Coral Reefs
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REPORT

Best practices for improved governance of coral reef marine protected areas

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Abstract Coral reef marine protected areas (MPA) are widely distributed around the globe for social and ecological reasons. Relatively few of these MPAs are well managed. This review examines the governance of coral reef MPAs and the means to improve coral reef MPA management. It highlights common governance challenges, such as confused goals, conflict, and unrealistic attempts to scale up beyond institutional capacity. Recommendations, based on field experience and empirical evidence from around the world, are made for best practices at various stages of MPA implementation.

Keywords Marine protected areas · Governance · Coral reefs

Marine protected areas and coral reef management

Marine protected areas (MPAs) have been established as an important tool for fisheries management, biodiversity conservation, habitat restoration and tourism development. They take many forms, but all have in common the characteristic of management interventions that are spatially organized. The most widely accepted definition for an MPA is the following.

> "Any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment." (Resolution 17.38 of the IUCN general assembly [IUCN—The World Conservation Union 1988] reaffirmed in Resolution 19.46 [IUCN—The World Conservation Union 1994]).

The growth of interest in MPAs has been remarkable. As ocean ecosystems, and associated human communities, are stressed as a result of overexploitation and habitat degradation, MPAs have been commonly offered as an important management intervention, especially for coral reef systems. This review of governance and MPA-related social science emphasizes some of the challenges and opportunities associated with MPAs. It draws from experiences around the world, but emphasizes the Philippines and coral reefs where there are a variety of long-term MPA examples to draw from.

Coral reef conditions are generally declining around the world (Hughes et al. 2003) with tremendous consequences for biodiversity, economies, and food security. MPAs have emerged as one of the most favored coral reef management tools to address issues of overfishing, habitat degradation, and to foster alternative livelihoods. While MPAs cover approximately 18.7% of the world's approximately 527,072 km^2 of coral reef, less than 0.01% of coral reefs are within no-take MPAs with no poaching and at low risk (Mora et al. 2006). In Southeast Asia, the global epicenter of marine biodiversity, approximately 12% of coral reefs are within MPAs, but the vast majority of these are at risk

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(Mora et al. 2006) and management processes frequently break down (Christie et al. 2003a). Pollnac et al. (2001) estimate that up to 80% of the MPAs in one area of the Philippines are not successful. A comprehensive MPA database for the Philippines (available through http://www.coast.ph/MPAdb/index.asp) includes 312 municipal government-declared MPAs covering 8,227 ha, all of which include coral reef areas. Of 235 such MPAs surveyed between 2001 and 2006 (Coastal Conservation and Education Foundation, CCEF 2005), 56% (or 131 MPAs) were classified into rating level 1 (MPA declared) or 2 (MPA legally established with management beginning) and 36% (or 84) were classified into rating level 3 (MPA enforced for 2 years or more) on a 5-point management effectiveness rating scale (1 = lowest rating level, 5 = highest rating level). A total of 9% (or 20) of the MPAs attained rating level 4 with consistent enforcement and community and government participation and support. None of these MPAs attained rating level 5 signifying full institutional and financial sustainability over a period of 5 or more years.

The preference for this spatial management tool for coral reef systems is grounded in ecological and social considerations. Some highly valued coral reef fish (e.g., Serranids and Lutjanids) have high site fidelity and increase in size and density within no-take MPAs in a relatively short timeframe (McClanahan et al. 2005; Russ et al. 2005). MPAs are also potentially socially viable. Coral reef MPAs can increase dive tourism providing livelihoods and are considered easier to enforce than seasonal closures or fishery management techniques that limit entry by generally poor artisanal fishers (White et al. 2006). Many Pacific Island coral reef fisheries are place-based with longstanding spatial management tenurial systems in place (Johannes 1981; Cinner 2007). While not accurately documented, the vast majority of Philippine MPAs are established to protect coral reefs and associated sea grass systems (White et al. 2006).

