserve marine resources as well as provide social and economic benefits to local communities. Yet the percentage of MPAs that might be considered “successful” or effective on ecological and/or socio-economic accounts is debatable. Measurement of biophysical and socio-economic outcome indicators has become de rigueur for examining MPA management effectiveness so that adaptive feedback loops can stimulate new management actions. Scholars and practitioners alike have suggested that more attention should be given to the inputs that are likely to lead to successful MPA outcomes. This paper briefly discusses the potential ecological and socio-economic outcomes of MPAs then reviews the literature on three categories of inputs – governance, management, and local development – that lead to effective MPAs. In conclusion, the paper presents a novel inputs framework that incorporates indicators for governance, management and development to be used in the design and analysis of MPAs.

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## 1. Introduction

Marine protected areas (MPA) are set aside to protect the marine environment [1]. MPAs are promoted globally as a tool for managing fisheries, conserving species and habitats, maintaining ecosystem functioning and resilience, preserving biodiversity, and protecting the myriad of human values associated with the ocean [2–5]. Ecologically, MPAs have been shown to be effective at protecting or reducing degradation of habitats and ecosystems [4,6,7] and increasing biomass and species diversity, richness, and numbers [8,9]. While the principal mandate of MPAs is conservation of marine resources and biodiversity, beneficial local development outcomes are also a pre-cursor of local support for these initiatives [10,11].

A significant body of literature suggests that MPAs can have beneficial outcomes for the environment and for local communities. It has long been theorized that the creation of MPAs,

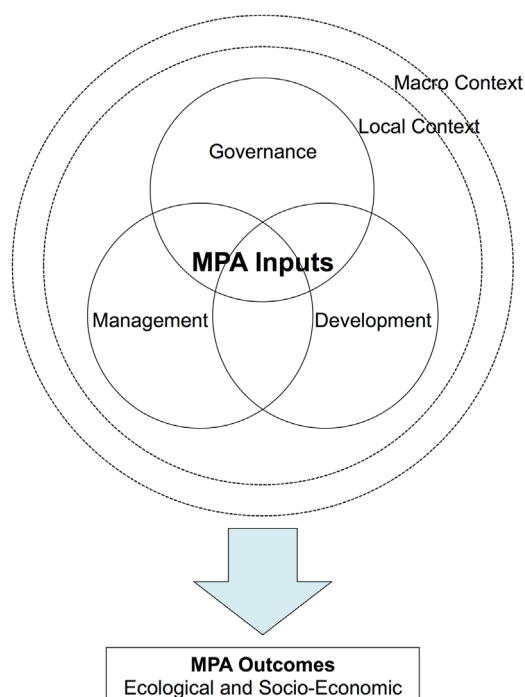
particularly no-take-zones (NTZ), can lead to beneficial outcomes for local fisheries through the replenishment of commercially valuable and depleted stocks leading to the “spillover” of adult fish into surrounding waters [4,12,13]. Authors have also suggested that socio-economic and conservation outcomes might be balanced through the development of tourism [14–16] and also through the promotion of other alternative livelihood strategies [17,18].

The proposition that MPAs both *can* and *should* lead to win-win outcomes for conservation and development thus satisfying the needs of conservationists, governments, fishers, tourism operators, and local communities is becoming the dominant paradigm. However, the successful achievement of this dual mandate is more complex in reality than in theory. Indeed, many authors and reports have questioned how effective MPAs have been at achieving either social or ecological outcomes [19–21]. De Santo [22] suggests that with agreements to establish MPAs in 10% of the ocean [23], quality is being lost in the push towards quantity and more attention needs to be given to achieving successful outcomes for conservation and local communities [10,24,25]. As noted by Gjertsen [26] “Disentangling the factors that contribute to effective conservation and improved human welfare is difficult, but necessary for understanding when these win-win scenarios are likely to emerge”. Yet the majority of research on management effectiveness

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**Fig. 1.** Beneficial marine protected area outcomes depend on contextual factors and inputs.

has been on measuring impacts and outcomes rather than identifying input variables that produce effective MPAs and proposing solutions [27].

Previous research suggests that MPAs can contribute to positive outcomes in certain contexts and given the right inputs. The remainder of this paper will discuss contextual factors and inputs that contribute to beneficial socio-economic and ecological outcomes from MPAs through a review of the literature. Increased attention to the planning and provision of appropriate governance, management and development inputs in consideration of contextual factors is likely to lead to more beneficial MPA outcomes (Fig. 1). The authors propose a novel inputs framework to be used in the design and analysis of MPAs. The following section briefly reviews the extensive literature on the ecological and socio-economic outcomes of MPAs.

## 2. The outcomes of MPAs

### 2.1. Ecological outcomes

The potential ecological benefits of MPAs to marine systems include process benefits, ecosystem benefits, population benefits, and species benefits [28]. No-take reserves, in particular, may result in beneficial environmental outcomes. A global review of no-take reserves affirms that no take MPAs have resulted in average increases in biomass of 446%, species density of 166%, in species richness of 21%, and in size of organisms of 28% [8]. Claudet et al. [29] found that larger reserve size leads to greater reserve fish density but that larger buffer zones result in decreases. Lester and Halpern [30] also showed that partially protected areas may result in some benefits but that there is a significant difference between no-take areas and partially protected areas in terms of overall benefit and density of organisms. Recently, Edgar et al. [9] demonstrated that MPAs produce significant increases in biomass and species diversity when they have four or five of the following key features: older, larger, isolated, non-extractive, and

effectively enforced. No-take MPAs also lead to spillover of adult species into surrounding areas [31]. MPAs can protect critical habitats, such as coral reefs, mangroves, and seagrass beds [4]. For example, individual MPAs and networks may lead to improvements in coral cover, reef ecology, and structural integrity through limiting the effects of destructive fishing practices on reefs [6,32,33] and through increasing resilience to climate change [34,35].

Though environmental benefits are possible the number of MPAs that are managed effectively may be in the minority [20,36,37]. For example, Burke et al. [19] estimate that 14% are effectively managed in SE Asia and Lowry et al. [21] estimate that less than 20% of 1100 MPAs in the Philippines are managed effectively. Globally, only 24% of all protected areas are managed 'soundly' [38]. These figures raise questions about the number of MPAs that are achieving their ecological objectives or potential. Furthermore, many of the potential ecological benefits of MPAs are threatened by broader environmental conditions and extreme events [34,39], levels of management in the broader seascape [11,40,41], and impacts of current and future development within MPAs [42].

### 2.2. Livelihood and community outcomes

MPA creation reallocates rights or bundles of rights, which can lead to a combination of benefits and negative consequences for the various stakeholders involved [43]. Fishing and harvesting of other marine resources is the primary livelihood of many coastal people [44]. MPAs should benefit local fishers through the spillover of fish and other harvestable species [4]. Research shows that well managed MPAs can lead to fisheries benefits for local communities through increased catch and increased catch per unit effort [31,45–51]. Larger scale commercial fisheries, too, may benefit from the creation of no take zones; however, since spillover tends to occur at smaller spatial scales (on average up to 800 m from MPA boundaries) the provision of benefits to larger commercial fisheries would most likely require creation of larger MPAs or extensive networks [31,45]. However, fisheries benefits may be unequally shared among groups within and between communities [52,53]. Though MPAs may benefit local fisheries in the long term, in the short term compensation or alternative livelihood options need to be considered since displacement of rights to access the resource can lead to short-term hardships [50,54,55]. Diversification into alternative livelihoods may also reduce overall pressure on fisheries and the resource base [56]. However, care must be taken in assessing the vulnerability of proposed alternative livelihoods to future stressors such as climate change [57,58].

