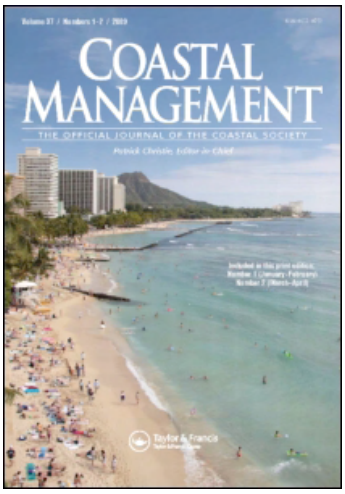

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Back to Basics: An Empirical Study Demonstrating the Importance of Local-Level Dynamics for the Success of Tropical Marine Ecosystem-Based Management

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Back to Basics: An Empirical Study Demonstrating the Importance of Local-Level Dynamics for the Success of Tropical Marine Ecosystem-Based Management

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This analysis of marine ecosystem-based management (EBM) and marine protected area (MPA) networks in the Philippines demonstrates that local-level governance and institutional dynamics are central to management effectiveness. Using survey and interview data from 36 communities in the Central Visayas, key variables are identified that are correlated with and predictive of marine protected area success. Empirically based management guidelines are: (1) EBM and MPA design must be context appropriate, (2) capacity development to develop MPA leadership and the technical skills are a good investment, (3) strict and fair punishment for infractions of legitimate rules should be utilized and appear to be welcomed by local residents, and (4) conflict and controversy are a predictable part of MPA design and implementation and need to be planned for. Most importantly, while scaling up management interventions can make both biological and institutional sense, there is a point at which institutional capacity is exceeded. This study strongly suggests that in the Philippines, and likely many other tropical contexts, establishing large-scale EBM, MPA networks, or extensive centrally planned zonation schemes based primarily on national law, international targets, and command-and-control policy are likely to fail. The pressing imperative of ocean-wide environmental decline should not be used to justify infeasible and poorly designed management interventions that ignore local dynamics and institutional constraints.

Keywords ecosystem-based management, human dimensions, marine, Philippines

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Introduction

There has been an evolution of marine Ecosystem-Based Management (EBM) models and efforts, including the large marine ecosystem (LME) approach (Sherman et al., 2005), ecosystem-based fisheries management (EBFM) (Pikitch et al., 2004; Christie et al., 2007), and ecosystem approach to fisheries (EAF) (FAO, 2003; World Wild Fund for Nature Australia, 2002). One widely accepted definition of marine EBM is:

> Ecosystem-based management is an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors . . . (McLeod et al., 2005, 1)

Proponents of these approaches agree that ocean ecosystems are facing growing pressures and that ecosystem function should be a central component of management regime design, but differ in their problem definition, scale, institutional approach, and balance of environmental and socioeconomic goals (Christie et al., 2007). These EBM-related models rely on common management techniques such as marine protected areas (MPAs), fisheries management, and coastal management. They also advocate for management at ecologically relevant scales and consideration of ecological functions, such as trophic dynamics (Christie et al., 2007).

As a management framework designed to shape human behavior, EBM success will depend, to a large degree, on our understanding of and ability to influence integrated socioecological systems, institutions, incentives, and tradeoffs. Despite important recent contributions (Hennessey & Sutinen, 2005) there remains considerable room for empirical work on these fronts. Much of the EBM literature lacks a true management dimension linked to a particular context. The focus tends toward an idealized version of how the results of fishery or ecosystem management "should" be accomplished without adequate consideration of what is being done and of the constraints on current efforts. Movement toward recommending ecosystem approaches must specify the social conditions, institutions, laws, budgets, and information that are required to actually achieve the ecosystem goals. The developing country context, with its relatively weak formal institutions and widespread poverty, is also poorly understood with respect to EBM approaches.

This article approaches the study of EBM in the Philippines by analyzing social data that was collected about two favored management tools—MPAs and MPA networks. Likely 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 [1988] reaffirmed in Resolution 19.46 [1994])

MPA networks have been defined in the following manner:

> A collection of individual marine protected areas operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fulfill ecological aims more effectively and comprehensively than individual sites could alone. The network will also display social and economic benefits, though the latter may only become fully developed over long time frames as ecosystems recover. (WCPA/IUCN, 2007, 3)

MPA networks are intended to have multiple roles.

> Sometimes it is more economically sustainable to establish several marine reserves instead of one big reserve in a particular area. For example, in some regions it might not be feasible to include a portion of each habitat in a single marine reserve without disrupting human activities. In such cases, ecological benefits can be maximized by creating multiple reserves that are close enough together to act as a network. In a marine reserve network, young and adults traveling out of one reserve may end up being protected in another reserve. Marine reserve networks provide more protection than a set of individual, unconnected reserves. (PISCO, 2007, 12)

EBM uses tools other than MPAs, but this article focuses on this particular management tool given its favored status within the EBM discourse, their increasingly wide usage through out the world, and targets for global MPA networks.

It is clear from a review of the literature and the aforementioned definitions that MPA networks are primarily designed and assessed with ecological principles in mind and intended to attain ecological goals that may eventually result in social and ecological benefits. This is not necessarily how this management tool is evolving in the field, as this article demonstrates, with social and institutional networks designed around a collection of MPAs within manageable governance boundaries. Stakeholders create viable social and information diffusion networks around MPAs that are a valuable means of addressing marine resource management and poverty reduction needs in developing country contexts (Pietri et al., 2009). Socioecological MPA networks, with balanced social and ecological goals, may represent a more accurate and equally compelling marine resource management tool worthy of research and expansion (Aswani & Hamilton, 2004). A socioecological MPA network can be defined as:

> A collection of individual marine protected areas, management institutions and constituencies operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fulfill ecological, social, economic and governance aims more effectively and comprehensively than individual sites could alone.

The use of MPAs has a long history in the Philippines. MPAs in the Philippines manifest varying degrees of success, ranging from "paper" (existing only in legislation) and non-functional MPAs to those, such as Apo Island, that have achieved worldwide recognition for their achievements (Christie & White, 2007; Lowry et al., 2009; Maypa et al., 2002; Pollnac et al., 2001; Russ et al., 2005; White et al., 2002; World Bank, 2006). While not formally documented, the vast majority of Philippine MPAs are established to protect coral reefs and associated seagrass systems (White et al., 2006).

