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Marine protected areas and fisheries: bridging the divide

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ABSTRACT

1. Long-term and well-managed marine protected areas (MPAs) can, under the right circumstances, contribute to biodiversity conservation and fisheries management, thus contributing to food security and sustainable livelihoods.

2. This article emphasizes (1) the potential utility of MPAs as a fisheries management tool, (2) the costs and benefits of MPAs for fishing communities, and (3) the foundations of good governance and management processes for creating effective MPAs with a dual fisheries and conservation mandate.

3. This article highlights case studies from numerous regions of the world that demonstrate practical and often successful solutions in bridging the divide between MPA management and fisheries sustainability, with a focus on small-scale coastal fisheries in order to emphasize lessons learned.

4. To be an effective fisheries management tool, MPAs should be embedded in broader fisheries management and conservation plans. MPAs are unlikely to generate benefits if implemented in isolation. The spatial and temporal distribution of benefits and costs needs to be taken into account since proximal fishery-dependent communities may experience higher fishing costs over the short and long-term while the fisheries benefits from MPAs may only accrue over the long-term.

5. Key lessons for effectively bridging the divide between biodiversity conservation and fisheries sustainability goals in the context of MPAs include: creating spaces and processes for engagement, incorporating fisheries in MPA design and MPAs into fisheries management, engaging fishers in management, recognizing rights and tenure, coordinating between agencies and clarifying roles, combining no-take-areas with other fisheries management actions, addressing

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the balance of costs and benefits to fishers, making a long-term commitment, creating a collaborative network of stakeholders, taking multiple pressures into account, managing adaptively, recognizing and addressing trade-offs, and matching good governance with effective management and enforcement.

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INTRODUCTION

The divide between biodiversity conservation and fisheries management in the context of marine protected areas (MPAs) should be examined within the broader context and history of marine conservation and fisheries management. Driven by changes in demographics, markets, technology, and the global extent of commercial fisheries and related environmental declines, both fisheries management and conservation have become increasingly governed and managed in a top-down fashion by national agencies and international bodies over the preceding centuries (Charles, 2001; Roberts, 2007). The challenges of managing both fisheries and biodiversity conservation priorities have been well documented (FAO, 2011). Management capacity, enforcement, lack of transparency, insufficient participation of fishers and other stakeholders in the MPA design process, loss of livelihoods and marginalization of fishing communities, and sustainable financing are often cited as underlying factors influencing success or failure. Yet numerous studies have shown that, in addition to their well-documented conservation benefits, well-managed MPAs can increase fish biomass inside MPAs and spillover under certain conditions (Halpern, 2003; Russ *et al.,* 2004; Lester *et al.,* 2009; Garcia *et al.,* 2013b). In policy circles, a new dialogue is emerging towards a convergence of these overlapping goals and a better understanding of the potential trade-offs between biodiversity conservation and fisheries management in MPAs (Salomon *et al.,* 2011). In this paper, MPAs are considered to include fisheries conservation areas and closures, marine reserves or no-take areas with primarily a conservation mandate, and multiple-use MPAs.

The divide between MPAs and fisheries is often illustrated through the viewpoint of fishers and is supported by perception surveys of communities adjacent to and within MPAs (Sunde and Isaacs, 2008; Bavinck and Vivekanandan, 2011; Bennett and Dearden, 2014a). These studies continue to raise questions about the inequitable impacts of MPAs on fishing communities and the ineffective conservation of marine resources. They also highlight the need to ensure that local fishers and communities are able to secure an equitable distribution of the costs and benefits of biodiversity conservation within and across generations when MPAs are implemented, and that MPA governance systems and management processes are fair and effective (ICSF, 2012; Bennett and Dearden, 2014b; Bennett and Chan, in press). They also emphasize the importance of understanding the incentives that encourage local people to participate in conservation (Jones *et al.,* 2013).

Another reason for the divide stems from historical differences in stakeholder priorities for MPAs at international, national, and local levels. For example, the international focus of MPA policies has been on the preservation of wilderness spaces and on the conservation of species, habitats, and biodiversity (Day *et al.,* 2012; Bennett and Chan, in press). While often maintaining a primary focus on conservation, national MPA mandates also promote research, education and recreation, often for populations that live at a distance from the MPA. At the local level, traditional MPAs have been long used for the management of local fish stocks. However, wilderness, conservation, and recreation mandates can seem foreign and exclusionary. These differing perspectives and mandates can lead to tensions

among institutions or communities. Pressure from civil society groups and international policy changes have begun to mitigate these tensions by encouraging the adoption of co-management structures and the incorporation of differing perspectives into multiple-use MPAs and MPAs with a fisheries mandate (Garcia *et al.,* 2013a, b).

The divide between fisheries and MPAs may also refer to the lack of integration between MPA management and broader marine and fisheries management institutions. It is well recognized that MPAs should be embedded in broader fisheries or spatial management frameworks – such as the Ecosystem Approach and Integrated Coastal Zone Management (FAO, 1996, 2009; Cicin-Sain and Belfiore, 2005). The harmonization of legal, institutional, and administrative frameworks is difficult and makes arrangements across coastal systems more complex (Weigel *et al.,* 2011). However, embedding MPAs within the larger fisheries framework (and vice versa) is generally necessary for achieving the desired fisheries outcomes and it also avoids duplication of effort particularly for the enforcement of regulations, monitoring and evaluation, and surveillance (FAO, 2011).

