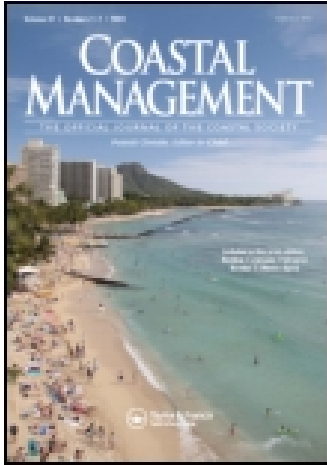


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Jesse G. Hastings^a, Michael K. Orbach^b, Leah B. Karrer^c & Les Kaufman^d

^a Department of Geography, National University of Singapore, Singapore

^b Duke University Marine Lab, Duke University, Beaufort, North Carolina, USA

^c The Global Environment Facility, Washington, DC, USA

^d Department of Biology, Boston University, Boston, Massachusetts, USA

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Lessons Learned from the Marine Management Area Science Program: Insights for Global Conservation Science Programs

JESSE G. HASTINGS,¹ MICHAEL K. ORBACH,² LEAH B. KARRER,³ AND LES KAUFMAN⁴

¹Department of Geography, National University of Singapore, Singapore

²Duke University Marine Lab, Duke University, Beaufort, North Carolina, USA

³The Global Environment Facility, Washington, DC, USA

⁴Department of Biology, Boston University, Boston, Massachusetts, USA

Drawing on experiences from the four regions and the overall conduct of the Marine Management Area Science (MMAS) program, this concluding article highlights emergent cross-cutting themes that affected MMAS programs across the regions, summarizes the important conservation outcomes of the MMAS program, and then discusses lessons gained from the actual process of conducting the MMAS program. Based on these insights, particularly the last section, this article concludes with recommendations for other conservation programs, specifically those that are global in scope and are science-based with a specific intent to apply that science to conservation action.

Keywords marine conservation, nongovernmental organizations, science to policy

Cross-Cutting Themes that Emerged from the MMAS Program

This article summarizes the general themes that—even though they might not have been formal, direct objects of scientific study in the various disciplinary and interdisciplinary projects and instruments—emerged from the activities of the Marine Management Area Science (MMAS) program that transcend regions, and which are important contextual characteristics for the MMAS program and its outcomes as a whole.

Global Economic, Social, and Cultural Change

The concept of MMAS was to assess marine management areas (MMAs) as experimental interventions, exploring their effects on human and natural components of the coastal ecosystem. Doing so assumes that each study system is independent of the rest of the world, which of course none really are. It is difficult to see the effects of specific MMAs on coastal communities as evidenced in Belize, for example, where the economy and society are affected by broader social, cultural, and economic change. Although specific effects can be pinpointed, they pale in comparison to the effects of these broader changes. In that some of these broader effects, in particular leisure-tourism development, can be

Address correspondence to Michael K. Orbach, Duke University Marine Lab, Duke University, 135 Duke Marine Lab Road, Beaufort, NC 28516, USA. E-mail: mko@duke.edu

traced to the value of MMAs to the leisure-tourism industry, all of these effects are linked together.

Multi-Ethnicityⁱ

All of the MMAS regions are noteworthy for a pervasive mix of ethnicities in the coastal zone that characterizes and defines the cultural involvement with and effects from MMAs in the research communities. A great portion of the cultural effect of MMAs in the study communities is circumscribed by the role of kinship, community, and ethnicity. For example, in Belize this mix was especially diverse—Creole, Garifuna, Maya, and Mestizo in particular, a mix that extends from southeastern Mexico south to coastal Honduras. Fijian society is a juxtaposition—not so much a mixture—of Pacific Island and Hindu immigrant ethnicities, with a smattering of several expat and colonial influences mixed in. Coastal Brazil is also a cultural melting pot, and while Bahia's unique blend of ethnicities may be an institution in itself, there are clear elements of Amerindian, Portuguese, and West African cultures. In the tropical eastern Pacific, Panama is a hybrid of Amerindian and Hispanic cultures, while the Galapagos is chiefly Hispanic but with strong German and other expat sensibilities blended into a sort of founder culture born of isolation and significant migration from mainland Ecuador. The symbiosis and limited blending of cultures in these study sites played key roles in governance, and also general receptivity to marine conservation and management interventions.

Histories of Colonialism and Mercantilism

Colonialismⁱⁱ defined, and to some extent still defines, the socioeconomic and cultural character of all of the MMAS study areas, particularly with regard to fishing and fisheries policy and management. The modern nation of Belize is a proud democracy, but like our other study areas bore a strong imprint of colonialism. Belize began as a British Colony and the associated mercantilist economy, wherein raw goods and natural products are shipped out of the country and processed and more expensive goods are shipped in, created a cycle of negative domestic economies and dependence. In Fiji, the British Colonials attempted to replace the *qoliqoli* system with a central civil fishery management system, but were never completely successful; the current system is a blend of the two. Social, economic and cultural aspects of colonialism still exist in all four MMAS regions, and affect coastal and marine policy as well as other areas of policy and management.

Lots of Water, Lots of Reef, Small Human Population

The effects of individual MMAs as well as our ability to measure these effects are both complicated by the vast area of sea surface that can be fished relative to the size of the fishing population, and even more so, the very few vessels involved in monitoring fishing activities and enforcing fishing regulations. This is probably the reason that formal territoriality is not very much in evidence, for example, among fishermen in Belize, and that there has not been more protest over the creation of each individual MMA—there has always been somewhere else to fish. This circumstance changes as more MMAs are created (see the seventh theme). It also varied among MMAS sites. The situation in Brazil was somewhat similar to Belize, while in Fiji there is a formal marine tenure system (of contiguous *qoliqoli*) in play, and in Panama the total area in question was relatively small and concentrated (although imbedded in the much larger Eastern Tropical Pacific).

Cyclical Lack of Involvement and Communication Difficulties between Local Communities and the MMA Process

Significant attempts have often been made to include all stakeholders and local communities in the MMA establishment process. Of particular note are the history of Friends of Nature-Southern Environmental Alliance (SEA), Laughing Bird Caye, and Gladden Spit in Belize, and the establishment and expansion of the marine park and extractive reserve system in southern Bahia, Brazil. However, these efforts to ensure a participatory process have been uneven among MMAs and through time. Often the communication and involvement are been full-on at the beginning of a funded project or initiative, and then diminish over time until the next initiative starts up. In Fiji, this problem was largely avoided because of the existence of the Fiji local managed marine area (FLMMA) system, which provided continuity in stakeholder involvement.

Connections among, and Cumulative Effect of, MMAs

Although the effect of each individual MMA on commercial and subsistence fishers may be small, the cumulative effect of increasing the number of MMAs is potentially very great. At most MMAS sites there was not originally an overall plan for the siting or function of the MMAs as a group, nor any account taken of the cumulative impact on commercial or subsistence fishers, or the opportunity for both more effective conservation (e.g., corridors) or economic and social (e.g., designated areas where commercial or subsistence fishers MAY fish) stability through such planning. However, as the MMAS program came to a close, these were topics of discussion at all of the study sites. This is a particular issue in locations such as Belize and Fiji, where the MMAs in some form are so numerous.

General Fisheries Management

Many topics related to general fisheries management do not seem to have been fully considered in the rush to establish MMAs. Such topics include:

- The need for a robust fishing license system;
- Adequate data collection programs;
- Effective monitoring and enforcement;
- The full use of traditional ecological knowledge in “modern” management;
- Consideration of features such as designated fishing areas tied with local communities;
- Fisheries planning in the context of ecosystem-based management, other marine ecosystem services, or watershed-coastal linkages.

Political and Administrative Organization

All of the MMAS sites were democracies, either parliamentary (Fiji, Belize) or presidential (Brazil, Panama, Ecuador). Consequently, public policies are influenced by the political party that is predominant, or by political activities generally. For example, over the last eight years in Brazil, PT (the Labor Party) was has held office and many policies were directed to the eradication of poverty, development of community infrastructure, and empowerment of traditional populations. Changes in the party in power can involve

shifts in environmental and other policy arenas. Emergent local issues also influence the course of coastal policy, as we saw during the project in Brazil (dredging, mangrove clearing for shrimp farms), Belize (mangrove clearing for real estate development and tourism, offshore oil development), Ecuador (overpopulation and unsustainable tourism in Galapagos), and Fiji (death of a chief, coups, catastrophic coastal floods made worse by severe upland deforestation).

BINGOs

A current, healthy trend among big international nongovernmental environmental organizations (BINGOs) is toward decentralization and emphasis on local capacity. Although question of influences from outside of the country still arise, the fact that BINGOs had established offices in-country was an important factor in the levels of success achieved by MMAS. For example, in Brazil there are Conservation International (CI) offices in Bahia Province where the MMAS work was focused, as well as in Rio and Belo Horizonte, affording ready access to important decision makers. This proved critical in producing much of the scientific and political work necessary to the establishment of new MMAs in Brazil. This work included science and activism with respect to such activities as offshore oil and gas development and aqua-and mariculture. The role of personnel from the Smithsonian Tropical Research Institute (STRI)—with support from CI—in the Coiba Island case in Panama is another example.

