Governing marine protected areas: social-ecological resilience through institutional diversity

P.J.S. Jones[1*], W. Qiu[1], E.M. De Santo[2]

[1] Department of Geography, University College London, UK.

[2] Marine Affairs Program, Dalhousie University, Halifax NS, Canada.

[*] Correspondence to: P.J.Jones@ucl.ac.uk

Synthesis paper for a special issue of Marine Policy: *Governing marine protected areas: towards social-ecological resilience through institutional diversity*. Editors – De Santo EM, Jones PJS, Qiu W and Clifton J (based on MPA Governance project www.mpag.info)

Abstract

Marine protected areas (MPAs) worldwide are facing increasing driving forces, which represent a major and increasing challenge for MPA governance. The Marine Protected Area Governance (MPAG) project examined a range of different incentives – economic, interpretative, knowledge, legal and participative – employed to address the driving forces and promote effectiveness in 20 case studies across the globe. This paper argues that, regardless of the MPA governance approach adopted (i.e. government-led, decentralised, private or community-led), resilience in MPA governance systems derives from employing a diversity of inter-connected incentives. The significance of institutional diversity to governance systems parallels that of species diversity to ecosystems, conferring resilience to the overall social-ecological system. The paper concludes that, in the face of strong driving forces, rather than relying on particular types of incentives and institutions, it is important to recognise that the key to resilience is diversity, both of species in ecosystems and of institutions in governance systems.

Key Words

Marine protected areas; governance; incentives; resilience; social-ecological system; institutional diversity

Research Highlights

- Five different categories of MPA governance approach are identified
- Different types of incentives are combined in governing MPAs in different contexts
- Interactions between the incentives lead to a hypothesised 'web of incentives'
- Legal incentives represent strong links in such a 'web of incentives'
- Diversity of inter-connected incentives is key to resilience in MPA governance systems

Marine conservation in the face of strong driving forces

It is widely acknowledged that protected areas are being increasingly influenced by the global forces of economic development and socio-political change [1,2]. Such 'driving forces' have also been discussed in terms of 'the root causes of biodiversity loss'[3]. The MPAG case studies that are the focus of this Special Issue illustrate that with specific regard to MPAs such driving forces include:

- The increasing reach of global fish markets for a growing and increasingly affluent human population, coupled with the increasing reach and effort capacity of fishing vessels through 'technological creep' [e.g. 4-6];
- The increasing reach and numbers of tourists and increasing the pressures of large-scale corporate tourism [e.g. 7-9];
- Large-scale coastal development, urbanisation and infrastructure developments, including those promoted by national or local governments [e.g. 8-11];
- Poverty and the dependence of local human populations on marine resources for subsistence [e.g. 12];
- The enhanced mobility of people and thereby the increasing potential for migration to coastal areas, where economic development and subsistence opportunities tend to be relatively good [e.g. 5, 6, 9]; and
- The increasing and legitimate desire of the local population, which may itself be increasing through population growth, to not only feed themselves and their families on a subsistence basis, but also to improve their material standard of living and their prospects, as people increasingly aspire, including through media exposure, to a more secure, comfortable, consumerist and technological 'western' lifestyle [e.g. 5].

Such driving forces are a major and increasing challenge for MPA governance, as they represent forces that can combine to perturb, disrupt and, ultimately, collapse the underlying governance systems. Declines of marine resources and ecosystem degradation as a result of such driving forces have been well documented in the literature and observed in some of the case studies examined in the MPAG project [e.g. 5, 8]. Furthermore, the findings from the case studies support the view that such driving forces not only lead to biodiversity loss, but may also threaten traditional livelihoods and lead to the inequitable distribution of costs and benefits associated with MPAs. For example, the increasing power and reach of industrial fishing fleets and corporate tourism industries have resulted in the marginalisation of traditional resource users and an inequitable distribution of benefits in a number of case studies [e.g. 6, 8].

In the MPAG case studies, a variety of different incentives (Table 1) has been applied to support biodiversity conservation and sustainable resource management in the face of such driving forces, as discussed in subsequent sections. These incentives represent different sources of 'steer' in MPA governance, promoting decisions and behavioural changes, in a way that provides for the fulfilment of biodiversity conservation and sustainable use objectives.

Table 1 Incentives used in the MPAG analysis [13]

Incentive category	Incentives (and the number of MPA case studies that cited using them)	
1. Economic	1.1	Promoting economically and ecologically sustainable resource use, through spill-over effects and enhancing direct and indirect use values from resources (13)
	1.2	Green marketing of products and services from the MPA (7)
	1.3	Measures to reduce the 'leakage' of the economic benefits from the MPA away from local people (4)
	1.4	Providing economic compensation for restricted users for profits foregone (3)
	1.5	Payments for the flow of ecosystem services provided by the MPA (0)
	1.6	Allocation or reinforcement of community/user property rights (7)
	1.7	Promoting alternative livelihoods (6)
	1.8	Improvements in local infrastructure and living standards (7)
	1.9	Protection from incoming users (4)
	1.10	Funding from private or NGO sources to promote the effectiveness of the MPA through the use of various incentives, provided that this funding does not lead to 'institutional capture' – undue influence on MPA governance that undermines the effectiveness of the MPA (15)
2. Interpretative	2.1	Public communication, education and awareness raising on the importance/vulnerability of marine ecosystems and the benefits of the MPA e.g. through newsletters, web sites, education programmes, media campaigns etc. (20)
	2.2	Role of celebrity 'champions' (3)
	2.3	Promoting recognition of the potential benefits from well-managed MPAs e.g. spillover to surrounding fisheries, enhanced resilience, ecosystem services (10)
	2.4	Promoting recognition of MPA regulations and restrictions, including boundaries (4)
3. Knowledge	3.1	Integration of local/traditional/indigenous knowledge in MPA decision-making (9)
	3.2	Maximising scientific knowledge to guide/inform MPA decision-making and monitoring/evaluation (15)
	3.3	Promoting mutual respect and collective learning between different knowledge owners e.g. scientists and local resource users (10)
	3.4	Developing mechanisms for independent advice &/or arbitration in the face of conflicting information &/or uncertainty (3)

	3.5	Agreed basis for the role of precautionary approaches in the face of uncertainty (2)
4. Legal	4.1	International-regional-national-local regulatory obligations that require effective MPA conservation, including the potential for top-down interventions (10)
	4.2	Clarity and consistency in defining the legal objectives of MPAs, general and zonal restrictions, jurisdictional boundaries, and roles/responsibilities of different authorities and organisations (9)
	4.3	Effective judicial system for penalising transgressors (3)
	4.4	Legal provisions to ensure public rights and transparency in MPA management (7)
	4.5	Legal or other official basis for cross-sectoral/cross-jurisdictional restrictions to support the achievement of MPA objectives (6)
	4.6	Performance standards/conditions/criteria/requirements related to the MPA's conservation objectives and attached to user/property rights, participatory governance structures, etc. (4)
	4.7	Scope for flexibility – adaptive management and local discretionary action, maintaining building on and working through local customary institutions, provided that this does not undermine the fulfillment of conservation objectives (3)
	4.8	Ensuring that sufficient national-local-state capacity, political will, surveillance technologies and financial resources are available to enforce all restrictions equitably on all local and incoming users, including addressing driving forces – pressures from immigration, corporate mass tourism, fisheries market forces etc. (7)
5. Participative	5.1	Participative governance structures and processes such as user committees, public consultations, participative GIS planning etc., including training to support such processes (15)
	5.2	Participative enforcement, e.g. peer enforcement, community rangers and wardens etc. (3)
	5.3	Building trust/social capital between different actors (7)
	5.4	Transparent participation and decision-making processes (7)
	5.5	Clear rules on the means and degree of participation from different groups, and the unbiased representation of all user groups in participation processes (3)
	5.6	Bringing in 'neutral' facilitators to facilitate participative processes (3)