A typology of MPA management approaches

Marine protected areas take various forms around the world and the terminology is confusing. A "sanctuary" in the Philippines is strictly off limits to extractive uses, while a "traditional fishing reserve" allows for fishing with non-destructive gears. These terms are not consistent globally. Geographic scales also vary tremendously, from 2 ha community-based MPAs, to the thousands of square kilometers of the zoned Great Barrier Reef National Marine Park. MPAs can consist of temporary or permanent closures. In the Philippine context, MPAs usually consist of a "no-take" area(s) with some type of buffer or other nearby zones within which extractive and non-extractive uses are regulated.

Table 1 Ostrom's design principles for long-enduring common property regimes

1. Clearly defined boundaries defining who has rights to withdraw resources and the boundaries of the common resource
2. Congruence between appropriation (restricting time, place, technology, etc.) and provision rules (requiring labor, material, and money) and local conditions
3. Collective-choice arrangements
4. Monitoring of conditions and behavior
5. Graduated sanctions depending on the seriousness of an offense
6. Conflict-resolution mechanisms
7. Minimal recognition by government authorities of rights of appropriators to organize
8. Nested enterprises with monitoring, enforcement and governance activities organized in multiple levels for common-pool resources that are part of larger systems

Governance may be conceived as "the formal and informal arrangements, institutions, and mores which determine how resources or an environment are utilized; how problems and opportunities are evaluated and analyzed, what behavior is deemed acceptable or forbidden, and what rules and sanctions are applied to affect the pattern of resource and environmental use." (Juda 1999:90) Various models, including top–down, bottom–up, co-management, and traditional management regimes, are utilized to implement MPAs (Christie and White 1997). As a general premise, how these management models evolve is influenced by whether there are functional common property regimes in place or resources are open access. MPAs can, in fact, serve to reinvigorate common property regimes that had been dismantled over time. Ostrom (1990:90) has demonstrated, mainly through an analysis of terrestrial systems, that various design principles are associated with successful and long-term common property regimes (Table 1).

Legal recognition of community and local governments rights to establish small scale MPAs, as discussed below, has resulted in a proliferation of MPAs in the Philippines (Eisma et al. 2005). Empirical research demonstrates that when collective action and conflict resolution mechanisms break down, MPA effectiveness rapidly deteriorates (McCay and Jentoft 1996; Trist 1999; Pollnac et al. 2001; Christie et al. 2003a; Christie 2004; Walley 2004).

Based on a review of MPA policy and governance research[1] and of published implementation strategies[2] a typology of MPA governance systems is presented including

[1] Consisting primarily, but not exclusively, of a review of the leading marine policy journals: Ocean and Coastal Management, Marine Policy and Coastal Management.

[2] Consisting primarily of a review of MPA News (http://www.mpa-news.org), the gray literature, and various MPA guidebooks and reviews (e.g., Salm and Clark 2000; Sobel and Dahlgren 2004; National Research Council 2001), and personal communications.

a few examples MPAs (Table 2). MPA governance is heavily influenced by the particular socio-political, historical, and socio-economic context of a site. The problems associated with the development of globalized management models that can be effectively exported around the world is, in fact, one of the most important lessons of a decade of research (Brechin et al. 2003; Christie et al. 2005). Trade-offs are associated with each of these governance systems. The interplay between social and ecological goals, and a consideration of context, will suggest a particular approach.

Traditional

Traditional ocean governance became known globally through the work of Johannes (1981), Ruddle (1988, 1994), and Aswani and Hamilton (2004). The fact that, in some societies, MPAs had existed for millennia, grounded in taboo and social norms, suggests that these governance systems are sustainable and effective in some contexts. While uncertain, many other societies (e.g., the Philippines, Indonesia) that are highly reliant on nearshore coral reef fisheries, and related to Pacific Island cultures likely had similar regimes prior to the disruptions caused by colonialism and rapid population growth. The negative effects of globalization on Palau's traditional management systems suggests that they are potentially fragile and best suited to support modest, local commercial and subsistence activities (Johannes 1981). Recently, there has been considerable effort to strengthen such traditional management systems throughout the West Pacific Islands. The Locally-Managed Marine Area network, discussed below, represents one such effort (see http://www.lmmanetwork.org/).