The Critical Role of Local Community Organizations

The involvement of local community organizations is critical in the establishment and management of any type of spatial management, but this is especially true of an extractive reserve because infractions cannot be detected merely by observing the presence of a fisherman within the borders of the reserve. The Corumbau extractive reserve (RESEX) in Brazil was established with strong support from a local community organization, but this organization has undergone many changes during the 10 years since the reserve was set up. The newer Cassuruba RESEX is different from Corumbau in several important ways that point to a future of conflicts and negotiation in the process of community empowerment there.

Community will has played a key role in the national debate over the future of Belize's coastal resources. Powerful political and money interests are bargaining for massive real estate development on the coast and cayes, often clearing mangrove forest and dredging reef in defiance of the country's environmental laws, and sidestepping requirements for environmental impact assessment or offering flawed environmental impact assessments (EIAs). Opposing these interests are feisty, well-organized conservation and area management organizations like Association of Protected Area Management Organizations (APAMO), Protected Area Conservation Trust (PACT), Toledo Institute for Development (TIDE), Belize Audubon Society, and Programme for Belize. While these groups do receive outside support, and collaborate closely with international NGOs, the zeal is entirely home-grown. Particularly noteworthy challenges are coastal oil exploration in the south of Belize against strong opposition led by indigenous peoples; opposition to offshore oil development, community opposition to the development of a massive cruise ship port near the town of Placencia, the unsuccessful opposition to the destruction of Belize's most magnificent mature mangrove forest at Sittee Point, successful opposition to the construction of a cobia aquaculture facility next to a coral reef off Placencia,

and well-organized opposition to the repeated attempts at illegal mangrove clearing and development in the South Water Caye Marine Reserve off Dangriga. It appears that a majority of Belizean citizens wish to preserve a rich way of life that is strongly dependent on intact natural habitats. The result would be an economy friendly to high-end ecotourism but opposed to intensive mass tourism development. If Belize yet succeeds in preserving its world-caliber ecological heritage, it will be due mostly to enthusiastic community engagement and advocacy.

In Fiji, the most important local community organizations are the village councils, which oversee the traditional MMAs, or *qoliqolis*. The traditional cultural understandings and relationship in Fijian society form the basis for historic and current resource management practices. Attempts to weaken or circumvent these traditional understandings and relationships have led to failure of management initiatives; incorporating them leads to success.

Local Resource Management must be Supported at Higher Levels

Although traditional Fiji customs and practices can form the basis for effective MMA management, those customs and practices must be backed up and supported by national civil law, because not everybody in Fiji is a traditional Fijian. The Fijian population is diversifying, and this is reflected in such activities as migratory fishing by Indo-Fijian and non-indigenous fishermen. As discussed earlier, Belize and Brazil coastal peoples are distinct in their diversity, but band together across ethnic lines in coastal co-management. However, strong state and federal laws are important to reinforce community goals. In Panama and Galapagos ethnic diversity was lower, but federal legislation was still key as local communities dealt with the challenges of population turnover, and for Galapagos, a mass influx of marine resource users from the mainland.

The Problem of Effective Monitoring and Enforcement

Poaching is a serious problem, as revealed by biophysical monitoring at the MMAS sites. Enforcement was spotty over time and space and many of even the no-take marine reserves were only minimally effective, or very effective but only for a short time. This is a worldwide phenomenon (Campson et al. 2010).

The Role of Larger Processes and Events in the Context of History

The events at all of the MMAS sites during the 5-year window of the project were strongly shaped by all that had gone before. In Panama, the fact that Coiba Island had been a well-protected penal colony since the early 20th century was critical in the establishment of the MMA. When the decision to close the penal colony was made, there was significant conflict, from the local to the national level, with respect to the future use of the island and the surrounding marine environment. Ultimately, the decision was made to create the MMA with major involvement of a broad-based MMA Advisory Council. Also, the fact that the land side of Gulf of Chiriqui is undergoing significant change and development in general, apart from the management of marine resources, is significant in the lives of the communities that are located on and use the Gulf, including the MMA. Job opportunities in the construction industry, for example, highlight the role of other occupations as alternatives to commercial fishing.

In Brazil, the MMAS program was strongly shaped by efforts already under way to characterize and protect Bahia's globally unique coral reef system through the creation of a marine national park, and by conflicts between conservation and industrial interests that were already in play at the time that the project began. Work at the Belize project site evolved naturally from an existing system in which local nongovernmental organizations (NGOs) managed marine protected areas. Against that backdrop, project outputs were guided by local needs in dealing with emergent development issues.

In Fiji, a dream of the CI country director to create an "Islandscape"—that is, a *vanua* or watershed conservation vision linking the *qoliqolis* that connect the two main islands of Viti Levu and Vanua Levu across Bligh Water, the channel between them, had to be set aside due to political strife over preservation in the important nearby Sovi Basin. Thus, the direction taken by MMAS in each host region was guided by and contingent on the political winds blowing at the time of project inception.

The Role of Physical Distance and Isolation

Despite the program's focus on marine area management, efforts at active enforcement were generally less effective because of the simple logistical factor of remoteness. In Brazil, the no-take area on the Itacolomis reefs at Corumbau (offshore from the extractive reserve) was effective while enforced, but enforcement lapsed after only a few years. Densities of budiao azul (*Scarus trispinosus*), the large parrotfish whose herbivorous habits can have a major positive influence on coral reef health, went up in the no-take area when it was enforced, and down when enforcement lapsed. However, large parrotfish and grouper remained most abundant on reefs farthest from shore—these apparently protected by rising fuel prices and the risks of going so far to catch them. In Panama, the fact that Coiba Island lies dozens of kilometers offshore, in addition to its history as a penal colony, contributed to the relative lack of use of the marine area that eventually became the MMA. A similar thing may be operating in Belize, where the only no-take area among those we examined to show measurable (although barely significant) effects on fish biomass at diving depths of 10 to 30 meters was the farthest from shore: Half Moon Caye on Lighthouse Atoll. The benefits of remoteness were less obvious in Fiji, perhaps owing to a willingness by fishers to travel.

Program Challenges and Outcomes of MMAS

MMAS results and the process of conducting the program contributed to numerous conservation impacts in the regions, including the creation of new and improved MMAs, the establishment of improved fisheries regulations, greater public awareness, enhanced political commitments to conservation, improved scientific capacity, and stronger collaborations. The program also faced several systemic challenges that unfolded over the course of the program, and we will begin with a brief description of those systemic challenges.

Program Challenges

Program Coordination (Herding the Cats). With over 50 principal investigators (PIs) spread across many different public and private institutions and five countries, the task of simply finding the people and institutions, setting up contract arrangements, negotiating

terms, overseeing and monitoring the work, and obtaining products in an appropriate format was huge. This highlights the importance of the MMAS Core Team, which shouldered much of the burden of these tasks.

Different Cultures and Political Economies. Each of the program locations exhibited different cultures, socioeconomic characteristics, and political economies. Thus the attitudes and beliefs about specific problems and issues—and potential solutions—differed considerably. Cultural differences also came into play in such activities as the negotiation of contracts, research styles and approaches, and the conduct of interpersonal relations on program issues and activities. Sensitivity to these differences, which required different approaches in the different locations, was critical to the success of the program.

Divided Attention. With the exception of the MMAS Core Team and certain of the MMAS Regional science-to-action (S2A) coordinators (referred to as coordinators throughout this special issue), no one in the program had the MMAS program as their full-time job. This meant that the activities of the MMAS program always shared the attentions of the participants with other tasks. With so many participants in different locations, this phenomenon tended to have a cumulative effect on the momentum of the program, which again had to be continually stimulated by the MMAS Core Team and others such as the cross-site disciplinary coordinators and coordinators.

Individual Personalities. In addition to the cultural differences, every individual in the program had a unique—and often strongly expressed—personality. This defined the character of their interactions with others, on everything from research approaches to general manner of communications. Again, sensitivity to—and facility with—such interactions among different personalities was critical to the success of the program.

Attention to these programmatic challenges was as important to the conduct of the program as the specific conduct of the research or policy application, as is evident from the descriptions of the activities in each of the four regions.