The development of alternative livelihood programs that benefit local people is an often-advertised benefit of MPA creation that is challenging to achieve in practice. The most often suggested alternative livelihood strategy is tourism, in the form of SCUBA diving, snorkeling, boating, wildlife viewing, historical and cultural tourism, eco-voluntourism, and even recreational fishing [14,59–63]. Tourism has significant potential as an MPA financing mechanism [15,64–66] and may lead to economic benefits at a broader scale; however, the level of local community benefit from and involvement in tourism can be minimal. Some MPAs, such as the Great Barrier Reef MPA in Australia [67], Mendes Island MPA in the Mediterranean [68], and Tsitskamma National Park in South Africa [69], have resulted in significant increases in tourism visitation and revenue [51,70]. A global study of 78 coral reef MPAs found that 75% of tourism jobs were retained locally [71]. However, a lack of testing for additionality – i.e., measuring the impact of an activity or intervention through comparison with a status quo metric or reference case – does not ensure that these

benefits are causally related to the MPA and not just mirroring outside changes. For many MPAs, though, the level of local involvement in tourism may be minimal due to outside ownership, centralization and leakage of profits, outside hiring, lack of mechanisms for benefit sharing, and lack of local capacity [16,54,72–75]. If local communities are not benefiting from tourism, it is likely to widen pre-existing inequalities and it may even lead to increased fishing effort.

Though tourism has seen some success as an alternative livelihood strategy, it is debatable whether other alternative livelihood programs or strategies show long-term promise for supporting local communities or marine conservation since benefits are often minimal and connections to markets are problematic [51,73,76,77]. Other potential alternative livelihood strategies include agriculture, raising livestock, aquaculture, mariculture, seaweed farming, beekeeping, handicrafts, tree nurseries, and pearl farming [72,73,77–80]. Tapping into Payments for Ecosystem Services (PES) markets, which provide economic incentives to stakeholders for managing the environment to provide various ecological services, might also provide an incentive for local conservation while providing an alternative livelihood option. Potential markets can include species-based markets [81,82], carbon markets [83,84], bio-prospecting markets [73], biodiversity markets [85], and tourism PES markets [86,87]. MPAs can also contribute to local livelihoods through direct employment in the management of the area; however, this livelihood option is rarely discussed in the literature leading to questions about how often locals are employed in this stead.

MPAs and the aforementioned livelihood strategies can result in mixed outcomes in terms of community social and economic development. MPAs can lead to increased food security, wealth and household assets, and levels of employment (particularly from tourism), diversified livelihoods, improved governance, greater access to health and social infrastructure, revitalized cultural institutions, strengthened community organization, greater participation in natural resource management, increased empowerment of women and reinvigorated common property regimes for local communities [16,40,48,50–52,69,73,74,88–94]. Ecological services, such as coastal protection, may also lead to reduced vulnerability and improved household security. Yet MPAs and related developments can also lead to contrary socio-economic outcomes, including increased conflict and political struggle, exacerbated vulnerabilities, negative socio-cultural change, increased restrictions, decreased levels of power and alienation in natural resource management processes, forced migration, loss of assets, increased social tension, loss of social and educational facilities, inequitable distribution of benefits, further marginalization of marginalized groups, loss of tenure, as well as

decreased food security in the short term and for some groups [10,16,41,43,50,53,54,65,69,72–75,88,89,91,93,95–100]. In short, livelihood and socio-economic outcomes from MPAs vary widely and can range from very positive to very negative depending on the context and inputs.

### 3. Back to inputs: Development, management, and governance

In order for MPAs to be successful over the long-term, both substantive outcomes and procedural inputs need to be taken into account. One shortcoming of much prior research on MPA effectiveness is that outcomes are measured without adequate information about whether or which management actions are being taken. Achieving outcomes requires attention to three categories of inputs: governance, management and local development. Why these three categories? First, they correspond with three complementary but distinct strands of literature on creating effective PAs and MPAs. All three categories are important considerations to ensure the longevity, and thus effectiveness of MPAs [9,101]. Second, governance and local development considerations are often encompassed conceptually under management, which is problematic for several reasons: (a) subsuming governance or development under the auspices of management does not do justice to the full complexity of governance or development processes; (b) different individuals or organizations may be better positioned – in terms of knowledge, skills, and affiliations – to address each category of inputs (e.g., managers may not have the training or skills to support development initiatives); and, (c) governance is an umbrella term which refers to the institutions, structures and processes which determine how and whether management can function effectively to address societal or environmental issues whereas management is the “resources, plans, and actions that are a product of applied governance” [102]. A more in depth discussion of governance is provided in Section 3.2.

Third, there are inherent feedbacks between the three categories of inputs (Fig. 2). The relationship between environmental conservation cum management and local livelihoods and socio-economics is not linear with improvements in one resulting in the other (or vice versa). The interdependency between conservation and local development demands that both are addressed simultaneously while also confronting procedural or governance considerations. Governance institutions and processes, for example, provide a supportive policy environment for effective management and enable the achievement of beneficial development outcomes. Governance, which refers to the individuals who are responsible for creating legislation, policy and institutions, are also

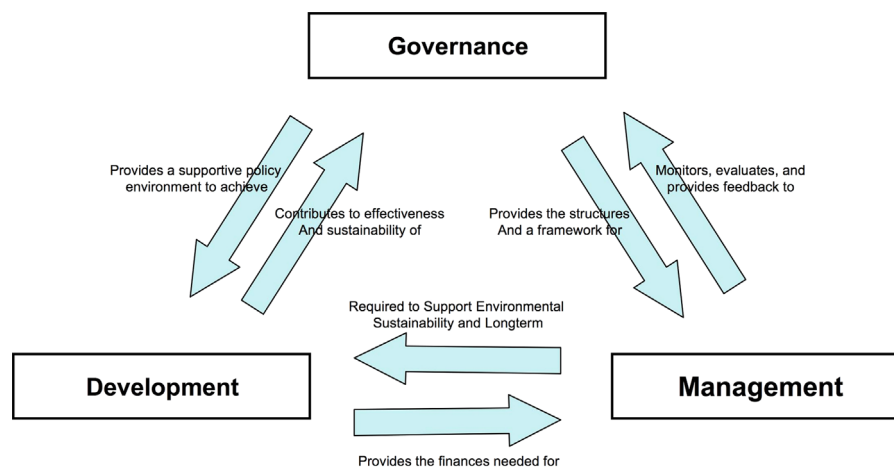


Fig. 2. The interactions between governance, management, and development in achieving beneficial outcomes in MPAs.

responsible for establishing “good” procedures – fair, equitable, participatory, legitimate, transparent, accountable, integrated, adaptable – for development and management. Successful development is important as it provides the finances needed for both governance and management, engenders support for MPA management, and contributes to the effectiveness and sustainability of governance structures. Finally, management is required to support environmental sustainability and thus the long-term viability of MPA related development while also monitoring, evaluating, and providing feedback to governance bodies.

The following section will examine what considerations in each of these three categories of input – governance, management, and development – are likely to contribute to beneficial MPA outcomes. First, it needs to be acknowledged that the success of both conservation and development are influenced by the local and macro social, economic, and ecological contexts within which the MPA operates.