Community-based management

Community-based MPA management strategies are frequently employed in contexts with weak formal higher-level institutions, decentralization of decision-making, or where community-rights activism is strong. Weak formal government support may be due to a lack of financial or technical resources. In these contexts, that are common through much of the tropics, bottom–up governance regimes may be the only feasible option.

There are various advantages to bottom–up strategies. They tend to engage resource users more effectively than top–down strategies since they lead to a sense of trust, collaboration, and ownership among participants (Christie and White 1997; Pollnac and Pomeroy 2005). These strategies are also responsive to local conditions that resource users know intimately from regular interactions (e.g., Johannes 1981; Christie et al. 2000). Finally, if carefully

Table 2 Marine protected area governance systems, characteristics, and key examples as reviewed

	Traditional: based on pre-colonial management systems and traditional ecological knowledge, taboo systems	Bottom-up: led primarily by resource users, generally small-scale, participatory	Co-management: joint management by resource users and government	Centralized: led by government agency, consultative with resource users	Private: led by private sector
Africa			Mafia Island (Tanzania), Kenya		Chumbe Island, Tanzania
Asia		Apo Island (pre 1992), San Salvador Island (pre 1990), Philippines	Tubbataha National Marine Park, Apo Island and San Salvador Island (at present), Philippines		
Pacific Islands	Palau, America Samoa, Locally Managed Marine Areas (LMMA network) in Western Pacific				
Caribbean			Souffriere, St. Lucia		
United States					Florida Keys, United States
Australia					Great Barrier Reef National Marine Park

implemented, their attention to meaningful participation tends to lead to sustainable long-term management regimes, especially if the bottom–up process and participating resource users and organizations eventually engage the government (White et al. 1994; Balgos 2005; Pomeroy and Rivera-Guieb 2006). In the broader sense, bottom–up management approaches represent an important means by which communities are able to reassert authority over resources upon which they depend.

If resource users have been disenfranchised from their resource bases and marginalized from decision-making for decades or even centuries, change will likely proceed at a slow pace and will encounter many obstacles both internally and from external forces that are not in favor of change (Morris and Mueller 1992; Christie et al. 2000). Community-based initiatives may also be destabilized when neighboring communities and leaders do not support MPA implementation. The scaling up of bottom–up management to address large-scale processes affecting coastal environments and communities (including climate change, overfishing, and pollution) is challenging.

Co-management

The fundamental principle of co-management is that it involves resource users and formal policy makers (e.g., the government) in a process of joint decision-making (Pinkerton 1989; White et al. 1994; Christie and White 1997; Pomeroy et al. 2001; Nielsen et al. 2004; Pomeroy and Rivera-Guieb 2006). It is frequently one of the outcomes of a community-based process that has matured to the point whereby resource users and policy makers (and other entities such as the private sector) have comparable influence and willingness to collaborate (Christie et al. 2000). Co-management can also be used to strengthen long-standing rights that affect the allocation of resources and implementation of MPAs (Pinto da Silva 2004).

Co-management, as a compromise between bottom–up (led by resource users in the strict sense) and centralized management, potentially represents the best of both models, engaging resource users and government officials in an equitable and transparent planning process that is formally recognized and sanctioned. However, based on comprehensive, comparative research in Southeast Asia and Southern Africa, "the practical adaptation by governments of the co-management approach has most often been limited to involving fishing communities in the implementation process, an 'instrumental co-management' approach. Governments have generally not perceived co-management as a means to introduce more democratic principles into fisheries management, but have recognized co-management as an instrument to reach its management objectives more efficiently by involving fishing communities in the implementation process" (Nielsen et al. 2004:154). Experience in Tanzania, Nicaragua, Brazil and the United States demonstrates that co-management processes that are not attendant to power dynamics and establishment of conflict resolution mechanisms run the risk of breaking down (Christie et al. 2000; Dukes and Firehock 2001; Pinto da Silva 2004; Walley 2004). With these challenges in mind, examples such as the Tubbataha Marine Park management council demonstrate the potential of co-management and multi-sectoral management boards to ensure balanced representation from stakeholder groups (Arquiza and White 1999; Tongson and Dygico 2004).