Program Outcomes

The Establishment of New MMAs and No-Take Zones. One of the biggest achievements of MMAS was the influence the study results had on the establishment of new MMAs including, in some cases, no-take areas. In Brazil the Socioeconomic Study results showed that over 1,000 families depended on the Cassuruba mangroves for their livelihoods and results from the Cross-Shelf Habitat Linkages study showed that the mangroves play a critical role for the commercial fisheries (Curado 2010; Moura and Lindeman 2010). These insights, combined with the detailed habitat maps from the Inter-Reefal Mapping study (Dutra et al. 2010), were critical in stopping a shrimp farm proposed for the area and ultimately in gaining political, including presidential, support for the establishment of the Cassuruba RESEX.

Results from the Fiji studies, particularly the Cultural study, had substantial impact on community interest in new MMAs, largely because they were shared through a series of community oriented workshops involving multiple researchers as well as community and NGO leaders that emphasized shared experiences (Veitayaki 2010). In Belize the baseline data from the Ecological Monitoring study was incorporated into the zoning plan

for the Sapodilla Cayes leading to the establishment of a no-take area of approximately 5% of the marine reserve (Shank and Kaufman 2010).

The improvement and expansion of existing MMAs. MMAS results also influenced the improvement of existing MMAs. In Brazil, for example, the MMAS results, which demonstrated the high biodiversity of the coastal ecosystems and the cultural significance of the mangroves, were instrumental in the successful application and subsequent declaration of Abrolhos National Park as a RAMSAR site. In addition, the results from the Inter-Reefal Habitat Mapping study, which showed that Abrolhos had a more extensive reef system than previously documented, contributed to plans for the expansion of the Abrolhos National Park boundaries and to plans for protection zones (Dutra et al. 2010). Drawing on these experiences, CI-Brazil was invited to advise on the establishment of a 1.12 million hectare MMA network in Sao Paulo State.

In Panama the MMAS studies, particularly the local Socioeconomic and Governance, Economic Valuation and the Fisheries Assessment, were critical in the development of the Coiba National Park management plan, including the establishment of resource management zones, absolute protection zones, primitive zones, cultural zones, natural recuperation zones, and special use zones, and for creating substantial support and enthusiasm for the Park by conveying its ecological and socioeconomic significance (Jordan 2010; Montenegro 2010; Vega 2010). In Galapagos, findings from the Ecological, Socioeconomic and Governance Monitoring studies were communicated to prominent government officials through information packets, which facilitated discussion and feedback regarding the zoning plans for the Galapagos Marine Reserve (Banks 2010; Quiroga 2010).

Strengthened Fisheries Policies. MMAS played a significant role in strengthening fisheries policies in the regions. In Belize, results from the Ecotourism Effects on Spawning Fish study were incorporated into a Code of Conduct called "How to Dive on Spawning Aggregations," developed by the Southeast Association (Heyman and Lobel 2010). The Cruise Ship Impacts study results also were used to develop a code of conduct for snorkeling on reefs (McField and Thompson 2009). In Fiji the MMAS results also contributed to revisions of the Fisheries Act, particularly the findings from the Cultural Roles study, which highlighted the need for a legal framework for community established *tabu* areas (Veitayaki 2010). In Brazil, the MMAS studies enabled CI-Brazil to join a new fisheries monitoring program with the Ministry of Fisheries and the NGO EcoMar. These three organizations are collaboratively monitoring all the fisheries in the Abrolhos bank with each organization providing skills, technical expertise, and experience.

The MMAS results may have had the biggest impact in Panama where results from the Fisheries Assessment, which showed the importance of maintaining snapper reproductive stocks protected by no-take areas, and results from the Socioeconomic and Governance study, which identified the areas and frequency of fishing activity as well as governance issues, helped to convince the Directive Council and local fishermen groups to establish a fishing no-take zone ringing Coiba one mile from the coast (Jordan 2010; Vega 2010). Results from the Fisheries Assessment, which showed that fishermen were catching sexually immature snapper, also helped to increase public support for use of appropriately sized hooks (Vega 2010).

Increased Awareness and Strengthened Commitments. MMAS also raised awareness and strengthened commitments to MMAs. In Fiji MMAS facilitated a series of community

workshops on marine conservation conducted by teams of scientists, NGO representatives and community leaders, which also became engaged in collecting biological and socio-economic information, disseminating information on natural resources, and sharing lessons with other villages. These workshops highlighted results and experiences with MMAs, which helped communities feel commitment and ownerships of their *tabus* as they saw that *tabus* worked in their own and other areas, which led to greater support for MMAs. In total 80 communities took part in some sort of workshop discussion, with over 60% of communities showing a stronger commitment to existing *tabus*, or interest in creating new *tabus*. Finally, MMAS, through scientific monitoring of LMMAs, also provided international, scientific credibility to the LMMMA approach by validating community based research and monitoring results and showing that LMMAs are biophysically, socially, and culturally beneficial.

In Belize, MMAS initiatives heightened awareness of coastal issues in Belize. In particular, the 2010 Belize Reef Summit entitled *Someday is Now! Save our Reef, Demand a Plan*, which highlighted MMAS results through an engaging video, drew public and high level political attention to the state of Belize's natural environment thereby motivating stakeholders across Belize to work to protect their marine resources by developing a coastal management plan.

MMAS Improved Regional Scientific Capacity. MMAS improved regional scientific capacity building in the regions, including providing the opportunity for advancement for scientists early in their careers. Through a collaboration with the Ministry of Science and Technology, CI-Brazil engaged over one hundred Brazilian youth in marine conservation science as part of the "Open Your Eyes to Science" initiative, which included direct training workshops, internships, and mentoring opportunities. CI-Brazil also led training workshops for marine resource managers, oceanography students, marine professionals, and other stakeholders on MMAs management and science. In Belize the MMAS studies provided capacity building in coral reef monitoring and statistical analysis to fifteen Belizeans, which helped build their own skills and benefit their organizations. Similarly, in Fiji the Ecological Monitoring study trained a team of individuals from NGOs, the Ministry of Fisheries, and University of South Pacific in coral reef and fish survey techniques giving them skills that have endured past MMAS' departure (Bertrand 2010). The Fijian PIs leading the Socioeconomic and Governance Monitoring and the Economic Valuation, who were in the beginning stages of their careers, gained capacity and knowledge by working on MMAS projects (Fong 2010; Korovulavula 2010). They then brought this increased knowledge into future research endeavors and thus strengthened Fiji's overall scientific capacity.

Improved Collaborations. The MMAS program also improved collaborations due to the interdisciplinary and S2A emphasis of the studies, which required multiple partners. The funding and opportunities provided by MMAS enabled CI-Brazil to strengthen its linkages with research universities, which yielded improved data sharing, new scientific proposals, and media projects. In Fiji, the process of revising and discussing the MMAS projects in FLMMMA's Working Groups, conducting MMAS projects at FLMMMA sites, and engaging in MMAS-funded FLMMMA community workshops helped to strengthen communicative ties among FLMMMA partners and address communication problems among stakeholders. In Panama, the results from the macro Socioeconomic and Governance study, which highlighted the need for increased coordination and information exchange between institutions responsible for Coiba National Park, led to the establishment of four new sub-commissions tasked with improving coordination and information exchange (Suman, Mate, and Samonte-Tan 2010).

Lessons Learned from the Program Process

In addition to impacting conservation outcomes in the regions, the MMAS Program resulted in important lessons for how to run global conservation science programs. These lessons can be synthesized around the following themes and questions:

- Program Initiation—What were the important characteristics of how the MMAS program was initiated in each country?
- Networks, Partnerships, and Coalitions—What networks, collaborations and coalitions developed in conjunction with the MMAS work?
- Participation across Scales and the Science–Policy Boundary—How did the programs engage key stakeholders at local to national levels and from various sectors?
- Accountability and Ability to Learn—How did the program incorporate new knowledge and experience?
- Science to Action—What measures were critical to ensuring the science influenced conservation action at the local to global scales?
- Assessment Context—How did the sites' political, socioeconomic, scientific, or historical context affect how MMAS worked?

Program Initiation

Brazil. Entry of MMAS into Brazil was assisted by CI-Brazil and early discussions between this office and CI headquarters staff. As with all the other regions, the overall structure of this global program was decided by the SAC, MMAS Core Team, and the Moore Foundation. However, in the Brazil case, CI-Brazil was able to provide input in 2004 and 2005 into the initial proposal to the Gordon and Betty Moore Foundation (GBMF), thus giving them buy-in and enabling early thinking about how MMAS would dovetail with existing Brazil science and management efforts. In turn, this thinking enabled MMAS in Brazil to get an earlier start than the other regions.

The experience of MMAS in Brazil also emphasizes the importance of understanding the governance and socioeconomic context before initiating a scientific program in order to take advantage of opportunities. In the case of Brazil, large-scale ongoing threats increased the salience of scientific results. Immediate threats such as shrimp farming served to mobilize CI-Brazil, the Chico Mendes Institute, NGO partners, SOS Abrolhos, and some sectors of the local communities against a common enemy. Once mobilized, these groups needed rigorous scientific data to support their political positions. MMAS data was well suited to fill this gap. Without these threats, MMAS data would still have been useful but possibly less timely and used.