The approach to Philippine MPA management is generally decentralized and based on community-based or co-management principles (Christie & White, 1997), but this is not unique to the Philippines (Castilla & Defeo, 2001; Pomeroy & Rivera-Guieb, 2006; World Bank, 2006; White et al., 2002). Recently, there has been a growing effort to create networks of MPAs that are based on ecological *and* social principles (Armada et al., 2009; Eisma-Osorio et al., 2009; Lowry et al., 2009; Pietri et al., 2009). All of these MPAs and MPA networks are embedded with on-going fisheries management regimes that control illegal fishing practices (e.g., the use of blast, cyanide, fine mesh nets, trawls in nearshore areas), but generally do not control fishing effort. Fishing effort is generally displaced from the no-take MPA to neighboring areas as there is no restriction on timing or numbers of gears outside the MPAs. Ocean zoning is generally not yet practiced except in some small areas of national significance. While the legal frameworks are well developed, the institutional support and enforcement of rules are weak in many cases (Eisma et al., 2005; Lowry et al., 2005).

There are methodological reasons to focus mainly on MPAs as well. In order to improve the feasibility of research on a complex management framework such as EBM and to isolate the factors that improve the likelihood of success, this analysis focuses on the preferred and best documented management tool—MPAs—which are embedded within larger EBM processes. The analysis then explores the governance implications of scaling up MPA management to ecologically relevant levels, a criterion of EBM (Christie et al., 2007; McLeod et al., 2005). Governance is conceived of 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, 91). Given the scale of the EBM mandate, this analysis focuses on institutional coordination aspects of governance.

While it is impossible and inappropriate to provide prescriptions for all contexts, this empirical study has clear management and design implications that go beyond the Philippines. This study is an initial response to the following practical need highlighted by Christie et al. (2007, 244):

> There is no clear road map to scale up from community-municipal to larger ecosystem levels. In contrast to the prevailing practice and theory that emphasize participatory processes, many of the key articles on institutionalization of marine EBM emphasize national and international accords as central to management success (Wang, 2004). In practice, the incentives for participating in scaled-up management and curtailing resource extraction may become unclear at higher levels of management required by ecosystem-based fisheries management (EBFM). Resolving when EBFM is most appropriately dependent on command and control (ala Pikitch et al., 2004, Wang, 2004) or bottom-up management models (Christie and White 1997) or a combination of both will require experimentation and evaluation. (Christie et al., 2007, 244)

This analysis is focused on identifying practical strategies and tactics that will maximize the chances of MPA, MPA networks, and EBM success. In order to develop this type of information we need an analysis of comparable data collected across a range of sites where probabilities associated with the various factors said to impact success of EBM and MPAs can be estimated.

Methods

Sample

It was decided to conduct the analysis within one nation as a means of controlling for aspects of national legislation and policies that could impact establishment and success of MPAs, MPA networks, and EBM. A cross-national study would only further complicate an already complicated analytical problem. The Philippines was selected because the nation has had more experience and a larger number of MPAs and groundbreaking coastal management and marine EBM than any other country. The MPAs in the Philippines also manifest a wide range of levels of success.

The focus within the Philippines is on two self-described examples of EBM that are using MPA networks as a key management tool in Danajon Bank off of Bohol Island and the fringing reefs off of South Cebu Island. The sample is a representative quota sample including only MPAs that include coral reef area, allow no fishing within the boundary, and were officially recognized by municipal ordinance for at least three years. It was selected to include sites manifesting a range of "success," as measured by an objective multi-variable rating system (White et al., 2005).

Research Site Descriptions

The South Cebu Island sites are found on the southwest and southeast sides of the island. The lead implementing agency for these MPAs is the Coastal Conservation and Education Foundation or CCEF (see Eisma-Osorio et al., 2009 and www.coast.ph). The southeast Cebu study site (Figure 1) consists of approximately 118 kilometers of shoreline and 726 hectares of coral reefs along the Cebu Strait, separating the islands of Cebu and Bohol (Eisma-Osorio et al., 2009). The efforts in the southeast Cebu area were supported with 7 years of grants from the David and Lucile Packard Foundation covering 8 municipalities and 49 *barangays*. Each municipality has multiple *barangays* (or villages) within its boundary. The MPA sites in Southwest Cebu are within 2 municipalities. While the two Cebu areas are separated geographically, MPAs were established by local governments and CCEF using comparable planning and implementation methods. The Cebu nearshore area is composed mainly of a combination of coral reef, seagrass, and mangrove habitat and is characterized by a sharply sloping shoreline and multiple fringing reefs. In the 1980s, coral reefs in this area were generally degraded, with most in fair to poor condition.

Management efforts are beginning to show promising results in terms of habitat improvements and fish yields (Eisma-Osorio et al., 2009). The area's MPAs were established individually and increasingly are being managed collectively through a "cluster" of municipal governments and government agencies with the support of CCEF—the most obvious manifestation of scaled up management. Presently, there are 22 MPAs (average size 13.8 ha) totaling 290 ha of no-take areas or 0.24% of the total combined municipal waters. Thirteen MPAs (in 15 *barangays*, average MPA size 15.6 ha) in Southeast Cebu and 3 MPAs (in 3 *barangays*) in Southwest Cebu were selected for study, which represented a range of MPA effectiveness (White et al., 2005). These MPAs are not a formal biological network, as defined earlier because their locations were not chosen to maximize connectivity or representation of marine habitats. However, based on institutional collaboration, especially joint enforcement, there is growing interest in collective management and establishment of a multi-municipality MPA network.