2. Governance categories

Five broad approaches to MPA governance can be recognised in the 20 case studies examined to date. This categorisation is based on the defining characteristics and attributes of MPA governance, particularly the allocation of authority and responsibilities between different parties and/or actors involved in governing MPAs, and the key incentives used to steer related processes. Although the number of case studies within each category is small, this categorisation enables contextualized comparisons of different case studies and governance approaches. The remainder of this section examines the main incentives that were employed in the case study MPAs, as well as those needed to improve governance in each category.

The five governance approach categories and the MPAs assigned to them are summarised in Table 2. The effectiveness score was assigned to each case study through discussions between the case study representative and the MPAG research team (i.e. the authors of this paper). It is therefore worth noting that such effectiveness scores are mainly based on expert opinions, rather than ecological monitoring data. The scoring system is summarised in Jones et al [13, p15] as well as in the supplementary material in the previous paper [14], but suffice to say that a score of 0 indicates that no impacts have been addressed, while a score of 5 indicates that all impacts from local-regional activities have been completely addressed. The remaining metrics give important socio-economic information on the national context: per capita GDP gives an indication of the relative wealth of the country while the GDP annual growth rate gives an indication of the rate at which wealth is increasing. State capacity is the average of the indicators for six dimensions of governance developed and analysed by the World Bank: voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law; and control of corruption [15]. The average of the state capacity indicators, which range from -0.86 to +1.65, serves as an indicator of the national capacity of the state[1] for enabling stable governance that could contribute to the effective achievement of strategic societal objectives. The Human Development Index (HDI) is a combination of metrics that indicate societal 'health', particularly education, life expectancy and standard of living. The closer to 1, the more developed a country is in these respects, the ranking indicating their relative position in the HDI of all the world's ranked countries.

These metrics are important as they enable the MPA governance approach to be considered in the wider national governance context and relative to other case studies in other countries, recognising the importance of context in such governance analyses [16]. The 20 MPA case studies are summarised in these respects in Table 2 and some key findings and examples are discussed below for MPAs in each of the five governance approach categories.

[1] The term 'state capacity' is used in this study to (a) reflect the fact that the governance capacity metrics evaluate the quality of governance from a government or state function perspective; and (b) avoid confusion with our use of the term 'governance' to include a wider range of governance approaches other than government or state functions.

Table 2 An overview of the MPAG case studies in each governance approach category, including some key metrics for the countries in which these case studies are located [17, 18]

MPA governance approach	*Case Study MPA name*	*Country*	*Effectiveness*[1]	*National Per Capita GDPUS$*[2]	*GDP annual growth rate (%)*[2]	*State capacity*[3]	*HDI (world ranking)*[4]
(I) Managed primarily by the government under clear legal framework	Great Barrier Reef Marine Park	Australia	3	38,200	2.4	1.65	0.935 (2)
	Darwin Mounds Marine Special Area for Conservation	UK	3	36,700	0.7	1.48	0.847 (26)
	North East Kent European Marine Site	UK	3	36,700	0.7	1.48	0.847 (26)
	Wash & North Norfolk Coast European Marine Site	UK	3	37,000	0.7	1.48	0.847 (26)
	National Marine Sanctuaries	USA	3	47,500	0.4	1.36	0.899 (4)
	California MPAs under the MLPA (Marine Life Protection Act)	USA	Too early to assess	47,500	0.4	1.36	0.899 (4)
(II) Managed by the government with significant decentralisation and/or influences from private organisations	Sanya Coral Reef National Marine Nature Reserve	China	2	6,000	9.0	-0.47	0.655 (89)
	Seaflower MPA	San Andres Archipelago, Colombia	1	9,200	2.4	-0.38	0.685 (79)
	Galápagos Marine Reserve	Ecuador	1	7,500	6.5	-0.86	0.692 (77)
	Karimunjawa Marine National Park	Indonesia (Coral Triangle)	2	3,900	6.1	-0.50	0.593 (108)
	Wakatobi National Park	Indonesia (Coral Triangle)	2	3,900	6.1	-0.50	0.593 (108)
	Tubbataha Reefs Natural Park	Philippines (Coral Triangle)	3	3,300	3.8	-0.48	0.635 (97)
	Ha Long Bay World Heritage Site	Vietnam	2	2,800	6.2	-0.56	0.566 (113)
(III) Managed primarily by local communities	Os Minarzos Marine Reserve	Spain	3	34,600	0.9	0.95	0.861 (20)
	Isla Natividad MPA	Mexico	3	14,300	1.3	-0.14	0.745 (56)

under collective management arrangements							
(IV) MPAs managed primarily by the private sector and/or NGOs granted with property-management rights	Great South Bay Marine Conservation Area	USA	2	47,500	0.4	1.36	0.899 (4)
	Chumbe Island Coral Park	Tanzania	4	1,400	7.1	-0.29	0.392 (148)
(V) No clearly recognisable effective governance framework in place	Baleia Franca Environmental Protection Area	Brazil	1	10,200	5.1	0.04	0.693 (73)
	Pirajubaé Marine Extractive Reserve	Brazil	0	10,200	5.1	0.04	0.693 (73)
	Cres-Lošinj Special Zoological Reserve	Croatia	1	18,400	2.4	0.38	0.765 (51)

[1] See 2.4 in Jones et al 2011 [13] for details of effectiveness score.

[2] National per capita gross domestic product (GDP) and GDP growth rate figures are sourced from the CIA World Factbook (2009) [17].

[3] Based on Kaufmann et al. (2009) [15]; see section 2.5 in [13].

[4]The Human Development Index and rankings are based on the figures for the year 2009, sourced from the UN Human Development Report [18, Table 2**]**

Approach I: MPAs managed primarily by the government under clear legal framework (government-led)

MPA governance under this category is characterised by having a well-established legal framework, with clearly defined MPA objectives, responsibilities of different government agencies, and rights and obligations of the public. Legal incentives are the key influence in most MPA-related processes, ensuring that the statutory conservation objectives are fulfilled in MPA decision-making. However, the legal framework also provides a basis for the participation of local people who directly and indirectly use the MPA, which is guided by specific legal provisions as a means of promoting transparency, equity and compliance in achieving statutory MPA objectives. The case studies in this category show that having a strong legal framework does not preclude opportunities for user participation. For example, the Great Barrier Reef Marine Park rezoning process [19] and the California MLPA initiative [20] are widely recognised as good examples of combining stakeholder participation and scientific knowledge in the MPA literature [21-23], and they are both underpinned by strong legal mandates and political leadership, which enabled coordinated and sustained efforts over relatively large spatial and temporal scales.