### 3.1. A note on context: Micro to macro considerations

Context is an important determinant of the nature and extent of the outcomes and the success of protected areas throughout the world. No MPA can be disassociated from either the local social, cultural, economic, political, and environmental context or macro level contextual factors, such as history, politics, policies, macro-economics, environmental shocks, climate change, demographic shifts, and technology. These contextual factors, which need to be incorporated into MPA design and management, can be differentiated from inputs in that they may be difficult or even impossible to predict, control, or change. This is particularly true for macro level factors, such as climate change [103].

Though contextual factors at the macro level are less controllable, local level factors can be incorporated directly into development, management, and governance approaches and inputs [10,104]. Micro-level contextual factors that can influence outcomes include assets (i.e., natural, social, financial, physical, political, and human capital), underlying norms and values, pre-existing social and political structures, cultural practices, ecosystem health and population dynamics, resources utilized, and fishing methods or harvesting practices. The underlying assets in a community might be a particularly important focus for designing MPA-related development interventions as assets form the basis of livelihood options and adaptability, the choice of livelihoods, cultural norms, strength of institutions, levels of compliance, and choices of gear/use of destructive gear [91,105]. The localized biology and ecology of an area will also influence the level of fisheries or tourism benefits that are achievable from MPA creation [106]. For example, MPAs that are more isolated tend to produce significantly greater biomass and species benefits [9]. Though a more extensive discussion of the role of context in determining outcomes is beyond the scope of the current paper, the importance of considering context in the design of governance, management, and development inputs for MPAs cannot be overstated. Otherwise, there is a “risk of misfit” to the context resulting in ineffectual or even counter productive actions [107].

MPAs may not be suitable management interventions in all contexts [106,108]. MPAs cannot protect against all threats to the marine environment [109] and may not be effective for protecting all types of fish stocks—for example, highly migratory species [106]. Hargreaves-Allen et al. [71] suggest that MPAs are unlikely to be successful if there are high levels of conflict, numerous uncontrollable external stressors, or alternative forms of development and livelihoods are not possible.

### 3.2. Governance: Institutions, processes, and structures

Governance is the structural, institutional, ideological, and procedural umbrella under which development programs and

management practices operate. Natural resource governance can be defined as “the interactions among structures, processes and traditions that determine how power and responsibilities are exercised, how decisions are taken, and how citizens or other stakeholders have their say” [110]. Governance determines how and whether the *interactions* of structures, processes, and institutions coalesce to solve societal and environmental problems [111,112]. Effective governance requires the design of institutions that are instrumental in “encourag[ing] people to choose to behave in a manner that provides for certain strategic policy outcomes, particularly biodiversity conservation objectives, to be fulfilled” [37,113]. Governance can be evaluated based on whether it effectively supports the achievement of MPA outcomes and also whether it engages with the principles of “good” governance—including legitimacy, transparency, accountability, inclusiveness, fairness, integration, capability, and adaptability [102,110]. The importance of these guiding principles is generally supported by the recent literature on MPA governance, management, and development. The following section will explore three aspects of governance that are required to establish a solid base for management and development and the achievement of beneficial socio-economic and environmental outcomes from MPAs: (1) the creation of an enabling institutional and organizational environment; (2) the process of implementation and design of MPAs; and, (3) the choice of management structures and MPA design (i.e., strict no-take, multiple use, multiple use with no-take zone).

#### 3.2.1. An enabling institutional and organizational environment

The concept of *institutions* often refers to both “soft” and “hard” institutions such as norms, rules, policies, and laws after [114]. Institutions are manifest in formalized organizations (e.g., governmental, non-governmental, and community based organizations) and structures (e.g., co-management and MPA format) and the interactions amongst these bodies. Institutions and organizations can act as drivers, constraints, or supports for effective MPA management and local development depending on the level of institutional linkage, congruence, coordination, and cooperation across scales [73,100,115]. The harmonization of legal frameworks and mandates, policies at various levels, local rules and regulations, cultural norms and individual attitudes is both a challenge and an imperative for enabling effective management and development. As Camargo et al. [116] state when “policy-making is dispersed and ambiguous along regional and national scales [this] generates conflicts or difficulties when executing policy at local levels”. Without harmonized institutions, MPAs can have conflicting and counterproductive results. Such is the case in Thailand, where national legislation contains provisions for participation but ministerial mandates and local managers retain top-down approaches to MPA management leading to community-managerial conflicts and limited benefits [100,117].

Clear legal and policy mandates are required for cross-jurisdictional and governmental agency cooperation and the achievement of desired MPA outcomes [40,73,100,118]. Policies that support effective management and natural-resource dependent livelihoods include clear rules of access and territorial rights, recognition of title/tenure, laws to support enforcement, legal mechanisms to support and guarantee meaningful participation in design and implementation, and clarity of MPA objectives [11,40,54,55,116,118–121]. Congruence is also required between formal regulations, informal rules, and customary norms and practice [120], facilitated by policies that support the incorporation of local management systems and rules into MPA management and regulations [122,123]. Local norms that support conservation and restraint in resource harvesting may provide



the most valuable platform for the sustainable management of common pool resources such as MPAs [120,124,125].

Successful alternative development schemes also rely on enabling institutional and policy environments. The use of market mechanisms such as PES, for example, requires clarity of land tenure, ability to legally enter contracts, local rights to the resource, and legal frameworks that support market mechanisms [126]. Lack of these enabling policies may prevent the successful use of PES in areas with state control. PES programs also require local support and willingness to participate [86,126]. Benefits from tourism may also require negotiation of local access rights, policies that ensure benefits are accrued locally, and policies that do not undermine local land ownership [54,75,97]. Macro level normative and policy support for sustainable local development in MPA communities is needed both in national governments and in international conservation organizations [72,100,127].

The level and quality of interactions between governmental, non-governmental, scientific, private sector, and community-based organizations both vertically and horizontally also influences the effectiveness of management and development programs [94,115]. Vertical interactions refers to interactions between individuals and groups at higher and lower organizational levels and spatial scales while horizontal interactions refers to interactions between groups at the same organizational level or spatial scale [128]. As Prasertchaoensuk et al. [100] write: “[when] there is a lack of co-ordination, co-operation and integration between the various organizations and agencies related either directly or indirectly to the management of marine and coastal resources and biodiversity, [this] leads to, at best, inefficient and incoherent, and, at worst, conflicting and counterproductive implementation at the local level”. Cooperation, coordination, and consolidation of roles is required within and between governmental agencies, NGOs, geographical communities, and various user groups, since all of these organizations have important roles to play in MPAs see, for example, [95]. Cooperation at various scales is increasingly recognized as a means to ensure the success of tourism as it may result in increases in the breadth of the decision making base, reduction of conflicts, and pursuit of shared goals [111]. Collectives of regional and international NGOs can be effective at supporting both conservation and development as partnerships can result in increased coordination of on-the-ground actions [127]. Linkages to decision-making bodies at local, regional, and national levels influence a community’s ability to adapt to change and to self organize for management or development purposes [122]. Having links with an outside organization that plays an “honest broker”, such as an NGO or university, may also help in mediating differences between and within communities [129]. National level grassroots organizations, such as Pamana in the Philippines [130], may be perceived as the most legitimate outside organization and as a result might be in the best position to support community outcomes in MPAs, through networking at various scales, advocating for communities nationally and internationally, and empowering communities through on-the-ground actions. Lastly, levels of social capital – a term which refers to trustful, cooperative and reciprocal relationships within and between groups [130] – may be an important indicator of the quality of collaborative interactions [120]. Various authors, for example, emphasize the importance of having forums and networking opportunities for creating trust, building relationships, facilitating communication and co-learning, and creating greater awareness and knowledge amongst partners [116,122,131,132]. Social capital is also facilitated by development of shared norms and understandings through effective information sharing between the regional and local level, which requires institutional capacity and consistent and varied forms of engagement between community groups, NGOs, and various levels of government [133].