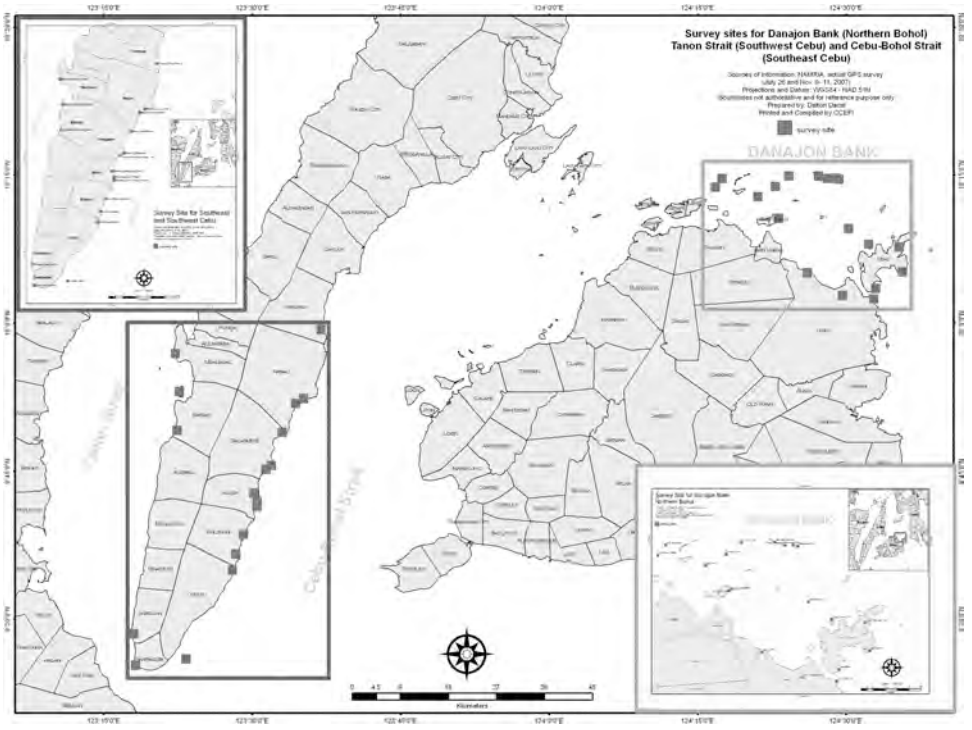

Figure 1. Cebu and Bohol research sites.

Danajon Bank (Figure 1) is located on the northern edge of Bohol Island in the Central Visayas Region. Currently, the lead institution for MPA implementation is the Fisheries Improved for Sustainable Harvest project or FISH (see Armada et al., 2009 and www.oneocean.org/fish/the_project.html). FISH is a 7-year project paid for by the US Agency for International Development. Many of these MPAs were established prior to FISH by other programs. The political boundaries of Danajon Bank encompass a large area of 17 municipalities spread over various island jurisdictions. The double barrier reef, one of only three in the entire Indo-Pacific region, consists of three large reefs and five smaller reefs spanning an area of 272 km^2 (Christie et al., 2006). Danajon Bank is a calm, relatively protected, low energy marine environment with high rates of sedimentation and poor light penetration. Despite high coral diversity, a study of benthic composition in nine focal areas found only an average of 25% living coral cover (FISH, 2005). Adjacent mangrove forests have been subject to pressure from both wood extraction and aquaculture activities (Christie et al., 2006). Twenty-eight small no-take MPA have been established by various government and nongovernmental organization (NGO) initiatives over the last two decades in the four municipalities included in this study—Talibon, Buen Unido, Ubay, President CP Garcia. This study conducted research in 18 MPAs in 18 *barangays*.

Complementary Research Methods

Complementary research methods were used to explore these issues from both a qualitative and quantitative perspective. Qualitative semi-structured interviews were conducted with 101 key informants between 2003 to 2007 to investigate, among other topics, their

perceptions of environmental change in the areas, their management experiences, their explanations for management successes and failures, and conflict. Informants, all of whom were involved in MPA and EBM implementation, were dive resort owners, resource users, MPA and EBM practitioners, community leaders, local government officials, and academics. A balance of ages and genders was ensured, although no youth were specifically interviewed due to human subject considerations. Interview data were analyzed using Atlas.ti software that allows for systematic analysis of qualitative information (Miles & Huberman, 1994; Strauss & Corbin, 1990).[i] This analysis consisted of identifying and labeling relevant themes within interviews (e.g., employment, perception of MPA impacts). Once portions of the interviews were coded, with some quotes failing into multiple themes, search commands (using code labels) were used to scan the interviews for quotes meeting two or more criteria (e.g., "diver resort owner informant" and "perception that the environment is improving"). As trends emerged (or predicted ones did not), theoretical memos were affixed to each code label. These analytic memos served as starting points to relate findings to the relevant literature and biological findings. This approach allowed the researchers to create an "analytic trail" that demonstrates how conclusions were reached.

The method used to measure the management processes and impacts takes advantage of the human ability to make graded ordinal judgments concerning both subjective and objective phenomena. Community members' perception of the MPA's impact on the resource is also an important indicator of how MPAs are believed to influence biophysical conditions and resources on which they rely. It is these perceptions that will influence their behavior regarding EBM or MPAs.

Structured survey interviews were conducted for 18 *barangays* (or villages) in each MPA network ($n = 36$) over a period of two months in 2007. For every *barangay*, 13 respondents were interviewed: 10 resource users, 2 members of the MPA management committee, and 1 local *barangay* government official. Interviews, conducted in the local dialect by Filipinos, focused on issues such as context, MPA social and ecological impacts, management practice, enforcement, fisheries management, and institutional coordination.

The statistical methods used in this analysis were modeled upon some of the methods of Pollnac et al. (2001) in their study of success of community-based MPAs in the Philippines. Key variables from survey questions were isolated, and the results were averaged across the user groups by *barangay*. The first half of the statistical analysis focused on the way in which various groupings of variables are related to MPA success. The selection of the variable groups and their prioritization was based on outputs from the qualitative interviews and site-level analyses that were described earlier. Correlation analysis was performed to determine if relationships existed between six measures of MPA success (i.e., dependent variables) and independent variables in the following categories: contextual variables, management and design variables, institutional coordination, enforcement, and capacity development. The measures of MPA success included both biological and social variables, consisting of the *barangay* officials' perception of: (1) MPA economic benefits and (2) overall sanctuary management effectiveness. Resource users' perceptions of: (3) fish abundance near MPAs after MPA establishment, (4) coral condition inside and near MPAs after MPA establishment, (5) degree of MPA rule compliance, and (6) strength of MPA rule enforcement. The six MPA success variables, measured using 5-point Likert scales, were reduced to three factors using principal component analysis. Then, multiple step-wise regression analysis was used to determine the strength of the significantly correlated variables as predictors of MPA success. Three measures of institutional collaboration were reduced to one factor using principal component analysis and the strength of significantly correlated variables as predictors was tested using multiple step-wise regression analysis.

Finally, a composite score of conflict surrounding MPAs was developed and the strength of significantly correlated variables was tested using multiple step-wise regression analysis. This analysis considers only potential linear relations between groups of variables through regression analysis, but it should be acknowledged that important nonlinear relationships may exist between variables. The initial correlation and regression analyses were conducted on MPAs that are part of two MPA networks, although most questions focused on individual MPAs within those networks. The analyses concerning institutional collaboration and enforcement are pertinent to understanding MPA *network* feasibility, because institutional collaboration is currently focused on improving enforcement at the MPA sites and reducing illegal fishing operations that cross municipal boundaries. Narrative data were used to build rich descriptions of phenomena.