This paper suggests that a renewed focus on improving governance institutions, structures, and processes has the most potential to bridge the divide between MPAs and fisheries. This is true in many, if not all, fisheries systems and particularly so in developing countries where small-scale fisheries and MPAs are part of complex systems involving many formal and informal institutions, ranging from national and provincial agencies, laws, and policies to community governance structures and local rules and norms. An effective governance system in this context must foster participation in order to incorporate the diversity of perspectives on MPA functions and find effective means to bridge the divide between fisheries and MPAs.

This paper starts with a review of the potential utility of MPAs as a fisheries management tool and fishers' perspectives on the costs and benefits of MPAs. Case studies are provided that highlight developing country and small-scale coastal fisheries' perspectives in order to emphasize lessons learned and the need for good governance and effective management.

MPAs AS A FISHERIES MANAGEMENT TOOL

Fishing or gear closures, which in practice can be considered types of MPAs, are only one type of fisheries management tool among many others and are not always the most effective (FAO, 2011; Garcia *et al.,* 2013b). Ecosystem considerations related to maintenance of the target resources have often been implicit in fisheries management but with the application of the ecosystem approach to fisheries (EAF), these aspects are addressed more broadly and more formally (FAO, 2009). The interactions between different ecosystem components – including human dimensions – are being increasingly recognized, and in the broader fisheries management context MPAs are likely to have a more important role to play. However, EAF does not preclude the need for some of the core elements of fisheries management, which aim to ensure sustainability and productivity by controlling fishing mortality on target and bycatch species and ensuring a fishing capacity level that does not lead to economic waste. This requires a suite of tools best suited to address the context-specific objectives of each fishery system (FAO, 2011).

Various forms of closures or MPAs and particularly no-take zones can be useful for protecting critical habitats or life stages of commercial species (e.g. spawning grounds), or in limiting bycatch by closing areas where bycatch rates are high. They can also be used for controlling fish mortality of sedentary species (i.e. species with short-range movements) where fish population distribution and habitat preferences are known (e.g. around a reef) and may also be useful in data-poor situations. MPAs can also be used to allocate access rights in specific locations with a view to have benefits accrue to certain users (e.g. artisanal fishing communities) or resolve user conflicts (Hilborn *et al.,* 2004; FAO, 2011).

Positive effects of MPAs with regard to the recovery of overfished stocks through increases in fish and biomass inside MPAs have been widely documented (Halpern, 2003; Lester *et al.,* 2009). There is some empirical evidence of contributions by MPAs to fishery production outside the protected area although mostly at smaller scales (Gell and Roberts, 2003; Halpern *et al.,* 2009). Fisheries benefits may occur through improved recruitment and subsequent spillover of fish from inside an MPA to areas where they can be fished outside (FAO, 2011; Garcia *et al.,* 2013b). An example of spillover effect is the Apo Island Marine Reserve in the Philippines where changes in biomass have benefited local fishers fishing outside the reserve (Russ *et al.,* 2004). The positive fisheries effects of MPAs can lead to increased food and livelihood security in local fishing communities (Roberts *et al.,* 2001; Sanchiroco and Wilen, 2002). Still, spillover effects may or may not be sufficient to compensate for catch losses due to the closed area depending on size, species, and location, and the benefits may be few and short-lived without effective fisheries management at broader scales (Garcia *et al.,* 2013b). In addition, higher fishing costs may affect coastal fishery-dependent communities over the short and long-term, while the fisheries benefits from MPAs may only accrue over the long-term. The equitable distribution of costs and benefits to local communities needs to be considered during MPA planning and management (Pomeroy and Christie, 2006) – a point that will be taken up in the following section.

Two important lessons emerge from the literature on MPAs as fisheries management tools. First, the fisheries outcomes of MPAs depend on an array of social, governance, and ecological factors. For example, Aburto-Oropeza *et al.* (2011) consider that the important increase in biomass in Cabo Pulmo National Park in Mexico was made possible by effective enforcement and widespread community support, and because economic benefits through tourism were created for villages in the surrounding area. Mechanisms need to be put into place to ensure that benefits from alternative livelihoods, such as tourism development, accrue to the local fishing communities in order to offset opportunity costs and to maintain support (Bennett and Dearden, 2014b). Evidence suggests that MPAs can have conservation and fisheries benefits when they are no-take, well-enforced, large, and when a variety of management actions have been taken (Edgar *et al.,* 2014; Di Franco *et al.,* in press). Second, MPAs are rarely effective as a fisheries management tool if used in isolation (Halpern *et al.,* 2009; Gaines *et al.,* 2010). The net effect on fish stocks will depend not solely on the MPA, but on the range of management measures in place for the fishery. If the MPA is the only measure, it is likely to lead to displacement of fishing effort, resulting in higher fishing costs, but no overall decrease in fishing pressure. MPAs need to be accompanied by fisheries management measures that manage the fishery and associated ecosystem as a whole, including access regimes (e.g. quotas or licences) embedded within broader sustainable fisheries management regimes (Charles, 2001).