### 3.2.2. *The MPA implementation and design process*

A key factor that influences the success of MPAs is the initial design and implementation process since this is a time when local support can be gained or lost [10,11]. Three main themes cut across the literature on MPA implementation and design. First, the establishment of support requires attention to the initial entry into communities to establish trust and build relationships [79,94,121]. Environmental education on ecosystem functioning and ecology, the impacts of human activity and how to mitigate the negative impacts of these activities, and the rationale behind MPAs should be done prior to MPA consultations if this knowledge is not already present [119]. Often there is a lack of local understanding of the definition and implications of MPAs [134]; however, it is also important not to create overzealous expectations for MPA outcomes as these can be detrimental to later support [135]. The linking of communities with other communities and outside organizations at this stage allows for the sharing of knowledge, experiences, resources, and responsibility and creation of social networks and alliances in support of the MPA [136].

Two other central themes emerging from the literature are the importance of broader participation and stakeholder engagement and the incorporation of social, economic, environmental, and institutional contextual factors into MPA design, management, and local development. As Charles and Wilson [11] urge, the consultation of relevant stakeholders should be done at all stages of MPA design, implementation, and in ongoing management: “involvement builds the confidence of people to manage their own resources and encourages results that are long lasting” [94]. Although this is well recognized in MPA design practice, it is rare that stakeholders are involved at the earliest stages of establishment of MPA performance expectations [137]. The rationale behind participation is that it encourages information exchange, encourages collaboration, builds confidence and empowerment in community groups, increases management effectiveness, and facilitates the development of mutually acceptable solutions [11,101,116,138]. Early and meaningful participation may also reduce conflict among user groups and thus long term enforcement costs [139,140]. One important rationale for initial participation is the development of clear objectives for the MPA [11,140]. Murray [141] suggests that full participation is required to identify and address the full range of divergent and overlapping objectives in MPA creation [142], which may be able to be reconciled through the creation of multiple use MPAs [24]. In order for participation to be effective, there is a need to recognize the heterogeneity of communities and stakeholder groups, recognize the potential impacts of institutions and entitlements on the ability of certain groups to participate, consider potential equity issues and asymmetries, and incorporate marginalized groups [121].

Effective mechanisms for participation may also lead to a more complete understanding and incorporation of the social, economic, cultural, political, and environmental context within which the MPA is going to operate. MPAs must be “adapted to the exigencies of local situations, recognizing that each location has its unique social, cultural, and ecological contexts that influence the trajectory of MPA implementation and impact” [10]. Traditional knowledge and management mechanisms (such as species taboos, gear restrictions, and closures), customary tenure, local norms and rules of use, and traditional and current resource use patterns should be incorporated into MPA design and implementation [40,45,53,73,79,143–145] when it is determined that they are effective and sustainable [140,146]. Through incorporation of these factors, MPAs can result in the strengthening and reinvigoration of traditional mechanisms and cultures [132]. However, these considerations should also be combined with broader contextual considerations stemming from the proactive use of social, economic, political, and natural scientific methods, tools, and approaches to

design MPAs [11,147–149]. For example, Aswani and Lauer [150] show how MPA networks can be designed using a combination of anthropological and natural scientific methods to merge traditional knowledge and use patterns in GIS. Ban et al. [151] compare the use of Marxan planning software with a community-based approach to MPA planning on the west coast of Canada showing that both methods produced similar results. Moreover, careful site selection based on a variety of social considerations and ecological factors “might be the most important things that MPA managers can do” [152].

### 3.2.3. *Choice of management structure and MPA design*

Two formal structures that are the most directly impacted by the interaction between institutions and context are the management structure adopted and the MPA design. Structures for the management of MPAs can be visualized as top-down (i.e., centralized management), bottom-up (i.e., community-managed or common property regimes), or cooperatively managed (i.e., community-based, co-management) which lie on the continuum between the two extremes. Every management approach comes with potential risks and benefits; however, co-management is broadly viewed as the most effective and acceptable approach [73,122,139,140,153]. Though a top-down approach may be suitable where there is no resident population, centralized management has often been criticized for alienating local people, increasing local conflict, resulting in limited levels of local benefit, and even resulting in failure [73,96,100,118,139]: “The unpopularity of the top-down regime [lies] in its failure to respect local sensibilities” [88]. Though a bottom up approach may be more acceptable than top-down approaches see [120], this approach may also have issues with corruption and changes in the local government may result in MPA failure [88,154]. Furthermore, unless specific capacity building efforts are implemented, bottom-up approaches may lack the expertise to undertake the ecological monitoring to determine whether the ultimate purpose of MPAs, biodiversity conservation, is being achieved.

Co-management is the “sharing of power and responsibility between governments and communities” [155], which brings the strengths, knowledge, powers and resources of both parties together. The attributes of co-management include the incorporation of traditional and scientific knowledge into management, the pivotal role played by local stakeholders leading to increased empowerment for local communities and reduced enforcement costs, and the creation of partnerships across organizations at various scales which helps to mitigate against local and macro level uncertainties [89,111]. Legitimacy and support are gained through the sharing of power and participation [107]. Yet co-management also faces challenges related to increased bureaucracy, funding uncertainty, time commitments, local capacity and willingness to participate, and achievement of an appropriate balance of governmental and community input and control [120,139,155]. McConney and Pena [156] recommend that attention is paid to building and supporting the capacity for co-management. Co-management could be seen as a critical response to the failures of the top-down regime. Yet Singleton [121] notes the potential irony of the current focus on creating systems of co-management when she comments: “It would be unfortunate if the search for an alternative to one-size-fits-all, top-down regulatory styles resulted in rigidly proscribed processes of incorporating diverse actors into MPA processes—a sort of new orthodoxy of collaborative practice”. Institutional diversity and a mixture of top-down, bottom-up, and community-based incentive approaches, Jones et al. [37] suggest, are the most effective approach to MPA governance and the level of co-management should be designed to fit the socio-political context.

Where communities are involved there is also a general convergence around the creation of multiple-use MPAs that incorporate a no-take zone [24,94,96,157]. Since the creation of strict no-take MPAs is often met with opposition by affected fishers, Perera and de Vos [149] suggest that high levels of resource dependency in the developing world may make the creation of exclusive reserves untenable. However, no-take zones may be a necessary part of providing the full extent of ecological and socio-economic benefits to the individuals whose livelihoods depends on the quality of the natural base [5]. In order to achieve the most benefit for different user groups and to reduce conflict, the creation of zones for different user groups may also be required [4,68,158]. In spite of the general convergence around co-management and multiple-use MPAs containing no-take areas, there are scenarios where other formats such as privately owned and managed reserves or Entrepreneurial MPAs [90] or marine extractive reserves [96] may produce the most successful outcomes for both conservation and communities within a particular context.

### 3.3. *Development: Alternative livelihoods and programs*

Consideration needs to be given to mitigating the social impacts of MPAs through enhancement and diversification of livelihoods [18,32,72,105]. This section explores the processes and inputs required to achieve more successful livelihood interventions.