Results and Discussion

The overall logic guiding the analyses presented in this section is that contextual and MPA design and management processes impact MPA and MPA network success. As EBM requires institutional collaboration, this will be the principle dynamic examined that has direct relevance to EBM feasibility. Between site differences on these variables will be examined to elucidate significant and predictive relationships.

Correlations between Contextual Variables and Measures of MPA Success

Various statistically significant correlations between contextual variables and the six measures of MPA success emerge upon examination (four of which are the same as Pietri et al., 2009) (Table 1). These contextual variables include measures of basic social conditions as well as perceived conditions that are possibly relevant to resource management. Most apparent are the negative correlations between perceived increases in fish abundance since MPA establishment and improved coral cover since MPA establishment and population levels in 2000. Resources may be more intensively utilized as population in an area increases or it may be more difficult for larger, and more complex, human populations to cooperate in marine resource management. Similarly, the remoteness of an area from the municipal center where population densities are higher is positively correlated with perceived increased fish abundance since MPA establishment—a finding consistent with Cinner and McClanahan's (2006) documentation of a strong positive correlation between fish trophic level and increased distance from markets. As social heterogeneity of a community increases, measured as the number of religions, *barangay* officials are less likely to report benefits derived from the MPA—a finding in agreement with Pollnac et al. (2001). The perceived threat of illegal commercial fishing operations is also positively correlated with perceived improvements in the environment. External threats to a community's resource base may motivate enactment of resource management protection, in line with Pollnac et al. (2001) and general social movement theory (Morris & Mueller, 1992).

Correlations between Management and Design Variables and Measures of MPA Success

The aforementioned findings support the logic of expanding management effort to respond to the growing competition and conflict between artisanal and commercial fishing operations. Such an approach to EBM will rely on no-take MPAs, but also general fishery management because this is the main marine resource use (World Bank, 2006). For EBM

Table 1
Spearman's Rho correlation coefficients between contextual variables and measures of MPA success

	MPA economic benefits for community [B]	Effectiveness of MPA management[B]	Increased fish abundance[R]	Improved coral condition[R]	Increased MPA compliance[R]	Improved enforcement effectiveness[R]
Population in 2000[B]	−0.172	0.192	−0.452**	−0.354*	−0.129	−0.012
Different *barangay* captains since 1990[B]	0.215	−0.046	−0.137	−0.025	0.175	0.036
Distance from municipal center[B]	0.098	−0.075	0.404*	0.271	−0.310	−0.216
Number of religions[B]	−0.382*	0.098	−0.171	−0.157	0.248	0.298
Tourism present[B]	0.000	−0.145	−0.115	0.056	0.046	0.084
Number of active community groups[B]	0.008	0.050	−0.117	−0.241	0.005	0.048
Municipal fishing grounds threatened by commercial fishing[R]	0.124	−0.315	0.376*	0.435**	−0.067	−0.211

*$p < .05$; **$p < .01$; $n = 36$. [B] = *Barangay* Council member; [R] = Resource user.

and MPA networks to succeed, basic conditions must be met. Table 2 identifies basic correlations between measures of management effectiveness and the six measures of MPA success. These metrics of management effectiveness, estimated using Likert Scales or as presence/absence, measure the presence of community groups, participatory processes and government support for MPAs—conditions that were identified as critical by other studies (Christie, 2004; Maypa et al., 2002; McClanahan et al., 2006; White et al., 2002).

There were notably few strong direct correlations between these variables. Resource users' evaluation of MPA management committee effectiveness strongly correlates with their opinion of enforcement effectiveness. *Barangay* officials' evaluation of the management committee effectiveness correlates with their general opinion of sanctuary management effectiveness and with resource user's sense that MPA rules are complied with. Surprisingly, the involvement of the current *barangay* captain in MPA managment is negatively correlated with resource user ratings of MPA rule compliance—possibly an indication that elected *barangay* political leadership and MPA management should remain separate. Community support, as reported by resource user informants, was strongly correlated with their perception of increases in fish abundance since MPA establishment and inversely correlated with *barangay* official's opinion that sanctuaries were effectively managed. Other variables that measured perceptions of whether community membership or municipal government opinion was considered during planning or management, the presence of alternative livelihood programs, or the presence of MPA officers were not significantly correlated with these measures of MPA success.

Correlations between Institutional Coordination and Measures of MPA Success

The expansion of management in Cebu and Bohol to include a widening array of coordinated management activities requires considerable inter-institutional coordination (Eisma-Osorio et al., 2009; Armada et al., 2009). Institutional coordination was measured, using Likert and presence-absence variables, at multiple levels and mainly emphasized coordination around a key MPA management activity—enforcement. Ideally this coordination should take place at various levels of governance (Ostrom, 1992; Hennessey & Sutinen, 2005; Young et al., 2007). Findings using correlation analysis alone are not conclusive but identify important patterns of interrelationships between measures of MPA success and institutional collaboration (Table 3). *Barangay* official opinion that MPA management is coordinated with other *barangays* is significantly correlated with their opinion that the MPA has generated benefits for the community and resource user opinion that coral cover has increased in the area. Similarly, increased inter-MPA management committee collaboration is strongly correlated with resource user evaluation of enforcement effectiveness. Communication with the local mayor about MPA management, coordination between mayors, and membership of MPA management committee members on their respective *barangay* councils were not significantly directly correlated with these six measures of MPA success (but may be indirectly related through intermediary processes).

Correlations between Enforcement and Measures of MPA Success

As demonstrated by this quote, enforcement of MPA and fishery regulations is a high priority for most coastal residents and leaders.