Centralized management

Centralized management was historically the most common governance regime in colonial and post-colonial societies. Colonial governments frequently replaced more decentralized, traditional governance systems as a means of efficiently extracting natural resources (Christie and White 1997; Robinson 1997; Walker 1997; Nielsen et al. 2004). In the global North, strong government bureaucracies and clear legal mandates frequently established fisheries (and possibly environmental management) agencies as policy makers for catch allocations and MPA design and management (Suman et al. 1999; Scholz et al. 2004).

Centralized management is commonly perceived as having the benefit of efficiency and scientific grounding. Technical specialists who understand the theory associated with MPA planning and assessments are able to design sophisticated plans, especially with recently developed software that aids modeling and decision-making (e.g., MARXAN, ECOPATH, etc.). Currently, a heated debate regarding protected area management and the role of scientific and local (non-scientific) knowledge is underway (Terborgh 1999; Brechin et al. 2003; Chapin 2004). These debates have important implications for how particular forms of knowledge are utilized in planning processes and whether MPAs will be justified principally for biodiversity conservation, marine resource management, sustainable development or empowerment of marginalized social groups. These goals are not necessarily mutually exclusive, but require explicit consideration of the trade-offs associated with centralized management or any management framework.

The most serious limitations of centralized management are associated with how stakeholder groups will respond to policies that will affect them but for which they do not feel responsible. Centralized planning may not be sensitive to localized impacts of MPAs that may result in considerable socio-economic and demographic changes (Trist 1999;

Walley 2004). Experiences in the Florida Keys National Marine Sanctuary demonstrated that centralized management (and reticence to use human dimensions data) can derail planning processes (Suman et al. 1999; Helvey 2004).

The recent establishment of global targets for MPAs implies, in some manner, that international bodies are willing to assert their influence, a process that some advocates of MPAs have expressed concern over since it may undermine wide commitment to ocean conservation and short circuit complex planning processes (Agardy et al. 2003). Similarly, the use of executive power to establish a large MPA such as the Northwestern Hawaiian Islands, while impressive in scale, may eventually create a backlash by fishing operators and cultural groups that wish to continue relatively small-scale fishing activities.

On the other hand, centralized management can be effective. In many countries, consultative participation is required with ultimate decision-making and fiscal allocation decisions remaining with the government (e.g., Day 2002 on Australia). During the recent re-zoning of the Great Barrier Reef Marine Park (GBRMP), the Australian government implemented a comprehensive consultative process that generated an unprecedented 30,000 formally submitted comments that helped with the drafting and re-zoning whereby 33% of the GBRMP is now in no-take status (Fernandes et al. 2005).

Private management

While not commonly practiced, MPAs can either be explicitly or de facto privately managed. Chumbe Island, Tanzania represents one of the best known examples of the former and has demonstrated considerable resilience in the face of some criticisms that highlight the privatization of what have historically been public resources (MPA News 2003). As with centralized management, private management tends to generate considerable controversies. This is particularly the case if the "social contract" established by a community-based MPA process is breached in which case compliance rates are likely to decline (Christie et al. 2002). Private management may also struggle to compete with the "subsidized management" of other MPAs that benefit from grants (Riedmiller 2000). But, as highlighted by Riedmiller (2000), the private sector can act efficiently and decisively.