Brazil MMAS also illustrates the power of a cohesive and engaged civil society in pushing environmental and social change. More so than the other regions, Brazil has a large amount of well-funded NGOs, associations, and coalitions, and these civil society members had a perceptible influence on governmental decisions.

Eastern Tropical Pacific Seascape. The timing of the entry of MMAS into Panama was optimal. While, like the other MMAS regions, the basic structure of MMAS was decided by a small group, there was very early engagement with CI ETPS and CI Meso Sur. Therefore, these offices were able to use their region-specific knowledge to advise how MMAS best could enter the region. For example, these offices had knowledge of the Coiba management plan process, enabling the MMAS studies to immediately make an

impact with ongoing work. Likewise, early discussions with a MMAS SAC member from the Galapagos laid the groundwork for easy entry into Ecuador.

Panama also represents the clearest example among the MMAS regions of why it is necessary to have a firm knowledge of political, socioeconomic, and institutional realities of a country before studies begin. The existence of organizational offices helps to give a (foreign) initiative this information. For example, the knowledge of CI ETPS and CI Meso Sur that Coiba was constructing its management plan meant that MMAS could engage where its results would be immediately used. Likewise, a strong scientific capacity in Panama ensured that MMAS knew it could rely on local scientists and utilize their knowledge and networks; a strong civil society ensured that MMAS results would be used as leverage by NGOs beyond CI.

Fiji. Because the basic programmatic framework of MMAS was decided by the headquarters office, donor, and an overarching SAC, when MMAS first approached Fiji it had to overcome a perception of foreign ownership and little local input. Contributing to this perception was some interpersonal issues between international NGO officers. Experiences in Fiji also show that it is important to know if umbrella organizations or other governance mechanisms are operating in a country. Existence of these organizations creates greater opportunities for participation and adaptation of studies to local context. Choosing to work outside of these organizations can cause severe disruptions.

MMAS results in Fiji contributed almost exclusively to decision making processes at the local scale. Contributing to the national level discussion was more difficult; the government of Fiji had recently undergone a military coup and was seen as quite unstable; thus, FLMA and MMAS focused mainly on community level engagement. Being aware of the political reality enabled the coordinator to avoid unproductive efforts and focus on a scale where change could realistically happen.

Belize. Entry of MMAS into Belize suffered due to the same reasons as the Fiji region; there was a perception of little local input into MMAS' design. There was the early 2005 EarthWatch workshop, and there were early one-on-one discussions with selected Belizean organizations after the initial MMAS model had been designed by the SAC and the GBMF. However, these discussions—while well intentioned—could not provide full information to the very broad swath of NGOs and other stakeholder groups in Belize. Furthermore, they were often viewed as coming late in the study development process. This may have handicapped S2A efforts as it meant that the MMAS studies were not as visible or as relevant to organizations that felt excluded from design input.

Belize is also a case study in why it is important to understand the institutional context of a country before program initiation. Overall, despite the personal efforts of the core MMAS team, the coordinator, and others, dissemination of scientific results was not as successful as hoped due somewhat to country specific factors. With hindsight, it is clear that the lack of country-wide participatory processes (combined with no CI office), low scientific capacity at the University of Belize, and low cohesiveness of the Belizean NGO sector hindered S2A efforts. If these factors had been considered at the region selection phase, Belize may not have been selected or selected only with much greater on the ground support (a full time region coordinator, for example). See Table 1 for overall recommendations for program initiation.

Table 1
Recommendations for program initiation

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1. Early in the conceptual phase, identify priority regions (which may be specific MMAs, countries, or districts) for the global network so that region-based conservation leaders can engage in framing the global program to avoid a group of outsiders setting the global stage for what will ultimately be implemented in the regions.
 2. Encourage donors to structure funding timelines and allocations so that early engagement with stakeholders in program sites is possible.
 3. Accordingly, early in the process and throughout, actively engage the regional leadership in the development of the global framework.
 4. Within each region, establish a lead institution (preferably directly affiliated with the global office) and identify a science-to-action coordinator that is respected and actively engaged in relevant conservation initiatives to be responsible for coordinating activities between scientists and target audiences.
 5. Within each region, focus on a few site-specific efforts (i.e., one or two MMAs) instead of trying to address multiple efforts with numerous players and issues.
 6. Consider political realities when selecting target audiences.
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Networks, Partnerships, and Coalitions

Internal. One of the major challenges of MMAS was that it involved numerous partners not only external to CI, but also within the CI organization itself. Most critical to success were the relationships built among the scientists, coordinators, and the MMAS Core Team. Each group had its own responsibilities that together ensured quality science with a good chance to influence conservation. Establishing these relationships early while the research was being designed ensured that policy implications were considered. The S2A Regional Workshops played a key role in this regard as they brought together all the region-specific scientists to listen to the coordinators and the other stakeholders regarding their priority knowledge needs and to discuss how the research results could address those needs. Numerous prior and subsequent one-on-one meetings helped the science adapt to needs as they evolved. The Core Team played a critical role in initiating these relationships, maintaining consistency while sharing across the regions and ensuring that the interests of the donor were being met.

MMAS was housed within CI's Center for Applied Biodiversity Science (CABS); however, it was closely tied to the Global Marine Division (GMD) and the Field Division. Until the last year, the senior director and the senior PI reported to the heads of CABS and GMD. The partnerships within CABS was important for access to expertise when not available in-region. In particular MMAS was able to access experts in the geographic information systems (GIS), economics, and species departments. Small amounts of funding were provided to these departments to provide expertise for particular projects. Unique to CABS, however, MMAS did not house all the expertise within the MMAS Core Team. Instead of bringing HQ experts to the regions to conduct analyses, it was decided that it would be more effective to develop partnerships and provide grants to in-country partners. When outside experts were needed in cases of lacking capacity, they were sought from around the world, including from within CABS. Also unique to CABS and CI in general, MMAS had restricted funding. Consequently, the program was focused on the agreed objectives and studies. In contrast, much of the rest of the organization

had unrestricted funds and was more at liberty to fund more opportunistic projects that did not adhere to a particular set of agreed objectives.

The relationship with GMD was important for the links to the Seascapes field programs, which are overseen by GMD, and for influencing global marine conservation thinking, such as the development of the Ocean Health Index, a recent global initiative (see www.oceanhealthindex.org). GMD was particularly important early in the program for developing relationships between the MMAS staff, who were new to CI, and the field program staff.

Most critical were the partnerships with the Field Programs, specifically CI Brazil, CI Pacific and CI Eastern Tropical Pacific Seascape. In Fiji, ETPS and Brazil, CI had long-standing relationships in the regions; whereas, in Belize CI had a few projects, but no long-term capacity and consequently partnerships were established with local NGOs, Friends of Nature and the Healthy Reef Initiative. While MMAS Core Team were responsible for the project and reported to the donor, the field program staff were the ones who could most benefit from the research process and results and, consequently, had strong opinions regarding what research should be done and how. The resulting dynamic required a balance by the MMAS Core Team between the top-down donor expectations and the bottom-up field needs, all the while trying to maintain a consistent set of cross-cutting scientific objectives. This balance was particularly difficult early-on because the themes and regions were selected by the SAC and CI HQ staff with limited consultation with the field programs. Early discussions were sometimes contentious between CI HQ staff and field colleagues as they discussed what research had been broadly agreed with the donor, what was needed in the region and how to tailor the research to those needs while working with the best scientists.

Each coordinator was responsible for ensuring the science was appropriate, relevant, and useful for regional conservation initiatives and for feeding the key messages into those initiatives. Consequently, they were responsible for in-region partnerships with stakeholders, including government agencies, other NGOs and the private sector at local to national levels as appropriate. In regions where there was a history of working five or more years on marine issues, such as in Brazil and Galapagos/ETPS, the existing partnerships naturally built into working relationships on MMAS. In Fiji and Belize, an appropriate person had to be found to coordinate the program and then relationships built with other partners. In Fiji this process delayed studies over a year; however, the resulting relationship with FLMMA was invaluable for sharing the results and influencing policy. In all regions, the S2A Workshops were critical in building the relationships as they provided a mechanism for openly discussing the needs of the region and how MMAS could address those needs. The subsequent workshops as results emerged were equally important in strategizing how to use the results to best serve policy.

Partners determining the most appropriate target audiences was also critical for success. In Fiji, the coordinator focused on FLMMA and the village chiefs. This was both because the national government was somewhat unstable, and because the goals of MMAS matched well in scope and scale with the traditional *vanua* approach to watershed and coastal ocean management. Through FLMMA, she organized a series of village trips with scientists, conservationists, and other village leaders experienced in MMAs. These targeted teams visited villages to discuss what they had learned elsewhere and became an important mechanism for sharing insights about MMAs from the MMAS studies and elsewhere. Many of the villagers commented that scientists (even from Fiji) typically did not return to the area and they were impressed and excited to be discussing the implications of the research to their communities. In contrast, in Brazil the team worked with all levels

of government, sharing the research insights and their implications for policy decisions. The impact was most striking in the establishment of the Cassuruba RESEX in which discussions with municipal leaders, fishermen cooperatives, state representatives, and the president's office eventually led to the designation of a vast and threatened mangrove forest as a marine management area.