> De la Victoria: I'll be six years in this job by October—my work is difficult because of the hazards that go with it. When we do market denial, one box [of

Table 2
Spearman's Rho correlation coefficients between measures of management and design processes and measures of MPA success

	MPA economic benefits for community[B]	Effectiveness of MPA management[B]	Increased fish abundance[R]	Improved coral condition[R]	Increased MPA compliance[R]	Improved enforcement effectiveness[R]
Effectiveness of MPA management committee[B]	0.289	0.384*	–0.256	–0.187	0.382*	0.279
Effectiveness of MPA management committee[C]	0.035	0.239	0.087	−0.058	0.058	0.322
Effectiveness of MPA management committee[R]	−0.014	0.183	0.191	0.291	0.24	0.581**
Current *barangay* captain involved in sanctuary[B]	0.031	0.059	0.017	−0.230	−0.450**	−0.15
Community support for MPA[C]	0.241	0.321	0.002	−0.111	0.099	0.362*
Community support for MPA[R]	0.043	−0.344*	0.534**	0.321	−0.06	−0.042
Informants' view considered in MPA design[C]	0.023	−0.007	0.289	0.301	0.127	0.187
Informants' view considered in MPA design[R]	0.061	0.054	0.074	0.057	−0.308	0.078
Community members consulted for MPA design[R]	0.255	0.014	−0.045	−0.034	−0.027	−0.165
Community decided where MPA located[C]	0.203	0.182	−0.242	−0.194	−0.076	0.2
Municipal government decided where MPA located[C]	−0.193	−0.213	0.195	0.127	0.051	0.058
Presence of alternative income projects[C]	−0.011	0.062	−0.085	0.037	0.018	−0.101
Presence of MPA management officials[C]	0.108	0.228	0.158	0.205	0.024	0.165

*$p < .05$; **$p < .01$; $n = 36$. [B] = *Barangay* Council member; [C] = Management committee member; [R] = Resource user.

Table 3
Spearman's Rho correlation coefficients between measures of institutional coordination and MPA success

	MPA economic benefits for community[B]	Effectiveness of MPA management[B]	Increased fish abundance[R]	Improved coral condition[R]	Increased MPA compliance[R]	Improved enforcement effectiveness[R]
Sanctuary management committee coordination with committees from other municipalities[B]	0.219	0.078	−0.049	−0.118	0.210	0.053
Coordinate sanctuary enforcement with neighboring *barangays*[B]	0.411*	0.234	0.154	0.339*	0.158	0.14
Coordinate sanctuary enforcement with neighboring *barangays*[C]	0.293	0.146	−0.199	−0.109	0.172	0.213
Inter-sanctuary management committee collaboration[C]	0.023	0.178	−0.027	−0.029	−0.109	0.457**
Helpful to communicate with mayor about sanctuary management[C]	0.073	0.167	0.102	0.033	−0.073	0.071
Sanctuary management committee also elected *barangay* officials[C]	0.246	0.034	−0.043	−0.219	−0.176	−0.264
Mayors collaborating to improve sanctuary management[B]	0.307	0.062	−0.132	0.013	−0.060	0.155
Mayors collaborating to improve sanctuary management[C]	0.117	0.08	0.153	0.245	0.076	0.184

*$p < .05$; **$p < .01$; $n = 36$. [B] = *Barangay* Council member; [C] = Management committee member; [R] = Resource user.

> illegal fish] which we are able to confiscate will cost 10,000 pesos to15,000 pesos. About 100 kilos of dynamited fish. I received many death threats but I never carried a firearm even if I am authorized. For me, its enough that I am doing my job well and I have a clear conscience . . . (June 6, 2002)

Enforcement is so important that some individuals are willing to risk their lives to reduce rampant illegal fishing. This informant, in fact, was subsequently killed for his outspoken position and actions, allegedly by perpetrators of large-scale illegal fishing operations (Cebu City Government website, 2006; Republic of the Philippines Office of the Press Secretary website, 2006).

Rather than supplying enforcement equipment or stipends for enforcement officers, FISH and CCEF have conducted various educational seminars on topics such as proper evidence collection and Philippine marine law. The enforcement activities in Cebu include both MPA and fishery regulations. This analysis considers the relationships between measures of enforcement activities and the six measures of MPA success.

Enforcement effectiveness was measured in multiple ways and at different levels of governance using Likert and presence-absence variables and then correlated to measures of MPA success. MPA management committee members and resource users had different opinions about the effectiveness of the local *barangay*-level MPA and fishery regulation enforcement units referred to as *bantay dagat* or sea guards (Table 4). According to resource users' interviews, the involvement of *bantay dagat* in enforcement of MPA and fishery regulations was negatively correlated with perceived fish abundance since MPA implementation, but if the *bantay dagat* was perceived as effective, fish abundance was reported to have increased. This finding suggests that *bantay dagats* are not always effective in carrying out their enforcement duties. While not directly measured, effective *bantay dagat* are generally reliant on financial, legal, and equipment support from local municipal governments. *Bantay dagat* involvement in enforcement was also strongly positively correlated with self-compliance with MPAs rules. In agreement with Kuperan and Sutinen (1998), the importance of fairness of enforcement, or legitimacy, is supported by the strong positive correlations between this variable and MPA rule compliance and perceptions of general enforcement effectiveness. The strictness of punishment is an important consideration as well. The severity of sanctions for MPA rule violations was positively correlated with resource user estimates of fish abundance and negatively correlated with resource user evaluations of self-compliance with rules. Resource users reported higher sanctions for MPA rule violations in those communities where they rated enforcement as generally effective and where community MPA management committees rated MPAs as well managed. Sustained funding for MPA management is strongly correlated with improved enforcement. And clear MPA boundaries are correlated with self compliance with MPA rules and improved enforcement.

Correlations between Capacity Development and Measures of MPA Success

Capacity development through management experience, formal and informal education, and leadership are central to the development of inter-institutional collaboration (Lowry et al., 2005; Pietri et al., 2009). Measure of capacity within the NGO and local government, two critical entities, and leadership capacity were measured using Likert and presence/absence variables and related to measures of MPA success. The perception that local municipal government and NGO personnel are technically skilled is positively correlated with perceived fish abundance increases (Table 5). Similarly, both management committee members and

Table 4
Spearman's Rho correlation coefficients between measures of rule enforcement and MPA success

	MPA economic benefits for community[B]	Effectiveness of MPA management[B]	Increased fish abundance[R]	Improved coral condition[R]	Increased MPA compliance[R]	Improved enforcement effectiveness[R]
Bantay dagat involved in sanctuary enforcement[C]	−0.152	−0.214	−0.153	−0.207	0.134	0.117
Effectiveness of *bantay dagat*[C]	0.128	0.073	0.078	0.041	0.123	0.228
Bantay dagat involved in sanctuary enforcement[R]	0.270	0.028	−0.355*	−0.196	0.433**	0.320
Effectiveness of *bantay dagat*[R]	−0.077	0.263	0.341*	0.115	−0.128	0.451**
Fair sanctuary rule enforcement[R]	0.008	0.320	−0.269	0.087	0.505**	0.707**
Strict sanctuary rule enforcement[C]	−0.081	−0.053	0.385*	0.19	−0.343*	0.084
Strict sanctuary rule enforcement[R]	−0.043	0.358*	−0.192	0.064	0.204	0.536**
Sustained funding for the sanctuary[C]	0.038	0.267	−0.181	0.011	0.313	0.458**
MPA boundaries marked[R]	−0.050	0.293	0.021	0.158	0.383*	0.357*

*$p < .05$; **$p < .01$; $n = 36$. [B] = *Barangay* Council member; [C] = Management committee member; [R] = Resource user.