To date, the MPAG project has examined five case studies in three countries (Australia, the UK and the US) in this governance approach category. The three countries represented have relatively high per capita GDPs (average US$41,300), state capacities (average +1.5) and HDIs (average 0.894), while the MPAs have a relatively high effectiveness (average 3) (Table 2). This approach would thus seem to be most appropriate to more economically developed countries (MEDCs) with strong state-federal governance frameworks, and well-established legal and judicial systems.

One of the key weaknesses of this governance approach is related to the complex jurisdictional and bureaucratic systems in these MEDCs. The responsibilities for managing different uses of marine resources, particularly fisheries management and marine conservation, are still under different government authorities and jurisdictions. Cross-sectoral and cross jurisdictional integration is a major challenge to MPA governance, an issue seen in the Great Barrier Reef Marine Park, the US National Marine Sanctuary System, and the California Marine Life Protection Act case studies. The implementation of marine spatial planning may be a way forward to contextualise and streamline the integrated management of MPAs and other sectoral activities. In addition, increasing public participation and the integration of local knowledge into MPA decision-making processes are also identified as key areas in which improvements can be made [4, 24], which will empower local users towards a better balance of power in such top-down MPA initiatives.

Approach II: MPAs managed by the government with significant decentralisation and/or influences from private organisations (decentralised governance)

MPA governance under this category is characterised by a sharing of authority and responsibilities between central/federal governments and lower levels of government, or between government agencies and NGOs/private entities. MPAs are managed in accordance with formal regulations and/or through partnerships and negotiations between different parties. A variety of governance incentives are employed in MPAs adopting this approach, which include the provision of alternative livelihoods to local communities [7,8], re-investing tourism revenue to support both MPA management and community development [8, 25, 26], and promoting community participation in park planning, monitoring and enforcement [7].

To date, the MPAG analysis has examined seven case studies in six countries (China, Colombia, Ecuador, Indonesia, the Philippines and Vietnam) within this governance approach category. The six countries represented all have relatively low per capita GDPs (average US$5,400) state capacities (average -0.54) and HDIs (average 0.638), while the MPAs have a medium effectiveness (average 1.9) (Table 2). This approach would thus seem to be characteristic of less economically developed countries (LEDCs) undergoing various forms of decentralisation, where there is a degree of commitment to conserve marine biodiversity and promote sustainable fisheries but a relatively weak state capacity, hence the tendency towards decentralisation.

One of the main weaknesses identified in MPA governance in this category is the lack of political will and national and/or local state capacity for the effective enforcement of MPA regulations, providing for economic development and sources of food perhaps being more important political priorities. Most MPAs in this category are facing multiple and strong driving forces including growing coastal populations, increasing domestic and international demand for seafood, and rapid development of mass tourism, most of which cannot be fully controlled and mitigated through actions at the local level and require interventions at the national or even international levels. The need for legal incentives underpinned by the political will to use them, often manifest in a lack of funding and human resources for enforcement, is identified in a number of case studies in this category [6, 8].

A second key weakness of MPA governance in this category is a lack of incentives for ensuring fairness and equity in the sharing of benefits derived from the MPA. Incentives cited as needed for improving MPA governance in the case studies include the allocation or reinforcement of user/property rights to communities and traditional users [8], more funding to develop alternative livelihoods and sustainable business enterprises owned by local communities [7], and fair sharing of the economic benefits of the MPA [6].

Finally, insufficient use of scientific knowledge [8] and the precautionary principle [5], and a lack of effective integration of local knowledge [10] are also areas identified as being needed to improve governance in some MPAs in this category.

Approach III: MPAs managed primarily by local communities under collective management arrangements (community-led)

MPA governance under this category is characterised by local communities taking a lead in the conservation and sustainable management of marine resources. Community organisations (e.g. local fishing cooperatives) are often granted a significant level of autonomy to collectively decide the rules governing MPA management. External organisations, such as government departments and conservation NGOs, may have an important role in enabling and reinforcing such community initiatives, and ensuring that community efforts are consistent with existing legal and policy objectives at a national or supranational level, including fisheries and biodiversity conservation obligations. All categories of incentives are employed, examples include the allocation and reinforcement of territorial user rights for fishers (TURFs) in the Os Miñarzos Marine Reserve [27], the allocation of a twenty-year exclusive fishing concession to the local fishing cooperative in the Isla Natividad MPA [28], promoting mutual respect and collective learning between scientists and local users, and the integration of local knowledge in MPA design and monitoring processes [27,28].

To date the MPAG analysis has examined two case studies in two countries (Spain and Mexico) in this governance approach category. The two countries represented differ

significantly in their socio-economic contexts, with per capita GDPs (US$) of 34,600 and 14,300, and state capacities of +0.95 and -0.14 , while the MPAs have a relatively high effectiveness (3 in both MPAs) (Table 2). This approach would thus seem to be opportunistic, but effective in certain contexts, particularly when communities are empowered to develop and enforce rules for managing common pool resources, subject to certain conditions related to biodiversity and resource conservation.

One of the major challenges to MPA governance in this category is that although existing governance arrangements have been successful in addressing over-exploitation of valuable marine resources in the current context, they are vulnerable to changes in the wider socio-economic and political environment. These changes include shifts in external markets, which may devalue products and services from a MPA, or in the political will to renew community rights to marine resources, as in the case of the Isla Natividad MPA. Such wider-scale changes and related driving forces may significantly influence communities' incentives and capacity to effectively control natural resource use. In both case studies in this category, legal incentives are cited as being needed to reinforce community rights and current management arrangements.

Another concern is that the power awarded to some community organisations and groups may generate equity concerns, which may lead to the exclusion of 'outsiders' or non-elite members of a community. For example, in the Isla Natividad MPA, the Mexican constitution indicates that anyone may use resources for subsistence, but from the perspective of the fishing cooperatives this is the kind of loophole through which poaching occurs. In this case, an MPA may be an effective way for the cooperatives to ensure that even 'subsistence' use of resources like abalone is further restricted for members of the community who are not members of the cooperative [28], reinforcing and potentially widening local inequities. Whilst governance structures in community-based MPAs such as Isla Natividad may appear to be non-hierarchical, they can actually represent hierarchical structures based on local entitlements. Isla Natividad's communities were discussed at the MPAG workshop in terms of 'a hierarchy of wannabees', reflecting the desire amongst non-members of the co-operative to become affiliated with the co-operative in order to gain access rights to the lucrative abalone fishery.

Approach IV: MPAs managed primarily by the private sector and/or NGOs granted with property/management rights (private-led)

MPA governance under this category is characterised by non-governmental and/or private organisations taking the main responsibility for MPA management and enforcement. Such organisations are often granted with permanent property rights or temporary management rights to a particular area of sea, which is managed for conservation and sustainable resource use. Such organisations work independently of their own volition, but often collaborate with public institutions to enhance conservation efforts. A variety of incentives are used to steer MPA management in this category, including reinvesting profits generated from ecotourism to support MPA management and community development in a sustainable manner [12], providing environmental education to a wide range of audiences such as community members, students and tourists [12], and developing participative governance structures and processes that bring together community, government and NGO representatives in MPA initiatives [12,29].