Integrated coastal management and MPA effectiveness

Marine protected areas should be thought of as one important management strategy within a larger area-wide coastal and fisheries management framework. Where competition for coastal resources exists, careful design and implementation of integrated coastal management (ICM) can help ensure continued benefits and sustainable management of coastal resources. ICM is a process aimed at guiding coastal area development in an ecologically sustainable fashion (Chua 1998; Cicin-Sain and Knecht 1998; White and Chua 2004; Kay and Alder 2005; White et al. 2005).

> "The essential elements of this management process are simultaneous integration and coordination on multiple levels, which can incorporate national and local government working together with community groups in an iterative assessment, planning, and implementation process" (Christie and White 1997:163).

The need for ICM regimes beyond the borders of MPAs is especially important in tropical developing countries where MPAs tend to be small and implemented at the local scale, such as in Philippines and parts of the Caribbean and South America (Salm and Clark 2000; Balgos 2005; McClanahan et al. 2005; White et al. 2005; World Bank 2006). In the case of the GBRMP and Belize, land-use patterns have had a considerable affect on coral reefs thus necessitating integrated management of coastal areas (Cho 2005). When using MPAs to stabilize fish yields, it is increasingly apparent that small isolated MPAs will not be effective if they are not nested within broader area management programs that address external issues such as over fishing (Christie et al. 2002; White et al. 2006).

Emerging coral reef MPA networks

A group of MPAs that interact with one another ecologically and/or socially form a network. Networking among individual MPAs and groups of practitioners is underway in some places. The Great Barrier Reef National Marine Park (a network of various zones) and various emerging networks of MPAs in Southeast Australia, the Red Sea and Gulf of Aden, Mexico, and Belize represent important examples (Day 2002; Gladstone et al. 2003; Bezaury-Creel 2005; Cho 2005; MPA News 2006).

The network efforts in Australia, Mexico, the Red Sea, and Belize are government-led efforts with considerable non governmental organization (NGO) assistance. All of these efforts have experienced some degree of controversy when user groups have expressed concerns over dislocation or networks that benefit certain economic groups (e.g., tourism over fishing interests in Belize described in Cho 2005). In the cases of Belize and Red Sea, it is unclear what principles or linkages justify characterization of these MPAs as a network (Gladstone et al. 2003; Cho 2005). Analysts of the Mexico case state that the process is necessarily a slow one

that requires considerable capacity development (Bezaury-Creel 2005).

Marine protected area networks can take various forms with both ecological and social goals. In addition to "ecological MPA networks" designed to ensure genetic connectivity, spillover, and habitat conservation (Palumi 2002; Palumbi 2004), "social MPA networks" are also being formed to facilitate learning and coordination of administration and planning. The *PAMANA KA* (Philippines), the Coastal Conservation and Education Foundation-assisted Southeastern Cebu (Philippines), and Pacific Islands Local Marine Management Area (LMMA) networks involve thousands of community leaders and MPA practitioners and provide solidarity and learning opportunities for participants and now influence national policies in various countries (Lavides and Tiburcio 2002; http://www.coast.ph/; http://www.lmmanetwork.org). Since MPAs and MPA networks are, from the perspective of resource users, intended to address both environmental and socio-economic needs, complementary ecological and social goals and designs need greater research and policy support (White et al. 2006).

Legal and jurisdictional issues that affect coral reef MPAs

Consideration of the legal structures, jurisdictional arrangements, and institutional capacities shape the feasibility of MPA management framework as outlined in Table 2. Reinvigoration of traditional management rules as in the Western Pacific, allow these important traditions to survive today. The decentralized governance structure, encoded in the Philippines Constitution, 1991 Local Government Code, 1998 Fisheries Code, strongly suggests adoption of community-based and co-management frameworks.