Brazil. The main MMAS partner in Brazil was CI-Brazil, a field office with years of science and management experience in the Abrolhos region. Partnering with CI-Brazil meant that CI-Brazil could continue and expand their previous work, enabling a long-term scientific dataset that would be more credible to stakeholders. Additionally, using CI-Brazil as the main conduit for the MMAS studies meant that the studies could benefit from their extensive relationships with local, regional, and national partners. Their involvement with networks, partnerships, and coalitions was extensive, ranging from one-on-one partnerships with local NGOs, national universities, and governmental departments to involvement in large national coalitions ProAbrolhos and SOS Abrolhos. These relationships improved the design and utilization of MMAS science in three ways: (a) they enabled the recruitment of qualified PIs with a keen understanding of the Abrolhos context, (b) they provided a mechanism for gaining input into the design of the studies, and (c) they provided a mechanism for results to be quickly shared and inputted in political processes.

ETPS. MMAS succeeded in quickly linking up to several strong partners in Panama. CI ETPS and CI Meso Sur—being part of CI's worldwide organizational structure—were obvious early partners; however, STRI was the Panamanian partner that allowed the MMAS studies to have the greatest leverage over the course of the initiative. STRI is a respected research institution and had extensive networks throughout Panama. This partnership allowed quick recruitment of highly qualified MMAS PIs, knowledge of the Coiba management and science context, and most importantly, knowledge of the country's governance processes and immediate access to Coiba's Directive Council and its Scientific Board.

Choices of partners in Galapagos were more limited than in Panama. CI-ETPS made the obvious choice in choosing to quickly link up to the Charles Darwin Research Station. The station, because of its recognized expertise, existing data, and close linkages to the Galapagos National Park Service, could leverage the studies into management and policy impacts.

Belize. MMAS did not succeed in establishing a strong, early partnership with any organization in Belize. While the Belize coordinator had been heavily involved with SEA and the intention was to leverage his involvement in SEA to a strong partnership, in the end his involvement—due partially to it being part-time and his other commitments—did not seem to bring the institutional capacity of a partner. MMAS tried to partner with MBRS and APAMO; however both organizations were young and weak during much of MMAS' implementation. Lacking a strong on-the-ground partner meant that MMAS needed to rely on individual efforts of the PIs and the MMAS Core Team to gain input into the studies and leverage MMAS results. As many of these individuals were foreign to Belize, this meant that efforts were (unavoidably) iterant and sporadic.

Fiji. The assistance of a CI office in Samoa, and subsequently the coordinator in the CI-Fiji office, allowed a strong partnership to be built with FLMMA. FLMMA served

as an umbrella organization; it brought government, academic, NGO, and community stakeholders together to hold discussions and orient the MMAS studies toward relevant Fijian science needs. MMAS research could strengthen FLMMA's ability to do future work, make use of their history to leverage impacts, use FLMMA's connection to community level stakeholders, build on FLMMA's scientific expertise and communication capacity, and utilize FLMMA's information sharing mechanisms (annual meetings, working groups). However, FLMMA was not primarily a scientific institution. Involvement of key faculty from the University of the South Pacific in Suva and scientists from the Wildlife Conservation Society and Wetlands International—most of whom were also actively engaged with FLMMA, thus helped greatly in strengthening the science–policy bridge for the MMAS program in Fiji (see Table 2 for overall recommendation on partnerships).

Table 2
Recommendations for partnerships

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1. Establish partnerships with networks of colleagues.
 2. Identify target audiences (government leaders, private sector, community leaders), engage them from the beginning and keep them updated and engaged throughout (Belize vs. Fiji).
 3. Work with these audiences to identify knowledge gaps for policy and management and focus research plans to address those needs.
 4. At the global scale, seek advice (e.g., science advisory committee) from both experienced scientists and seasoned conservationists (e.g., science and conservationist advisory committee) to ensure both perspectives are addressed and to avoid the perception of foreign scientists driving science and policy agendas in the regions.
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Participation across Scales and the Science–Policy Boundary

Scientific Advisory Committee. The core idea behind the SAC was to bring multidisciplinary experts together to participate and give their advisory input, and to ensure scientific rigor and objectivity in MMAS planning. Valuable advisory input was received through one-on-one conversations between members of the SAC and members of the core MMAS team. However, some members of the SAC felt that the large committee meetings added little value, and were unsure whether members existed as a review, advisory, or decision making body. A general sense of confusion and disorganization emanated from interviews with some SAC members. Some SAC members were concerned that the committee held little real power, with the meetings taking place simply to review MMAS strategic decisions.

Another issue was that early on in the SAC's functional life, many relationships with regions had not been built yet since the regions were not selected until after the themes were agreed on. This made it difficult to have collaborative SAC-region conversations. SAC members, as well as regional scientists, felt as if greater opportunities for interaction would have been helpful earlier in the process. Because of this timing conflict, SAC members found it difficult to give advice for regional projects.

In response to this concern and the realization that an advisory committee for MMAS should include both scientific and policy experts, in 2006 the SAC meetings were

expanded to include the coordinators. This expansion was significant in that it greatly increased the SAC's insight into regional activities. Virtually everyone agreed that this process, of involving the coordinators with the SAC, could have usefully begun earlier.

Brazil. The most relevant factor enabling participation across scales and the science-policy boundary was the involvement of CI-Brazil. CI-Brazil had strong relationships with the MMAS Core Team as well as with local and national stakeholders through networks, partnerships, and coalitions. These relationships allowed local PIs, which brought their own personal and professional networks, to solicit participation. Workshops, one on one conversations, and informal interactions—including with policymakers from important agencies such as the Chico Mendes Institute—solicited input, helped to under knowledge needs, and ensured future S2A applicability. These participative interactions would have been difficult or impossible without CI-Brazil's involvement and its excellent reputation with local, national, and international stakeholders. While Brazil MMAS did benefit greatly from CI-Brazil's institutional history, its success is at least equally attributable to the personal energy and commitment of individual activist-scientists who happened to work for CI in the early phases of MMAS, but later moved on to university positions, there leveraging substantial additional resources.

At the local level, participation was assisted by two additional factors. First, CI-Brazil's involvement in Abrolhos National Park's Consultative Council and Corumbau RESEX deliberative council allowed government, NGO, private sector, and local community stakeholders to stay engaged in the studies' progress and feel that the results were salient to their needs. These councils, similar to Coiba's Directive Council, were a regular iterative mechanism for information sharing and feedback. Second, CI-Brazil's capacity building programs— involving both high school and college age students—created a local constituency that supported marine science and spread information to families and friends.

ETPS. Several factors enabled engaged participation in Panama across scales and the science-policy boundary. Most importantly, the Coiba Directive Council and the Scientific board functioned as an efficient MMAS information sharing and coordination mechanisms. Regular meetings solicited input and kept a wide range of Panamanian NGO and government stakeholders informed and updated, boosting the MMAS studies' local salience and legitimacy. Second, involvement of CI offices ensured that programmatic decisions were made by those with a better understanding of the science and management context. Decentralization allowed STRI, CI Meso Sur, and CI-ETPS to complement MMAS funding with funding from the Walton Family Foundation and United Nations Educational, Scientific and Cultural Organization (UNESCO). Combined funding enabled a greater number of participatory workshops where community input into MMAS studies during the data collection and result dissemination phases was collected.

Local PIs possessed a strong knowledge of the socioeconomic, ecological, and cultural realities of Coiba, as well as extensive personal and professional networks. Local PIs (at STRI) set up an early workshop in 2006 that allowed stakeholders to give input into the design of the MMAS studies. These factors eliminated a learning curve that would have resulted from foreign scientists coming into the country; it also allowed the PIs to better understand salient science and management needs. Local PIs used discussions across scales—up to the MMAS Core Team— and across the science-policy boundary to engender participation and solicit input from a wide range of groups.

Interviews revealed that these factors encouraged the vast majority of stakeholders from the government, academic, and NGO sectors to feel engagement and support for MMAS studies. Community members, while not as supportive of MMAS studies generally—instead focusing on their development needs—found that participatory workshops gave them opportunities to voice their opinions and have a (limited) say.

In Galapagos, the involvement of the Charles Darwin Research Station and the University of San Francisco in existing ongoing participatory processes meant that they could quickly harness knowledge of management needs and use these connections to disseminate results.