MPAs THROUGH THE EYES OF FISHERS

For centuries, indigenous peoples and artisanal fishers have used various forms of closures and protected areas to manage fisheries. These locally created and managed MPAs have included spatial, gear, seasonal, species, size, and access or tenure restrictions (Johannes, 1978, 1981; Charles, 2001; Cinner *et al.,* 2005, 2006; Cohen and Foale, 2013; Hauzer *et al.,* 2013). Historically, their locations and regulations were shaped by local knowledge, beliefs, and values and implemented through traditional mechanisms and governance institutions. The relative success of these sites and compliance with regulations could be attributed to their cultural or spiritual value, their perceived legitimacy, the strength of social contracts between users, and the implementation of local enforcement and sanctioning mechanisms. In the absence of commercial-scale fisheries and when local management and enforcement was effective, such areas could increase fisheries and harvesting yields for local fishers and subsistence harvesters. For example, McClenachan *et al.* (2014) show that fisheries yields in Hawaii were historically more

abundant than they are today as a result of strict closures and enforcement.

However, in many places around the world, top-down fisheries management regimes have resulted in the decline or loss of traditional fisheries management mechanisms, including closures (Johannes, 1978; McClenachan and Kittinger, 2013). MPAs were 're-discovered' by scientists in the 20th century after the closure of the North Pacific during World War II (Claudet, 2011), promoted by conservationists, fisheries managers, and international policy makers and then implemented in a mostly top-down fashion that has often been met with opposition by local fishers and communities (Sloan, 2002; Bennett and Chan, in press). The reasons for small-scale fisher opposition to top-down MPAs are commonly threefold. First, exclusionary MPA policies can lead to unintended social and economic consequences including livelihood impacts, poverty, loss of tenure, community conflicts, and even physical displacement (Christie, 2004; Pomeroy and Christie, 2006; Mascia *et al.,* 2010; Bavinck and Vivekanandan, 2011; Bennett and Dearden, 2014a). These negative impacts occur when lack of consideration is given to the needs and values of local stakeholders and communities during the creation and management of MPAs. This is exemplified in the principal mandates of many MPAs citing knowledge, enjoyment, and conservation – all values that may ignore the needs of local fishers and communities in developing nations who rely directly on the ocean for livelihoods and survival. Second, top-down MPAs have often resulted in the further marginalization of vulnerable groups and populations from marine governance processes (Diegues, 2008; Sunde and Isaacs, 2008; Prasertcharoensuk *et al.,* 2010). Third, the conservation goals, and thus legitimacy, of top-down MPAs is often not well communicated and therefore questioned or not understood by local fishers (Faasen and Watts, 2007; Leisher *et al.,* 2012). Understandably, inequity in governance processes or socio-economic outcomes and/or illegitimacy and ineffectiveness in management goals and outcomes can lead to lack of support by local fishers for MPA initiatives.

In recent decades, there have been a number of important improvements to MPA policy and practice that may enhance MPA processes and/or outcomes in the context of fisheries. In policy, MPAs have increasingly taken on a broader sustainable development mandate (Noel and Weigel, 2007). This has included increasing emphasis on multiple-use MPAs that incorporate the values of multiple stakeholders, that support local development, and that aim to produce fisheries benefits as well as increase ecosystem resilience. There has also been a resurgence of interest in locally managed marine areas (LMMAs) and community-based MPAs (Samonte *et al.,* 2010; Vierros *et al.,* 2010), as well as in implementing various forms of co-management for previously created MPAs (McConney and Pena, 2012; Smith, 2012). Programmes of participation, relationship-building, outreach, education, and communication are frequently implemented to improve relationships and increase the understanding of the potential costs and benefits of MPAs for fisheries (Dalton *et al.,* 2012; Leisher *et al.,* 2012). Considerable attention has been given to improving the management effectiveness of MPAs (Pomeroy *et al.,* 2004; Hockings *et al.,* 2006; Bennett and Dearden, 2014b). Those improvements often lead to better socio-economic or fisheries outcomes and an improved perception of MPAs by fishers and fishing communities owing to improved processes and understandings (Leisher *et al.,* 2007; Diegues, 2008).

CASE STUDIES AUTHOR

The cases studies presented below (Figure 1) exemplify steps taken to harmonize MPA conservation and fisheries management objectives.

MPAs and fisheries management in a developing country: Guinea-Bissau

As in most developing countries, an important challenge for Guinea-Bissau is that of marine biodiversity and ecosystem conservation. Protected areas cover a quarter of the national territory, but

Figure 1. Locations for case studies highlighted as examples of MPA conservation and fisheries harmonization.

poverty, growing population density, and an increased mobility of multiple demographics, including migrant fishers, are causing stress to marine environments. Intensive exploitation of marine resources by small-scale fishers, resulting from a scarcity of economic opportunities and financial resources are major constraints facing MPAs and fisheries management. Indeed, management is caught between the requirements of conservation and development which are sometimes contradictory in the short-term.