Seminal works on common property (Ostrom 1990) and institutional arrangements (Sabatier and Mazmanian 1983; May and Burby 1996) suggest that principles for institutional design, including top–down and bottom–up accountability, are discernable. Field research involving thousands of interviews in the Philippines, Indonesia, and West Pacific Island states suggests that fair and effective law enforcement (Pollnac and Pomeroy 2005), knowledge of the law (World Bank 1999), and consistency between national and local laws and institutional goals (Eisma et al. 2005; Lowry et al. 2005) are important to MPA effectiveness and sustainability. For example, the establishment of a National Integrated Protected Areas System (NIPAS) in the Philippines has strengthened some protected areas, but eroded management of well-known and successful community-based MPAs such as Apo Island. The collection of divers fees that were to be used for local development projects, while potentially a strong incentive for MPA management, became controversial when national agencies failed to disburse these funds for several years. Eventually, the issue was resolved, largely due to the effective lobbying by the MPA management board.

The importance of a clear legal mandate for a management board is central to success, as demonstrated in the early failures of Souffriere in St. Lucia (Siirila 2000). The subsequent clarification of the management board's roles and responsibilities and relation to agencies with formal enforcement capacity improved management. With a community-level process, the establishment of a municipal ordinance, or some similar legal instrument, is a critical step allowing for enforcement and sanctioning of violators if necessary (Christie et al. 2003a; White et al. 2006). Impunity of influential entities that pollute the environment (Eisma et al. 2005) or manage destructive fishing networks can quickly undermine commitment to MPA management, an unfortunately common condition in many developing country contexts.

Implementation of any MPA is a long term and complex endeavor. It requires cross-institutional collaboration in almost all cases. Technical assistance, education, and capacity development are clearly some of the cornerstones of developing effective MPA governance. In the most successful examples of MPAs (e.g., Apo Island, Tubbataha, GBRMP) long-term institutional support has been available (Arquiza and White 1999; Day 2002; White et al. 2002, 2005; Fernandes et al. 2005). Designing appropriate incentives for such long-term institutional commitments is a particularly site-specific process, but some factors are consistent:

- Constituency development (Olsen and Christie 2000) that can hold institutions accountable;
- Long-term funding as with GBRMP and the United States Sanctuaries program or development of endowment funds and user fee systems as with Tubbataha (White et al. 2005);
- Acknowledgement of success and development of leadership (Department of Environment and Natural Resources et al. 2001)
- Policy makers take on marine conservation and fisheries management as a serious issue through personal experience (e.g., former President Fidel Ramos in the Philippines—a committed diver and supporter of MPAs).

Conflated goals and untested mandates reducing coral reef MPA success

Marine protected areas have multiple objectives to maintain and restore biodiversity, aesthetic, recreational, and fishery

conditions. These objectives, while potentially complementary, may lead to conflict or at least trade-offs that must be carefully considered. Coral reef MPAs in tropical countries are frequently designed to meet both biodiversity conservation and fisheries management objectives. In some cases, these double objectives have been met (Maypa et al. 2002; Russ et al. 2005). In other cases, objectives change, are unclear, or differ among constituency groups. Such dynamics delayed the establishment of the Florida Keys Sanctuary (Suman et al. 1999), and eroded community support for small MPAs in the Philippines (Christie 2004). But maximizing fisheries and conservation benefits simultaneously with the same MPAs may, in fact, be unrealistic and result in collective action problems (Jones 2006).

Unclear goals and inattention to social dynamics are almost certain to result in conflict that derails MPA implementation. Conflict can come in various, and complex, forms (Dukes and Firehock 2001). The guidebooks for MPA planning generally highlight inter-resource user group conflicts that derive from competition for the same resources or spaces (Salm and Clark 2000; Sobel and Dahlgren 2004). Zoning schemes are one potential solution that has worked in locations with sufficient capacity for enforcement of detailed, spatially-explicit regulations.

In the Philippines, conflict between tourism brokers and fishing communities has emerged after control of an MPA was usurped by more powerful tourism interests (Christie 2004; Oracion et al. 2005). This sort of conflict may represent competition for marine resources (if divers remove resources), but also is generated from a sense among marginalized fishing communities that MPA rules are not equitable and that their traditional spaces and even MPA management efforts have been taken over by powerful interests (Trist 1999). Conflict can emerge if autocratic decision-making or selective implementation of regulations takes place (Nielsen et al. 2004; Eisma et al. 2005; Oracion et al. 2005).