#### 3.3.1. *Alternative livelihoods: Enhancement and diversification*

Livelihood enhancement and diversification may stem pressure on natural resources and support conservation objectives while decreasing local poverty and vulnerabilities [56,159]. Enhancement of current livelihoods can refer to improving the efficiency and effectiveness of current practice through reducing waste, reducing the destructiveness of fishing and harvesting practice, and/or moving products up the value chain through processing, packaging and improved marketing [17,77]. Livelihood diversification refers to expansion or alteration of individual or household livelihood portfolios and strategies through engaging in new or novel livelihood practices, and shifting fishing and harvesting to other areas or to a wider variety of species often using different practices. This latter category might include, for example, long lining for pelagic species using lights or using fish aggregating devices to fish for tuna [76,91]. The former category of livelihood diversification, which represents the majority of the literature focusing on alternative livelihoods, can include tourism, agriculture, raising livestock, aquaculture, mariculture, seaweed farming, beekeeping, handicrafts, tree nurseries, pearl farming, and capturing PES markets.

Some authors argue that the achievement of either beneficial socio-economic or conservation outcomes through livelihood enhancement, diversification, and/or the provision of livelihood alternatives has been elusive [20,73,77]. Torell et al. [77] suggest that the development of alternatives may be more likely to fail than enhancing current practice. Alternative livelihood programs may fail to deliver expected or desired outcomes due to a number of factors including lack of linkage between development and conservation [77,127], local capacity barriers [76,160], unaccounted for values related to traditional livelihoods [86,161,162], and economic factors such as shifting input costs and access to markets [51,73,82]. Successful development of livelihood alternatives may also simply encourage in-migration [163] or lead to the re-investment of newfound income in fishing [76,164] which will both lead to increasing pressure on local resources. Most authors concur that focusing on a portfolio of substitutable and interchangeable resource-based and non-resource-based livelihoods is

more effective than using any single strategy [35,77,86,93,126,127]. A focus on any single livelihood strategy may exert unsustainable pressure on specific facets of the environment while also increasing local vulnerability [56,122]. Two additional topics pertinent to achieving beneficial development outcomes deserve further attention: (1) the factors that tend to lead to successful alternative livelihood programs, and (2) the need for management of development to ensure long-term viability of livelihoods. The second point will be discussed in the following section on management.

### 3.3.2. *Successful development programs: Process and requirements*

Specific inputs are required for each type of development intervention (i.e., tourism, aquaculture, PES, etc.). A discussion of each livelihood is beyond the scope of the current paper; however, this review revealed a number of themes regarding the achievement of successful outcomes from various development interventions. First, the literature addresses how development needs to adopt participatory, adaptive, and equitable processes. Rarely are livelihoods initiatives imposed by organizations from the outside sustained over the long term. As an antidote to top-down development, participatory development processes may be more likely to lead to successful outcomes through facilitating co-learning and consensus-building, empowerment, and local mobilization [11,76,96,104,127]. Simple processes, such as Participatory Rural Appraisal [165] or the Sustainable Livelihood Enhancement and Diversification (SLED) approach [159], can be used to facilitate participation in development. Development should also adopt an adaptive process of monitoring, feedback, and learning [35,111]. Adaptive learning also needs to be integrated into MPA-related conservation and development discourse and practice at a broader scale so that failed initiatives are not repeated and successes are recognized. Conservation and development programs should address the needs of potentially marginalized groups. Incorporating gender considerations, for example, into design of development programs and women's resource use patterns into MPA design can lead to greater benefits for households and the larger community [53,78,93].

Participatory processes can also lead to an improved understanding of the context from the perspective of local people which can be incorporated into the design of locally grounded and appropriate solutions [104,126,166]. Pre-assessments are important since assumptions about context can result in unsuccessful programs of action [167]. It is important to understand how micro to macro level contextual factors, such as access to markets, local capabilities, policy environments, levels of social cohesion, leadership capacity, and cultural norms, influence current marine uses and how these may facilitate or impede alternative livelihood development [35,75,161,168].

Third, authors suggest that development of alternative livelihoods often requires attention to building local capabilities through increasing financial and human capital, as well as physical assets (e.g., fishing gear, boats, basic and tourism infrastructure). Ongoing programs of education and capacity building are necessary for resource users to nurture occupational flexibility and acquire the skills necessary to engage in new livelihoods [17,122,160,169,170]. Independent of the type of development, authors emphasize that particular attention needs to be given to entrepreneurship, business management, and marketing [76,77,159,160,162]. Much attention is also given to the need for short-term seed money and/or longer term financing for supporting alternative livelihood developments. Outside financing can sometimes be obtained for the start-up phase of a development project. However, Torell et al. [77] posit that in the long run grants are counterproductive to sustainability. Authors often suggest that money from PES markets [82,126], lease money from entrepreneurial MPAs [171], trust funds [73,172], user fees

[65,66], and micro-credit schemes [91] should be funneled towards alternative livelihood development, scholarships, tourism infrastructure, or health and social infrastructure (not just towards MPA management as is often argued). Cinner [167] makes a case that procuring funding is essential to help fishers break out of the poverty trap that necessitates their use of destructive fishing gear. Micro-credit schemes may show the most promise for empowering individuals and encouraging community ownership of development [76,77].

Finally, the creation of an enabling institutional and organizational environment can facilitate the implementation of alternative livelihood programs that maximize local benefits. Policies that safeguard access and that recognize tenure can be key to ensuring that local communities benefit from tourism, that community property is not sold to outside interests, and that conflict is minimized with outside interests [11,54,75,98]. Development policies that restrict the scale and type of developments can also ensure that development is kept within ecologically and socially sustainable limits [127]. Mechanisms to ensure that benefits are shared equitably and that leakage of financial and employment benefits is minimized need to be put into place [69,74,75,89,153,173,174]. A wide variety of organizations at various scales can have important roles to play in ensuring that development programs are successful [73,111]—including international NGOs acting as intermediaries in PES projects [126], businesses identifying development opportunities [76], and community and user associations advocating for local people [55]. Productive relationships with private sector partners – for example, through the development of private-sector developed 'Entrepreneurial MPAs' [171,175]—may also benefit local communities through the payment of coral reef leases by hotels or diving companies for diving in trade for exclusion of fishers' withdrawal and access rights and patrolling services see also [180].

## 3.4. *Management: Strategies and requirements*

The effective management of MPAs is of critical importance for achieving desirable environmental outcomes, for ensuring local support, and for the long-term viability of livelihoods. Without effective management many MPAs are just 'paper' parks that have no real purpose for existence other than perhaps to protect them from highly extractive industries [176]. Managing natural resources is largely about managing human interactions with the natural environment but it is also about responding to broader changes in the human and natural environment. MPA managers use site specific strategies to manage human actions, incursions, and developments at the local scale and mitigate against changes at the macro scale. The effectiveness of management is influenced by availability of resources, legislative and public support, levels of cross-scale coordination and cooperation, and a number of other governance considerations. These topics are explored in the following section.