However, the case of Guinea-Bissau shows that synergy is possible. Collaboration first developed at the local level around consultative forums that brought together community stakeholders and decentralized authorities. The purpose was to allow key interest groups to reach a collective agreement relating to access rights and permitted fishing techniques. This agreement took the form of a comprehensive zoning scheme among five zones. This scheme accounts for the diversity of fishers and types of fishing that occur within these zones thanks to a participatory decision-making process which was initiated in the Urok Marine Protected Area (established in 2005), and which will be extended to other MPAs.

Collaboration also developed at the institutional level where various entities share complimentary responsibilities for MPA management and enforcement. The Ministry of Fisheries is responsible for MPA zoning and the issuance of fishing licences, the Fisheries Monitoring Service (FISCAP) is responsible for surveillance patrols and enforcement of national regulations, and the Institute of Biodiversity and Protected Areas (IBAP) is in charge of the management of protected areas. This multi-stakeholder participatory approach at both the community and institutional level has allowed the protected area to reconcile conservation and fisheries management objectives. The planned next step is the participation of IBAP in negotiations regarding fisheries agreements and their financial components.

Managed access area expansion in Belize

Located at the western edges of the Caribbean Sea, Belize's coastline boasts 280 km of barrier reef - the longest in the Western Hemisphere (Cooper *et al.*, 2009). These waters are home to an abundance of

species and habitats that benefit the people of Belize through commercial fishing and tourism activities, including almost 15 000 Belizeans who depend directly on fishing for their livelihoods

In Belize, despite the implementation of an ecosystem-based approach to fisheries management and conservation, the effects of an open access fishing policy became evident in recent decades as fish stocks declined and local fishers came into ever increasing conflict with fishers from neighbouring countries (Foley, 2012). To rectify the situation, the Belize Fisheries Department in partnership with the Toledo Institute for Development and Environment (TIDE), Wildlife Conservation Society (WCS), Environmental Defense Fund (EDF), and Belizean fishers decided to explore Managed Access (MA). MA is a form of catch-share that, 'limits access to General Use Zones within (already existing) reserves, restricted by a licensing system to 'traditional fishers,' as defined via community consultation with guidelines produced by Fisheries Department, and which establishes catch limits for commercial species that fishers depend on for their livelihoods' (Foley, 2012).

The partnership engaged in discussions with hundreds of fishers about the principles of rights-based management at two pilot sites, Port Honduras Marine Reserve and Glover's Reef Marine Reserve which were initially created to protect important reefs and mangroves of the MesoAmerican reef (Epstein, 2014). The partnership supported the establishment of MA Committees, community-selected groups that represent fishers and work with the Government on the implementation of Managed Access. Through extensive discussion with the MA Committees, the Fisheries Department was able to consult fishers when defining the parameters of the licensing programme and designing the catch share management system.

The MA programme has decreased incidents of illegal fishing in the area, resulting in a 60% decline in violations of fishing regulations (Spruill, 2013; Epstein, 2014). Seventy per cent of Belizean fishers in the MA sites report catching more fish, and 80% report increased compliance with, and enforcement of, fishing regulations (Oak Foundation, 2013 unpublished). The result of this inclusive process is that more than 200 fishers are now licensed through the new management programme and nearly all fishers at the sites report that they are satisfied with the MA system and are increasingly calling for expansion. They also reached beyond just the key fisheries interests and launched a national-level public education campaign using social marketing techniques like radio advertisements, interviews, murals, and making a presence at high-profile national events in order to raise awareness about the benefits of the MA programme. A thoroughly designed public and stakeholder engagement plan as well as an extensive community consultation process that has ensured adequate levels of compliance with, and long-term support of, the managed access programme has also increased support for marine biodiversity conservation of the national reserves through shifts in attitudes. Following the increase in support of these programmes by fishers and other stakeholders and a reduction in illegal fishing, the Government of Belize publicly committed to expanding them nationwide to cover the country's entire MPA network (45% of Belize's fished waters) by 2015 (Epstein, 2014).

Municipal leadership in community management and enforcement in Tinambac, Philippines

Off the coast of the barangays (villages) of Agay-ayan and Caloco in the Province of Camarines Sur, the AGCA Marine Sanctuary (50 ha no-take zone and 48 ha buffer zone) was created to conserve marine biodiversity and improve the fish catch of fishers. The main threats include: overfishing; destructive fishing practices, namely the use of compressor traps, cyanide, and dynamite, and illegal fishing by commercial fishers. Because of these practices, average daily fish catches had declined from 10 kg per day in the 1960s to 2 kg per day by the early 2000s (Demesa *et al.*, 2013).

In order to address these problems a partnership was developed between three local entities: the municipal government, an NGO, and a fishers association in Tinambac, a community of 1200 adjacent to the AGCA MPA (Demesa,

unpublished). They achieved this by launching a social marketing campaign featuring the slogan 'This is Ours,' as well as a mascot, *Agcaton*, a red grouper, which is one of the economically important local fish species. The campaign spread its message using T-shirts, posters, school uniforms and songs. In doing so, this partnership was able to reach out to the 350 fishers and wider community of Tinambac to explain the benefits of respecting the MPA as well as build support for, and compliance with, its regulations and policies (Borenstein, 2012).