Belize. There was a dedicated effort to recruit local scientists as PIs so as to enable studies to be accessible to Belizean management and science needs. This recruitment suffered somewhat due to the low scientific capacity at the University of Belize (UB). PIs engaged in an extended process of discussing the workplans with the MMAS Core Team. Discussions across the science–policy boundary in Belize during workplan design were less extensive. PIs did work with the coordinator to craft their studies to speak to management and policy needs; however, the inability of foreign PIs to have regular, in-person contact with Belizean stakeholders meant that they needed to rely exclusively on his input.

Several factors hampered engaged participation during the data collection phase of the studies. First, unlike other regions, there was no obvious iterative, participatory process for all of the studies into which to feed their results. There was no CI office and no strong national-level association. The Association of Protected Area Management Organizations (APAMO) had just been established in 2007 and lacked institutional capacity compared to a long-standing association like FLMMA in Fiji. The MBRS project was under review and floundering. UB was weak and under-resourced. Thus, for extended periods of time between 2007 and 2010 workshops, feedback on progress was relayed solely through newsletters and one-on-one communications. Second, focusing the studies on multiple MMAs instead of one meant that a larger set of MMA managers needed to be updated and consulted. Third, foreign PI's time in Belize was limited; when they were in Belize, they were focused on collecting and analyzing data as opposed to holding extensive stakeholder discussions. Fourth, the coordinator had many obligations, and his involvement through a part-time contract was not sufficient. A person that had been paid full time from the beginning of the scientific projects to coordinate S2A efforts in Belize could have been more helpful. This person could have devoted their time to getting out information, keeping people updated, and trying to better tie the science into management decisions.

Ironically, the design of the natural science studies in Belize was among the strongest and most carefully laid out, comparing biophysical aspects of no-take and open-access areas stratified across the Belizean portion of the Mesoamerican reef. However, an integrated experimental design and national perspective do not guarantee political or institutional preparedness for integrated conservation policy. By the end of the MMAS study period, Belize had moved much more strongly in this direction with the establishment of the Environmental Research Institute at UB, and the success of the Healthy Reefs Initiative.

Fiji. In Fiji, there was a concerted effort to recruit local scientists as PIs so to gain local knowledge and provide an understanding of the policy context. Scientists took time to hold discussions across scales and with academics, managers and policymakers while drafting the study workplans.

The ability to hold effective, participatory discussions was assisted by personal and professional networks, creation of a memorandum of understanding (MOU), involvement in FLMMA's working groups, and the coordinator's efforts. Personal and professional networks allowed scientists to engage with experts when needed. The MOU set out terms of collaboration between CI and FLMMA. The working groups operated as a regular forum for a diverse array of stakeholders to engage, learn, and give input. The coordinator was invaluable in engaging a wide range of stakeholders, leading working group discussions, creating communication opportunities, and organizing community workshops.

While designing and implementing the studies in this participatory fashion took time and possibly delayed scientific progress, the process built trust between CI and FLMMA, which in turn enhanced the ability of the studies to lead to policy and management impacts. FLMMA partners felt like CI was treating them with respect. These feelings of mutual respect enabled the partners to see the studies as more theirs and made them more willing to accept the findings as valid and useful (see Table 3 for overall recommendations on participation).

Table 3
Recommendations for participation

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1. If engaging an international multidisciplinary board, connect them to on-site programmatic efforts as early as possible and make their role clear from the beginning.
 2. Strategize as to the most effective right levels for targeting policy across local to national scales and across sectors to influence policy (Fiji focused on villages; Brazil focused on all levels).
 3. Engage in-country senior PIs to leads studies and only bring in outside expertise when it is not available locally.
 4. Provide mentoring and training opportunities, conduct seminars.
 5. Establish mechanisms for scientists to spend time pre/post data collection talking with key partners regarding findings to date and general insights; commit to returning to the region to share results and discuss implications.
 6. When engaging outside expertise, establish capacity building mechanisms for in-country scientists to eventually take ownership.
 7. Support existing networks of colleagues by serving roles such as establishing a research council to review proposals to MPAs from scientists (a la FLMMA Biological Working Group that Lo set-up).
 8. In addition to training directly related to the studies, provide training on data storage, organization and analysis.
 9. Provide data and results to regional data systems to ensure accessibility long term.
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Accountability and the Ability to Learn

Belize. The experiences of MMAS in Belize showed a propensity of CI to learn. In the last phases of MMAS in Belize, CI retooled and hired a scientist from the Smithsonian Tropical Research Institute as the Belize coordinator. This was a positive step as she had both scientific acumen and time to commit to S2A dissemination. The lack of a CI office in Belize meant that there was one less accountability mechanism to give feedback to the

MMAS Core Team in the United States; it was difficult for CI to know that stakeholders were unsatisfied with their input into the design of the studies until the large 2007 workshop.

Brazil. The meetings of the deliberative and consultative councils served as accountability mechanisms, allowing local stakeholders an opportunity to provide their opinion and feedback on MMAS studies. The existence of a CI-Brazil office in Caravelas also allowed day to day interactions with locals, and enabled one of the Brazilian PIs to be constantly keyed in.

The fights over the shrimp farms in Abrolhos provide the clearest evidence of MMAS being able to learn. CI-Brazil used their political connections and coalitions, in addition to the MMAS study results, to fight an organized development campaign. Flexible adaptation proved key as CI-Brazil engaged through judicial, legislative, and direct action methods.

ETPS. From the beginning, MMAS planned that the Panama studies would feed into Coiba's management plan. It was not a coincidence but rather a well-thought-out strategy. The implementation of this strategy progressed relatively smoothly and therefore produced few situations to learn from mistakes. Downward accountability in Panama was greatly strengthened through meetings of the Directive Council, existence and use of the CI Meso Sur and CI-ETPS offices, and participatory workshops in communities.

Fiji. When MMAS realized that their initial approach to doing research in Fiji was unsuccessful, they quickly pivoted to engaging with FLMMA and creating a more participatory process. This ability to learn was assisted by the CI office in Samoa, which understood what stakeholders in Fiji were thinking and saying, and let the MMAS Core Team know that its initial research approach was unsuccessful in bridging science and policy (see Table 4 for overall recommendations on accountability).

Table 4
Recommendations for accountability and the ability to learn

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1. Stay attuned to developments and strategies through networks of colleagues actively engaged in conservation efforts.
 2. Be willing to make team and staff changes when they are unsuccessful.
 3. Ensure existing consultative councils are actively engaged in deciding research priorities and use the councils to get feedback from these key decision-makers regarding the proposed studies and ultimately to use the results to inform decision-making.
 4. Bring in an external team to evaluate progress starting during early phase.
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Science to Action

Belize. The ultimate Belize coordinator took the lead in knowledge translation. S2A outreach ramped up in 2010 and closed some of the earlier information gaps with Belizean stakeholders. Engaging posters, videos, booklets, and t-shirts, in addition to methods that reached a large audience—such as newspapers, radio, and television—significantly extended the reach of MMAS study messages. Each of these products was planned

through the S2A matrix, and intended to persuade a particular audience and achieve a specific management or policy impact.

Brazil. S2A outreach efforts by Brazil CI staff and PIs were helpful in disseminating understandable messages through videos, banners, posters, and presentations. Local stakeholders, many of which were illiterate, needed these products to fully understand MMAS scientific results and incorporate them into their lives. S2A products were accepted by local stakeholders as credible because of the trust built by CI-Brazil's long term presence.

ETPS. While S2A outreach efforts by the coordinator were helpful in communicating results to communities and the general public at the end of the MMAS cycle, earlier ongoing engagement and clear management linkages were even more critical to S2A impacts. Specifically, having scientific results translated into communicable, understandable language and inputted directly into ongoing processes such as Directive Council meetings ensured that the MMAS study results would be used. In Galapagos, the efforts of one of the Ecuadorian PIs complemented the ability of the Charles Darwin Research Station to spread key messages and motivate management and policy change.

Fiji. The Fiji coordinator took the lead role in active knowledge translation. While S2A outreach materials such as t-shirts, posters, and booklets were useful and contributed to scientific messages being heard and understood, the most effective translation was done through in-person community workshops. The workshops worked because they disseminated understandable messages, included MMAS PIs who could speak directly about their research, and engaged community members in participatory activities that linked MMAS study results directly to local livelihoods and traditional management practices (see Table 5 for overall recommendations on S2A).