To date the MPAG analysis has examined two case studies in two countries (the US and Tanzania) within this governance approach category. The two countries represented are even

more heterogeneous than those in Category III, with the highest and the lowest figure for per capita GDPs (US$47,500 and 1,400), state capacities of +1.36 and -0.29, and HDIs of 0.899 and 0.392, respectively. Given these major differences between the US and Tanzanian contexts, it is particularly notable that while the Great South Bay Marine Conservation Area (US) has an effectiveness score of 2, the Chumbe Island Coral Park (Tanzania) has the highest effectiveness score of all the case studies, at 4 (Table 2). This indicates that such private-led MPAs can be highly effective, even in challenging national contexts, this being significantly attributable to the very strong leadership role of the founder of the Chumbe Island Coral Park, coupled with measures that spread the MPA's benefits to local communities.

As in community-led MPAs, privately managed MPAs are also vulnerable to changes in the political and economic environment, which may, for example, affect the land lease and management agreements entrusted to the private company or NGO, as in the case of the Chumbe Island Coral Park. Political will and support from government authorities, in terms of providing and enforcing a legal and policy framework for conservation, is as important in private-led MPAs as in other categories.

Approach V: No clearly recognisable effective governance framework in place

MPA governance in this category is undermined by a lack of political will, leadership and state capacity at all levels to develop effective governance structures and processes that would support the achievement of any MPA objective, often in the face of strong driving forces. Few incentives are successfully applied to address conflicts and steer MPA processes.

To date, the MPAG analysis has examined three MPAs in two countries (Brazil and Croatia) in this governance approach category. The two countries represented have medium per capita GDPs (US$) of 10,300 and 18,600 and state capacities of +0.04 and 0.38, while the MPAs have a low effectiveness (0-1).

It should be noted that strong driving forces are not unique to MPAs in this category, in that several other MPAs, particularly those under governance approach II, are also facing similar conflicts and challenges to meeting conservation objectives. Such conflicts can be mitigated and reduced through the use of different incentives, as shown in previous case studies; however, considerable leadership and commitments, be it from the state, NGOs, the private sector and/or communities, must underpin the use of such incentives. Compared to MPAs in other governance approach categories, the limited use of economic and legal incentives in MPAs in this category is most notable, as they are important elements of the MPA governance framework in the other categories examined, providing the 'carrot' and/or 'stick' that are needed to steer MPA governance.

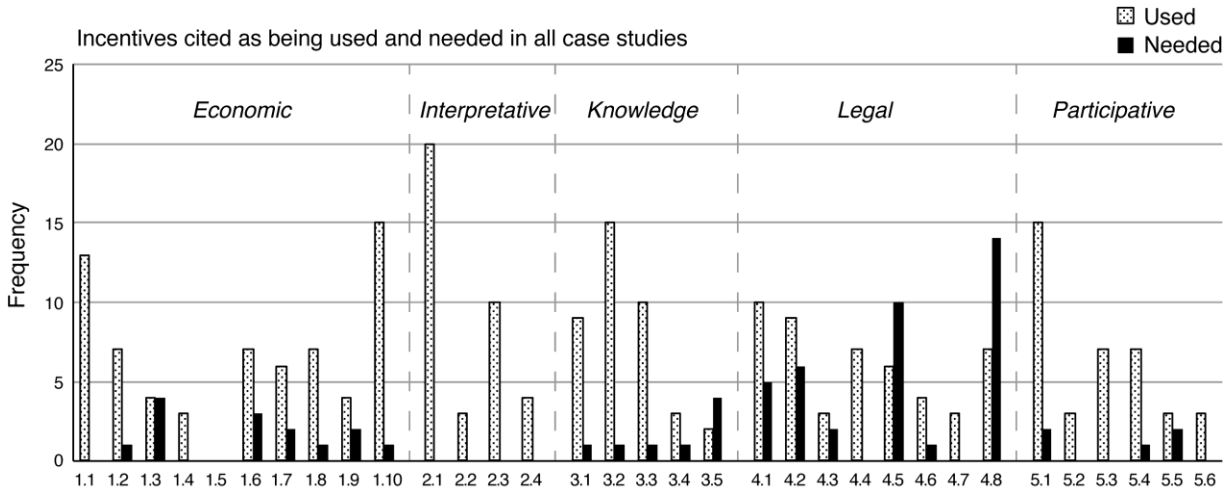
3. Which incentives were most frequently cited as used and needed?

Overall, the results from this relatively small pool of preliminary case studies show that a wide range of incentives are currently being used to govern the MPAs. Only one incentive was not cited as being used or needed amongst this preliminary sample of case studies – payments for the flow of ecosystem services provided by the MPA. This suggests that while there is a growing emphasis in the literature on the critical need to maintain/restore the flow of marine ecosystem services [30], it would appear that the logical extension of this, in the form of such payments to support effective and equitable MPA governance, has not yet been realised.

The incentive most frequently cited as being used in MPAG case studies is the use of communication, education and awareness-raising programmes to promote appreciation of the importance and vulnerability of marine ecosystems and the benefits of the MPA (interpretative incentive 2.1, see Figure 1). This is followed, in terms of the incentives most frequently cited as being used, by maximising scientific knowledge to guide/inform MPA decision-making and monitoring-evaluation (knowledge incentive 3.2), establishing participative governance structures and processes (participative incentive 5.1) and funding from private or NGO sources to promote the effectiveness of the MPA (economic incentive 1.10).

In contrast, the four incentives most frequently cited as being needed to improve MPA governance are all legal incentives, ensuring sufficient state capacity, political will and surveillance resources are available to enforce all restrictions (legal incentive 4.8) being the most frequently cited. This is followed by legal or other official basis for cross-sectoral/cross jurisdictional restrictions (legal incentive 4.5), clarity and consistency in defining the legal objectives, restrictions, boundaries and responsibilities (legal incentive 4.2), and international-local regulatory obligations that require effective MPA conservation, including the potential for top-down interventions (legal incentive 4.1). In most case studies, there is a need for more and better-implemented legal incentives, which represent strong elements of the governance framework that support other types of incentives, as discussed below.