As a means of creating incentives to comply with regulations, the mayor supported the placement of three to six fish wardens (often fishers who used to fish illegally) in each coastal barangay. Each warden was provided a stipend and given the responsibility of supporting the enforcement of the MPA's policies through regular patrols and infraction reporting. The local government also agreed to pay for a 24/7 patrol boat and provided for the construction of a typhoon proof guardhouse (Borenstein, 2012).

After 2 years of strict enforcement by the local community, measurements revealed that fish biomass increased significantly inside the MPA from 32.8 MT km^{-2} in 2011 to 55.6 MT km^{-2} in 2012. Significant reduction in use of dynamite and cyanide in fishing benefited seaweed farmers, some of whom observed an increase of almost 20% in their seaweed harvest (Demesa *et al.*, 2013). Some 83% of the fishers say they no longer fish inside the no-take zone (NTZ) (Borenstein, 2012). This locally-owned approach to MPA management and enforcement is being replicated in the Philippines at 25 other sites.

No-take areas help fisheries on the Great Barrier Reef

The Great Barrier Reef Marine Park Authority used a systematic conservation planning approach to achieve quantitative objectives for multiple biodiversity features, guided by biophysical operating principles. The rezoning of the Great Barrier Marine Park in 2004 increased no-take areas (NTAs) from 4.6% to 33.3% of the total area. The new zones were designed so as to represent at least 20% of each of the 70 marine bioregions defined for the exercise (Fernandes *et al.*, 2005). The 5-year rezoning process involved significant consultations with the public and key stakeholders, including recreational and commercial fishers in order to minimize the opportunity costs to users, build on traditional knowledge, and thus ensure better implementation of, and compliance with, the rezoning plan (Tanzer, pers. comm.).

There has been ample evidence now that within NTAs, there are more and bigger (target) fish than outside the NTAs (Evans and Russ, 2004; Mapstone *et al.*, 2004). Target species within NTAs also have broader size and age distributions, more males, and larger females (Adams *et al.*, 2000; Mapstone *et al.*, 2004; Begg *et al.*, 2005). Work on the Great Barrier Reef also shows exponential increases in the number of eggs produced by slightly larger female (target) fish: for example an increase in size from 18–30 cm in stripey snapper (*Lutjanus carponotatus*) was observed and correlated with increases in batch fecundity (the estimated egg production from a single spawning of all mature fish in a given area) from ~7000 to >700 000 eggs. This means a 2.5-fold difference in batch fecundity per unit area between NTAs and fished areas (average on the three survey sites). Greater batch fecundity, longer spawning seasons, and potentially greater larval survival due to larger egg size from bigger individuals might significantly enhance the potential benefits of no-take marine reserves on the Great Barrier Reef (Evans *et al.*, 2008). Furthermore, novel genetic analysis was used to show that NTAs export larvae to nearby fished areas, and in significant numbers: 28% of an area in NTAs around the Keppel Islands in the Great Barrier Reef has delivered 50% of the juvenile recruitment found in adjacent fished areas (Harrison *et al.*, 2012).

Besides the contribution of NTAs to sustaining fisheries in the Great Barrier Reef through a positive effect on target fish species, fish fecundity and larval export, NTAs can also improve habitat quality, maintain ecosystem structure and function, and maintain ecosystem goods and services (McCook *et al.*, 2010; Graham *et al.*, 2011; Olds

et al., 2014). No-take areas on the Great Barrier Reef Marine Park's coral reefs also allow the restoration of ecosystem dynamics through cascade effects to other trophic levels (Graham *et al.,* 2003; Boaden and Kingsford, 2013).

Mediterranean MPAs: fisheries benefits of 'old' reserves and co-participatory management models

The Mediterranean Sea hosts 677 MPAs: 161 of national status, nine of international status and 507 Natura 2000 marine sites (Gabrié *et al.,* 2012). Most MPAs are located in coastal areas and thus directly deal with the issue of integrating fisheries and MPA management, specifically through small-scale, artisanal fisheries. Artisanal fisheries represent roughly 86% of the approximate 42 000 fishing boats operating in the Mediterranean Sea (Maynou *et al.,* 2013). Although in decline and generally not properly accounted for scientifically or politically, artisanal fisheries are still highly relevant for the 21 riparian countries of the Mediterranean coasts, providing around 100 000 direct jobs in the EU alone (Maynou *et al.,* 2013).