Table 5
Recommendations for science to action

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1. Establish a S2A coordinator for each region who is responsible for ensuring the science leads to conservation action.
 2. Partner with decision-makers early in the research process to identify information needs so that plans can be tailored accordingly.
 3. Continue to engage decision-makers throughout data collection so that they are interested in results.
 4. As results emerge, identify succinct key messages, consider how they relate to existing conservation efforts, identify the most relevant target audiences and strategize how to disseminate these messages.
 5. Produce materials appropriate to the audience (e.g., white papers for ministers, posters for village chiefs, radio spots for general public).
 6. Discuss key messages with target audiences employing these supportive materials through existing forums (e.g., community meetings, council workshops).
 7. Engage in stakeholders' regular meetings in order to feed findings and insights directly into decision-making as appropriate (e.g., CI Brazil).
 8. Host consultative workshops to bring together scientists and decision-makers.
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Assessment Context

Belize. Belize is a case study in why it is important to understand the institutional context of a country before program initiation. Overall, despite the personal efforts of the core MMAS team, the coordinators, and others, dissemination of scientific results was not as successful as hoped due somewhat to country specific factors. With hindsight, it is clear that the lack of country-wide deliberative processes (combined with no CI office), low scientific capacity at UB, and low cohesiveness of the Belizean NGO sector hindered S2A efforts. If these factors had been considered at the region selection phase, Belize may not have been selected or selected only with much greater on the ground support (a full time coordinator, for example).

Brazil. The experience of MMAS in Brazil emphasizes how large-scale threats ongoing in a country can increase the salience of scientific results. Immediate threats such as shrimp farming served to mobilize CI-Brazil, the Chico Mendes Institute, NGO partners, SOS Abrolhos, and some sectors of the local communities against a common enemy. Once mobilized, these groups needed rigorous scientific data to support their political positions. MMAS data was well suited to fill this gap. Without these threats, MMAS data would still have been useful but possibly less timely and used.

Brazil MMAS also illustrates the power of a cohesive and engaged civil society in pushing environmental and social change. More so than the other nodes, Brazil has a large number of well-funded NGOs, associations, and coalitions, and these civil society members had a perceptible influence on governmental decisions.

ETPS. Panama represents the clearest example among the MMAS regions of why it is necessary to have a firm knowledge of political, socioeconomic, and institutional realities of a country before studies begin. The existence of organizational offices helps to give a (foreign) initiative this information. For example, the knowledge of CI-ETPS and CI Meso Sur that Coiba was constructing its management plan meant that MMAS could engage where its results would be immediately used. Likewise, a strong scientific capacity in Panama ensured that MMAS knew it could rely on local scientists and utilize their knowledge and networks; a strong civil society ensured that MMAS results would be pushed used as leverage by NGOs beyond CI.

Fiji. Experiences in Fiji show that it is important to know if umbrella organizations or other governance mechanisms are operating in a country. Existence of these organizations creates greater opportunities for participation and adaptation of studies to local context. Choosing to work outside of these organizations can cause severe disruptions.

MMAS results in Fiji contributed almost exclusively to decision-making processes at the local scale. Contributing to the national level discussion was more difficult; the government of Fiji had recently undergone a military coup and was seen as quite unstable; thus, FLMMA and MMAS focused mainly on community level engagement. Being aware of the political reality enabled Lo to avoid unproductive efforts and focus on a scale where change could realistically happen (see Table 6 for overall recommendations on context).

Table 6
Recommendations for assessment context

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1. Work where there is institutional commitment and history (i.e., where there is an experienced institutional office).
 2. Work where there is scientific capacity to minimize the need for outside expertise.
 3. Work where there are strong networks of conservationists working across government, NGO, and private sectors that foster capacity building and sharing of information and use of science.
 4. Work in areas that have strong participatory civil societies, areas that are actively engaged in conservation, which may be areas experiencing an environmental crisis, which often galvanizes action.
 5. If working in countries where #1–4 are not present, expect a longer and more difficult time period to bring science to fruition and feed into conservation action.
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Since 2010 for the MMAS Program Regions

Life is never the same when a five-year, over \$2,500,000 per year program, which has provided a myriad of conservation support services as described above, ends. Conservation International, although it retains much of its marine-related work, formally disbanded the MMAS Program after funding ceased. However, the vast majority, if not all, of the researchers, organizations, and others involved in the MMAS Program have continued to work in their respective MMAS regions, with funding from other sources.

The durability of the MMAs in all four MMAS regions—and the general nature of the biophysical, socioeconomic and cultural, and governance outcomes described above—is high even though institutions, both public and private, have continued to come, go, and evolve in all four regions. In Belize, activities such as “Fragments of Hope” and the funding for territorial user rights-based fishery (TURF)-based policy and management have emerged to compliment the MMAs there. In Brazil, a sustainable seafood program has developed to take advantage of the resources of the MMAs in the Abolhos region. In ETPS, the four sub-commissions of the Coiba National Park Directive Council and the fishermen and stakeholder workshop process established under the MMAS Program have continued their work within the Coiba National Park Management Plan, including establishing a stand-alone Fisheries Management Plan for Coiba. In Fiji, MMAs under the basic historic *qoliqoli* structure remain revitalized in part through the efforts of the MMAS Program.

In all four regions, as is reflected in the other sections of this conclusion, events continue to be driven by funding, leadership, technical and professional capacity, and community and stakeholder involvement.

Top Six Pieces of Advice for Global Marine Conservation Science Initiatives

Drawing on the above highlights from the MMAS Program impacts and emerging themes, the following is a consolidated list of advice for future global marine conservation science initiatives.

Build a Framework from the Bottom-Up and from the Top Down

During program initiation, engage regional scientific and conservation experts in prioritization exercises to set the global framework together with global experts. Early engagement of the on-the-ground perspective will contribute to a well-founded framework, facilitate tailoring the framework to local context and ultimately facilitate buy-in to long-term results. At the same time the global experts can help identify globally significant and emerging conservation and scientific priorities, ensure comparability across regions and ultimately help synthesize findings for global learning. However, in doing so, recognize the inherent difficulty in this—between locally customized projects and globally comparable ones and ensure a balance among these needs. For example, MMAS agreed on a core set of ecological, socioeconomic, and governance monitoring indicators for all regions; however, each region added indicators based on their needs and existing datasets.

Tailor to Local Context and Adapt to Evolving Circumstances

Recognize that circumstances will change and that it is important, therefore, to incorporate mechanisms for new scientific questions (e.g., blue carbon) to be addressed and political opportunities to be taken advantage of. Climate change was not a main stream MMA issue when MMAS initiated and, consequently, was not clearly incorporated into the framework. With virtually no budget flexibility for emerging research needs, the program had to seek outside support to conduct vulnerability assessments in the regions, which then benefited from the groundwork of research funded by MMAS. In contrast the S2A budget (15% for each study) was separate from the research budget and not as strictly constrained, which enabled resources to be allocated as needed to integrate the results into decision-making. Scientific agendas need to allow for new projects during the course of the program and the S2A budgets need to be separate from the research budgets and have sufficient flexibility to allow expenditures for S2A to be tailored as needed.

Take advantage of local circumstances and recognize barriers that need to be addressed. In Belize and Fiji there was relatively limited scientific capacity and, consequently, outside experts led some of the studies in these two MMAS regions. However, in order to ensure longevity, mentoring, training and long-term partnering were significant components of these programs. In the case of Brazil, a crisis emerged with a proposal to build the nation's largest shrimp farm in an ecologically significant mangrove area. The MMAS program recognized this crisis as an opportunity to synthesize and convey the research results showing the ecological and economic significance of the mangroves to the commercial fisheries, which helped halt the proposal and get the area declared a MMA.

Ensure Global Learning

From the beginning, consider what key themes the program will inform and then strategize mechanisms for global learning. The core themes for MMAS were MMA socioeconomic, governance and ecological effectiveness, resilience, connectivity, socioeconomic significance and economic development, and governance. MMAS took two approaches. For some themes, research was specifically designed with comparable methods in each of the four regions and the results were then synthesized across the regions. For management effectiveness, the ecological, socioeconomic,

and governance monitoring protocols were designed for comparability across a core set of indicators that then ensured quantitative analysis for global learning. This approach was also taken with the economic valuation and cultural roles studies. The other approach used by MMAS was to conduct global studies that specifically built on case studies from around the world, including but not limited to the four MMAS regions. For example, the Economic Incentives study looked at 27 case studies from around the world of alternative livelihood, fisheries buy-out and conservation agreements to draw out overarching lessons. In addition to peer reviewed publications, the results for each theme were synthesized into a series of 13 booklets and guide-books (available at www.science2action.org) that were each distributed to over 3,000 stakeholders at various forums and by mail and tens of thousands by e-mail.

It is difficult to ensure that people working at one site take the initiative to communicate and compare results with colleagues at other sites elsewhere in the world. There was a strong bias among project participants in each study area that conditions in that place should be regarded as unique and distinct from anywhere else. While this was less true of MMAS scientists than other participants, even MMAS PI's exhibited reluctance to devote energy to cross-site comparison and synthesis. Some but not all of the difficulty can be attributed to technical communication problems (e.g., Skype, and sometimes even the Internet, did not function reliably in Belize during the MMAS program period, and other sites suffered from limited bandwidth). Consequently, the networked learning community envisioned at project conception was very challenging to achieve, and never fully came together.