Table 5
Spearman's Rho correlation coefficients between measures of capacity and MPA success

	MPA economic benefits for community[B]	Effectiveness of MPA management[B]	Increased fish abundance[R]	Improved coral condition[R]	Increased MPA compliance[R]	Improved enforcement effectiveness[R]
Technical skill level of municipal government[C]	0.083	−0.013	0.343*	0.019	−0.202	−0.095
Technical skill level of NGO[C]	0.208	−0.283	0.359*	0.143	−0.034	0.111
Clear MPA leader[C]	0.158	−0.037	0.427**	0.154	−0.279	−0.112
Clear MPA leader[R]	0.158	0.109	0.413*	0.414*	0.009	0.199

*$p < .05$; **$p < .01$; $n = 36$. [B] = *Barangay* Council member; [C] = Management committee member; [R] = Resource user.

resource users reported an increase in fish abundance in sites with clear leaders supporting the MPA.

Relationships between Combinations of Factors and MPA Success

While examining correlations between individual variables is useful, consideration of interactions between multiple variables is likely more realistic. Through the use of principle component analysis with varimax rotation, the six measures of MPA success were reduced to three components of MPA success. Each component is based on underlying relationships between individual variables. Table 6 presents the results of the analysis using varimax rotation. The scree test was used to determine the number of components. The three components account for a total of 76% of the variance in the data set. Items loading highest on the first component are clearly related to biological measures of success; thus, the component is named "biological improvement." Items related to enforcement effectiveness and MPA management load highly on the second component and that component is named "enforcement and management effectiveness." Items related to MPA economic benefits and compliance loaded highest on the third component, which is labeled "economic benefits and compliance." The three components clearly reflect the goals of MPA management efforts—improved biological conditions including more abundant fish and improved coral reef cover, effective enforcement, rule compliance, and generation of economic benefits for local communities.

Component scores representing the position of each community on each component were created. The component scores are the sum of the component coefficients times the sample standardized variables. These coefficients are proportional to the component loadings. Hence, items with high positive loadings contribute more strongly to a positive component score than those with low or negative loadings. Nevertheless, all items contribute (or subtract) from the score; hence, items with moderately high loadings on more than one

Table 6
Rotated component matrix for measures of MPA success

	Biological improvement	Enforcement and management effectiveness	Economic benefits and compliance
Increased fish abundance[R]	0.901	−0.145	−0.122
Improved coral condition[R]	0.900	0.224	0.127
Improved enforcement effectiveness[R]	0.183	0.876	0.008
Effectiveness of MPA management[B]	−0.110	0.828	0.003
MPA economic benefits for community[B]	−0.007	−0.128	0.845
Increased MPA compliance[R]	0.008	0.353	0.674
Percent variance explained	28%	28%	20%
Total variance explained:	76%		

[B] = *Barangay* Council member; [R] = Resource user.

component (e.g., MPA rule compliance for the analysis presented here) will contribute at a moderate level, although differently, to the component scores associated with both components.

The next logical analysis concerns the relative importance of the predictor or independent variables in terms of their individual and combined ability to account for variance in the MPA success component scores. This can be accomplished with regression analysis, and most efficiently with step-wise regression analysis. In this analysis, those variables that exhibited statistically significant bivariate correlations with the six MPA measures of success (drawing from aforementioned analyses) were intercorrelated with the three MPA success component scores. The independent variable with the highest correlation to the MPA success component score under consideration (the one that explains the most variance in the MPA success component score) was entered first into the multiple regression equation. Then the effects of the entered variable were controlled, and the variable with the next highest partial correlation with the MPA success component score under consideration was entered into the equation. The R^2 (squared multiple correlation coefficient, which is equal to the amount of variance explained in the MPA success component score) for the independent variables and the dependent was then calculated. This step-wise procedure is continued for each of the three MPA success component scores until some pre-set criterion is reached. In this case, the criterion was that the variable to be entered has a $p < .05$ and the criterion for removal of an already entered variable was $p > .10$. Partial correlations were carefully examined at each step to ensure that multi-collinearity did not have an effect on the analysis. The results of these analyses for the three MPA success component scores can be found in Table 7. Due to the criteria imposed on the step-wise procedure ($p < .05$ for entry and $p > .1$ for removal), only a limited number of independent variables entered the regression equations. The variables Municipal fishing threatened by commercial fishing and effectiveness of *Bantay dagat* entered for the "Biological improvement" component. Fair sanctuary rule enforcement and Strict sanctuary rule enforcement entered for the "Enforcement and management effectiveness" component. Coordinate sanctuary enforcement with neighboring *barangays* and Effectiveness of MPA management committee entered for the "Economic benefits and compliance" component. These independent variables account, respectively, for 39%, 47%, and 31% (see Adjusted R^2) of the variance for the three component scores—relatively high levels for social research.

These findings indicate that efficient and fair enforcement are critical to MPA success. The existence of an external threat, such as intrusion by illegal large-scale commercial vessels into municipal waters, can motivate commitment to MPA management. And that strengthening management and enforcement institutions and facilitating coordination increase the likelihood of MPA success (Pollnac et al., 2001; Lowry et al., 2005; White et al., 2002). Given the informants, the survey findings stress dynamics at the community and inter-community level.

Relationships between Combinations of Factors and Institutional Collaboration

Inter-institutional collaboration is necessary for EBM and MPA networks that span jurisdictional lines. CCEF and FISH have emphasized and supported inter-*barangay* and inter-municipal government collaboration, especially for enforcement. As demonstrated with this quote, the Southeast Cebu cluster management council and Bohol municipal governments decided to emphasize inter-municipal government collaboration for patrolling and case filing to improve MPA rule enforcement (Armada et al., 2009; Eisma-Osoria et al., 2009).