Fisheries co-management – including through the use of MPAs – is a form of governance that can lead to sustainable management of fish stocks, protection of critical habitats, and maintenance of livelihoods and traditions (Lleonart *et al.,* 2014). It requires adequate networking, collaboration, co-learning, leadership, inclusion, and enforcement. Across the European coast of the Mediterranean, artisanal fishers have organized themselves into a network, exchanging best practices and ensuring they have a voice in political fora (www.medartnet.org). A joint project between park managers, researchers, and WWF has recently looked at the key factors determining the successes or failures of artisanal fisheries management in coastal MPAs (Di Franco *et al.,* in press). For the 26 MPAs that have been assessed – most of them located in Spain, Italy, and France – preliminary results show that fisher engagement at each MPA site is the single most important attribute that leads to effective management that encompasses ecological, economical, and socio-cultural components. A good management framework – together with ecological principles related to the MPA location, as well as good enforcement and compliance – is key to ensure the MPA is functional and can deliver fisheries benefits within and beyond its borders. In that survey, well managed MPAs show an increase or a stabilization of catch per unit effort over years.

Karimunjawa National Park, Indonesia

Karimunjawa National Park is situated in the Java Sea, and is managed by the Ministry of Forestry, with support from the Wildlife Conservation Society (WCS) and other NGOs. Of the 10 273 people living within the 111 625 ha MPA 70% are fishers (Yulianto *et al.,* 2009), with common target fisheries including: grouper, mackerel, snapper, sea cucumbers, lobster, anchovy and yellowtail fusilier. Direct economic gain to local communities from fisheries activities has been valued at >$US 700 000 per year (Nababan *et al.,* 2010). However, between 2004 and 2009 ecological monitoring showed a decline in fish biomass as a result of overfishing (Campbell *et al.,* 2012) and in response to this the National Park Authority, with support from WCS and partners, undertook several key steps in an effort to reverse this trend, including:

- banning Muroami and purse seine fishing gears from the park;
- re-designing the zoning plan of the park with fishers and a broader array of stakeholder input;
- initiating a rights-based management approach where only local fishers have access to nominated species though a range of controls.

Today, both the design of the MPA and the management systems being implemented have the joint goals of ensuring both biodiversity conservation and promoting sustainable fisheries productivity (BTNK, 2012). The park is highly zoned, with 48 distinct NTZs covering ~20% of the park area, with the waters outside official zoning designated as 'traditional use only' (BTNK, 2012). Fishers and community members actively participate in managing these areas, undertaking joint patrols and implementing a unique hotline phone number for the communities

to report any observed violations or activities potentially detrimental to local fisheries. Compliance with NTZs has increased by nearly 40% since 2010, and already local fishers are reporting up to 10% increases in the abundance of squaretail coral trout (*Plectropomus areolatus*) and camouflage grouper (*Epinephelus polyphekadion*) (WCS, pers. comm).

Recognizing the role that MPAs have on positively impacting fisheries and the involvement of fishers in the design and management processes, has been integral to bridging the divide between the interests of biodiversity conservation and fisheries productivity within this park.

Marine protected area (MPA) as an ecosystem-based fisheries management tool in Malaysia

In 1990, in reaction to declining trends of fish abundance, the government of Malaysia embarked on an ecosystem-based fisheries management initiative and established an MPA in Peninsular Malaysia. The main objective of establishing this MPA was to increase fisheries resources through the protection of critical habitat for breeding, shelter, and the growth of target species. The government was mainly concerned with two major contributions from the fisheries sector: sustainable food security and employment opportunities.

To date, there are 42 MPAs with a total area of 2318.43 km^2 in Peninsular Malaysia. These MPAs are being managed using the Fisheries Act of 1985. The governance structure involves federal, state, and local government agencies. In 1987, an MPA trust fund was established as a sustainable financing mechanism. Since 2003 the government has charged an entry fee to anyone entering the MPAs, and the revenue collected to-date has covered 40% of the operational costs of managing the MPAs.

Pulau Payar Marine Park, which is situated around four small islands, with a total area 187.73 km^2, lies within the Bay of Bengal Large Marine Ecosystem. Before the establishment of this MPA, the area was a major anchovy fishing ground. Fisheries resources in the area, especially the anchovies, were so depleted that the establishment of the MPA did not give rise to objections from local communities or fishers, although initial support from fishers was low, as ecosystem-based fisheries management was a yet to be proven management mechanism.

The objective to increase the fish stocks within the MPA was achieved, in part, in 5 years, namely the recovery of small pelagic species, and within 10 years there was a marked recovery of fish higher in the food chain. Using Reef Check methodology assessments of both snapper and grouper showed higher abundances at Palau Payar Marine Park than at any other island surveyed in Malaysia. Snapper (131.08 individuals per 500 m^3) are the most abundant food fish, with lower populations of grouper (2.83 per 500 m^3) and parrot fish (2.08 500 m^3) (Reef Check Malaysia, 2012). This recovery in fish abundance inside the marine protected area contributed to a spill-over into the surrounding areas and consequently after about 10 years of the MPA being established the level of acceptance and support from the fishing community increased.

Marine protected areas, a tool for rebuilding fish stocks: the case of the Quirimbas National Park, Mozambique

In Mozambique, about 42% of the entire population lives on the coastline and depends on marine resources as their main source of food and income. In 2002, the government of Mozambique declared part of the Quirimbas Archipelago a National Park (QNP). The park's management plan was developed with the support of WWF and integrates marine conservation with economic and social well-being objectives (Quirimbas National Park (QNP), 2013).