Figure 1. The incentives cited as being used and needed in the MPAG case studies. The numeric labels on the x-axis correspond to the list of incentives in Table 1



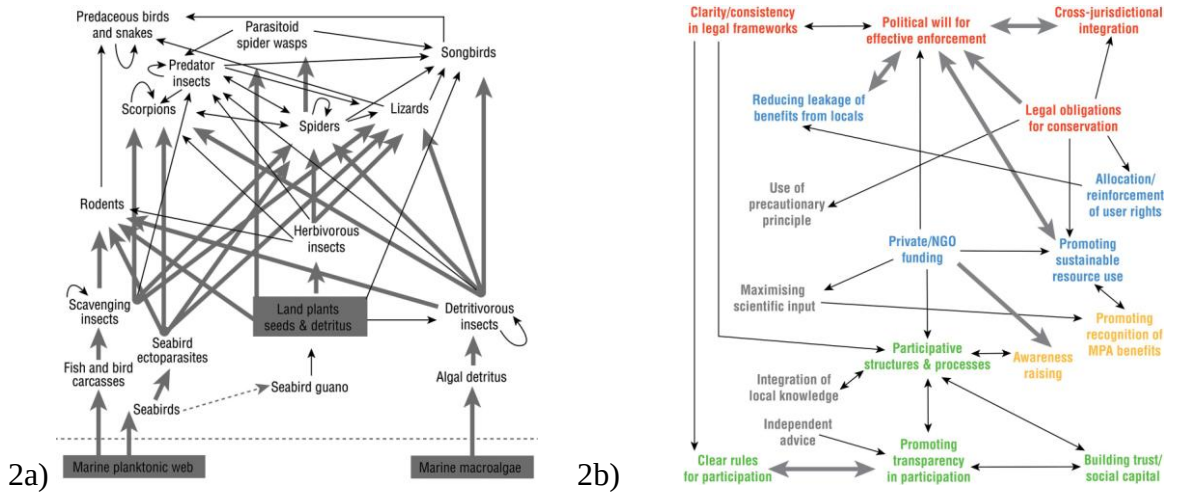
4. Improving MPA governance: resilience through diversity

In addition to the relative contribution of individual incentives in supporting MPA governance, the analysis also reveals the inter-connections between different incentives (see supplementary material). The 20 MPAs examined exhibited strong and weak interconnections in their webs of incentives (Figure 2). An example of a strong interconnection would be the need for effective enforcement of conservation regulations to promote sustainable resource use, and ensuring that the economic benefits of the MPA are equitably shared amongst all local users, including measures to reduce 'leakage' of such

benefits away from local people. The effective enforcement of conservation regulations is, in turn, dependent on robust legal frameworks and cross-jurisdictional integration between different government agencies.

In this respect, an MPA governance system can be understood as a web of inter-connected incentives, the stability and resilience of the governance system deriving from the interconnections between multiple incentives. It is now widely accepted that 'ecosystem stability is woven by complex webs', in that higher species diversity, particularly the weak and strong trophic interactions between species, tends to lead to more resilient ecosystems [31]. It can be argued that resilience in governance systems follows the same trend, in that higher institutional diversity, including interactions amongst incentives, tends to lead to more resilient governance systems.

Figure 2a. Food web complexity, adapted from [31]. The web depicts strong (thick lines) and weak (thin lines) trophic interactions. **Figure 2b**. Web of incentives illustrating the interconnections between different incentives, exhibiting strong (thick lines) and weak (thin lines) interconnections, adapted from [13]. The symbol → indicates a one-way interaction with one incentive reinforcing another; ↔ indicates a two-way interaction with two incentives reinforcing each other.



Recognising that it is important to consider the inter-linkages between the social governing system and the ecological system to be governed [32, 33], it follows that ecosystem resilience is linked to the resilience of the governance system that aims to protect a given marine area [34]. Resilience becomes important from this dual perspective in order for the marine ecosystem being governed to withstand the stresses and potentially perturbing effects of driving forces. A logical extension of this concept is that the stronger the driving forces, the more resilient the MPA governance system needs to be, in order to withstand and respond to stresses, in a way that prevents or mitigates negative impacts on the underlying ecological system. This again requires a diversity of inter-connected incentives and supporting institutions at local, national and supra-national levels.

This understanding resonates with findings from a number of fields, including ecology, social-ecological systems (SESs), and common-pool resource governance. Ecological

resilience, defined as the ability of an ecosystem to absorb shocks, resist phase shifts and regenerate after natural or human-induced disturbances [35, 36], increases with species diversity. Species richness confers functional redundancy, i.e. declines in one species are functionally compensated by increases in other species providing a similar ecological function, and response diversity, i.e. variations among species in their responses to environmental change, both of which are important for ecological resilience [36, 37].

In marine ecosystems, the selective removal of some species by fishing and other human activities can have effects that cascade down the food web, examples of which have been documented in coral reef [36,38], kelp forest [39], estuary [40] and pelagic open water ecosystems [41]. Using paleoecological, archaeological, historical and ecological records, Jackson et al. [42] showed that human activities, particularly fishing, have been affecting marine ecosystems for many centuries, largely through the removal of apex predators. Such species are 'strong interactors' in the food web, the abundance of which has a strong effect on other species, either directly (e.g. through predator) or indirectly (e.g. through competition or other effects) [42,43]. The loss of such 'strong interactors' and, thereby, of interactions in the food web can have destabilising effects on the food web and trophic structure, undermining resilience in the ecosystem [42,43]. There can be a time lag of decades to centuries between the onset of overfishing and the resultant ecological change as a result of functional redundancy, i.e. other species resuming the ecological functions of overfished species, until they too were depleted by overfishing or diseases [42].

Improved knowledge of ecological resilience inspired similar approaches to understanding resilience in linked social-ecological systems (SESs). Resilience in such SESs has multiple dimensions – ecological, economic and social. Social sources of resilience include institutional diversity, social capital, networks and learning capacity [44, 45]. Many examples of resilient SESs are based on work on common-pool resource (CPR) institutions [46 -48]. Traditionally, based on the study of small-scale, localised natural resource systems, the CPR scholarship is arguably influenced by 'Habermasian ideals of communicative rationality', which raises challenges when such analyses are applied to the study of complex and large-scale SESs, such as marine ecosystems [49]. Ostrom and Cox [48] argue that in studying such SESs, institutional theorists need to move beyond 'panaceas' and recognise what ecologists have recognised for a long time: that SESs are complex systems with non-linear, dynamic processes that span across multiple spatial and temporal scales. In parallel with ecological theories, the diversity and redundancy of institutions at multiple organisational levels, from individual actors to actor groups, organisations and governments, is an important element of governance systems that are needed to govern complex SESs [50,51].

We argue that the application of the MPAG empirical framework contributes to the development of inter-disciplinary research into the governance of complex SESs. We hypothesise that the use of different incentives confers functional diversity and redundancy in the governance system, and the results of this preliminary analysis support this hypothesis. For example, economic incentives provide for livelihoods security and equitable sharing of resource benefits; knowledge incentives promote understanding of the ecosystem and collaborative learning; and participative incentives empower local users in decision-making, all of which have been identified as important sources of resilience in SESs [45,48,51]. In addition, legal incentives have been identified as having important 'stabilising effects' in MPA governance in the MPAG case studies analysed to date, providing legal certainty regarding the objectives of MPAs, principles for decision-making, responsibilities of different organisations and property rights.

Ebbesson [52] argues that rule of law and legal certainty are not necessarily incompatible with the flexibility and adaptive capacity required in the governance of SESs, in that environmental laws are often constructed in an 'open texture' manner, providing scope for discretion and adaption. Furthermore, legal certainty may help strengthen the accountability and legitimacy of processes and decisions, and support public participation and access to justice [52], which is demonstrated in several MPAG case studies in governance approach category I. The implications of this analysis is that resilience in MPA governance systems derives from the diversity of incentives, which, when functioning synergistically, help prevent loss in species diversity and promote increases in ecosystem resilience. This diversity includes legal incentives as strong elements of the governance system.