### 3.4.1. *Management strategies*

As discussed previously, both traditional resource-based and alternative forms of development can have negative impacts on the environment. Since the long term success of local MPA-related livelihoods, such as fishing and tourism, often relies on the health and productivity of the local environment there is a need for ongoing management of development: "Sustainable use approaches are predicated on the concept that the living resources of an MPA replenish themselves naturally and can be exploited within limits" [24]. For example, not managing tourism may threaten the longevity of the benefits that MPAs can provide [61,177,178]. Management of tourism includes establishing and adhering to a local carrying capacity, limiting levels of development, establishing



standards for development, creating zones for tourism, and implementing management strategies to ensure recreational impacts are avoided—i.e., from trampling, anchoring, and diving [14,16,54,178]. Limiting recreational impacts may include strategies such as educating tourists and experience providers, installing mooring buoys, rotating dive sites, spacing out divers, monitoring divers, and establishing and enforcing regulations [16,42,74,179]. Management strategies for mitigating the impacts of tourism on local communities should also be considered. Similarly, if aquaculture is deemed an acceptable MPA use, management strategies may include establishing a suitable carrying capacity, raising mainly herbivorous species, and developing sustainable aquaculture [80].

The management of fishing, harvesting, and other resource extraction activities, such as coral mining, both inside MPAs and in the broader seascape outside MPAs is also necessary. Required management actions might include reducing levels of extraction, establishing extractive and no-take zones, shifting the focus of fishing effort, reducing destructive gear use and destructive fishing practice, controlling outside access, and effectively enforcing regulations [48,73,96,139,180]. Effective enforcement of regulations is broadly recognized as an essential aspect of any form of open or limited access pool of resources [124,155], including marine protected areas [181]. Roberts [182] argues that MPAs are effective tools for fisheries management but that “Benefits can be quickly dissipated by targeted fishing. Therefore, high levels of protection and resolute enforcement will produce the greatest benefits.” According to Samonte et al. [89] the enforcement chain includes five important steps – surveillance and detection, interception and arrest, prosecution, and sanctions – and “it is only as strong as the weakest link”. A contextually tailored and seamless program of monitoring, control and surveillance (MCS) that incorporates a variety of measures is indispensable to any program of enforcement [183,184]. Sanctions can include the confiscation of illegal gear [105] but these sorts of actions need to be legally supported [149]. Enforcement of regulations needs to be done in a consistent and fair manner to be perceived as legitimate [91,100,185]. The rapid onset of enforcement of regulations at the inception of an MPA might increase resistance and non-compliance so enforcement might be implemented gradually or at later stages in MPA management [186]. Pro-active actions, such as clearly delineating boundaries, are also important ways to encourage compliance [187].

Education and awareness raising programs about rules, regulations, boundaries, management objectives, MPA effects, resource quality, the role of humans in impacting and improving resource quality, and even the existence of the MPA may be “softer” ways of gaining support, reducing destructive activities, and increasing compliance [6,17,90,116,122,153,169,188]. Often there is little local awareness of MPAs and without effective communication strategies, illegal fishing practices or “poaching” inside MPA boundaries may continue unabated [139,158]. To effectively disseminate information in many contexts, communication and education campaigns may need to incorporate both formal and creative mechanisms such as door-to-door visits, posters, workshops, and radio campaigns [139].

Finally, the proactive and ongoing management of conflict between different and often competing forms of development and user groups is also necessary. Conflicts are often present, for example, between fishers and the tourism industry [54,97,134]. These conflicts may be overcome through education of divers about local peoples and respect for fishing gear [180], application of zoning to provide specific areas for fishers and tourists [88], and/or provisions recognizing local access and use rights. Formal and informal processes for promptly resolving persistent inter and intra-group conflicts also need to be incorporated into MPA management [40,134,189].

In brief, the management strategies discussed previously include the following: (a) implementing a carrying capacity and establishing standards for disparate forms of development, (b) establishing conflict resolution strategies and zoning for multiple uses, (c) increasing knowledge and awareness through education and communication campaigns, (d) broader management of fishing, harvesting, and extraction activities, and (e) effectively enforcing rules and regulations. Site specific management actions are also required for controlling specific human impacts and livelihood activities and for adapting to the impacts of broader environmental changes.

### 3.4.2. Management processes and requirements

Also consistent with the literature on good governance and development processes, writings on MPA management emphasize the importance of adopting integrated or nested, integrative, adaptive, transparent, and participatory management processes. To be effective in achieving their potential, MPAs should not be “islands of protection” but *nested* within Integrated Coastal Zone Management (ICZM) or Ecosystem-Based Management (EBM) regimes [4,11,190–192] and/or broader networks of MPAs [51,143,193]. Both ICZM and EBM imply the incorporation of social, economic, cultural, political, and environmental considerations or values at the level of the broader land and seascape into management. For example, coral reef MPAs might be more resilient to the impacts of climate change when combined with the reduction of sedimentation and nutrient loading and land-based and marine sources of pollution [34]. Networks can improve dispersal and connectivity between MPAs as well as spreading risks through replication of habitats and ecosystems [194,195]. Horigue et al. [136] also notes that “scaling up MPAs to form networks is a means to improve management of individual MPAs, and coordinate MPA establishment through collective action and sharing of information and experiences”. Additionally, MPAs can be more effective in supporting fisheries if they are nested within a suite of fisheries management actions outside the boundaries of the MPA [45,48,73,196,197].

Active implementation of *adaptive* management – that is a deliberate cycle of monitoring, evaluation, analysis, planning, and implementation – can serve to continually correct the course of MPA management strategies [24,101,122,198]. Adaptive management reflects a shift away from a linear view of the world and recognizes that MPAs are part of a dynamic, non-linear, and complex system [199]. *Integrative* research stemming from various social and natural science methods and tools in combination with local and traditional knowledge should also inform both broader integration and adaptive management frameworks [40,45,53,73,79,122,143,144]. Drew [200], for example, reviews various examples of how folk taxonomy and systematics and local knowledge of populations and ecological relationships can be used to augment western science in MPA management.

Finally, there is widespread consensus that meaningful *participation* in decision-making and inclusion of relevant stakeholders are a necessary pre-cursor to effective management [94,122]. Participation offers an opportunity for information exchange, increases accountability and collaboration among stakeholders, leads to the development of mutually acceptable solutions and regulations, reduces feelings of alienation, and increases *transparency* [11,88,121,149,201]. Rosendo et al. [201] suggest that participation in management will help to develop a sense of ownership and support, which ultimately may improve compliance. However, as Heck et al. [202] report not all stakeholders will wish to participate in management decisions at all stages of the MPA design and management process.



Effective management requires support in the form of an enabling policy and organizational environment. A secure source of finances and governmental and local capacity are also required to buttress management processes and strategies ranging from participation to enforcement. Given that the “lack of income has been identified as a primary reason for [management] failure” [203], the development of cost effective management structures and sustainable financing mechanisms is of great import for MPA sustainability. Initial funding for MPA establishment can sometimes be secured through loans from multi-lateral development banks, grants and donations from a variety of public, civil and private sector organizations, debt-for-nature swaps, and government sources [204]. This funding is often short term. Potential sustainable solutions for financing management include PES markets, user fees from tourism, environmental trust funds, and private sector solutions such as hotel-managed marine reserves [15,73,90,174,205]. Finally, individual leadership is an important ingredient in the success of MPA management [206].