Table 7
Predictors of MPA success

	Standardized coefficient	*T*	*p*
Dependent variable: Biological improvement (score standardized)			
Standardized independent variables:			
Municipal fishing grounds threatened by commercial fishing[R]	.612	4.221	<.001
Effectiveness of *bantay dagat*[R]	.466	3.212	.003
$R = .65$; $R^2 = .42$; Adj. $R^2 = .39$; $F = 11.02$; $p < .001$; $n = 33$			
Dependent variable: Enforcement and management effectiveness (score standardized)			
Standardized independent variables:			
Fair sanctuary rule enforcement[R]	.301	4.016	<.001
Strict sanctuary rule enforcement[R]	.324	2.402	.023
$R = .71$; $R^2 = .50$; Adj. $R^2 = .47$; $F = 15.05$; $p < .001$; $n = 33$			
Dependent variable: Economic benefits and compliance (score standardized)			
Standardized independent variables:			
Coordinate sanctuary enforcement with neighboring *barangays*[B]	.430	2.635	.015
Effectiveness of MPA management committee[B]	.393	2.409	.024
$R = .60$; $R^2 = .36$; Adj. $R^2 = .31$; $F = 6.87$; $p = 0.004$; $n = 27$			

[B] = *Barangay* Council member; [C] = Management committee member; [R] = Resource user.

Table 8
Rotated component matrix for institutional collaboration for enforcement

	Enforcement coordination
Mayors collaborating to improve sanctuary management[B]	.791
Inter-sanctuary management committee collaboration[C]	.807
Coordinate sanctuary enforcement with neighboring *barangays*[C]	.889
Total variance explained	69%

[B] = *Barangay* Council member; [C] = Management committee member.

> Interviewer: How did you cooperate with each other in order to implement the laws and policies in the sanctuary?
>
> Government informant: We did this through patrolling. There's unity in the patrolling. . . . We have a schedule for the patrol. When the patrol boat from Talibon comes here in Bien Unido to get those deputized to be in the patrol . . . if they are able to capture the illegal fishers in Bien Unido, Bien Unido has jurisdiction where to file the case [in court]. . . (July 2007)

In both locations, municipal governments have invested in and share enforcement equipment such as boats and radios. Agreements and lines of communication between these municipalities allow for efficient pursuit of illegal fishers across municipal sea boundaries, a relatively new regulatory ability that allows for management to be scaled up beyond individual municipal boundaries.

As above, the following analysis uses principal component analysis to create component scores that measure the use of inter-institutional collaboration for enforcement of MPA and fishery regulations and other management responsibilities, which are then used as dependent variables in multiple regression analysis. Table 8 exhibits the results of the principal component analysis conducted on three variables measuring institutional collaboration at various levels of governance—mayors, *barangay* councils, and MPA management committees. The overall goal is to identify those processes and conditions that facilitate effective inter-institutional collaboration across jurisdictional boundaries—a key requirement for EBM feasibility.

As previously, a component score representing the position of each community in relation to this component was created. Step-wise multiple regression was used to identify those independent variables that best predicted the component measure of inter-institutional collaboration. With guidance from the qualitative interview data and published accounts in this context (Lowry et al., 2005; White et al., 2005), variables were examined in the step-wise regression analysis that measured processes and conditions that may influence institutional strength and incentives to collaborate such as the participatory decision-making processes, leadership, educational efforts, institutional capacity, sustainable funding, and external threats to fishery resources.

Due to the criteria imposed on the stepwise procedure ($p < .05$ for entry and $p > .1$ for removal), only a limited number of independent variables entered the regression equations (Table 9). The variables Technical skill level of NGO, Involvement in MPA training, and

Table 9
Predictors of institutional collaboration for enforcement

	Standardized coefficient	*T*	*p*
Dependent variable: Enforcement coordination component (score standardized)			
Standardized independent variables:			
Technical skill level of NGO[C]	.595	4.326	<.001
Involvement in MPA training[C]	.504	3.700	.001
Community members consulted for MPA design[R]	.464	3.425	.002
$R = .74$; $R^2 = .55$; Adj. $R^2 = .50$; $F = 10.548$; $p < .001$; $n = 30$.			

[C] = Management committee member; [R] = Resource user.

Community members consulted for MPA design entered as the best predictors of the component measure of inter-institutional collaboration for enforcement and explain 50% of the variance for the component score. These findings strongly validate the role of skilled external institutions such as CCEF and FISH, which facilitate inter-institutional collaboration through educational and participatory planning processes. Investment in human capacity development and participatory processes are, therefore, critical to the success of EBM and MPA networks.

Relationships between Combinations of Factors and Conflict

The challenges associated with EBM and MPA networks are complex and potentially overwhelming (Christie et al., 2007). A recurring challenge to MPA implementation and sustainability is the emergence of conflict between proponents and opponents of MPAs. Conflict between and among government institutions, environmental NGOs, fishing communities, and tourism brokers are increasingly well documented (Christie, 2004). While conflict surrounding MPAs is well documented in many cases around the Philippines, the conflict surrounding the MPAs of Bohol and Cebu would best be described as ubiquitous but relatively minor. The measure of presence of MPA conflict (0 = no conflict and 1 = conflict) are reported by categories of informants in the 36 sites as follows: *barangay* officials (75%), MPA management committee members (71%), and resource users (64%). When present, the level of MPA conflict (1 = minor, 2 = serious, 3 = very serious) are reported by categories of informants in the 36 sites as follows: *barangay* officials (median = 1.0), MPA management committee members (median = 1.0), and resource user (median = 1.0). The consistency of responses for presence and level of conflict between informant types indicates the reliability of these data.

To examine conditions or processes that may contribute to the presence of conflict in Cebu and Bohol surrounding MPA planning and implementation, regression analysis was preformed. The scores for conflict presence were summed to create a composite conflict presence score for all informant types (range = 0.75–3). Based on a consideration of the qualitative interview data, correlations scores and MPA literature (Christie & White, 2007; Oracion et al., 2005; Pollnac et al., 2001), 17 independent variables were considered, which represented MPA design criteria, perceived improvements in coral cover and fish abundance, the sharing of benefits, MPA leadership, the technical skill of the municipal government, the

Table 10
Predictors for presence of conflict

	Standardized coefficient	*T*	*p*
Dependent variable: Composite conflict presence score			
Standardized independent variables:			
Increase in fish abundance[R]	.562	3.971	.001
Community decided MPA location[C]	.421	2.939	.007
MPA boundaries clearly marked[C]	.374	2.656	.014
Benefits equally shared[R]	−.331	−2.326	.029
$R = .75$; $R^2 = .56$; Adj. $R^2 = .48$;	$F = 7.27$;	$p = .001$;	$n = 28$

[C] = Management committee member; [R] = Resource user.

strength of the *bantay dagat*, the strictness of MPA rule violation punishment, the fairness of enforcement, the marking of MPA boundaries, and degree of participatory planning.