Partner with Networks of Scientists and Decision-Makers at Local to Global Scales

Identify existing networks that can provide a mechanism for reaching a broad audience to gain input and ultimately disseminate results. These networks are critical for tapping into the latest thinking on science and conservation priorities as well (throughout the program) and then (particularly toward the end) sharing the findings to move the latest science forward and to influence decision-making by reaching as many decision makers as possible. These networks facilitate a broad reach that would be difficult to impossible one-on-one as exemplified by such networks as FLMMA in Fiji, which includes representatives from the MMAs throughout Fiji, NGOs, government agencies, and academia.

Strengthen Capacity through Short-Term and Long-Term Efforts

At a minimum, establish short-term capacity-building measures, such as hiring in-country experts, including junior scientists in research teams, mentoring junior scientists, conducting training workshops and holding seminars to share and discuss protocols as well as results and their conservation implications.

To ensure longevity of the projects and their results, pursue long-term capacity building measures, such as actively engaging in formal and informal regional scientific and conservation network opportunities (e.g., Belize Annual Marine Science Conference, monthly meetings of the Belize Association of Protected Area Managers Organization), providing data to regional databases and institutions, conducting training workshops on data storage, organization, and analysis (e.g., the Ecological Monitoring PI provided extensive training to tourism, fisheries and conservation staff on data management, which helped them manage their data), promoting partnerships between in-region universities and foreign universities with relevant expertise (e.g., Boston University and University of

Belize built a strong exchange program building on the MMAS experience) and pursuing scholarships for junior scientists (e.g., Belizean Eli Romero initiating graduate studies at the University of Belize sister institution, Boston University).

Strategize Science-to-Action (S2A)

Beginning with the program conceptualization phase, establish strong partnerships at global to local levels between scientists and decision-makers. As a key step, identify “science integrators” responsible for these relationships for each region and at the global scale. Recognizing the iterative nature of these tasks, have them work with the team to:

First, identify timely conservation initiatives and the relevant decision-makers at multiple scales (village to national) and across sectors (government, private, NGOs). Discuss information needs with these decision-makers in order to then think through how to design research agendas and then the specific studies to meet those needs in order to ultimately influence conservation decision-making.

Second, work with the scientists to develop workplans that articulate not only the research questions, methodology, anticipated publications and budget (scientists’ draft), but also the anticipated conservation impact (e.g., help zone a MMA), target audiences and how they will be engaged in the research (e.g., Fisheries Department, staff invited to field collection), capacity building efforts and anticipated products (S2A directors draft). Set-aside 15% of each research budget specifically for S2A, which should be retained in the program funds (e.g., not part of the scientists’ grant).

Third, engage decision-makers throughout the course of the research so that as new conservation issues arise, research plans can be modified accordingly (if possible) and so that the decision-makers appreciate and respect the findings once they emerge.

Fourth, as results emerge, work with the scientists to identify the key messages. Rethink the target audiences and relevant conservation initiatives and then consider how the key messages can inform those initiatives. Develop supportive materials (e.g., white papers, presentations, posters, videos) that help articulate the key messages in accessible, engaging formats as appropriate to the target decision-makers. Discuss these messages with the decision-makers in forums appropriate to them, such as association meetings, village council meetings, one-on-one discussions and community workshops designed to influence the conservation initiatives. See www.science2action.org/guidebook for further ideas regarding strategizing S2A.

Conclusion

What we have described above is a program of science and conservation action that was conceptualized in 2003; formally began as a funded program in 2005; and concluded as a funded program in 2010. To revisit the “take home” messages of this program from the introductory article:

1. The MMAs program concept was initiated at a high level in both the marine conservation and philanthropic communities. The initial high-level discussions led directly to the further development and funding of the program concept, primarily between GBMF and CI, and ultimately with worldwide partners in the four regions and elsewhere.
2. During proposal development the program evolved from a strict marine science program into a marine science and conservation program, and from a

primarily biophysical science program to a relatively balanced biophysical and social science and policy program. In the end many of the most significant scientific findings, which were of great use in the translation of the scientific results into policymaking and implementation, were from the social and physical sciences.

3. The commitment to a fully funded professional staff to manage the program, in addition to the input from scientists and top organizational managers, shaped the program. A common error in the conceptualization and implementation of conservation programs is to devote too high a percentage of the program resources to the production, as opposed to the use, of the science. The early commitment of 15% of individual project funding to S2A—a decision made by the Core Team—is an example of how the MMAS program avoided this error. In addition, the overall organization, tracking, and oversight for the program would not have been possible without the dedicated efforts of the Core Team.
4. An early commitment was made to the use of in-country professionals and constituents as integral and primary components of the program. This is the “bottom-up” part of the “Top Down *and* Bottom Up” aspect of the program. Especially in the case of programs such as MMAS, which are time- and funding-limited and circumscribed, the integral involvement of people and institutions “on the ground” is critical to the continuity of the conservation programs over time after the funded program is completed.
5. The decision to focus on MMAs—a concept closely related to “marine spatial planning”—as opposed to a focus on no-take reserves only, was an early program decision that ultimately allowed the full range of biophysical and social scientific factors to come to bear on the development and realization of the marine conservation goals.
6. In all four of the focus areas (five countries: Belize, Brazil, Ecuador, Fiji, and Panama) MMAs were created or assisted through the MMAS program. In all locations, the MMAs were successful in achieving biophysical and socioeconomic and governance objectives, to different degrees and in different ways. This highlights several critical aspects of the use of MMAs:
 - The biophysical, socioeconomic, cultural, and governance objectives should be clear and developed early in the process with integral input from constituents.
 - There are many different “tools” available for policy and management of MMAs including, in the case of fishery management, for example, quotas, size limits, time and area restrictions, and limited access programs. No one combination of these and other measures will be appropriate for all MMAs—the policy and management program must be tailored to the biophysical, socioeconomic, cultural, and governance objectives and constraints of the particular case.
 - No matter what the configuration of the policy and management program for the MMA, monitoring and enforcement is critical to achieving the objectives of the program.

Notes

i. **Ethnicity**, or **ethnic group**, is defined as a socially defined category of people who identify with each other based on common ancestral, social, cultural, or national experience.

“Ethnicity: definition of ethnicity.” *Oxford Dictionaries*. Oxford University Press. (accessed December 28, 2013).

ii. For the purposes of this article, **colony** is defined as a country or an area that is governed by people from another, more powerful, country, and **colonialism** as the relationship between the colony and its governing country.

References

- Banks, S. 2010. Marine Management Area Science: Insights from Galapagos. *Final report from the Charles Darwin Foundation to the CI-MMAS Program (May 200–Dec 2009)*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx please provide access dates for all cited urls
- Bertrand, J. F. 2010. *Core MMA ecological monitoring: Fiji final report*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Campson, T., R. Pomeroy, C. Dahlgren, S. Gopal, L. Kaufman, H. Patel, B. Shank, and J. F. Bertrand. 2010. *Conservation international global management effectiveness study*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Curado, I. 2010. *Socioeconomic and governance assessment: Brazil*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Dutra, G., R. Moura, A. Bastos, D. Klein, N. Secchin, P. Sumida, A. Guth, et al. 2010. *Habitat mapping—Abrolhos*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Fong, S. 2010. *Core MMA socioeconomic and governance monitoring: Fiji final report*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Heyman, W., and P. S. Lobel. 2010. *Spawning aggregation ecotourism: What is the effect of ecotourism on spawning behavior?* Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Jordan, O. 2010. *Socioeconomic and environmental diagnostic of 10 communities in the area of influence of Coiba National Park*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Korovulavula, I. 2010. *Core MMA economic valuation: Fiji final report*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- McField, M., and A. Thompson. 2009. *Evaluating visitor impacts on reef health*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Montenegro, R. 2010. *Valoracion Economica de Los Recursos Turisticos Y Pesqueros Del Parque Nacional Coiba*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Moura, R., and K. Lindeman. 2010. *Cross-shelf connectivity—Abrolhos*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Quiroga, D. 2010. *Galapagos marine area (MMA) socioeconomic and governance assessment: Final report*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx
- Shank, B., and L. Kaufman. 2010. *Effectiveness of marine managed areas of central and southern Belize: Spatial variations in major community processes and the implications for local management success*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmases/pages/what_we_produce.aspx

- Suman, D., J. Mate, and G. Samonte-Tan. 2010. *Coiba National Park governance analysis*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmms/pages/what_we_produce.aspx
- Vega, A. 2010. *Coiba fisheries assessment*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmms/pages/what_we_produce.aspx
- Veitayaki, J. 2010. *Core MMA cultural roles: Fiji final report*. Arlington VA: Conservation International. http://www.conservation.org/about/centers_programs/mmms/pages/what_we_produce.aspx