5. Cross-cutting issues and policy implications

In the analyses of the 20 case studies examined to date, a number of cross-cutting issues were identified, which have a significant influence on MPA effectiveness, regardless of the context and governance approach applied. Addressing such issues plays an important role in improving MPA governance in the case studies.

The role of the state is critical in enabling and supporting the implementation of various incentives in all MPA governance categories. Even in MPAs in categories II, III and IV (decentralised, community-led and private), governments still play a major role in providing a supportive legislative and policy environment and in controlling and mitigating the driving forces that cannot be effectively addressed at a local scale. The increasing diversity, reach and magnitude of driving forces means that in most MPAs, it is a matter of when, not if, such driving forces will eventually become strong enough to perturb or disrupt the MPA governance system. Such potential has already come to fruition in several of the case studies, e.g. Galápagos Marine Reserve, Sanya MPA, Seaflower MPA and Baleia Franca Environmental Protection Area, while others were considered to be particularly vulnerable to such potential, e.g. Isla Natividad MPA and Chumbe Island Coral Park.

It appears that MPAs in countries with a rapidly developing and emerging economy (e.g. China, Ecuador, Brazil) are particularly vulnerable, as the driving forces are strong and there is a shortage of state capacity, resources and political will in these countries to address driving forces that promote economic growth. As the waves of economic development reach less developed countries, MPAs in these countries are likely to face similar challenges if appropriate governance systems are not in place. We argue that despite the trend towards decentralisation and co-management in protected area governance, a degree of regulation and state control is necessary to withstand the potentially perturbing effects of driving forces, including those originating from within the state apparatus. From this perspective, the need for legal incentives and state intervention is not a return to 'command and control' or 'fortress conservation'. If used appropriately, they enhance the resilience of the MPA governance system and support the implementation of other incentives.

Leadership is another key factor that contributes to progress in a number of case studies. It can come from individuals and organisations from state [19], NGO [29], private [12], academic or local community sectors [27]. In all contexts, having dedicated and widely respected individuals and organisations can help establish a long-term vision for the MPA, build trust between different parties, mobilise support for the implementation of various incentives, and strengthen the MPA governance framework.

Equity has been identified as a concern for MPA governance in a number of case studies, manifested by a lack of fairness in the allocation of benefits and costs associated with conservation [6,8,10]. Equity affects the resilience of a MPA governance system as a high level of perceived inequity undermines resource users' willingness to comply with conservation rules or participate in MPA processes, thus limiting the effectiveness of governance incentives and exacerbating the tendency towards over-exploitation. The case studies also show that equity can be enhanced while fulfilling conservation obligations, through the inclusion of a wide range of users and stakeholders in decision-making [4,20], protecting the rights of traditional and indigenous users [7,19], compensating local users for opportunities forgone [25], and investing in community education and welfare [12].

The promotion of stewardship through the assignment of property rights, in combination with other incentives, plays a key role in the success of the case studies that adopted governance approaches III and IV. Stewardship contributes to resilience in an MPA governance system, as incentives aimed at generating support from communities and users, such as economic, interpretative and participative incentives, are more likely to be successful if underpinned by a strong sense of stewardship.

Finally, local, national and international NGOs have played important roles in governing MPAs, often providing the funding, knowledge, facilitation and guidance that are needed for MPA management. Several case studies indicate that NGOs can play an instrumental role in developing and implementing incentives, particularly in developing countries, where there may be a lack of state capacity and political will for effective MPA management.

5. Conclusion

Overall, the inter-disciplinary and realist institutional analyses presented in this paper indicate that MPA governance systems and the ecosystems they are intended to conserve are linked, in that resilience in governance systems tends to prevent or mitigate the perturbations caused by driving forces, leading to resilient ecological systems. The analyses also indicate that regardless of the governance approach adopted, resilience in MPA governance systems derives from employing a diversity of inter-connected incentives, forming a complex web of institutional arrangements. This tends to lead to a more complex web of trophic interconnections, as a result of the recovery and conservation of biodiversity through the effective fulfillment of related MPA objectives.

CPR analysts have previously argued for the potential for upward spirals of reciprocated cooperation and trust, leading to improved governance and related benefits, mirrored by the potential for downward spirals of non-cooperation and mistrust leading to diminished governance and related costs [53]. Drawing on this argument and the preliminary findings of our analyses of MPA governance, the complexity of governance and ecological systems can be considered to have the potential to co-evolve in an upward spiral of ecological recovery and increased cooperation, as inter-connected incentives for conservation in the institutional system lead to the recovery of trophic inter-connections in the ecological system, increasing the resilience of both systems and the flow of ecologically derived benefits, as well as verifying and promoting the development and improvement of incentives for the more effective conservation of MPAs.

The outcomes of this project, to date, thus resonate with findings from studies on CPR governance and social-ecological resilience, in that building resilient governance systems depends on a range of factors, such the provision of property rights, local participation in

rule-making, cross-scale linkages and institutional diversity. However, the preliminary results from the MPAG case studies also highlight the critical role of legal incentives, and of the state, in enabling and maintaining resilient, effective and equitable governance systems for marine conservation. These preliminary findings support arguments that the instrumental roles of the state, expressed mainly in terms of legal incentives and the need for political will in this study, need to be constructively incorporated into governance analyses of SESs, rather than adhering to the conceptual and empirical condition that the state should provide only a neutral facilitation role. This instrumental role sometimes includes controlling the activities of certain marine users in order to strategically pursue the fulfillment of wider-scale and longer-term conservation goals, especially if growing societal concerns about declines in biodiversity are to be addressed [49].

Traditionally, social science research related to environmental governance has focused on a certain set of incentives, particularly community participation and local tenure, as a means of supporting conservation. There has been a similar observation that earlier studies in marine ecological and fisheries sciences tend to have a much narrower focus on individual species and were confined to limited temporal and spatial scales [54]. The recognition that an increasing diversity of species and trophic interactions leads to resilience in ecosystems is at the heart of modern ecological science and ecosystem-based management. The empirical framework and preliminary analyses presented in this paper offer opportunities for a parallel conceptual development in social science, based on the inter-connected nature of institutions, and for integrating social and ecological sciences in providing better advice for conserving marine ecosystems.

6. References

[1] Büscher B, Whande W. Whims of the winds of time? Emerging trends in biodiversity conservation and protected area management. Conservation and Society 2007; 5(1): 22-43.

[2] Dearden P, Bennett M, Johnston J. Trends in global protected area governance, 1992-2002. Environmental Management 2005; 36(1): 89-100.

[3] Wood A, Stedman-Edwards P, Mang J. The root causes of biodiversity loss. London: Earthscan; 2001.

[4] Jones PJS. The Wash & North Norfolk Coast European Marine Site– governance analysis. 40-59 in Jones PJS, Qiu W, De Santo EM (editors) Governing marine protected areas: getting the balance right - Volume 2. Technical report to Marine & Coastal Ecosystems Branch, UNEP, Nairobi, <www.mpag.info>; 2011 [accessed 20.11.12].