#### 4. Discussion

In theory, MPAs can have a broad array of ecological and socio-economic benefits. In practice, the creation of no-take MPAs or zones in multiple use MPAs has been shown to result in beneficial ecological outcomes. Yet, the percentage of the planet's ocean (recent estimates range from ~1% to 3.2% [207–209]) and Exclusive Economic Zones (~2.86–7.4% [210,211]) that are protected is still quite low and an even smaller percentage of these are designated as no take areas. As noted previously even fewer of these areas may be managed effectively and thus producing the desired ecological results. Furthermore, the relationship between MPAs and local communities is often problematic which is a concern since perceptions of benefit may be a precursor of support and ultimately success. Impact studies have shown that MPAs have often led to quite divergent livelihood and socio-economic outcomes for local communities.

The conceptualization of inputs offered in this paper is a continuation of discussions about what is required to achieve

successful outcomes from PAs and MPAs [101,102,159,212–217]. This review suggests that the success of MPAs in achieving desired ecological and socio-economic outcomes locally is determined largely by managers' abilities to determine and provide the necessary governance, management, and local development inputs required by micro to macro level contextual factors (Fig. 3). Provision of the inputs required to create effective MPAs is also essential because lack of attention to processes or outcomes may result in the downgrading, downsizing or degazettement of protected areas that are not deemed effective, legitimate or equitable [218]. This is a dangerous outcome for further creation or improvement of MPAs in different national contexts and for achieving MPA conservation targets set out under the CBD. Long-term thinking is required since older MPAs are more ecologically effective and more supported by local communities. There are a number of themes that were consistent across the literature on creating effective MPAs that are summarized below.

For governance, the literature focuses on the importance of having clear, enabling, and harmonized institutions (i.e., laws, policies, and norms), of creating cooperative and coordinated networks of organizations, and of having implementation processes that are participatory, contextualized, and that focus on building relationships of trust. There is also general convergence around the adoption of co-management, as an alternative to top-down and bottom-up management regimes, and the creation of multiple use MPAs with a no-take zone. However, MPA management regimes and designs need to be tailored to each social, economic, political and ecological context. The various aspects of good governance – legitimacy, transparency, accountability, inclusiveness, fairness, integration, capability, and adaptability – can also be found throughout the literature on management and development.

Previous research on development emphasizes the importance of both enhancing and diversifying livelihoods to include a mixture of natural resource-based and non-natural resource-based livelihoods and of having participatory, contextualized, adaptive, and equitable development programs. These literatures also emphasize the importance of capacity building—focusing on human, social, physical, and financial capital. In terms of financial

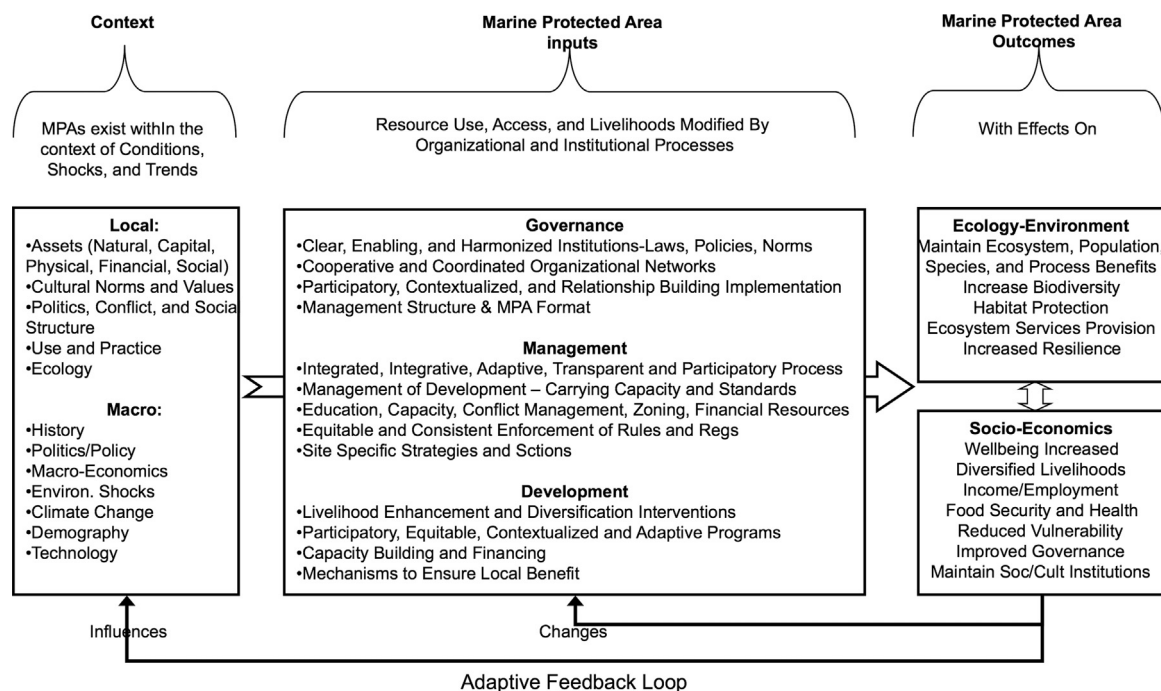


Fig. 3. Marine protected areas from inputs to outcomes as mediated by context.

**Table 1**  
Framework for analyzing marine protected area inputs.

Indicator	Corresponding question	Rating and discussion
<b>Governance category</b>		
Clear and enabling policies and norms	Are laws, policies and local norms clear, enabling and consistent?	
Clear targets and actions	Are conservation targets clearly identified and actions being taken to achieve them?	
Planning process	Is there a clearly articulated MPA planning process?	
Fit to social and ecological context	Is the MPA type and format chosen contextualized to fit the ecological and social context?	
Appropriate co-management	Are collaborative management arrangements contextually appropriate, inclusive, efficacious, equitable and representative?	
Integrated in broader scale management	Is the MPA integrated within a broader scale system of management (e.g., EBM, ICZM)?	
MPA network	Is the MPA part of a representative and connected network of MPAs?	
Participation and relationships	Was the MPA implemented in a manner that was participatory and encouraged trust and relationship building?	
Transparency	Are decisions made in a transparent manner?	
Legitimacy of governors	Are MPA managers appointed in a manner that is deemed legitimate by stakeholders?	
Accountability	Are governors and managers held accountable for their actions?	
Coordinated organizational network	Is there a cooperative and coordinated network of organizations supporting the MPA?	
Incorporates local governance	Are local and informal governance systems incorporated into management structures and processes?	
Adequate capacity for participation	Is adequate human and financial capacity provided to facilitate participatory processes?	
Mechanisms to adapt governance	Are there institutionalized mechanisms to monitor and adapt governance institutions, structures and processes?	
Social capital	Are there forums and networking opportunities for building relationships and sharing learning?	
Tenure and rights	Are rights and land tenure arrangements clearly articulated?	
<b>Management category</b>		
Management plan	Is there a complete and accessible management plan that states MPA objectives and specific measures to achieve them?	
Financial resources	Are there adequate financial resources to support management?	
Site specific management strategies	Are there site specific management strategies being taken to mitigate against and adapt to threats within and around the MPA?	
Marked Boundaries	Are the boundaries of the MPA marked and accepted by local stakeholders?	
Multiple use zones	Have zones for different uses been established and marked?	
No take areas	Are “no-take” areas an integral part of the MPA and adequate to achieve conservation targets?	
Outreach and education	Is there an effective program of outreach, education and awareness building?	
Communications	Is there a communications strategy?	
Clear rules and regulations	Are rules and regulations clearly defined and communicated?	
Graduated sanctions	Is there a system of graduated sanctions that are legally supported?	
Enforcement	Are rules and regulations equitably and consistently enforced?	
Conflict resolution	Is there a process for resolving conflicts?	
Management capacity	Is there sufficient capacity – people and equipment – to carry out management?	
Capacity building	Is there a program of capacity building for staff?	
Monitoring and evaluation	Is there a program for monitoring ecological outcomes and evaluating management actions?	
Adaptive management	Is there baseline ecological data?	
Knowledge and information	Is there a means to adapt management based on new information and changing conditions?	
Diverse knowledges	Is there sufficient knowledge of the ecology of the area and of the species or habitats that the MPA aims to protect?	
Standards and carrying capacity	Are scientific and local/traditional knowledge integrated into management?	
Monitoring and surveillance	Is park-related use and development being managed through establishing standards and carrying capacity?	
External threats	Is there an adequate program of monitoring and surveillance?	
Incentives	Do managers work with stakeholders outside the MPA to ensure that external threats are minimized?	
Cultural and historical values	Are there appropriate and effective incentives in place to increase local compliance?	
Visitor facilities and services	Are there systems in place to articulate and safeguard cultural and historical features, resources and values?	
<b>Local development category</b>		
Mechanisms to ensure local benefit	Are there adequate facilities and services for visitors?	
Contextualized interventions	Are there mechanisms to ensure benefits of conservation accrue to local people?	
Equitable benefits	Do development interventions consider the social and cultural context?	
Financing	Are there mechanisms to ensure equitable outcomes for disenfranchised groups?	
Capacity building	Is there a means to finance alternative livelihood programs?	
Livelihood infrastructure	Is there a program of capacity building to develop the skills of local people?	
Participation	Is there sufficient infrastructure to support existing and alternative livelihood options?	
Adaptive development	Is the process of development participatory?	
Development professionals and partnerships	Is there a means to adapt the development program based on experience and outcomes?	
Monitoring and evaluation of development	Do conservation organizations include dedicated community development professionals or maintain partnerships with development organizations?	
Enhanced and diversified livelihoods	Is there a program for monitoring socio-economic outcomes and evaluating local development programs?	
Connected to markets	Are livelihoods being enhanced and diversified to include both natural resource-based and non resource-based livelihoods?	
Long-term commitment	Are alternative livelihood programs connected to viable markets?	
Leadership	Is there a long-term commitment to partnering on developing alternative livelihoods?	
	Is there an individual or group that is taking the lead in advocating for local development?	