Some have suggested that conflict emerges based on ideological assumptions embedded within models such as ICM that may favor an influential and wealthy sector (e.g., international tourism) over a marginalized one (e.g., reef miners) (Nichols 1999). Worldviews surrounding MPAs and appropriate goals vary between user groups (Christie et al. 2003b). While not empirically tested in various contexts, it is almost certain that influential donors, international NGOs, scientists advocating MPAs, and resource users have distinct worldviews and social constructions of the ocean (Steinberg 2001) that, unless accounted for in MPA planning and implementation, will likely result in conflict.

Increasingly, and sometimes uncritically, arguments for larger scale interventions are made. Such arguments, while grounded in appropriate desires to maximize ecological function for MPAs, are not often realistic or grounded in careful analysis of institutional feasibility and incentives. For example, the Large Marine Ecosystem (LME) movement, that proposes to manage systems at multi-national scales, is moving forward globally and would benefit for comparative analysis of institutional and governance options (Christie et al. 2006). It is notable that the argument for scaling up is rarely made by resource users or field personnel, who have a sense for what is possible in developing countries. This suggests that LME or global MPA network proponents should proceed with caution or run the risk of a backlash that labels such efforts as an attempt to "lock up" resources or "edicts" from the developed world. Finally unrealistic targets can drive a process in a manner that does not allow for well-designed interventions (Agardy et al. 2003; Christie et al. 2005). While there is likely more than a bit of strategy associated with proclamations of MPA targets, ambitious goals will not likely be met (MPA News 2005). This is an important signal that should be carefully analyzed. The reason may not simply be that funds are lacking. In short, there is a need for more local initiatives (local and national governments) that are scaled up (not imposed from above) and are not dependent on targets or the driving forces of international organizations (World Bank 2006). Conflicts grounded in competition for scarce resources or ideological beliefs will require consistent attention grounded in the theory and practice of conflict resolution (e.g., Dukes and Firehock 2001) that have yet to be widely adapted to diverse social contexts and marine resource issues.

With these cautionary comments in mind, some countries, like Australia and possibly the United States, have the will, financial, and institutional capacity to embark on large-scale MPAs and should pursue their development with the standards of participation, transparency, and equity as guiding principles. The development of a United States-wide MPA network, to include large areas such as the Northwest Hawaiian Islands, is important and may succeed if it balances the interests of conservationists, fishers, and the public. Large-scale efforts should be pursued, but only with care and appropriate timelines, in developing countries.

In conclusion, coral reef MPAs are an important management tool generating considerable scientific and public interest. The lessons of the Philippines (Buhat 1994; Wells and White 1995; Christie et al. 2003a) and supporting planning methods (Department of Environment and Natural Resources et al. 2001; Deguit et al. 2004; White et al. 2006) have broad relevance to other contexts. This management tool, if used wisely, has the potential to simultaneously improve coral reef ecological conditions as well as better the lives of dependent people (Vogt 1997; Russ et al. 2004). Greater research attention to the inextricably linked socio-ecological systems is

needed to identify how people respond to declining environmental conditions and conservation initiatives (Christie et al. 2003c; Mascia et al. 2003; White et al. 2004; Pomeroy et al. 2004, 2005; Scholz et al. 2004; Coastal Conservation and Education Foundation 2005; Wells 2006). In particular, the scaling up of MPAs to ecologically meaningful scales in a manner that does not undermine resource user commitment and overwhelm institutional capacity is a major challenge requiring research linked with practice. Consistent and just enforcement of MPAs represents a major practical challenge (Ostrom 1990; Kaplan 1998; Kuperan and Sutinen 1998; Honneland 2000; Jentoft 2000). Emergent models such as ecosystem-based management that are reliant on MPA networks and zoning schemes require greater empirical grounding in governance studies.

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