[5] Jones PJS. A governance analysis of the Galápagos Marine Reserve. Marine Policy 2013; **41**, 65-71

[6] Taylor E, Baine M, Killmer A, Howard M. Seaflower Marine Protected Area San Andres Archipelago, Colombia. Marine Policy 2013 **41**, 57-64

[7] Campbell SJ, Kartawijaya T, Yulianto I, Prasetia R, Clifton J. Co-management approaches and incentives to improve management effectiveness in the Karimunjawa National Park, Indonesia. Marine Policy 2013; **41**, 72-79

[8] Qiu W. The Sanya Coral Reef National Marine Nature Reserve, China: A governance analysis. Marine Policy 2013; **41**, 50-56

[9] Mackelworth P, Holcer D, Fortuna CM. Unbalanced governance: the Cres-Lošinj Special Marine Reserve, a missed conservation opportunity. Marine Policy 2013; **41**, 126-133

[10] Clifton J. Refocusing conservation through a cultural lens: improving governance in the Wakatobi National Park, Indonesia. Marine Policy 2013; **41**, 80-86

[11] Macedo H, Vivacqua M, Rodrigues HCL, Gerhardinger LC. Governing wide coastal-marine protected territories: a governance analysis of the Baleia Franca Environmental Protection Area in South Brazil. Marine Policy 2013; **41**, 118-125

[12] Nordlund LM, Kloiber U, Carter E, Riedmiller S. Chumbe Island Coral Park - Governance analysis. Marine Policy 2013; **41**, 110-117

[13] Jones PJS, Qiu W, De Santo EM. Governing marine protected areas – Getting the balance right. UNEP Technical Report, UNEP, Nairobi, <www.mpag.info>; 2011 [accessed 20.11.12].

[14] Jones PJS, De Santo EM, Qiu W and Vestergaard O. Introduction: an empirical framework for deconstructing the realities of governing marine protected areas. Marine Policy 2013; **41**, 1-4

[15] Kaufmann D, Kraay A, Mastruzzi M. Governance matters VIII: aggregate and individual governance indicators 1996–2008. World Bank Policy Research Working Paper No. 4978. Washington DC: World Bank; 2009.

[16] Jones PJS, Burgess J. Building partnership capacity for the collaborative management of marine protected areas in the UK: a preliminary analysis. Journal of Environmental Management 2005; 77(3): 227-243.

[17] CIA World Factbook <https://www.cia.gov/library/publications/download/download-2009/index.html>; 2009 [accessed 28.09.12].

[18] United Nations Human Development Report 2010. The Real Wealth of Nations: pathways to human development. New York: United Nations Development Programme; 2010. http://hdr.undp.org/en/media/HDR_2010_EN_Complete_reprint.pdf>; 2009 [accessed 28.09.12].

[19] Day JC, Dobbs K. Effective governance of a large and complex cross-jurisdictional MPA: Australia's Great Barrier Reef. Marine Policy 2013; **41**, 14-24

[20] Saarman E, Carr M. The California Marine Life Protection Act MPA network: a governance analysis. Marine Policy 2013; **41**, 41-49

[21] Olsson P, Folke C, Hughes TP. Navigating the transition to ecosystem-based management of the Great Barrier Reef, Australia. Proceedings of the National Academy of Sciences of the United States of America 2008; 105: 9489–9494.

[22] Gleason M, McCreary S, Miller-Henson M, Ugoretz J, Fox E, Merrifield M, McClintock W, Serpa P, Hoffman K. Science-based and stakeholder-driven marine protected area network planning: A successful case study from north central California. Ocean & Coastal Management 2010; 53: 52-68.

[23] McCay BJ, Jones PJS. Marine protected areas and the governance of marine ecosystems and fisheries. Conservation Biology 2011; 25(6): 1130-1133.

[24] De Santo EM. The Darwin Mounds Special Area of Conservation, United Kingdom. Marine Policy 2013; **41**, 25-32

[25] Dygico M, Songco A, White AT, Green SJ. Achieving MPA effectiveness through application of responsive governance incentives in the Tubbataha reefs. Marine Policy 2013; **41**, 87-94

[26] Hien BTT. Ha Long Bay World Natural Heritage Area – governance analysis. 137- 147 in Jones PJS, Qiu W, De Santo EM (editors) Governing marine protected areas: getting the balance right - Volume 2. Technical report to Marine & Coastal Ecosystems Branch, UNEP, Nairobi, <www.mpag.info>; 2011 [accessed 20.11.12].

[27] Perez de Oliveira L. A governance analysis of Os Miñarzos Marine Reserve of Fishing Interest. Marine Policy 2013; **41**, 95-102

[28] Weisman W, McCay B. Isla Natividad Marine Protected Area – governance analysis. 157-164 in in Jones PJS, Qiu W, De Santo EM (editors) Governing marine protected areas: getting the balance right - Volume 2. Technical report to Marine & Coastal Ecosystems Branch, UNEP, Nairobi, <www.mpag.info>; 2011 [accessed 20.11.12].

[29] LoBue C, Udelhoven J. Private ownership of underwater lands in Great South Bay: A case study in degradation, restoration and protection. Marine Policy 2013; **41**, 103-109

[30] MEA (Millennium Ecosystem Assessment) Ecosystems and human well-being: biodiversity synthesis. Washington, DC: World Resources Institute; 2005.

[31] Polis GA. Stability is woven by complex webs. Nature 1998; 395: 744-745.

[32] Jentoft S, van Son TC, Bjørkan M. Marine protected areas: a governance system analysis. Human Ecology 2007; 35: 611-622.

[33] Pollnac R, Christie P, Cinner JE, Dalton T, Daw T, Forrester GE, Graham NAJ, McClanahan TR. Marine reserves as linked social-ecological systems. Proceedings of the National Academy of Sciences of the United States of America 2010; 107(43): 18262-18265.

[34] Young OR. Institutional dynamics: resilience, vulnerability and adaptation in environmental resource regimes. Global Environmental Change 2010; 20: 378-385.

[35] Nyström M, Folke C, Moberg F. Coral reef disturbance and resilience in a human-dominated environment. Trends in Ecology & Evolution 2000; 15: 413–417.

[36] Bellwood DR, Hughes TP, Folke C, Nyström M. Confronting the coral reef crisis. Nature 2004; 429: 827–833.

[37] Elmqvist T, Folke C, Nyström M, Peterson G, Bengtsson J, Walker B, Norberg J. Response diversity, ecosystem change, and resilience. Frontiers in Ecology and the Environment 2003; 1(9): 488–94.

[38] Hughes TP. Catastrophes, phase-shifts, and large-scale degradation of a Caribbean coral reef. Science 1994; 265: 1547–1551.

[39] Steneck RS, Graham MH, Bourque BJ, Corbett D, Erlandson JM, Estes JA, Tegner MJ. Kelp forest ecosystems: biodiversity, stability, resilience and future. Environmental Conservation 2002; 29: 436-459.

[40] Myers RA, Baum JK, Shepherd TD, Powers SP, Peterson CH. Cascading effects of the loss of apex predatory sharks from a coastal ocean. Science 2007; 315(5820): 1846–50.

[41] Frank KT, Petrie B, Choi JS, Leggett WC. Trophic cascades in a formerly cod dominated ecosystem. Science 2005; 308: 1621–3.