capital, initial seed funding or ongoing financing through trust funds or micro-loan programs may be particularly helpful. It is also important to ensure that there are mechanisms that ensure local benefit from development through limiting leakage and outside employment.

In addition to having site specific management strategies and actions, the literature on management highlights the importance of having processes that integrate design and management broadly into the landscape, are integrative of scientific and local knowledge, adopt adaptive monitoring and feedback mechanisms, and are participatory and transparent. Ongoing management of MPA-related development is emphasized, particularly the establishment of standards and carrying capacity, as well as the consistent enforcement of regulations. Finally, education and awareness building programs, capacity building, conflict management, zonation, and financial resources are all emphasized as being significant contributors to the success of MPAs.

Through this review of the literature, the authors developed a list of inputs that are likely to contribute to successful MPA outcomes and incorporated these into a framework (Table 1). The proposed framework consists of a series of questions that correspond with indicators for governance, management and local development inputs. The potential utility of the inputs framework is threefold. First, it might provide governors and managers with a list of best practices or recommendations to lay the groundwork for creating more successful MPAs. Governors and managers could refer to the framework during the design and implementation phases of individual sites or entire systems of MPAs.

Second, it could serve as a monitoring and evaluation tool for examining whether, and to what extent, the recommended inputs require attention in individual sites or in entire systems of MPAs. Using either a semi-structured interview questionnaire, a series of triangulated qualitative interviews, or focus-group discussions with stakeholders representing different groups (e.g., government, natural and social scientists, NGOs, community representatives, fishers), each indicator in the framework might be explored in a qualitative manner or assigned a quantitative value. For a quantitative approach, the authors suggest using a similar rating method to that used by Timko and Satterfield [219]. Indicators might be rated on a scale from 0 to 4, where 0=very unsatisfactory, 1=unsatisfactory, 2=neutral, 3=satisfactory, and 4=very satisfactory based on individual interviews with various stakeholder groups. Mean scores could be calculated for each indicator as well as for each group to show which factors needed to be addressed. One of the benefits of this approach is that it would allow for comparisons among different sites, among different systems of MPAs or among different stakeholder groups' perceptions on each indicator. Repeated quantitative application of the framework would also allow changes to be easily tracked over time. Some indicators may not be applicable or not appropriate (n/a) in a particular context and could be excluded.

Third, the framework might be used to advocate for improved MPA practice by taking a scorecard approach—for example, through calculating likelihood of success scores. An overall score for each category – i.e., governance, management, local development – for an MPA could be calculated using the formula below.

Category score =

$$\frac{\text{Sum of indicator scores for category}}{\text{Total possible score for category (number of indicators used} \times 4)} \times 100 \quad (1)$$

This formula will calculate a percentage (%) out of 100 for each category—which might be assigned values as follows: 0–25%=very unlikely to succeed; 25–50%=unlikely to succeed; 50–75%=likely to succeed; 75–100%=highly likely to succeed. All three

categories might also be summed and divided by 3 for an overall score out of 100. For a more nuanced understanding, these somewhat crude metrics and scores should be supplemented with qualitative data from the interviews, focus groups or document reviews.

Whether the framework is used as a list or recommendations, a tool for monitoring and evaluation or as a scorecard, ultimately the goal of using the framework is to improve MPA ecological and socio-economic outcomes through adapting and improving governance, management and local development inputs. To be useful, results and methods need to be communicated in a transparent and accessible fashion. There are several limitations to the type of framework proposed here. First, no list of indicators is ever complete and, as such, a framework such as this should be seen as a living document. Second, all indicators are not applicable to all contexts. Unfortunately, there is no “magic bullet” formula that can be applied to achieve beneficial socio-economic and ecological outcomes for all MPAs. Third, measuring inputs is not a replacement for monitoring ecological and socio-economic outcome variables. Ideally, measuring inputs and outcome variables should be done in tandem as part of a long-term interdisciplinary program of monitoring and evaluation. This would allow researchers to understand better which inputs lead most effectively to desired outcomes in a variety of contexts. Fourth, calculating scores as suggested above and using this to assess likelihood assumes that all indicators have the same value, clearly an untenable proposition, given the emphasis that this review has placed on the importance of context-specific analyses. Thus, the scores should be treated with caution. Finally, this particular framework is likely more relevant to MPAs in a Low Development Country (LDC) context; however, the lessons explored and recommendations made herein also have implications for MPA creation and management in developing and developed countries.

## 5. Conclusion

MPAs have the potential to produce beneficial ecological and socio-economic outcomes. This review has identified a number of inputs that can contribute to the achievement of beneficial ecological and socio-economic outcomes from MPAs. In the real world, of course, it is challenging to reconcile the complexity and heterogeneity of real world MPA biophysical and community contexts and the uncontrollability and uncertainty of macro level factors. Our collective understanding of what combination of factors will ultimately lead to successful outcomes in the multiple contexts within which MPAs operate is still limited. However, a renewed focus on analyzing and providing place-specific governance, management and development inputs will likely lead to more ecologically productive and socio-economically beneficial MPAs. The framework presented in this paper is a step in that direction.

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