Table 10 displays the correlation results, which suggest that incidence of conflict increases as benefits such as increased fish abundance are realized but unequally shared with the community—a finding consistent with Christie (2004) and Oracion et al. (2005). The incidence of conflict also increased as MPA boundaries were clearly marked and the community decided the MPA location. While perhaps surprising, the presence of clear boundaries may reduce the possibility for informal resolution when determining whether rules have been violated, a common occurrence in the Philippines (Eisma et al., 2005). Also, conflict may be generated from internal conflicts over sanctuary location between rival community groups or fishers using distinct gear types as observed elsewhere (Christie, 2004). Considering that the level of overall conflict is relatively minor, this "low-level" conflict associated with setting boundaries through participatory processes should be interpreted as a common part of the MPA planning process that should be anticipated (and is preferable to the potential large-scale and irresolvable conflicts that emerge out of non-participatory planning processes). MPA planners should be prepared to encounter conflict derived from new MPA boundaries, strict enforcement, perceived inequitable distribution of MPA benefits, and even participatory planning processes that seek to resolve complex tradeoffs. The need for context-appropriate conflict resolution mechanisms and planning processes that help ensure equitable distribution of benefits is apparent if MPA networks are to succeed. Left unaddressed, conflict has the potential to derail MPA success and management sustainability (Christie, 2004). Considering that conflict levels are relatively low in Cebu and Bohol, it appears that CCEF and FISH are working in concert with decision-makers and communities to minimize inevitable conflict before it undermines MPA success.

Conclusions

Scaling up management to levels suggested by EBM guidelines will depend on a clear understanding of context, effective management, and means to overcome challenges. While there has been considerable buy-in to this new framework, based largely on mandates to maintain ecological function, there have been almost no empirical and comparative studies to elucidate the variables that will determine EBM feasibility. This study presents various

important lessons from nascent attempts at EBM in the Philippines and suggests avenues for future study. As MPAs are the preferred management tool for these EBM efforts, most of this study's analysis focuses on MPA implementation. These findings should be considered within the larger tropical context. The following are key findings that should be compared and contrasted with other contexts through empirical and practical experience.

First, the success of MPAs is influenced by the social context. Biological measures of success for MPAs are positively correlated with low populations, remoteness, and the perceived threat from external forces such as illegal commercial fishing. Social complexity, as indicated by religious diversity, is negatively correlated with perceived MPA benefits. These findings are in agreement with previous studies by Pollnac et al. (2001), Russ et al. (2005), Maypa et al. (2002), and White et al. (2002) and suggest site selection priorities.

Second, capacity development to develop MPA leadership and the technical skill level of NGOs and municipal government is a good investment. The methods to create leadership and technical skills range from formal to informal methods. In the Philippine context, the so-called community organizing approach to MPA implementation and coastal management is well established and empirically grounded. The means for capacity development and creation of social cohesion among MPA collaborators is further explored in Pietri et al. (2009).

Third, enforcement of MPA and fisheries management regulations is an on-going challenge in the Philippines and elsewhere. In this context, effective local enforcement depends on committed and financially supported local institutions such as the *bantay dagat* and municipal governments. When legitimate rules are violated, strict and fair punishment should be utilized and appear to be welcomed by local residents. The rationale for MPA rules cannot, however, be grounded mainly on biological imperatives set by outside conservationists (Christie, 2004; Oracion et al., 2005). Effective enforcement is reliant on institutional collaboration when management is expanded beyond local jurisdictions. The correlation and regression analysis results emphasize the importance of inter-*barangay* (or inter-community) and inter-MPA management committee collaboration. Further interviews with municipal officials demonstrated the importance of inter-municipal government and municipal–national government collaborations. As demonstrated by the regression analysis for institutional collaboration at all governance levels, facilitating effective inter-institutional collaboration depends on human capacity development and participatory planning processes. Effective enforcement is an ambitious task requiring coordination at various governance levels. The development of strong institutions capable of effective coordination is reliant on external support and participatory processes.

Fourth, conflict and controversy are a predictable part of MPA design and implementation. Ignored conflict will undermine MPA/EBM success. Identifying the dynamics and means to equitably resolve conflict requires greater research and project implementation attention. This, and other, studies demonstrate that conflict is associated with the generation and equitable distribution of benefits derived from an MPA (Christie et al., 2004; Oracion et al., 2005). Participatory planning processes, while essential to success, are also likely to become conflicted.

The most important conclusion of this study is that MPAs, MPA networks, and EBM feasibility is directly dependent on the effectiveness of participatory planning, inter-institutional collaboration, capacity development, consistent and fair enforcement, conflict identification and resolution, and distribution of benefits *at the local scale*. While scaling up can make both biological and institutional sense, there is a point at which institutional capacity is exceeded. This study, and others in the theme issue, strongly suggest that in the Philippine context, and likely many other tropical contexts, establishing large-scale

EBM, MPA networks, or extensive centrally planned zonation schemes based primarily on national law, international targets, and command-and-control policy will almost certainly fail, a finding in line with McClanahan et al. (2006).

While this research, a wide array of management case studies, and common sense lead one to this conclusion, a significant portion of the practice, funding, and natural science underpinning marine conservation appears to be advocating for a move away from locally driven ocean conservation. This study demonstrates that the pressing imperative of ocean-wide environmental decline should not be used to justify infeasible and poorly designed management interventions that ignore institutional constraints and move away from proven management approaches in the name of large-scale conservation. This study suggests that investment in EBM at a "governable scale" is most prudent and effective. Defining this governable scale will be context-specific and require considerable management acumen. Based on these empirical findings, and additional consultations with local government leaders and practitioners, 10 to 15 municipal governments in a discrete management unit serviced by a committed and experienced NGO working in tandem with local communities and government institutions appears to be the upper limit for governable EBM at present in the Philippines. This conclusion should be explicitly tested by examining MPA networks involving varying numbers of municipalities. Eventually, the size of the clusters could increase as a perceived need emerges and management capacity grows, but attention must be paid to exceeding levels of institutional capacity over the long term.

Note

1. More information about Atlas.ti is available at www.atlasti.de/.

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