[42] Jackson JBC, Kirby MX, Berger WH, Bjorndal KA, Botsford LW, Bourque BJ, Bradbury RH, Cooke R, Erlandson J, Estes JA, Hughes TP, Kidwell S, Lange CB, Lenihan HS, Pandolfi JM, Peterson CH, Steneck RS. Historical overfishing and the recent collapse of coastal ecosystems. Science 2001; 293: 629–38.

[43] Crowder LB, Norse EA. Essential ecological insights for marine ecosystem-based management. Marine Policy 2008; 32 (5): 772-778.

[44] Folke C. Resilience: The emergence of a perspective for social- ecological systems analyses. Global Environmental Change 2006;16: 253-267.

[45] Adger W. Social and ecological resilience: are they related? Progress in Human Geography 2000; 24(3): 347–364.

[46] Ostrom E. Governing the commons: the evolution of institutions for collective action. Cambridge: Cambridge University Press; 1990.

[47] Ostrom E. A diagnostic approach for going beyond panaceas. Proceedings of the National Academy of Sciences of the United States of America 2007; 104(39): 15181-15187.

[48] Ostrom E, Cox M. Moving beyond panaceas: A multi-tiered diagnostic approach for social-ecological analysis. Environmental Conservation 2010; 37(4): 1–13.

[49] Jones PJS. Governing protected areas to fulfil biodiversity conservation obligations: from Habermasian ideals to a more instrumental reality. Environment, Development and Sustainability. 2013: 15(1): 39-50

[50] Low B, Ostrom E, Simon C, Wilson J. Redundancy in social and ecological systems. Pages 83-114 in Berkes F, Colding J, Folke C (editors) Navigating Nature's Dynamics: building resilience for adaptive capacity in social-ecological systems. Cambridge: Cambridge University Press; 2002.

[51] Folke C, Hahn T, Olsson P, Norberg J. Adaptive governance of social-ecological systems. Annual Review of Environment and Resources 2005; 30: 441-473.

[52] Ebbesson J. The rule of law in governance of complex socio-ecological changes. Global Environmental Change 2010; 20: 414–422.

[53] Ostrom E. A behavioral approach to the rational choice theory of collective action: Presidential Address, American Political Science Association, 1997. American Political Science Review 1998; 92(1): 1-22.

[54] Hughes TP, Bellwood DR, Folke C, Steneck RS, Wilson J. New paradigms for supporting the resilience of marine ecosystems. Trends in Ecology & Evolution 2005; 20(7): 380-386.

Supplementary material

Table S1. Interconnections between different incentives, as identified in the 20 case studies analyzed. Strong interconnections, which are found in a relatively high number of case studies (6 or more), are shown in shaded text. The symbol → indicates a one-way interaction, ↔, a two-way interaction. 1 Great Barrier Reef Marine Park (Australia); 2 Darwin Mounds Marine Special Area of Conservation; 3 North East Kent European Marine Site; 4 Wash & North Norfolk Coast European Marine Site (UK); 5 US National Marine Sanctuaries (a network of MPAs with locations shown in grey color); 6 Californian MPAs under the Marine Life Protection Act (US); 7 Sanya Coral Reef National Marine Nature Reserve (China); 8 Seaflower MPA (Colombia); 9 Galápagos Marine Reserve (Ecuador); 10 Karimunjawa Marine National Park; 11 Wakatobi National Park (Indonesia); 12 Tubbataha Reefs Natural Park (Philippines); 13 Ha Long Bay UNESCO World Heritage Site (Vietnam); 14 Os Minarzos Marine Reserve of Fisheries Interest (Spain); 15 Isla Natividad MPA (Mexico); 16 Great South Bay Private Marine Conservation Area (US); 17 Chumbe Island Coral Park (Tanzania); 18: Baleia Franca Environmental Protection Area; 19 Pirajubaé Marine Extractive Reserve (Brazil); 20 Cres-Lošinj Special Zoological Reserve (Croatia)

Interconnection between incentives (the number in front of each incentive corresponds to those in the full list of incentives in Materials and methods)	Total number of case studies in which the interconnection is found	Case studies in which the interconnection is found (each number in this column corresponds to a case study as shown in Figure S1)
1.10 (Private or NGO Funding) → 1.1 (Promoting sustainable resource use)	3	9,10,11
1.10 (Private or NGO Funding) → 2.1 (Awareness raising)	9	2, 7, 9, 10, 11, 12, 13, 17, 20
1.10 (Private or NGO Funding) → 3.2 (Maximising scientific input)	3	1, 15, 20
1.10 (Private or NGO Funding) → 4.8 (Political will for effective enforcement)	5	11, 12, 15, 16, 17
1.10 (Private or NGO Funding) → 5.1 (Participative structures and processes)	4	6, 9, 11, 16
1.1 (Promoting sustainable resource use) ↔ 2.3 (Promoting recognition of MPA benefits)	2	1, 6
4.1 (Legal obligations for conservation) → 1.1 (Promoting sustainable resource use)	2	16, 20

1.1 (Promoting sustainable resource use) ↔ 4.8 (Political will for effective enforcement)	12	1, 4, 7, 8, 9, 10, 12, 14, 15, 17,18,19
4.8 (Political will for effective enforcement) ↔ 1.3 (Reducing leakage of benefits from locals)	7	7, 8, 9,14, 15, 18, 19
4.1 (Legal obligations for conservation) → 1.6 (Allocation/reinforcement of user rights)	5	1, 10, 14, 15, 16
2.1 (Awareness raising) ↔ 5.1 (Participative structures and processes)	4	1, 4, 6, 8
3.2 (Maximising scientific input) → 2.3 (Promoting recognition of MPA benefits)	4	1, 6, 12, 17
4.1 (Legal obligations for conservation) → 3.5 (Use of precautionary principle)	3	1,4,5
3.1 (integration of local knowledge) ↔ 5.1 (Participative structures and processes)	4	4, 8, 9, 14
3.4 (Independent advice) → 5.4 (Promoting transparency)	3	4, 6, 20
4.1 (Legal obligations for conservation) → 4.8 (Political will for effective enforcement)	7	1, 2, 4, 13, 16, 19, 20
4.2 (Clarity and consistency in legal frameworks) ↔ 4.8 (Political will for effective enforcement)	5	11, 12, 14, 19, 20
4.1 (Legal obligations for conservation) → 4.5 (Cross-jurisdictional collaboration in enforcement)	2	1, 3
4.2 (Clarity and consistency in legal frameworks) → 5.1 (Participative structures and processes)	2	9, 12
4.2 (Clarity and consistency in legal frameworks) → 5.5 (Clear rules for participation)	3	1, 4, 6
4.5 (Cross-jurisdictional collaboration in enforcement) ↔ 4.8 (Political will for effective enforcement)	11	1, 4, 5, 6, 7, 9, 10, 11, 12, 13, 16

5.3 (Building trust/social capital) ↔ 5.1 (Participative structures and processes)	5	3, 4, 5, 7, 15
5.1 (Participative structures and processes) ↔ 5.4 (Promoting transparency)	2	2, 5
5.3 (Building trust/social capital between different actors) ↔ 5.4 (Promoting transparency)	3	1, 4, 8
5.5 (Clear rules for participation) ↔ 5.4 (Promoting transparency)	6	1, 4, 7, 8, 9, 19