Since 2002, the QNP has established seven NTZs, or 'sanctuaries' as they are known locally, with the aim of protecting spawning grounds and restoring fish populations within and outside the MPA. These NTZs are managed jointly by small island communities and park authorities who have organized themselves into Fishing Committee Councils.

While NTZs represent only 0.05% of the total marine area of the park, they are contributing

towards a rapid buildup of fish populations in the park, including within fishing grounds. For instance, since the creation of the Matemo Island NTZ, fish diversity has increased, and while carnivores were the predominant species before the island became protected, more trophic groups are now represented. On Ibo Island, the effects of protection have also been witnessed outside of the MPA (i.e. increased fish diversity and size) due to the spill-over effect. However, in 2006, owing to a sudden spike in poaching, fishers noticed a decrease in the size of the fish within the NTZ and also within their fishing grounds. A public campaign involving fishing communities, local authorities, and park managers was then launched to promote understanding of the importance of NTZs and adequate protection for ensuring the recovery of fish stocks (Pires, unpublished manuscript).

Since then, local communities have voluntarily expanded the NTZ approach to other areas, even outside of the QNP (e.g. Pemba Bay). This shows again that working with local communities for the management of MPAs, monitoring and communicating results, promoting environmentally safe gear and practices, respecting ecological and social connectivity principles, and building business cases for MPAs are essential elements for ensuring that MPAs can contribute to preserving well-being, traditions, and fishing communities.

DISCUSSION

While the historical precursors to modern day MPAs were often undertaken by communities to support fisheries (Charles, 2001; Cohen and Foale, 2013), over time the management of fisheries and coastal ecosystems has become increasingly top-down and compartmentalized. Meanwhile, community structures for traditional fisheries management have often broken down and some traditional practices have been lost (McClenachan and Kittinger, 2013). In addition, international policy and many countries have been primarily focused on creating MPAs for environmental preservation and conservation, which has often led to conflicts among organizations with different mandates and stakeholders with different perspectives.

The case studies presented in this article discuss steps taken to bridge the divide between MPA conservation and fisheries management objectives in both developing and developed country contexts. The case study of Guinea Bissau highlights the conditions for balancing conservation and development, which are sometimes contradictory in the short-term. The Belize case study clarifies the prerequisites for an effective partnership between a government institution, NGOs and local fishers with the aim of implementing a catch shares management system. The Tinambac case study in the Philippines discusses innovative leadership and procedures for community management and enforcement. The Karimunjawa National Park case study in Indonesia describes the design of an MPA and a fisheries management system aimed at achieving the joint goals of biodiversity conservation and sustainable fisheries. The case of Pulau Payar Marine Park in Malaysia refers to the conditions for the success of an ecosystem-based fisheries management initiative that aims to improve food security and employment opportunities. The case of Quirimbas National Park in Mozambique points out some essential elements for ensuring the success of an MPA, such as respecting ecological and social connectivity principles. Experiences from developed countries are also instructive. In particular, the Great Barrier Reef case study in Australia focuses on the planning of an MPA network and the ecological outcomes of no-take areas. No-take MPAs can be much more difficult to establish and implement in developing countries given the dependence of rural fisheries on marine resources. The case study of Mediterranean MPAs points to the important role that a network organized by the artisanal fishers themselves can play and to participatory fisheries co-management processes as a means of bridging the divide between MPAs and fisheries.

One important part of the foundation that shapes the potential use of MPAs as a tool for both biodiversity conservation and fisheries management is the underlying governance framework. Governance refers to the formal or

informal organizations, institutions, policies, and processes through which decisions are made and actions taken at different scales from international to local (Lockwood, 2010; Lockwood *et al.,* 2010; Bevir, 2013; Bennett and Dearden, 2014b). According to Jones (2014), the function of governance is 'steering human behaviour through combinations of people, state, and market incentives in order to achieve strategic objectives' (p. 63). Governance can be judged effective or ineffective based on both processes and outcomes.

Based on the objectives of different actors and the enabling policy, legal, and institutional environment, top-down, bottom-up or co-management governance systems may be more appropriate and effective. A completely top-down approach for governance could in theory be strictly enforced and effective, given a government with political will and sufficient financing and capacity for management. However, many MPAs with top-down governance frameworks often become protected in name only or fishers may have little incentive to participate if the system is particularly hierarchical or perceived to be illegitimate (Bennett and Dearden, 2014a). Other times, lack of integration between legal and institutional systems creates challenges. At Parc National du Banc d'Arguin (PNBA) in Mauritania for example there is a lack of integration and coordination between the MPA and fisheries management surrounding the park.

Involving local fishers in the management of MPAs, a bottom-up approach, can be highly effective as they are the people most directly involved with daily activities on its waters and are directly impacted by the costs and benefits of the MPA. Other, broader management arrangements also benefit from the involvement of local fishers and communities. Networks of LMMAs, such as the MIHARI network in Madagascar, can further improve the effectiveness of community-based governance as previously isolated fishers have an opportunity to learn from one another (Mayol, 2013).

Co-management, involving many stakeholders, may be the most efficient form of governance for managing marine resources in the majority of areas (Garcia *et al.,* 2013b). Local communities that lack resources may not have the capacity to enforce MPA regulations or maintain the MPA over a long period of time owing to underlying socio-economic conditions. Those in more vulnerable states, subject to stresses like climate change, poverty, and starvation may be compelled to shift their priorities over time. Co-management can lead to empowerment of communities, better transparency, and decreased costs of enforcement, but is not without challenges including marginalization of the most vulnerable and increased transaction time and/or costs (Garcia *et al.,* 2013b; Weigel and De Monbrison, 2013). At many sites, however, a mix of incentives and a tailored approach to governance is most likely to be effective (Jones *et al.,* 2013).

Different governance structures can be successful if they are considered legitimate and fair by stakeholders, create consensus from competing objectives, use data in an adaptive management approach, and consider the economic needs of stakeholders (Garcia *et al.,* 2013b). Leadership from a respected member of the community is also one of the key elements of successful fisheries governance (Gutiérrez *et al.,* 2011). Building leadership and communications capacities into local institutions and communities is important to effectively manage marine resources. Studies on MPA governance also show that most MPAs would benefit from stronger legal structures that are part of wider coastal and fisheries management systems (Jones *et al.,* 2013). Other facets of effective MPA governance include: coordination and cooperation between organizations and across jurisdictions, adequate capacity, incorporation of local knowledge and pre-existing governance structures, consideration of local tenure and rights of access, transparency of decision-making processes, mechanisms to ensure accountability of managers, good relationships between managers and local fishers, enabling policies, and clearly articulated rules and planning and management processes (Bennett and Dearden, 2014b). As the case studies show, there are some common elements to effectively bridging the divide between the

imperatives of biodiversity conservation and the livelihoods and food security needs of fisheries through the good governance of MPAs. When and where an integrated and inclusive approach has been undertaken, there are a number of important lessons that are outlined below:

1. Integrate conservation and fisheries objectives through incorporating fisheries considerations into MPA design and MPAs into overall fisheries management frameworks.
2. Use no-take zones/no-take areas with other fisheries management actions.
3. Include fishers in the design and ongoing management of MPAs and conservation specialists in the design of fisheries management plans.
4. Create spaces for sharing and processes for meaningful engagement.
5. Build trust, social capital, and relationships.
6. Create a collaborative network with stakeholders and supporting organizations.
7. Increase coordination between agencies through an integrated management framework.
8. Monitor, communicate, and adapt management processes.
9. Plan and commit for the long-term.
10. Recognize access rights and tenure.
11. Address the balance of costs and benefits to fishers through alternative livelihood programmes and compensation schemes.
12. Consider equity in processes and outcomes.
13. Tailor the governance approach to the context.
14. Identify multiple pressures on the marine environment and take cumulative impacts into account.
15. Analyse and make trade-offs between objectives using available decision-making processes, integrated management approaches, and information processing software and methods.
16. Match good governance processes with effective management actions.

These lessons are consistent with a range of themes and tools emerging from previous international applications of MPAs, ecosystem-based approaches to fisheries management (EAF), and integrated coastal zone management. For example, strengthening the engagement of both fishers and a wider network of organizations (community organizations, NGOs, and governments) and individuals (community members and researchers) in both the design and management processes is consistent with FAO's recent literature on the ecosystem approach to fisheries, and co-management is recognized as best practice particularly in small-scale fisheries (Charles, 2001; FAO, 2011).

CONCLUSION

Reconciling biodiversity conservation and fisheries management objectives in the context of MPAs might be achievable under the right set of circumstances when considerable attention is given to governance and management. While this paper recognizes the challenges of doing so, it also stresses the urgency and necessity for looking at ecosystem conservation and resources management in a holistic, integrated manner if we are to reverse the downward trends in ocean health and associated food production. The international case studies that are discussed in this paper provide important lessons for incorporating fisheries considerations into integrated design and management approaches for MPAs. Key lessons for effectively bridging the divide between biodiversity conservation and fisheries sustainability goals in the context of MPAs include: creating spaces and processes for engagement, incorporating fisheries in MPA design, engaging fishers in management, addressing the balance of costs and benefits to fishers, recognizing rights and tenure, coordinating between agencies and clarifying roles, combining NTAs/NTZs with other fisheries management actions, making a long-term commitment, creating a collaborative network, taking multiple pressures on the marine environment into account, managing adaptively and using trade-off approaches. Finally, this paper highlights the need to match principles of good governance – i.e. legitimacy, transparency, equity, accountability, inclusiveness, fairness, connected, and resilient – with effective management through surveillance and enforcement, sustainable financing, effective siting, zoning for different uses and types of fisheries, education and capacity building programmes, and

monitoring and communication of benefits. Overall and as demonstrated by these case studies, rhetorics need to be turned into action. The costs of continuing with a 'business as usual' approach – and not integrating fisheries management and biodiversity conservation objectives – are simply too high and cannot be borne by the most vulnerable and coastal-dependent communities.

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